PART III: FEASIBILITY STUDY

C: NEW LANDFILL SITE SURVEY

PART III-C: NEW LANDFILL SITE SURVEY

1 Introduction

Boracay Island is one of the popular tourist resorts in the Philippines and the number of visitors has increased year by year and the amount of solid waste generated has rapidly increased and become one of the most serious problems on the Island. Following RA9003, the MOM closed the dumping site on Boracay Island and they try to develop a new Sanitary Landfill (SLF) in Brangay Kabulihan. This part includes the results of series of surveys for the development of the Kabulihan SLF.

2 Objectives

The site survey aimed to provide sufficient information and data necessary for the planning for the SLF. Specifically, the objectives of the survey on the new SLF are:

- To generate topographic, cross-sections and longitudinal profiles of the site,
- To establish the geological setting of the site including seismic condition,
- To determine the nature and characteristics of the geological strata,
- To obtain surface water quality upstream, downstream and within the site and groundwater quality at the site both during dry and wet seasons,
- To obtain the presence of landfill gases and record odor at and adjacent to the site,
- To document other relevant environmental conditions including ecological conditions,
- To prepare conceptual design of the new SLF as desk study for the feasibility study,
- To estimate the cost of the development of new SLF,
- To complete an environmental assessment, including appropriate mitigation measures and a suitable management program, and
- Drafting of the report amended from the existing IEE Report.

3. Scope of Works

The survey covered four major components. These were: 1) Topographic Survey, 2) Geological and Geotechnical Survey, 3) Environmental Survey and 4) Desk Study.

3.1 Topographic Survey

The survey consists of ground control and leveling surveys, with sufficient data points acquired to prepare appropriate and accurate topographic maps, longitudinal profiles and cross-sections. National Grid coordinates and an elevation system referenced to mean sea level were used.

Establishment of permanent bench marks, also referenced to national grid at the site on exposed bedrock or permanent structures. Surveying of the entire area is conducted by using a total station and by indicating all identifiable objects/structures on the ground like boreholes, groundwater wells, buildings, etc.

3.2 Geological and Geotechnical Survey

- A desk-based study, to acquire and collate relevant background information in conjunction with the environmental survey.
- A field based study, including field reconnaissance, intrusive site investigations, sample recovery and laboratory testing.
- Investigation of all the available soil profiles and geological information of the site and conduct sufficient field reconnaissance.
- Borehole drilling, sample recovery and subsequent laboratory testing, and installation of ground water monitoring wells.

Set out and record the precise location and elevation of the top of each borehole and groundwater monitoring wells, reference to national grid and mean sea level.

3.3 Environmental Survey

- Conduct a desk-based study, to acquire and collate relevant background information in conjunction with the geological survey; and
- A field-based study, including field reconnaissance, site investigations, sample recovery and laboratory testing and water quality test, meteorological measurement, hydrological and hydro-geological survey, other physical and natural environment survey, social condition survey; and support of public consultation

3.4 Desk Study

Conceptual design for the proposed SLF based upon the produced topographical map and taking into consideration the geological, soil and environmental conditions of the site includes following works:

- description of landfill type to be constructed including comparison of technical alternatives
- facilities to be incorporated in the design (locations of the facilities shall be shown on the layout plans)
- estimation of the capacities of the total landfill site and the proposed individual facilities
- preparation of development schedule, including any necessary land and dwelling acquisition, and other official procedures including Environmental Compliance and Certificate (ECC) procedures
- estimation of development costs based upon the derived bills of quantity, and preparation of scaled and dimensioned drawings and layout plans.

4. Methodologies

4.1 Topographic Survey

4.1.1 Reconnaissance Survey and Coordination

As an initial activity, and to familiarize with the site condition as well as to ensure the safety

of personnel and equipment, the survey team undertook a brief reconnaissance survey in each site. Coordination with the local officials of Barangay Kabulihan was undertaken.

During the reconnaissance survey, locations of the control stations established by the National Mapping and Resource Information Authority (NAMRIA), Philippine Coast and Geodetic Survey (PCGS) or the Philippine Reference System (PRS) were also identified.

4.1.2 Establishment of Horizontal and Vertical Control

From the NAMRIA/PCGS control stations with known established positions and elevations, permanent bench marks were established around the area for horizontal and vertical control. From these secondary control stations, all the survey points (topographic & cross-section) were observed. A high precision Global Positioning System (GPS) instrument was used to establish both the positions and elevations of the secondary control points that were used throughout the survey works.

4.1.3 Planimetric and Contour/Topographic Survey

Using a Total Station Instrument, oriented to a direction/data earlier from the GPS, all positions where the data points were observed and recorded in a data logger, the following the changes of the ground surface or landscape. In order to produce a planimetric and contour map with the required contour interval, the density and distribution of spot elevation were observed as many as possible. All planimetric features and structures which are visible or identifiable or interpretable from the ground including land use features, trails, boundaries of wooded areas, fences, orchards, buildings, roads, municipalities, cities and other features were surveyed, measured and recorded. Eight cross-section/profile survey is conducted across and along the slopes at 10 meters interval.

4.2 Geological and Geotechnical Survey

Basically, surface and sub-surface geological investigation is the scope of work undertaken which involve geologic survey by Brunton compass and meter tape method and core drilling of eight (8) bore holes, drilling of four (4) groundwater observation wells, excavation of six (6) test pits and infiltration test of four (4) sites.

This report incorporates all the field procedures and results adopted in the investigation. It is believed that the level of information is sufficient to judge the engineering properties of the overlying and underlying foundation materials.

4.2.1 Drilling and Core Sampling Methodology

The drill hole is advanced through overburden materials by wash boring and by dry coring method. To start, short piece casing is driven into the ground that also prevents the collapse of the overburden materials. The casing is normally cleaned up by means of a chopping bit attached to the lower end of the drill string. Drill rods are added to the drill string as the depth of boring increases. Casing are also driven to prevent the collapse of the boreholes at

sections of unstable soil is located.

When drilling is encountered the weathered bedrock, normally rotary drilling /coring operation is conducted by using the conventional NQ series double tube type core barrel with impregnated core diamond bits.

Extrusion of the core samples from the inner core barrel is made carefully. All core samples retrieved are carefully placed and arranged in standard, properly made wooden core boxes with cover according to depth provided with wooden spacers, to mark the beginning and end of each drill runs. The lengths of cores recovered are measured over the core run employed in order to come up with a recovery ratio expressed as Percentage Core Recovery.

4.2.2 Standard Penetration Test Methodology

Standard Penetration Test (SPT) was conducted in soft overburden materials, at every one (1) m interval in soil and weathered rock layers. It was performed by using a standard split-spoon sampler having 2" (50mm) OD and about 71 cm length. The split-spoon sampler was attached at the bottom of string of AW rods. It is driven into the entire depth of the sampling section (except when refusal is recorded within the section) by means of a 140 lb hammer free-falling along a guide rod from height of 76 cm onto a jar plate connected at the top of the string of AW rods. This procedure was carried out by using automatic tripping mechanism. It is driven to an initial penetration of 6 inches to by pass the disturbed soil materials at the top of the sampling section. The number of blow counts for the seating drive was recorded. The sampler is then advanced another 12 inches and the corresponding number of blow counts for each 6 inches of penetration is recorded. The total number of blow counts for the last 12 inches of penetration is known as the standard penetration resistance (N-value) of the soil. Correlation has been developed between the SPT N-value and soil parameters, which can be used for bearing capacity estimation. Tables C.4.2-1 and C.4.2-2 show the correlation between the granular and cohesive soil and the penetration resistance (N-value) recorded.

Table C.4.2-1 Correlation Between SPT and Soil Consistency for Granular Soil

Description	Very Loose	Loose	Medium	Dense	Very Dense
Relative Density Dr.	0-0.15	0.15-0.35	0.35- 0.65	0.65-0.85	0.85-1.00
Standard Penetration Test #N-Value	0-4	5-10	11-30	31-50	51 Up
Approx. Angle of Internal Friction Angle	25^0-28^0	28^0-30^0	30^0-35^0	35^0-40^0	40^0-43^0
Approx. Range of Moist Unit Weight, (KN/m^3)	11.0-15.7	14.1-18.1	17.3-20.4	18.3-22.0	20.4-23.6
Submerged Unit Weight (KN/m^3)	9.4	8.6-10.2	9.4-11.0	10.2-13.4	11.8

Source: JICA Study Team

Table C.4.2-2 Correlation Between SPT and Soil Consistency for Cohesive Soil

Description	Very soft	Soft	Medium	Stiff	Very Stiff	Hard
Unconfined Compressive Strength, Qu (KN/m^2)	0-23.9	23.9-47.9	47.9-95.8	95.8-191.6	191.6-383.1	383 -UP
Standard Penetration Test #N	0-2	3-4	5-8	9-16	17-32	33-UP
Approx. Range of Standard Unit Weight, Saturated (KN/m^3)	15.7-18.9		15.7-20.4		18.9-22.0	20.4 +

Source: JICA Study Team

After the conduct of the SPT on each test interval, the string of rods and split-spoon sampler are pulled out of the hole and the recovered disturbed sample is retrieved and placed in a moisture tight plastic bag for further visual examination and laboratory tests.

4.2.3 Permeability Test Methodology

(1) Water Pressure Test

In bedrock water pressure tests is conducted by descending method or using single packer assembly. The descending method is normally performed on boreholes drilled in broken ground or when there is danger of hole cave-in after drilling and washing. In addition, percolation tests were conducted on particular test sections of selected boreholes where water pressure cannot be established.

In the descending method, after drilling through the bottom of the test section desired, the drilling water is made to dissipate into the rock for at least 24 hours. The static groundwater level is measured together with the hole size and length of the packer assembly. Then the core barrel and string of drill rods are pulled out and the packer assembly is lowered down. The single rubber packer is set on the top of the test section. The section to be tested and the corresponding height of the instrument are recorded. The water inflow is determined from the water meter readings made at 5 minutes interval for all of the stages. The applied pressure is dependent on the depth of test section and the nature of the encountered bedrock.

(2) Percolation Test

Permeability test by open-end falling head method was performed in overburden formation. Hole advance was made either wash boring, rotary drilling or by use of chopping bit. Hole advance was made at any desired depth depending on the layer to be tested. Hole was properly cleaned to remove fine particles that could affect the permeability of the material. Before the start of the tests, the depth of casing, size of the casing, groundwater level and length of the open hole was recorded:

Fill the casing with water. Record time (To = 0) and drawdown (Ho = 0). Let the water in casing drop , measuring the drawdown at regular time or depth interval (t1,H1; t2, H2; t3, H3) until the water level is constant.

4.2.4 Infiltrometer Test Methodology

Field permeability using infiltrometer cylinder (25cm dia. x 35.7 H) was conducted on soil covering inside the proposed site of new SLF. Before testing layers with organic was stripped and than press the infiltrometer into ground of about 20cm. Filled with clean water the infiltrometer cylinder and then note the drawdown of water inside the cylinder for 2min., 5min., 8min., 10min., 15min., until within 2 hour period.

4.3 Environmental Survey

4.3.1 Water Environment

(1) Water Quality for Surface Water and Groundwater

Water quality monitoring was programmed both for surface and groundwater. In shallow stream, water is collected using a bucket until the desires volume of sample is attained. After sampling, the containers of each sample were properly labeled/coded to identify the location, date and time of sampling. Standard volume of samples, types of containers and preservation were strictly followed. The required storage or preservation time of samples, which normally depends on the transportation time to the laboratory was strictly followed. The monitoring sites are shown in Figure C.4.3.1 while the parameters monitored are summarized in Table C.4.3-1.

Table C.4.3-1 Parameters for Water Quality

1	Temperature(on-site observation)	14	Sulphate
2	pH (on-site observation)	15	Sodium
3	Color	16	Potassium
4	Turbidity	17	Calcium
5	DO	18	Magnesium
6	TSS	19	Iron
7	TDS	20	Lead
8	Conductivity (on-site observation)	21	Copper
9	Oil/Grease	22	Cadmium
10	BOD5	23	Chromium
11	COD	24	Total Mercury
12	Chloride as CL	25	Organo-Phosphate
13	Ammonia Nitrogen	26	Total coliform count

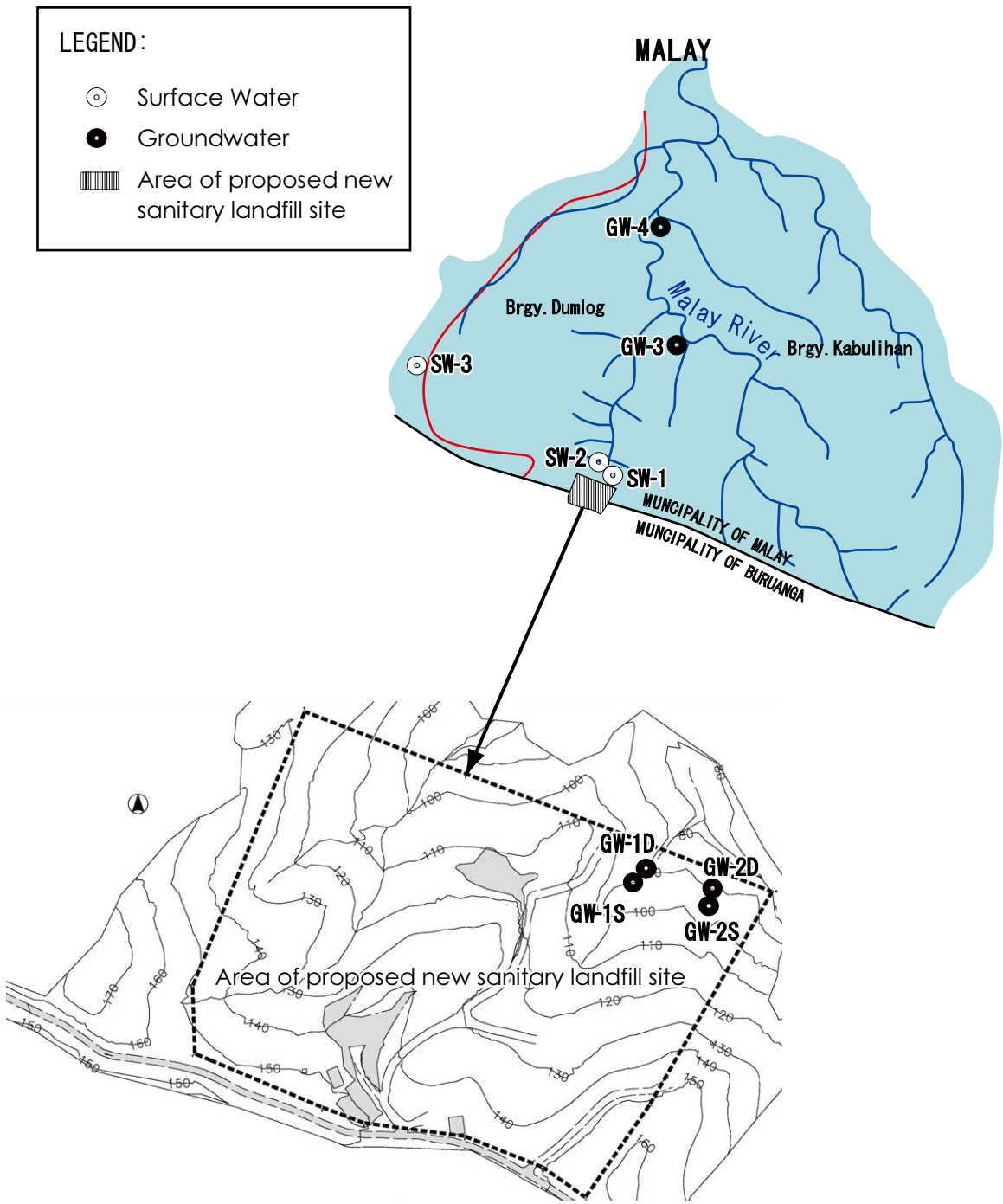


Figure C.4.3-1 Location of Water Sampling

Source: JICA Study Team

4.3.2 Air Environment

1) For the ambient air quality and noise monitoring, the levels of different gases at the proposed landfill site and around the area was observed using a portable gas meter and noise meter.
2) The gases required to be observed, are as follows:

Table C.4.3-2 Ambient Air Quality and Noise Monitoring

Parameter	Sampling Time	Method of Sampling/Analysis
H_2S	Daytime	Portable gas detector
CH_4	Daytime	-do-
CO_2	Daytime	-do-

Source: JICA Study Team

3) Levels of gases were directly observed from the portable gas meter.
4) Initial readings were observed during a walkthrough on top of the waste.
5) Succeeding measurement will be done on the drilled boreholes (waste area only).
6) For the gasses observed, measurements away from the site (towards the settlement area and in the nearest community) were done to establish the different level of gasses within the prescribed 3 km radius impact area.
7) Noise level measurements were done in the site and within the 3 km radius using a sound meter.
8) Recording of foul odors as observed by workers in the area as well as communities within the 3 km radius was documented by direct interview. The observations were correlated to the monitored gasses and composition of wastes in the area.
9) In addition, community interviews on observed and experienced odor in the area were done as part of the Natural Survey conducted.

4.3.3 Natural Environment

A faunal and floral assessment was conducted in Barangay Kabulihan, specifically in areas where the proposed landfill site was located. The assessment was augmented by a Natural Survey undertaken in July 17-25, 2007. The "Natural Survey" undertaken made use of a questionnaire that was divided into 4- parts focusing on the present condition of the physical (air, groundwater), biological (flora and fauna) and social/human environment (health, income sources, social acceptability of the plan) of the area within and adjacent to the dumpsite.

Data gathering for floral and faunal assessment was undertaken using three methodologies: a community resource mapping for Barangay Kabulihan, the location of the proposed engineered landfill; transect walks with selected community members, and a natural survey involving 177 respondents. The initial assessment/reconnaissance was done last June 11, 23, 24 and 25, 2007 for the terrestrial ecosystems. The reconnaissance survey was conducted in the terrestrial area and surrounding coastal waters.

The community resource mapping aimed to recreate the one dimentional picture of Barangay Kabulihan with members of the community. Information indicated in the map are: road networks, bridges/ foot bridges, water bodies, boundaries of sitios, location of social services, dugwells, pumps, general land uses, and settlement areas.

Transect walks were done to verify the existence and actual locations of information indicated in the community resource mapping as well as to survey flora and fauna in the direct impact area. Barangay officials acted as guides. Members of the community joined

the transect walk group. To complete the triangulation, a Natural Survey was also undertaken to communities purposely selected as they will be impacted to by the new landfill.

(1) Flora

A review of several secondary data on the vegetation was initially done. Comprehensive Land Use Plan for Malay Municipality 2000-2010, June 30, 2000. On top of this, actual field surveys were conducted in June 11-25, 2007 July 17-25, 2007.

The survey was conducted by randomly establishing 1.0 kilometer transect lines in the study area. The observers walked through the entire transect and noted the information such as species name, habitat and land use. Whenever difficulties or problems in identifying floral species were encountered by the observer, distinguishing morphological and/or behavioral characteristics were noted. Gathered information was then used as reference and/or points of comparison with field guides and other documentation.

Since the survey did not take into account statistical information, but simply focused on the inventory and identification of plant species including resource uses, an informal type of meeting was also initiated, which led to a discussion type of information extraction. The respondents were the KIs and in some occasions, settlers of communities near the sampling sites. Questions on flora in the project site were also included in the Environmental survey form administered by hired field enumerators.

(2) Wildlife/Fauna

The site was visited on June 11-13, 2007 to assess its wildlife habitat condition and biodiversity status, specifically focusing on amphibians, birds, mammals and reptiles. This was supplemented by interview of several local informants as well as the result of the Natural Survey undertaken on July 18-25, 2007. Information recorded during the field observation of birds includes sightings and birdcalls. Utilization of wildlife by local inhabitants was also noted down.

4.3.4 Human Environment

The characterization of the existing socioeconomic condition of the project area primarily made use of the extensive data generated in the secondary information available from the concerned LGU and local-based national agencies as well as related studies undertaken of the island. With these available information, the human/social component of the survey focused on validation, updating and further expanding/strengthening the basis for the assessment with particular emphasis on some data gaps on the new area and delving on key issues and concerns that may arise on its development plan. Key Informant (KI) interviews were conducted including some unstructured group interviews. The KIs comprised of persons in the locality who are knowledgeable of the issues. An environmental survey was likewise undertaken using a 5-paged standardized survey instrument to elicit data on the acceptability of the project and to further identify additional issues and concerns related to the proposed project.

(1) Data Collection Tools and Sampling

A rapid appraisal was done in a span of two months employing both primary and secondary data collection methods. Data gathering and baseline characterization were divided into two major areas: a) the Direct Impact Area covering the Malay Barangays of Kabulihan & Dumlog, and Buruanga Barangays of Mayapay & Alegria; and b) Secondary Impact Areas of Malay Barangays Naasog , Poblacion, Balusbos, Motag, Cubay Sur, Cubay Norte, Sambiray & Caticlan and Buruanga Brarangays Poblacion & Balusbos. The following were utilized for all areas:

- Natural Survey using Standardized Questionnaire (Quantitative and Qualitative)
- Key Informants (KIs) (Qualitative)
- Transect Walks (Quantitative)
- Community Resource Mapping
- Unstructured Group Interviews (Qualitative)
- Secondary Data (Quantitative)

Secondary data were utilized such as published secondary sources and documents from some line agencies operating in the Municipality of Malay. The following were conducted showing the total number of participants in the Study:

1. Natural Survey – 177 respondents:
   1.1 Malay Municipality
   36 respondents from Kabulihan, 16 respondent from Dumlog and 12 respondents from Poblacion, Motag, Cubay Sur, Cubay Nort, Sambiray and Caticlan
   1.2 Buruanga Municipality
   a. Mayapay 13
   b. Alegria 10
   c. Balusbos 8
   d. Poblacion 8
2. Key Informants – 4 respondents
3. Unstructured Group Interviews - 1

4.4 Desk Study

The desk study was conducted in accordance with "Technical Guidebook on Solid Waste Disposal Design and Operation, First Edition 2005" issued by the DENR and the National Solid Waste Management Commission (NSWMC). A site assessment survey was conducted with an ocular inspection to determine the general condition of the proposed site and the environmental hazards were evaluated. Engineering data needed in the development of the new landfill were gathered by the Study Team. Topographic survey of the proposed site was conducted after which sections were generated on the topographic map using the AutoCAD Land Desktop Software. Profiles were also generated using the computer on selected locations deemed ideal by the designer/engineer for the landfill site. Key points considered were the estimated capacity of the proposed landfill, slope stability of the area and proposed structures, depth of excavation, environmental protection, land topography and geological data. The volumes of excavation and landfill capacity were

calculated with the Auto CAD Land Desktop Software and based on the layouts and design levels of excavation of the various options, imaginary landfill finish profile and existing ground topography. Series of cross-sections were generated on selected key points and cross-section areas were determined using the computer software. With these areas as inputs, the volumes of excavation and expected landfill capacity (amount of waste) were calculated by end area method using MS Office software (Excel). Costs of excavation for the various options were computed based on the computer generated section end areas and volumes. The bill of quantities was derived using the basic assumptions on the conceptual design and cost estimates were determined using the unit costs.

5 Results

5.1 Topographic Survey

5.1.1 Permanent Control Stations

From the PCGS control stations with established positions and elevations, eleven (11) permanent benchmarks or control stations were established around the area for horizontal and vertical datum reference. A concrete monument was established in each station either on top of a permanent or stable structure like concrete or rock. A high precision Global Positioning System (GPS) instrument was used to establish both the positions and elevations of the secondary control points that were used throughout the survey works.

Table C.5.1-1 Established Control Stations in the Site

Station No	Northing	Easting	Elevation, Meter	Remarks
BSL-01	1324783.784	383245.656	66.576	Southern side of the area. Estab. On top of concete post
BSL-02	1324849.677	383299.745	51.867	At the base of waste
BSL-03	1324898.912	383288.331	40.407	At the base of waste
BSL-04	1324968.41	383270.756	59.848	Along the road on top of a rock near groundwater well # 1
BSL-05	1324896.94	383197.01	57.962	Along the road on top of concrete post in the northern side of the area

Source: JICA Study Team

Using a Total Station Instrument, oriented to a direction/data earlier from the GPS, all positions where the data points were observed and recorded in a data logger, the following the changes of the ground surface or landscape. In order to produce a planimetric and contour map with the required contour interval, the density and distribution of spot elevation were observed as many as possible.

All planimetric features and structures which are visible or identifiable or interpretable from the ground including land use features, trails, boundaries of wooded areas, fences, orchards, buildings, roads, municipalities, cities and other features were surveyed, measured and recorded. In addition, all the boring locations and other in-situ tests like the movable stake monitoring and soil depth and strength were also surveyed and located in the topographic map. Cross-section/Profile survey is conducted across and along the slopes at 10 meters interval.

5.1.2 Result of Topographic Survey

A topographic plan was generated for the entire area surveyed totaling 10.8 ha with contour interval of 1-m. Eight (8) cross-sections and the same numbers of longitudinal profiles were surveyed in directions of West to East and North to South, respectively. The spacing of the sections is twenty (20) meters. The sections are plotted in a scale of 1:500 m both for horizontal and vertical.

5.2 Geological Survey

5.2.1 Desk Based Survey

(1) General Geology

The project area is partly underlain by Sta. Cruz Formation (Pliocene to Pleistocene). Sta. Cruz Formation was originally designated by Cruz and Lingat (1966) as Sta. Cruz Sediments for the rocks that crop out west of Sta. Cruz along the Pandan-Nabas road at the neck of the peninsula. Exposures are also found at the western side, from west of Libertad to Malay. The formation consists of conglomerates, mudstone, siltstone, shale and Pliocene-Pleistocene reefal limestone. The conglomerate is bedded, poorly sorted, poorly to fairly consolidated with subangular to subrounded granule to cobble size clasts of metamorphic rocks. The sequence unconformably overlies the Fragante Formation, composed of massive, amygdaloidal, agglomeratic, and partly brecciated to basaltic lava flows intercalated with shale, conglomerate, and limestone.

(2) Stratigraphy

Regional mapping and aerial photo-interpretation undertaken by the Bureau of Mines and Geology have relegated the rocks into several groups of formations as shown below and is assumed as the generalized stratigraphic section of the region:

Table C.5.2-1 Stratigraphy of the Landfill Area Relative To Buruanga Peninsula

GEOLOGIC TIME					LITHOLOGY AND FORMATION (Francisco, 1956 and Cruz & Lingat, 1966)	
MILLION YEARS	ERA	PERIOD	EPOCH	AGE		
.01	CENOZOIC	QUARTERNARY	HOLOCENE		ALLUVIUM	ALLUVIAL DEPOSIT
1.8			PLEISTOCENE	LATE	FLUVIAL GRAVEL	
				EARLY		STA. CRUZ SEDIMENTS
5.0		TERTIARY	PLIOCENE	LATE	CALCAREOUS SHALE , CONGLOMERATE, & CORALLINE LIMESTONE	
				EARLY		
22.5			MIOCENE	LATE	BASALTIC LAVA FLOWS, INTERCALATED WITH SHALE, CONGLOMERATE & LIMESTONE	FRAGANTE FORMATION
				MIDDLE		
				EARLY		
38			OLIGOCENE	LATE		
				EARLY		
55			EOCENE	LATE		
				EARLY		
65			PALEOCENE	LATE		
				EARLY		
141	MESOZOIC	CRETACEOUS		LATE	PATRIA QUARTZ DIORITE	
				EARLY		
195		JURASSIC		LATE	BURUANGA METAMORPHIC COMPLEX	
				MIDDLE		
				EARLY		
250	PALEOZOIC	TRIASSIC		LATE		
				MIDDLE		
				EARLY		
280		PERMIAN		LATE		PATRIA QUARTZ DIORITE
				MIDDLE		
				EARLY		BURUANGA METAMORPHIC COMPLEX
		CARBONIFEROUS				

Source : Geology of the Philippines , Vol. One, BMG

(3) Regional Geologic Structures

Buruanga Peninsula located at the northwestern margin of the area is considered by F. Francisco to be an uplifted block with the peninsula neck. This narrow north-trending valley is now mostly covered with Pleistocene sediments, except where erosion has exposed the older rocks. The two rock formations flanking sides of the valley are widely divergent in age and lithology. The Miocene Fragante on the east and the pre-Tertiary Buruanga Metamorphic Complex on the west. The less resistant member of the Metamorphic Complex on the west side were deeply eroded and now underlie the valley, learning the more resistant marble further must be with a prominently higher relief. Above the eroded metamorphic are erosion remnants of the (Fragante) basalt which is overlain by more extensive Pleistocene sediments and coralline limestone covering trace of the fault. From these indications the presence, relative displacement and general trend of the marble along

the valley's western edge and brecciation of the basalt along the eastern edge are other clues; the physiographic also suggests the presence of high angle faults cutting across the peninsula along northeasterly trends. The anticline, synclinal and fault line structures indicated west of the peninsula's neck follow northeasterly to northwesterly directions.

(4) Seismicity

A total of seventy five (75) available earthquake records from the Philippine Institute of Volcanology and Seismology (PHIVOLCS) with magnitude of more than 3 and located within 75 km radius from the new landfill site were examined. The records showed that the largest earthquake occurred in June 14, 1990 with magnitude of 7.0 and epicenter located at approximately 68.38 km from the landfill site. The second highest magnitude of 6.70 occurred in June 15, 1928 with epicenter located approximately 14.50 km from the SLF.

Considering the earthquake magnitude and the proximity of its epicenter to the landfill area, it is reasonable from the engineering stand point of design, particularly the landfill area, to adopt the maximum earthquake magnitude of 7.0 in determining the maximum peak ground acceleration for the derivation of design earthquake coefficient.

Based on Iwasaki's formula, the earthquakes' respective ground acceleration and corresponding return periods are computed using their distance and magnitude. These values are then plotted where the expected ground acceleration for a required return period can be obtained from the graph.

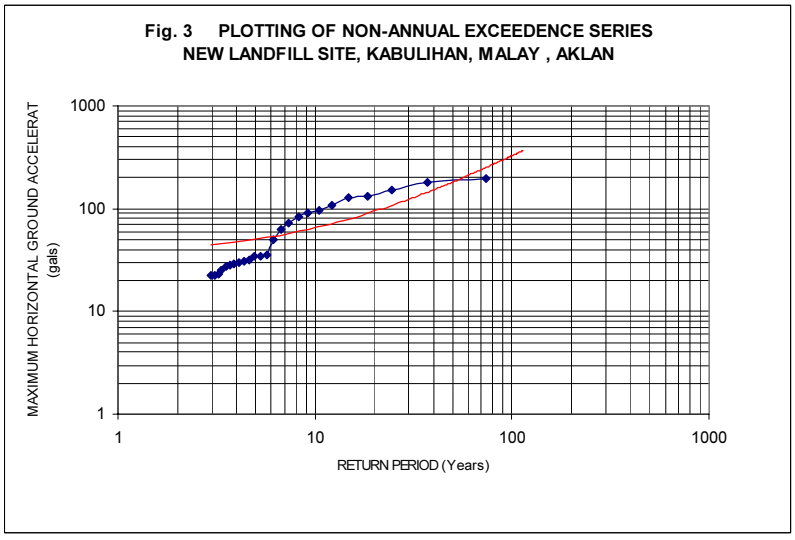


Figure C.5.2-1 Expected Ground Acceleration
Source: JICA Study Team

The subsurface classification of the foundation materials, which is underlain chiefly by recent deposit consisting of moderately compacted silt, sand, clay and weathered boulder rock fragments and totally weathered /residual soil (terra rosa), falls under the Medium-Hard Soil category. Using the study made by PHIVOLCS, which was based mainly from the attenuation formula of Fukushima and Tanaka, the peak ground acceleration would be approximately 0.39 g as shown in the Delineated Acceleration Map for Medium & Hard Soil

(Figures C.5.2-2, 3 and 4). The derived g value (0.204 g) is comparatively lower than the g value obtained from the abovementioned figures.

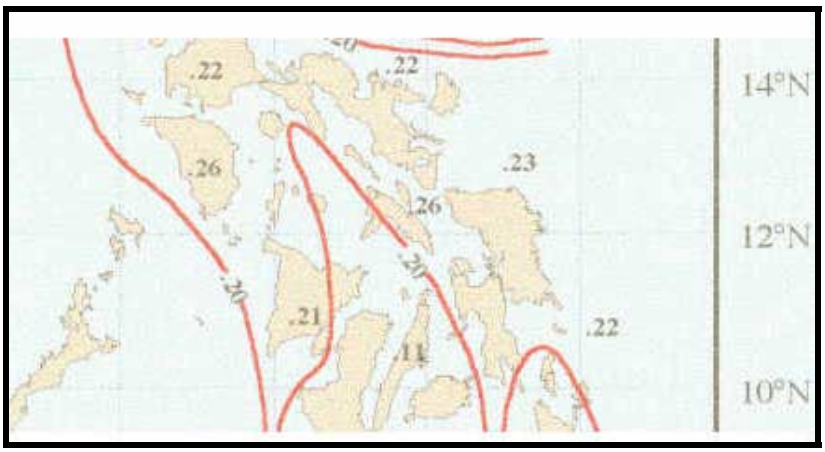


Figure C.5.2-2 g Factor Contour Map for Rock

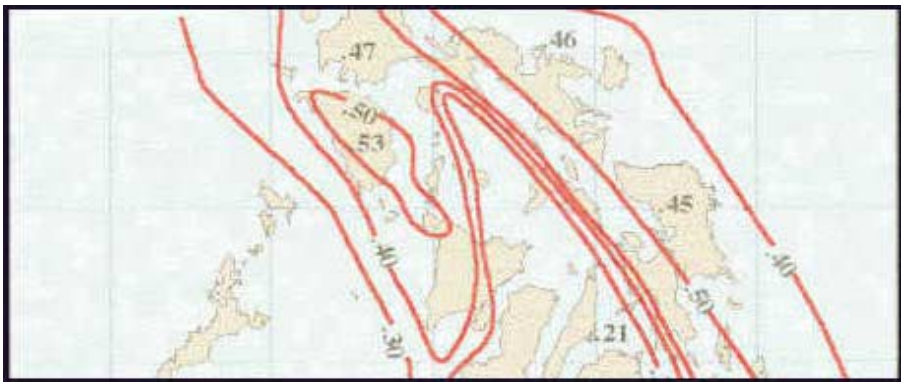


Figure C.5.2-3 g Factor contour Map for Hard Soil

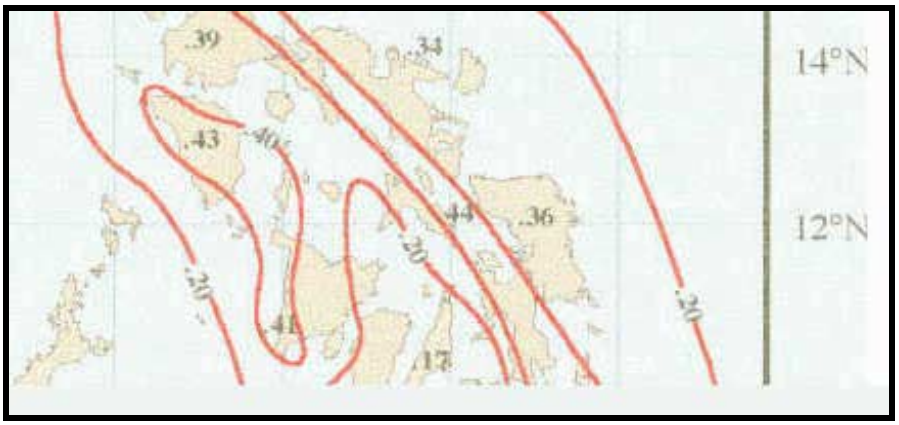


Figure C.5.2-4 g Factor Contour Map for Medium Soil

Source: PHIVOLCS

(5) Seismic Related Hazard

Seismic hazard is the risk of injury or death to man and damage or destruction of engineering structures by ground motions caused by faulting and earthquakes. Infrastructure facilities and the environment can be affected by an earthquake. The degree of impact on structures depends upon such factors as the magnitude and characteristics of the tremor, the response

characteristics of the geologic units upon which the facility is situated and of the facility itself, and the proximity of the facility to the energy source (seismic generator). The damage is caused by shaking and ground rupture generated by an earthquake. Some of this damage such as landslides, floods, liquefaction, etc. could result in numerous other types of hazards.

In the landfill site, the only identified seismic related hazard so far is slope failure. The factors causing the failure are related to the physical properties of the slope material and the subsequent history of crustal movements, erosion and weathering processes. Some of these factors are removal of lateral support, surcharge, transitory earth stresses, removal of underlying support, inherently weak material, orientation of the slope, amount of weathering, and changes in inter-granular forces, e.g. seepage force. Topography and drainage likewise play an important role.

Increase in seepage force or pore water pressure build-up within the slope during heavy rains through percolation or infiltration in addition to the orientation of the toe of the slope caused by the cut slope and the nature & condition of the soil are the factors that causes the slope failure.

(6) Geologic Condition

The sanitary landfill area is blanketed of considerably thick colluvial deposit (gravelly clay, sandy silt, silty sand & bouldery clay/sand/silt). Underlain by a thick totally weathered/residual soil (terra rosa) as indicative of moderately to strong tropical weathering from Sta. Cruz and Fragante formation (Interbeds of basalt flows, shale, siltstone, mudstone and conglomerate). Massive basalt outcrops are generally exposed along creek/river shoals. This rock unit of Fragante Formation is generally very dark gray color and with distinct volcanic flow bedding in places, trending to N 50-100 E and dipping from 40 to 60 degrees to the Northwest. Bed spacing is measured from 10 cm to 30 cm. Partings between beds of the rock unit were noted to be open and interconnected making this rock unit as pervious and relatively high percolation rate. Several joint sets, shears and fractures were measured as follows:

J-1 Strike-approximately N 60^0 W & dip-approximately 40^0 NE
J-2 Strike-approximately N S & dip-approximately 35^0 E
J-3 Strike-approximately EW & dip-approximately 65^0 N
J-4 Strike-approximately N 10^0 E & dip-approximately 40^0 NW
J-5 Strike-approximately N 30^0 E & dip-approximately 30^0 SE
J-6 Strike-approximately N 10^0 W & dip-approximately 70^0 NE
J-7 Strike-approximately N 10^0 W & dip-approximately 50^0 NE
J-8 Strike-approximately N 40^0 E & dip-approximately 60^0 NW
J-9 Strike-approximately N 20^0 W & dip-approximately 60^0 NE

Most of the joints and shears are steeply dipping (40^0-70^0) to vertical with dips mostly towards to the east or it is related to the high angle fold plunging to the east.

(7) Slope Stability

Based from the surface mapping and laboratory tests on the landfill area soil cover; the relationship between friction angle and cohesive strengths and stability of slopes of various materials were established as follows:

- Slope Height: 4-8 meters
- Slope Face Angle: 60-80 °
- Estimated Cohesion: 21.5 kPa
- Estimated Friction Angle: 19°
- Typical unit Weight of soil covering: 17 kN/m^3
- Unit Weight of Water: 9.8 kN/m^3
- Computed Horizontal Acceleration: 0.204 g

Since some of the Slopes section is already cut, factor of safety is definitely less than 1. Imminent slope failure is noted on the access road cut due to steepness of the existing slope angle.

(8) Hydro-geological Condition

Surface mapping and reconnaissance along the immediate vicinity of the new landfill site indicates that the area is widely underlain by fractured basalt (Fragante Formation) where groundwater within the rock unit is relatively developed. Under these condition, highly fractured basalt yields from less than 15 to 36 liters/minute and permeability (K) values is in the order of 10^{-5} m/sec (BMG , R.I. No. 100), February 1980. Unfortunately, based from the core drilling investigation only an upper (fractured) proportion of the underlying basalt (7-12m) of this resource will be an aquifer. The underlying layer is fresh and massive basalt which is non-bearing aquifer. During rainy season, surface run off along natural water ways is very high due to relatively low percolation rate of the thick overburden materials (silty clay, gravelly silt, clayey silt & bouldery/gravelly clay).

The presence of a highly pervious overburden material (silty sand/sandy silt) in the slope mass will increase the influx of surface and subsurface water toward the slope face. This could cause the build-up of a considerable hydrostatic head and would act as a driving force of considerable magnitude to trigger slope failures during rainy season. Poor drainage on the slope will further destabilize the slope mass by increasing seepage force.

The interface between the thick overburden and the highly/closely fractured basalt rock unit of the fragante formation is the probable aquifer within the area of study. The massive basalt underlying the highly fractured basalt is impermeable enough with approximate permeability of not greater than 10^{-5} m/sec to prevent any downward migration or vertical leakage of groundwater, at this depth the permeability diminish due to wide tight fractures/joints and the absence of significant geologic structures (sheared & fault zone) which serves as the migration path of groundwater.

Groundwater recharge depend on the amount of rainfall, data of evapo-transpiration and on the catchments/drainage area. Recharge rate is moderate to high due to the highly fractured basalt and loose colluvial /residual soil deposit.

5.2.2 Field Survey, Sampling and Laboratory Analysis

(1) Core Drilling exploration

Subsurface exploration by core drilling was undertaken to determine the engineering properties of overburden materials. A total of eight bore holes with an aggregate depth of 160.39 meters and four observation wells with a total depth of 80 meters was drilled .Table 5.2-2 shows the summary of the boreholes drilled, depth and elevation. A location map is also presented showing the boreholes drilled at the new landfill area.

Table C.5.2-2 Summary of Boreholes Drilled

Borehole Number	Total Depth Drilled (M)	Elevation (M)
BH-1	20.10	138.17
BH-2	20.04	138.40
BH-3	20.08	112
BH-4	20.13	127.21
BH-5	20.09	102
BH-6	19.65	108.77
BH-7	20.62	121
BH-8	19.68	147.24
GWD-1	25.00	89.47
GWS-2	15.00	90.20
GWS-3	15.00	86
GWD-4	25.00	86.20

Source: JICA Study Team

(2) Geologic Logs of Drill Holes

BH-1, which is located at the central upper slope of the landfill area drill to the depth of 20.10 meters from the ground surface. Eight (8) meters from the surface is made of alternating layers of silty sand, gravelly sandy silt and mixture of unconsolidated gravel, pebble, sand and silt. The underlying moderate to extremely weathered bedrock is alternating layers of basalt flows, shale, mudstone, siltstone and conglomerate (Fragante Formation). Core recovery of this borehole ranges from 7% to 28% indicating very poor rock quality designation.

The borehole drilled at the temporary dumpsite area, BH-2 (20.04m), encountered a nine (9) meters thick gravelly clay materials and underlain the same bedrocks (Fragante Formation). Core recovery ranges from 4% to 28%.

Borehole BH-3 (20.08M depth), which is located mid-right portion of the landfill area, penetrated through a fifteen (15) meters thick overburden materials composed essentially of layers of reddish silt clay and silty sand that are dense to very dense.

Borehole BH-4 (20.13M depth) was drilled at the mid-right portion of the landfill area encountered the same bedrock after seven (7) meters thick of reddish layers of silty clay and gravelly silty clay. The underlying bedrock is poor rock quality as depth increase poor core recovery is noted.

Borehole BH-5 (20.09M depth) is located at the northeastern portion of the new landfill area. The thickness of layers of gravelly silty clay and fat clay is about 18.65M. Poor core recovery ranges from 9% to 33 %.

Borehole BH-6 (19.65M depth) was drilled at the midsection of the landfill area. It is made of layers of silty/ clay gravel, silty clay and totally weathered bedrock. Poor core recovery ranges from 8% to 28%.

Borehole BH-7 (20.62M depth) is located upper midsection of the landfill area. The thickness of overburden is 13 meters. It is made of medium dense to very dense layers of silty sand, gravelly sandy silt, and gravelly silty clay.

Borehole BH-8 (19.68M depth) is located at the southwestern upper most section of the landfill area. It is made of medium dense to very dense layers of gravelly silty clay, gravelly/ clayey silt and silty/clayey gravel.

Boreholes GWD-1, GWS-2, GWS-3 and GWD-4 are located at the foot slope of the landfill area. It is covered with silty clay soil. It is underlain by basalt flow (Fragante Formation). The bed rock is closely fractured/jointed, and slight to moderately weathered.

(3) Standard Penetration Test Results

The SPT was conducted to determine the overburden bearing capacity/strength based from resulting N-values. The SPT results of all the boreholes conducted are shown in Table C.5.2-3. The SPT data reveals that there is an increase in bearing strength of the soil and deeply weathered rock in deeper portions. The overburden soils encountered across the site is made generally of reddish to yellowish gravelly silty and clayey silt of medium plasticity, and silty sand of very low to no plasticity. The bedrock encountered is slightly weathered and strong as noted in boreholes (GWD-1, GWS-2, GWS-3 &GWD-4) located near the lower most part of creek lines traversing the landfill area.

Based on the SPT results, the foundation materials at landfill area is covered with layers of medium dense residual and colluvial soils (22-26 N-value), and underlain with gradually grading to higher density overburden materials. The layers of moderately compacted overburden are dense (31-50 N-Value). The highly compacted overburden materials produced high SPT blow counts (>51 N-value), revealing an increase in compaction, consolidation and higher quantity of granural/or gravel fragments.

The typical soil and mechanical properties of strata estimated from the N-Value (SPT) undertaken from cohesive, non-cohesive and extremely to totally weathered intercalating basalt flow, shale, mudstone, siltstone and conglomerate are enumerated below.

Table C.5.2-3 Soil Mechanical Properties

Borehole No.	Depth (M)	SPT (N) Value	Relative Density , %	Typical Range of Unit Weight ,KN/M^3		Typical Ultimate Bearing Capacity (qu)=kg/cm^2
				Moist	Submerged	
BH-1	0.55-1.00	39	65-85	18.3-22.0	10.2-13.4	>4
	1.55 – 14.12	59 to refusal	85+	20.4-23.6	11.8	>4
BH-2	0.55 – 1.0	24	35-65	17.3-20.4	9.4-11	2 - 4
	1.55 – 3.0	42 -46	65-85	18.3-22.0	10.2-13.4	>4
	3.55-4.0	51	85+	20.4-23.6	11.8	>4
	4.55-7.0	47-48	65-85	18.3-22.0	10.2-13.4	>4
	8.0-9.10	refusal	85+	20.4-23.6	11.8	>4
BH-3	0.55-3.0	35-38	65-85	18.3-22.0	10.2-13.4	>4
	3.55-6.0	41-47	65-85	18.3-22.0	10.2-13.4	>4
	6.55-18.17	54 to refusal	85+	20.4-23.6	11.8	>4
BH-4	0.55-2.0	40-42	65-85	18.3-22.0	10.2-13.4	>4
	3.55-9.13	56 to refusal	85+	20.4-23.6	11.8	>4
BH-5	0.55-2.0	40-44	65-85	18.3-22.0	10.2-13.4	>4
	2.55 -17.70	51 to refusal	85+	20.4-23.6	11.8	>4
BH-6	0.55-5.0	31-39	65-85	18.3-22.0	10.2-13.4	>4
	5.55 -15.79	52 to refusal	85+	20.4-23.6	11.8	>4
BH-7	0.55-2.0	22-39	35-65	17.3-20.4	9.4-11	>4
	5.55-6.0	51	85+	20.4-23.6	11.8	>4
BH-7	6.55-9.0	48-49	65-85	18.3-22.0	10.2-13.4	>4
	9.55-15.78	54 to refusal	85+	20.4-23.6	11.8	>4
BH-8	0.55-2.0	21-26	35-65	17.3-20.4	9.4-11	2-4
	2.55-7.0	32-44	65-85	18.3-22.0	10.2-13.4	>4
	7.55-10.0	55-63	85+	20.4-23.6	11.8	>4

Source: JICA Study Team

(4) Permeability Test Results

A total of seven (7) settings consisting of four (4) percolation tests (PT) and three (3) water pressure tests (WPT) were conducted on the drill holes. Table C.5.2-4 below is the summary of the field permeability test results obtained from the boreholes.

Table C.5.2-4 Summary of Permeability Test Results

Borehole N0.	Type of Field Test	Test Section (M)	Average K (CM/SEC)	Remarks
BH-2	PT	6.3 - 7	7.74 X 10 -4	Pervious
BH-3	PT	3 - 4	5.70 X 10-5	Semi-pervious
BH-4	PT	2 - 3	5.51 X 10-4	Pervious
BH-5	PT	4.5 - 5	8.38 X 10-5	Semi-pervious
GWD-1	WPT	7 - 12	1.28 X 10-4	Pervious
GWD-1	WPT	13 - 18	4.39 X 10-5	Semi-pervious
GWS-2	WPT	7.50 – 15	2.6 X 10-4	Pervious

Source: JICA Study Team

The field permeability test results of the drill holes revealed that the overburden materials encountered ranged from pervious to impervious condition.

(5) Infiltration Test Result

Result of four (4) infiltration tests is presented in Table C.5.2-5. Average infiltration rates obtained at different soil texture varied from 5.35 centimeters to 17.65 centimeters per hour. In terms of basic infiltration, the rates varied from 3.21 cm to 10.24 cm per hour. The mean average of 11.95 and 6.83 cm per hour for average and basic infiltration, respectively, show a rapid values. These rapid intake rates suggest that the landfill area soil covering is granular and very pervious.

Table C.5.2-5 Result of Field Infiltration Test

Test Site No.	Location	Surface Soil Type	Infiltration Rate		Class
			Basic	Average	
1	Kabulihan, Malay	Gravelly/sandy silt/silty sand	3.21	5.35	Moderate
2	Kabulihan, Malay	Gravelly/sandy silt/silty sand	10.24	17.65	Rapid
3	Kabulihan, Malay	Gravelly/sandy silt/silty sand	6.84	12.66	Rapid
4	Kabulihan, Malay	Gravelly/sandy silt/silty sand	7.03	12	Rapid

Source: JICA Study Team

(6) Test Pitting

The main source of construction materials for the clay liner may be quarried at the landfill area and vicinity. A total of six (6) test pits have been dug at the site with a maximum depth of three (3) meters after stripping of unfavorable soil covering. Bulk samples were taken for laboratory analysis.

(7) Laboratory Test Result

Laboratory test results indicates that the physical properties of the soil such as natural moisture content (NMC) have values that ranges from 11.23 % to 28 % and the optimum moisture content (OMC) have values ranging from 15.5% to 20.27%. Such materials belong to the ML-SM group of soils characterized by low plasticity and compressibility.

Mechanical properties of the soil by California Bearing Ratio (CBR) test was conducted on the soil samples (TP-3 &TP-1). Values obtained for the Maximum Dry Density and Optimum Moisture Content is as follows :

Maximum Dry Density, MDD (g/cc)	1.74 to 1.85
Optimum Moisture Content, OMC (%)	15.5 to 20.27

Permeability tests conducted on three (3) samples used for the compaction tests resulted on coefficients of permeability (K ave.) within 10^{-5} to 10^{-6} cm/sec. indicating that the soils are practically semi-pervious to impervious when properly compacted.

(8) Groundwater Monitoring Wells

Four (4) ground monitoring wells were constructed at the foot slope of the landfill area. The area is covered about one (1) meter to 6.80 meters silty clay soil and underlain by closely fractured/jointed basalt. The rock is moderate to slightly weathered, hard and dense. The ground water level is ranging from 10.75m to 11.70m for GWD-1 & GWS-2 and 1.46m to 1.95m for GWS-3 & GWD-4respectively. The depths of ground water elevation of the boreholes are controlled by recharge source (creek /gulley/river) of the area.

5.2.3 Conclusion

Surface geo-mapping conducted at the landfill area reveals that alternating layers of fine soils (silty clay, clayey silt & gravelly silty clay), granular materials (silty sand, sandy silt, & gravel/sand/silt/pebble) and basalt flow favors the soundness of new landfill site. The alternating layers measured 25^0 to 70^0 dip against the slope face. In particular; silty clay, gravelly silty clay, clayey silt & basalt flow serves as impervious membrane that control the inflow of leachate into the groundwater table. Results of surface and geohazard mapping indicate that the slope surrounding the landfill area can undergo localized slope failure during intense rainfall of long duration since some portion of the upper layer soil is loose/unconsolidated.

The stability of the slope depends upon the future surcharge at the landfill area and vicinity. In addition, poor drainage conditions resulting to reduction in the shear strength of the slope mass and will lower the factor of safety of the slope.

The landfill area experienced earthquakes for every 11 to 22 years return period with magnitude ranging from 6.1 to 7.0 since it is located at considerable distance from the Tablas Fault. A properly designed landfill area has no risk in the considerably high ground acceleration.

Seismic analysis is an important factor that must be considered for the design of a sanitary landfill. The design earthquake coefficient is very crucial and should be derived based on delineated acceleration maps in soft soil, medium soil, hard soil and rock. Seismic induced hazards should likewise be anticipated and studied in order to protect the soundness of the proposed sanitary landfill project.

The subsurface investigation conducted indicated that the thickness of overburden materials at the landfill area ranges from 1.0 meter to more than 20 meters thick as shown in the lithologic logs. The colluvial deposit and residual soil of Sta. Cruz and Fragante Formations are regarded as overburden. The impression is that there are two (2) layers of overburden materials deposited in different geologic time. Only the older or deep-seated residual deposit is well-compacted/consolidated, that is in places overlain by the newly deposited or loose younger colluvial materials. However, field tests conducted yielded N-value ranging from 21 to >50 giving a medium dense to very dense nature and condition of the overburden materials.

The percolation test results revealed that the foundation material is highly pervious (10^{-4} cm/sec) wherein water infiltration is high causing pore water pressure build-up that eventually reduces the degree of consolidation/or compaction of the overburden materials.

The very pervious colluvial / old landslide deposit (foundation materials) in the landfill area can act as passageway of surface run-off. This can facilitate the infiltration of groundwater or rain water and thus result to slope failure. This was observed from the slopes located along the national highway connecting the town of Malay and Buruanga which shows progressive circular slope failure caused by underlying poorly unconsolidated materials and poor drainage condition.

The test pits and laboratory tests conducted indicated that the overburden materials are made of alternating layers of fine and granular soil. Selective mining is necessary to extract suitable materials for the clay lining of the landfill area.

Constant Head Permeability Test (CHPT) on remolded soil samples reveals that permeability (10^{-6} cm/sec) improves when it is properly compacted particularly in TP-6 soil samples of which made of gravelly silty clay and silty clay. The type of material is suitable for clay lining of the landfill area.

5.3 Environmental Survey

5.3.1 Water Environment

(1) Surface Water

Surface water samples collected in three monitoring station was brought to F.A.S.T laboratory for analysis. The result shows the following areas of concerns:

- High concentration of total coliform in all sampling locations including groundwater wells
- Presence of dursban and diazinon, normally found in insecticides and pesticides in a groundwater well used by the communities in Barangay Kabulihan

(2) Groundwater

The groundwater within the landfill site has been given focus since it is vulnerable to contamination from the solid waste. Four were selected as groundwater sampling sites.

(3) Aquatic Flora and Fauna

Another important ecosystem that is a direct receptor of the impact of the new landfill site is the riverine ecosystem of the Malay River. These riverine organisms include: fishes, shells, mollusks and crustaceans. The residents of Kabulihan catch these organisms mainly for their daily consumption and not for any economic gain like selling. Catching is done almost everyday as the Malay River serves the residents multiple purpose like bathing, doing their laundry and getting their domestic water. There is some information of riverine fish in down steam of new proposed SLF as well as the stretch of the Malay River and its turbutaries.

Some of the fishes such as goat fish or Philippine butterfly fish caught as well as mollusk such as snails, clams scallops and oysters of are in enumerated**.** Fishing is done in the deep seas of Pandan Bay or even Sulu Sea. A small percentage of the respondents are engaged in fishing as a source of income. In addition, corals are the most common type of coelenterates on Boracay Island and other reef on the Mainland of Malay. The hydrocorals-stony or hard corals come in various colors, shapes, sizes and forms.

5.3.2 Air Environment

(1) Landfill Gas

The geographical extent of air quality resistance has been considered up to 3 km radius from the project site. The landfill gas was recorded and shown in Table C.5.3-1.

Table C.5.3-1 Results of the Gas Sampling for Methane (CH_4), Carbon Dioxide (CO_2), Hydrogen Sulfide (H_2S), Ammonia (NH_3)

Station	Location	Time	Instrument Used	Result
1	Guard House	1:00 pm	G450 Portable Gas	Below detection limit
2	N 11°52.257' E121°54.360'	1:35 pm	G450 Portable Gas	Below detection limit
3	N 11°52.305' E121°54.405'	1:55 pm	G450 Portable Gas	Below detection limit
4	N 11°52.323' E121°54.414'	2:15 pm	G450 Portable Gas	Below detection limit
5	N 11°52.331' E121°54.443'	2:35 pm	G450 Portable Gas	Below detection limit

Source: JICA Study Team

1) Methane (CH_4)

Methane is non toxic, however, it is highly flammable and may form explosive mixture with air. It is violently reactive with oxidizer, halogen and some halogen-containing compound. Methane is also asphyxiant and may displace oxygen in an enclosed spaced. Asphyxia may result if the oxygen concentration is reduced to below 19.5% by displacement. The CH_4 was not detected during surface sampling.

2） Carbon Dioxide (CO_2)

Carbon Dioxide (CO_2)is a chemical compound composed of low oxygen atoms covalently bonded to a single carbon atom. It is a gas at standard temperature and pressure and exists in earth's atmosphere as a gas. It is a colorless odorless gas. When inhaled at higher concentration than usual atmospheric levels. It can produce a sour taste in the mouth and a stinging sensation in the nose and throat. At standard temperature and pressure, the density of carbon dioxide is around 1.98 kg/m^3, about 1.5 times that of air. The CO_2 level was not detected on the period of measurement.

3) Hydrogen Sulfide (H_2S)

Hydrogen Sulfide (H_2S) is a colorless gas that smells like a rotten eggs (from the Sulphur). Often referred to as "sewer gas" and is highly poisonous. Usually the poisoning caused by

hydrogen sulfide is through inhalation and has toxicity similar to cyanide. It is found in petroleum and natural gas and sometimes present in ground water. The results shown in Table C.5.3-2 from the different observation point during surface gas sampling, shows that H_2S is not detectable

4) Ammonia (NH_3)

It is normally encountered as a gas with a characteristics pungent odor. Although ammonia contributes significantly to the nutritional needs of earth, the gas itself is caustic and cause serious health damage.

Based on the results of the air sampling, the air quality within the proposed landfill and within the direct impact area is not detectable for gas emissions.

(2) Noise Level

The noise level was recorded and shown in Table C.5.3-2. The sounds recorded under normal condition is 40-60 dB(A). Normally the sound generated under normal condition was produced by wind blowing, animal sound, birds singing and workers in the site. The Maximum recorded sound was 60 dB (A).

Table C.5.3-2 Results of the Noise Level Measurement on July 29, 2007

Station	GPS Location	Time	Method/Instrument Used	Level (dBA)	Activities
1	N 11°52.257' E121°54.360'	1:35 pm	Portable Sound Meter	40-50	Normal condition, sound produce by air and 2-3 workers in the site.
2	N 11°52.305' E121°54.405'	1:55 pm	Portable Sound Meter	50-60	Sound produce by air and 4-5 workers in the site.
3	N 11°52.323' E121°54.414'	2:15 pm	Portable Sound Meter	50-60	Sound produce by air, 2-3 workers in the site cutting wood and birds singing.
4	N 11°52.331' E121°54.443'	2:35 pm	Portable Sound Meter	50-60	Sound produce by air, 2 workers in the site, birds singing and water flowing.

Source: JICA Study Team

According to the rules and regulations of the National Pollution Control Commission of the Philippines (NPCC), noise standards are set for four different categories, namely i) general areas, ii) areas directly fronting/facing 4- lane road, iii) areas directly fronting/facing 4-lane or wider road, and iv) for construction activities. These are shown in Table C.5.3-3.

Table C.5.3-3 Noise Standards in General Areas (dB)

Category of Area	Daytime	Morning & Evening	Nighttime
AA	50	45	40
A	55	50	45
B	65	60	55
C	70	65	60
D	75	70	65

Note:
AA – a section or contiguous areas which requires quietness, such as an area within 100 meters from school sites, nursery schools, hospitals and special homes for the aged.
A – a section or contiguous area which is primarily used for residential purposes.
B – a section or contiguous area which primarily a commercial area.
C – a section primarily reserved as a light industrial area, and
D – a section which is primarily reserved as a heavy industrial area.
– Daytime - 9:00 a.m. to 6:00 p.m.
– Morning - 5:00 a.m. to 9:00 p.m.
– Evening - 6:00 a.m. to 10:00 p.m.
– Nighttime - 10:00 a.m. to 5:00 p.m.
Source: NPCC

On the other hand, the maximum noise standards for construction activities and allowable working hours are show in Table C.5.3-4.

Table C.5.3-4 Maximum Noise Standards for Construction Activities and Allowable Working Hours Per Area

Class of Activity	Maximum Noise Level	Allowable Working Hours	Areas
Class 1	90 dB (A)	7:00 a.m. – 7:00 p.m.	AA,A,B
Class 2	85 dB (B)	7:00 a.m. – 7:00 p.m.	AA,A,B
Class 3-4	75 dB (C)	7:00 a.m. – 9:00 p.m.	AA,A,B

Source: NPCC

(3) Odor

In the site, odor is identified to be the location of the odor description and was conducted last July 28, 2007 at about 1-3 pm. Generally, the odor depends on the location of the receptor and it was concluded that no foul odor was experience in the proposed SLF only presence of abundant flies.

5.3.3 Flora

Barangay Kabulihan still is home to a great number of plant species which are endemic in the area. During the transect walk conducted, 60 plant varieties were identified used mainly as food, medicine, lumber and fuel by the residents. There was one introduced specie, mahogany which was seen during the transect walk, cultivated on a backyard. Endemicity of the plants is very prevalent within every 3-5 meters walk along the terrain of the Malay watershed.

(1) Fruit bats

Fruit bats are commonly observed in the area according to Barangay Kagawad Ms. Adelfa Tumaob, and Mr. Roberto Gulay, two of the KIs in the new landfill site. This claim has been supported by the local residents in the natural survey. These bats are sighted at Mt.

Luho especially in the afternoons. It is a large fruit-eating bat species of the family of Pteropodidae. These species preferred fruits of Bulabog (Parishia maingayi) and Bogo (Garuga floribunda) and as roosting trees in the area. Several species of fruit bats are found on the Mainland of Malay, but only two species are found to roost on Boracay Island namely Acerodon jubatus and Pteropus vampyrus which have been listed as endangered and vulnerable, respectively[1]. Acerodon jubatus is commonly known as the Golden-capped fruit bat and locally known as Kabog. These species is similar with Pteropus vampyrus in size, external appearance and habits. The color varies a great deal especially on the extent of the yellow or buff and orange-buff patch on crown and back of neck and upper back. The Pteropus vampyrus is commonly known as Red-necked flying fox and locally known as Kabog to residents. It is a large bat with long ears which is pointed at the tip. The body covered with fur at different degree of thickness. Generally, the color is blackish brown with head, neck and mantle as black while the shoulder, neck and rump are colored rufous-brown. Its definite roosts are often found in some particular clump of trees where they usually stay until driven away by necessary disturbance. Both species produce a very strong peculiar musky odor characteristics of their roosting area and very different from the urine stench of other animals.

Indiscriminate habitat destruction and hunting activities by residents are the two most common factors endangering fruit bats. Most people are not aware about the critical status of fruit bats nor they know how important fruit bats are to the forest.

(2) Monkeys (Cercopithecidae)

Monkey (Macaca fascicularis) - Unggoy, amo, in the area is commonly associated with many fallen young coconut fruits. Key informants stated that monkeys are often cited in the forested areas of the site and even on their yards and in the dumpsite. Some have even visited the “drilling group” of the study team. There are around 10-20 heads that are roaming around the areas. The members include both sexes and of all ages, headed by huge old male. Sometimes monkeys are captured for food and sometimes sold as pets. Some riverine organism and insects in the area were also discovered during the transect walk.

(3) Reptiles

There are several species of reptiles, the most dominant terrestrial herpetofaunal species in the area are the Malay Monitor Lizard (Varanus salvator of the family Pythonidae) and Python (Python reticulatus the family Pythonidae). These reptiles are carnivores and feed on small live animals. In the case of Python, they are so adaptable that they can even occasionally seek dwelling in human shelter. In addition, Python reticulatus is a natural predator for rats.

[1] International Union for the Conservation of Nature, 2002

5.4 Human Environment

5.4.1 General Information (Health Information)

Even before the operation of the SLF in the Kabulihan, respiratory diseases like pneumonia tuberculosis in on the top 5 of the leading causes of mortality in Malay. There are several medical facilities that caters to the people: a private hospital in Barangay Caticlan, a municipal hospital in Barangay Motag, a municipal health office (MHO) in Barangay Poblacion,an Emergency Hospital on Boracay Island and six (6) Barangay Health Stations.

5.4.2 Survey Area

Barangay Kabulihan, the location of the proposed SLF is one of the nine (9) Barangays covered by Malay Municipality. It is composed of seven (7) Sitios[2]: 1- Sitio Maliyong, 2- Sitio Proper, 3- Sitio Lingo, 4- Sition Minorok, 5- Sitio Agnaga, 6- Sitio Bajangan, and 7- Sitio Bulutinao. The SLF is presently located in Sitio Bulotinao and very near or nearly adjacent to another Malay barangays, Barangay Dumlog and Barangay, Buruanga Municipality. During the period of the survey in July-August 2007, Barangay Kabulihan has a total population of 500 and 115 households.

(1) Social Services

Kabulihan is accessible from the Poblacion via aconcrete national highway using a public transportation system the tricycle. A barangay feeder road and several bamboo foot bridges link the residents of the different sitios to the barangays proper. The Barangay is being served by an elementary school, a day care and a Roman Catholic Chapel. A basket ball court doubles a solar dryer for the residents

(2) Infrastructure Services

Aside from the free flowing waters of the Malay River, Agnaga River, and 7 creeks (Maliyong Creek, Bajangan Creek, TRO Creek, Bulutinao Creek, Mongilao Creek, a dead creek and an unnamed creek) traversing barangay Kabulihan, the residents are also served by two (2) water tanks located along Bajangan creek where 10 communal faucets are connected. More affluent families have installed motorized pumps (10 pumps). There are also 10 deep wells and 3 dug wells ('bubon').

Electricity in Malay is provided for by the Aklan Electric Cooperative (AKELCO). Communication is made easy with the services of Pantelco, Globe, PLDT, SMART, and other telecommunication companies.

(3) Economy

Aside from the income generated by tourist influx to Boracay Island and the Mainland of Malay is basically agricultural and fishing. Major agricultural products are coconut, copra, root crops, rice, and vegetables. However, majority of the residents, as represented by the respondents do not consider agriculture as their primary income source. In Kabulihan,

[2] Sitio is a political subdivision of a barangay, the smallest socio-political unit in the Philippines

many of the respondents are employed on the Boracay Island. Their agricultural product are mainly for their home consumption. Based on the Barangay Profile of Kabulihan 2004, there are 50 farmers in the community whose income is P 12,000/cropping. There are 30 fishermen with an average income of P 10,000/month.

(4) Resource Map

The resource map below was prepared with the community. It shows the settlement distribution along the Malay River and relative to the proposed SLF. The locations of water supply systems (dug wells, communal faucets motorized pumps, deep wells and water tank) are also indicated. Most of the social services are located in the Sitio proper. As also indicated in the map, the major land uses of Kabulihan are timber land, coconut land, rice area/ vegetable area and settlement area.

5.4.3 Perception Survey Result, Kabulihan, Malay

(1) Background

In July 2007, a perception survey was undertaken with the participation of the MOM. The extent of people's understanding and notions about the project was determined through a perception survey which dwelled on significant issues/concerns raised by the community stakeholders.

A total of 99 (29 Males, 70 Females) respondents came from the barangays of Kabulihan, Dumlog, Poblacion all of Malay Municipality and Barangay Mayapay of Buruanga municipality.

(2) Perception Survey Results

1) Project Awareness and Acceptance

(i) Awareness of the project

Of the 99 respondents, 73 (73%) signified awareness of the SLF plan in Barangay Kabulihan while 21 (21%) are not aware of it. Interesting point is the fact that 8 of these respondents who were not aware came from the 32 respondents of Barangay Kabulihan. Majority (87) have learned of the plan from local officials (the MOM and Barangay) while the remaining 12 respondents got their information from their neighbors-friends and family members.

Although there were a few number of respondents who learned the SLF project as early as 2005, majority learned about it in 2006 and some only in 2007.

(ii) Perceived potential impacts of the project to the respondents and communities

On the respondent's perception on benefit of the community from the project, 41% (41) responded "No", that is no impact will be caused by the landfill to the community. On the other hand, 35% (35) answered "Yes" and 19% expressed uncertainty over the possible impact the project may have to their community.

Sixty-eight percent of the respondents have answered that they are not expecting benefit

from the project, only 17% gave a positive response and 14 % were uncertain with the benefit. Reasons given for the "Uncertain Response" include destruction of the environment (air, water, land) as well as affect the health.

(iii) Involvement in the project consultation

On the question if the residents were consulted before regarding the project 50% answered that they were previously consulted on the project/ were involved during the project consultation. Forty-two percent (42%) however answered that hey were not involved. Majority of those who gave this answer came from Barangay Maypay of Buruanga.

(iv) In-favor of landfill

A big percentage of the respondents (70%) answered that they are not in favor of the project, and only 15% are in favor of having a land fill. Eleven percent answered "uncertain".

2) Special Concerns

i) Accident [sporadic explosions of fires]

When asked on whether they have heard of any occurrences of sporadic explosions in the SLF, only 31% have responded Yes, and the remaining 69% did not give any response. Those who answered Yes came from the Barangays Kabulihan, Dumlog, and Maypay which are adjacent to the SLF.

ii) Air pollution

As for the question of any observed effect of the SLF to the freshness of the air in their area, barangays Kabulihan, Dumlog and Maypay have observed a negative impact to the air freshness of their surroundings brought about by the SLF. This was observed by only a small percentage of respondents from Barangay Poblacion.

A high 80% of the respondents confirmed that dust occurrence have become more noticeable even with the temporary operation of the SLF. The 20% did not give any answer.

iii) Groundwater Quality

76 % of the respondents fear that the SLF may have a negative effect to their ground water quality, especially during the operation phase. Further, 40% responded that the effect may even be felt even after its closure.

iv). Noise

Eighty-one (81%) of the respondents answered that noise problem may be felt most during the construction, seven percent (7%) answered this may be felt during its operation phase, but 22% answered that this is not applicable to their location.

v) Benefits to the Project

While much of the impact anticipated by the respondents which the SLF has a negative connotation, some benefits were also being looked forward to. These are better business

opportunity as well as better SWM and mitigated effects on the environment.

vi) Land Value

In terms of the land value of their land located near the SLF, 70% of the respondents said that the SLF may have a devaluation effect to their land. 30% however answered this is not applicable to them.

vii) Occurrence of Traffic

Traffic occurrence along the entry points of the garbage trucks moving towards the SLF is anticipated to happen by 32% of the respondents. The others said that this is unlikely to occur since Kabulihan is not an urban center.

viii) Presence of Waste along the Roadside

Seventy nine percent (79%) have noticed the presence of the littered waste along the road sides flying out of the trucks going to the proposed SLF.

ix) Public Health

Almost 90% of the respondents have expressed concern over the health effects by having a SLF in their community because of the offensive odor, increase number of flies and increase rodent population.

x) Suggested measures

When asked of any suggestion to mitigate impacts that may be caused by the SLF, the most common responses were: the project proponent and operator should strictly follow the design and proper SLF management; practice garbage segregation, and let the community participate in actively.

5.5 Desk Study (Conceptual Design of the SLF)

5.5.1 Overall Landfill Footprint

Within the project site there are two principal drainage systems, one in the eastern half of the site and the second in the western half of the site. Both systems drain northwards from high ground located along the eastern, southern and western margins of the project site (Drawing No.K-01).

It is feasible to develop the project site in two Phases, each centered on and occupying the two principal valleys that drain the project site. Within the planning period it is necessary to develop only the first Phase (Phase 1) since this has more than adequate capacity to satisfy the volumetric requirements for the planning period.

Phase 1 of the SLF is proposed to be developed in the eastern valley (Drawing No.K-02). Phase 1 is rectangular in shape with approximate average dimensions of 130 m (NE-SW) by 120 m (NW-SE). The total landfill footprint of Phase 1 is approximately 15,635 m^2.

The eastern, southern and western margins of Phase 1 abut higher ground. Along the northern margin, however, the stream valley provides a natural break in the continuity of the

higher ground surrounding the landfill footprint. Accordingly in this latter location it is proposed to construct an embankment dam that serves to close off, and effectively raise in elevation, the lowest part of the landfill footprint.

In delimiting the extent of the landfill footprint and the location of site infrastructure outside of the landfill footprint (Drawing No. K-02), buffer zones have been incorporated into the Conceptual Design in order to:

- provide cordons sanitaires' around the periphery of the landfilling area,
- provide corridors for the planting of native vegetation,
- install site engineering works, for example surface water drainage measures, to mitigate potential environmental impacts both during construction and during ongoing operations,
- facilitate environmental monitoring of site activities, and
- provide a peripheral zone in which to install remedial engineering works should these be required at a later date.

At its closest approach, the landfill footprint lies approximately 10 m north of the southern margins of the project site, although the landfill footprint generally lies at a greater distance than this. Elsewhere the minimum buffer zone adopted is 20 m from the site boundary. Along the northern margin of Phase 1 residual waste will be disposed at a minimum distance of 60 m from the northern site boundary.

5.5.2 Phasing and Sub-Phase Development

Modern sanitary landfills are usually developed progressively on a Phase by Phase basis. It is proposed to adopt the same principle here in order to minimize initial investment costs and to make the site available for the secure disposal of residual waste as early as practicable.

The landfill footprint for Phase 1 has been subdivided into a series of Sub-Phases delimiting each major stage of phased progressive development. For preliminary planning purposes Phase 1 of the SLF has been subdivided into three principal Sub-Phases (designated Sub-Phase 1A, Sub-Phase 1B and Sub-Phase 1C), the sequential development of which is illustrated on Drawing No. K-03 to Drawing No. K-05 respectively.

The development of Phase 1 of the SLF will proceed progressively, with the timing of the construction of each Sub-Phase driven by the rate of waste input and the rate at which void space is utilized. The following timing is anticipated for each Sub-Phase of the initial Phase 1 development:

Table C.5.5-1 Anticipated Sub-Phase Lifespan

Sub-Phase	Total volume (m3) [1]	Cumulative Volume (m3)	Net volume (m3) [2]	Estimated Life (from 2009)	Sub-Phase Life (years)
1A-1	18,620	18,620	16,585	2009.57	0.57
1A-2	30,431	49,051	27,877	2013.04	3.48
1B	59,630	108,681	54,330	2020.00	6.96
1C	77,345	186,026	65,701	2030.00	10.00
Total	186,026		164,494		

Notes: 1 Total volume is the available air space between the top of the basal lining system (Drawing No. K-05) and the proposed restoration contours (Drawing No.K-09).
2 Net volume = total volume – volume of leachate collection gravel, capping layer and topsoil. Net volume is the available volume for waste disposal, inclusive of 5% allowance for 'daily' cover and provision for intermediate cover.
Source: JICA Study Team

It is envisaged that the landfill will be developed first in the lowest part of the valley along the northern margins of Phase 1 and then progress southwards up gradient. This overall sequence of working permits:

- the structural fill materials required for the embankment dam to be excavated immediately adjacent to the dam thus minimizing the temporary stockpiling and double handling of soil materials;
- the structural restraint necessary for the disposal of waste along the northern margins of Phase 1 to be constructed at the commencement of the project;
- the control of surface water flows;
- the progressive installation of drainage works, including a groundwater underdrain system beneath the embankment dam;
- the progressive installation of site engineering measures to control and collect contaminated water (leachate) generated within the waste disposal area;
- the installation of only a single leachate collection and extraction system, rather than individual systems installed in each Sub-Phase;
- continuous access to the waste disposal area using a single internal road system to be developed in the first stage of the landfill development; and
- if required, site development to be terminated at any time in the future should an alternative disposal site be considered for development, with the developed portion of the site readily restored and integrated into the adjoining land.

Sub-Phase 1A provides sufficient soil materials for the immediate full construction of the embankment dam to be constructed at the northern limits of Phase 1. Within Sub-Phase 1A, the initial cut (Sub-Phase 1A-1) has been designed to provide sufficient disposal capacity at the initial stages of the project to accommodate the volumes of residual waste already stored at the site and the additional volume of waste anticipated to require disposal by the time the site is ready to commence operations. Accordingly, once Sub-Phase 1A-1 has been developed all of the waste currently stored at the site can be transferred immediately to the waste disposal area. Thereafter, the balance of Sub-Phase 1 (Sub-Phase 1A-2) will provide additional disposal capacity for at least a further three (3) years or more.

In advance of Sub-Phase 1A being filled to capacity with waste, it is envisaged that Sub-Phase 1B will be developed to the south of the disposal area. The area to be developed

for Sub-Phase 1B can be act as the source of 'daily' and intermediate cover during operations in Sub-Phase 1A, thus avoiding the need to double handle materials from stockpile. Sub-Phase 1C will be developed beyond the current planning period.

5.5.3 Site Access

Access to the site is provided currently by an unsurfaced road, approximately 560 m in length, that runs from the existing Provincial Road between MOM and MOB. The road is single lane, with a running course that is typically 4 m wide. While the road is not deemed to be an 'all weather' road it is generally passable even during the rainy season.

Improvement of the access road, while of some benefit, is not considered to be a high priority and, therefore, has not been included in the current Conceptual Design. If the road were to be upgraded it would be recommended to undertake the following two measures:

- acquire an additional right of way of 4 m in three or four specific locations in order to provide passing places since the road is relatively long and has poor line of sight in several places. Currently vehicles may pass on the road but only with great difficulty; and
- provide an all-weather surface, either concrete or asphalt paved; in order to facilitate access to the site even during periods of heavy rainfall.

5.5.4 Site Preparation and Development

The floor of the landfill within the landfill footprint will be prepared in advance of the deposition of waste in all Sub-Phases and in adjacent areas of the site where support infrastructure is located. Site activities, within and adjacent to the landfill footprint, for which advance site preparation will be undertaken include:

- containment engineering on the base and sides of the disposal areas;
- installation of groundwater control measures;
- installation of surface water and storm water control measures;
- preparation of foundations for the embankment dam, leachate treatment pond and storm water retention pond;
- the site administration and operations compound; and
- internal site roads.

Site preparation works will generally involve the following:

- the clearance and grubbing of all vegetation from any area of the works;
- the excavation, removal and disposal of unsuitable organic materials and organic soils;
- the careful stripping and storing of existing soil-forming materials (topsoil, subsoil), although such materials are likely to be very thi or non-existent based upon site observations;
- the clearance and stockpiling of unweathered rock boulders for subsequent use on-site (for example, for use in slope protection and drainage works);

- the excavation and stock piling of superficial soils, either for general use (for example, structural fill, daily and intermediate cover) and for use as clay lining (completely weathered bedrock);
- compaction and grading of the sub-grade;
- excavation of soft spots and replacement with acceptable granular fill or structural fill; and
- potentially, the dozing and ripping of fractured and weathered rock.

The majority of site preparation works will focus on the development of the waste disposal area. Based upon the geological results of the site investigations the Conceptual Design assumes that depth of excavation of superficial soils within the landfill footprint is limited to a maximum depth of approximately 8 m and, wherever possible, is less than this based upon the following principal considerations:

- the requirements for site-won excavated soils is limited, in the main, to the formation of peripheral embankment works at the northern margin of Phase 1, and around the leachate treatment pond and storm water retention pond. Inevitably, there will be a surplus of excavated soils, which require storage on-site in the absence of these materials being exported and used off-site. The depth of excavation has been limited to minimize the storage requirements given the limited area available on-site for soil storage;
- the results of the borehole investigation indicate the potential presence of partially weathered bedrock locally at depths of approximately 10 m or so below existing ground level. In order to avoid exposure of such materials and to avoid the necessity to replace these materials it is deemed prudent to limit the overall depth of excavation within reasonable limits; and
- on the eastern, southern and western limits of each Sub-Phase, excavation is necessary into rising ground. In order to avoid potential slope instability even in the short-term condition, it has been deemed necessary, based upon geotechnical considerations, to limit slope heights to a maximum of approximately 10 m (at a cut gradient of 1H:1V) before it becomes necessary to bench the slope

Based upon the above, the development of each Sub-Phase of the landfill is envisaged to comprise two principal components:

- a generally flat to gently sloping bench (with a bench gradient typically at 20H:1V or less in the main part of the bench); and
- a cut slope, along the eastern, southern and western limits of the Sub-Phase, developed at a gradient of 1H:1V and to a height typically of 8 m or less.

Bench elevations have been set as follows:

- at 109-110 m for Sub-Phase 1A-1;
- at 115-116 m for sub-Phase 1A-2;
- at 124-126 m for Sub-Phase 1B; and
- at 134-135 m for Sub-Phase 1C.

The anticipated depth of excavation within each Sub-Phase is illustrated on a series of cross-sections through Phase 1 (see Drawing No.K-10 to Drawing No.K-13 respectively). In particular, cross-section A-A (Drawing No.K-11), cross-sections 1-1, 2-2 and 3-3 (Drawing No. K-12) and cross-sections x-x and Y-Y (Drawing No. K-13) depict the benched nature of the floor of the waste disposal area.

Excess soil excavated at the site and surplus to immediate requirements for site engineering works will be placed in stockpiles at the site. It will be necessary to form at least two discrete stockpiles, with clay soils suitable for use as a clay liner stored separately from soil materials for general site use. The potential location of such stockpiles is illustrated on Drawing No. K-02.

5.5.5 Embankment Dam

It is proposed that an embankment dam is constructed along the northern margin of Phase 1. The embankment dam will enhance the volumentric capacity of the landfill site. The dam increase the average depth of waste that can be deposited substantially across the whole of the landfill footprint, since restoration of the completed landfill can commence from the top of the dam rather than at the prevailing elevation of the ground surface at the toe of the structure. In view of the requirement to maximize the capacity of the site within the smallest feasible landfill footprint it is considered that the embankment dam provides the most cost-effective means of enhancing and maximizing the available site capacity.

A variety of configurations has been assessed for the embankment in terms of the location on site and the overall geometry (embankment crest elevation and overall slope gradient). The location envisaged for the embankment dam, as illustrated on Drawing No. K-03, is considered optimal since it maximizes the available height of the embankment and provides the most stable configuration since it abuts the valley-side slope immediately to the north-west of the outer slope of the dam. The overall geometry adopted for the dam is as follows (Drawing No. K-03 and Drawing No.K-07):

- crest level – 117 m ASL;
- crest width – 6.5 m;
- inner slope – 1H:1V;
- outer slope – a combination of 2H:1V in the lowest portion below the intermediate 3 m wide bench and 1.5H:1V above the intermediate bench

The embankment dam will be formed from site-won soils sourced from the excavations undertaken to develop Sub-Phase 1A-1. The estimated fill requirement to construct the embankment dam is approximately 13,300 m^3.

5.5.6 Groundwater Drainage and Management

Given that the embankment dam will be formed:

- across the valley which carries intermittent seasonal surface water flows; and
- from primarily clayey materials,

it is recommended that a granular drainage blanket, at least 0.6 m thick, is placed at dam foundation level in order to intercept and facilitate groundwater drainage and to relieve pore pressures during the construction of the dam. The drainage blanket will be provided with a perforated re-inforced concrete pipe, of 610 mm nominal diameter, embedded in the axis of the valley in order to provide a conduit for storm water flows arising from groundwater seepage (Drawing No.K-08).

No further groundwater interception measures are deemed necessary beneath the waste disposal area at present. However, if significant groundwater seepages are encountered during site construction then appropriate measures would need to be installed beneath the engineered barriers in order to evacuate groundwater and to prevent the build-up of groundwater beneath or behind any clay barriers. Such preventative measures would be required so as to minimize the potential seepage of groundwater into the site, which, ultimately, would contribute to the generation of leachate.

5.5.7 Engineered Barriers

Ideally, low permeability strata, for example clays, are used to inhibit the inflow of water into a landfill and the outflow of leachate. The geotechnical survey of the project site indicated that, whilst the permeability of the intact bedrock strata is very low, fractures and discontinuities render the bedrock *en masse* moderately permeable. Similarly the overlying colluvial soils and highly-completely weathered rock are also relatively permeable and water bearing, being in hydraulic continuity with the groundwater in bedrock fractures.

In situ and laboratory permeability measurements indicated typical permeabilities of the order of 5×10^{-5} cm/sec. As such, the site materials are considered marginal for use as natural clay liners unless considerable effort is undertaken in compacting the soils to the maximum dry density at the optimum moisture content. Given the prevailing climatic regime at the site the available construction time considered favorable for the installation of natural clay liners will be limited and likely to be restricted to the driest months of the year, in the period typically between January and April.

In the absence of *in situ* soils/rock of proven satisfactory low permeability, containment on the base and sides of the landfill could be provided by one of the following methods:

- the excavation and recompaction of selected clayey materials won on-site;
- the importation of approved natural clay of low permeability to line the site;
- the use of a geosynthetic flexible membrane; or
- the improvement of superficial materials *in situ*, for example by bentonite enrichment, in order to decrease the permeability characteristics of site materials to the level desired.

From environmental considerations, and given the nature and variability of the sub-grade within the landfill footprint, the Conceptual Design has adopted a dual approach, as follows:

- in the lowest parts of the site (Sub-Phase 1A-1) it is recommended to adopt a composite lining system comprising a geocomposite clay liner (GCL) above a

secondary clay liner, 0.6 m thick, formed from suitable site-won clay (Drawing No. K-06). While this lining system exceeds the requirements of a Level 1 landfill, the potential environmental sensitivity of the site dictates that high levels of containment are adopted where leachate accumulation will be greatest. Accordingly, since the lower bench will provide the focal point for all leachate drainage, it is recommended to adopt a composite lining system in this area. This also permits flexibility in landfill operations by providing the capability to store leachate in the lowerportion of the site at times of high leachate generation. In such circumstances added protection is afforded through the use of the GCL. Bentomat ST is a suitable GCL, suitably re-inforced where deployed on steep slopes; and

- in the remainder of the site (Sub-Phase 1A-2, Sub-Phase 1B and Sub-Phase 1C) the Conceptual Design is premised on the use of site-won materials recompacted to 95% of the maximum dry density at, or just wet of, the Optimum Moisture Content (range 0%-+4% of the OMC), in order to reduce the permeability to acceptable levels. For ease of construction, and for construction quality assurance purposes, it is recommended that the basal clay liner is 1.0 m thick, and formed from at least four layers of recompacted soil, with compaction undertaken using a sheep's foot roller. High standards of construction quality assurance including frequent checks on material quality and properties will be required to ensure successful installation of any clay liner.

It is assumed that the GCL will be installed, by suitably qualified and experienced professional contractors, only under dry conditions on a prepared and approved, compacted and rolled, sub-base free of sharp particles, stones, rocks, soft spots, roots and other deleterious matter.

The primary basal lining system will be constructed in stages across the entire floor of the landfill and shall extend up the sides of the landfill to the full extent of the landfill footprint. Where installed on slopes, the GCL shall be secured by means of an anchor trench at the margins of the landfill footprint (see Drawing No.K-06).

For the steep liner slopes along the eastern, southern and western margins of the Sub-Phases it is envisaged that the clay lining system will comprise a compacted clay highwall, 0.6 m thick where used as a secondary liner, or 1.0 m thick where forming the primary liner, built up as waste filling proceeds.

Site-won clay materials of suitable quality are also assumed to be used in the formation of the capping layer placed above the waste cells upon completion of filling in the cell. In order to minimize the migration of water through the cap, and hence to reduce long-term leachate generation, the cap should be a minimum of 0.75 m thick (Drawing No.K-06). If the quantities of available materials from the site so permit, the capping layer should be correspondingly thicker. As far as practicable the capping layer shall be formed of clay materials with an upper-bound permeability not greater than 1×10^{-9} m/sec.

5.5.8 Restoration Profile

For the Conceptual Design, the primary consideration has been to maximize the available void space. Accordingly, a steep restoration profile has been proposed. The exterior slopes of the completed landfill are envisaged to rise, as far as practicable, at a uniform gradient of 3H:1V, to a high point in the southern central portion of Phase 1.

The maximum depth of fill above the existing ground surface will be approximately 15 m (refer to Drawing No.K-11 to K-13 inclusive), with a total maximum depth of fill of approximately 20 m above the top of the basal engineered barrier. The overall gross volumetric capacity of Phase 1 is estimated to be approximately 186,000 m^3.

Above the capping layer it is envisaged that a layer of suitable organic soil, at least 15 cm thick, and capable of supporting vegetation will be installed progressively across the site at waste deposition is completed in specific parts of the site.

As for the development of the base of the site it is envisaged that areas of the site will be filled progressively up to full height (refer to Drawing No.K-15 to K-17). After completion of filling, an intermediate cover soil, 300 mm thick, will be placed over inactive parts of the site. Following a period of time to allow initial settlement to take place, typically of the order of 2 to 3 years, the site will be capped off and the final topsoil placed.

5.5.9 Leachate Collection System

To prevent a build-up of leachate within the landfill footprint and to minimize the hydraulic head acting across the basal lining system, it is necessary to collect and remove leachate from the landfill for recirculation or treatment prior to the discharge of the treated effluent off-site. Leachate collection shall be achieved through the following principal measures:

- grading the floor of landfill Sub-Phases to fall towards prescribed leachate drainage lines,
- the installation of a granular leachate drainage and collection layer above the primary lining system as described above, comprising 300 mm to 600 mm of uniform, non-calcareous, fine clean aggregate (typically 37.5-50 mm size), free draining with a permeability greater than 1 x 10^{-2} m/sec (Drawing No.K-06), and
- within the zones of thicker drainage gravel, the installation of 150 mm diameter perforated HDPE collection pipes, with a standard dimension ratio (SDR) of 17, graded to drain to a single collection sump located along the toe on the upstream face of the embankment dam in Sub-Phase 1A-1 (Drawing No.K-03).

The leachate flow zone will be provided with a non-woven geotextile placed between the gravel and the waste in order to prvent clogging of the drainage layer. A similar geotextile will also be installed where the gravel directly overlies a basal clay liner (rather than the GCL).

Secondary leachate collection pipes may be laid in the leachate collection layer as required. Where feasible, the main leachate collection ditches are intended to be laid at gradients steeper than 3.3% (30H:1V), in order to develop sufficient velocity in the leachate collection

piping to prevent solid deposition, thereby minimizing maintenance. Leachate drainage layers and leachate pipes are prone to silting and blockage by microbial and algal growth. Accordingly, the pipe work employed shall be sufficiently robust to permit jetting or rodding of the collection system, as necessary, to remove potential blockages.

The general arrangement and progressive development of the main leachate collection ditches and the leachate collection sump is illustrated on Drawing No.K-03 to K-05. Details provided on Drawing No.K-06.

5.5.10 Leachate Extraction and Transfer System

Leachate shall be removed from the active waste placement cell to a level as low as practical. It is proposed that the target control strategy shall be to limit the head on the lining system to a level with no more than 1.0 m of available leachate head on any point of the liner.

For the sake of simplicity it is envisaged that leachate will be drained from the collection sump through gravity, thus avoiding the necessity for continuous pumping of leachate from the site. It is anticipated that a 200 mm diameter HDPE pipe will transfer leachate from the leachate sump, through the embankment dam foundations, to the leachate treatment pond, as illustrated on Drawing No.K-07

In addition, and as a back-up in the event that the primary transfer system fails or becomes clogged, it is proposed that a side slope riser system, constructed from 450 mm nominal diameter HDPE with an SDR of 17, will be installed along the upstream face of the slope created by the dam (Drawing No.K-03). The side slope riser will permit direct access for submersible pumps to the leachate sump from which the leachate may be removed by pumping if required.

5.5.11 Leachate Management, Treatment and Discharge

The overall leachate control and management strategy is designed to focus on the following aspects of site design and operation:

- to minimize the generation of leachate within the active operational areas of the site;
- to prevent the build up of leachate within completed areas of the landfill;
- to minimize or avoid direct emissions of untreated leachate to surface water or groundwater; and
- to process leachate generated within the landfill to prescribed water quality standards prior to discharge of treated effluent off-site.

Accordingly, the principal elements of the leachate control and management system comprise the following:

- a leachate collection system installed progressively above, and in conjunction with, the basal lining system throughout Phase 1 (see Sub-Section 1.4.10 above);
- a leachate abstraction and transfer system to control leachate levels within the landfill and to deliver abstracted leachate to either the leachate treatment system for processing or to re-circulate the leachate back to the landfill;

- a leachate treatment system to process abstracted leachate to reduce its strength and modify is composition and quality in order that effluent may be discharged off-site to water quality standards matching, or better than, those stipulated in the effluent discharge consent criteria forming part of the ECC.

The basis of leachate control shall be the water balance of the landfill, taking account of liquid inputs, storage and absorptive capacity of the deposited waste and infiltration from rainfall. These factors affect the amount and timing of leachate generation and influence the measures required to deal with the leachate.

As noted elsewhere, the landfill shall be developed and operated on the cellular principle in order to limit and control water ingress to the Site. Minimization of rainfall infiltration and surface run on into the deposited waste are two principal means of restricting the uncontrolled generation of landfill leachate. .The following principles are proposed for primary leachate control and management:

- balancing of leachate flows and volumes, as far as possible, within already deposited waste;
- redistribution and re-circulation of leachate, under appropriate climatic conditions, to dry absorptive waste in order to reduce the volume of leachate;
- redistribution and re-circulation of leachate to completed areas of deposited waste to enhance the rate of flushing of contaminants through the site, to enhance rates of stabilization and ultimately to reduce the strength of leachate; and
- periodic intermittent mist spraying of leachate onto the restored surface of the landfill, under appropriate meteorological conditions, to enhance evaporation of leachate (the content of metal and non-biodegradable organic compounds permitting).

It is proposed that leachate redistribution and re-circulation to deposited waste shall form one core element of the leachate treatment strategy. As a limited discharge option, all efforts shall be undertaken to optimize evaporation of leachate generated and to reduce the volumes of leachate that require to be treated. Leachate re-circulation is key in optimizing the degradation of the waste material placed in the landfill. Final processing of mature leachate shall be undertaken in order to reduce the polluting potential and to ensure its suitability for discharge back into the aquatic environment. A preliminary assessment of potential leachate volumes has been undertaken on the basis of the following calculations:

$$L_o=[ER + IRA + WW] - [LTP + aW + DL]$$

Where:

L_o	=	free leachate retained;
ER	=	effective rainfall;
IRA	=	infiltration through restored and capped areas;
WW	=	inherent free water content of waste;
LTP	=	discharge of leachate off-site;

a	=	unit absorptive capacity of waste;
W	=	weight of absorptive waste;
DL	=	designed seepage rate.

A preliminary assessment of leachate generation at the site is reproduced in Table C.5.5-2. This indicates the likely scale of leachate generation for the assumptions specified on the Table. It is anticipated that the volumes of leachate generated on-site will be monitored regularly and site operational practices and the adopted leachate management strategy modified as necessary.

Leachate generation is likely to be highest in the first few years of development as the operational area is comparatively large in the absence of having capped any parts of the site. Leachate generation rates are estimated to be of the order of 20 m^3/day initially, declining to less than 15 m^3/day towards the active operational life of the landfill and about 2 m^3/day once the site is fully capped and restored. No information is available on the likely quality of leachate to be produced from the disposal of residual waste. Accordingly, there is no firm basis available upon which to select a suitable treatment strategy.

For the Conceptual Design it is assumed, based upon knowledge of leachate quality elsewhere in the Philippines, that simple treatment may be appropriate based upon the provision of aeration ponds.

Table C.5.5-2 Estimated Leachate Generation

Input Parameters:

Actual rainfall: 3,200 mm/pa Effective rainfall: 2,000 mm/pa

Infiltration 50 mm/pa – permanently capped/restored areas
300 mm/pa – temporarily capped/intermediate cover
3,200 mm/pa – active/uncapped areas

Waste density 0.75 t/m^3 Initial waste input 4,699 t/pa Absorptive capacity 0.080 m^3/per m^3 Active Site life 22 years

Year	Waste Year	Active Phase	Active Area (m^2)	Active Infiltration (m^3)	Temporary Cap (m^2)	Temporary Cap Infiltration (m^3)	Restored Area (m^2)	Restored Infiltration (m^3)	Total Water (m^3)	Annual Waste Input (tonnes)	Absorptive Capacity Input (m^3)	Cumulative Absorptive Capacity (m^3)	Evaporative Loss (m^3)	Annual Leachate (m^3)
2009	1	1A	2,330	7,456	0	0	0	0	7,456	4,699	501	501	280	6,675
2010	2	1A	2,000	6,400	2,330	699	0	0	7,099	4,993	533	1,034	240	6,326
2011	3	1A	2,000	6,400	1,000	300	0	0	6,700	5,431	579	1,613	240	5,881
2012	4	1A	2,000	6,400	1,000	300	1,000	50	6,750	5,694	607	2,221	240	5,903
2013	5	1B	1,500	4,800	1,000	300	1,500	75	5,175	5,270	562	2,783	180	4,433
2014	6	1B	1,500	4,800	1,000	300	2,800	140	5,240	5,125	547	3,329	180	4,513
2015	7	1B	1,500	4,800	1,000	300	2,800	140	5,240	4,862	519	3,848	180	4,541
2016	8	1B	1,500	4,800	1,000	300	4,000	200	5,300	4,599	491	4,339	180	4,629
2017	9	1B	1,500	4,800	2,000	600	4,000	200	5,600	4,612	492	4,830	180	4,928
2018	10	1B	1,500	4,800	2,000	600	5,000	250	5,650	4,599	491	5,321	180	4,979
2019	11	1C	1,500	4,800	1,500	450	5,000	250	5,500	4,599	491	5,812	180	4,829
2020	12	1C	1,500	4,800	1,500	450	7,500	375	5,625	4,599	491	6,302	180	4,954
2021	13	1C	1,500	4,800	1,500	450	7,500	375	5,625	4,599	491	6,793	180	4,954
2022	14	1C	1,500	4,800	1,500	450	7,500	375	5,625	4,599	491	7,283	180	4,954

Year	Waste Year	Active Phase	Active Area (m^2)	Active Infiltration (m^3)	Temporary Cap (m^2)	Temporary Cap Infiltration (m^3)	Restored Area (m^2)	Restored Infiltration (m^3)	Total Water (m^3)	Annual Waste Input (tonnes)	Absorptive Capacity Input (m^3)	Cumulative Absorptive Capacity (m^3)	Evaporative Loss (m^3)	Annual Leachate (m^3)
2023	15	1C	1,500	4,800	1,500	450	9,000	450	5,700	4,599	491	7,774	180	5,029
2024	16	1C	1,500	4,800	1,500	450	9,000	450	5,700	4,599	491	8,264	180	5,029
2025	17	1C	1,500	4,800	1,500	450	9,000	450	5,700	4,599	491	8,755	180	5,029
2026	18	1C	1,500	4,800	2,500	750	10,000	500	5,300	4,599	491	9,245	180	4,629
2027	19	1C	1,500	4,800	2,500	750	10,000	500	5,300	4,599	491	9,736	180	4,629
2028	20	1C	1,500	4,800	2,500	750	11,500	575	5,375	4,599	491	10,227	180	4,704
2029	21	1C	1,500	4,800	2,500	750	11,500	575	5,375	4,599	491	10,717	180	4,704
2030	22	1C	1,500	4,800	2,500	750	11,500	575	5,375	4,599	491	11,208	180	4,704
2031	23	Complete	0	0	2,500	750	11,500	575	575	0	0	11,208	0	575
2032	24	Complete	0	0	2,500	750	13,100	655	655	0	0	11,208	0	655
2033	25	Complete	0	0	0	0	13,100	655	655	0	0	11,208	0	655
2034	26	Complete	0	0	0	0	13,100	655	655	0	0	11,208	0	655
2035	27	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2036	28	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2037	29	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2038	30	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2039	31	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2040	32	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2041	33	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2042	34	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2043	35	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2044	36	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2045	37	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2046	38	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780

Year	Waste Year	Active Phase	Active Area (m^2)	Active Infiltration (m^3)	Temporary Cap (m^2)	Temporary Cap Infiltration (m^3)	Restored Area (m^2)	Restored Infiltration (m^3)	Total Water (m^3)	Annual Waste Input (tonnes)	Absorptive Capacity Input (m^3)	Cumulative Absorptive Capacity (m^3)	Evaporative Loss (m^3)	Annual Leachate (m^3)
2047	39	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2048	40	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2049	41	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2050	42	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2051	43	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2052	44	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2053	45	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2054	46	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2055	47	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2056	48	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2057	49	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780
2058	50	Complete	0	0	0	0	15,600	780	780	0	0	11,208	0	780

Accordingly, three aeration ponds are proposed, with a combined capacity of approximately 1,000 m^3, providing a hydraulic retention time of approximately 60 days. The location of the ponds is illustrated on Drawing No.K-02, while a typical cross-section through the ponds is illustrated on Drawing No.K-07. It is envisaged that the ponds will be developed in series, with gravity flow between ponds. Pond depth is set at 3 m. Pond 1 has the largest retention capacity of the three ponds, at 50% of the total capacity, with Pond 2 having 30% of the total capacity and Pond 3 20% of the total capacity.

The rate of discharge from the ponds, once the ponds are full, will be determined by the rate at which leachate enters the pond system. A gate valve will be provided to control the entry of leachate into the ponds and to facilitate temporary storage of leachate within the cell in times of high leachate flows.

It is envisaged that there will be little or no discharge of effluent from the ponds during th dry season since the likely evaporative losses from the pond surface may exceed the projected leachate inflow rates. However, during the rainy season it is inevitable that treated effluent will be discharged off-site, either directly through the outfall structure and drainage conduit (Drawing No. K-02 and Drawing No. K-07) or following re-circulation and spaying back onto restored parts of the site. During the rainy season it is anticipated that leachate strengths will be much lower on account of dilution by rainfall.

5.5.12 Landfill Gas Management

Primary measures to restrict the migration of landfill gas away from the site will comprise:

- the containment layers installed on the base, sides and top of the landfill; and
- vertical gas vents.

The latter measure has been incorporated to ensure that there is no build-up of gas beneath the capping system, notwithstanding that it is anticipated that the potential for gas generation is very low given that the waste to be disposed is proposed to be only residual waste. It is proposed that gas vents are installed only after waste filling is complete in any part of the landfill and the area has been capped.

The general arrangement of a typical vertical gas well is illustrated on Drawing No. K-21. The collection pipe is perforated over 10% to 20% of the surface area except for the upper two to three meters of the pipe over which length the pipe is solid (unperforated). The top of the gas well is sealed by a layer of impermeable material, typically bentonite grout. Each gas well will pass through the capping system in order to permit passive venting to the atmosphere.

Gas wells must accommodate vertical and lateral forces induced during waste degradation and settlement. Hence, it is anticipated that no gas vents will be installed until significant settlement of the waste has been accomplished and the relevant part of the site capped. It is recommended that no gas vent should be installed within the first 10 m of waste above the top of the lining system in order to prevent potential puncture of the basal lining system as a result of settlement and down drag.

For the purposes of the Conceptual Design it has been assumed that each gas vent has a sphere of influence of *c.* 60 m radius, and, accordingly, four gas wells are required in Phase 1. The approximate location proposed for the gas wells is illustrated on Drawing No. K-09.

5.5.13 Surface Water Management

Drainage systems are intended to intercept and dispose excess storm runoff. The excess runoff collected is conveyed through closed or open drainage systems and finally disposed into outfall joining the existing waterway, creek or river. In areas not bounded by roads, buildings and other structures, runoff is typically drained into open canals. The basic design considerations are:

- U-shaped concrete-lined canal - used for permanent drainage lines;
- V-shaped earth canal with side slope of 2H:1V - used for temporary drainage lines;
- design gradient of canal bottom is optimized based on site topographic condition;
- 10 year return period for storm flow; and.
- a minimum freeboard (FB) of 0.20 meter from the water surface level to the top of canal structure has been adopted.

Typical design details are illustrated on Drawing No. K-08.

The overall permanent drainage system proposed for Phase 1 is illustrated on Drawing No. K-09. There will be two principal permanent drainage lines, one to the east of the landfill footprint ("D1") and the second one to the west ("D2"). The drainage lines will drain the periphery of the landfill footprint as well as capture rainfall shed off the capped and restored surface. The maximum anticipated flow volumes at the outfall from the site is less than 1 m^3/sec even when the permanent drainage system is fully constructed.

The development of the drainage system is envisaged to be progressive in line with the overall phased site development. In the initial stages of construction the permanent drainage line for Sub-Phase 1 will be developed once the embankment dam is constructed (Drawing No. K-15). Thereafter, the permanent drainage lines will be extended southwards as filling proceeds and further areas of Phase 1 are developed for waste disposal.

It is proposed to provide a small storm water retention pond solely to service site needs. The pond will provide a source of water for use in irrigating restored parts of the site during periods of dry weather. It may also provide a supply of water for use in times of emergency, for dust suppression on site roads or for cleansing of operational plant and equipment. .

The temporary drainage system will be developed at the back of each bench in order to capture surface water and groundwater seepages and to prevent such flows from entering the active landfill area. This drainage system will link into the permanent drainage system as it exits each bench (Drawing No. K-13 to K-15).

The outfall structure is designed to return captured flows (surface and subsurface runoff) to the river or waterway without serious scouring or erosion. It is proposed to use a gabion mat, as illustrated on Drawing No. K-08, for the outfall of the surface water flows along the northern margin of the project site (Refer to Drawing No. K-09).

5.5.14 Administration and Operations Compound

It is proposed that the landfill site will be provided with the following administration and operational facilities adjacent to the entrance to the site:

- entrance gates;
- guard house;
- new site office building;
- parking lot and hardstanding;
- temporary waste storage area, allied with the existing materials recovery facility (MRF);
- fencing and compound lighting;
- site utilities – electricity, water supply, and communication links;
- weather station; and
- special waste cell.

The proposed arrangement of the administration and operations compound is illustrated on Drawing No. K-18.

The existing site entrance will be replaced by a new site entrance located towards the south-western corner of the site (Drawing No. K-02). Thereafter, the administration and operations compound will be developed in the highest part of the project site adjacent to the existing access road. Site development will comprise some cut and fill compared to prevailing site contours.

It is proposed that the administration and operations compound will be fenced, using fencing of standard design (See Drawing No. K-21). Both the existing site entrance and the new site entrance will be provided with gates, the latter also with a guard house for security purposes (Drawing No. K-20). Similarly, the access to the landfill area will also be gated, thus enclosing the whole of the administration area.

The existing office building will be replaced by a new office building, of floor area 120 m^2, of standard design and construction (see Drawing No. K-20). The office building will have provision for a shower and utility rooms, as well as provision for a weighbridge office in the event that a weighbridge is installed at a later date. A small parking area will be provided for employee and visitor's vehicles.

Although a weighbridge is not currently included in the Conceptual Design, given the small quantities of residua waste to be disposed at the site, there are a number of material benefits to the installation of a weighbridge at the site, including the ability to confirm the weight of waste delivered to the site. The design of the administration and operations compound includes provision for a weighbridge in the future, even though not presently incorporated in the Conceptual Design.

The existing shed for materials recovery will be maintained and will be supplemented by a paved area for the temporary storage of garbage. This area will permit the unloading and temporary storage of residual waste received at the site on a daily basis and its consolidation into a quantity/volume of waste sufficient to justify the use of landfill operational plant.

On the basis that up to 15 tons of residual waste will be received on a daily basis it is not considered economical to:

- run landfill operating plant on a daily basis, since such plant would be grossly underutilized and would likely run for less than half an hour per day; and
- have a full complement of staff for site operations each and every day.

The practical alternative, therefore, is to temporarily accumulate residual waste on-site until such time as it becomes efficient and economical to transfer the waste to the active disposal area. It is anticipated that waste transfer and disposal operations would likely be undertaken once or possibly twice per week.

The temporary storage area consists of an asphalt paved area, up to 350 m^2 in extent, upon which waste will be unloaded and then covered temporarily as required.

5.5.15 Site Roads and Hardstandings

It is proposed that the whole of the administration and operations compound is paved using 50 mm thick asphalt pavement in order to ensure all-weather working conditions.

From the administration and operations compound it is proposed to develop a permanent site road, also asphalt paved, which will serve as the primary access to the landfill site throughout the whole of the operating life of Phase 1 (Drawing No. K-18). Given site topographic conditions and the steep gradients on-site, it is not considered viable to construct and maintain unsurfaced roads for the primary access route. The profile along the primary access road indicates gradients as steep as 20%, necessitating that the drivable surface be paved. Typical details of the proposed access road are illustrated on Drawing No. K-19.

5.5.16 Utilities

The site will be provided with a permanent power supply which will entail the extension of the existing power line from the Provincial Road to the administration and operations compound, over a distance of approximately 600 m. While there is an existing water supply on-site, this is often dry. Accordingly, it is proposed to sink a new deep well in an attempt to provide a sustained permanent source of non-potable water for site use. A telephone line will also be provided to the site.

5.5.17 Special Waste Cell

It is estimated that 26.74 tons of HCW will be delivered to the SLF between now and the end of 2017. At an assumed density of 0.25 t/m^3, this equates to a total volume of approximately 107 m^3 that requires secure disposal within the planning period

Table C.5.5-3 Estimated Requirements for Secure Disposal of HCW

Year	HCW (kg/d)	HCW (tpa)	Annual Volume (m3) [1]	Cumulative Volume (m3)	No. of Bins [2]
2008	6.6	2.42	9.66	9.66	0.9
2009	6.8	2.48	9.93	19.59	1.8
2010	7	2.56	10.22	29.81	2.8
2011	7.1	2.59	10.37	40.18	3.7
2012	7.3	2.67	10.69	50.86	4.7
2013	7.4	2.70	10.80	61.67	5.7
2014	7.6	2.77	11.10	72.76	6.7
2015	7.7	2.81	11.24	84.01	7.8
2016	7.8	2.85	11.42	95.42	8.8
2017	7.9	2.88	11.53	106.96	9.9
Total		26.74	106.96		

Notes: 1 Assumed density is 0.25 t/m^3
2 Capacity per bin is 10.812 m^3

It is proposed that a secure cell is provided for special wastes within the fenced operations compound, at the location illustrated on Drawing No. K-18. The cell, to be constructed adjacent to, but not within, the proposed landfill footprint for residual waste, will be developed separately and progressively as the volume of special wastes demands.

The proposed design of the special cell is based upon securely encapsulating special wastes as follows (refer to Drawing No. K-21):

- the cell will be excavated 4 m into existing ground and will be founded in suitable clay-rich soil of low permeability;
- the bas and sidewalls of the cell will be lined with compacted clay liner a minimum of 0.6 m thick and with a permeability that should be no greater than 1 x 10-^{7} cm/sec;
- the inside of the cell will be lined with HDPE 1.5 mm thick;
- the base of the cell will contain a small sump designed to collect any liquids. Collected liquids will be treated as contaminated and directed to the leachate treatment pond for processing once the chemistry of the liquid has been checked and the liquid has proven to be non-toxic, non-hazardous and non-corrosive. Unsuitable liquids will be abstracted and treated separately to render them fit for treatment in the leachate treatment pond;
- within the excavated cell, a series of re-inforced concrete bins will be cast in situ, of general dimensions 4 m long, 2 m wide and 2 m deep. The bins have the capacity to handle approximately one years estimated HCW delivered to the site;
- bins will be filled progressively and once at full capacity will be sealed at the top with re-inforced concrete, thus encapsulating the waste within the bin;
- the excavated cell will be provided with a roof to prevent the ingress of rainwater, as well as a peripheral drainage system around the margins of the cell to minimize the generation of leachate within the base of the cell; and
- once part of the cell is completed it will be covered with a clay liner, at least 1.0 m thick designed to shed water away from the completed cell.

Appendix

Appendix III-C-1 Amendment of IEE (Provisional)

1. Introduction

The Environmental Impact System (EIS) in the Philippines has been established and is now considered as an important component in planning and implementing a total environment management strategy for the country. Under the EIS, national development is undertaken minimizing or mitigating the threats to the environment brought about by development projects.

DAO 2006-10, Series 2006, promulgates the guidelines on the categorization of final disposal facilities or sanitary landfills (SLFs), in support of RA 9003. There are four categories based on the potential net residual waste disposal:

- Category 1: final disposal facility or SLF for an LGU or cluster of LGUs with net residual waste of ≤ 15 tones per day (TPD),
- Category 2: final disposal facility or SLF for an LGU or cluster of LGUs with net residual waste of > 15 TPD, but ≤ 75 TPD,
- Category 3: final disposal facility or SLF for an LGU or cluster of LGUs with net residual waste of > 75 TPD, but ≤ 200 TPD, and
- Category 4: final disposal facility or SLF for an LGU or cluster of LGUs with net residual waste of > 200 TPD.

The guidelines also clarify the Environmental Compliance Certificate (ECC) requirements for each category. Categories 1 and 2 need an IEE checklist, while Categories 3 and 4 need an IEE report in order to obtain an ECC. A SLF with a capacity of 1,000 TPD and above must prepare an environmental impact statement (EIS) for an ECC.

2. Background

The area of the proposed SLF, Kabulihan SLF, totals about 6.25 ha in the 10-year SWM plan. The project aims to construct the SLF in order to protect the ecological environment from pollution caused by rampant and indiscriminate throwing of waste, through proper waste disposal.

Since the proposed Kabulihan SLF is classified as Category 1, the Municipality of Malay (MOM) only needs to submit an IEE checklist to obtain an ECC. The MOM has finished an IEE study for the SLF which was proposed in the past and submitted an IEE report to the DENR-EMB Regional 6 Office on February 10, 2007. The office has approved it and issued an ECC for the proposed SLF on June 5, 2007 with several conditions. However, the 10-year SWM Plan and F/S has modified several components of the SLF for which the ECC was issued. Thus, the MOM now needs to amend the existing IEE report to obtain an amended ECC. This study of the environmental and social considerations was therefore aimed at supplementing the IEE previously done by the MOM in order to obtain the amended ECC.

3. Approach and Methodology

3.1 Approach

The current ECC for the SLF on the Mainland of Malay was issued on June 5, 2007 with several conditions for environmental management. The conditions of the ECC have been taken into consideration in the design of the newly proposed SLF as environmental mitigation measures as well as the Environmental Management and Monitoring Plan (EMMP).

On the other hand, it is necessary to amend the current ECC mainly because the area of the SLF will be expanded from 5 ha in the current IEE to 6.25 ha. There are two levels of ECC amendment, i.e. major and minor. If a modified project includes components such as expansion of land or project area, major changes in process flow or technology to be used, the ECC amendment is categorized as "major". Meanwhile, modifications of components such as typographical error, extension of deadlines for submission of post-ECC requirements, extension of ECC validity, change in company name or ownership, decrease of land or project area or production capacity, are regarded as minor requests. Therefore, the ECC amendment for the proposed SLF is regarded as "major" and the legislative procedures for amending the ECC are as follows:

- The MOM should request an ECC amendment by a letter with necessary data to the DENR-EMB Region 6 Office.
- After receiving the letter, the DENR-EMB Region 6 Office immediately starts to evaluate the request.
- An ECC amendment should be approved by the DENR-EMB Region 6 Office. For an ECC issued based on the IEE study, the period of reviewing the amendment request shall not exceed 30 working days.

3.2 Methodology

The IEE study encompassed the physicochemical, biological and socio-cultural dimensions of the affected environment. The IEE study passed through the following stages:

Table C A .3.2-1 Stage of the IEE Study

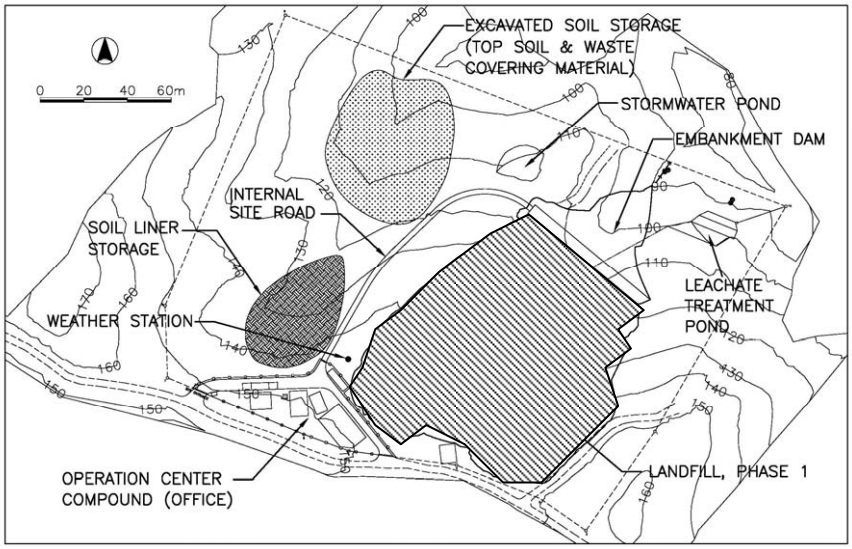
Stage	Activity
1	Preliminary Preparation
2	Scoping
3	Final preparation and mobilization
4	Baseline studies, eco-profiling and validation
5	Impact identification and prediction
6	Proposals of environmental mitigating measures that mitigate and/or offset negative impacts and enhance positive impacts.
7	Environmental management and monitoring planning
8	Preparation of IEE document
9	Public consultation

Source: JICA Study Team

4. Project Description

There are a number of fundamental considerations in developing the overall design concept of the SLF. The key features of the development plan of the SLF are summarized in Table C A.4.1-1.

Table C A.4.1-1 Overall Project Description

<table>
<tr><td>Item</td><td>Description of Proposed New Sanitary Landfill Site (Phase I)</td></tr>
<tr><td>Location and area</td><td>Location: Barangay Kabulihan, Municipality of Malay, Aklan Province
Area: 6.25ha</td></tr>
<tr><td>Waste amount and characteristics to be hauled</td><td>- Amount of waste to be hauled to the SLF
<table>
<tr><th>Year End</th><th>Incoming Waste (tons per day)</th><th>Planned Residuals (tons per day)</th><th>Incoming Waste (tons per annum)</th><th>Cumulative Waste (tons)</th></tr>
<tr><td>2007</td><td>-</td><td>-</td><td>4,500</td><td>4,500</td></tr>
<tr><td>2008</td><td>10.70</td><td>12.84</td><td>4,699</td><td>9,199</td></tr>
<tr><td>2009</td><td>11.40</td><td>13.68</td><td>4,993</td><td>14,193</td></tr>
<tr><td>2010</td><td>12.40</td><td>14.88</td><td>5,431</td><td>19,624</td></tr>
<tr><td>2011</td><td>13.00</td><td>15.60</td><td>5,694</td><td>25,318</td></tr>
<tr><td>2012</td><td>12.00</td><td>14.40</td><td>5,270</td><td>30,588</td></tr>
<tr><td>2013</td><td>11.70</td><td>14.04</td><td>5,125</td><td>35,713</td></tr>
<tr><td>2014</td><td>11.10</td><td>13.32</td><td>4,862</td><td>40,575</td></tr>
<tr><td>2015</td><td>10.50</td><td>12.60</td><td>4,599</td><td>45,174</td></tr>
<tr><td>2016</td><td>10.50</td><td>12.60</td><td>4,612</td><td>49,785</td></tr>
<tr><td>2017</td><td>10.50</td><td>12.60</td><td>4,599</td><td>54,384</td></tr>
</table>
- Waste to be hauled to the SLF is residual waste and treated health care waste</td></tr>
<tr><td>Overall feature of the project</td><td> 
</td></tr>
<tr><td>Main facility and equipment</td><td>Landfill area (including liner system), embankment dam, ground drainage system, surface water management system, leachate collection system, leachate extraction and transfer system, leachate treatment system, landfill gas management system, special waste cell, operation center compounds, other equipment for landfill and transport, etc</td></tr>
<tr><td>Implementation schedule</td><td>Construction (Phase I): 2008 to 2013
Operation (Phase I): 2009 to 2017</td></tr>
<tr><td>Estimated project cost</td><td>Initial Investment: PhP 60.8 million
Operation and Maintenance Cost: PhP 22.8 million (until 2017)</td></tr>
</table>

Source: JICA Study Team

5. Current Condition

5.1 Physical Environment

Surface water surveys were conducted at three locations. One was taken from a spring near the site, and the others were taken at major creeks which drain from the site. The samples were collected in the dry season on June, 2007 and rainy season on September, 2007. The result did not show any significant differences between the dry and rainy seasons. The result revealed that there was no critical contamination in the water environment around the site except for coliform. The samples were collected in the dry season on June, 2007 and rainy season on September, 2007. The result did not show any significant differences between the dry and rainy seasons. The analysis of surface water detected magnesium and iron, but their concentrations were not at critical levels. In terms of lead, copper and cadmium, most samples had a concentration below their detection limits. However, total number of coliform was 2 to 9 times higher than the Philippine standard.

As for the groundwater surveys, the samples were taken from water quality monitoring wells in the site and the existing wells located along the Malay River. The same as the surface water survey, neither the quality of the water in the monitoring wells nor of the existing wells showed critical contamination except for coliform. Though the analysis detected magnesium and iron, their concentrations were not at critical levels. Concentrations of lead, copper and cadmium of most samples were below their detection limits. All of the samples had much more coliform than the Philippines standard.

The result of the air quality survey did not indicate any landfill gas in the ambient air in or around the site. Four parameters, CH_4, CO_2, H_2S and NH_3, were surveyed at five sampling points in the site using a G450 Portable Gas Detector. The concentrations of all four parameters were below the detection limits of the Portable Gas Detector. In terms of odor, no offensive odors were experienced during the survey on the site.

During the survey, the noise levels were recorded as 40 - 60 dB (A), which is levels recorded under the normal conditions. The sound was generated by wind blowing, animal and bird singing, and working activities without operation of heavy equipment.

5.2 Ecological Environment

Based on the interview survey, the Malay River and its tributaries provide habitat for shellfish, eels and shrimp. The residents in Barangay Kabulihan do not catch them to sell but rather for their daily consumption although fishing activities are not popular around the mouth of the Malay River. Goat fish, snapper, butterfly fish and rabbitfish are commonly caught at a depth of over 15m of in offshore areas around the northern part on the Mainland of Malay.

Barangay Kabulihan, as well as the site, is home to a great number of plant species which are endemic in the area. During the survey, 60 kinds of plants were observed. Local residents utilize them as food, medicine, and materials for weaving and building houses.

Fruits bats are commonly observed by local residents around the site. Indiscriminate habitat destruction and hunting activities by the residents threaten the fruit bats. Monkeys commonly inhabit the areas around the site as well. In addition, several species of reptiles live around the site.

5.3 Social Environment

Barangay Kabulihan, consisting of seven sitios (the smallest socio-political unit and a political subdivision of a barangay), had a total population of about 500 persons and 115 households at the survey time. Land use within a 1 km radius from the site is mainly composed of five categories such as agricultural land, coconut plantation, grassland, secondary forest and small areas of paddy fields. Though most of the local residents are engaging in agricultural and fishing activities, many of the residents interviewed earn their income through work on Boracay Island.

In addition to water from the Malay River, Agnaga River and seven creeks, local residents use two water tanks located along Bajangan creek to which ten communal faucets connect. There are ten deep wells and three dug wells around the site. Some of the more affluent families have installed motorized pumps.

The perception survey was conducted targeted 99 residents around the site. About 15% were in favor of the project since it could contribute to improving the SWM. However, about 70% of the respondents showed their concerns about pollution of the environment and affects on their health. In terms of specific issues, 76 % of the respondents had a concern that the SLF may cause negative effects on the groundwater quality especially during the operation phase. A total of 40% were anxious about the groundwater contamination which may continue even after its closure. Furthermore, about 70% of the respondents said that the SLF may devalue their land.

While the respondents worried about the negative impacts caused by the SLF, they anticipated some benefits through the project implementation. Positive impacts expected by the respondents were better business opportunities and improvement of SWM.

6. Environmental Impacts

The environmental impacts caused by the development of the SLF have been identified and assessed to determine whether the proposed SLF is environmentally sound or not. The identified environmental impacts are summarized in Table C A.6-1 based on the Procedural Manual of the DENR.

Table C A.6-1 Identified Environmental Impacts by the SLF

Potential Impacts	Environmental Impact/Effects	Type of Impact + or -	Duration: ST-Short Term LT- Long term	Magnitude S-Significant M-Moderate I-Insignificant
Construction Phase				
1. Geology and Hydrogeology	1. Soil Erosion and Siltation	-	LT	M
	2. Potential Slope Failure and Landslide	-	ST	M
	3. Change in Landform and Geomorphology	-	LT	M
2. Hydrology	1. Increase in surface Run-off	-	ST	I
	2. Decrease in river carrying capacity	-	ST	I
3. Water Quality	1. Increase of surface water turbidity	-	ST	M
	2. Contamination of inland and marine water	-	ST	I
4. Air Quality	1. Increase of dust	-	ST	I
	2. Increase concentration of NOx and SOx	-	ST	I
	3. Noise	-	ST	I
	4. Offensive odor	-	ST	I
5. Biota and Ecosystem	1. Siltation	-	LT	M
	2. Pollution load	-	LT	I
	3. Site clearance	-	ST	I
6. Socio-Economic	1. Generation of jobs	+	ST	I
	2. Increase in business/ economic activities	+	ST	I
	3. Increase in indirect revenues	+	ST	I
	4. Change in land use	-	LT	I
	5. Local conflict of interest	-	ST	I
7. Health and Safety	1. Possible occurrence of diseases	-	ST	I
	2. Possible accidents	-	ST	I
Operation Phase				
1. Geology and Hydrogeology	1. Potential stoppage of spring flow and/or redirection of groundwater flow	-	LT	M
2. Hydrology	1. Increase in surface Run-off	-	ST	I
3. Water Quality	1. Increase of surface water turbidity	-	ST	M
	2. Contamination of inland and marine water	-	ST	S
	3. Contamination of groundwater	-	LT	S
4. Air Quality	1. Gaseous emissions	-	LT	I
	2. Odors	-	LT	M

Potential Impacts	Environmental Impact/Effects	Type of Impact + or -	Duration: ST-Short Term LT- Long term	Magnitude S-Significant M-Moderate I-Insignificant
5. Biota and Ecosystem	1. Siltation 2. Pollution load	- -	LT LT	I M
6. Socio-Economic	1. Job opportunities	+	LT	M
7. Health and Safety	1. Possible occurrence of diseases 2. Possible accidents	- -	ST ST	I I

Source: JICA Study Team

6.1 Construction Phase

6.1.1 Potential Impacts Associated with Geology and Hydrogeology

The effects of the construction activities includes geological instability and disturbances, modification in land form and soil erosion that may be caused by the breakage and movement of earth materials, possible stoppage and or redirection of spring flows, etc. Although the project probably has no significant impact on the geology of the site, the potential impacts associated with geology and hydrogeology during the construction phase are as follows:

- Soil erosion and siltation
- Potential slope failure and land slide
- Change in landform and geomorphology

(1) Soil Erosion and Siltation

The runoff of fine materials would originate from bench slopes, development areas, road surfaces, and embankments. It is expected that during heavy downpour, fine materials would be transported down to the lower areas into the Malay River.

Soil erosion and siltation are expected to be occurred at the site and the area where store the earth materials. It is noted that the landfill activities require earth cover material which will be taken from the site. Because the development of the SLF may need plenty of earth materials that can be utilized for lining and covering, the landfill construction is likely to contribute to soil erosion by altering the soil, vegetation and topography of the areas as follows:

- By stripping the shrubs and grass to provide for construction site, soil erosion is exacerbated. The vegetation serves to reduce surface run-off velocity, hold the soil in place and increase transpiration rates,
- To extract earth materials, an area where a plenty of rock and earth will be broken and loaded is required and particles from the spoils are eroded from that area during downpours, and,
- Excavations, road cuts and embankments alter the topography and the alteration will likely elevate soil erosion.

Soil erosion likely leads to siltation and increase in turbidity level of the surface water near the landfill site.

(2) Potential Slope Failure and Landslide

Geological mapping indicates that the proposed site is not within any identified geo-hazard zone. No mass movement has been observed within the site, nor in the adjacent areas. Hence, the MGB concluded that the area is suitable for the SLF. The strategic location of a confining catchment basin minimizes precipitate run-off that could discharge on the intermittent creek, and no flooding is expected since the area is anchored in the 250 meters elevation and gentle slope mountain. However, it is emphasized that a detailed engineering geological/geotechnical investigation should be conducted to assess and characterize the potential instability and select appropriate mitigation works.

Slope failure and instability are likely to occur on the cut slopes, on the portions where significant discontinuities (faults, cracks, fractures) occur. The instability is likely to occur during the rainy season because the saturated condition would increase the pore water pressure on the rock mass. The increase in pore pressure reduces the shear strength of the rock. When the shear stress acting on the rock exceeds the shear strength, instability may occur.

(3) Change in Landform and Geomorphology

The change in landform and geomorphological features within the site is significant. This impact is irreversible and inherent to landfill projects. The clearings and excavation would break the topography. The soil, shrubs and grass shall be replaced by compacted waste. The alteration caused by the landfill construction would also occur in case of no mitigation measure.

6.1.2 Potential Impacts on Hydrology

(1) Increase in Surface Run-off

The SLF development will require the construction of landfill facilities, access/haulage roads, and clearings within the site. These are expected to increase surface water runoff. Stripping, re-grading and compaction of these areas may reduce ground permeability. Consequently, the peak flow from the disturbed areas is expected to increase. The surface runoff is likely to be silted that could likely increase the turbidity levels in the river.

(2) Decreased River Carrying Capacity

With the construction works, ground clearing and earth movement is likely to accelerate soil erosion. The sediments may be carried downstream into the Malay River. If the siltation

cannot be controlled, the sediments may settle and constrict the waterway. Consequently, the river's drainage capacity may be reduced and the risk of flooding increases in the flood plain areas along the waterway.

6.1.3 Potential Impacts on Water Quality

(1) Surface Water Quality

A potential increase in turbidity in the Malay River may be caused by siltation. Siltation could be brought about by erosion, the transport of fine materials from the construction area, and increased surface water runoff, flowing towards the river.

The heavy equipment needs fuel and lubricants during construction. If these oil products are not handled properly, these would likely find their way to the Malay River, which may pollute the river.

The construction works could generate industrial and domestic wastes. The industrial waste include worn engine parts, old belts, bearing, steel plates, etc. without proper containment, the surface and groundwater sources may be contaminated with heavy metals, chemicals, and other wastes. The domestic wastes comprise mainly of sewage, fecal matter and garbage.

(2) Coastal Marine Water Quality

The potential siltation in the Malay River could find its way into the coastal water particularly during heavy downpours, which may make the waters turbid. The marine surface current may carry the suspended solids (SS) to the fishing grounds of local fishermen. The oil and other domestic waste water released from the site during construction that runs into the Malay River could eventually reach the coastline and these pollutants would increase the BOD and lower the DO levels in the water.

6.1.4 Potential Impacts on Air Quality

(1) Air Quality

Based on the assessment, the air quality in the landfill area was good and NO_x and SO_x were still very low. The construction works at the site such as the use of heavy equipment are expected to have an impact on the area's air quality through elevated levels of dust and a minor extent of NO_x and SO_x. Impact areas are the immediate vicinities of the access roads and landfill construction site.

During construction earth cutting and the movement of the earth that involves the hauling and transport of materials is likely to raise the concentration of Total Suspended Particulates (TSP) significantly and may even exceed the DENR Standards. However, this condition is only temporary and only for a short period of time during the land preparation and construction phase. During quarrying dust would be generated by the loading, hauling, and stock piling of earth materials. However, this condition will only be sporadic and temporary occurring only during dam construction activity.

(2) Odor

The proposed SLF was already used for stockpiles of the residual waste from the MRFs on Boracay Island and on the Mainland of Malay. Odors were identified especially during transfer of stockpiles of waste, thus generation of odor is expected.

(3) Noise

Ground preparation and clearing activities, construction and quarrying activities will undoubtedly generate noise in the area. The noise generators will be the heavy equipment such as bulldozers, payloaders, rollers, dump trucks, etc.

Table C A.6.2-1 provides the noise levels typically produced by the construction equipment. All sound ratings of the listed equipment exceeds the DENR Standard of 75 dB(A). Depending on the type and extent of activity to be undertaken the noise level as a result of the use of several types of equipment can be computed using the formula given below:

$$N=10 \log (10^{-(N1/10)} + 10^{-(N2/10)} + \dots 10^{-(Nn/10)})$$

Where:

N = total noise level of construction activities

N_1 to N_n = noise level of each equipment

Table C A. 6.2-1 Typical Noise Levels by Construction Equipment

Equipment Type	Sound Level (dB(A)) at 15 meters from source
Air Compressor	75-87
Backhoe	71-92
Compactor	72
Concrete Mixer	75-88
Concrete Pump	82
Crane	76-88
Front Loader	72-81
Generator	80-93
Grader	81-97
Jackhammer	87-88
Paver	95-105
Pile Driver	70-90
Pumps	78-95
Tractor	78-95
Bulldozer	83-93
Truck	68-95

Source: Larry W. Canter; "Environmental Impact Assessment", 1977

However, sound or noise travels in longitudinal waves through the air and gradually dissipates as it travels away from the source. Noise reduction or attenuation occurs as sound travels to various distances, hundred by structures and vegetation along its path. As a sequence of this buffering process, the resultant noise levels of the equipment are lower as listed in Table C A.6.2-2.

Table C A.6.2-2 Noise Level at Various Distances from the Source

Equipment	Noise Level (dBA)			
	30 m	80 m	120 m	240 m
Air Compressor	69-80	63-75	57.-9	51-63
Backhoe	65-86	59-80	53-74	47-68
Compactor	60	66	54	48
Concrete Mixer	69-82	63-76	57-70	51-64
Concrete Pump	76	70	68	54
Crane	70-80	64-74	58-68	52-62
Front Loader	66-75	60-74	54-63	48-57
Generator	66-76	60-70	54-64	48-58
Grader	74-87	68-81	62-75	56-69
Jackhammer	75-91	69-85	63-79	57-73
Paver	81-82	76-75	69-70	63-64
Pile Driver	89-88	83-93	77-87	71-81
Pumps	64-84	58-78	52-72	44-66
Tractor	72-89	66-63	60-77	54-71
Bulldozer	72-89	66-83	60-77	54-71
Truck	77-87	71-81	65-75	59-69
Vibrator	92-75	56-69	50-63	44-57

Source: Larry W. Canter; "Environmental Impact Assessment", 1977

6.1.5 Potential Impacts on Biota and Ecosystem

(1) Potential Impacts on Freshwater Biology

Based on biological assessment, the downstream portion of the Malay River is generally in good condition. During the construction period, stressors such as silt, oil, and organic loads may potentially be introduced.

Siltation could have adverse impacts that include destabilization of streambeds and loss of habitat of species. Smothering of invertebrates and general changes in benthic community structures such as reduction in density, loss of diversity and increase in populations of tolerant species could potentially occur. Extreme disturbance such as excavations and overburden stripping would destruct small streams and drainage networks and may lead to loss of floral and faunal habitats. Accidental spills of the substances and pollutants from the construction works, which may be flown into the Malay River, may also have a potentially adverse effect on the ecosystem.

(2) Potential Impacts on Marin Biology

The proposed SLF is located about 7 km from the coastline. Nevertheless, the potential impacts on the marine ecology are projected as minimal to moderate level. However, siltation generated by the construction activities could potentially find its way into the Malay River which discharges into the coastline which may have a potentially adverse effect on the marine ecosystem. Accidental spills of the substances and pollutants from the construction works, which may be flown into the Malay River and eventually reach the coastline, may also have a potentially adverse effect on the marine ecosystem.

6.1.6 Potential Socio-economic Impacts

One of the positive economic impacts will be the generation of job opportunities to the local people. This provides income to the people and increases their disposable income. The construction work will create a multiplier effect where various economic activities will be promoted. This leads to the creation of more jobs and disposable income will also increase. The project purchases of supplies and materials from local firms together with expenditures by project workers typically result in increased business activities and employment in the local trade and service sectors.

The SLF is proposed within grassland as contained in the Proposed General Land Use Plan of Malay. The construction of the SLF is not expected to modify the land use classification since the area falls within the grassland zone. The site is dominated by shrubs locally known as "an-an", associated with batino, duhat, lagasi, tungaw-tungaw, alagaw, puti-an, inyam, coconut, hambu-aya and other locally known tree and shrubs. The site is devoid of trees and shrubs, and is overgrown with grasses consisting of cogon and carabao grass and will undergo a total change in land use.

6.1.7 Potential Impacts on Health and Safety

There will be an inflow of new workers for the construction of the SLF. The possibility of outbreaks of infectious disease from such workers can not be neglected. Meanwhile, there is a possibility to happen accidents in the construction activities.

6.2 Operation Phase

6.2.1 Potential Impacts Associated with Geology and Hydrogeology

The engineering geological condition may have a strong bearing on the stability and integrity of the site. Seismology may influence the sensitivity of the site to seismic events such as earthquakes that could lead to slope failures. The geology of the site will also have a bearing on the type of soil of which physical characteristics would dictate the susceptibility of the soil to erosion.

Groundwater in the upland area of the site is relatively deep. The springs and seepages appear to be structurally controlled, mainly by fractures and cracks. The site is likely to be relatively less vulnerable to groundwater contamination compared to the lowland area that is underlain by alluvial material.

6.2.2 Potential Impacts on Water Quality

The contaminated runoff from the leachate would be discharged into the freshwater during rainy season when the heavy rainfall increases. During rainy season, the runoff rates are expected to be relatively higher, resulting in the dilution of the contaminants. It would be possible that the runoff effluent from the SLF may result in further degradation of the aquatic environment in case of no mitigation measures. On the other hand, no discharge of the

leachate is expected during dry season.

Contaminated surface runoff could have potential adverse impact on downstream freshwater quality. Once any of the pollutants reach the marine environment, they may cause marine water quality degradation and pose a threat to the coastal marine ecosystem. Another scenario that could develop is that surface water runoff may be diluted once it reaches the marine environment. Regular monitoring of surface water quality could determine the actual effects, which could provide crucial information for the management of the SLF.

Potential groundwater contamination caused by the infiltration of untreated or poorly treated leachate into the subsurface, which could eventually intersect with the groundwater flow that is projected towards the coastal zone. In addition, the absence of leachate treatment facilities for the workers could potentially cause the contamination of groundwater.

6.2.3 Potential Impacts on Air Quality

(1) Air Quality

The geographical extent of air quality impacts has been considered from the site as well as from the road where delivery vehicles pass. The operation of the SLF has the potential to cause the following air quality impacts:

- Gaseous emissions from heavy equipment during operation,
- Gas emissions from vehicles transporting waste during operation, and
- Landfill gas emissions such as methane, carbon dioxide, carbon monoxide, sulphur dioxide, and nitrous oxide.

(2) Odor

The SLF has been used for stockpiles of the residual waste from the MRFs on Boracay Island and on the Mainland of Malay. Odors were identified especially during transfer of waste, thus generation of odor is expected.

6.2.4 Potential Impacts on Biota and Ecosystem

As discussed in the construction phase, siltation could have adverse impacts that include destabilization of streambeds and loss of habitat of species. Pollutants from leachate as well as oil spills would have adverse impacts on biota and ecosystem.

6.2.5 Potential Socio-Economic Impacts

The disposable income of the people could increase, which lead to business opportunities where more people will be encouraged to put up their own small businesses, and that generates employment, thus generating more disposable income and creating a growing cycle of economic growth.

6.2.6 Potential Impacts on Health and Safety

The SLF tends to become breeding and feeding grounds for vectors and animals such as flies, rodents, birds, goats, and stray dogs. Moist waste is an ideal breeding ground, thereby multiplying vermin, rodents and other disease vectors if not properly handled. The operation of the SLF has the potential to cause the following health impacts:

- Possible occurrence of vector diseases such as dengue, malaria, etc.
- Possible occurrence/increase of gastro-intestinal and respiratory problems
- Possible occurrence/increase water-borne diseases such as scabies and other fungal diseases.

7. Environmental Management Plan

7.1 Summary of Environmental Management Plan

The Environmental Management Plan proposed for the development of Kabulihan SLF is summarized in Table C A.7.1-1.

Table C A.7.1-1 Summary of Environmental Management Plan

Component	Impact	Mitigation
Construction Phase		
1. Geology and Hydrogeology	1. Soil erosion and siltation 2. Potential slope failure 3. Change in landform and geomorphology	1. The extent of earthworks should be minimized especially erosion prone areas. 2. Existing vegetation on the site should be retained whenever possible. 3. Contractor should use the best construction practices in order to minimized earthworks and implement site protection and rehabilitation measures. 4. A regular engineering geological, geotechnical and hydrological monitoring focusing on geological hazards shall be conducted to identify unstable areas and take preventive measures.
2. Hydrology	1. Increase of surface run-off 2. Decreased river carrying capacity	1. Silted portion of Malay River should be desalted if necessary. 2. Immediate re-vegetation to prevent/reduce erosion and siltation.
3. Water quality	1. Siltation 2. Pollution loads	1. Refer to soil erosion and siltation mitigating measures for geology and hydrogeology. 2. Good housekeeping, regular inspection of working areas, provision of waste containment 3. Construction areas will be provided with septic sanitation facilities. 4. Contractor must be directed to clean up the construction site and carry out site remediation works
4. Air quality	1. Pollutants (Dust, NOx and SOx) 2. Odor 3. Noise	1. Spraying of water on access roads, haulage roads and other dust generating areas. 2. Bulk cement delivery, rather than bags whenever possible so as to reduce dust emissions. 3. Speeds of vehicles should be regulated especially close to population centers. 4. Re-vegetation of open and disturbed areas which will not be used by the operation. 5. Immediate cover to the waste. 6. All temporary stockpiles waste should be stored, handled and transported appropriately. 7. Contractor should be mandated to implement a preventive repairs and maintenance program to keep the gas emissions low. 8. The use of properly maintained heavy equipment fitted with appropriate muffler or silencers 9. The work schedule shall be limited in day time 10. Special instruction to drivers and heavy equipment operators to use their engines properly, avoid excessive pumping on the fuel and use of horn.

Component	Impact	Mitigation
5. Biota and ecosystem	1. Siltation 2. Pollution loads 3. Land clearance	1. Refer to soil erosion and siltation mitigating measures for hydrogeology 2. Refer to mitigation measures for water quality
6. Socio-economic	1. Jobs opportunities 2. land use change 3. Local conflicts	1. Qualified resident in the locality will be given priority. 2. Conduct consultation with the affected parties prior to the project
7. Health and safety	1. Health 2. Safety	1. Waste treatment facilities such as septic tanks will be installed on the site. 2. Practice personal hygiene and proper sanitation 3. First aid equipment shall be made available at the site. 4. Periodic medical examination 5. Provision of dust respirators to equipment operators who are exposed to dust while operating their equipment, like drillers, heavy equipment operators. 6. Use proper personnel protective equipment (PPE) such as hard hats, gloves steel toe boots, goggles, mask 7. Safety training and educational drive should be given to construction workers. 8. Clear safety signs and warnings should be placed along strategic locations 9. Safety and warning devices such as reflectors, lights shall be installed at designated spots.
Operation Phase		
1. Geology and Hydrogeology	1. Geology	1. Refer to geology and hydrogeology soil erosion and siltation mitigating measures. 2. Engineering geological monitoring should be conducted
2. Hydrology	1. Increase of surface run-off	1. Silted portion of Malay should be desilted. 2. Immediate revegetation of disturbed areas.
3. Water quality	1. Surface water contamination 2. Marin water contamination 3. Groundwater Contamination	1. Provision of impermeable layer underneath liner such as clay and synthetic liner to prevent contamination of the groundwater. 2. Provision of proper drainage system 3. Installation of leachate collection and treatment system 4. Installation of monitoring wells at the upstream and downstream of the landfill site 5. Re-direct surface run-off towards settling/aeration pond or treatment system.
4. Air quality	1. Air pollutants 2. Landfill gas 3. Odor	1 Refer to air quality mitigating measures in the construction phase. 2 A gas ventilation system installed in the SLF. 3 Buffer zone along the periphery of the SLF. 4 Regular monitoring of landfill gas 5 Hauling trucks provided with a cover, 6 Regular cover soil for prevention of bad odors. 7 Aeration of the leachate retention pond 8 Regular monitoring of odor condition in/around the SLF
5. Biota and ecosystem	1. Siltation 2. Pollution loads	1. Immediate revegetation of disturbed areas. 2. Refer to water quality mitigation measures
6. Socio-economic	1. Jobs opportunities	1. Priority will be given to the qualified local people

Component	Impact	Mitigation
7. Health and safety	1. Health 2. Safety	1. Waste treatment facilities such as septic tanks installed on the site. 2. Practice personal hygiene and proper sanitation 3. First aid equipment available at the site. 4. Periodic medical examination 5. Use proper personnel protective equipment (PPE) such as gloves steel toe boots, goggles and mask. 6. Safety training and educational driven should be given to construction workers and personnel. 7. Clear safety signs and warnings should be placed along strategic locations 8. Safety and warning devices such as reflectors and lights should be installed at designated spots.

Source: JICA Study Team

7.2 Discussion of Environmental Mitigation Measures

7.2.1 Construction Phase

Major environmental impacts predicted during the construction phase were evaluated as moderately significant and temporary. They can be minimized or mitigated well by an appropriate design based on a detailed site survey and construction management.

(1) Environmental Mitigation Measures for Impact on Geology and Hydrogeology

1) Soil Erosion and Siltation

To mitigate the adverse impact of the erosion/mobilization of the sediments and materials, particularly during the rainy season, the mitigation measures are proposed as follows:

- The extent of earthworks should be minimized to those that are necessary. Minimization should be incorporated in the earthworks plan; the actual extent of works delineated on the ground and pointed to the heavy equipment operator; and the actual earth movement should be supervised on site. Contractors should use the best construction practices which are specified within the contract documents.
- Extensive grading and earthworks should be minimized in erosion-prone areas. Existing vegetation on the construction site should be retained whenever possible.
- The construction of the landfill will require extensive excavation to achieve the desired level at about 10-20 m depth. Excavation will yield several types of materials including earth and loose rock from shallow excavations and rock from deeper excavations. Much of this material can be used for landfill backfilling, soil cover and other materials for landfill construction, e.g. suitable rock can be used for concrete aggregate, while unsuitable rock can be used as road surfacing and in riprap protection.
- The stockpile area should have a buffer of at least 10 m from a river/creek and from slopes. Spoils and stockpiles management should be implemented.
- Site protection and rehabilitation measures that address soil erosion resulting from construction should be adopted by the contractor. This should be stipulated in the

contract as well as the conditions that will ensure environmental integrity will be maintained during construction and this will become the contractor's responsibility.

2) Potential Slope Failure

A detailed engineering, geological and geotechnical assessment, involving subsurface investigation and slope stability analysis, were conducted for the site. Slope stability analysis shall be made for existing slopes and cut slopes to determine the susceptibility of the ground to slope failure. The other measures are proposed as follows:

- The appropriate drainage system should be put in place to avoid build-up of pore water pressure and reduce the shear strength of the ground.
- Major earthworks should be situated away from residential and other facility areas. This is to minimize risks during extreme emergencies such as heavy downpour or earthquake.
- A regular engineering, geological, geotechnical and hydrological monitoring should be conducted. Special attention should be given to cracks, creeps and other signs of weakness. The actual water flows, flood levels, and seepages must also be monitored especially as they affect the stability of structures.
- Monitoring of geological hazards shall be conducted to identify unstable areas and take preventive measures. Geological hazards such as rock fall and landslide are difficult to predict, but proper monitoring could maintain flexibility and quick response to potential risks and dangers.
- Engineering mitigating measures such as grouting and slope stability measures should be implemented when necessary.

3) Change in Landform and Geomorphology

The change in landform should be mitigated by a progressive rehabilitation and plan. This consists of the following measures:

- Access roads, stockpile area and other clearings no longer needed by operations should immediately be rehabilitated. Rehabilitation measures include among others covering bare areas with topsoil and planting with cover crops to prevent erosion.

(2) Environmental Mitigation Measures for Potential Impacts on Hydrology

The impacts of increased surface run-off from the construction area and other development works as well as the reduced river carrying capacity due to siltation should be minimized by the following measures:

- Silted sections of the Malay River should be desilted if necessary, and
- Immediate re-vegetation to prevent/reduce erosion and siltation.

(3) Environmental Mitigation Measures for Potential Impacts on Water Quality

The soil erosion and sediment control measures are likely to mitigate the increase in turbidity

in the Malay River and then coastal marine water. On the other hand, the following measured for contamination of the Malay River with fuel, oil and grease and other pollutants are proposed as follows. This need to be included in the contract documents and the specifications determined.

- Spills of oil and grease should be avoided by good housekeeping, regular inspection of the working areas and provision of waste containment.
- The construction site should be provided with septic sanitation facilities. No untreated human waste should be allowed to enter any water course.
- When construction is completed, the contractor should clean up the site by removing all equipment and temporary facilities and carry out site remediation works.

(4) Environmental Mitigating Measures for Potential Impacts on Air Quality

1) Pollutants Control

To effectively minimize dust generation, the following dust control measures should be adopted.

- Spraying of water on access road and other dust generating areas.
- Bulk cement delivery, rather than bags, should be used, wherever possible, so as to reduce dust emissions and eventual problems with disposal of the large number of bags.
- Speeds of vehicles in dusty areas such as access roads that are close to population centers should be regulated.
- Re-vegetation of open and disturbed areas which will not be used by the operations.

Although the expected concentration of NO_x and SO_x is projected to be lower than the DENR standard, the contractors should be mandated to implement preventive repairs and maintain the equipment and vehicles to keep gas emissions low.

2) Odor Control

To minimize the odor from the transfer of temporary stockpiles of waste during construction, the following control measure should be conducted:

- Immediate cover to odorous waste after disposal
- Temporary cover of stockpile in the area.
- All temporary stockpiles waste should be stored, handled and transported appropriately.

3) Noise Control

For noise pollution, the mitigating measures are as follows:

- Use of properly maintained heavy equipment fitted with appropriate mufflers or silencers, and
- Special instruction to drivers and heavy equipment operators to use their engines properly, avoid excessive pumping on the fuel and use of horn.

(5) Environmental Mitigating Measures for Potential Impacts on Biota and Ecosystem

The soil erosion and sediment control measures and the other pollutants control are likely to minimize the potential impacts on biota and ecosystem. On the other hand, excessive clearance of the land should be prohibited in order to mitigate adverse impacts on the terrestrial ecosystem.

(6) Environmental Mitigation Measures for Socio-economic Impacts

The proposed SLF site is located along the boundary line between Barangays Kabulihan, Malay and Barangay Mayapay, Burunaga, Aklan. About two third of the area falls within Timber Land Block-A of Malay, Aklan (Project No. 13 per LC Map No. 2922 certified on October 15, 1980) while the remaining area falls within Alienable & Disposable Block-1 of Buruanga, Aklan (Project No 6 per LC Map No. 2324 certified on January 4, 1960). It is specifically located at the southern portion of open access area of the CBFM Project of Kabulihan Farmers and Forest Developers Association (KAFFDA), however, the project was issued a cancellation order on January 25, 2006 by the DENR for violating the terms and conditions of the agreement.

Consultations with the affected parties prior to the project should be conducted. All negotiations and compensation shall conform the Philippine Law derived from the Bill of Rights of the Philippine Constitution “No one shall be deprived of life, liberty or property without due process of law nor anyone denied equal protection of laws and private property not to be taken for public use without just compensation”.

(7) Environmental Mitigation Measures Potential Impacts on Health and Safety

1) Health

Waste treatment facilities such as septic tanks will be installed on the site. No untreated human waste should be allowed to enter any water course.

- To practice personal hygiene and proper sanitation,
- To install first aid equipment at the site, and
- To conduct periodic medical examination.

2) Safe

The following measures are proposed to ensure the safety during the construction works:

- Proper personal protective equipment (PPE) such as hard hats, gloves, steel-toe boots, goggles and masks should be used.
- Safety training and educational drive should be given to construction workers and personnel.
- Clear safety signs and warnings should be placed along strategic locations at the site.
- Safety and warning devices such as reflectors and lights should be installed at designated spots.

7.2.2 Operation Phase

(1) Environmental Mitigation Measures for Potential Impacts on Geology and Hydrogeology

Although the measures discussed for the construction phase are likely to mitigate the incidence of slope failure or mass movement, some areas may experience slope failures because of their geological structural condition. Therefore, engineering geological monitoring should be conducted periodically.

(2) Environmental Mitigation Measures for Potential Impacts on Hydrology

In order to mitigate the increase of surface run-off from the site, rainwater collection system to handle increased surface run-off should be installed. The facility should be sized according to the expected rainfall, vegetative cover and size, type and topography of catchment.

(3) Environmental Mitigation Measures for Potential Impacts on Water Quality

The soil erosion and sediment control measures are likely to mitigate the increase in turbidity in Malay River. In addition, the potential risks of surface and groundwater contamination due to leachate is to be mitigated by the following measures:

- Peripheral drainage systems will be installed to prevent storm water from running into the SLF and off the surrounding water environment.
- Leachate control system will be installed. Retention and recirculation facility associated with aeration of the leachate is installed.
- In order to reduce the percolation of the leachate to groundwater, installment of a liner system on the bottom of cells is recommended.
- The wastewater from the maintenance workshop will be treated before being discharged.
- Applying a clay cap upon the individual cells to reduce generation of leachate.
- Regular monitoring on Malay River, groundwater, and leachate will be planned.

(4) Environmental Mitigation Measures for Potential Impacts on Air Quality

1) Pollutants

To effectively minimize dust generation, the following dust control measures should be adopted:

- Spraying of water on the access road and other dust generating areas,
- Speeds of vehicles in dusty areas such as access roads should be regulated,
- Re-vegetation of open and disturbed areas which will not be used by the operation, and
- Provision of vegetation buffer.

Although the expected concentration of NO_x and SO_x is projected to be low, the proponent should be mandated to implement preventive repairs and maintenance of the equipment and vehicles to keep gas emissions low.

2) Landfill Gas Control

To minimize the impacts of landfill gas during the operation, the following control measures should be conducted:

- Installation of a gas ventilation system in the SLF.
- Buffer zone along the periphery of the SLF.
- Regular landfill gas monitoring.

3) Odor Control

To minimize the odor during the operation, the following odor control measures should be conducted:

- Hauling waste with a cover.
- Regular cover soil for prevention of bad odors.
- Aeration of the leachate retention pond.
- Buffer zone along the periphery of the SLF.
- Regular monitoring of odor condition in/around the SLF.

(5) Environmental Mitigating Measures for Potential Impacts on Biota and Ecosystem

The soil erosion and sediment control measures, and installation of leachate control and treatment system at the site could contribute to minimize the potential impacts on biota and ecosystem. In addition, a clay cap upon the individual cells overlain by a layer of agricultural soil suitable for vegetation growth should be applied.

(6) Environmental Mitigating Measures for Potential on Socio-Economic Impacts

In order to improve the positive impact, the following enhancement measures are necessary:

- Prioritized hiring of local workers as much as possible, and
- Secure operation materials from local markets as much as possible.

(7) Environmental Mitigation Measures for Potential Impacts on Health and Safety

1) Health

Waste treatment facilities such as septic tanks will be installed on the site. No untreated human waste should be allowed to enter any watercourse. The other measures to be taken are proposed as follows:

- To practice personal hygiene and proper sanitation,
- To install first aid equipment at the site, and
- To conduct periodic medical examination.

2) Safety

Safety training and education should be given to workers and the other measures are proposed as follows:

- Proper personal protective equipment (PPE) such as hard hats, gloves, steel-toe boots, goggles and masks should be used.
- Clear safety and warning signs should be placed along strategic locations at the site.
- Safety and warning devices such as reflectors and lights should be installed at designated spots.

8. Environmental Monitoring

8.1 Monitoring Protocol

Although the DENR-EMB has the primary mandate of monitoring under the Philippine EIS System, the other stakeholders (e.g., proponent) have equally significant roles in the monitoring system. The DENR has always recognized the vital contribution of proponents and other stakeholders. The DENR-EMB, with its overall mandate to implement the Philippine EIS System, is the responsible agency that shall ensure that the monitoring objectives are achieved.

The compliance and impact monitoring shall be carried out in accordance with established procedures and protocols. Within the framework of the EIS System, the responsibilities of monitoring projects are lodged with the EMB regional offices. The EMB central office shall provide policy guidance and, if necessary, technical assistance to the LGUs concerned. As a minimum requirement in compliance monitoring, DENR-EMB focuses on the following:

- status of proponent's delivery of commitment made in its EMP.
- effectiveness of the committed EMP in mitigating project's environmental impacts.
- meeting the terms and conditions of the ECC.

All projects covered by the EIS System and issued ECCs are subject to periodic monitoring by the EMB, i.e., compliance and impact monitoring, in accordance with established procedures and protocols. The conduct of monitoring starts once an ECC is issued to the project. Proponents required to establish an Multi-Party Monitoring Team (MMT) and shall put up the corresponding Environmental Monitoring Fund (EMF) not later than the initial construction phase of the project.

8.2 Multi-Party Monitoring Team (MMT)

8.2.1 Formation of Multi-Party Monitoring Team

The provision of the MMT shall be taken from Chapter 7 of the DAO 2003-30. The MMT shall be formed immediately after the issuance of ECC. The purposes for organizing the MMT are to encourage public participation, greater stakeholders' vigilance and provide

appropriate check and balance mechanisms in the monitoring of project implementation. The MMT also serves as the focal group to handle complaints from stakeholders at the local level.

The EMB, in coordination with the proponent, should organize the MMT to enable it to function as an autonomous environmental monitoring partner. With due consideration to the nature and location of the project, the MMT should be composed of various stakeholders such as representatives of the DENR-EMB, PENRO, CENRO, MOM, Barangays, NSWMC and local residents.

8.2.2 Functions of the MMT

The MMT shall monitor project compliance with the conditions stipulated in the ECC and commitments made in the EMP by:

- reviewing and validating proponent's Self Monitoring Report (SMR) and other reports (e.g., third party audits), and submits Compliance Monitoring and Verification Report (CMVR) to DENR-EMB,
- preparing, integrating, and disseminating simplified monitoring reports and recommendations to the DENR,
- interfacing with proponent, third party auditors and other parties, or engage the services of other expects as deemed necessary,
- initiating popularization of monitoring results for community consumption,
- prepare the MMT Manual of Operations (MOO), work and financial plan, and other plans/reports based on the proponent's EMMP,
- institutionalize best practice for EMF management and administration, and
- receiving complaints/requests from the public-at-large for transmittal to the proponent and the DENR-EMB and be able to recommend immediate measures against the complaint.

All monitoring activities of the MMT shall require the completion of a findings report - called CMVR, a copy of the CMVR shall be submitted to the EMB Regional Office.

8.3 Environmental Monitoring Plan

The Environmental Monitoring Plan which includes the one for post-closure phase is proposed as shown in Table C A.8.1-1.

Table C A.8.1-1 Environmental Monitoring Plan for the SLF

Project Phase	Components	Parameters	Measurements	Monitoring Points	Frequency	Reference Standards	Responsibility
Construction	Groundwater	Temperature, pH, Color, Turbidity, Dissolved Oxygen, Total Suspended Solids, Total Dissolved Solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Four installed monitoring wells in the site and two existing wells downstream of Malay River	Monthly	Philippine Standard for Drinking Water (PSDW)	MOM, Contractor
	Surface Water	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Three points (upstream of the site, near the site and downstream of the site)	Monthly	DAO No. 34 (Class A)	MOM, Contractor
Operation	Leachate	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total Suspended Solids, Total Dissolved Solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Outflow point from the SLF	Volume, Temperature and pH: everyday; Others: Monthly	DAO No. 35 (Category II)	MOM, Contractor
	Discharged water (Leachate)	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Point of discharge to the water environment	Volume, Temperature and pH: everyday; Others: Monthly	DAO No. 35 (Category II)	MOM, Contractor
	Groundwater	Temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Four installed monitoring wells in the site and two existing wells downstream of Malay River	Monthly	Philippine Standard for Drinking Water (PSDW)	MOM, Contractor
	Surface water	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Three points (upstream of the site, near the site and downstream of the site)	Monthly	DAO No. 34 (Class A)	MOM, Contractor

Project Phase	Components	Parameters	Measurements	Monitoring Points	Frequency	Reference Standards	Responsibility
	Landfill gas	Gas temperature, Methane (CH_4), Carbon Dioxide (CO_2), Hydrogen Sulfide (H_2S), Ammonia (NH_3)	Measurement of ambient concentrations (1999 Philippine Clean Air Act)	At installed gas venting facilities	Monthly	1999 Philippine Clean Air Act	MOM, Contractor
	Offensive odors	Check 'unpleasantness'	'Unpleasantness' by surveyor	Three points at the site	Everyday	-	MOM, Contractor
	Extent of disease vectors	-	Visual check	The areas where waste is disposed	Weekly	-	MOM, Contractor
Post-closure	Leachate	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Outflow point from the SLF	Volume, Temperature and pH: everyday; Others: Monthly	DAO No. 35 (Category Ⅱ)	MOM
	Discharged water (Leachate)	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Point of discharge to the water environment	Volume, Temperature and pH: everyday; Others: Monthly	DAO No. 35 (Category Ⅱ)	MOM
	Groundwater	Temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Four installed monitoring wells in the site and two existing wells downstream of Malay River	Monthly	Philippine Standard for Drinking Water (PSDW)	MOM
	Surface water	Discharge, temperature, pH, Color, Turbidity, Dissolved Oxygen, Total suspended solids, Total dissolved solids, Conductivities, Oil/Grease, BOD, COD, Chloride as Cl, Ammonia Nitrogen, Calcium, Magnesium, Iron, Lead, Copper, Cadmium, Chromium Hexavalent, Mercury, Coliform	DAO No. 34 and 35	Three points (upstream of the site, near the site and downstream of the site)	Monthly	DAO No. 34 (Class A)	MOM
	Landfill gas	Gas temperature, Methane (CH_4), Carbon Dioxide (CO_2), Hydrogen Sulfide (H_2S), Ammonia (NH_3)	Measurement of ambient concentrations (1999 Philippine Clean Air Act)	At installed gas venting facilities	Monthly	1999 Philippine Clean Air Act	MOM

Source: JICA Study Team

9. Public Consultation Meetings

The MOM organized public consultation meetings regarding the new SLF. Table C A.9.1-1 presents their summarized outlines.

Table C A.1.9-1 Summary of Public Consultation Meetings

No.	Study Phase	Main Subject	Date	Number of Participants
1	Preliminary survey on the new SLF site	– Introduction of the plan of the new SLF – Explanation of geological and physical environmental assessments of the new SLF site	4th of April, 2006	8
2	Preliminary survey of the new SLF site	– Explanation of geological and physical environmental assessment of the new SLF site and its approval	30th of November, 2006	8
3	F/S (Drafting IEE report)	– Background of the proposed SLF project – Project description – Environmental and social issues	10th of December, 2007	38

Source: MOM and JICA Study Team

9.1 First Public Consultation Meeting

The MOM organized the first public consultation meeting at the Malay Session Hall on the Mainland of Malay on April 4, 2006. The Mayors of MOM and MOB, all of barangay chairpersons of the MOM, DENR Aklan and DENR-EMB Region 6 personnel attended the meeting.

In the meeting, the MOM introduced their ideas for development of the new SLF and explained the results of the geological and environmental assessments. The DENR and MOM conducted the geological and environmental assessments on the proposed new SLF site in order to identify its area, land classification and ecological conditions. The survey revealed that about one fifth of the area is Timber Land, i.e. public land, and rest of it is classified as Alienable and Disposable Land, i.e. land which can be owned privately.

9.2 Second Public Consultation Meeting

The MOM held the second public consultation meeting at the Barangay Hall in Barangay Kablihan on November 30, 2006. The MOM explained that the DENR had determined that the proposed site was suitable for the new SLF based on the geological and environmental assessments. The Council of Barangay Kablihan endorsed the development of the new SLF on the condition that the several conditions presented in the minutes are complied with.

9.3 Third Pubic Consultation Meeting

The MOM held the third public consultation meeting on December 10, 2007. The objective was to explain the project outline, such as the background, necessity, location and key components of the design, development plan, and a brief presentation on the results of the environmental and social survey to relevant stakeholders. The meeting also aimed at collecting participants' opinions and concerns. The participants expressed their opinions and concerns, and the MOM answered them. The local language, Tagalog, as well as English were used in the meeting.

Thirty eight (38) participants attended the meeting. They were composed of the barangay chairperson, members of Kagawad (council at barangay level), officials from the SB, staff from the MOM, official of DENR-EMB, Kabulihan Farmers and Forest Developers Association (KFFDA) and the JICA Study Team.

(1) Main Discussion

Throughout the meeting, the atmosphere was supportive for the new SLF project and the attendees actively exchanged their opinions. Firstly, in terms of environmental aspects, the impact on the groundwater and surface water quality was one of the things that most concerned the participants. Several measures, such as a leachate treatment facility, which were incorporated into the design of the SLF to prevent deterioration of the water quality, were explained. The MOM also explained the results of present water quality tests and a plan to monitor the quality. On the other hand, one participant raised a concern about breeding of flies and offensive odors due to disposed waste in the SLF. The participants discussed that it is biodegradable waste that causes breeding of flies and offensive odors, and strict segregation is crucial before the waste is transferred into the SLF. The participants and MOM confirmed that the new SLF would accept residual waste and the importance of the IEC for enhancing segregation activities.

Secondly, the participants and the MOM discussed the importance of waste diversion. The major components of SWM are reduction, recycling, composting and final disposal of residual waste. To reduce the amount of residual waste, the business sector should tackle reducing the amount of waste discharged. Recycling and composting activities should be enhanced as well. These activities would contribute to extend the life span of the SLF. The participants and the MOM agreed that solidarity is crucial to promote better SWM.

Finally, the participants requested the MOM to continue disclosure of information and implement all of the necessary actions in management of the new SLF.

(2) Findings and Recommendations

Most of the participants were in favor of the new SLF project. However, the meeting revealed the following concerns among the attendees:

- impacts on groundwater and surface water quality
- breeding of flies and offensive odors
- methods to deal with the residual waste currently stockpiled in Yapak, Barabag and Maonc-Manoc MRFs on Boracay Island
- proper waste transportation by vehicles for prevention of waste scattering along roads
- Appropriate implementation of necessary actions in management of the new SLF by the MOM

The above findings and recommendations have been reflected on the SLF design as mitigation measures and the proposed EMMP. It was still strongly recommended that the MOM should address these concerns and take necessary actions in suitable manners and times. The MOM should continue to disclose information not only to governmental officials but also to the local residents.

Appendix III-C Photos

Overall Profile of Proposed Site of New Sanitary Landfill Site

Benchmark for Topographic Survey

Excavation of Borehole for Geological Investigation

Excavation of Groundwater Monitoring Well

Water Suction for Boring

Surface Water Monitoring Point

DAILY DRILLING REPORTS

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

Borehole No. 1

DATE STARTED May 29, 2007
DATE COMPLETED June 14, 2007
WATER LEVEL 1.35 meters
WEATHER Fair
DEPTH OF HOLE 20.10 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
S - 1	1.00	Brown		Clay/garvel	SPT	39	10	20	19	28
S - 2	2.00	Brown		Clay/garvel	SPT	65	25	30	35	20
S - 3	3.00	Brown		Clay/garvel	SPT	66	28	28	38	22
S - 4	4.00	Brown		Clay/garvel	SPT	59	30	28	31	28
S - 5	5.00	Brown		Clay/garvel	SPT	64	32	34	34	26
Reaming of NW Casing down to 4.50 meters depth										
Redrill / or removed all drill cuttings and conducted Percolation Test at 4.50 m. to 5.00 m. depth										
June 12, 2007										
S - 6	6.00	Brown		Clay/garvel	SPT	71	33	36	35	24
S - 7	7.00	Brown		Clay/garvel	SPT	70	32	34	36	26
S - 8	8.00	Grayish		Clay/garvel	SPT	75	36	36	39	26
C - 1	9.00	Grayish			Coring	Length of Run = 1.00 m.				20
C - 2	10.00	Grayish			Coring	Length of Run = 1.00 m.				32
C - 3	11.00	Grayish			Coring	Length of Run = 1.00 m.				27
June 13, 2007										
C - 4	12.00	Grayish			Coring	Length of Run = 1.00 m.				
C - 5	13.00	Grayish			Coring	Length of Run = 1.00 m.				
S - 9	13.00/13.13	Grayish			SPT	50/12				10
June 14, 2007										
S - 10	14.00/14.12	Gray			SPT	50/12				11
S - 11	15.00/15.14	Gray			SPT	50/14				12
S - 12	16.00/16.11	Gray			SPT	50/11				10
S - 13	17.00/17.14	Gray			SPT	50/14				10
S - 14	18.00/18.11	Gray			SPT	50/11				10
S - 15	19.00/19.17	Gray			SPT	50/13				13
S - 16	20.00/20.10	Gray			SPT	50/10				7
	Total Depth of Hole = 20.10 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aldan

Borehole No. 2

DATE STARTED June 12, 2007
DATE COMPLETED June 14, 2007
WATER LEVEL 1.45 meters
WEATHER Fair
DEPTH OF HOLE 20.04 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
S - 1	1.00	Brown		Clay/Gravel	SPT	24	8	10	14	25
S - 2	2.00	Brown		Clay/Gravel	SPT	42	12	18	24	26
S - 3	3.00	Brown		Clay/Gravel	SPT	46	15	21	25	21
S - 4	4.00	Brown		Clay/Gravel	SPT	51	16	25	26	21
S - 5	5.00	Brown		Clay/Gravel	SPT	47	15	21	26	27
S - 6	6.00	Brown			SPT	47	18	20	27	24
S - 7	7.00	Gray			SPT	48	20	21	27	29
- Reaming of NW Casing Down to 6.30 m. Depth										
- Redril / or removed drill cuttings and conducted Percolation Test at 6.30 m. to 7.00 m. Depth										
June 13, 2007										
C - 1	8.00	Gray			Coring	Length of Run = 1.00 m.				27
S - 8	8.00/8.12	Gray			SPT	50/11				8
C - 2	8.12/9.00	Gray			Coring	Length of Run = 0.88 m.				33
S - 9	9.00/9.10	Gray			SPT	50/10				6
C - 3	9.10/10.00	Gray			Coring	Length of Run = 0.90 m.				28
S- 10	10.00/10.14	Gray			SPT	50/14				9
C - 4	10.14/11.00	Gray			Coring	Length of Run = 0.86 m.				10
S - 11	11.00/11.08	Gray			SPT	50/8				6
S - 12	12.00/12.12	Gray			SPT	50/12				8
June 14, 2007										
S - 13	13.00/13.10	Gray			SPT	50/10				8
S - 14	14.00/14.09	Gray			SPT	50/9				8
S - 15	15.00/15.10	Gray			SPT	50/10				8
S - 16	16.00/16.06	Gray			SPT	50/6				5
C - 5	16.06/17.00	Gray			Coring	Length of Run = 0.94 m.				38
S - 17	17.00/17.06	Gray			SPT	50/6				6
S - 18	18.00/18.05	Gray			SPT	50/5				5
S - 19	19.00/19.05	Gray			SPT	50/5				5
S - 20	20.00/20.04	Gray			SPT	50/4				4
	Total Depth of Hole = 20.04 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

Borehole No. 3

DATE STARTED June 15, 2007
DATE COMPLETED June 16, 2007
WATER LEVEL 1.38 meters
WEATHER Fair
DEPTH OF HOLE 20.08 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 15, 2007										
S - 1	0.55/1.00	Brown		Clayey/Silt	SPT	37	10	16	21	20
S - 2	1.55/2.00	Brown		Clayey/Silt	SPT	35	12	15	20	26
S - 3	2.55/3.00	Brown		Clayey/Silt	SPT	38	12	17	21	25
S - 4	3.55/4.00	Brown		Clayey/Silt	SPT	41	15	18	23	28
- Reaming of Casing down to 3.00 m. Depth										
- Redrill / or removed all drill cuttings and conducted Percolation Test at 3.00 m. to 4.00 m. Depth										
S - 5	4.55/5.00	Brown		Clayey/Silt	SPT	46	15	21	25	30
S - 6	5.55/.00	Brown		Clayey/Silt	SPT	47	14	19	28	28
S - 7	6.55/7.00	Brown		Clayey/Silt	SPT	56	21	26	30	25
S - 8	7.55/8.00	Brown		Silty/Clay	SPT	54	21	24	30	27
S - 9	8.55/9.00	Brown		Silty/Clay	SPT	57	21	26	31	36
S - 10	9.55/10.00	Brown		Silty/Clay	SPT	70	20	30	40	30
June 16, 2007										
S - 11	10.55/11.00				SPT	67	28	29	30	30
S - 12	11.55/12.00				SPT	70	25	27	43	20
S - 13	12.55/13.00				SPT	72	26	30	42	25
S - 14	13.55/14.00				SPT	73	27	31	42	22
S - 15	14.55/15.00				SPT	83	30	35	48	27
S - 16	15.55/15.00				SPT	91	30	41	50	22
S - 17	17.00/17.20				SPT		40	50/5		18
S - 18	18.00/18.17				SPT		48	50/2		15
S - 19	19.00/19.14				SPT		50/14			14
S - 20	20.00/20.08				SPT		50/8			8
	total Depth of Hole = 20.08 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

Borehole No. 4

DATE STARTED June 15, 2007
DATE COMPLETED June 17, 2007
WATER LEVEL 1.88 meters
WEATHER Fair
DEPTH OF HOLE 20.13 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 15, 2007										
S - 1	0.55/1.00				SPT	40	12	17	23	21
S - 2	1.05/2.0				SPT	42	11	18	24	23
- Reaming of NW Casing Down to 2.00 m. Depth										
June 16, 2007										
C - 1	2.00/3.00									38
Conducted Percolation Test at 2.00 m. to 3.00 m. Depth										
S - 3	3.55/4.00				SPT	58	22	22	31	30
S - 4	4.55/5.00				SPT	56	20	26	30	32
S - 5	5.55/6.00				SPT	60	21	28	32	32
C - 2	6.00/7.00				Coring	Length of Run = 1.00 m.				30
- Continue Reaming of NW Casing Down to 3.00 m. Depth										
S - 6	8.00/8.13				SPT		50/13			13
S - 7	9.00/9.13				SPT		50/12			10
June 17, 2007										
S - 8	10..00/10.09				SPT		50/9			9
S - 9	11.00/11.23				SPT		44	50/8		10
C - 3	11.23/12.00				Coring	Length of Run = 0.77 m.				21
S- 10	13.00/13.21				SPT		47	50/6		10
C - 4	13.21/14.00				Coring	Length of Run = 0.79 m.				20
S - 11	15.00/13.13				SPT		50/13			9
C - 5	15.13/16.00				Coring	Length of Run = 0.87 m.				28
S - 12	17.00/17.21				SPT		46	50/6		12
S - 13	18.00/18.13				SPT		50/13			13
S - 14	19.00/19.20				SPT		47	50/5		12
S - 15	20.00/20.13				SPT		50/13			13
	Total Length of Hole = 20.13 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

Borehole No. 5

DATE STARTED June 19, 2007
DATE COMPLETED June 20, 2007
WATER LEVEL 1.46 meters
WEATHER Fair
DEPTH OF HOLE 20.09 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 19, 2007										
S - 1	0.55/1.00	Brown			SPT	40	11	18	22	30
S - 2	1.55/2.00	Brown			SPT	44	12	20	24	27
S - 3	2.55/3.00	Brown			SPT	52	17	25	27	32
S - 4	3.55/4.00	Brown			SPT	54	19	26	28	33
S - 5	4.55/5.00	Brown			SPT	54	18	25	29	28
- Reaming of NW Casing Down to 7.50 m. Depth										
- Redrill / or removed all drill cuttings and conducted Percolation Test at 4.50 m. to 5.00 m. Depth										
S - 6	5.55/6.00	Brown			SPT	55	18	27	28	29
S - 7	6.55/7.00	Brown			SPT	55	19	25	30	25
June 20, 2007										
C - 1	7.00/8.00				Coring	Length of Run =		1.00 m.		29
S - 8	8.55/9.00				SPT	51	16	23	28	20
S - 9	9.55/10.00				SPT	55	19	24	29	23
S - 10	10.55/11.00				SPT	53	19	23	30	24
S - 11	11.55/12.00				SPT	56	21	25	31	21
S - 12	12.55/13.00				SPT	61	23	28	36	22
S - 13	13.55/13.90				SPT		35	50/10		18
S - 14	14.55/14.81				SPT		36	50/11		20
S - 15	15.55/15.29				SPT		38	50/9		20
S - 16	16.55/16.75				SPT		40	50/5		12
S - 17	17.55/17.70				SPT		50/15			14
S - 18	18.55/18.69				SPT		50/14			14
C - 2	18.69/20.00				Coring	Length of Run =		1.31 m.		32
S - 19	20.00/20.09				SPT		50/9			9
	Total Length of Hole = 20.09 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

Borehole No. 6

DATE STARTED June 22, 2007
DATE COMPLETED June 24, 2007
WATER LEVEL 1.50 meters
WEATHER Fair
DEPTH OF HOLE 19.65 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 22, 2007										
S - 1	0.55/1.00				SPT	35	11	16	19	20
C - 1	1.00/2.00				Coring	Length of Run =		1.00 m.		22
S - 2	2.55/3.00				SPT	39	12	18	21	21
S - 3	3.55/4.00				SPT	31	123	14	12	22
S - 4	4.55/5.00				SPT	35	13	16	19	22
- Reaming of NW Casing Down to 4.50 m. Depth										
- Redrill / or removed all drill cuttings and conducted Percolation Test at Section 4.50 m. to 5.00 m. Depth										
June 23, 2007										
C - 2	5.00/5.55				Coring	Length of Run =		0.55 m.		25
S - 5	5.55/6.00				SPT	52	16	24	28	20
C - 3	6.00/6.55				Coring	Length of Run =		0.55 m.		26
S - 6	6.55/7.00				SPT	52	17	25	27	25
S - 7	7.55/8.00				SPT	52	18	23	29	28
S - 8	8.55/9.00				SPT	55	19	25	30	23
S - 9	9.55/10.00				SPT	53	20	22	31	27
S - 10	10.55/11.00				SPT	55	21	24	31	24
S - 11	11.55/12.00				SPT	60	22	28	32	23
S - 12	12.55/12.80				SPT		28	50/15		27
June 24, 2007										
S - 13	13.55/13.80				SPT		36	50/10		24
S - 14	14.55/14.81				SPT		38	50/11		20
S - 15	15.55/15.79				SPT		41	50/9		17
S - 16	16.55/16.70				SPT		50/15			15
S - 17	17.55/17.69				SPT		50/14			14
S - 18	18.55/18.63				SPT		50/8			8
S - 19	19.55/19.65				SPT		50/10			16
	Total Length of hole = 19.65 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

BOREHOLE NO.. 7
DATE STARTED June 26, 2007
DATE COMPLETED June 28, 2007
WATER LEVEL 1.40 m.
WEATHER Fair
DEPTH OF HOLE 20.62 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 26, 2007										
S - 1	0.55/1.00	Brown			SPT	22	8	10	12	25
S - 2	1.55/2.00	Brown			SPT	39	10	18	21	24
C - 1	2.00/3.00				Coring	Length of run = 1.00 m.				31
C - 2	3.00/4.00				Coring	Length of run = 1.00 m.				33
C - 3	4.00/5.00				Coring	Length of run = 1.00 m.				30
S - 3	5.55/6.00				SPT	51	16	25	26	30
	- Reaming of NW Casing Down to 4.50 m.									
June 27, 2007										
S - 4	6.55/7.00				SPT	49	17	23	26	27
S - 5	7.55/8.00				SPT	48	16	22	26	28
S - 6	8.55/9.00				SPT	49	18	22	27	28
S - 7	9.55/10.00				SPT	55	18	25	30	31
S - 8	10.55/11.00				SPT	54	22	24	30	35
S - 9	11.55/12.00				SPT	58	21	24	34	32
S - 10	12.55/13.00				SPT	60	21	25	35	36
S - 11	13.55/13.85				SPT		35	50/15		30
June 28, 2007										
S - 12	14.55/14.80				SPT		40	50/10		25
S - 13	15.55/15.78				SPT		45	50/8		23
S - 14	16.55/16.69				SPT		50/14			14
S - 15	17.55/17.63				SPT		50/12			12
S - 16	18.55/18.65				SPT		50/10			10
S - 17	19.55/19.66				SPT		50/11			11
S - 18	20.55/20.62				SPT		50/11			
	Total Length of Hole = 20.62 m.									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

BOREHOLE NO..8

DATE STARTED July 01, 2007
DATE COMPLETED July 03, 2007
WATER LEVEL 1.52 m.
WEATHER Fair
DEPTH OF HOLE 19.60 m.

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
July 01, 2007										
S - 1	0.55/1.00				SPT	21	5	10	11	25
S - 2	1.55/2.00				SPT	26	11	13	13	26
S - 3	2.55/3.00				SPT	32	12	15	17	23
S - 4	3.55/4.00				SPT	37	15	17	20	23
S - 5	4.55/5.00				SPT	39	16	18	21	23
S - 6	5.55/6.00				SPT	44	19	20	24	27
	- Reaming of NW Casings Down to 4.50 m. Depth									
July 02, 2007										
S - 7	6.55/7.00				SPT	43	17	24	29	21
S - 8	7.55/8.00				SPT	55	16	24	31	21
S - 9	8.55/9.00				SPT	56	20	25	31	24
S - 10	9.55/10.00				SPT	63	21	27	36	22
S - 11	10.55/11.00				SPT	66	25	31	35	21
S - 12	11.55/12.00				SPT	69	27	31	38	25
S - 13	12.55/12.85				SPT		30	50/15		23
S - 14	13.55/13.83				SPT		41	50/13		21
S - 15	14.55/14.81				SPT		43	50/11		14
July 03, 2007										
S - 16	15.55/15.80				SPT		48	50/10		10
S - 17	16.55/16.69				SPT		50/14			13
S - 18	17.55/17.68				SPT		50/13			11
S - 19	18.55/18.69				SPT		50/14			10
S - 20	19.55/19.68				SPT		50/13			9
	Total Length of Hole = 19.68 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

BOREHOLE NO.. GWD # 1
DATE STARTED June 20, 2007
DATE COMPLETED June 25, 2007
WATER LEVEL 11.95 meters
WEATHER Fair
DEPTH OF HOLE 25.00 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 20, 2007										
C - 1	6.00/7.00				Coring	Length of Run = 1.00 m.				0.15
C - 2	7.00/800				Coring	Length of Run = 1.00 m.				0.45
- Reaming of NW Casing Down to 3.00 m. Depth										
June 21, 2007										
C - 3	8.00/9.00				Coring	Length of Run = 1.00 m.				0.33
C - 4	9.00/10.00				Coring	Length of Run = 1.00 m.				0.31
C - 5	10.00/11.00				Coring	Length of Run = 1.00 m.				0.11
C - 6	11.00/12.00				Coring	Length of Run = 1.00 m.				0.18
- Conducted Water Pressure Test from 7.00 m. to 12.00 m. Depth										
June 22, 2007										
C - 7	12.00/13.00				Coring	Length of Run = 1.00 m.				0.12
C - 8	13.00/14.00				Coring	Length of Run = 1.00 m.				0.15
C - 9	14.00/15.00				Coring	Length of Run = 1.00 m.				0.13
C - 10	15.00/16.00				Coring	Length of Run = 1.00 m.				0.21
C - 11	16.00/17.00				Coring	Length of Run = 1.00 m.				0.26
C - 12	17.00/18.00				Coring	Length of Run = 1.00 m.				0.35
- Conducted Water Pressure Test from 13.22 m. to 18.00 m. Depth										
June 23, 2007										
C - 13	18.00/19.00				Coring	Length of Run = 1.00 m.				0.21
C - 14	19.00/20.00				Coring	Length of Run = 1.00 m.				0.31
C - 15	20.00/21.00				Coring	Length of Run = 1.00 m.				0.22
C - 16	21.00/22.00				Coring	Length of Run = 1.00 m.				0.24
C - 17	22.00/23.00				Coring	Length of Run = 1.00 m.				0.19
C - 18	23.00/24.00				Coring	Length of Run = 1.00 m.				0.23
C - 19	24.00/25.00				Coring	Length of Run = 1.00 m.				0.18
June 24 - 25, 2007										
Installation of 25 meters (Piezometer) PVC Pipe										
	Total Length of Hole = 25.00 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

BOREHOLE NO.. GWD # 2
DATE STARTED June 23, 2007
DATE COMPLETED June 24, 2007
WATER LEVEL 11.65 meters
WEATHER Fair
DEPTH OF HOLE 15.00 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 23, 2007										
	0.00/6.00	Brownish	Clayey	Sandy	Coring	Length of run - 6.00 m.				
		- Reaming of NW Casings Down to 3.00 m. Depth								
	6.00/8.00	Highly Fractured Rocks Formation			Coring	Length of run 2.00 m.				
June 24, 2007										
	8.00/10.00	Highly Fractured Rocks Formation			Coring	Length of run 2.00 m.				
	10.00/15.00	Black, medium to Coarsed Grained Sand			Coring	Length of run 5.00 m.				
Installation of 15 meters (Piezometer) PVC Pipe										
	Total Length of Hole = 15.00 meters									

BOREHOLE NO.. GWD # 3
DATE STARTED June 27, 2007
DATE COMPLETED July 03, 2007
WATER LEVEL 0.48
WEATHER Fair
DEPTH OF HOLE 15.00 meters

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
June 27, 2007										
	0.00/.030	Orange	Clayey	Silt	Coring	Length of run - 0.30 m.				
	0.30/0.80	Boulders	Quartz		Coring	Length of run - 0.50 m.				
	0.80/5.50	Orange	Stiff	Silty Clay	Coring	Length of run - 4.70 m.				
	- Reaming of NW Casing Down to 3.00 m. Depth									
July 02, 2007										
	5.50/10.00	y Fractured Rocks			Coring	Length of run - 4.50 m.				
July 03, 2007										
	Black Medium to Coarse Grained Snad				Coring	Length of run - 5.00 m.				
Installation of 15 meters (Piezometer) PVC Pipe										
	Total Length of Hole = 15.00 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill (New Site)
LOCATION Malay, Aklan

BOREHOLE NO.. GWD # 4
DATE STARTED July 04, 2007
DATE COMPLETED July 07, 2007
WATER LEVEL 2.32 m.
WEATHER Fair
DEPTH OF HOLE 25.00 meters
OPERATOR M. COZ

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
July 04, 2007										
	0.00/6.00				Coring Dry Block					
C - 1	6.00/7.50				Coring	Length of run - 1.50 m.				0.37
C - 2	7.50/9.00				Coring	Length of run - 1.50 m.				0.22
	- Reaming of NW Casing Down to 3.00 m. Depth									
C - 3	9.00/10.50				Coring	Length of run - 1.50 m.				0.30
July 06, 2007										
C - 4	10.50/12.00				Coring	Length of run - 1.50 m.				0.21
C - 5	12.00/13.50				Coring	Length of run - 1.50 m.				0.22
C - 6	13.50/15.00				Coring	Length of run - 1.50 m.				0.25
C - 7	15.00/16.50				Coring	Length of run - 1.50 m.				0.25
C - 8	16.50/18.00				Coring	Length of run - 1.50 m.				0.18
C - 9	18.00/19.50				Coring	Length of run - 1.50 m.				0.26
C - 10	19.50/21.00				Coring	Length of run - 1.50 m.				0.18
July 07, 2007										
C - 11	21.00/22.50				Coring	Length of run - 1.50 m.				0.22
C - 12	22.50/24.00				Coring	Length of run - 1.50 m.				0.6
C - 13	24.00/25.00				Coring	Length of run - 1.50 m.				0.26
Installation of 25 meters (Piezometer) PVC Pipe										
	Total Length of Hole = 25.00 meters									

Appendix 1 DAILY DRILLING REPORT

PROJECT Geological Survey Sanitary Landfill **(Old Site)**
LOCATION Malay, Aklan

BOREHOLE NO.. GWD # 1
DATE STARTED June 25, 2007
DATE COMPLETED July 15, 2007
WATER LEVEL 56.59 m.
WEATHER Fair
DEPTH OF HOLE 60.00 meters
OPERATOR W. OSOTEO

SAMPLE NO.	DEPTH (meters)	VISUAL DESCRIPTION OF SOIL			OPERATION	N BLOWS	No. OF BLOWS			% REC. (CM)
		COLOR	CONSISTENCY	MATERIAL			15	15	15	
C - 1	0.00/3.00				Coring	Length of run - 3.00 m.				0.20
C - 2	3.00/6.00				Coring	Length of run - 3.00 m.				0.16
C - 3	6.00/9.00				Coring	Length of run - 3.00 m.				0.22
C - 4	9.00/12.00				Coring	Length of run - 3.00 m.				0.20
C - 5	12.00/15.00				Coring	Length of run - 3.00 m.				0.21
C - 6	15.00/18.00				Coring	Length of run - 3.00 m.				0.22
C - 7	18.00/21.00				Coring	Length of run - 3.00 m.				0.17
C - 8	21.00/24.00				Coring	Length of run - 3.00 m.				0.18
C - 9	24.00/27.00				Coring	Length of run - 3.00 m.				0.14
C - 10	27.00/30.00				Coring	Length of run - 3.00 m.				0.20
C - 11	30.00/33.00				Coring	Length of run - 3.00 m.				0.21
C - 12	33.00/36.00				Coring	Length of run - 3.00 m.				0.26
C - 13	36.00/39.00				Coring	Length of run - 3.00 m.				0.17
C - 14	39.00/42.00				Coring	Length of run - 3.00 m.				0.17
C - 15	42.00/45.00				Coring	Length of run - 3.00 m.				0.20
C - 16	45.00/48.00				Coring	Length of run - 3.00 m.				0.21
C - 17	48.00/51.00				Coring	Length of run - 3.00 m.				0.23
C - 18	51.00/54.00				Coring	Length of run - 3.00 m.				0.33
C - 19	54.00/57.00				Coring	Length of run - 3.00 m.				0.34
C - 20	57.00/60.00				Coring	Length of run - 3.00 m.				0.92
Installation of 60.00 meters (Piezometer) PVC Pipe										
	Total Length of Hole = 60.00 meters									

LITHOLOGIC LOGS

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWS-2

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 90.20M

DIP : VERTICAL

BEGUN: 23-Jun-07

FINISHED: 24-Jun-07

DEPTH OF OVERBURDEN: 6.00M

BEARING:

TOTAL DEPTH: 15.00M

WATER TABLE EL.:

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Brownish to Reddish Color									1 2 3 4 5 6			0.00 - 6.00M; Top soil. Silty clay soil. Firm when dry. Medium plstic when moist. Reddish color.
90-95% Water Return,Dark grayish color					2.6X10⁻⁴	4	4	5	7 8 9 10 11 12 13 14	0		6.0 -10.00M; Basalt. Broken core ranging from 2cm to 3 cm. With iron oxide along fracture/broken plane. 10.00-14.00M; Drill cuttings/sludge.Basalt. Dark gray to black color. 14.00-15.00M; Basalt. Broken core , size ranging from 2cm to 3 cm . Slighly weathered.
						3	3	5		0		
									15 16 17 18 19 20			

EXPLANATION:

Wn Weathering Number
W-1 Solid
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Minimum Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argilized (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-4

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 86.20M

DIP : VERTICAL

BEGUN: 4JULY 2007

FINISHED: 7 JULY 2007

DEPTH OF OVERBURDEN: 6.80M

BEARING:

TOTAL DEPTH: 25.00M

WATER TABLE E 2.32M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
						3	3	5	21			20.00 - 22.50 M; Basalt . Slightly weathered. Broken cores ranging from 2cm to 12 cm.
									22	0		
						2	2	3	23	40		22.50 - 25.00 M; Basalt . Slighily weathered. Massive. Dense. Joints healed with calcite. Joints dip 40 -70 degrees.
						2	2	5	24	0		
									25			
									26			
									27			
									28			
									29			
									30			
									31			
									32			
									33			
									34			
									35			
									36			
									37			
									38			
									39			
									40			

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Medium Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argilized (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-4

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION: 86.20M

DIP : VERTICAL

BEGUN: 4JULY 2007

FINISHED: 7JULY2007

DEPTH OF OVERBURDEN: 6.80M

BEARING:

TOTAL DEPTH: 25.00M

WATER TABLE EL.:

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
50-85 % Water Return Brownish to Reddish Color									1			0.00 -1.00M; Top soil. Sandy silt . Loose/or friable. With amount of weathered rock fragments.
									2			1.00-6.00M ; Basalt . Extremely weathered. Rock fragments with iron oxides.
									3			
									4			
									5			
						4	4	5	6			
									7	0		
									8			
									9			6.00 - 20.00 M; Basalt . Slighlly weathered. Broken cores ranging from 2cm to 12 cm.
									10			
									11			
									12			
									13			
									14			
									15	20		
						3	3	4	16			
									17			
									18			
									19	0		
									20			

EXPLANATION:

Wn Weathering Number
- W-1 Sound
- W-2 Slightly Weathered (appreciable oxidation at joint)
- W-3 Medium Weathered (matrix slightly weathered)
- W-4 Deeply Weathered (matrix deeply weathered)
- W-5 Totally Weathered, Argilled (only traces of original structure)

Jn Joint Number
- J-1 1 Joint/m
- J-2 2 - 5 Joints/m
- J-3 6 - 10 Joints/m
- J-4 11 - 20 Joints/m
- J-5 >20 Joints/m

Hn Hardness Number
- H-1 Very Hard (hardly broken by hammer)
- H-2 Hard (edge hardly broken by hammer)
- H-3 Medium Hard (Easily broken by Hammer)
- H-4 Slightly Hard (easily squeezed by finger)
- H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-1

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION: 89.47M

DIP : VERTICAL

BEGUN: 20 June 2007

FINISHED: 25 June 2007

DEPTH OF OVERBURDEN: 6.80M

BEARING:

TOTAL DEPTH: 25.00M

WATER TABLE E 11.95M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95% Water Return. Grayish Color.						2	2	5	21–40	0		21.00 - 25.00 M; Basalt . Slightly weathered to fresh . Broken core ranging from 3cm to 5cm. Grayish Color.

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Moderately Weathered (matrix slightly weathered)
W-4 Deeply Weathered (mostly deeply weathered)
W-5 Totally Weathered, Argillized (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-1

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 89.47M

DIP : VERTICAL

BEGUN: 20 June 2007

FINISHED: 25 June 2007

DEPTH OF OVERBURDEN: 6.80M

BEARING:

TOTAL DEPTH: 25.00M

WATER TABLE E 11.95M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. K(CM/SEC)	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Brownish to Reddish Color									1 2 3 4 5 6			0.00 - 6.00M; Top soil. Silty clay soil. Firm when dry. Medium plstic when moist. Reddish color.
												6.0 - 6.80M; Pebble to cobble fragments. 6 cm maximum diameter.
90 - 95 % Water Return , grayish color					1.28 X 10⁻⁴	4	3	5	7 8 9 10			6.80 - 10.00 M; Basalt . Heavily broken rock fragments ranging fom 2cm to 4cm . Heavy iron oxides on matrix & fracture planes . Angular rock fragments. Dark Grayish Color
					4.39X10⁻⁵	3	3	5	11 12 13 14 15	0		10.00 - 16.00 M; Basalt , heavily broken, rock fragments size ranging from 3cm to 5cm .With slight iron oxides on matrix & fracture planes . Angular rock fragments. Dark grayish color.
						2	2	5	16 17 18 19 20			16.00 - 20.00 M; Basalt . Slightly weathered to fresh . Broken core ranging from 3cm to 5cm. Grayish Color.

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Moderately Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argillied (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-8

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 147.24 M

DIP : VERTICAL

BEGUN: 1-Jul-07

FINISHED: 3-Jul-07

DEPTH OF OVERBURDEN: > 19.68 M

BEARING:

TOTAL DEPTH: 19.68M

WATER TABLE E 1.52M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S. P. T. DEPTH FROM	S. P. T. DEPTH TO	S. P. T. N VALUE 20 40 60 80	W. P. T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
									1			0.00 - 10.00M; Gravelly Silty Clay. Medium plastic .With few amount of weathered gravel fragments. Yellowish mottles with milky color.
									2			
									3			
									4			
									5			
									6			
									7			
									8			
									9			
									10			10.00-13.83M; Clayey silt with considerable amount of sand.Soft whe wet. Firm when dry. Yellowish color.
									11			
									12			
									13			
									14			
									15			
									16			13.83-19.68M; Silty/Clayey Gravel. Medium to highly weathered rock fragments. Yellowish color.
									17			
									18			
									19			
									20			

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Moderate Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argillied (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-7

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION: 121.00M

DIP : VERTICAL

BEGUN: 26-Jun-07

FINISHED: 28-Jun-07

DEPTH OF OVERBURDEN: 13.85M

BEARING:

TOTAL DEPTH: 20.62M

WATER TABLE E 1.40M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
									1			0.00 - 0.20M; Silty Sand. Slightly wet. Friable/loose. Non-plastion and with few gravel fragments. Yellowish Color.
									2			0.20- 5.00M; Gravelly/sandy silt. Non-plastic. Friable and moist in place. Loose. Reddish Color.
									3			
									4			
									5			
									6			
									7			
									8			5.00 - 13.85M; Gravelly Silty Clay. Medium plastic .With few amount of weathered gravel fragments. Yellowish mottles with milky color.
									9			
									10			
									11			
									12			
									13			
									14			
									15			
									16			13.00-20.00M; Drill cuttings/sludge . Basalt. Dark grayish color.
									17			
									18			
									19			
									20			

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Moderately Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argillized (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-6

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 108.77M

DIP : VERTICAL

BEGUN: 22-Jun-07

FINISHED: 24-Jun-07

DEPTH OF OVERBURDEN: 5.00M

BEARING:

TOTAL DEPTH: 19.65M

WATER TABLE E 1.50M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE. LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%)	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Reddish to yellowish Color	20 40 60 80			20 40 60 80					1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20			0.00 -3.00M; Clayey/silty Gravel. Loose. Deeply weathered rock fragments.Yellowish color.
												3.00-5.00 M ; Silty clay. Firm when dry Medium plastic. Reddish color.
												5.00-6.55M; Medium to extremely weathered gravel fragments . Fragments size ranges from 1 cm to 3 cm .
90 - 95 % Water Return , greenish color												6.55 -13.85M; Shale . Extremely weathered bedrock . High plastic. Greenish color.
90 - 95 % Water Return , Dark grayish color						4	5	5		0		13.85 - 19.65M; 12.85-19.65M; Basal Highly to weathered . Dark grayish black color.

EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Minimum Weathered (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argilized (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-5

N: Pls. See Topo Map
COORDINATES
E: Pls. See Topo Map

GROUND ELEVATION : 102.00M

DIP : VERTICAL

BEGUN: 19-Jun-07

FINISHED: 20-Jun-07

DEPTH OF OVERBURDEN: 18.65M

BEARING:

TOTAL DEPTH: 20.00M

WATER TABLE E 1.46M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	Percolation Test, K(CM/SEC)	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Reddish Color					4.919×10^{-4}				0-18		0≡0≡0≡0	0.00-7.00M; Gravelly Silty Clay. Firm when dry. Medium plastic when wet. With few weathered gravel fragments. Reddish color.
50 - 95 % Water Return , Dark Yellowish color				Refusal					7-8		♦0♦0♦	7.0-8.00M; Extremely weathered rock fragments.
									8-13		≈≈≈≈	8.00-13.00M; Fat Clay . High plastic. Yellowish color.
90 - 95 % Water Return , Dark greenish color									13-16		♦≡♦≡♦	13.00-16.75M; Gravelly Clay. Slightly plastic. Greenish Color.
									16-18		♦≡♦≡♦	16.75 - 18.65M; Fat Clay. High plastic. With coal fragments. Black color.
90 - 95 % Water Return , Black color									18-20		≈≈≈≈	18.65 - 20.00M; Basalt. Extremely weathered rock fragments .
90 - 95 % Water Return , Dark grayish color						3	4	5		0	ΛΛΛΛ	

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Moderate Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argillied (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-4

N: Pls. Refer Topo Map
COORDINATES
E: Pls. Refer Topo Map

GROUND ELEVATION : 127.21 M

DIP : VERTICAL

BEGUN: 15-Jun-07

FINISHED: 17-Jun-07

DEPTH OF OVERBURDEN: 7.00M

BEARING:

TOTAL DEPTH: 20.00M

WATER TABLE E 1.88M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	Percolation Test, K (CM/SEC)	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Reddish Color					5.51 X 10^{-4}				1			0.00-1.00M; Silty Clay. Medium plastic With slight amount of gravel fragments Firm in place. Reddish Color.
									2			1.00-3.00M; Gravelly Silty Clay. Firm when dry. With few amount of silt. Rock fragments extremely weathered. Reddish color.
90-95 % Water Return Yellowish Color									3			
									4			3.00-7.00; Gravelly Silty Clay. Medium plastic. Weathered rock fragments. Yellowish brown color.
									5			
									6			
									7			
									8			7.00-11.20M; Drill cuttings /sludge. Fine Sand to silt . Grayish Color. Basalt .
									9			
									10			11.20-12.00M; Basalt. Pebble to cobble size rock fragments.
									11			
						3	3	5	12			12.00-13.20M; Drill cuttings /sludge. Fine sand to silt . Grayish Color.Besa
90 - 95 % Water Return , grayish color									13			
						3	3	5	14	0		13.20-14.00M; Basalt. Pebble to cobble rock size fragments.
									15			14.00-15.10M; Drill cuttings /sludge.Basalt . Fine sand to silt . Grayish color.
						3	3	5	16			
									17			15.10-16.00M; Pebble to cobble rock fragments. Basalt.
									18			
									19			16.00-20.00M; Drill cuttings/sludge. Basalt. Fine Sand to silt. Grayish col
									20			

EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Medium Weathered (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argillized (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-3

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 112.00M

DIP : VERTICAL

BEGUN: June 15, 207

FINISHED: 16-Jun-07

DEPTH OF OVERBURDEN: 15.00M

BEARING:

TOTAL DEPTH: 20.00M

WATER TABLE E 1.38 M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S. P. T. DEPTH FROM	S. P. T. DEPTH TO	S. P. T. N VALUE 20 40 60 80	Percolation Test, K (CM/SEC)	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Reddish Color									1			0.00 - 1.00M; Silty Clay. Firm when dry. Medium plastic when moist. Reddish color.
90-95 % Water Return Yellowish Color					1.79×10^{-4}				2 3 4 5			1.00- 5.00M; Silty Sand. Friable when moist . Slight to non-plastic. Yellowish color
90 - 95 % Water Return , Reddish brown color									6 7 8 9 10 11 12 13 14			5.00 - 15.00M; Silty Clay . Firm when when moist. Medium to high plastic. Brownish mottles with reddish & whitish soil.
90 - 95 % Water Return , Black color									15 16 17 18 19 20			15.00 - 20.00 M; Drill cuttings /sludge . Basalt. Coarse sand size rock fragments.

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Medium Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Applied (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: BH-2

COORDINATES N: Pls. See Topo Map E: Pls. See Topo Map

GROUND ELEVATION : 138.40M

DIP : VERTICAL

BEGUN: 12-Jun-07

FINISHED: 14-Jun-07

DEPTH OF OVERBURDEN: 16.10M

BEARING:

TOTAL DEPTH: 20.00M

WATER TABLE E 1.45 M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GSR SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	Percolation, k (CM/SEC)	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return , Yellowish Brown Color				Refusal	7.74×10^{-4}				1 2 3 4 5 6 7 8 9			0.00 -9.00M; Gravelly Clayey Silt. Slighlly plastic with few amount of medium to highly weathered rock fragments. Yellowish to brownish color
						3	3	5	10			9.00 - 11.00M; Volcanic rock fragment ranging from 2 cm to 7 cm. . Basalt .
90-95 % Water Return , Greyish Color									11 12 13 14 15 16	0		11.00 - 16.10M. Sludge/drill cuttings. Basalt. Grayish color.
						3	4	5	17 18 19 20			16.10 - 20.00M; Basalt rock fragments.Moderately weathered . Rock fragments range from 2 cm to 7 cm diameter.

EXPLANATION:

Wn Weathering Number
W-1 Very fresh. No weathering of mineral component
W-2 Fresh. Some minerals are weathered slightly. Usually no alteration along joint/fracture/crack planes.
W-3 Fairly fresh. Some minerals are weathered are weathered. Joints/fractures/cracks are stained & weak
W-4 Weathered . Fresh portions still remain partially .
W-5 Strongly Weathered. Most minerals are weathered & altered to second mineral

Jn Joint Number
J-1 Spacing over 30 centimeters
J-2 Spacing 10-30 centimeters
J-3 Spacing 3-10 centimeters
J-4 Spacing 1-3 centimeters
J-5 < 1 centimeter

Hn Hardness Number
H-1 Very hard. Broken into knife edged pieces by strong hammer blow.
H-2 Hard . Broken into pieces by strong hammer blow.
H-3 Brittle . Broken into pieces by strong hammer blow.
H-4 Very brittle. Easy broken into pieces by medium hammer blow
H-5 Soft , able to dig with hammer or easily broken by finger pressure.

Appendix 2

GEOLOGIC LOG OF DRILL HOLE

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWS-3

N: Pls. See Topo Map
COORDINATES
E: Pls. See Topo Map

GROUND ELEVATION : 86.00M

DIP : VERTICAL

BEGUN: 27-Jun-07

FINISHED: 3-Jul-07

DEPTH OF OVERBURDEN: 3.00M

BEARING:

TOTAL DEPTH: 15.00M

WATER TABLE EL.:

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	S.P.T. DEPTH FROM	S.P.T. DEPTH TO	S.P.T. N VALUE 20 40 60 80	W.P.T. LUGEON VALUE	Weathering Number	Hardness Number	Joint Number	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Brownish to Reddish Color									1			0.00 - 0.30M; Top soil. Silty clay soil. Firm when dry. Medium plastic when moist. Reddish color.
									2			0.30 -3.0M; Bouldery silty clay; Rock fragments ranging from 5cm to 30cm.
									3			
									4			
									5			
									6			
									7			
90-95 % Water Return. Dark Grayish Color.						3	4	5	8			3.00 -10.00M; Basalt. Broken core ranging from 2cm to 4 cm. With iron oxide along fracture/broken plane.
									9			
									10	0		
									11			
									12			10.00-14.00M; Drill cuttings/sludge. Basalt . Dark gray to black color.
									13			
									14			
									15			
									16			
									17			
									18			
									19			
									20			

EXPLANATION:

Wn Weathering Number
W-1 Sound
W-2 Slightly Weathered (appreciable oxidation at joint)
W-3 Moderately Weathered (matrix slightly weathered)
W-4 Deeply Weathered (matrix deeply weathered)
W-5 Totally Weathered, Argillied (only traces of original structure)

Jn Joint Number
J-1 1 Joint/m
J-2 2 - 5 Joints/m
J-3 6 - 10 Joints/m
J-4 11 - 20 Joints/m
J-5 >20 Joints/m

Hn Hardness Number
H-1 Very Hard (hardly broken by hammer)
H-2 Hard (edge hardly broken by hammer)
H-3 Medium Hard (Easily broken by Hammer)
H-4 Slightly Hard (easily squeezed by finger)
H-5 Soft (easily broken by finger

AS BUILT
WELL DESIGN

Appendix 3

NEW LANDFILL SITE OBSERVATION WELL

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWS-2

N: Pls. see Topo Map
COORDINATES
E: Pls. see Topo Map

GROUND ELEVATION : 90.20M

DIP : VERTICAL

BEGUN: 23-Jun-07

FINISHED: 24-Jun-07

DEPTH OF OVERBURDEN: 6.00M

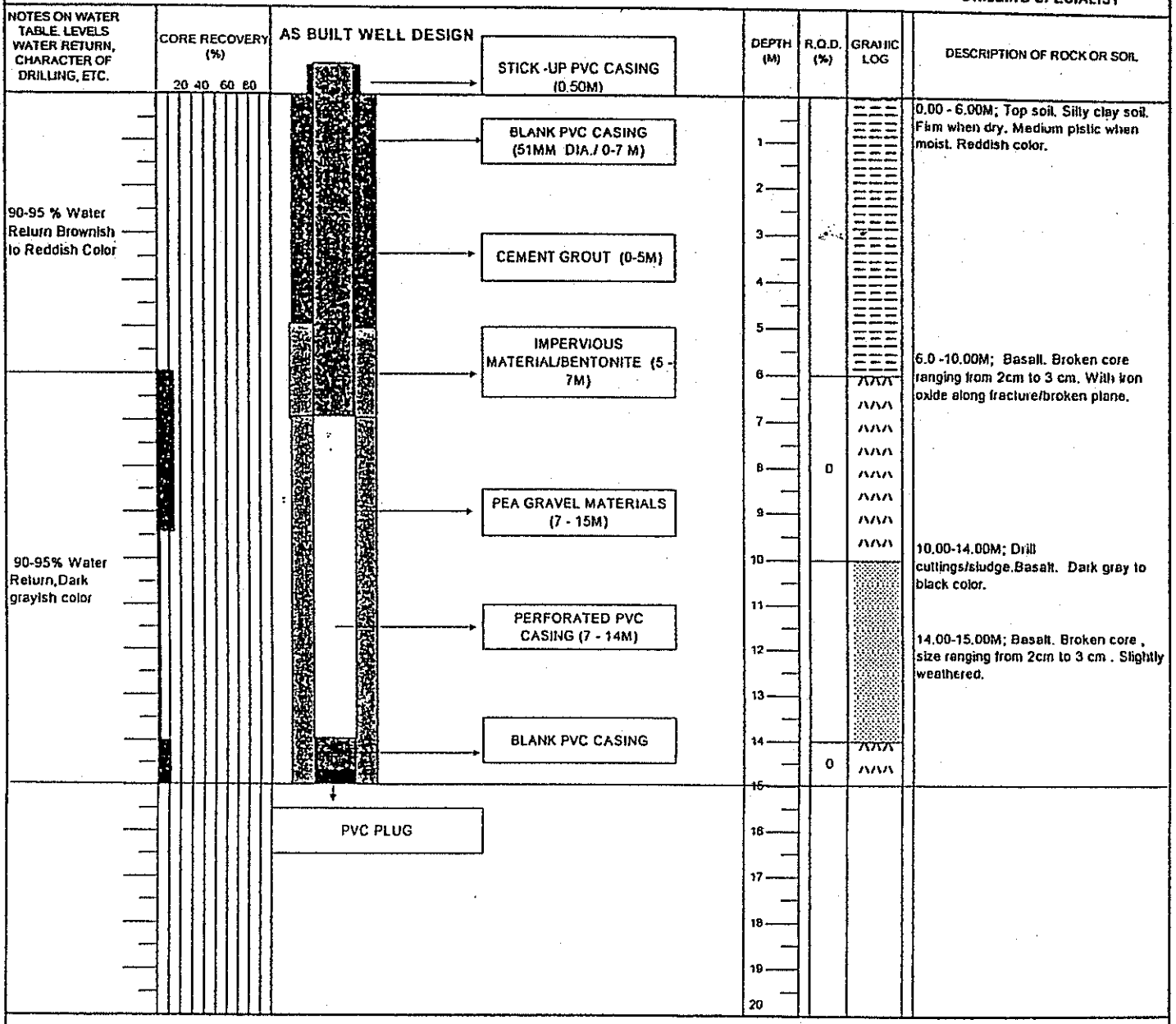
BEARING:

TOTAL DEPTH: 15.00M

WATER TABLE EL.:

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST



EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Minimum Weathered (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argillied (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

Appendix 3

NEW LANDFILL SITE OBSERVATION WELL

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-4

N: Pls. See Topo Map
COORDINATES
E: Pls. See Topo Map

GROUND ELEVATION : 86.20M

DIP : VERTICAL

BEGUN: 4JULY 2007

FINISHED: 7 JULY 2007

DEPTH OF OVERBURDEN: 1.00M

BEARING:

TOTAL DEPTH: 25.00M

WATER TABLE E 1.90M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	AS BUILT WELL DESIGN	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
		PERFORATED PVC CASING (20 - 23.50M)	21	0		20.00 - 22.50 M; Basalt . Slightly weathered. Broken cores ranging from 2cm to 12 cm.
		PEA GRAVEL MATERIALS (20 - 25M)	22			
			23	40		22.50 - 25.00 M; Basalt . Slightly weathered, Massive. Dense. Joints healed with calcite. Joints dip 40 -70 degrees.
		BLANK PVC PIPE	24	0		
		PVC PLUG	25			
			26			
			27			
			28			
			29			
			30			
			31			
			32			
			33			
			34			
			35			
			36			
			37			
			38			
			39			
			40			

EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Minimum Weathered (matrix slightly weathered)
W-4	Deeply Werathered (matrix deeply weathered)
W-5	Totally Weathered, Argillied (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

Appendix 3

NEW LANDFILL SITE OBSERVATION WELL

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-1

COORDINATES N: Pls. see Topo Map E: Pls. see Topo Map

GROUND ELEVATION : 89.47M

DIP : VERTICAL

BEGUN: 20 June 2007

FINISHED: 25 June 2007

DEPTH OF OVERBURDEN: 6.80M

TOTAL DEPTH: 25.00M

WATER TABLE E 11.95M

LOGGED BY: W. L. LAYAOEN

BEARING:

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE, LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	AS BUILT WELL DESIGN	DEPTH (M)	R.Q.D. (%)	GRAHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95% Water Return. Grayish Color.		PERFORATED PVC CASING (20 - 23.5M); PEA GRAVEL MATERIALS (20 - 25M); BLANK PVC CASING; PVC PLUG	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	0		21.00 - 25.00 M; Basalt . Slightly weathered to fresh . Broken core ranging from 3cm to 5cm. Grayish Color.

EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Moderately Weathered, (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argillized (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

Appendix 3

NEW LANDFILL SITE OBSERVATION WELL

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWD-4

N: Pls. see Topo Map
COORDINATES
E: Pls. see Topo Map

GROUND ELEVATION: 86.20M

DIP : VERTICAL

BEGUN: 4JULY 2007

FINISHED: 7JULY2007

DEPTH OF OVERBURDEN: 1.00M

BEARING:

TOTAL DEPTH: 25.00M

WATER TABLE E 1.90 M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	AS BUILT WELL DESIGN	DEPTH (M)	R.Q.D. (%)	GRAPHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Brownish to Reddish Color		STICK -UP PVC CASING (0.50M) BLANK PVC CASING (51MM DIA./ 0-15 M) CEMENT GROUT (0-13M) 76MM DIA. BOREHOLE IMPERVIOUS MATERIAL/BENTONITE(13 - 15M) PEA GRAVEL MATERIALS (15 - 20M) PERFORATED PVC CASING (15 - 20M)	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20	0 20 0		0.00 -1.00M; Top soil. Sandy silt . Loose/or friable. With amount of weathered rock fragments. 1.00-6.00M ; Basalt . Extremely weathered. Rock fragments with iron oxides. 6.00 - 20.00 M; Basalt . Slightly weathered. Broken cores ranging from 2cm to 12 cm.

EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Moderate Weathered (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argilled (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by fingor)
H-5	Soft (easily broken by fingor

Appendix 3

NEW LANDFILL SITE OBSERVATION WELL

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULOHAN, MALAY, AKLAN

HOLE NO.: GWD-1

N: Pls. see Topo Map
COORDINATES
E: Pls. see Topo Map

GROUND ELEVATION : 89.47M

DIP : VERTICAL

BEGUN: 20 June 2007

FINISHED: 25 June 2007

DEPTH OF OVERBURDEN: 6.80M

TOTAL DEPTH: 25.00M

WATER TABLE E 11.95M

LOGGED BY: W. L. LAYAOEN

BEARING:

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST

NOTES ON WATER TABLE LEVELS WATER RETURN, CHARACTER OF DRILLING, ETC.	CORE RECOVERY (%) 20 40 60 80	AS BUILT WELL DESIGN	DEPTH (M)	R.Q.D. (%)	GRAPHIC LOG	DESCRIPTION OF ROCK OR SOIL
90-95 % Water Return Browish to Reddish Color		STICK -UP PVC CASING (0.50M); BLANK PVC CASING (51MM DIA./ 0-15 M); CEMENT GROUT (0-13M)	1 2 3 4 5 6			0.00 - 6.00M; Top soil. Silty clay soil. Firm when dry. Medium pistic when moist. Reddish color.
			6			6.0 - 6.80M; Pebble to cobble fragments. 6 cm maximum diameter.
90 - 95 % Water Return , grayish color		76MM DIA. BOREHOLE; IMPERVIOUS MATERIAL/BENTONITE (13 - 15M); PEA GRAVEL MATERIALS (15 - 20M); PERFORATED PVC CASING (15 - 20M)	7 8 9 10 11 12 13 14 15 16 17 18 19 20	0		6.80 - 10.00 M; Basalt . Heavily broken rock fragments ranging fom 2cm to 4cm . Heavy iron oxides on matrix & fracture planes . Angular rock fragments. Dark Grayish Color 10.00 - 16.00 M; Basalt , heavily broken, rock fragments size ranging from 3cm to 5cm .With slight iron oxides on matrix & fracture planes . Angular rock fragments. Dark grayish color. 16.00 - 20.00 M; Basalt . Slightly weathered to fresh , Broken core ranging from 3cm to 5cm. Grayish Color.

EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Moderate Weathered (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argillied (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

Appendix 3

NEW LANDFILL SITE OBSERVATION WELL

FEATURE:

PROJECT: NEW LANDFILL SITE

LOCATION: KABULIHAN, MALAY, AKLAN

HOLE NO.: GWS-3

N: Pls. See Topo Map
COORDINATES
E: Pls. See Topo Map

GROUND ELEVATION : 86.00M

DIP : VERTICAL

BEGUN: 27-Jun-07

FINISHED: 3-Jul-07

DEPTH OF OVERBURDEN: 3.0 M

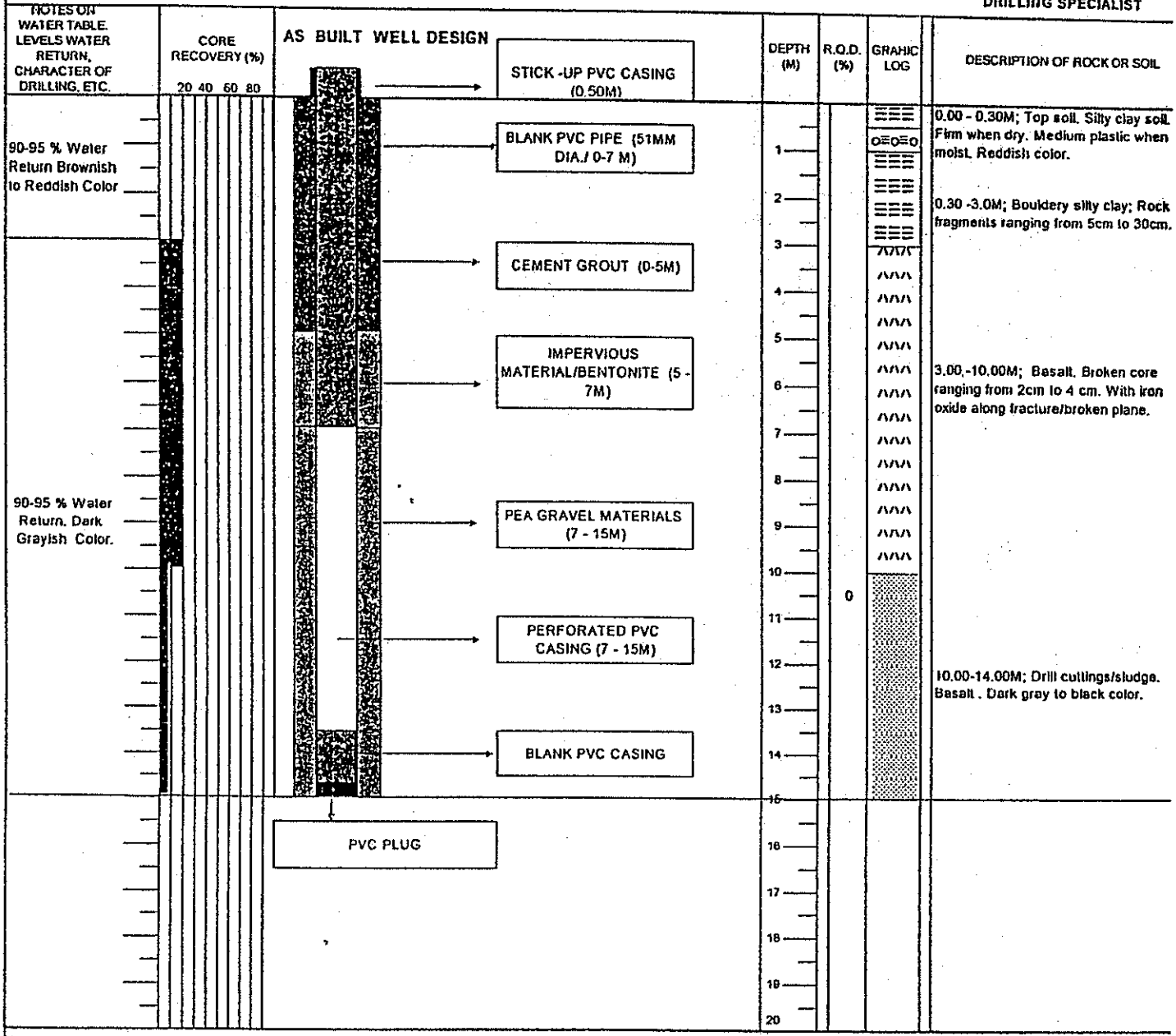
BEARING:

TOTAL DEPTH: 15.00M

WATER TABLE E 1.46 M

LOGGED BY: W. L. LAYAOEN

CONTRACTOR: GRS SURVEY & DRILLING SPECIALIST



EXPLANATION:

Wn	Weathering Number
W-1	Sound
W-2	Slightly Weathered (appreciable oxidation at joint)
W-3	Minimum Weathered (matrix slightly weathered)
W-4	Deeply Weathered (matrix deeply weathered)
W-5	Totally Weathered, Argilled (only traces of original structure)
Jn	Joint Number
J-1	1 Joint/m
J-2	2 - 5 Joints/m
J-3	6 - 10 Joints/m
J-4	11 - 20 Joints/m
J-5	>20 Joints/m
Hn	Hardness Number
H-1	Very Hard (hardly broken by hammer)
H-2	Hard (edge hardly broken by hammer)
H-3	Medium Hard (Easily broken by Hammer)
H-4	Slightly Hard (easily squeezed by finger)
H-5	Soft (easily broken by finger

PERMEABILITY TEST DATA AND RESULTS

PERCOLATION TEST
OPEN END TEST - FALLING HEAD METHOD

PROJECT: New Landfill Site
LOCATION : Kabulihan, Malay, Aklan

BOREHOLE NO. : BH - 1
DEPTH OF HOLE (M) : 5.00 Meters
DEPTH OF CASING (M) : 4.50 Meters
TOP OF CASING FROM NGL (M) : 0.22 Meters
WATER TABLE FROM TOP OF CASING (M)
DATE : June 07, 2007

SECTION TESTED (M)	TIME ELAPSED (MIN.)	DRAWDOWN (CM)
4.50 - 5.00	0 - 1	0 - 0
4.50 - 5.00	1 - 2	0 - 0
4.50 - 5.00	2 - 5	0 - 0
4.50 - 5.00	5 - 10	0 - 0
4.50 - 5.00	10 - 15	0 - 0

BOREHOLE NO. : BH - 2
DEPTH OF HOLE (M) : 7.00 Meters
DEPTH OF CASING (M) : 6.30 Meters
TOP OF CASING FROM NGL (M) : 0.30 Meters
WATER TABLE FROM TOP OF CASING (M) : 0.45 Meters
DATE : June 12, 2007

SECTION TESTED (M)	TIME ELAPSED (MIN.)	DRAWDOWN (CM)
6.30 - 7.00	0 - 1	0 - 10
6.30 - 7.00	1 - 2	10 - 11
6.30 - 7.00	2 - 5	11 - 11
	5 - 10	11 - 11
	10 - 15	11 - 11

BOREHOLE NO. : BH - 3
DEPTH OF HOLE (M) : 4.00 meters
DEPTH OF CASING (M) : 3.00 meters
TOP OF CASING FROM NGL (M) : 0.30 meters
WATER TABLE FROM TOP OF CASING (M) : 0.48 meters
DATE : June 15,2007

SECTION TESTED (M)	TIME ELAPSED (MIN.)	DRAWDOWN (CM)
3.00 - 4.00	0 - 1	0 - 12
3.00 - 4.00	1 - 2	12 - 13
3.00 - 4.00	2 - 5	13 - 14
3.00 - 4.00	5 - 10	14 - 14
3.00 - 4.00	10 - 15	14 - 14

PERCOLATION TEST
OPEN END TEST - FALLING HEAD METHOD

PROJECT: New Landfill Site
LOCATION : Kabulihan, Malay, Aklan

BOREHOLE NO. : BH - 4
DEPTH OF HOLE (M) : 3.00 meters
DEPTH OF CASING (M) : 2.00 meters
TOP OF CASING FROM NGL (M) : 0.30 meters
WATER TABLE FROM TOP OF CASING (M) : 1.88 meters
DATE : June 16, 2007

SECTION TESTED (M)	TIME ELAPSED (MIN.)	DRAWDOWN (CM)
2.00 - 3.00	0 - 1	0 - 13
2.00 - 3.00	1 - 2	13 - 15
2.00 - 3.00	2 - 5	15 - 15
2.00 - 3.00	5 - 10	15 - 15
2.00 - 3.00	10 - 15	15 - 15

BOREHOLE NO. BH - 5
DEPTH OF HOLE (M) : 5.00 meters
DEPTH OF CASING (M) : 4.50 meters
TOP OF CASING FROM NGL (M) : 0.30 meters
WATER TABLE FROM TOP OF CASING (M) : 0.46 meters
DATE : June 19 2007

SECTION TESTED (M)	TIME ELAPSED (MIN.)	DRAWDOWN (CM)
4.50 - 5.00	0 - 1	0 - 12
4.50 - 5.00	1 - 2	12 - 14
4.50 - 5.00	2 - 5	14 - 15
4.50 - 5.00	5 - 10	15 - 15
4.50 - 5.00	10 - 15	15 - 15

BOREHOLE NO. BH - 6
DEPTH OF HOLE (M) : 5.00 meters
DEPTH OF CASING (M) : 4.50 meters
TOP OF CASING FROM NGL (M) : 0.30 meters
WATER TABLE FROM TOP OF CASING (M)
DATE : June 22, 2007

SECTION TESTED (M)	TIME ELAPSED (MIN.)	DRAWDOWN (CM)
4.50 - 5.00	0 - 1	0 - 12
4.50 - 5.00	1 - 2	12 - 14
4.50 - 5.00	2 - 5	14 - 15
4.50 - 5.00	5 - 10	15 - 20
4.50 - 5.00	10 - 15	20 - 20

WATER PRESSURE TEST

PROJECT: New Landfill Site
LOCATION Malay, Aklan

BOREHOLE NO. GWD # 1

METHOD OF TESTING Descending (WPT)
SIZE OF HOLE NQ
HT OF PRESSURE GAUGE 0.50 M
WATER LEVEL 11.50 M
DATE OF TEST June 21, 2007

SECTION TESTED (M)	PRESSURE (PSI)	TIME (MINUTES)			WATERMETER (LITERS)		TOTAL WATER TAKE
		START	END	ELAPSED	START	FINAL	
7-12	5	1:30	1:35	5	639	669	30
7-12	10	1:38	1:43	5	675	707	32
7-12	15	1:45	1:50	5	710	748	38
7-12	10	1:55	2:00	5	750	780	30
7-12	5	2:10	2:15	5	790	815	26

BOREHOLE NO. GWD # 1

METHOD OF TESTING Descending (WPT)
SIZE OF HOLE NQ
HT OF PRESSURE GAUGE 0.50 M
WATER LEVEL 11.20 M
DATE OF TEST June 22, 2007

SECTION TESTED TESTED (M)	PRESSURE (PSI)	TIME (MINUTES)			WATERMETER (LITERS)		TOTAL WATER TAKE
		START	END	ELAPSED	START	FINAL	
13-18	10	4:30	4:35	5	950	964	14
13-18	20	4:50	4:55	5	975	993	18
13-18	30	5:00	5:05	5	998	1021	23
13-18	20	5:10	5:15	5	1030	1046	16
13-18	10	5:20	5:25	5	1055	1065	10

BOREHOLE NO. GWD # 2

METHOD OF TESTING Descending (WPT)
SIZE OF HOLE NQ
HT OF PRESSURE GAUGE 0.50 M
WATER LEVEL 7.50
DATE OF TEST

SECTION TESTED TESTED (M)	PRESSURE (PSI)	TIME (MINUTES)			WATERMETER (LITERS)		TOTAL WATER TAKE
		START	END	ELAPSED	START	FINAL	
7.5-15	5	4:10	4:15	5	1124	1247	123
7.5-15	10	4:18	4:23	5	1261	1352	91
7.5-15	15	4:25	4:30	5	1369	1471	102
7.5-15	10	4:32	4:37	5	1492	1580	88
7.5-15	5	4:40	4:45	5	1596	1670	74

NEW SANITARY LANDFILL SITE
Kabulihan, Malay, Aklan Province

Appendix 4 COMPUTATION OF PERCOLATION TEST

PERCOLATION TEST : BH-1

Depth		Test Data			R	L	R2/2L(t2-t1)	ln (L/R)	ln (h1/h2)	K (cm/sec)	Average K (cm/sec)	Remarks
From	To	t (sec)	H2 (cm)	H1 (cm)	(cm)	(cm)						
4.5	5	60	0	0	3.75	50	0.00234375	2.590267165	#DIV/0!	#DIV/0!		
4.5	5	60	0	0	3.75	50	0.00234375	2.590267165	#DIV/0!	#DIV/0!		
4.5	5	300	0	0	3.75	50	0.00046875	2.590267165	#DIV/0!	#DIV/0!	#DIV/0!	Pervious
4.5	5	300	0	0	3.75	50	0.00046875	2.590267165	#DIV/0!	#DIV/0!		
4.5	5	300	0	0	3.75	50	0.00046875	2.590267165	#DIV/0!	#DIV/0!		

PERCOLATION TEST : BH-2

Depth		Test Data			R	L	R2/2L(t2-t1)	ln (L/R)	ln (h1/h2)	K (cm/sec)	Average K (cm/sec)	Remarks
From	To	t (sec)	H2 (cm)	H1 (cm)	(cm)	(cm)						
6.3	7	60	1	10	3.75	30	0.00390625	2.079441542	2.302585093	1.87E-02		
6.3	7	60	10	11	3.75	30	0.00390625	2.079441542	0.09531018	7.74E-04		
6.3	7	300	11	11	3.75	30	0.00078125	2.079441542	0	0.00E+00	3.90E-03	Pervious
6.3	7	300	11	11	3.75	30	0.00078125	2.079441542	0	0.00E+00		
6.3	7	300	11	11	3.75	30	0.00078125	2.079441542	0	0.00E+00		

PERCOLATION TEST : BH-3

Depth		Test Data			R	L	R2/2L(t2-t1)	ln (L/R)	ln (h1/h2)	K (cm/sec)	Average K (cm/sec)	Remarks
From	To	t (sec)	H2 (cm)	H1 (cm)	(cm)	(cm)						
3	4	60	1	12	3.75	100	0.001171875	3.283414346	2.48490665	9.56E-03		
3	4	60	12	13	3.75	100	0.001171875	3.283414346	0.080042708	3.08E-04		
3	4	300	13	13	3.75	100	0.000234375	3.283414346	0	0.00E+00	1.99E-03	Pervious
3	4	300	13	14	3.75	100	0.000234375	3.283414346	0.074107972	5.70E-05		
3	4	300	14	14	3.75	100	0.000234375	3.283414346	0	0.00E+00		

PERCOLATION TEST : BH-4

Depth		Test Data			R	L	R2/2L(t2-t1)	ln (L/R)	ln (h1/h2)	K (cm/sec)	Average K (cm/sec)	Remarks
From	To	t (sec)	H2 (cm)	H1 (cm)	(cm)	(cm)						
2	3	60	1	13	3.75	100	0.001171875	3.283414346	2.564949357	9.87E-03		
2	3	60	13	15	3.75	100	0.001171875	3.283414346	0.143100844	5.51E-04		
2	3	300	15	15	3.75	100	0.000234375	3.283414346	0	0.00E+00	2.08E-03	Pervious
2	3	300	15	15	3.75	100	0.000234375	3.283414346	0	0.00E+00		
2	3	300	15	15	3.75	100	0.000234375	3.283414346	0	0.00E+00		

NEW SANITARY LANDFILL SITE
Kabulihan, Malay, Aklan Province

Appendix 4 COMPUTATION OF PERCOLATION TEST

PERCOLATION TEST : BH-5

Depth		Test Data			R	L	R2/2L(t2-t1)	ln (L/R)	ln (h1/h2)	K (cm/sec)	Average K (cm/sec)	Remarks
From	To	t (sec)	H2 (cm)	H1 (cm)	(cm)	(cm)						
4.5	5	60	1	12	3.75	50	0.00234375	2.590267165	2.48490665	1.51E-02	3.22E-03	Pervious
4.5	5	60	12	14	3.75	50	0.00234375	2.590267165	0.15415068	9.36E-04		
4.5	5	300	14	15	3.75	50	0.00046875	2.590267165	0.068992871	8.38E-05		
4.5	5	300	15	15	3.75	50	0.00046875	2.590267165	0	0.00E+00		
4.5	5	300	15	15	3.75	50	0.00046875	2.590267165	0	0.00E+00		

PERCOLATION TEST : BH-6

Depth		Test Data			R	L	R2/2L(t2-t1)	ln (L/R)	ln (h1/h2)	K (cm/sec)	Average K (cm/sec)	Remarks
From	To	t (sec)	H2 (cm)	H1 (cm)	(cm)	(cm)						
4.5	5	60	1	12	3.75	50	0.00234375	2.590267165	2.48490665	1.51E-02	3.29E-03	Pervious
4.5	5	60	12	14	3.75	50	0.00234375	2.590267165	0.15415068	9.36E-04		
4.5	5	300	14	15	3.75	50	0.00046875	2.590267165	0.068992871	8.38E-05		
4.5	5	300	15	20	3.75	50	0.00046875	2.590267165	0.287682072	3.49E-04		
4.5	5	300	20	20	3.75	50	0.00046875	2.590267165	0	0.00E+00		

NEW SANITARY LANDILL SITE

Kabulihan, Malay , Aklan Province

Appendix 4 COMPUTATION OF WATER PRESSURE TEST

BOREHOLE NUMBER : GWD-1
LENGTH OF TEST SECTION (m): 5.00 M
HT. OF PRESSURE GAUGE (m): 1.75 M

HOLE DIAMETER: NQ
Cp VALUE : 4,900.00
GWATER LEVEL : 11.95
DATE :

NUMBER OF TEST	TEST SECTION		TIME (min)	PRESSURE (psi)	WATER METER READING		TOTAL FLOW (liters)	FLOW RATE (gal/min)	TOTAL HEAD (ft)	k VALUE (ft/year)	k VALUE (cm/sec)	LUGEON VALUE (lugeon)	REMARKS
	TOP (meter)	BOTTOM (meter)			INITIAL (liters)	FINAL (liters)							
1	7.00	12.00	5.00	5.00	639.0	669.0	30.00	1.50	48.46	151.67	1.46E-04	8.1336	PERVIOUS
2	7.00	12.00	5.00	10.00	675.0	707.0	32.00	1.60	60.01	130.64	1.26E-04	7.0061	PERVIOUS
3	7.00	12.00	5.00	15.00	710.0	748.0	38.00	1.90	71.56	130.10	1.26E-04	6.9769	PERVIOUS
4	7.00	12.00	5.00	10.00	750.0	780.0	30.00	1.50	60.01	122.48	1.18E-04	6.5682	PERVIOUS
5	7.00	12.00	5.00	5.00	790.0	815.0	25.00	1.25	48.46	126.39	1.22E-04	6.7780	PERVIOUS
									AVERAGE:	132.25	1.28E-04	7.0925	PERVIOUS

NEW SANITARY LANDFILL SITE

Kabulihan, Malay, Aklan Province

Appendix 4 COMPUTATION OF WATER PRESSURE TEST

BOREHOLE NUMBER : GWD-1
LENGTH OF TEST SECTION (m): 5.00 M
HT. OF PRESSURE GAUGE (m): 1.75 M

HOLE DIAMETER: NQ
Cp VALUE : 4,900.00
GWATER LEVEL : 11.95
DATE :

NUMBER OF TEST	TEST SECTION		TIME (min)	PRESSURE (psi)	WATER METER READING		TOTAL FLOW (liters)	FLOW RATE (gal/min)	TOTAL HEAD (ft)	k VALUE (ft/year)	k VALUE (cm/sec)	LUGEON VALUE (1ugeon)	REMARKS
	TOP (meter)	BOTTOM (meter)			INITIAL (liters)	FINAL (liters)							
1	13.00	18.00	5.00	10.00	950.0	964.0	14.00	0.70	68.05	50.40	4.87E-05	2.7031	SEMI-PERVIOUS
2	13.00	18.00	5.00	20.00	975.0	993.0	18.00	0.90	91.15	48.38	4.67E-05	2.5946	SEMI-PERVIOUS
3	13.00	18.00	5.00	30.00	998.0	1021.0	23.00	1.15	114.25	49.32	4.76E-05	2.6450	SEMI-PERVIOUS
4	13.00	18.00	5.00	20.00	1030.0	1046.0	16.00	0.80	91.15	43.01	4.15E-05	2.3063	SEMI-PERVIOUS
5	13.00	18.00	5.00	10.00	1055.0	1065.0	10.00	0.50	68.05	36.00	3.48E-05	1.9308	SEMI-PERVIOUS
									AVERAGE:	45.42	4.39E-05	2.4360	SEMI-PERVIOUS

NEW SANITARY LANDFILL SITE

Kabulihan, Malay Aklan Province

Appendix 4 COMPUTATION OF WATER PRESSURE TEST

BOREHOLE NUMBER : GWS-2
LENGTH OF TEST SECTION (m): 7.50 M
HT. OF PRESSURE GAUGE (m): 1.75 M

HOLE DIAMETER: NQ
Cp VALUE : 2,800.00
GWATER LEVEL : 7.50
DATE :

NUMBER OF TEST	TEST SECTION		TIME (min)	PRESSURE (psi)	WATER METER READING		TOTAL FLOW (liters)	FLOW RATE (gal/min)	TOTAL HEAD (ft)	k VALUE (ft/year)	k VALUE (cm/sec)	LUGEON VALUE (1ugeon)	REMARKS
	TOP (meter)	BOTTOM (meter)			INITIAL (liters)	FINAL (liters)							
1	7.50	15.00	5.00	5.00	1124.0	1247.0	123.00	6.15	41.90	410.99	3.97E-04	25.7136	PERVIOUS
2	7.50	15.00	5.00	10.00	1261.0	1352.0	91.00	4.55	53.45	238.36	2.30E-04	14.9130	PERVIOUS
3	7.50	15.00	5.00	15.00	1369.0	1471.0	102.00	5.10	65.00	219.69	2.12E-04	13.7454	PERVIOUS
4	7.50	15.00	5.00	10.00	1492.0	1580.0	88.00	4.40	53.45	230.50	2.23E-04	14.4213	PERVIOUS
5	7.50	15.00	5.00	5.00	1596.0	1670.0	74.00	3.70	41.90	247.26	2.39E-04	15.4700	PERVIOUS
									AVERAGE:	269.36	2.60E-04	16.8527	PERVIOUS

INFILTRATION FIELD TEST DATA

Appendix 5 NEW SANITARY LANDFILL SITE

Barangay Kabukihan, Malay , Aklan Province

INFILTROMETER READING

INFILTRATION No. 1

Date : June 08, 2007

TIME	DRAWDOWN READING (CM)	CHANGES
0 min,	4.00 cm.	cm.
2 min,	8.00 cm.	4.00 cm.
5 min,	14.00 cm.	6.00 cm.
8 min,	19.00 cm.	5.00 cm.
10 min,	25.00 cm.	6.00 cm.
15 min,	31.00 cm.	6.00 cm.
20 (7) min,	33.00 cm.	2.00 cm.

INFILTRATION No. 2

Date : June 08, 2007

TIME	First Test		Second Test	
	DRAWDOWN READING (CM)	CHANGES	DRAWDOWN READING (CM)	CHANGES
0 min,	0 cm.	0 cm.	0 cm.	0 cm.
2 min,	10.00 cm.	10.00 cm.	8.00 cm.	8.00 cm.
5 min,	26.00 cm.	16.00 cm.	15.00 cm.	7.00 cm.
8 (3.30) sec.	29.50 cm.	3.50 cm.	24.00 cm.	9.00 cm.
10 (8.36) sec.			29.50 cm.	5.50 cm.

INFILTRATION No. 3

Date : June 09, 2007

TIME	First Test		Second Test	
	DRAWDOWN READING (CM)	CHANGES	DRAWDOWN READING (CM)	CHANGES
0 min,	0 cm.	0 cm.	0 cm.	0 cm.
2 min,	11.00 cm.	11.00 cm.	9.00 cm.	9.00 cm.
5 min,	18.00 cm.	7.00 cm.	15.00 cm.	6.00 cm.
8 min,	25.00 cm.	7.00 cm.	20.00 cm.	5.00 cm.
10(6.48) min,	29.50 cm.	4.50 cm.	26.00 cm.	6.00 cm.
15(2.11) min,			29.50 cm.	3.50 cm.

Appendix 5 NEW SANITARY LANDFILL SITE

Barangay Kabukihan, Malay , Aklan Province

INFILTROMETER READING

INFILTRATION No. 4

Date : June 08, 2007

TIME	First Test		Second Test	
	DRAWDOWN READING (CM)	CHANGES	DRAWDOWN READING (CM)	CHANGES
0 min,	0 cm.	0 cm.	0 cm.	0 cm.
2 min,	5.00 cm.	5.00 cm.	4.00 cm.	4.00 cm.
5 min,	10.00 cm.	5.00 cm.	7.00 cm.	3.00 cm.
8 min,	16.00 cm.	6.00 cm.	11.00 cm.	6.00 cm.
10 min,	20.00 cm.	4.00 cm.	13.00 cm.	2.00 cm.
15 min,	29.00 cm.	9.00 cm.	18.00 cm.	5.00 cm.
20 min,			24.00 cm.	6.00 cm.
25 min,			29.00 cm.	5.00 cm.

LABORATORY TEST DATA

NATURAL MOISTURE CONTENT

NATURAL MOISTURE CONTENT

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
DATE:

new land fill

SAMPLE NO.	TP 1A	TP 3A	TP 4A	TP 5A	
DEPTH m	1.00	1.00	2.00	1.00	
CONTAINER NO.	A13	A40	A12	A37	
CONT. + WET SAMPLE g	312.5	214.5	165.5	335.5	
CONT. + DRY SAMPLE g	258	181	140	265	
WT. OF CONTAINER g	22	22.5	22	21	
MOISTURE LOSS g	54.5	33.5	25.5	70.5	
WT. OF DRY SAMPLE g	236	158.5	118	244	
MOISTURE CONTENT %	23.09%	21.14%	21.61%	28.89%	

SAMPLE NO.	TP 2	TP 6			
DEPTH m	2.00	1.50			
CONTAINER NO.	A26	A35			
CONT. + WET SAMPLE g	622.5	693			
CONT. + DRY SAMPLE g	470.5	585.5			
WT. OF CONTAINER g	22	21.5			
MOISTURE LOSS g	152	107.5			
WT. OF DRY SAMPLE g	448.5	564			
MOISTURE CONTENT %	33.89%	19.06%			

NATURAL MOISTURE CONTENT

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: Kabulihan, Malay, Aklan
DATE:

NEW LANDFILL

SAMPLE NO.	BH1 ~ SS2	BH2 ~ SS2	BH3 ~ SS3	BH4 ~ SS2	BH5 ~ SS2
DEPTH m	1.55 ~ 2.50	1.55 ~ 2.00	2.55 ~ 3.00	0.55 ~ 1.00	1.55 ~ 2.00
CONTAINER NO.	A5	A10	A12	A6	A8
CONT. + WET SAMPLE g	359	318	438	294	300
CONT. + DRY SAMPLE g	304	269	396	253	249
WT. OF CONTAINER g	21	22	22	22	23
MOISTURE LOSS g	55	49	42	41	51
WT. OF DRY SAMPLE g	283	247	374	231	226
MOISTURE CONTENT %	19.43%	19.84%	11.23%	17.75%	22.57%

SAMPLE NO.	BH5 ~ SS8	BH5 ~ SS9	TP 4D		
DEPTH m	8.55 ~ 9.00	18.55~18.65	3.30		
CONTAINER NO.	A3	A15	A13		
CONT. + WET SAMPLE g	429	263	262		
CONT. + DRY SAMPLE g	338	230	223		
WT. OF CONTAINER g	22	22	22		
MOISTURE LOSS g	91	33	39		
WT. OF DRY SAMPLE g	316	208	201		
MOISTURE CONTENT %	28.80%	15.87%	19.40%		

ATTERBERG LIMIT

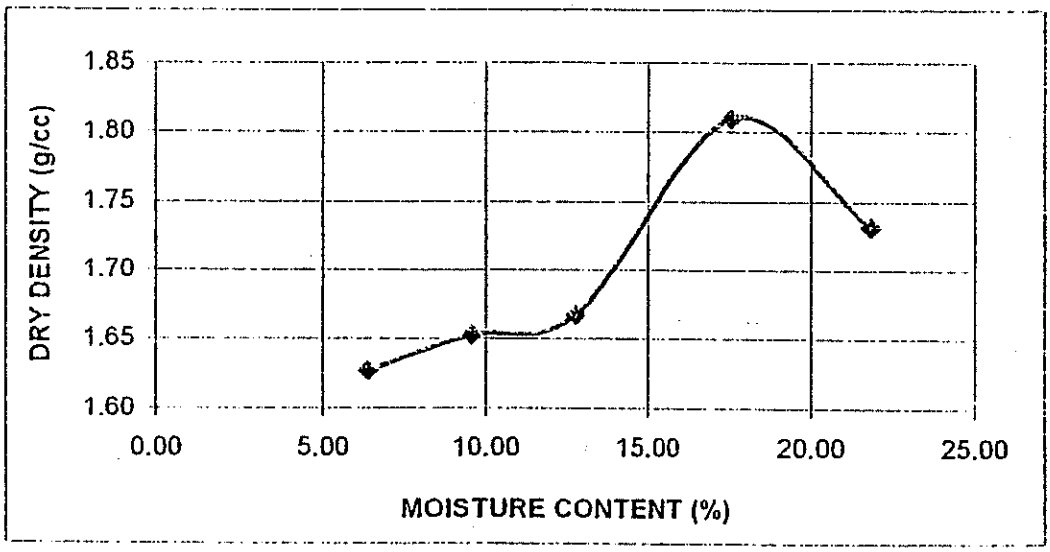
MOISTURE DENSITY RELATIONS

PROJECT : Geological Study and Soil Investigation for the Proposed New Landfill Site
LOCATION: Barangay Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP 2 ~ new landfill

Trial Number	1	2	3	4	5
Water added in ml	200	200	200	200	200
Mold + Wet Soil (g)	3530	3602	3664	3888	3872
Mold (g)	1966	1966	1966	1966	1966
Wet Soil (g)	1564	1636	1698	1922	1906
WET DENSITY (g/cc)	1.73	1.81	1.88	2.13	2.11
Container Number	A15	A17	A11	A20	A2
Container (g)	22	22	22	22	22
Container + Wet Soil (g)	221	262	243	276	262
Container + Dry Soil (g)	209	241	218	238	219
Water (g)	12	21	25	38	43
Dry Soil (g)	187	219	196	216	197
MOISTURE CONTENT (%)	6.42	9.59	12.76	17.59	21.83
DRY DENSITY (g/cc)	1.63	1.65	1.67	1.81	1.73

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.812
Optimum Moisture Content (OMC), %	18



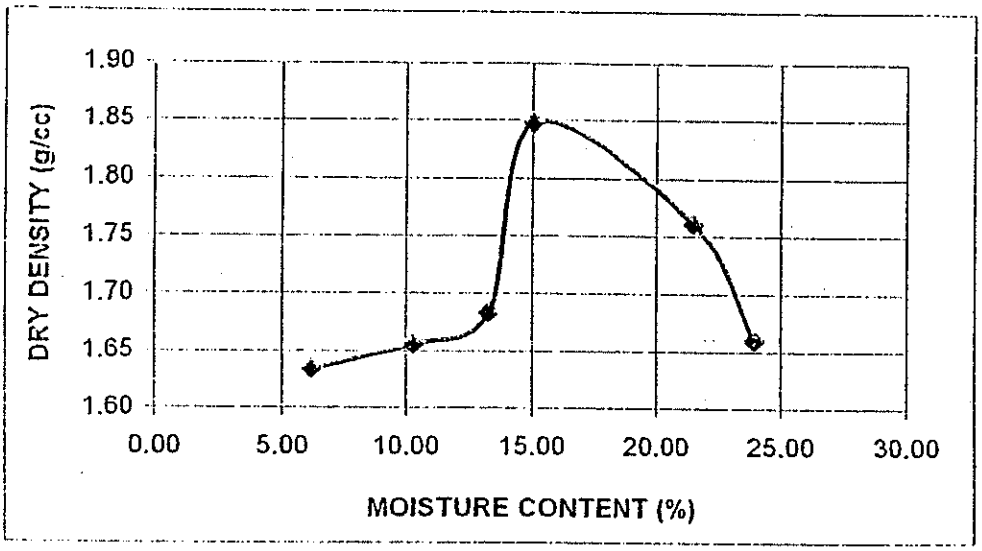
MOISTURE DENSITY RELATIONS

PROJECT : Geological Study and Soil Investigation for the Proposed New Landfill Site
LOCATION: Barangay Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP 4B ~ new landfill

Trial Number	1	2	3	4	5	6
Water added in ml	200	200	200	200	200	200
Mold + Wet Soil (g)	3534	3616	3689	3886	3899	3825
Mold (g)	1966	1966	1966	1966	1966	1966
Wet Soil (g)	1568	1650	1723	1920	1933	1859
WET DENSITY (g/cc)	1.74	1.83	1.91	2.13	2.14	2.06
Container Number	A19	A24	A28	A27	A23	A25
Container (g)	22	22	22	22	22	22
Container + Wet Soil (g)	142	172	201	152	276	348
Container + Dry Soil (g)	135	158	180	135	231	285
Water (g)	7	14	21	17	45	63
Dry Soil (g)	113	136	158	113	209	263
MOISTURE CONTENT (%)	6.19	10.29	13.29	15.04	21.53	23.95
DRY DENSITY (g/cc)	1.63	1.66	1.68	1.85	1.76	1.66

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.851
Optimum Moisture Content (OMC), %	15.5



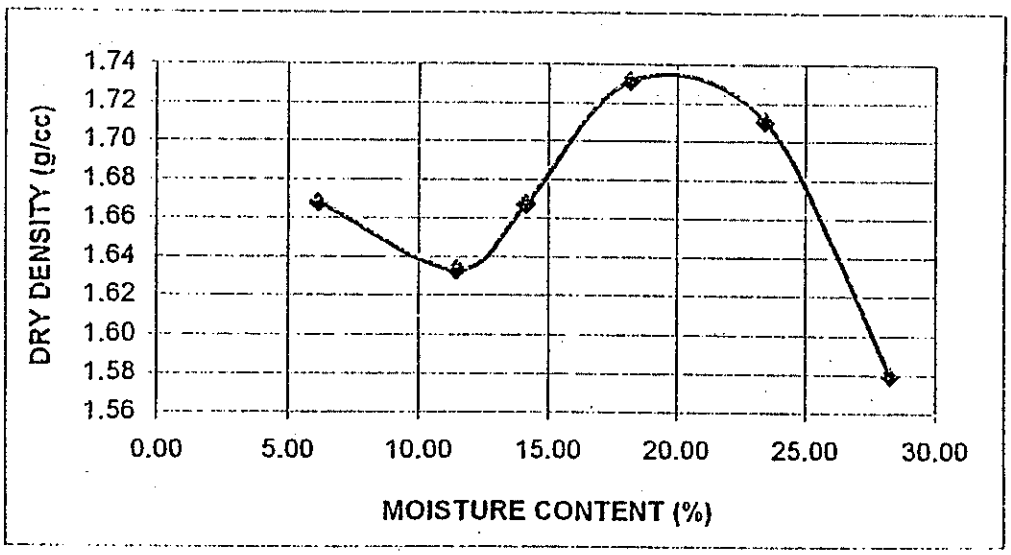
MOISTURE DENSITY RELATIONS

PROJECT : Geological Study and Soil Investigation for the Proposed New Landfill Site
LOCATION: Barangay Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP 5A ~ new landfill

Trial Number	1	2	3	4	5	6
Water added in ml	200	200	200	200	200	200
Mold + Wet Soil (g)	3566	3610	3685	3814	3873	3797
Mold (g)	1966	1966	1966	1966	1966	1966
Wet Soil (g)	1600	1644	1719	1848	1907	1831
WET DENSITY (g/cc)	1.77	1.82	1.90	2.05	2.11	2.03
Container Number	A1	A12	A8	A9	A13	A10
Container (g)	22	22	22	22	22	22
Container + Wet Soil (g)	159	168	135	139	159	217
Container + Dry Soil (g)	151	153	121	121	133	174
Water (g)	8	15	14	18	26	43
Dry Soil (g)	129	131	99	99	111	152
MOISTURE CONTENT (%)	6.20	11.45	14.14	18.18	23.42	28.29
DRY DENSITY (g/cc)	1.67	1.63	1.67	1.73	1.71	1.58

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.735
Optimum Moisture Content (OMC), %	19.8



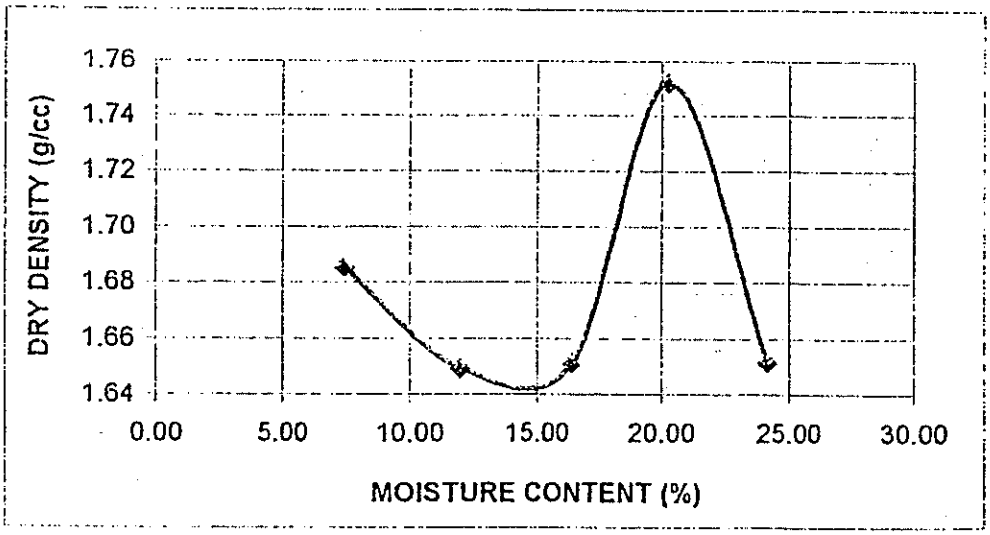
MOISTURE DENSITY RELATIONS

PROJECT : Geological Study and Soil Investigation for the Proposed New Landfill Site
LOCATION: Barangay Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP 6A ~ new landfill

Trial Number	1	2	3	4	5	
Water added in ml	200	200	200	200	200	
Mold + Wet Soil (g)	3602	3634	3703	3869	3818	
Mold (g)	1966	1966	1966	1966	1966	
Wet Soil (g)	1636	1668	1737	1903	1852	
WET DENSITY (g/cc)	1.81	1.85	1.92	2.11	2.05	
Container Number	A3	A6	A7	A11	A16	
Container (g)	22	22	22	22	22	
Container + Wet Soil (g)	94	125	114	111	202	
Container + Dry Soil (g)	89	114	101	96	167	
Water (g)	5	11	13	15	35	
Dry Soil (g)	67	92	79	74	145	
MOISTURE CONTENT (%)	7.46	11.96	16.46	20.27	24.14	
DRY DENSITY (g/cc)	1.69	1.65	1.65	1.75	1.65	

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.75
Optimum Moisture Content (OMC), %	20.27



GRAIN SIZE ANALYSIS

Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: Kabulihan, Malay, Aklan

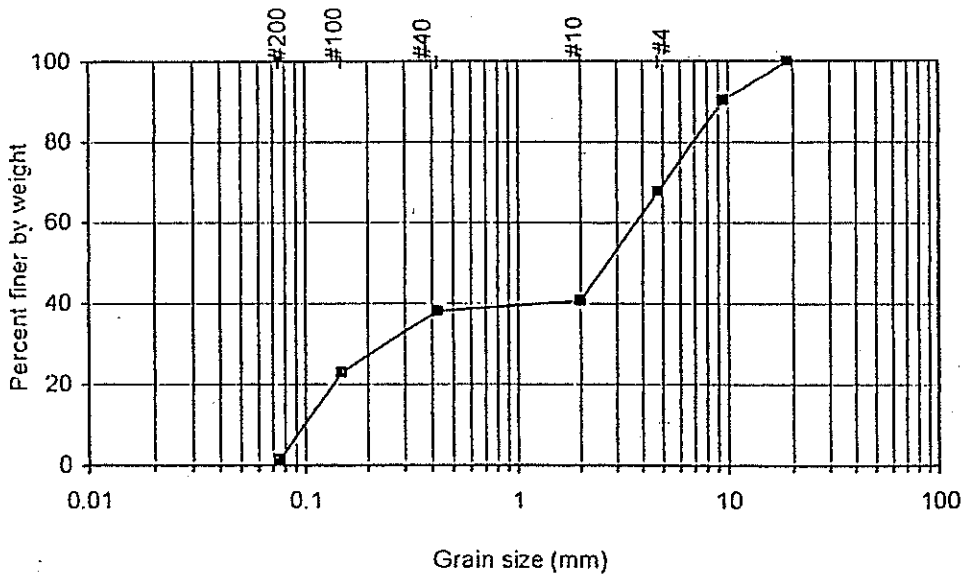
Boring number: TP 5 (new landfill) Sample number: B

Analyst name: Test date:

Sample description:

Sample mass M_0 = *147.00* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	0.0	147.0	100.00
3/8"	9.500	14.0	133.0	90.48
4	4.750	33.0	100.0	68.03
10	2.000	40.0	60.0	40.82
40	0.425	4.0	56.0	38.10
100	0.150	22.0	34.0	23.13
200	0.075	32.0	2.0	1.36
pan		2.0	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: Kabulihan, Malay, Aklan

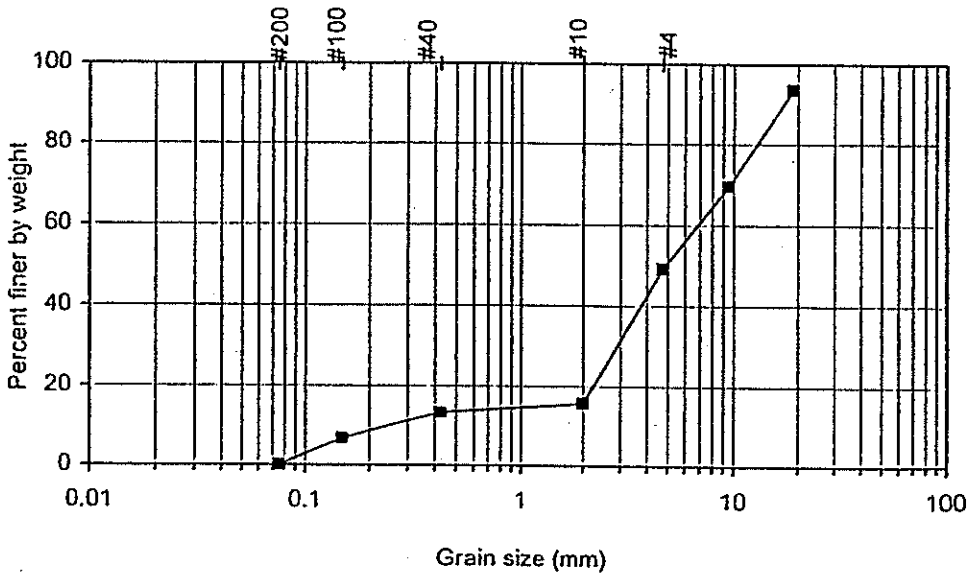
Boring number: TP 4 (new landfill) Sample number: B

Analyst name: Test date:

Sample description:

Sample mass M_0 = *256.30* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	16.0	240.3	93.76
3/8"	9.500	62.0	178.3	69.57
4	4.750	52.0	126.3	49.28
10	2.000	86.0	40.3	15.72
40	0.425	6.0	34.3	13.38
100	0.150	17.0	17.3	6.75
200	0.075	17.0	0.3	0.12
pan		0.3	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: Kabulihan, Malay, Aklan

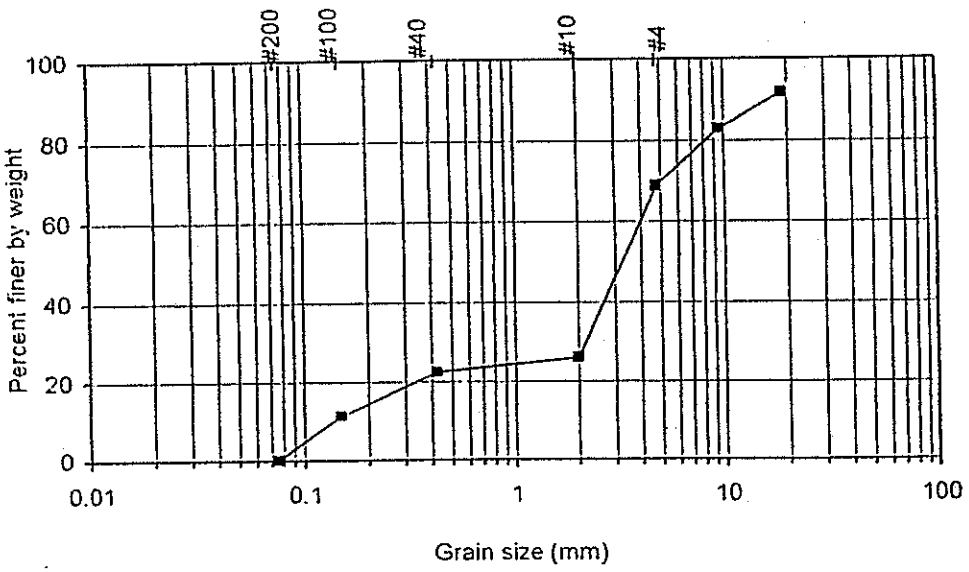
Boring number: TP 1 (new landfill) Sample number:

Analyst name: Test date:

Sample description:

Sample mass M_0 = *222.40* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	18.0	204.4	91.91
3/8"	9.500	20.0	184.4	82.91
4	4.750	31.0	153.4	68.97
10	2.000	95.0	58.4	26.26
40	0.425	8.0	50.4	22.66
100	0.150	25.0	25.4	11.42
200	0.075	25.0	0.4	0.18
pan		0.4	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: Kabulihan, Malay, Aklan

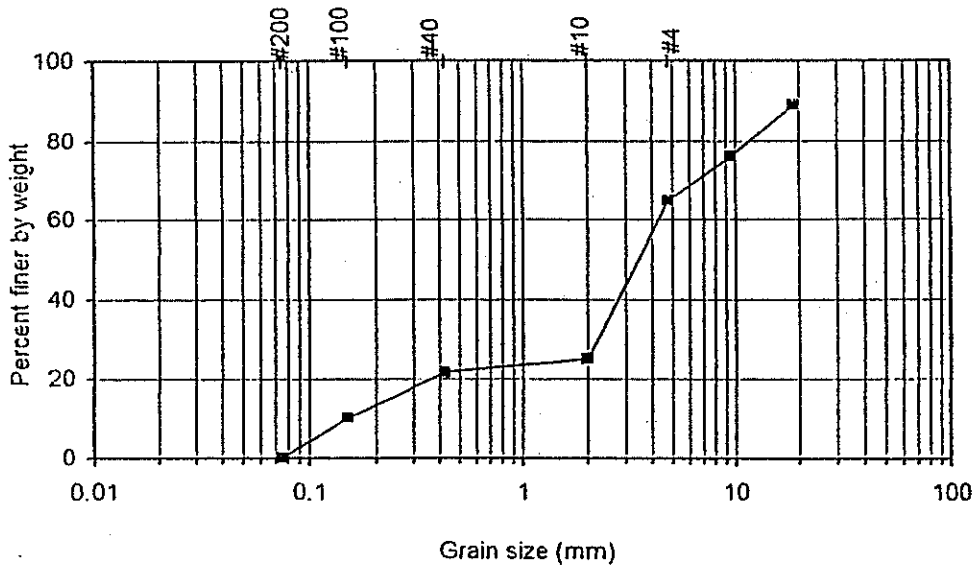
Boring number: TP 2 (new landfill) Sample number:

Analyst name: Test date:

Sample description:

Sample mass M_0 = *276.40* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	30.0	246.4	89.15
3/8"	9.500	36.0	210.4	76.12
4	4.750	31.0	179.4	64.91
10	2.000	110.0	69.4	25.11
40	0.425	9.0	60.4	21.85
100	0.150	32.0	28.4	10.27
200	0.075	28.0	0.4	0.14
pan		0.4	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: Kabulihan, Malay, Aklan

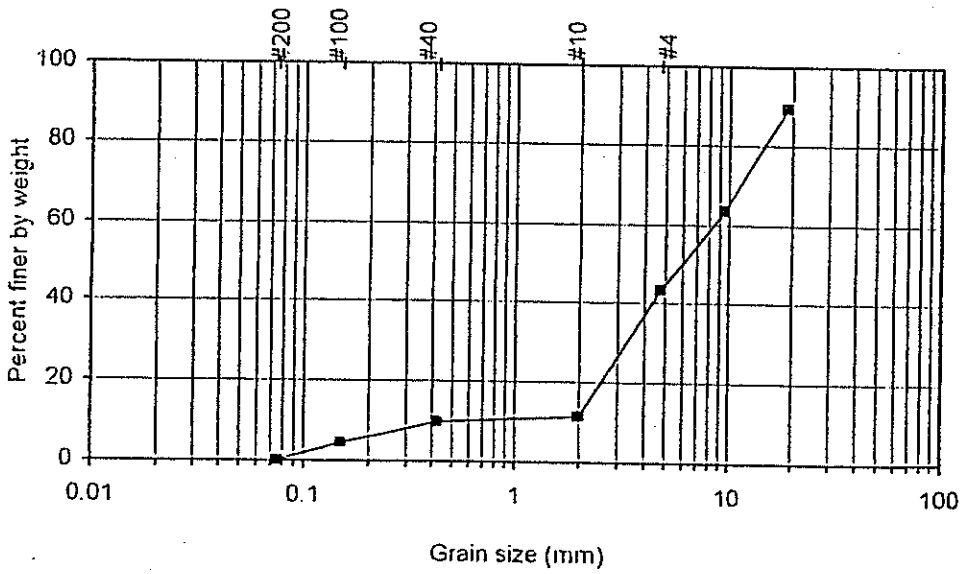
Boring number: TP 3 (new landfill) Sample number: A

Analyst name: Test date:

Sample description:

Sample mass M_0 = *233.20* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	25.0	208.2	89.28
3/8"	9.500	60.0	148.2	63.55
4	4.750	47.0	101.2	43.40
10	2.000	74.0	27.2	11.66
40	0.425	4.0	23.2	9.95
100	0.150	12.0	11.2	4.80
200	0.075	11.0	0.2	0.09
pan		0.2	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: AKLAN

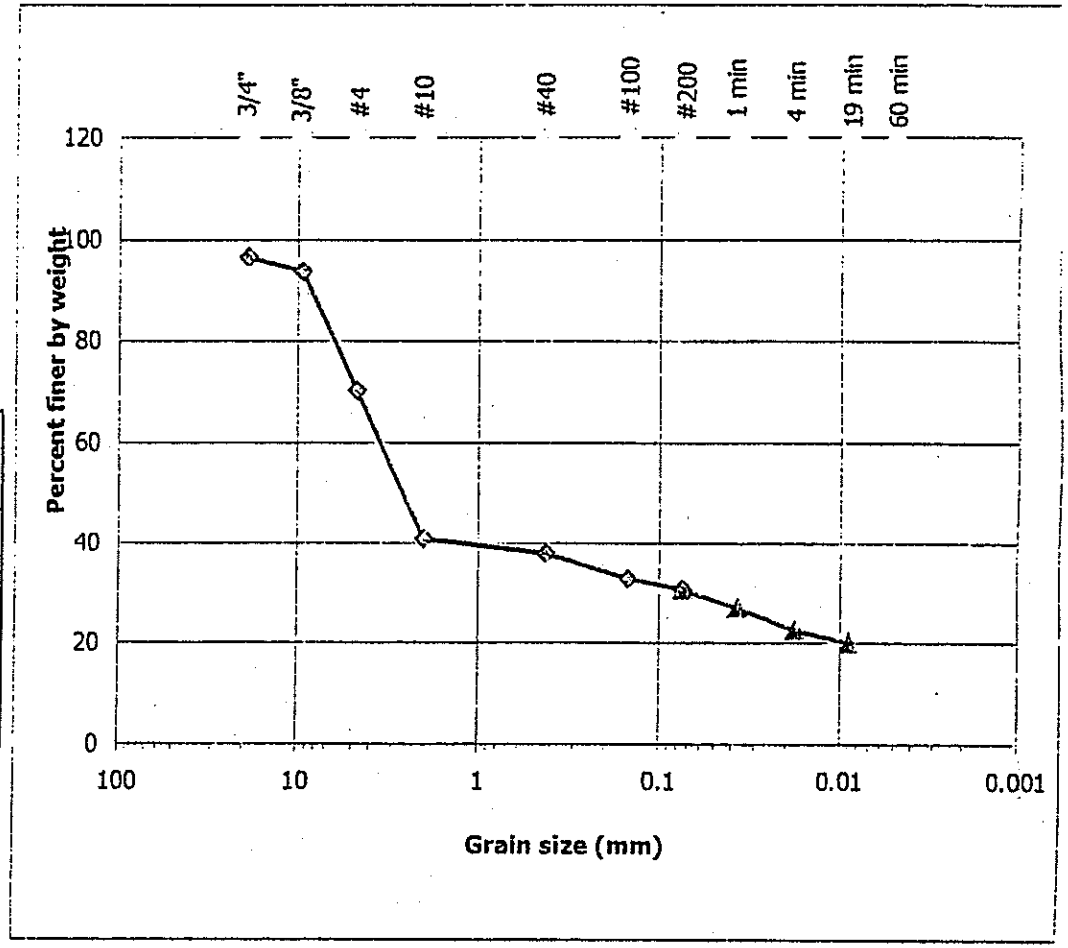
Boring number: TP 6B Sample number:

Analyst name: Test date:

Depth (m): 0.20 ~ 1.25m

Sample mass M_o = *555.50* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	19.0	536.5	96.58
3/8"	9.500	16.0	520.5	93.70
4	4.750	131.0	389.5	70.12
10	2.000	162.5	227.0	40.86
40	0.425	16.0	211.0	37.98
100	0.150	28.0	183.0	32.94
200	0.075	12.5	170.5	30.69
pan		170.5	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: AKLAN

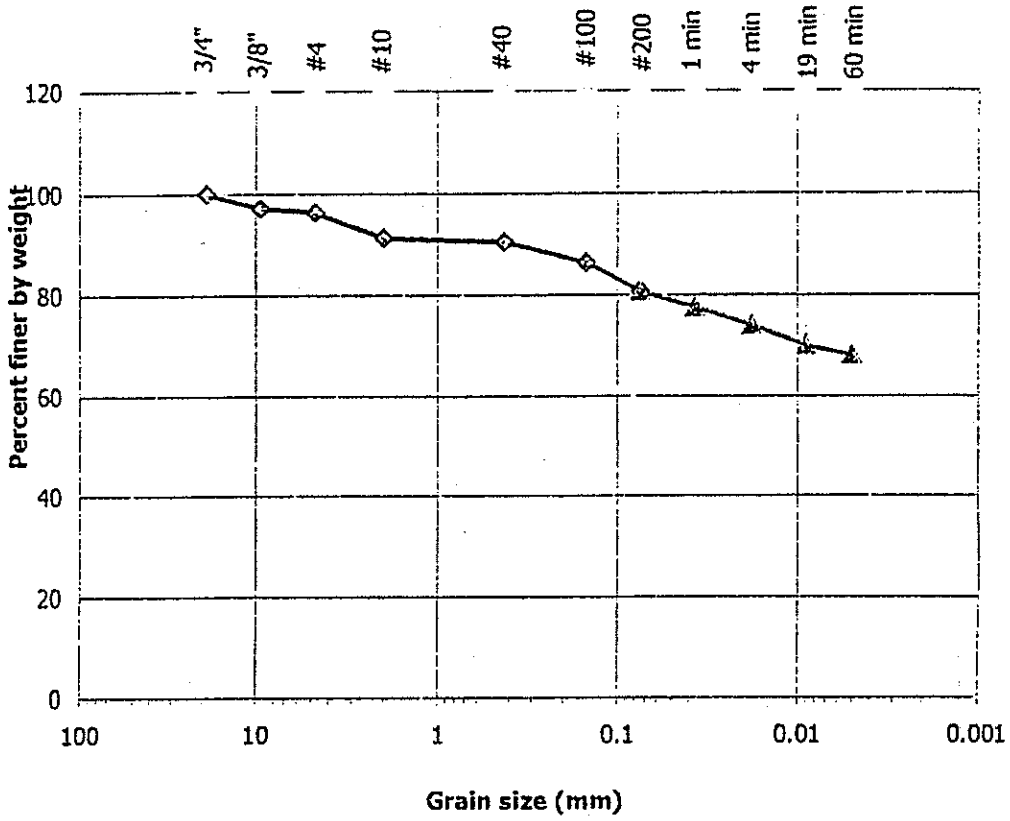
Boring number: TP 5B Sample number:

Analyst name: Test date:

Depth (m): 0.20 ~ 2.20m

Sample mass M_0 = *457.33* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	0.0	457.3	100.00
3/8"	9.500	13.0	444.3	97.16
4	4.750	4.0	440.3	96.28
10	2.000	23.5	416.8	91.14
40	0.425	3.5	413.3	90.38
100	0.150	18.5	394.8	86.33
200	0.075	26.0	368.8	80.65
pan		368.8	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: AKLAN

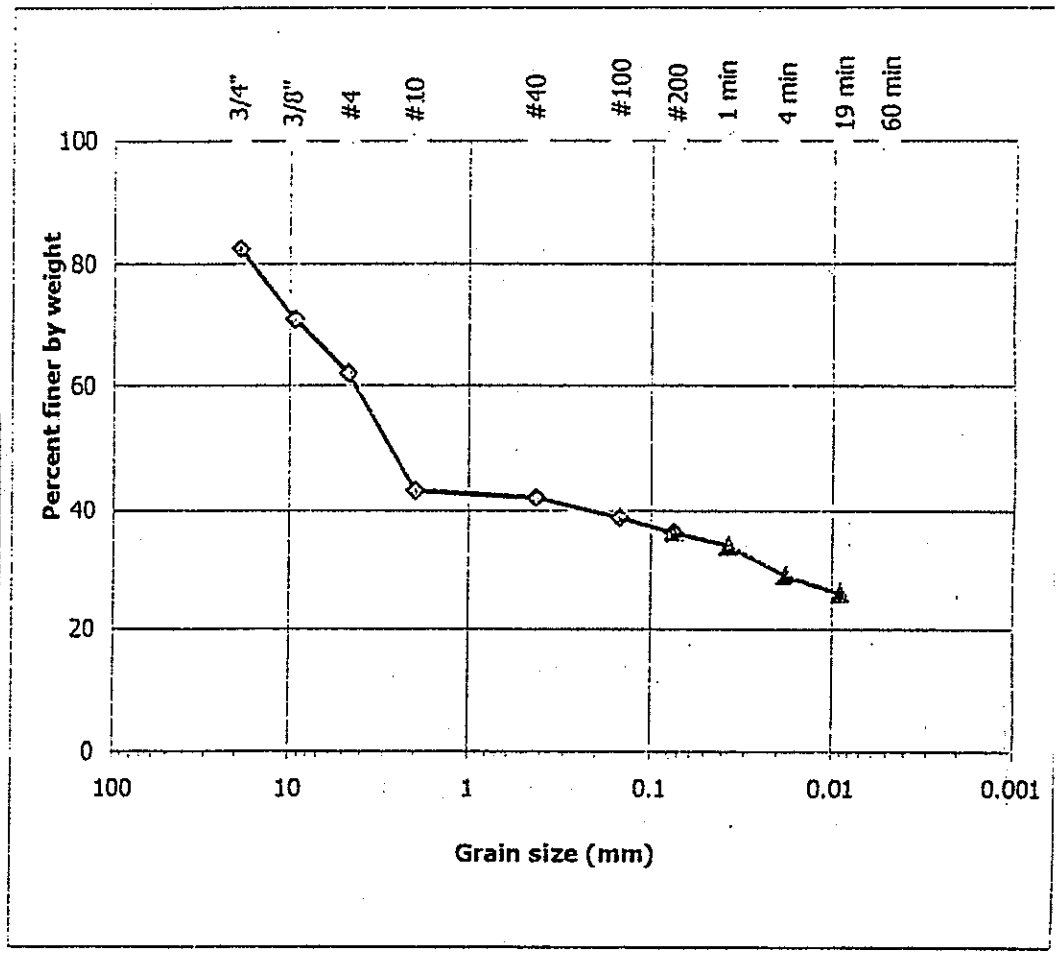
Boring number: TP 4B Sample number:

Analyst name: Test date:

Depth (m): 0.90 ~ 1.20m

Sample mass M_0 = *404.96* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	70.5	334.5	82.59
3/8"	9.500	48.0	286.5	70.74
4	4.750	35.5	251.0	61.97
10	2.000	76.0	175.0	43.20
40	0.425	4.5	170.5	42.09
100	0.150	13.5	157.0	38.76
200	0.075	10.0	146.9	36.29
pan		146.9	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: AKLAN

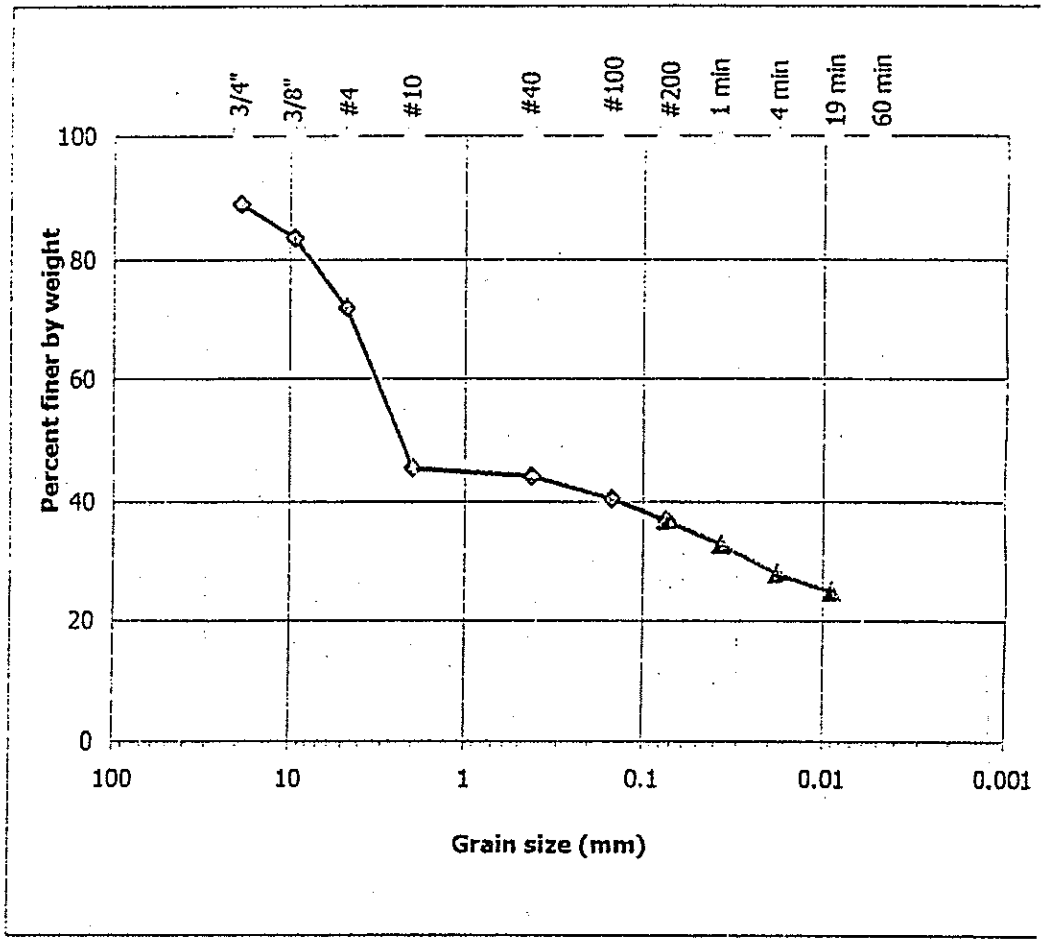
Boring number: TP 3B Sample number:

Analyst name: Test date:

Depth (m): 0.30 ~ 1.20m

Sample mass M_0 = *357.14* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	39.0	318.1	89.08
3/8"	9.500	19.5	298.6	83.62
4	4.750	41.5	257.1	72.00
10	2.000	95.0	162.1	45.40
40	0.425	4.5	157.6	44.14
100	0.150	13.0	144.6	40.50
200	0.075	12.5	132.1	37.00
pan		132.1	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: AKLAN

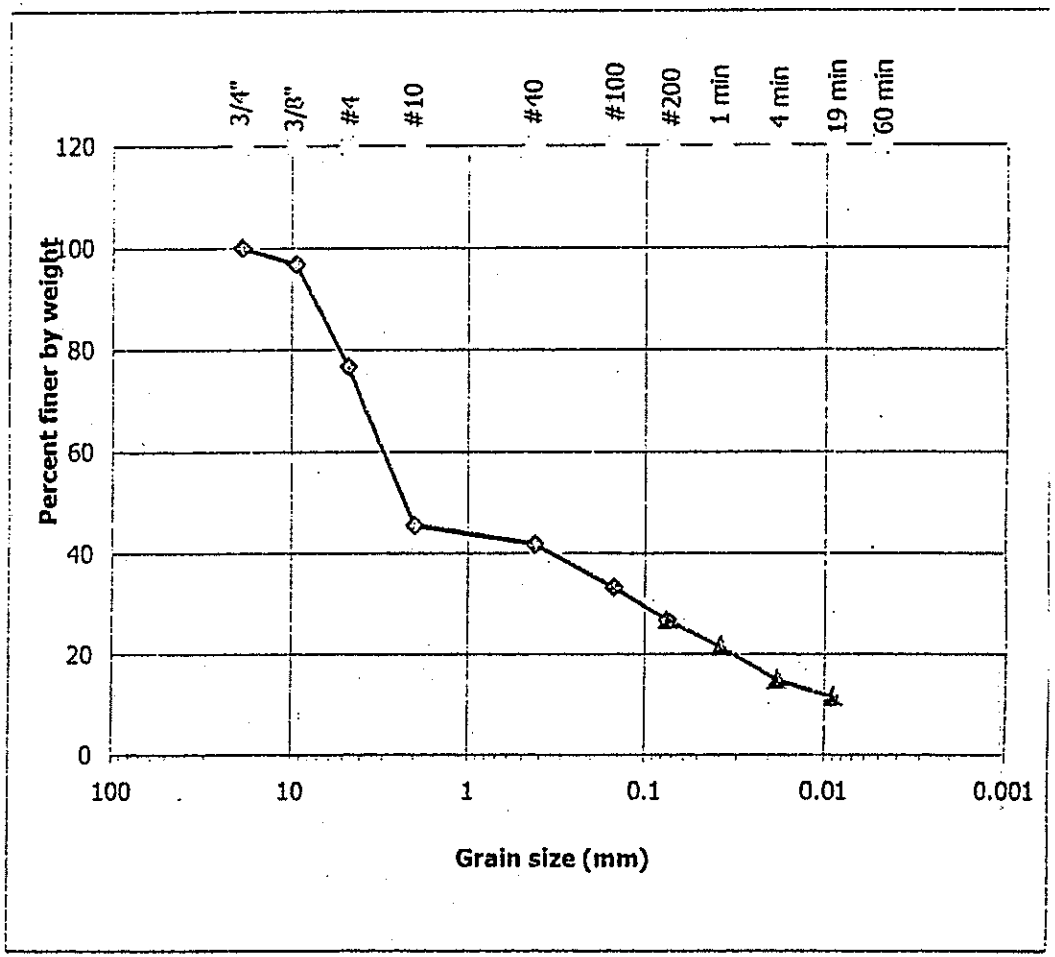
Boring number: TP 2B Sample number:

Analyst name: Test date:

Depth (m): 0.30 ~ 3.0m

Sample mass M_0 = *445.00* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	0.0	445.0	100.00
3/8"	9.500	14.0	431.0	96.85
4	4.750	90.0	341.0	76.63
10	2.000	138.5	202.5	45.51
40	0.425	16.5	186.0	41.80
100	0.150	38.0	148.0	33.26
200	0.075	29.0	119.0	26.74
pan		119.0	0.0	0.00



Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: AKLAN

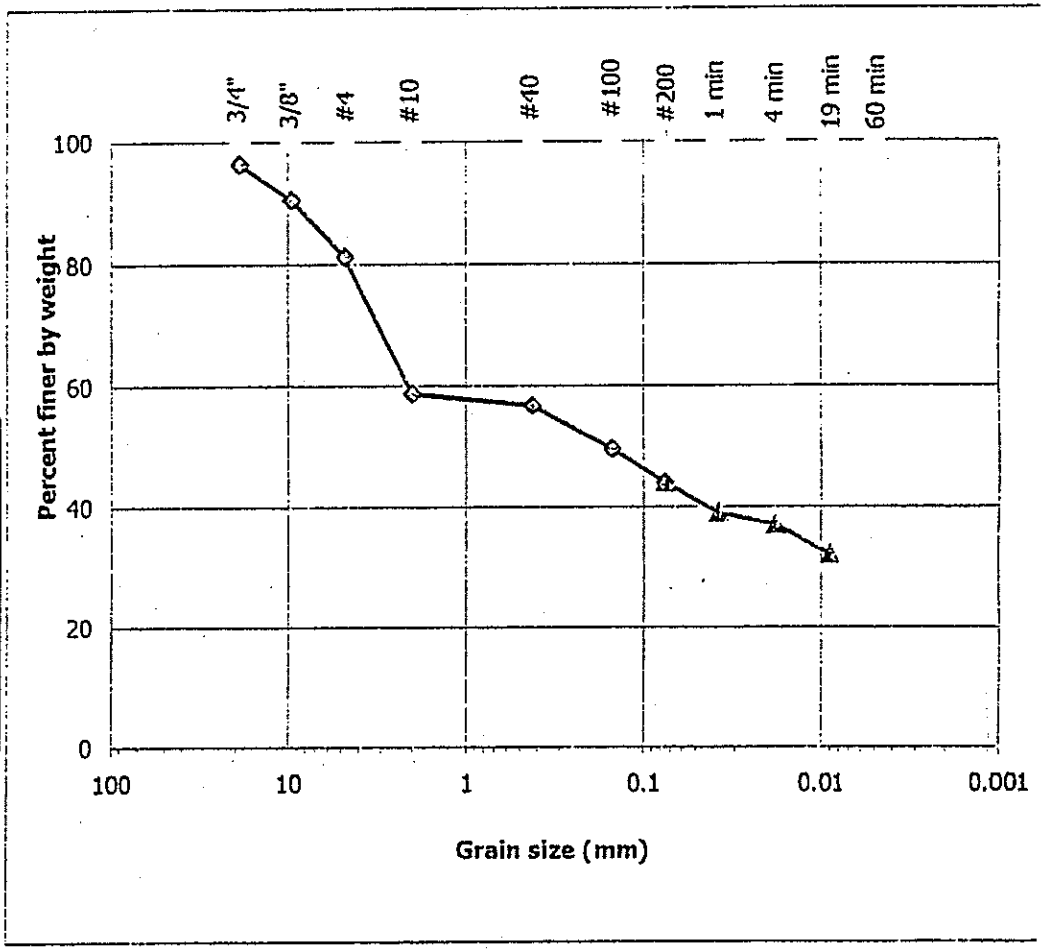
Boring number: TP 1B Sample number:

Analyst name: Test date:

Depth (m): 0.30 ~ 2.20m

Sample mass M_0 = *477.29* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	17.5	459.8	96.33
3/8"	9.500	27.5	432.3	90.57
4	4.750	44.5	387.8	81.25
10	2.000	107.5	280.3	58.73
40	0.425	9.5	270.8	56.73
100	0.150	34.0	236.8	49.61
200	0.075	27.0	209.8	43.95
pan		209.8	0.0	0.00



CONSTANT HEAD PERMEABILITY

Constant Head Permeability

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site

LOCATION : Kabulihan, Malay, Aklan

Analyst Name: *J. Dunan, D. Colasito*
Test Date: *8/2/2007*
Soil Sample: *TP-6 Light brown CLAY*
Specific gravity G_s = *2.65*
Specimen dry mass M_d = *44.60* g
Specimen height H = *1.60* cm
Specimen diameter D = *4.85* cm
Piezometer tap distance L = *3.10* cm
Initial void ratio e = 0.76
Dry unit weight g_d = 14.80 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	*3.70*	*3.70*	*3.70*
Duration of sampling (s) t	*14435*	*15662*	*18605*
Mass of water collected & container (g) M_{wc}	*2.0*	*2.0*	*2.0*
Mass of container (g) Mc	*0.0*	*0.0*	*0.0*
Water temperature (°C)	*26*	*26*	*27*
Hydraulic gradient i	2.9	2.9	2.9
Discharge velocity (cm/s) v	0.00001	0.00001	0.000
Permeability at ambient temperature (cm/s) k_T	0.000003	0.000002	0.000002
Permeability at 20°C (cm/s) k	0.000002	0.000002	0.000002

Average permeability at ambient = 0.000002 cm/s
Average permeability at 20°C = 0.000002 cm/s

Constant Head Permeability

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site

LOCATION : Kabulihan, Malay, Aklan

Analyst Name: *J. Dunan, D. Colasito*
Test Date: *8/2/2007*
Soil Sample: *TP-2 Light yellowish brown CLAY*
Specific gravity G_s = *2.66*
Specimen dry mass M_d = *45.00* g
Specimen height H = *1.60* cm
Specimen diameter D = *4.85* cm
Piezometer tap distance L = *3.10* cm
Initial void ratio e = 0.75
Dry unit weight g_d = 14.93 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	*3.10*	*3.10*	*3.10*
Duration of sampling (s) t	*616*	*635*	*630*
Mass of water collected & container (g) M_{wc}	*2.0*	*2.0*	*2.0*
Mass of container (g) Mc	*0.0*	*0.0*	*0.0*
Water temperature (°C)	*25*	*26*	*26*
Hydraulic gradient i	2.9	2.9	2.9
Discharge velocity (cm/s) v	0.00018	0.00017	0.00017
Permeability at ambient temperature (cm/s) k_T	0.00006	0.00006	0.00006
Permeability at 20°C (cm/s) k	0.00005	0.00005	0.00005

Average permeability at ambient = 0.00006 cm/s
Average permeability at 20°C = 0.00005 cm/s

Constant Head Permeability

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site

LOCATION : Kabulihan, Malay, Aklan

Analyst Name: *J. Dunan, D. Colasito*
Test Date: *8/1/2007*
Soil Sample: *TP-4 Light brown CLAY*
Specific gravity G_s = *2.65*
Specimen dry mass M_d = *26.70* g
Specimen height H = *1.00* cm
Specimen diameter D = *4.85* cm
Piezometer tap distance L = *3.70* cm
Initial void ratio e = 0.83
Dry unit weight g_d = 14.18 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	*3.70*	*3.70*	*3.70*
Duration of sampling (s) t	*631*	*600*	*600*
Mass of water collected & container (g) M_{wc}	*4.6*	*4.5*	*4.2*
Mass of container (g) Mc	*0.0*	*0.0*	*0.0*
Water temperature (°C)	*25*	*26*	*27*
Hydraulic gradient i	4.7	4.7	4.7
Discharge velocity (cm/s) v	0.00039	0.00041	0.000
Permeability at ambient temperature (cm/s) k_T	0.00008	0.00009	0.00008
Permeability at 20°C (cm/s) k	0.00007	0.00008	0.00007

Average permeability at ambient = 0.00008 cm/s
Average permeability at 20°C = 0.00007 cm/s

Sieve Analysis

ASTM D 422

Project: Geological Study and Soil Investigation for the New Proposed Landfill Site

Location: Kabulihan, Malay, Aklan

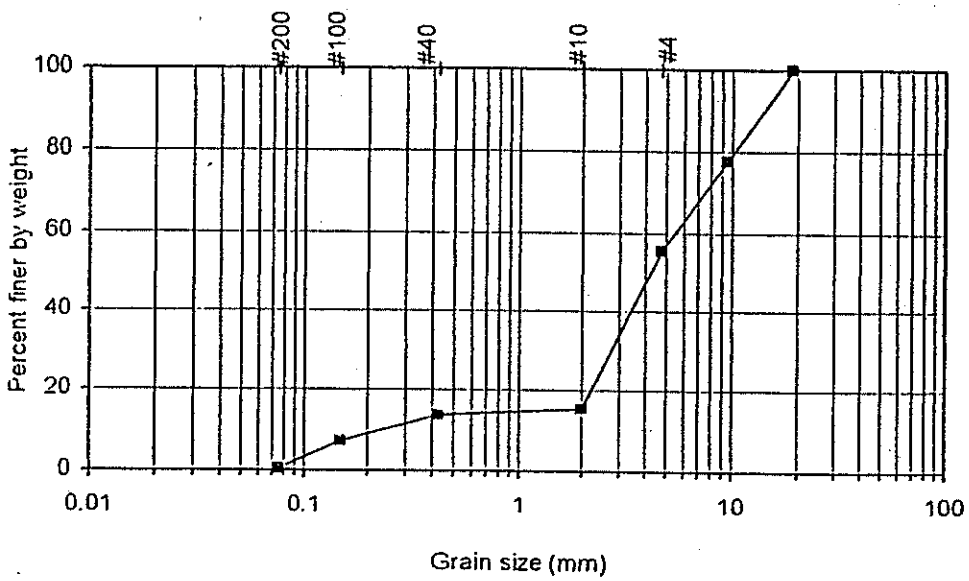
Boring number: TP 4 (new landfill) Sample number: A

Analyst name: Test date:

Sample description:

Sample mass M_0 = *173.70* g

US sieve number	Sieve opening (mm) d	Mass retained (g) M	Mass passing (g) M_p	Percent finer by weight p
3/4"	19.000	0.0	173.7	100.00
3/8"	9.500	39.0	134.7	77.55
4	4.750	38.0	96.7	55.67
10	2.000	70.0	26.7	15.37
40	0.425	3.0	23.7	13.64
100	0.150	11.0	12.7	7.31
200	0.075	12.0	0.7	0.40
pan		0.7	0.0	0.00



Constant Head Permeability

Analyst Name: *R. Dunan, X. Pasilaban*
Test Date: *11/12/2007*
Soil Sample: *TP-1AMedium yellowish brown CLAY*

Specific gravity G_s =	2.65	
Specimen dry mass M_d =	26.60	g
Specimen height H =	1.00	cm
Specimen diameter D =	4.85	cm
Piezometer tap distance L =	3.70	cm
Initial void ratio e =	0.84	
Dry unit weight g_d =	14.12	kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	3.70	3.70	3.70
Duration of sampling (s) t	1200	1222	1212
Mass of water collected & container (g) M_{wc}	4.0	4.5	4.2
Mass of container (g) Mc	0.0	0.0	0.0
Water temperature (°C)	25	26	26
Hydraulic gradient i	4.7	4.7	4.7
Discharge velocity (cm/s) v	0.0002	0.0002	0.0002
Permeability at ambient temperature (cm/s) k_T	0.000038	0.000042	0.000040
Permeability at 20°C (cm/s) k	0.000034	0.000037	0.000035

Average permeability at ambient = 0.00004 cm/s
Average permeability at 20°C = 0.00004 cm/s

Constant Head Permeability

PROJECT : Soil Investigation for theProposed New Sanitaryy Landfill Site

LOCATION : Barangay Kabulihan, Malay , Aklan

Analyst Name: *R. Dunan, X. Pasileban*
Test Date: *11/12/2007*
Soil Sample: *TP-2 Light yellowish brown CLAY*
Specific gravity G_s = *2.66*
Specimen dry mass M_d = *45.00* g
Specimen height H = *1.60* cm
Specimen diameter D = *4.85* cm
Piezometer tap distance L = *3.10* cm
Initial void ratio e = 0.75
Dry unit weight g_d = 14.93 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	*3.10*	*3.10*	*3.10*
Duration of sampling (s) t	*629*	*631*	*615*
Mass of water collected & container (g) M_{wc}	*2.0*	*2.0*	*2.0*
Mass of container (g) Mc	*0.0*	*0.0*	*0.0*
Water temperature (°C)	*25*	*26*	*26*
Hydraulic gradient i	2.9	2.9	2.9
Discharge velocity (cm/s) v	0.00017	0.00017	0.00018
Permeability at ambient temperature (cm/s) k_T	0.00006	0.00006	0.00006
Permeability at 20°C (cm/s) k	#NAME?	#NAME?	#NAME?

Average permeability at ambient = 0.00006 cm/s
Average permeability at 20°C = #NAME? cm/s

Constant Head Permeability

Analyst Name: *R. Dunan, X. Pasilaban*
Test Date: *11/12/2007*
Soil Sample: *TP-3 Medium yellowish brown CLAY*

Specific gravity G_s = 2.66
Specimen dry mass M_d = 26.75 g
Specimen height H = 1.00 cm
Specimen diameter D = 4.85 cm
Piezometer tap distance L = 3.70 cm
Initial void ratio e = 0.84
Dry unit weight g_d = 14.20 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	3.70	3.70	3.70
Duration of sampling (s) t	1370	1380	1371
Mass of water collected & container (g) M_{wc}	6.0	6.2	6.0
Mass of container (g) Mc	0.0	0.0	0.0
Water temperature (°C)	25	25	25
Hydraulic gradient i	4.7	4.7	4.7
Discharge velocity (cm/s) v	0.0002	0.0002	0.0002
Permeability at ambient temperature (cm/s) k_T	0.000050	0.000052	0.000050
Permeability at 20°C (cm/s) k	0.000045	0.000046	0.000045

Average permeability at ambient = 0.00005 cm/s
Average permeability at 20°C = 0.00005 cm/s

Constant Head Permeability

PROJECT : Soil Investigation for the Proposed New Sanitary Landfill Site

LOCATION : Barangay Kabulihan , Malay, Aklan

Analyst Name: *R. Dunan, X. Pasilaban*
Test Date: *11/12/2007*
Soil Sample: *TP-4 Light brown CLAY*
Specific gravity G_s = *2.65*
Specimen dry mass M_d = *26.70* g
Specimen height H = *1.00* cm
Specimen diameter D = *4.85* cm
Piezometer tap distance L = *3.70* cm
Initial void ratio e = 0.83
Dry unit weight g_d = 14.18 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	*3.70*	*3.70*	*3.70*
Duration of sampling (s) t	*603*	*627*	*615*
Mass of water collected & container (g) M_{wc}	*4.6*	*4.5*	*4.2*
Mass of container (g) Mc	*0.0*	*0.0*	*0.0*
Water temperature (°C)	*25*	*26*	*27*
Hydraulic gradient i	4.7	4.7	4.7
Discharge velocity (cm/s) v	0.00041	0.00039	0.000
Permeability at ambient temperature (cm/s) k_T	0.00009	0.00008	0.00008
Permeability at 20°C (cm/s) k	#NAME?	#NAME?	#NAME?

Average permeability at ambient = 0.00008 cm/s
Average permeability at 20°C = #NAME? cm/s

Constant Head Permeability

Analyst Name: *R. Dunan, X. Pasilaban*
Test Date: *11/12/2007*
Soil Sample: *TP-5 Light brown CLAY*

Specific gravity G_s =	2.65
Specimen dry mass M_d =	26.35 g
Specimen height H =	1.00 cm
Specimen diameter D =	4.85 cm
Piezometer tap distance L =	3.70 cm
Initial void ratio e =	0.86
Dry unit weight g_d =	13.99 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	3.70	3.70	3.70
Duration of sampling (s) t	1307	1288	1286
Mass of water collected & container (g) M_{wc}	4.0	4.0	4.0
Mass of container (g) Mc	0.0	0.0	0.0
Water temperature (°C)	25	25	25
Hydraulic gradient i	4.7	4.7	4.7
Discharge velocity (cm/s) v	0.0002	0.0002	0.0002
Permeability at ambient temperature (cm/s) k_T	0.000035	0.000036	0.000036
Permeability at 20°C (cm/s) k	0.000031	0.000032	0.000032

Average permeability at ambient = 0.00004 cm/s
Average permeability at 20°C = 0.00003 cm/s

Constant Head Permeability

PROJECT : Soil Investigation for the Proposed New Sanitary Landfill Site

LOCATION : Barangay Kabulihan, Malay, Aklan

Analyst Name: *R. Dunan, X. Pasilaban*
Test Date: *11/12/2007*
Soil Sample: *TP-6 Light brown CLAY*
Specific gravity G_s = *2.65*
Specimen dry mass M_d = *44.60* g
Specimen height H = *1.60* cm
Specimen diameter D = *4.85* cm
Piezometer tap distance L = *3.10* cm
Initial void ratio e = 0.76
Dry unit weight g_d = 14.80 kN/m^3

Trial	1	2	3
Piezometer level distance (cm) Dh	*3.70*	*3.70*	*3.70*
Duration of sampling (s) t	*14435*	*15662*	*18605*
Mass of water collected & container (g) M_{wc}	*2.0*	*2.0*	*2.0*
Mass of container (g) Mc	*0.0*	*0.0*	*0.0*
Water temperature (°C)	*26*	*26*	*27*
Hydraulic gradient i	2.9	2.9	2.9
Discharge velocity (cm/s) v	0.00001	0.00001	0.000
Permeability at ambient temperature (cm/s) k_T	0.000003	0.000002	0.000002
Permeability at 20°C (cm/s) k	#NAME?	#NAME?	#NAME?

Average permeability at ambient = 0.000002 cm/s
Average permeability at 20°C = #NAME? cm/s

CALIFORNIA BEARING RATIO

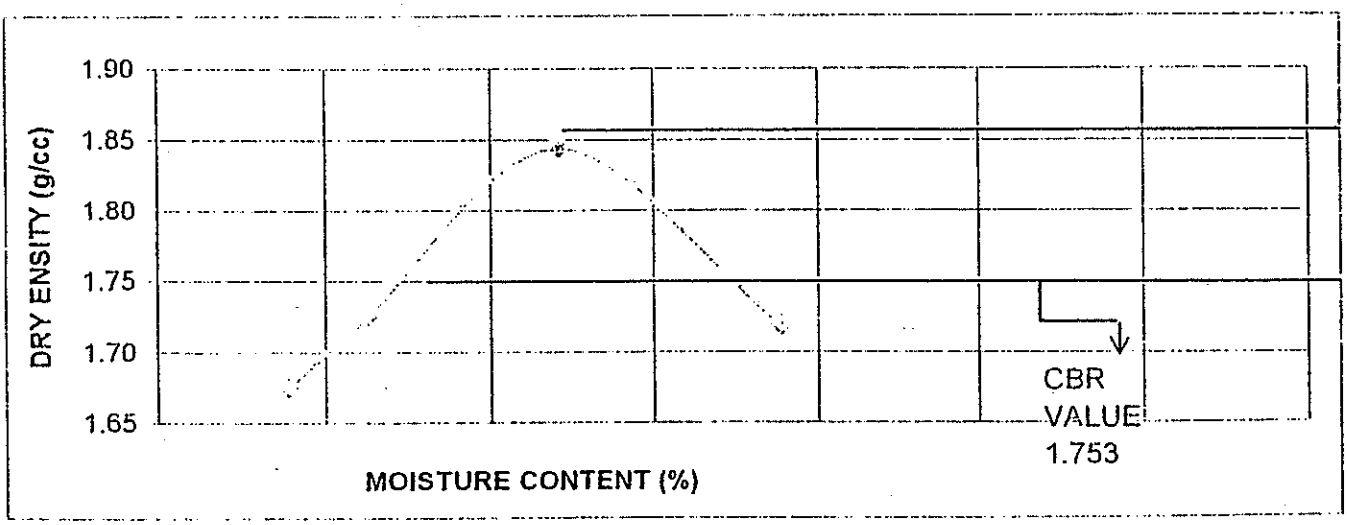
CALIFONIA BEARING RATIO

PROJECT : Geological Study and Soil Investigation for the Old and New Proposed Landfill Site
LOCATION: Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP1

Trial Number	1	2	3	4
Water added in ml	200	200	200	200
Mold + Wet Soil (g)	3614	3701	3917	3890
Mold (g)	1966	1966	1966	1966
Wet Soil (g)	1648	1735	1951	1924
WET DENSITY (g/cc)	1.82	1.92	2.16	2.13
Container Number	B2	B3	B6	B1
Container (g)	12	12	12	12
Container + Wet Soil (g)	196	160	197	230
Container + Dry Soil (g)	181	145	170	188
Water (g)	15	15	27	42
Dry Soil (g)	169	133	158	176
MOISTURE CONTENT (%)	8.88	11.28	17.09	23.86
DRY DENSITY (g/cc)	1.68	1.73	1.84	1.72

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.845
Optimum Moisture Content (OMC), %	17.5



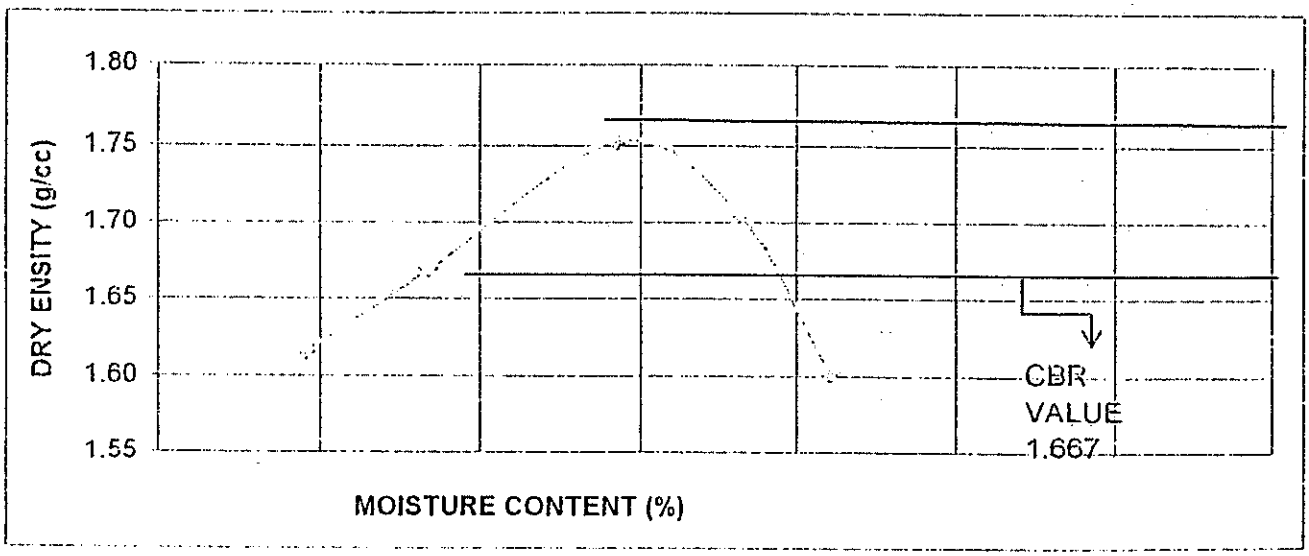
CALIFORNIA BEARING RATIO

PROJECT : Geological Study and Soil Investigation for theProposed New Landfill Site
LOCATION: Barangay Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP 3A

Trial Number	1	2	3	4	5
Water added in ml	200	200	200	200	200
Mold + Wet Soil (g)	3566	3676	3855	3865	3791
Mold (g)	1966	1966	1966	1966	1966
Wet Soil (g)	1600	1710	1889	1899	1825
WET DENSITY (g/cc)	1.77	1.89	2.09	2.10	2.02
Container Number	A29	A26	A21	A30	A3
Container (g)	22	22	22	22	22
Container + Wet Soil (g)	228	183	183	224	317
Container + Dry Soil (g)	210	164	157	186	256
Water (g)	18	19	26	38	61
Dry Soil (g)	188	142	135	164	234
MOISTURE CONTENT (%)	9.57	13.38	19.26	23.17	26.07
DRY DENSITY (g/cc)	1.62	1.67	1.75	1.71	1.60

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.755
Optimum Moisture Content (OMC), %	19.9



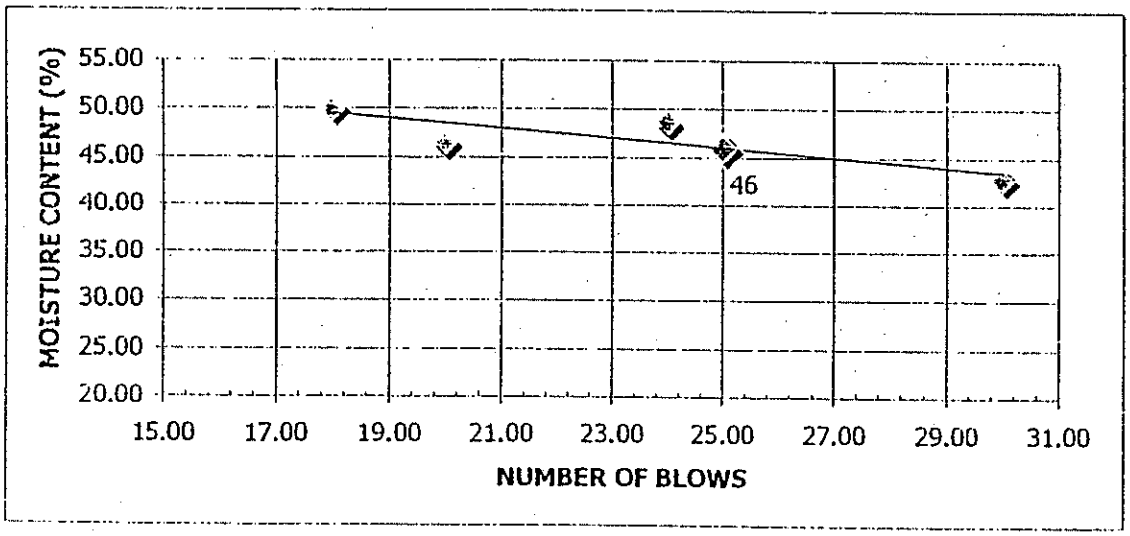
PROCTOR COMPACTION TEST

LIQUID AND PLASTIC LIMIT TEST

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
SAMPLE NO.: TP 5
DEPTH (m) : 0.20 ~ 2.20

	LIQUID LIMIT				PLASTIC LIMIT	
DETERMINATION NO.	1	2	3	4	A	B
Container Number	B33	B34	B32	B35	B22	B29
Container + Wet Soil (g)	16.5	18.5	17	18.5	14.5	14
Container + Dry Soil (g)	15	15	15.5	16.5	14	13.5
Moisture Loss (g)	1.5	3.5	1.5	2	0.5	0.5
Container (g)	11.5	7.8	12.5	12.2	12.5	12
Dry Soil (g)	3.5	7.2	3	4.3	1.5	1.5
Moisture Content (%)	42.86	48.61	50.00	46.51	33.33	33.33
Number of Blows	30	24	18	20	33.33	

FLOW CURVE



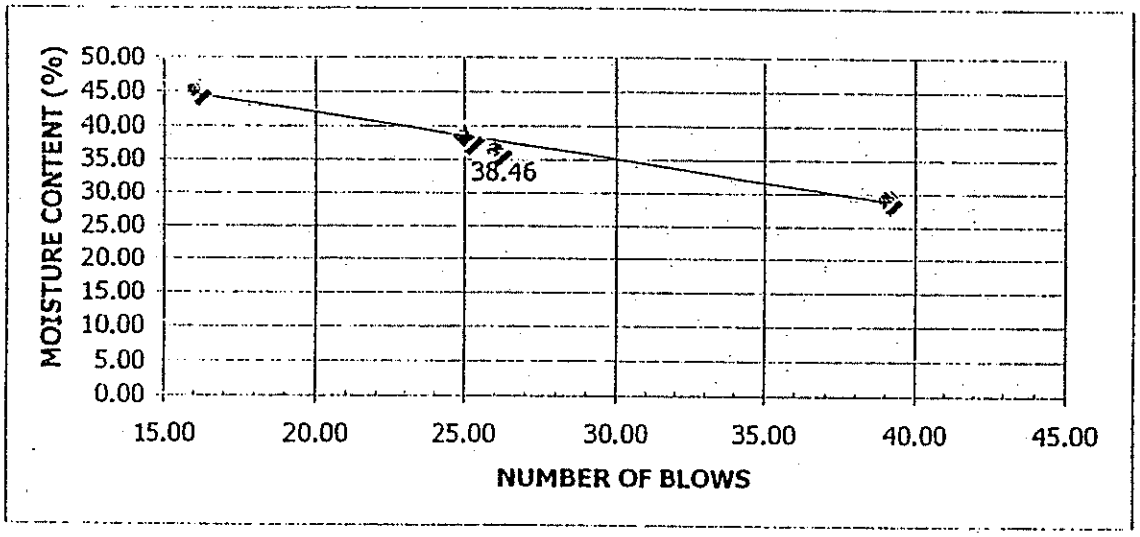
LIQUID LIMIT: 46.00
PLASTIC LIMIT: 33.33
PLASTIC INDEX: 12.67

LIQUID AND PLASTIC LIMIT TEST

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
SAMPLE NO.: TP 4
DEPTH (m) : 0.90 ~ 1.20

	LIQUID LIMIT				PLASTIC LIMIT	
DETERMINATION NO.	1	2	3	4	A	B
Container Number	A35	A21	A26	A39	B26	B28
Container + Wet Soil (g)	29.5	30	30.5	28	15	14.5
Container + Dry Soil (g)	28	27.5	28	26.5	14.5	14
Moisture Loss (g)	1.5	2.5	2.5	1.5	0.5	0.5
Container (g)	23.9	22	21.5	21.4	12	11.5
Dry Soil (g)	4.1	5.5	6.5	5.1	2.5	2.5
Moisture Content (%)	36.59	45.45	38.46	29.41	20.00	20.00
Number of Blows	26	16	25	39	20.00	

FLOW CURVE



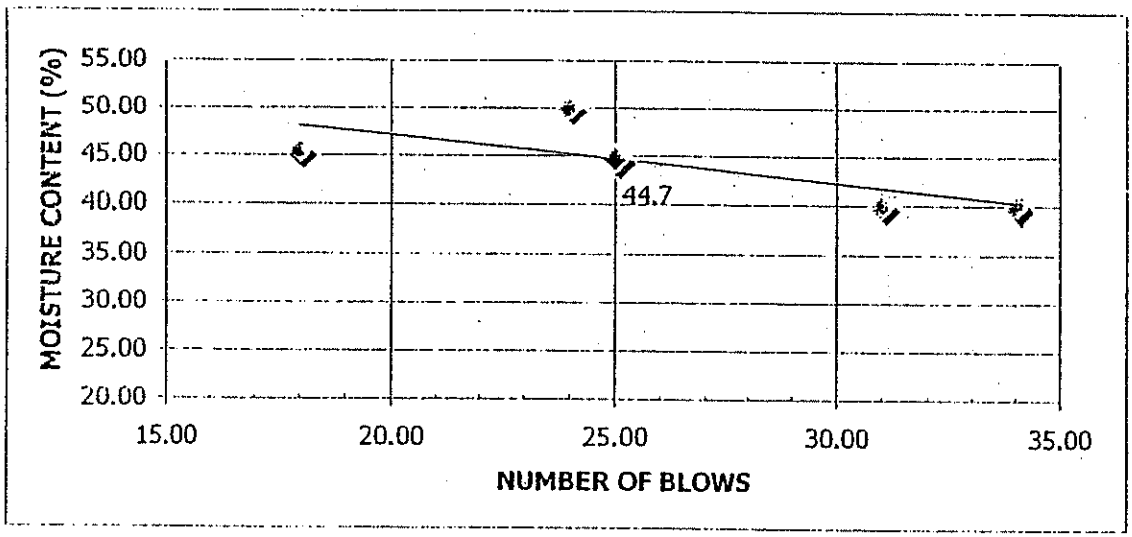
LIQUID LIMIT: 38.46
PLASTIC LIMIT: 20.00
PLASTIC INDEX: 18.46

LIQUID AND PLASTIC LIMIT TEST

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
SAMPLE NO.: TP 3
DEPTH (m) :

	LIQUID LIMIT				PLASTIC LIMIT	
DETERMINATION NO.	1	2	3	4	A	B
Container Number	B2	B10	B1	B8	B6	B27
Container + Wet Soil (g)	19	15.5	18	20	16.5	16.5
Container + Dry Soil (g)	17	14.5	16	17.5	16	15.5
Moisture Loss (g)	2	1	2	2.5	0.5	1
Container (g)	12	12	12	12	12	12
Dry Soil (g)	5	2.5	4	5.5	4	3.5
Moisture Content (%)	40.00	40.00	50.00	45.45	12.50	28.57
Number of Blows	34	31	24	18	20.54	

FLOW CURVE



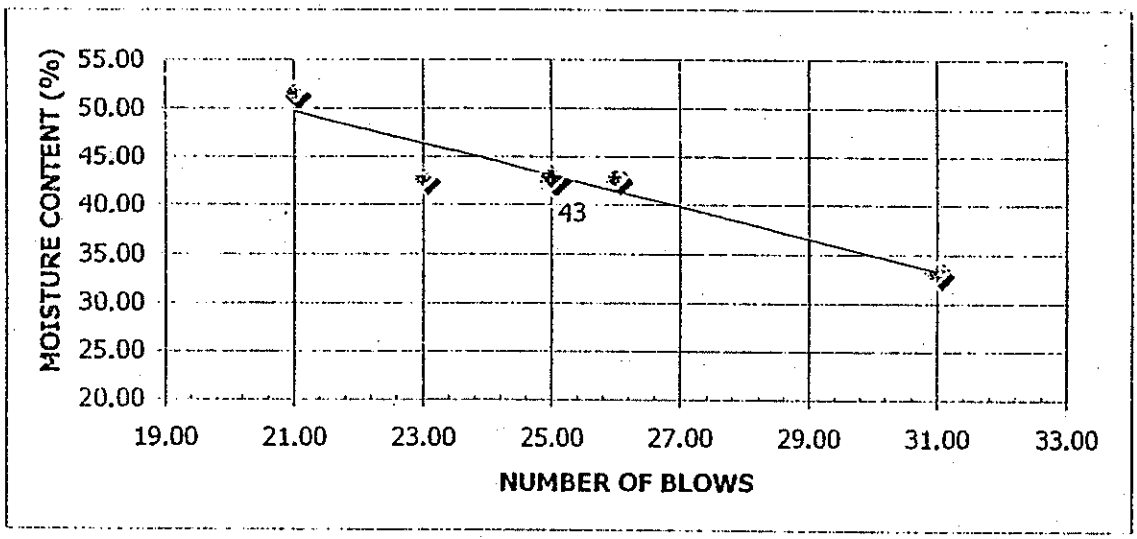
LIQUID LIMIT:	44.7
PLASTIC LIMIT:	20.54
PLASTIC INDEX:	24.16

LIQUID AND PLASTIC LIMIT TEST

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
SAMPLE NO.: TP 2
DEPTH (m) : 0.30 ~ 3.0

	LIQUID LIMIT				PLASTIC LIMIT	
DETERMINATION NO.	1	2	3	4	A	B
Container Number	B2	B34	B35	B25	B10	B22
Container + Wet Soil (g)	21	27.5	23.5	35	14.5	13.5
Container + Dry Soil (g)	19	23	20.5	27.5	13.5	13
Moisture Loss (g)	2	4.5	3	7.5	1	0.5
Container (g)	13	12.5	13.5	13	11	11
Dry Soil (g)	6	10.5	7	14.5	2.5	2
Moisture Content (%)	33.33	42.86	42.86	51.72	40.00	25.00
Number of Blows	31	26	23	21	32.50	

FLOW CURVE



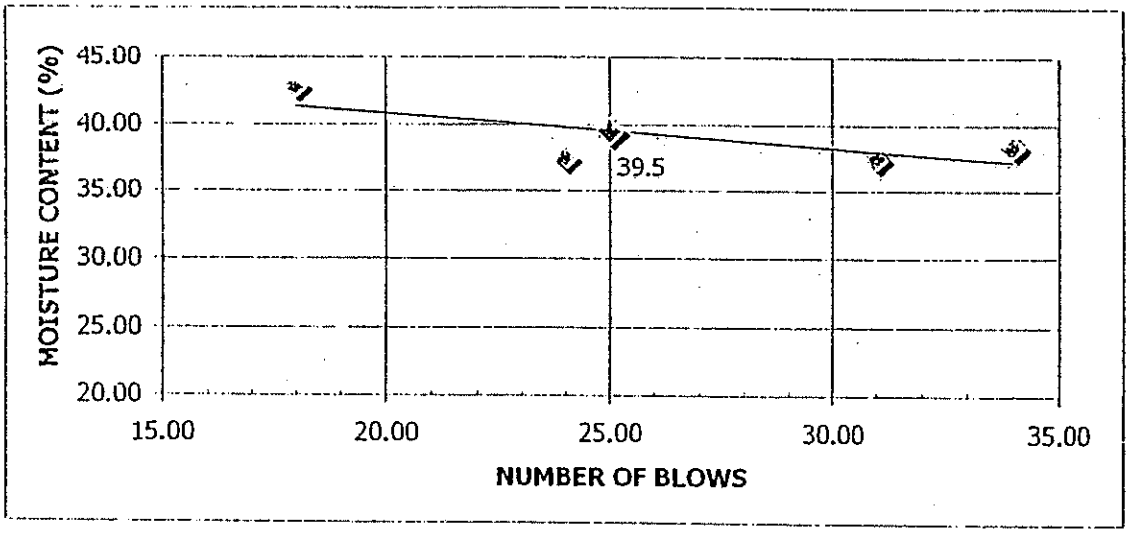
LIQUID LIMIT: 43.00
PLASTIC LIMIT: 32.50
PLASTIC INDEX: 10.50

LIQUID AND PLASTIC LIMIT TEST

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
SAMPLE NO.: TP 1
DEPTH (m) : 0.30 ~ 2.20

	LIQUID LIMIT				PLASTIC LIMIT	
DETERMINATION NO.	1	2	3	4	A	B
Container Number	B21	B31	B30	B24	B23	B25
Container + Wet Soil (g)	21	17	17.5	17	14.5	14.5
Container + Dry Soil (g)	18.5	15.5	16	15.5	14	14
Moisture Loss (g)	2.5	1.5	1.5	1.5	0.5	0.5
Container (g)	12	11.5	12	12	11	11
Dry Soil (g)	6.5	4	4	3.5	3	3
Moisture Content (%)	38.46	37.50	37.50	42.86	16.67	16.67
Number of Blows	34	31	24	18	16.67	

FLOW CURVE



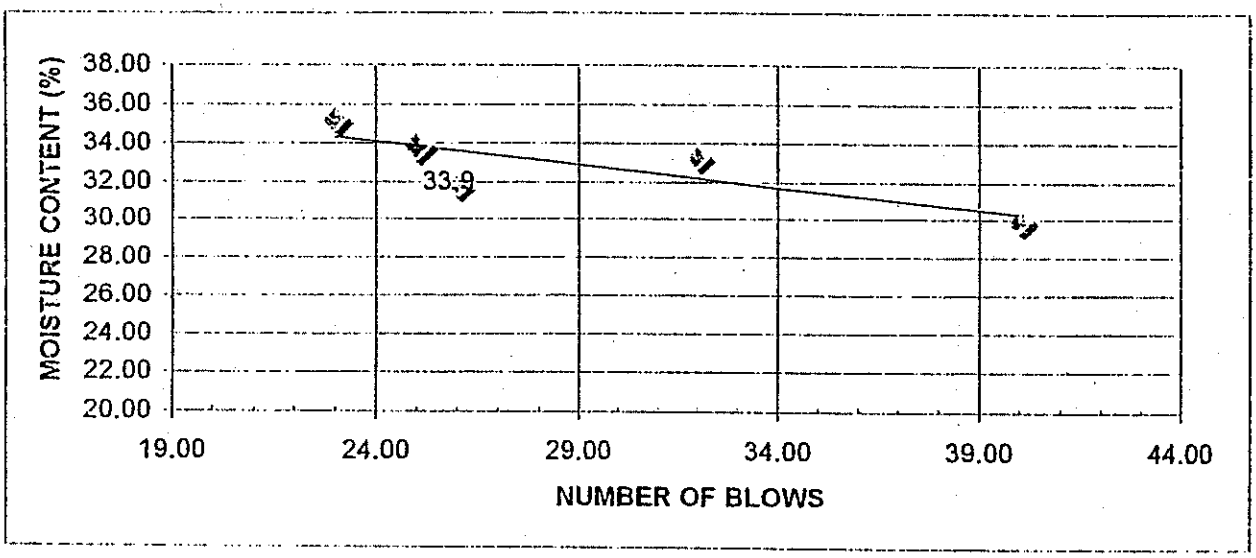
LIQUID LIMIT: 39.5
PLASTIC LIMIT: 16.67
PLASTIC INDEX: 22.83

LIQUID AND PLASTIC LIMIT TEST

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: AKLAN
SAMPLE NO.: TP 6
DEPTH (m) : 0.20 ~ 1.25

	LIQUID LIMIT				PLASTIC LIMIT	
DETERMINATION NO.	1	2	3	4	A	B
Container Number	B22	B10	B31	B23	B32	B2
Container + Wet Soil (g)	26	31	28	35.5	15	16
Container + Dry Soil (g)	23	26.5	24.5	29.5	14	15
Moisture Loss (g)	3	4.5	3.5	6	1	1
Container (g)	13	13	13.5	12.5	11	12
Dry Soil (g)	10	13.5	11	17	3	3
Moisture Content (%)	30.00	33.33	31.82	35.29	33.33	33.33
Number of Blows	40	32	26	23	33.33	

FLOW CURVE



LIQUID LIMIT: 33.90
PLASTIC LIMIT: 33.33
PLASTIC INDEX: 0.57

DIRECT SHEAR TEST

Determination of Shear Strength by Direct Shear Test

Information Provided to the Laboratory

Tested by: MLB

Project : New Proposed Landfill Site

Location : Boracay

Test Pit No. : TP - 1

Checked by: FSA

Approved by: BBA

Laboratory Information

Date sample received : 23/7/2007
Test date : 23/7/2007
Testing technician : MLB
Test method used : ASTM
Test method variation : None
Room temperature range : 28 °C Max. 22 °C Min.
Particle density : 2.65 g/cm³ Assumed
Visual description : silty CLAY
:

Sample type : Test Pit

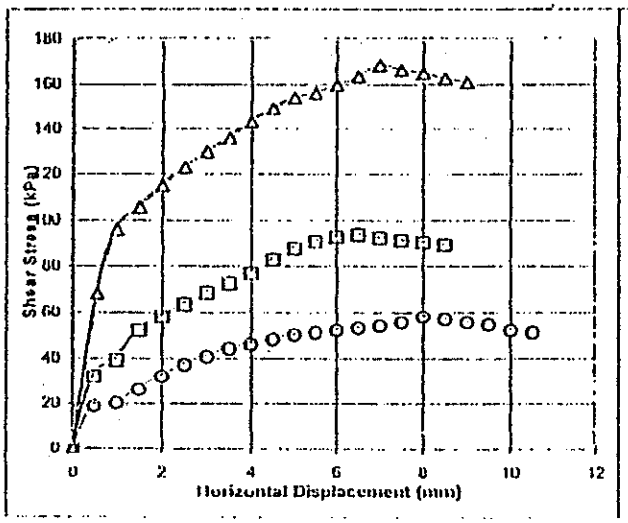
Test Results

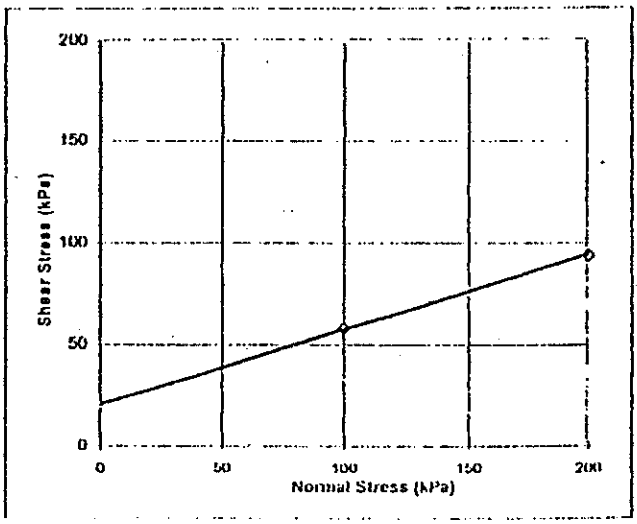
Area of specimen mm^2 : 4032
Height of specimen mm : 19
Moisture content % : 24.4
Bulk density g/cm^3 : 2.09
Dry density g/cm^3 : 1.68
Rate of strain mm/min : 0.0024
Specimen tested : wet

Load Step	Applied Normal Stress kN/m^2	Maximum Shear Stress kN/m^2	Displacement at Max. Stress mm
1	100	58.0	7.5
2	200	93.7	6.5
3	400	168.6	7.0

Cohesion Intercept *(C')* = 21 *kPa*

Angle of Shear Resistance *(Ø')* = 20 °





Remarks:

Laboratory Manager

Determination of Shear Strength by Direct Shear Test

Information Provided to the Laboratory

Tested by: MLB

Project : New Proposed Landfill Site

Location : Boracay

Test Pit No. : TP - 5

Checked by: FSA

Approved by: BBA

Laboratory Information

Date sample received : 23/7/2007
Test date : 23/7/2007
Testing technician : BBA
Test method used : ASTM
Test method variation : None
Room temperature range : 28 °C Max. 22 °C Min.
Particle density : 2.65 g/cm³ Assumed
Visual description : silty CLAY

Sample type : Test Pit

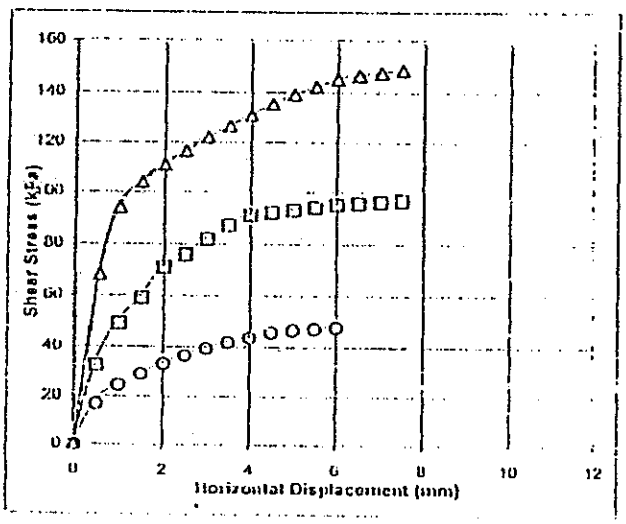
Test Results

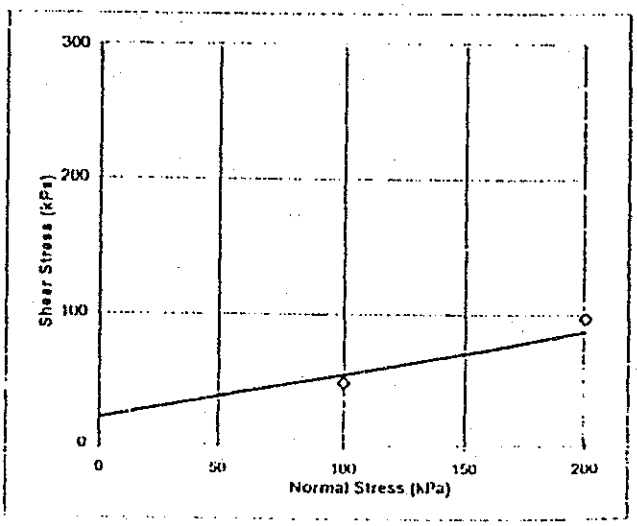
Area of specimen mm^2 : 4032
Height of specimen mm : 19
Moisture content % : 23.2
Bulk density g/cm^3 : 2.09
Dry density g/cm^3 : 1.70
Rate of strain mm/min : 0.0024
Specimen tested : wet

Load Step	Applied Normal Stress kN/m^2	Maximum Shear Stress kN/m^2	Displacement at Max. Stress mm
1	100	47.6	6.0
2	200	96.7	7.5
3	400	148.8	7.5

Cohesion Intercept (C') = 22 *kPa*

Angle of Shear Resistance (Ø') = 18 °





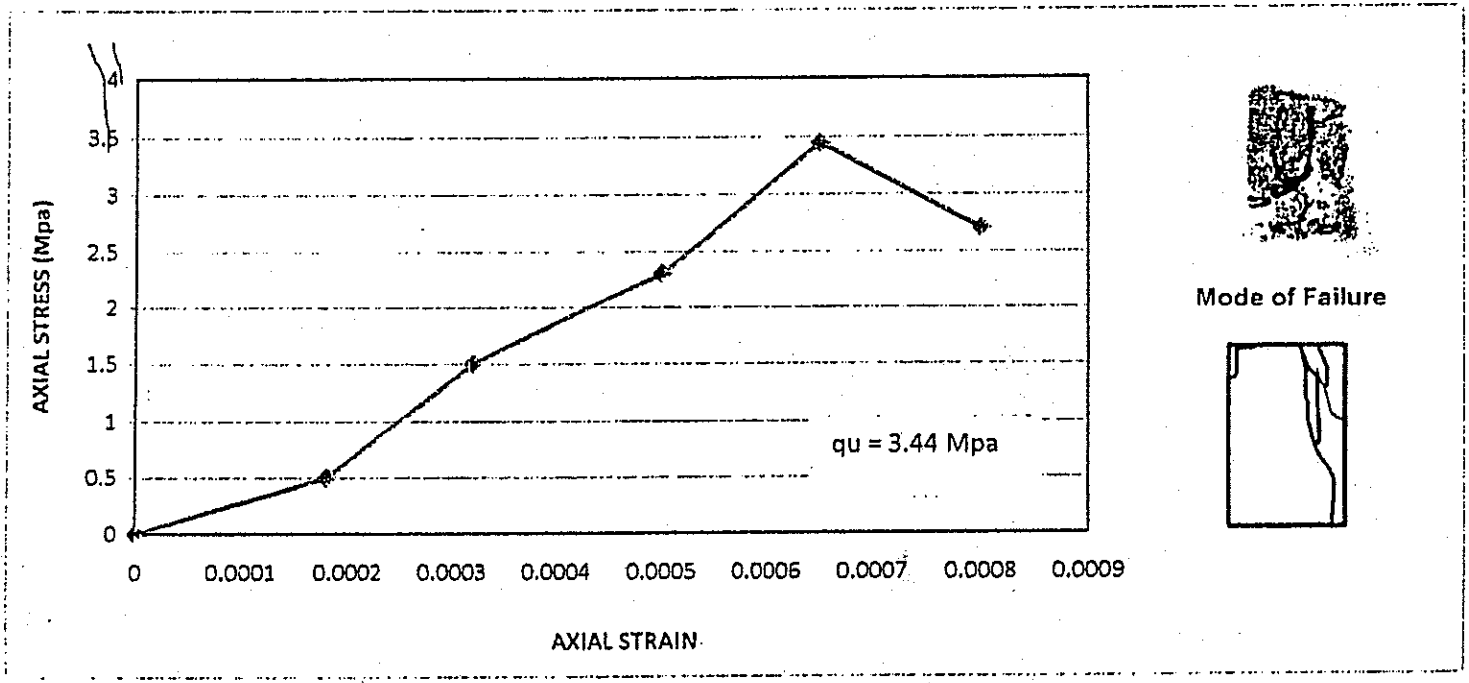
Remarks:

Laboratory Manager

UNCONFINED COMPRESSION TEST

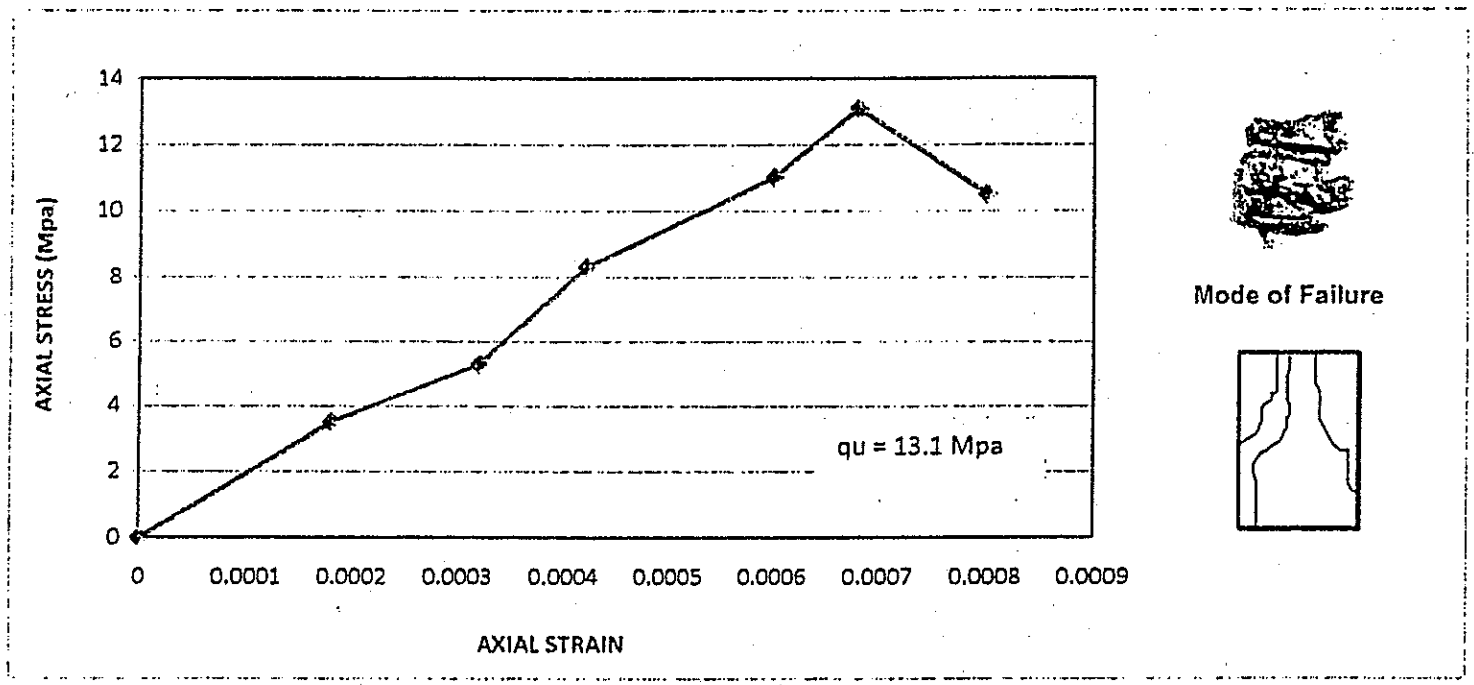
UNCONFINED COMPRESSION TEST

PROJECT	Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION	Kabulihan, Malay, Aklan
BOREHOLE NO.	BGW ~1
DEPTH	10.00 ~ 10.10m
DIAMETER	4.4 cm
HEIGHT	8.8 cm



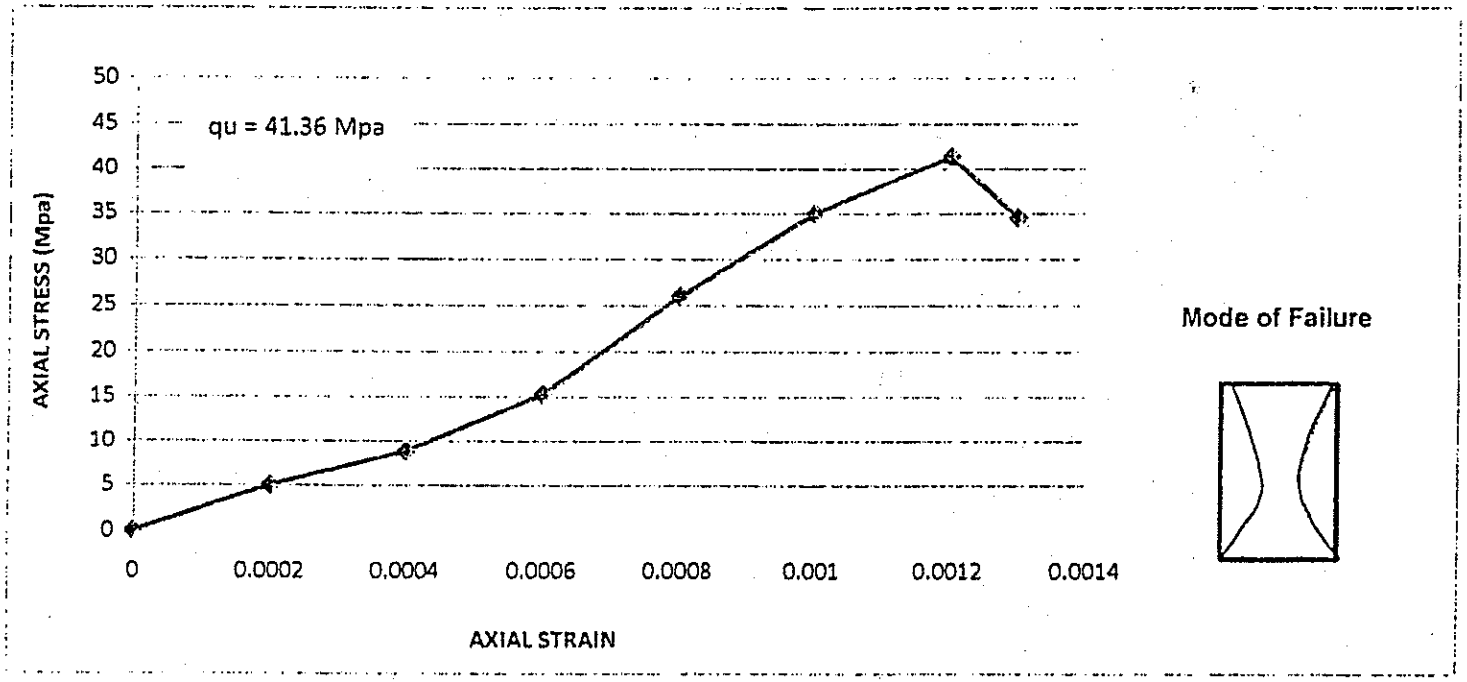
UNCONFINED COMPRESSION TEST

PROJECT	Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION	Kabulihan, Malay, Aklan
BOREHOLE NO.	GWS ~ 3
DEPTH	8.00 ~ 8.13m
DIAMETER	4.7 cm
HEIGHT	9.4 cm



UNCONFINED COMPRESSION TEST

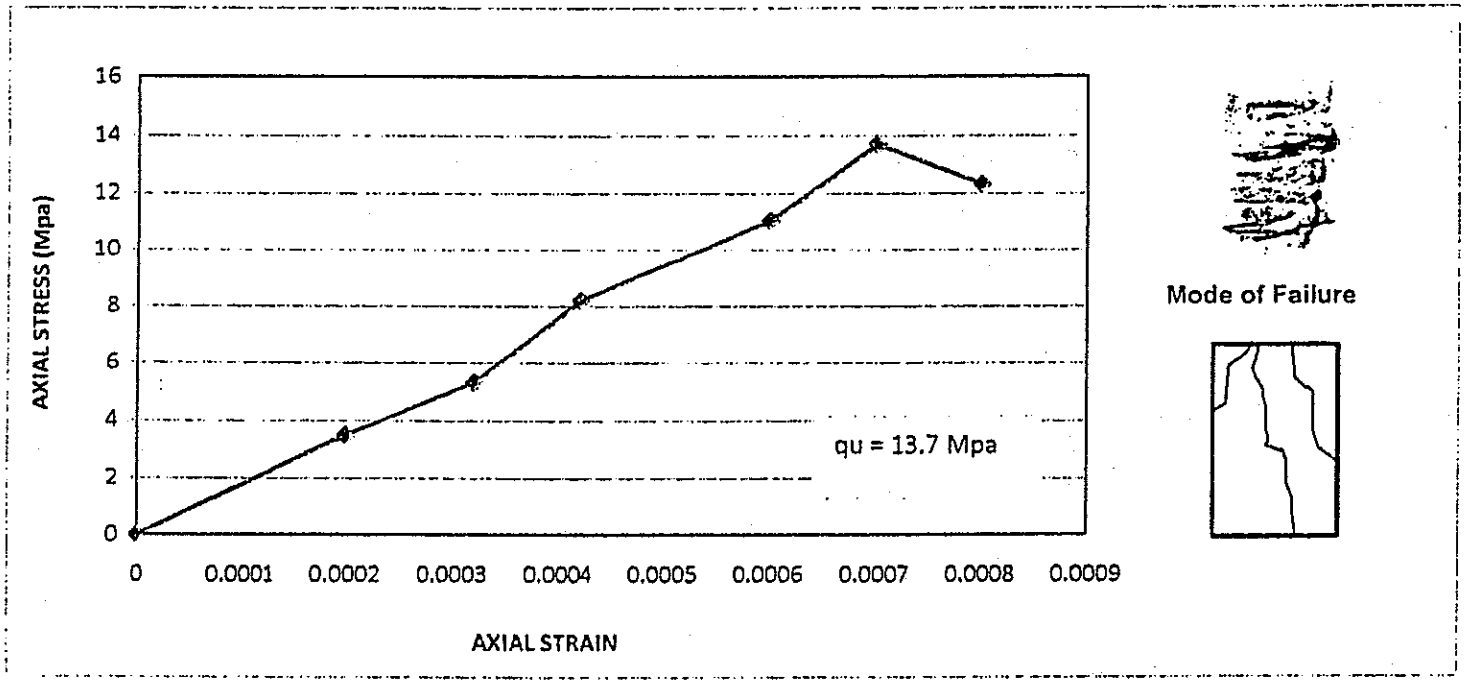
PROJECT	Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION	Kabulihan, Malay, Aklan
BOREHOLE NO.	GWD ~ 1
DEPTH	18.00 ~ 18.12m
DIAMETER	4.75 cm
HEIGHT	9.5 cm



GRS SURVEY & DRILLING SPECIALI

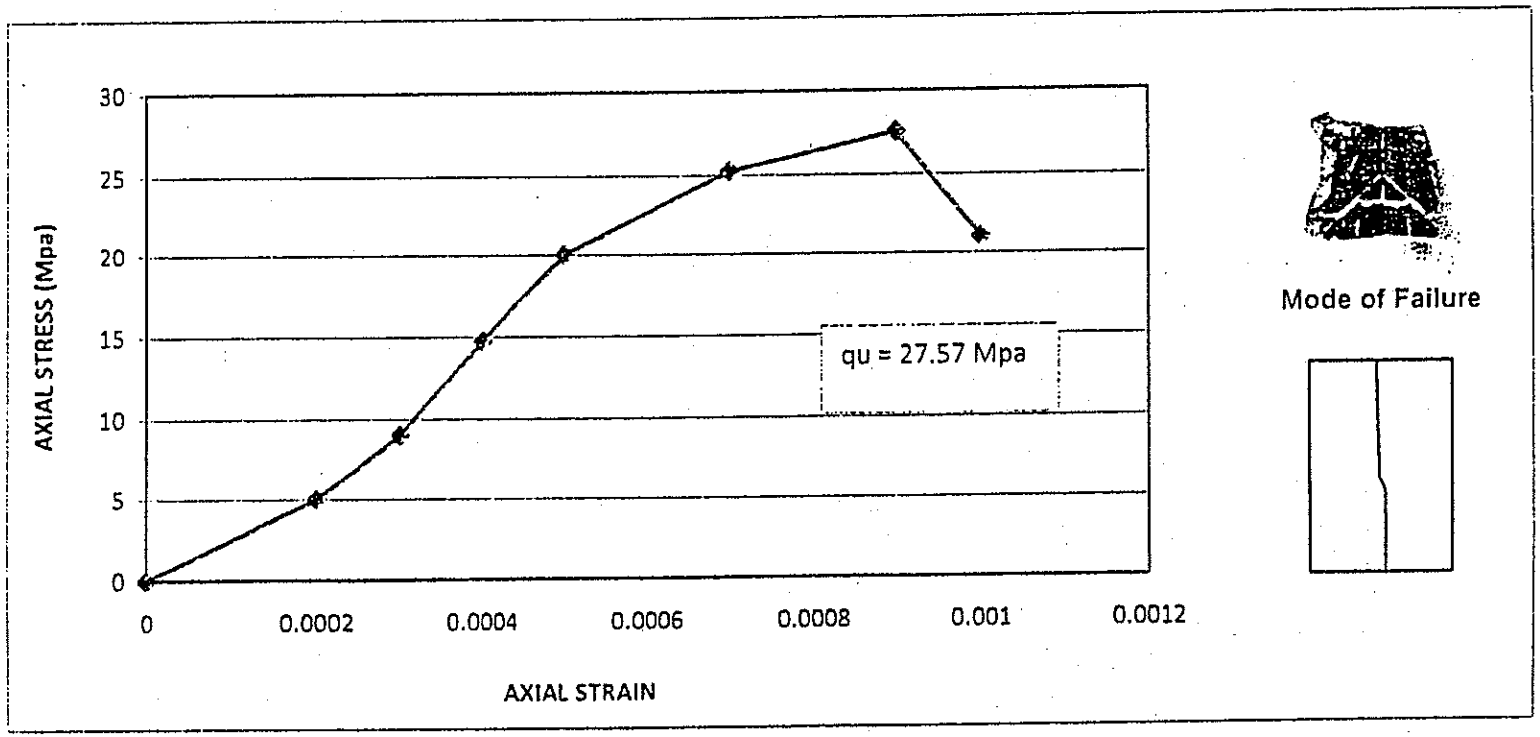
UNCONFINED COMPRESSION TEST

PROJECT	Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION	Kabulihan, Malay, Aklan
BOREHOLE NO.	BGW ~ 1
DEPTH	59.80 ~ 60.00
DIAMETER	4.8 cm
HEIGHT	9.6 cm



UNCONFINED COMPRESSION TEST

PROJECT	Geological Study and Soil Investigation for the New Proposed Landfill Site	
LOCATION	Kabulihan, Malay, Aklan	
BOREHOLE NO.	GWS ~ 4	
DEPTH	22.5 ~ 22.7m	
DIAMETER	4.75	cm
HEIGHT	9.5	cm



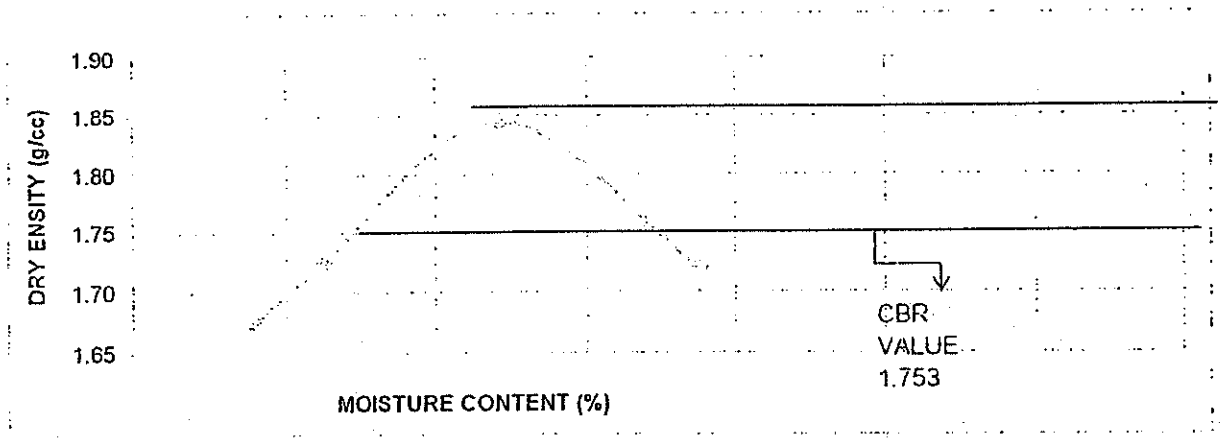
CALIFONIA BEARING RATIO

PROJECT : Geological Study and Soil Investigation for the Old and New Proposed Landfill Site
LOCATION: Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP1

Trial Number	1	2	3	4		
Water added in ml	200	200	200	200		
Mold + Wet Soil (g)	3614	3701	3917	3890		
Mold (g)	1966	1966	1966	1966		
Wet Soil (g)	1648	1735	1951	1924		
WET DENSITY (g/cc)	1.82	1.92	2.16	2.13		
Container Number	B2	B3	B6	B1		
Container (g)	12	12	12	12		
Container + Wet Soil (g)	196	160	197	230		
Container + Dry Soil (g)	181	145	170	188		
Water (g)	15	15	27	42		
Dry Soil (g)	169	133	158	176		
MOISTURE CONTENT (%)	8.88	11.28	17.09	23.86		
DRY DENSITY (g/cc)	1.68	1.73	1.84	1.72		

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.845
Optimum Moisture Content (OMC), %	17.5



GRS SURVEY & DRILLING SPECIAL

CALIFORNIA BEARING RATIO

PROJECT : Geological Study and Soil Investigation for the New Proposed Landfill Site
LOCATION: Kabulihan, Malay, Aklan
DATE:

SAMPLE NO. TP 3A

Trial Number	1	2	3	4	5	
Water added in ml	200	200	200	200	200	
Mold + Wet Soil (g)	3566	3676	3855	3865	3791	
Mold (g)	1966	1966	1966	1966	1966	
Wet Soil (g)	1600	1710	1889	1899	1825	
WET DENSITY (g/cc)	1.77	1.89	2.09	2.10	2.02	
Container Number	A29	A26	A21	A30	A3	
Container (g)	22	22	22	22	22	
Container + Wet Soil (g)	228	183	183	224	317	
Container + Dry Soil (g)	210	164	157	186	256	
Water (g)	18	19	26	38	61	
Dry Soil (g)	188	142	135	164	234	
MOISTURE CONTENT (%)	9.57	13.38	19.26	23.17	26.07	
DRY DENSITY (g/cc)	1.62	1.67	1.75	1.71	1.60	

Volume of Mold (cc)	903.21
Method Used (A, B, C, D)	C
Rammer (2.5 kg, 4.5 kg)	2.5 kg
Layer No. (3, 5)	3 layers
No. of Blows / Layer (25, 56)	25 blows
Maximum Dry Density (MDD), g/cc	1.755
Optimum Moisture Content (OMC), %	19.9