BASIS OF DESIGN REPORT
DRAFT

Tinian Landfill
Commonwealth of the Northern Marina Islands

60% Submittal

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1.0 INTRODUCTION

This Design Report contains information for the proposed Tinian Landfill Project located on Tinian Island. The Design Report has been prepared in accordance with the following guidance and regulatory documents:

- Code of Federal Regulations, Title 40 (40 CFR), Parts 257 and 258
- Title 65, Commonwealth of Northern Mariana Division of Environmental Quality, Chapter 65-80 Solid Waste Management Regulations.
- Clean Water Act 33 USC 1251 to 1387.
- 40 CFR Part 60
- Environmental Assessment (EA) Finding of No Significant Impact – 2008.
- Comprehensive Study Report 2005.

Additional design criteria included constructability, availability of materials, and minimizing initial capital costs along with long-term operation and maintenance costs.

1.1 BACKGROUND

Tinian Landfill is leased by the Commonwealth of Northern Mariana Islands (CNMI) from the US Department of Defense. The proposed site is located in the Western Pacific Ocean approximately 3,730 miles southwest of Hawaii at 15 degrees 5 minutes north longitude and 145 degrees 45 minutes east Latitude. The site is located 2 miles northwest of West Tinian Airport and 4 miles northwest of the village of San Jose. The airport is part of the Commonwealth Port Authority (CPA), which was notified of EA scoping meetings, along with CNMI government offices, and did not comment on the project during the EA process.

Access to Tinian would be via a new all weather access road from Riverside Drive. The project includes some modifications to Riverside Drive at the start of the main access road to improve sight distance, to facilitate truck movements, and convey drainage. Access via Riverside Drive was included in the EA along with a supporting traffic analysis. No improvements to Riverside Drive itself are considered as part of the landfill design.

The proposed landfill would be regulated pursuant to applicable Federal (Code of Federal Regulations, Part 258, 60) regulatory requirements.

1.1.1 SITE LAYOUT

The overall site will be laid out on a parcel approximately 1,600 feet long (east-west) by 850 feet wide (north-south), covering approximately 30 acres. The landfill will be 1,000 feet long (east-west) by 440 feet wide (north-south), covering just over 10 acres.

The facilities on the landfill will include: a scale and scale house; ancillary facilities; entrance and access road; a construction, demolition, and disaster disposal area; a metal and white goods storage area; and asbestos disposal trenches. The Tinian Landfill will include the following diversion and material processing areas: a metals and construction demolition storage area; a mulch/compost storage area; and stockpiles for topsoil, interim, and daily cover. A storm water pond, leachate pump station, leachate treatment pond, and septage drying beds will be located on the site.

The landfill property is 30 acres with 10 acres designated for landfill disposal operations.

1.1.2 DESIGN CAPACITY

The proposed landfill footprint will provide net disposal airspace (refuse only) of approximately 164,000 cubic yards (CY) with an estimated operational life of 18 years. There is an option of placing an additional 12-foot refuse lift over this site to increase the net disposal airspace capacity to 233,000 CY.

The proposed landfill was designed to provide a minimum of 20 years of refuse disposal capacity generated from residents, non-resident workers, tourism, and disaster debris on the island. The capacity requirements were estimated based on waste generation projections from 2011 and the most recent population and growth rate estimates. In 2011, Tinian's population was estimated to be 3,683 people. A waste generation rate of 4.06 pounds per capita per day was applied to the population estimate, with an annual growth rate of 2%, to calculate the waste tonnages generated per year. Assuming the proposed landfill will be constructed and operational by 2013, the proposed landfill would receive 868,109 tons of refuse over the twenty year site life.

The refuse density is projected to be 1,000 pounds per cubic yard (lbs/CY), based on the small daily tonnage and the typical compaction densities achieved by a track loader (see Equipment Requirements). Because of Tinian's remote location, a track loader was chosen as the more appropriate equipment for compaction over a conventional compactor due to the loader's versatility to perform a variety of necessary operations on site, as well as its ability to construct and compact sloping refuse lifts.

A cover ratio of 2 to 1 was calculated based on waste generation rates, refuse density, daily cell geometry, proposed cover material thickness and application. The daily cell was assumed to be 20 feet wide with lift depths of 2.5 feet after compaction. Subsequent daily cells will be filled on top of the first cell for five days of operation (or less depending on the number of days a week the site is open) to create a weekly operating cell. An alternative daily cover (ADC) would cover be the typical cover material of the daily cells, and soil cover would be placed over the cell once a week (see Section 7.4). The cover soil ratio will vary with the dimensions of the daily cell. The 2 to 1 cover ratio is an average of the cover ratio for the first 20 years of landfill operation (2013-2033) and assumes the use of ADC.

The capacity demand based on the projected tonnages, refuse density and daily cover usage, for a twenty year site from 2013 through 2033 is 235,000 cubic yards of airspace, not including the volume required for final cover. The April 7, 2011 technical memo includes details of all assumptions, design parameters, and tables used for calculating the capacity demand, although the memorandum is prepared based on a minimum 30-year site life.

The conceptual subgrade and fill plans provide capacity greater than 300,000 CY of disposal capacity (with the optional Phase 6). Cover soils on the site may be limited and the total volume may be reduced or increased based on cover soil usage. Landfill operations are further described in 1.1.3.

1.1.3 LANDFILL OPERATIONS

The site will operate as a municipal solid waste landfill[1] in accordance with applicable local and Federal regulations. The landfill will accept non-hazardous solid wastes, inert wastes, asbestos containing materials (ACM), construction/demolition/disaster clean-up debris, and dewatered septage sludge.

Liquids that percolate through the waste will drain to the leachate collection and removal system (LCRS). The leachate will then be treated by constructed wetlands

[1] "Municipal solid waste landfill (MSWLF) unit means a discrete area of land or an excavation that received household waste, and that is not a land application unit, surface impoundment, injection well, or waste pile, ... A MSWFL unit also may receive other types of RCRA Subtitle D wastes, such as commercial solid waste, non-hazardous sludge, conditionally exempt small quantity generator waste and industrial solid waste... (40 CFR 258.2).

described in Section 2.3.5. After treatment through the constructed wetlands, the liquids will be discharged to percolate through the ground.

Dewatered septage and solid waste will be accepted for disposal in lined areas. The CNMI will be shown as the operator of record on all permits and approvals, including the Municipal Solid Waste Landfill Facility Permit. The septage will be dewatered at the site using the sand drying beds described in Section 4.0.

Construction and demolition debris would be handled at the site as part of routine site operations. Material would be sorted at the construction and demolition material processing area with residue disposed of at the landfill. In the event of a natural disaster, debris generated from the event will be disposed of at the landfill. There is an area designated for disaster debris processing. The size of the debris processing area and the material processing procedures will be developed and or modified in a manner that is specific to the nature of the disaster event and the type and quantity of debris that is generated.

Because the site is located in an area with limited soil availability, it is recommended that the Owner pursue permitting use of processed green material, tarps, and/or construction and demolition material as daily cover material in landfill construction. Use of alternative materials in landfill construction would also assist in meeting diversion goals of Executive Order 13514. According to 40 CFR 258.21(b), "Alternative materials of an alternative thickness (other than at least six inches of earthen material) may be approved by the Director of an approved State if the owner or operator demonstrates that the alternative material and thickness control disease vectors, fires, odors blowing litter, and scavenging without presenting a threat to human health and the environment." According to the Environmental Protection Agency Region 9 website at <http://www.epa.gov/region09/waste/partners/mswislands. html>, the Commonwealth of Northern Mariana Islands is not considered an approved State for the use of daily cover.

1.1.4 REGULATORY PERMITS

No operating permits have been issued for the site. The following documents, in addition to regulatory requirements, were considered in design:

- USA EPA Environmental Assessment Finding of No Significant Impact – 2009.
- Comprehensive Study Report 2005.

Environmental compliance for the landfill is provided by an Environmental Assessment Finding of No Significant Impact prepared pursuant to the National Environmental Policy Act (NEPA) process (13 CFR Part 316).

1.1.4.1 ANTICIPATED PERMITS

Section 9.3 lists anticipated permits needed for construction and landfill operations.

1.2 PROJECT DESCRIPTION

The Tinian Landfill design includes 5 liner construction phases (which range from 2 to 3 acres each) and 5 fill phases with one optional sixth fill phase, which is a vertical lift over the entire landfill's top deck. The Phase I development area would provide a net disposal capacity (refuse only) of approximately 20,900 cubic yards. The remaining liner construction would occur in stages as waste filling progresses and the sequence can be adjusted depending on actual refuse inflow rates and associated capital cost.

Construction of Phase I liner will also include installation of most of the site's infrastructure. The Phase 1 project includes approximately 40,500 CY of excavation for liner construction and additional site infrastructure. The Phase 1 area is 2.5 acres and will accommodate the first 10,000 tons of municipal solid waste.

Excavated material will be stockpiled in areas within the property boundary. Material that is suitable for daily cover will be stockpiled in an area adjacent to the Landfill liner limit.

1.3 DOCUMENT PURPOSE AND SCOPE

The objective of this report is to present a detailed summary of the design including supporting calculations and assumptions. The as submitted present the presents the elements of the design completed for the 60 percent design stage. The report lists describes design intent, summarizes the analysis and calculations and the sizing and material specifications for the site infrastructure. The report includes:

Construction Plans

- Construction Specifications Table of Contents
- Modular Building Shop Drawings
- Hydrologic and Hydraulic Calculations for Storm Drain System
- Leachate Collection and Removal System (LCRS)
    - Hydrologic evaluation of Landfill Performance (HELP) Modeling

  - Pipe Capacity Calculations
- Geosynthetic Calculations
  - Overburden Stress on Geomembrane/Cushion calculation
  - Anchor Trench
- Geotechnical Design Report

The construction plans and specifications will provide the Contractor with the information necessary to construct the project and the owner with liner construction monitoring procedures to verify that the work has been completed in accordance with the plans and specifications and applicable regulatory requirements.

2.0 LINER SYSTEM

This section describes the composite liner design, the design criteria and design calculations. Construction elements are also discussed and include a description of the excavation, subgrade preparation, composite liner system, LCRS, protective cover soil layer, and surface water drainage control system. References are also made to the Construction plans with are included as Appendix A.

2.1 COMPOSITE LINER DESIGN

The liner is designed to comply with 40 CFR part 258.40 (b). The liner is to be constructed of the following components from top to bottom:

- 2-foot thick protective cover soil layer.
- 350-mil drainage geocomposite with an 8-oz geotextile on both sides.
- 60-mil thick HDPE double-sided textured geomembrane.
- Geosynthetic clay liner (GCL) subbase layer.
- High strength reinforcing layer (woven geotextile) beneath the GCL to reinforce the liner strength and protect against potential settlement and sinkhole formation.
- Prepared subgrade

The limit of disturbance for the Phase I excavation area is approximately 18.87 acres, of which approximately 2.5 acres will be lined. The dimensions of the Phase I liner area are approximately 420 by 270. Within this configuration, the floor area consists of approximately 1.9 acres and the slopes are approximately 0.6 acres. The subgrade and LCRS plans for Phase I are shown on Drawings 7 and 8 in Appendix A.

The Phase I bottom liner is designed with an average 3 percent gradient with run-off being diverted to the southern perimeter drain. Subgrade elevations were designed to maintain positive gravity flow of liquids though the LCRS and the outfall system. Excavated material from Phase I will be used as constructed fill in the project or will be stockpiled in an area that is adjacent to the liner limit for use as daily cover material during landfill operations.

2.2 PHASED LINER SYSTEM PLAN

Phase sizing is based on estimated incomming tonnage and desired capacity. Building the liner in phases reduces leachate generation through the diversion of surface water. Capital cost are spread over a larger time through interim drainage and leachate controls. In addition the integrity of the liner system is increased by limiting the exposure of the liner's geosynthetic materials to the elements.

The site has been divided into five liner phases. Each phase is estimated to be filled in 3 to 5 years based on incomming tonnage projections. There is an optional refuse fill phase, Phase 6 that does not include liner construction that has also been included in the phasing. The phasing plans are included as Figures in Appendix A.

2.3 DESIGN CRITERIA

2.3.1 COMPOSITE LINER SYSTEM

The LCRS is designed to collect and convey leachate that may be generated within the refuse prism to constructed wetlands for treatment. The liner system reflects current design criteria requirements in 40 CFR parts 257 and 258, also known as "Subtitle D." 40 CFR Part 258 describes prescriptive liner design standards and includes the following:

- Maintaining leachate levels at one foot (30 cm) or less at all points over the composite liner system per 40 CFR 258.40(2).
- Designing a system capable of collecting and removing twice the anticipated maximum daily volume of leachate from the landfill cells.
- A minimum gradient of one percent in the mainline.
- Long term maintenance-free performance compatibility in the leachate environment and under the expected maximum landfill loading conditions.

In addition to the above-mentioned criteria, the LCRS is designed in accordance with the following objectives:

- To rapidly transport collected leachate from the liner floor to the discharge point.
- To maintain a reasonable and effective collection pipe spacing over the landfill base.
- To maintain a pipe orientation that generally crosses the predominant leachate drainage direction on the cell floor to generate the maximum possible system redundancy and collection efficiency.
- To support the liner in the event of sinkhole formation.

These objectives were used to reduce the amount of time that leachate remains on the liner, thereby, reducing the potential for migration of leachate through the liner system.

For the liner construction, a composite liner system and an LCRS are proposed, which meet the requirements specified in 40 CFR Parts 257 and 258 (Subtitle D).

Appendices E and F contain the design support calculations for the composite liner system. The calculations in Appendix E provide a numerical check of the integrity of the liner material to resist puncture, shearing, and tearing and Appendix F presents the HELP model analysis and supporting LCRS calculations which ensure the LCRS has adequate capacity for the modeled leachate generation at the site.

2.3.1.1 PROTECTIVE COVER SOIL LAYER

A two-foot thick protective cover soil layer will be placed over the floor area and slopes to protect the underlying composite liner system. The protective cover soil layer material will consist of screened on-site material generated from cell excavation and would comply with the gradation and permeability requirements for protective cover soil material to be incorporated in the construction specifications.

Protective soil cover within 12 inches of the FML shall not contain rock particles in excess of one inch in the greatest dimension to minimize tearing the geotextile during spreading and placement. Protective Cover Soil material placed in the upper 12-inches shall not contain rock particles in excess of 3-inches in the greatest dimension. The upper 12 inches of the protective soil cover material shall be compacted to a minimum 90 percent of the maximum dry density as determined by ASTM D 1557.

2.3.1.2 LOW PERMEABILITY LAYER

The low permeability layer consists of a 60-mil HDPE geomembrane over a GCL.

2.3.1.3 OVERBURDEN STRESS ON GEOMEMBRANE

The overburden stress on the geomembrane is included in Appendix E. As shown in the calculation, an 8-ounce per square yard geotextile will protect the geomembrane during construction and after final grades have been reached.

2.3.2 GRADING

The floor areas of the liner will be sloped at 3 percent. The side slopes of the liner will have a maximum slope of 4 horizontal to 1 vertical. Section 3.0 describes additional requirements for liner construction.

2.3.3 HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP) MODELING

Leachate generation was calculated for the landfill liner and final cover.

For the landfill liner two analyses were performed, one on the base and slope liner, utilizing the HELP Model (results are included in Appendix F).

In order to develop the proper design criteria and performance parameters for the LCRS, leachate generation rates were calculated using the USEPA's Hydrologic Evaluation of Landfill Performance (HELP) model Visual HELP 2203 computer program, which uses representative rainfall and evapotranspiration data to calculate the amount of leachate that might be generated in a Municipal Solid Waste Landfill (MSWLF).

This program takes into account the total area of the landfill, representative precipitation patterns, representative evapotranspiration, and the hydraulic conductivity of various construction materials to calculate leachate generation and accumulation.

The HELP model is a quasi-two-dimensional iterative hydrological model of water movement across, into, through, and out of landfills (Schroeder et al., 1994). Inputs for the model include weather, soil, and design data. The model uses solution techniques that account for the effects of the following:

- Surface storage,
- Runoff,
- Infiltration,
- Evapotranspiration,
- Vegetative growth,
- Storage of soil moisture,
- Lateral drainage of water in drainage layers,
- Vertical percolation of soil water, and
- Leakage through hydraulic barriers (geomembranes, clay, or geomembrane/clay composite liners).

The model used for Tinian Landfill included the following layers:

Table 1. HELP Model Scenarios

Scenario	Layers in HELP
5-foot thick solid waste over liner floor	• Vertical percolation layer (6-inch thick cover layer) • Vertical percolation layer (5-foot thick solid waste layer) • Vertical percolation layer (2-foot thick protective cover soil layer) • Lateral Drainage Layer (350-mil geocomposite) • Flexible Membrane Liner (60-mil HDPE liner) • Barrier Soil Liner (the geosynthetic clay liner (GCL) was modeled as a 0.2-inch thick bentonite layer).
5-foot thick solid waste over liner side slopes	• Vertical percolation layer (6-inch thick cover layer) • Vertical percolation layer (2.5-foot thick solid waste layer - average thickness over slope) • Vertical percolation layer (2-foot thick protective cover soil layer) • Lateral Drainage Layer (350-mil geocomposite) • Flexible Membrane Liner (60-mil HDPE liner) • Barrier Soil Liner (the geosynthetic clay liner (GCL) was modeled as a 0.2-inch thick bentonite layer).
35-foot thick solid waste over liner floor	• Vertical percolation layer (6-inch thick cover layer) • Vertical percolation layer (35-foot thick solid waste layer) • Vertical percolation layer (2-foot thick protective cover soil layer) • Lateral Drainage Layer (350-mil geocomposite) • Flexible Membrane Liner (60-mil HDPE liner) • Barrier Soil Liner (the geosynthetic clay liner (GCL) was modeled as a 0.2-inch thick bentonite layer).
35-foot thick solid waste over liner side slope	• Vertical percolation layer (6-inch thick cover layer) • Vertical percolation layer (35-foot thick solid waste layer – 17.5-foot average thickness over slope) • Vertical percolation layer (2-foot thick protective cover soil layer) • Lateral Drainage Layer (350-mil geocomposite) • Flexible Membrane Liner (60-mil HDPE liner) • Barrier Soil Liner (the geosynthetic clay liner (GCL) was modeled as a 0.2-inch thick bentonite layer).
Final Cover over deck area	• Vertical percolation layer (2-foot thick vegetative layer) • Lateral Drainage Layer (350-mil geocomposite) • Flexible Membrane Liner (60-mil HDPE liner)
Final Cover over slope areas	• Vertical percolation layer (2-foot thick vegetative layer) • Lateral Drainage Layer (350-mil geocomposite) • Flexible Membrane Liner (60-mil HDPE liner)

2.3.3.1 DEFAULT PARAMETERS

The HELP model requires climatological data, soil, vegetative cover type characteristics, and design specifications to perform the water balance analysis. The HELP model incorporates a synthetic weather generator that can produce daily rainfall and mean daily temperatures based on climatological patterns for various cities throughout the Unites States. The synthetic daily weather generator uses statistical coefficients to enable the user to generate daily rainfall and mean daily temperature values for a specific station. Default options for vegetative types and characteristics for soil types are available for use when site-specific estimates are not available. To facilitate the water balance analysis, parameters were chosen as discussed in the following sections.

2.3.3.2 CLIMATE

The HELP model contains historical climatological data in its database that allows the user to select a station close to the site under consideration. The program generates a routine designed to preserve the dependence in time and the correlation between variables and the seasonal characteristics in actual weather data at the specified location. Some weather data (evapotranspiration, temperature, and solar radiation) required for the HELP model were synthetically generated using the HELP model's default weather data for the Guam area – the closest location in the HELP model for which data existed – and were corrected for the latitude of the proposed Tinian Landfill. Guam is located south east of Tinian and has similar weather patterns to Tinian. Descriptions of various weather data inputs are described below. Evaporation data for the project consisted of the following:

- Evaporative Zone Depth – 10 inches;
- Maximum leaf area index –(good stand of grass);
- Dates starting and ending the growing season – 0 and 365 (Julian date);
- Normal average annual wind speed – 9 miles per hour (mph); and,
- Normal average quarterly relative humidity – 72 percent first quarter, 71 percent second quarter, 77 percent third quarter, and 75 percent fourth quarter.

2.3.3.3 SOIL LAYER CHARACTERISTICS

Cap scenarios can be constructed in the HELP model by entering one soil types with varying thickness. Soil data can be entered into the HELP model by using default soil/material textures, user-defined soil textures, or manual options for soil porosity, field capacity, wilting point, and hydraulic conductivity. The soil texture types are classified according to U.S. Department of Agriculture textural classification system and the Unified Soil Classification System (USCS).

2.3.3.4 HELP ANALYSIS

General design requirements for the separate layers that compose the landfill liner and cover systems include layer type and layer thickness. The four general types of layers that can be modeled are:

1. Vertical percolation,
2. Lateral drainage,
3. Barrier soil liner, and
4. Geomembrane liner.

For model simulations, it was assumed that precipitation runoff will occur over 100 percent of the landfill area.

The leachate generation analysis used rainfall data adjusted to 30-year annual rainfall records in the computer modeling software. As previously stated, the computer program synthesized the rainfall data from a designated Guam weather station, corrected for the site latitude, and created the precipitation record with a peak daily of 9.49 inches.

Based on the results of the HELP analysis, it is anticipated that leachate generation volumes will be as shown in Table 1:

Table 2 Peak Leachate Generation Summary

Scenario	**Gallons per Day of Leachate Generation (Design Values)***
5-foot lift over base (Phase I Temporary Condition)	1,821
5-foot lift over slope (Phase I Temporary Condition) (2.5-foot average thickness over slope)	76,999
35-foot lift over base (Entire Site Full)	24,385
35-foot lift over slope (Entire Site Full) (17.5-foot average thickness)	25,197

* Design values are double the calculated peak daily leachate volume captured in the drainage layer from HELP multiplied by the liner area.

The predicted peak daily volume of leachate generated formed the basis for the design of the leachate collection system. The leachate generation analysis is included as part of Appendix F.

2.3.4 LEACHATE COLLECTION AND REMOVAL SYSTEM

2.3.4.1 SLOPES

Leachate from the slope area will either drain through the protective cover into the drainage geonet and conveyed to the main floor LCRS and will flow along the operation layer/refuse interface to the toe-drain.

2.3.4.2 FLOOR AREAS

The LCRS for the floor area will consist of a drainage geocomposite overlaying the FML to provide drainage. Perforated collection pipes and mainline pipes within the LCRS floor areas will transition to a solid header line that will drain to a six-foot diameter lined concrete sump. From the sump, the liquids will be conveyed to a constructed wetlands for treatment. The sump is sized to collect leachate generated from the landfill, wastewater from the buildings, and liquids that drain from the septage ponds.

2.3.4.3 COLLECTION PIPES

As shown in the Hydrologic Evaluation of Landfill Performance (HELP) analysis, the LRCS laterals will be spaced a minimum of 200 feet apart. All of the laterals will connect and drain towards the leachate collection mainline pipe, and to the leachate sump.

The drainage layer of the cell floor will be drained by perforated pipe in gravel wrapped trenches. The laterals will drain to a 6-inch diameter mainline which will drain to a sump. Treatment of liquids captured in the LCRS is described in Section 2.3.5.

2.3.4.4 CLEANOUTS

Cleanouts are located where the laterals meet the side slopes and extend up the slopes to allow access for maintenance of the lines.

2.3.5 LEACHATE TREATMENT SYSTEM

A landfill leachate treatment system consisting of constructed wetlands has been designed to meet the following criteria: minimal energy consumption and no discharge to surface water bodies.

There was no data available for the leachate constituents of the leachate that will be generated from the refuse on the island of Tinian. Therefore, water quality sampling data was reviewed for the Marpi Municipal Solid Waste Landfill (MMSWL) (CNMI DPW, 2009). The MMSWL was chosen due to its proximity to Tinian and assumed similar solid waste stream. Data from the leachate collection pond, prior to entering the vegetated submerged bed (VSB) treatment system, and treated leachate effluent discharged from the VSB treatment system, were compared with USEPA primary and secondary drinking water standards (EPA, 2011). Water quality parameters with detectable values are shown in Table 3. The CNMI is under the jurisdiction of the USEPA, Region 9 (Government Engineering, 2005).

Table 3. Marpi Municipal Solid Waste Landfill Influent and Effluent Data

Parameter	US EPA Primary Drinking Water Regulations Maximum Contaminant Levels	US EPA Secondary Drinking Water Regulations Maximum Contaminant Levels	Influent (MLF-006/001) 8/26/09 12:10 PM☐	Effluent (MLF-007/002) 8/26/09 12:30 PM☐
pH	N/A	6.5-8.5	8.0	7.7
TSS (mg/L)	N/A	500	40	20
BOD (mg/L)	NV	NV	8 *	38 *
Ammonia-N (mg/L)	NV	NV	44	17
Arsenic (µg/L)	10.0	N/A	**90.6**	**63.7**
Chromium (µg/L)	100	N/A	50.6	32.5
Cobalt (µg/L)	NV	NV	9.26	7.56
Nickel (µg/L)	NV	NV	41.7	36.0
Vanadium (µg/L)	NV	NV	12.3	11.8

Notes:

*BOD performed under conditions outside method temperature range. Control Standards and blanks exceed method limits with high bias; therefore all results are estimates.

NV	No Value
N/A	Not Applicable
90.6	Bold value indicates an exceedance of an established standard
☐	Indicates date/time sampled

All volatile organic compounds (VOCs) were non-detectable above reporting limits. Possible reasons for non-detectable values of VOCs were high precipitation or flows in August causing dilution of the landfill leachate. Only Arsenic was found to exceed EPA drinking water standards even though the VSB system removed thirty percent of the influent Arsenic. Arsenic has been reported to be naturally occurring in the project area.

Based on review of existing data, a constructed wetland appears to be a viable method for treatment of landfill leachate on Tinian based on the anticipated constituents in the leachate. Once the leachate has been treated in the wetland the liquids will drain to an infiltration pond.

Vegetated wetlands act as both physical filters and sites of biological and chemical activity to alter or fix contaminants in place. Surface air creates an aerobic environment which promotes the oxidation of VOCs and precipitation of aqueous metals. Below the surface, the organic planting substrate consumes oxygen, creating an anaerobic or oxygen-deprived zone which promotes sulfide mineral formation.

The constructed wetlands have been designed to receive an estimated 32,470 gallons per day (gpd) of leachate as determined from the HELP model for the site and approximately 251.5 gpd of liquid septage waste for a total influent flow of 32,722 gpd. The quantity of septage flow was estimated from typical wastewater generation quantities (Metcalf and Eddy, 1991), assuming 3.5 people are on-site (13 gpd/capita for a part-time mechanic, 15 gpd/capita for the equipment operator, administrator, and scale operator), and assuming 1,000 gallons of septage waste are delivered to the site during a 5-day week.

Based on a review of case studies of constructed wetlands for the treatment of landfill leachate, a system from Springdale, Pennsylvania was found to have 92% removal efficiency for Arsenic from 61 ug/L in the influent to 5 ug/L in the effluent (Terry, 1998). The area required for treatment was determined by scaling the flow and treatment area to that of Springdale, while maintaining the same depth of the Springdale system (0.1 foot or less). Removal rates for constructed wetlands are largely a function of surface area and hydraulic retention time. The area of the constructed wetlands in the Springdale system is approximately 1.32 acres for a flow of 57,600 gpd and an Arsenic loading rate of 10 g/acre-day. The area of the constructed wetlands at Tinian is approximately 1.10 acres for a flow of 32,722 gpd and an Arsenic loading rate of 11 g/acre-day.

Equation 1. Arsenic Loading Rate at Springdale

$$\frac{0.061mg}{L}\times\frac{40gall}{\min}\times\frac{60\min}{1hr}\times\frac{24hr}{dat}\times\frac{3.785L}{gall}\times\frac{1g}{1000mg}\times\frac{1}{1.32acres}=\frac{10g}{acre\bullet day}$$

Equation 2. Estimated Arsenic Loading Rate at Tinian

$$\frac{90.6\mu g}{L}\times\frac{32{,}722gall}{day}\times\frac{3.785L}{gall}\times\frac{1g}{10^{6}\mu g}\times\frac{1}{1.10acres}=\frac{11g}{acre\bullet day}$$

Equation 3. Ratio of Flow Rate to Treatment Area at Springdale

$$\frac{Q}{A}=\frac{57{,}600gpd}{1.32acres}=43{,}636gpd/acre$$

Equation 4. Estimated Ratio of Flow Rate to Treatment Area at Tinian

$$\frac{Q}{A} = \frac{32{,}722 gpd}{1.10 acres} = 29{,}747 gpd / acre$$

Equation 5. Estimated Water Depth at Tinian

$$\frac{Q}{A} = D = \frac{43{,}74\,ft3/day}{47{,}916\,ft2} = 0.09\,ft$$

The hydraulic retention time anticipated at Tinian for a 1.5-foot water depth is approximately 16 days, with the potential for a hydraulic retention time of 32 days if 1.5-feet of freeboard is also included.

Equation 6. Hydraulic Retention Time

$$\frac{V}{Q} = HRT = \left(\frac{47{,}916\,ft^2}{4{,}374\,ft^3\,perday}\right)(1.5\,feet) \approx 16.4 days$$

EPA secondary wastewater treatment standards for biochemical oxygen demand (BOD) and total suspended solids (TSS) require 85% removal and a 30-day and 7-day average concentration of 30 mg/L and 45 mg/L, respectively. Utilizing an equation for BOD removal in an ideal single aerated lagoon (Metcalf and Eddy, 2003), a BOD decay rate value of 0.4/day (k), a hydraulic retention time of 16 days (τ), and a typical septic tank BOD value as the influent BOD (EPA, 2012) effluent BOD is anticipated to meet the EPA standard for removal of BOD as follows:

Equation 7. Estimated BOD Removal

$$BODeffluent = \frac{BOD\text{influent}}{1 + k\tau} = \frac{93.5 mg / L}{1 + (0.5 / day)(16 days)} = 10.4 mg / L$$

68 percent of TSS was removed from influent values in the Springdale System. A typical medium strength concentration for TSS for untreated domestic wastewater of 210 mg/L was obtained from Metcalf and Eddy, 2003 and was assumed to be representative of the septage waste TSS concentration. Additionally, a maximum influent concentration of 50 mg/L for TSS from Marpi data reviewed from November 2007 to August 2009 was used. The anticipated concentrations from the leachate and septage were weighted according to the anticipated respective flows and are expected to meet the EPA standard for removal of TSS as follows:

$$\frac{(251.5 gpd)(210 mg / L) + (32{,}470)(50 mg / L)}{32{,}722 gpd} = 51 mg / L$$

$$51mg/L-(51mg/L\times 0.68)=16mg/L$$

Removal rates for other constituents of possible concern, such as acidity, Arsenic, Aluminum, Boron, and Iron range from 12 to 98 percent for the Springdale system.

3.0 GEOTECHNICAL INFORMATION

A geotechnical investigation was conducted for the Tinian Landfill. Design calculations were performed for various elements of the liner system. The following slope stability calculations are included as part of the geotechnical report in Appendix C.

3.1 GEOPHYSICAL SURVEY

3.1.1 SURFICIAL GEOLOGY

No significant rock outcrops were observed, with the exception of the southwest corner of the property, where large exposed limestone boulders may be indicative of previous military development. No visible scarps or evidence of faulting were observed by on-site geologists. Sinkholes or surficial voids were not evident in the area of study. The perimeter of the proposed landfill was located in the field using handheld GPS units, in close coordination with the surveyor crew.

3.1.2 SUBSURFACE INVESTIGATION

Ten shallow test pits ranging from 25 to 30 feet long were excavated. Pinnacled solution detrital coralliferous fossiliferous limestone was encountered at all locations at depths ranging from approximately 2.5 to 9 feet below ground surface. Overlying the pinnacled solution limestone were lean clay, silty clay and clayey silt units.

3.1.2.1 LINER AREA RECOMMENDATIONS

Based on field observations of the surficial geology, the geotechnical report in Appendix C recommends a minimum depth of 4 feet to be excavated. In areas where the landfill subgrade is less than 4 feet below grade, the excavation beyond the subgrade depth would be backfilled with engineered fill to meet the subgrade.

In areas where limestone pinnacles are encountered, it is recommended that the excavations be extended to a depth where flat limestone beds can be achieved.

3.1.3 SUPPLEMENTAL GEOTECHNICAL INVESTIGATION

The February 2012 TTBAS Geotechnical Design Report discussed a potential concealed bedrock fault trending from southwest to the northeast towards the western portion of the landfill site. In order to evaluate the presence of a fault in this location, a site investigation consisting of excavating an exploratory trench was conducted between September 5 and September 7, 2012. The results of this investigation indicated that no fault was present on the site. The findings are presented in a memorandum dated September 28, 2012, in Appendix C.

3.2 DESIGN CALCULATIONS

3.2.1 LINER SLOPE STABILITY

Slope stability was analyzed for liner subgrade slopes per 40 CFR Part 258.15, which require the operator to ensure the project site will not be constructed against unstable areas, which may compromise the integrity of landfill structural components.

A slope stability analysis, which included site-specific geotechnical field investigations and calculations for static and pseudostatic slope stability, was prepared. The models and results of this work are included in of Appendix C. The following four scenarios were evaluated:

- Temporary cut slope stability before liner construction.
- Temporary protective cover soil stability prior to refuse placement
- Interim Phase 1 refuse prism slope stability during refuse placement
- Global slope stability at final closure condition.

Slope stability analyses were performed using Slope/W for the static and seismic (i.e., pseudo-static) cases using Spencer's method with slip surface optimization option. The stability of the PCS cover along the highest cut slope prior to refuse placement was analyzed using a closed-form solution for two-part wedge with sliding along a critical interface for a finite slope length (Giroud et al., 1995). The stability was evaluated for unsaturated conditions for a 4 horizontal to 1 vertical slope 14 feet high.

For the slope liner, the governing displacement shear strength is expected to develop along the critical interfaces between the woven geotextile and GCL or between the textured HDPE geomembrane and GCL. Accordingly, stability analyses utilized large displacement shear strength for these interfaces with a friction angle of 13 degrees based on conservatively published data.

For the base liner, the governing (minimum) peak shear strength is expected to develop along the critical interfaces between the woven geotextile and GCL or between the woven geotextile and the prepared subgrade, or within GCL, depending on the overburden stress. Accordingly, stability analyses utilized a bilinear shear strength envelope with friction angle of 20 degrees for normal stresses less than 1,300 pounds per square foot (psf) and a friction angle of 6 degrees and cohesion of 100 psf for the larger normal stresses. Prior to construction, these interface shear strength parameters are considered minimum prescriptive values that should be verified and confirmed for the actual liner materials for these liner interfaces.

Acceptance criteria for the slope stability analysis for the various design conditions are as follows:

- FSstatic greater than 1.25 for temporary/interim condition.
- FSstatic greater than 1.5 for permanent static condition.
- FSpseudostatic greater than 1 or acceptable permanent seismic displacement.

The calculated factors of safety for the liner design were greater than the acceptance criteria in the analysis.

Seismic stability of the proposed landfill slopes under final configuration has been evaluated for the critical cross section by subjecting the section to seismically induced ground motions with a 10 percent probability of exceedance in a 250 year period, as required by 40 CFR. This analysis determines that the landfill will remain functional following the design seismic event and will not experience excessive displacements. The magnitude of permanent seismic deformations analysis was done using the simplified semi-empirical predictive relationship, which is more rigorous than pseudostatic slope stability analyses. Seismically-induced permanent displacements of 6 to 12 inches are considered acceptable per Section 6 of RCRA Subtitle D. The calculated permanent seismic displacement was 8 inches for the slope under final configuration, and is considered acceptable.

3.2.2 GEOTECHNICAL RECOMMENDATIONS

The project specifications and CQA would require for materials to be tested ensuring they meet minimum shear strength requirements prior to construction.

Chapter 7 of the Geotechnical Report includes recommendations to be implemented during construction. During mass excavation, the exposed subgrade of the Phase I area will be observed and mapped by a qualified geologist to verify geologic and geotechnical characteristics, to identify any adverse geologic conditions that may affect the integrity of the composite liner system, and to confirm suitable foundation conditions are achieved prior to placement of engineering fill and overlying liner and refuse systems.

Over-excavation and backfill would be conducted beneath the liner subgrade to provide a suitable foundation. In areas, where the proposed liner subgrade is at least 4 feet below the existing grade, the liner subgrade should be over-excavated and backfilled to one-foot depth. Areas where the liner subgrade is less than 4 feet below the existing subgrade, should be over-excavated at least 4 feet or to expose continuous limestone bedrock, to remove pinnacles that may be present at the liner subgrade. The foundation of the perimeter berm will also be over-excavated 4 feet below the existing grade.

It is possible that localized solution cavities may be encountered at the site. The infilling of cavities will be excavated and replaced with engineered fill, 1 or 2 sack cement slurry, or grout. The remediation means will be determined in the field by the representative Geotechnical Engineer (TTBAS Geotech Report page 7-4).

4.0 WASTEWATER AND SEPTIC WASTE

4.1 ON-SITE WASTEWATER

All residences and businesses use septic and seepage tanks, leaching fields, or holding tanks to dispose of sewage. "A significant number of households within the proposed San Jose collection area do not have any septic system instead utilizing cesspools or pit latrines" (USACOE, 2008. Page 33) There is no central wastewater treatment plant on the island.

Wastewater from onsite buildings will drain to a septic/holding tank. From this tank, the liquids will drain to the LCRS sump. From here, the liquids will be pumped to the constructed wetlands, described in Section 2.3.5, for treatment. The modular buildings within the landfill property are anticipated to generate 51.5 gpd of wastewater.[2]

4.2 SEPTAGE GENERATION

As previously stated, the predominant wastewater disposal method on Tinian Island is septic or seepage tanks. These tanks require regular maintenance which includes the pumping of septage out of the tanks. The proposed landfill site includes a facility for the treatment of septage waste with residual solids to be disposed of in the landfill.

It is anticipated that 1 truck per week will deliver septage to the Tinian Landfill (USACOE, 2008. Appendix H, Page 6). In addition, the septage from the future military facilities and onsite septic system will will likely be drained annually and the septage from the onsite buildings will be transported to the onsite septage area.

For design, it was conservatively assumed that 500 to 1,000 gallons per week of septage would be delivered to the sand drying beds.

4.3 SEPTAGE SYSTEM DESIGN

A septage handling and disposal facility will be constructed adjacent to the leachate treatment ponds. Septage waste consists of liquids that have a high solid content that are pumped from septic tanks.

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[2] 13 gpd/capita X 0.5 (part time mechanic + 15 gpd X 3 (equipment operator, administrator, scale operator) = 51.5 gpd. Generation rates from Table 2-3 of Metcalf & Eddy, 1991.

In order to dispose of the septage in a lined landfill, the septage must first be dewatered to not contain free liquids per the Paint Filter Liquids Test described in 40 CFR 258.28 (c)(1). A series of three sand drying beds will provide a low energy intensive and low-maintenance treatment option for the septage, to achieve the required moisture content level.

The sand drying beds will treat incoming septage by separating the solids from the liquids through the dewatering and drying of the trapped solids. Once dewatered, the resultant cake can be collected and placed in the landfill. The liquids will percolate through the sand and be conveyed to the leachate treatment system (constructed wetlands described in Section 2.3.5). The Septage Handling Facility location and design is included with the landfill Drawings in Appendix A.

The sand drying beds have a sand layer that is two feet thick with two feet of freeboard above the sand layer. Beneath the sand is an underdrain system. The underdrain piping consists of perforated pipe in a gravel trench wrapped in geotextile that drains at a two percent slope to the LCRS sump described in Section 2.3.5.

The sand drying beds will have a geotextile in the middle of the sand layer as a maintenance barrier. Over time, as the sludge is removed, the thickness of the sand layer will be reduced. The geotextile layer will have the added effect of keeping fines from the septage from migrating into the lower one-foot of sand. Once the geotextile layer is exposed, the upper one-foot thick layer of sand will be replaced. The sand drying beds will be lined with geosynthetic clay liner, HDPE geomembrane, drainage geocomposite, and a geotextile cushion layer to protect the underlying geosynthetics. The drying beds will be sheltered by a cover in order to keep precipitation off of the septage which would reduce the drying efficiency of the beds.

4.4 SEPTAGE OPERATIONS

Incoming vehicles will unload directly at the sand drying beds. One of the sand drying beds will be active for the septage disposal, while the remaining two beds will be used for draining/drying septage. The moisture content of the septage is approximately 60 percent after 10 to 15 days under favorable conditions (Metcalf & Eddy, 1991, Page 871). Therefore, in order to ensure the septage has been sufficiently dewatered, a cycle for each drying bed will be a maximum of 15 days of disposal and a minimum of 30 days of drying.

As previously stated the sand layer thickness will decrease over time and will need to be replaced, in addition the sand layer may eventually clog with fine particles and no longer function adequately. If the sand layer is clogged, the sand layer shall be removed, and either disposed of in the landfill or stockpiled over the constructed liner footprint to be used as daily cover (if approved). Once the clogged sand layer material is removed, a new sand layer is placed over the drying bed. The septage cake and sand could be removed with a front-end loader or available equipment onsite (CAT 953D waste handler).

4.4.1 DESIGN CALCULATIONS

Calculations were done for sizing the underdrain pipe and overburden pressure on the geomembrane liner.

The piping will enable a minimum discharge velocity of 1.6 feet per second.

The overburden pressure on the geomembrane in the sand drying bed is included in Appendix F.

5.0 LANDFILL GAS MANAGEMENT

As organic solid waste naturally degrades in the landfill, it will generate gas primarily composed of methane and carbon dioxide. The quantity of landfill gas generated depends of the quantity of waste, organic content, and moisture content. A landfill gas collection and treatment system is not anticipated to be required due to the volume of the site. However, simple design features will be provided for future connections to a passive venting system or collection system under vacuum upon final cover construction or in the event that landfill gas is detected.

5.1 POTENTIAL LANDFILL GAS GENERATION

The potential landfill gas generation has been analysed in the project Environmental Analysis (USACOE, 2008, Page 52). The landfill gas generation was estimated to be as follows using an EPA emissions model:

Table 4. Landfill Gas Vapor Estimates Peak Year (Table 5.1 from USACOE, 2008)

Gas	Emission Rate		
	Mg/Year*	Ft^3/Year	Tons/Year
Total Landfill Gas	42.9	9,386,757	57.1
Methane	87.6	72,818	1.09
Carbon Dioxide	17.0	72,818	22.4
NMOC*	4.02	974	4.42

*MG = Megagram (1 million grams)
NMOC = non-methane organic compound

Some NMOC are listed as hazardous air pollutants (HAP) under the Clean Air Act 42 USCA 7412(b). The estimated NMOC quantity is well below the thresholds of 10 ton per year for individual HAPs and 25 ton per year total HAP that would trigger air permitting requirements.

5.2 REGULATORY REQUIREMENTS

Based on the designed capacity, the net refuse capacity is approximatley 233,000 cubic yards or approximately 178,000 cubic meters. The designed refuse capacity of the is less than the 2.5 million cubic meter threshold, which triggers the applicability of 40 CFR part 60, Subpart WWW. Therefore, no landfill gas collection and control system is projected to be required at this time.

Should methane monitoring at the site indicate that the methane level exceeds regulatory standards, above 25 percent of the lower explosive limit at the property boundary or in facility structures per 40 CFR 258.23, then a landfill gas collection and control system may need to be installed.

5.3 PERIMETER LANDFILL GAS MIGRATION MONITORING

The landfill will have perimeter probes spaced approximatley 500 feet apart to monitor landfill gas generation. In addition, monitoring would occur at the buildings (scalehouse, administration office, and maintenance area).

5.4 GAS COLLECTION SYSTEM

The project Environmental Assessment requires for landfill gas to be managed to control the discharge of potentially dangerous gases into the atmosphere.

It is recommended that the final cover incorporate a passive gas venting system to allow gas generated from underneath the landfill final cover to be vented to prevent damage to the cover and minimize potential subsurface migration of landfill gas. The passive system would allow relatively low operation and maintenance needs for long term use during the post-closure maintenance period.

Based on monitoring results, if an active collection and treatment system were necessary, the vents could be readily connected to a vacuum system to collect the gas and convey it to a treatment system via flare or energy recovery (if feasible in the future based on the volume of gas generated and methane content). An active collection and treatment system is not anticipated to be necessary due to the anticipated volume of waste and the estimated peak landfill gas generation shown in Table 4.

6.0 WATER RESOURCES

6.1 SURFACE WATER DRAINAGE SYSTEM

The surface water control structures were designed per 40 CFR 258.26 and 40 CFR 258.27. The project site is located outside of floodplains and wetlands areas per 40 CFR 258.11 and 258.12, respectively.

The proposed run-on control structures consist of trapezoidal channels, an access road crossing (Arizona Crossing), and a southern berm to divert run-on around the landfill operating area and supporting facilities. Localized controls around facilities and the operating areas will include grading the ground surface to maintain drainage flows away from ancillary facilities and operating areas.

The run-off control structures consist of a perimeter drainage system that conveys flows to a storm water infiltration pond.

6.1.1 EXISTING CONDITIONS

The Tinian Landfill will be located in an area where storm water percolates into the ground or evaporates. There are no surface water bodies in the project area. The nearest water body that the project would discharge flows to is the Western Pacific Ocean. "...potential contamination of the surrounding environment (including groundwater) could occur from the discharge of surface waters generated from the MSWL facility" (USACOE, 2008. Page 46). A hydrology analysis was conducted to determine run-on and run-off flows to size drainage control structures. Permanent erosion control features include hydroseeding, and a storm water infiltration basin to capture sediment. In addition, during landfill operations, storm water would be directed around operating areas by localized earthen berms and best management practices for erosion controls would be implemented.

6.1.2 HYDROLOGY ANALYSIS

TR55 was used to determine peak flows values based on the Rational Method for a 25-year, 24-hour storm. The TR55 software was developed by the USDA and uses the Soil Conservation Science method. Time of concentration values used in TR55 were calculated using Excel based on Kirpich and Mannings equations for overland sheet flow and channelized flow, respectively. The flow velocities input in the time of concentration calculations were determined using FlowMaster. The time of concentration values were entered into TR55 for determining the runoff flows.

Where the time of concentration for a flow path was less than 0.1, TR55 defaulted to a minimum value of 0.1.

Precipitation data was obtained from the NOAA website for rain gauge 91-4874 on Tinian Island. The 25 year, 24 hour cumulative rainfall value was determined to be 11.6 inches.

The SCS rainfall distribution was assumed to be Type I based on site location - Pacific maritime climate with wet winters and dry summers. This is based on weather in Hawaii, which is the nearest location with a similar climate on the SCS map. Native onsite soils contain lean clay which indicates a type D soil. Native ground was assumed to be covered with brush, weeds, grass mix with a good cover, which yields a SCS curve number of 73.

6.1.2.1 RUN-ON

Run-on controls were designed based on a 25-year, 24-hour storm in compliance with 40 CFR 258.26. Run-on generally drains in a westerly direction within the landfill property boundary and will be diverted around the operating portion of the site via perimeter channels. Some on the drainage control structures extend outside of the western property line between Riverside Drive and the site. A hydrology analysis of the site was prepared to determine the existing flows to size the run-on control structures (Appendix F).

The undeveloped portions of land drain to large open areas with shallow flow. Native stream flow was assumed to be a trapezoidal channel with a 100 foot wide base and 10:1 side slopes. A weedy grass vegetated channel bed was assumed with a Mannings value of 0.045.

Land in the vicinity of the site was previously divided into parcels by roads with drainage swales on either side (see Hydrology Map in Appendix F). Drainage alongside the previously constructed roadway was assumed to be the same vegetative channel bottom with steeper 4:1 side slopes. Because these roads were designed to cutoff and convey flows, hydrologic boundaries were drawn where these roads could be identified.

The total flow was estimated to be approximately 1,240 cubic feet per second. After the existing site run-on was calculated, the resultant flows from TR55 were input into the FlowMaster software to verify the sizing of the run-on control structures using Manning's equations for open channel flow.

6.1.2.2 RUN-OFF

Runoff from the landfill operating area will sheet flow from the deck area to side slopes. The perimeter of the landfill will have a channel to capture flows from the landfill area. The surface water captured in the channel will be conveyed to a permanent NPDES infiltration pond with an overflow wier that outlets to a trapezoidal channel to convey flows away from the landfill operating area. The infiltration pond is large enough to allow flows from a 25-year, 24-hour storm to infiltrate into the ground and prevent an increase in run-off from the pre-developed condition.

6.1.3 EROSION AND SEDIMENT CONTROL

The site will be designed and operated to comply with 40 CFR 258.27 to control sediment discharge.

In addition, during landfill operations, the site would be graded to maintain drainage away from operating areas. Localized temporary earthen berms would be constructed to assist in directing flows around the disposal areas.

6.1.3.1 TEMPORARY EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMP'S)

To meet the requirements of the EPA National Pollutant Discharge Elimination System General Permit for Discharges from Large and Small Construction Activities (Construction General Permit - CGP), a draft storm water pollution prevention plan has been developed by Tetra Tech to be finalized by the contractor prior to construction of the site

The National Pollutant Discharge Elimination System (NPDES) storm water program requires construction site operators engaged in clearing, grading, and excavating activities that disturb one acre or more, including smaller sites in a larger common plan of development or sale, to obtain coverage under an NPDES permit for their storm water discharges. EPA Region 9 is the permitting authority for the CNMI.

During construction, temporary erosion control measures will be employed by the construction contractor as described in the draft Storm Water Pollution Prevention Plan (SWPPP) to minimize both short and long term impacts resulting from minor alteration of the topography. Typical erosion control measures applied during construction will include the use of berms, fiber rolls, cut-off ditches, temporary ground cover vegetation, and the application of water and/or soil stabilization and protection materials. Silt fences shall be constructed and continuously inspected and repaired to prevent silt runoff from the project site.

6.1.3.2 PERMANENT EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES (BMP'S)

Upon completion of grading activities, the bare soil areas will be hydroseeded. The site is designed with relatively mild slopes (4 horizontal: 1 vertical) that will keep storm water flows relatively mild; thus limiting the potential for erosion of the slopes.

Runoff from the landfill will be conveyed to a perimeter channel that drains into a permanent storm water pond to infiltrate into the ground and capture sediment. The storm water pond will be periodically cleaned as needed.

Portable pumps can be placed to convey non-contact stormwater within each phase to the surface water drainage system until the waste height increases enough to convey surface water flows to the perimeter channel.

6.2 GROUNDWATER

Fresh groundwater at the project site occurs as a basal groundwater lens within the Mariana Limestone that floats on the denser seawater. There are no known structural features that would result in hydrologic subdivisions in the aquifer at the subject site.

The groundwater elevation is expected to be highest inland and to decrease as groundwater flow towards and discharges at the coast. According to Tetra Tech's Geotechnical Design Report (Page 4-6), groundwater is at depths ranging from 161 to 216 feet below ground surface.

Groundwater generally flows from the north-central highlands and the southeastern ridge towards the coast. The water table is relatively flat throughout a majority of the island. Water levels are usually less than two feet above mean sea level. The freshwater lens, which is at about 40 feet, is the thickest in the median valley. Fresh groundwater at the project site occurs as a groundwater lens within the Mariana limestone.

6.2.1 GROUNDWATER MONITORING SYSTEM

The groundwater monitoring network at Tinian Landfill consists of 3 groundwater wells (shown on the site plan – Sheet 2) that are screened within the limestone. The wells were installed at locations upgradient and downgradient of the Tinian Landfill, as shown in Figure 3. Boring logs and well completion details for the three groundwater monitoring wells are included in the Geotechnical Report. The boreholes were drilled a minimum of 20 feet into the saturated zone to ensure 15 feet of screened interval of the well spans the uppermost portion of the water-bearing unit to account for seasonal fluctuations. The monitoring wells were drilled with air rotary drill rig by using the air foam lift method with a 8 ¾-inch diameter tri-cone rock bit.

The wells were constructed using Schedule 80 PVC casing materials and well screen. The filter pack is approximately five feet above the well screen, which is 20 feet long with washed 3/8-inch limestone gravel surrounding the screen. The remaining borehole annulus was sealed with approximately a five-foot thick bentonite chip seal that is overlain by 3/8-inch washed limestone gravel to a depth of 50 feet below ground surface (bgs). Neat cement grout was placed from the surface to a depth of 50 feet bgs. Subsequent to reaching the total depths, monitoring wells were completed with permanent surface monuments that were constructed of a locking steel stovepipe that is surrounded by a concrete well pad and four concrete-filled bollards.

Following monitoring and well construction, a single well, steady state drawdown pump test was conducted on monitoring well MW-02 for eight hours. Pump rate and water level changes were recorded during the pump test.

6.2.1.1 GROUNDWATER QUALITY

To obtain baseline groundwater chemistry or background groundwater quality, samples were collected from monitoring well MW-02 immediately following the completion of the pump test. Samples were analyzed for Constituents of Concern (COCs) as defined in 40 CFR 258, Appendix I.

"Seven analytes were detected at concentrations above the laboratory detection limits. The detected analytes and reported concentrations were; selenium at a concentration of 0.035 milligrams per liter (mg/L), zinc at 0.65 mg/L, acetone at 60 micrograms per liter (ug/L), chloride at 1300 mg/L, nitrate at 3.3 mg/L, sulfate at 190 mg/L and a TDS concentration of 2900 mg/L. None of the detected constituent concentrations were above regulatory limits. Groundwater quality assessment indicates that the groundwater in the portion of the aquifer at MW-2 is brackish. This determination is based on the reported chloride concentration of 1300 mg/L and the reported TDS concentration of 2900 mg/L" (Draft Geotechnical Report, Page 4-7).

6.2.1.2 GROUNDWATER MONITORING PROGRAM

The groundwater monitoring program is developed in accordance with 40 CFR 258.53.

Groundwater sampling and analysis will be performed semi-annually during the active life of the facility and the post-closure period. During each groundwater sampling event, the groundwater elevations will be measured at each well and the rate and direction of groundwater flow will be determined from the data. Subsequent to the completion of each sampling and analysis event, the owner or operator will determine whether there has been a statistically significant increase over background groundwater quality at each monitoring well.

7.0 ANCILLARY FACILITIES

7.1 ACCESS ROADS

Site access design will include an all weather main entrance road and perimeter road. Access will be provided to support facilities including the scale house, administration offices, maintenance area, and other ancillary facilities and material storage areas.

Internal temporary haul road design will be incorporated into the phasing design.

Construction traffic will be routed along temporary haul roads.

7.2 SITE BUILDINGS

Modular buildings are proposed for the scale house and administration building. A pre-engineered steel building is proposed for the maintenance facility. The proposed modular buildings and foundation design have been done based on anticipated seismic and winds. The supporting calculations for stability analysis, anchoring/mounting requirements, and specifications for foundation construction will be included in the 90 percent submittal. Modular buildings would be delivered to the site as preassembled inside crates.

7.2.1 SCALEHOUSE

The scale and scale house are based on anticipated site traffic and scale operations being performed by a single scale operator. The scale house is proposed to be a prefabricated structure (booth) measuring 4 feet by 6 feet. The building has electricity prewired, a telephone pull box, and heating and air conditioning. The booth is designed to mount directly onto a concrete pad. We have provided a floor plan of a typical booth, although the final floor plan may vary depending on manufacturer. Vehicles entering the site would weigh in full and weigh out empty to determine the tons disposed of. The weights would be recorded by an automated software such as Mettler Toledo's Auto Scale Software, which is also used at Saipan's Lowe Base Refuse Transfer Station and Marpi Solid Waste Facility.

7.2.2 ADMINISTRATIVE OFFICE

The administrative office will be located north of the scale area. The building will have electricity prewired, a telephone pull box, and heating and air conditioning. The building is designed to mount directly onto a concrete pad. The power source for the entire site and communications equipment (including a network server) will be located in this building. From this structure, conduit will be installed for electrical and communications lines to the scale house and ancillary facilities.

The site plan (Drawing 2 in Appendix A) includes a footprint of the facility and its approximate location. A conceptual floor plan is included in Drawing 18 in Appendix A. The administrative facility is a 30 x 10 prefabricated steel modular structure. The facility sizing is based on a suggested landfill staffing plan of four (4) employees: an administrator/manager, a scale operator, an equipment operator, and a part-time mechanic. In order to accommodate the needs of staff and the site, the facility will include the following:

- Break room/lunch room with kitchenette.
- A unisex restroom and locker facilities.
- An emergency shower and eyewash station.
- A single office.

7.2.3 MAINTENANCE FACILITY

The maintenance facility is proposed to be a pre-engineered metal building. The dimensions will be approximately 60-feet by 70-feet. It will include two 25-foot wide equipment maintenance bays and a 10-foot wide workshop area for parts storage and tools. This facility will be covered and can have an open or closed wall (with roll-up doors), depending on CNMI preference.

7.3 ASBESTOS CONTAINING MATERIAL (ACM) DISPOSAL AREA

A proposed ACM disposal area is to be located on the north eastern side of the landfill disposal footprint. ACM disposal regulations specify that the material be double bagged and promptly covered after disposal. Additionally the specific location of ACM disposal trenches will have signs posted and location surveyed and recorded, to avoid accidental excavation. 40 CFR 61.152/66.545.

The location of the ACM disposal area is flexible and may change based on the final site layout.

7.4 MATERIALS FOR REUSE/DIVERSION FROM DISPOSAL

To assist Tinian in meeting diversion goals of Executive Order 13514, materials could be diverted from disposal to conserve landfill capacity by reusing them onsite or in construction of the landfill. Diversion from disposal may include use of material: in building internal all weather access roads; alternative solid waste cover materials (other than excavated soil); and erosion control. White goods such as large metal appliances (i.e. refrigerators, air conditioners, water heaters, and stoves) could be diverted from disposal for metals recycling offsite.

As described in Section 1.1.2, the landfill design capacity calculations assume use of alternative daily cover materials. Materials that could be reused in landfill construction or as alternative cover materials include yard waste, mulch, topsoil, construction demolition and disaster cleanup disposal (C/D/DCD), and wood waste/woody debris. According to 40 CFR 258.21(b), "Alternative materials of an alternative thickness (other than at least six inches of earthen material) may be approved by the Director of an approved State if the owner or operator demonstrates that the alternative material and thickness control disease vectors, fires, odors blowing litter, and scavenging without presenting a threat to human health and the environment." According to the Environmental Protection Agency Region 9 website at <http://www.epa.gov/region09/waste/partners/mswislands .html>, the Commonwealth of Northern Mariana Islands is not considered an approved State.

7.4.1 YARD WASTE, MULCH, AND TOPSOIL

The long-term topsoil and cover material stockpiles will be located south of the landfill operating area. A designated mulch and yard waste stockpile area would be located west of the site. Daily cover and potential alternative daily cover materials (i.e., yard waste and mulch) for use immediately would be stockpiled just east of the landfill operating area. Yard waste, mulch, and topsoil would be ground and used at the site for slope stabilization, erosion control, and alternative daily cover. Depending on the quality of material, yard waste may be further processed to be sold as landscaping material with strict controls in-place.

Regulation of composting facilities has been delegated to the states and Tinian does not currently have any composting regulations. Tetra Tech recommends that the composting operations are developed in a manner that will avoid the need for liner and leachate collection. If more advanced processing occurs in the future, composting operations could be conducted only above the lined portions of the site.

7.4.2 CONSTRUCTION, DEMOLITION, AND DISASTER CLEANUP DISPOSAL (C/D/DCD) AREA, WOOD WASTE/WOODY DEBRIS STAGING AREA, AND WHITE GOODS AREA

The C/D/DCD, wood waste/woody debris, and white goods will be located west of the landfill operating area. It is proposed to be a graded pad surrounded by K-rails for temporary storage and easy access and mobility to accommodate the fluctuating size and location of the area. Typical construction and demolition waste can be temporarily stored and processed for reuse or disposal at the landfill.

In the event of a natural or manmade disaster, the site will receive a large quantity of disaster debris in a short period of time. The volume will likely overwhelm disposal operations; therefore, a staging area will need to be established. The location and size of the area could vary depending on the size and the scope of the disaster event.

Large quantities of these wastes are inorganic in nature and do not need to be disposed in the lined municipal solid waste landfill. Typically these wastes can be buried in an excavated trench, backfilled, and capped after completion of fill.

Wood waste, and wood debris from land clearing and other natural clean vegetative wastes would be ground and used at the site for slope stabilization, erosion control, and alternative daily cover.

White goods would have a designated unloading area to be temporarily stored and eventually recycled offsite. Refrigerants in air conditioning units and refrigerators may need to be removed by onsite staff for proper disposal prior to offsite recycling.

7.5 UTILITIES

7.5.1 ELECTRICAL UTILITIES

Because there are no existing electrical utilities near the site, the most cost effective option, is to provide onsite generators to provide power. The generators will be located in the maintenance and administrative office building. From here, conduit will be routed to the scalehouse and pumps to distribute power. The generator will be specified to provide adequate for the capacity and peak loading at the site. The following table summarizes power needs for the site.

Table 5 Facilities Requiring Power

Facility	Electricity/Equipment Need	Power Demand
Offices	Duplex outlets and fluorescent lights with single pole wall switch.	125 Amps - assume 120\240 Volts (15,000 Watts)
Maintenance Area	Pneumatic equipment	To Be Determined
Scale house	Duplex outlets and fluorescent lights with single pole wall switch.	40 Amps, 120\240 Volt Single Phase (4,800 Watts)
Non-Potable Water Supply	Well Pump* (1.5 HP)	1.5 kVA (1,500 Watts)
	Booster Pump* (1.5 HP)	1.5 kVA (1,500 Watts)
	Pneumatic Tank Air Compressor* (0.5 HP)	0.5 kVA (500 Watts)
Landfill liquids collection system (leachate, wastewater, and septage liquids)	Sump pump and controls*	To Be Determined

* Assume one horsepower (HP) equals one kVA for sizing equipment.

7.5.2 COMMUNICATION

7.5.2.1 EXISTING INFRASTRUCTURE

Tinian has fiber optic and microwave as a backup to the fiber optic. However, these facilities are located relatively distant from the landfill and it is not feasible to connect to the existing facilities due to the cost of trenching from the site to the utility connection point.

7.5.2.2 LANDFILL NEEDS

There will be 3 to 4 landfill employees. The site will require reliable communications via phone, internet, and e-mail. In addition, internal site communications would be via radio. It is assumed at least 4 phone lines would be required with each employee having an e-mail account and internet access on 2 computers. In the event traditional telephone service cannot be provided to the site, then alternative measures will need to be explored. This would require a DS-1 (digital signal level 1) or T1 line with capacity provided via satellite or cellular connection.

During construction, the Tetra Tech recommends use of temporary satellite with a DS-1 (digital signal level 1) or T1 line with capacity and cellular phones.

7.6 WATER SUPPLY

7.6.1 POTABLE DRINKING WATER

Drinking water for landfill employees will be provided in the form of bottled drinking water delivered from a nearby village. Landfill employees will not be permitted to drink water from faucets, hose spigots, or any sources other than bottled drinking water.

7.6.2 NON-POTABLE WATER

Non-potable water for use in faucets, sanitary facilities, dust suppression and site maintenance will be obtained from well MW-02 near the northeastern portion of the site. The well construction diagram for MW-02 is presented in Appendix C of this Design Report. Groundwater in the uppermost portion of MW-02 is brackish with chloride concentrations at 1,300 mg/L and total dissolved solids at 2,900 mg/L.

A three-inch Grundfos (Model 22SQ-220 - 1.5 horsepower (hp)) submersible well pump will pump water from the well at approximately 15 gallons per minute (gpm). The water will then be boosted by a Goulds Water Technology (Model 3SV-07 - 1.5 hp) pump to a 10,000 gallon Hanson hydropneumatic tank. It is anticipated that the hydropneumatic tank will be operated in the pressure range of 40 to 70 pounds per square inch (psi). The hydropneumatic tank will pressurize a 4-inch PVC below ground water main located near the site buildings. two-inch PVC laterals will extend from the four-inch main to the site buildings.

A six-inch Klein fill stand will tie into the main near the tank for the purpose of filling the site water truck. It is anticipated that only two water truck loads per day will be required for dust suppression.

7.7 FENCING

The perimeter of the site will have 6-foot height chainlink fencing to control access to the site. The fencing alignment is shown on Drawing 9 of the Drawings in Appendix A.

8.0 FINAL CLOSURE DESIGN

The proposed landfill final cover design has been evaluated with the goal of limiting infiltration of water into the site and will also incorporate landfill gas management as described in Section 5.0.

8.1 FINAL COVER

Federal regulations under 40 CFR, Part 258.60(b) allows an operator to propose an alternative final cover to the standard prescriptive cover design. Several factors were taken into consideration in evaluating the proposed alternative final cover system design for the Tinian Landfill to provide adequate performance. These factors include: i) regulatory requirements; ii) climatic conditions; iii) material availability; iv) erosion protection; v) potential vegetation growth; vi) short and long term performance; and vii) end use at closure. Due to the location of the Tinian Landfill, the lack of availability of earthen materials, constructability, and the factors mentioned above, an alternative final cover (see Figure 7) with the following components from top to bottom is proposed:

- Two-foot thick vegetative layer.
- Drainage geocomposite.
- LLDPE or 60-mil HDPE.
- 1-foot thick foundation layer assumed to be in place as intermediate cover upon closure.
- Passive landfill gas venting system described in Section 5.0.

As shown in the HELP model, the proposed final cover design results in an infiltration rate of $2.35X10^{-10}$ cm/s. This is less than the minimum required $1X10^{-5}$ cm/s. The HELP model for the final cover is included in Appendix F.

Due to the anticipated deeper rooting systems of the native vegetation to be planted on the final cover, the 24-inch thick vegetative layer was selected instead of the minimum 6-inch thick layer required by the Federal regulations to accommodate the longer roots.

8.2 EROSION CONTROL

Continuous erosion control measures will be utilized at the site during landfill operations and closure to minimize the soil loss from the landfill. Excessive soil loss will be mitigated by limiting the distance water must travel before reaching a channel or other drainage structures. Maintenance of the storm water basin will be conducted semi-annually and will continue throughout the post-closure maintenance period.

After the landfill is closed, vegetative materials will be established over the surface of the landfill to serve as the primary erosion control feature. The site will be vegetated with native species.

8.3 DRAINAGE CONTROL SYSTEM

The site's run-on and run-off storm water drainage structures were designed to control precipitation produced by the 25-year, 24-hour storm event. The methodology and calculations used to verify this design are provided in Appendix C. The site drainage controls will protect the landfill from washouts, erosion, and inundation resulting from a storm or a flood produced by this storm event. The site's final grades (final cover subgrades are shown in Figures E and F in Appendix A) were designed to promote lateral runoff of precipitation and prevent ponding over solid wastes.

Run-on from all areas adjoining the landfill will be diverted around the landfill through a system of perimeter ditches and berms. See Figures in Appendix D for the drainage plan and associated hydrology analysis.

The proposed final drainage control system configuration is shown in Appendix D. The proposed final drainage control system will include exterior slope downdrains, deck area grading, deck drainage berms, deck inlets, bench drains, trapezoidal and triangular perimeter drains and an infiltration basin. Some of the interim drainage control system facilities may be utilized as part of the final drainage control system for the site.

On-site drainage features are intended to control run-on to or run-off from the landfill areas. Storm water on the landfill deck will sheet flow until it is intercepted by a berm located around the deck perimeter. The deck berm will then direct run-off flows to corrugated metal flume downdrains. The downdrains will be perpendicular to slope contours and located on topography, and anchored into, the final landfill slope surface. The will be extended up completed side slopes of the landfill as the filling progresses. The downdrains will also accommodate inlets at each bench. The gradient of these downdrains will follow the surface of the refuse slope (typically 3:1). The downdrains will outlet to a concrete perimeter channel within that directs flow into an infiltration basin. Stormwater from the landfill side slopes will sheet flow into the concrete perimeter channel. Stormwater from the surrounding facilities will sheet flow off-site. Run-off conveyance structures will be sloped to convey flows to the storm water infiltration basin.

9.0 SCHEDULE AND CONSTRUCTION SEQUENCE

9.1 DESIGN

Design is scheduled to be complete by June 2012. The final design will include construction Drawings and Specifications for Phase 1 of the site development. The construction will then begin after construction permits (see section 9.3.1) have been obtained.

9.2 CONSTRUCTION

The start of construction is to be determined and is anticipated to begin shortly after completion of design. Phase 1 construction is anticipated to occur over 9 months. The estimated construction schedule is as follows:

- Mobilization, including establishing temporary site access, staging area set up, and delivery of construction materials (3 months).
- Construction of permanent run-on and run-off controls (2 months).
- Grading of access road and Phase 1 liner area excavation (2 months).
- Modular buildings, site infrastructure, and liner (2 months).

9.3 PERMITS

9.3.1 CONSTRUCTION PERMITS

Prior to site construction, the project would require the following permits:

- National Pollutant Discharge Elimination System (NPDES) General Permit for Discharges from Construction Activities issued by EPA.
- One-Start Earthmoving and Erosion Control Permit issued by CNMI Department of Environmental Quality.

The notice of intent for the NPDES permit is required to be submitted to the EPA at least 14 days prior to construction. The application for the One-Start permit has a lead time of 21 days for review prior to construction.

9.3.2 OPERATING PERMITS

During site operations, the landfill would be operated pursuant to 40 CFR 258 and in conformance with the following permits:

- Solid Waste Management Permit issued by the CNMI Department of Environmental Quality.

- National Pollutant Discharge Elimination System Multi-Sector General Permit (MSGP) issued by EPA.

9.4 OPERATION EQUIPMENT AND STAFFING

The owner will purchase the necessary equipment for disposal operations. In addition at start up, a truck with a fuel tank will be needed for mobile equipment fueling or another manner for delivering fuel to the site. A water truck may be needed for dust control along with a mobile water fill stand.

It is estimated that 3.5 staff people will be required. These include a part time mechanic and full time equipment operator, administrator, and scale operator.

9.5 START OPERATIONS

To maintain the integrity of the liner system and provide for efficient collection and removal for leachate, procedures will be implemented to control fill sequencing, refuse placement and LCRS operations after liner construction as described below.

9.5.1 FILL SEQUENCE AND CONTROL

The conceptual liner construction staging plan will be developed based on the findings of the geotechnical report. The liner construction phasing will begin from the west of the landfill and progress to the east. By developing the landfill in this direction, excavation performed by a contractor will be minimized because the greater volume of the excavation lies in the eastern end of the landfill. Excavation for future liner phases can be performed by site operations, reducing overall site development costs. With the first liner phase, the leachate collection sump will be constructed, and subsequent phases will be tied into the existing leachate collection system. The plans show the LCRS mainline piping once the liner construction sequence has been developed. The LCRS will be designed in greater detail to include any necessary lateral piping and the grading of the LCRS trenches.

The interim and complete refuse fill plans are presented in Figures A through F in Appendix A.

The Phase I development area will provide approximately 20,900 CY of net disposal airspace capacity.

9.5.2 REFUSE PLACEMENT

The following procedures will be implemented to minimize the potential for damage to the liner system resulting from initial disposal operations.

9.5.2.1 REFUSE PLACEMENT

The first lift of MSW and associated daily cover will be graded to direct clean storm water and surface water run-off away from the cell and to minimize storm water infiltration into the refuse prism.

Refuse will be visually inspected to eliminate objects that could be driven through the liner system during placement and compaction of the initial lifts of refuse. Refuse inspection will be conducted continuously throughout the period of refuse placement against the liner.

9.5.2.2 REFUSE UNLOADING, SPREADING, AND COMPACTING

Refuse transport vehicles can travel in direct contact with the protective cover soil layer. The heaviest pieces of landfill equipment should minimize direct contact of the protective cover soil layer. Any area of the protective cover soil layer that appears to have been disturbed by heavy equipment shall be inspected. Incoming refuse vehicles will tip loads onto the protective cover soil layer. After MSW has been unloaded from the vehicles, a uniform lift thickness will be established. To minimize the potential for objects to penetrate the protective cover soil layer, refuse will not be pushed excessively. During compaction, all compaction equipment will stay on the deck of the refuse fill and will not operate on the front slope of refuse or the protective cover soil layer. The side slope liner system will be anchored and protected for future liner tie-in. The liner system will be monitored for potential damage from erosion, ultraviolet degradation, equipment impacts, and animal burrowing.

10.0 BIOLOGICAL MITIGATION MEASURES

Based on results of the environmental analysis, project mitigation measures are required for the Tinian Monarch and Brown Tree Snake. The Tinian Monarch was the only species identified for protection under the CNMI endangered species statutes and Endangered Species Act (ESA) for the proposed project site. The brown tree snake is a non-indigenous invasive species on Tinian and incoming shipments for construction and goods for continued operations would potentially increase the risk of introduction of non-indigenous invasive species such as the brown tree snake. The potential of the brown tree snake becoming established on Tinian is a threat to the Tinian Monarch.

10.1.1 TINIAN MONARCH

The Tinian Monarch is endemic to Tinian and is listed as a threatened species under CNMI endangered species statutes. This species was formerly listed as threatened under the ESA, but was delisted in September 2004. Construction will be scheduled to avoid the "high breeding season," which occurs in the months of January, May and September. In the event that a Tinian Monarch nest is encountered during construction activities, the construction contractor will cease construction activities in the immediate vicinity of the tree containing the nest and the appropriate authorities at the CNMI DFW and/or USFWS will be immediately notified of the find by the construction contractor. Subsequent consultation with the CNMI DFW will be undertaken to determine the best course of action with regard to resuming construction activities.

10.1.2 BROWN TREE SNAKE

The potential of the non-indigenous and invasive brown tree snake becoming established on Tinian is a threat to the Tinian Monarch and requires mitigation measures. "To mitigate the accidental introduction of the brown tree snake from Guam into Tinian, the construction contractor shall work with the CNMI Division of Fish and Wildlife (DFW) Brown Tree Snake Quarantine Program (BTSQP) Manager to coordinate the shipment of supplied and equipment to Tinian and the work site to ensure that all shipments have been first inspected on Guam (if that is the origin) and then re-inspected on Tinian with certified brown tree snake Canines. In addition, all construction contractor personnel working at the proposed SMWL project site would attend the Brown Tree Snake Identification and Capture (BTSIC) Training prior to commencement of construction activities. BTSIC Training would be provided by the DFW BTSQP and could be held on either Saipan or Tinian.

Furthermore, existing protocol and procedures for the quarantining of the brown tree snake (and other NIS introductions) from cargo vessels operations at Tinian Harbor would also apply to material shipments for the proposed project." (USACOE, 2008. Page 56).

10.2 VISUAL SCREENING

A screening plan will be developed to construct soil berms and landscaping using native species along the site's frontage to Riverside Drive. The screening berm design is based on the fill height, location of site facilities, and vegetation height.

The Screening Plan will be Drawing 10 in Appendix A.

11.0 CONSTRUCTION SPECIFICATIONS

Construction will be monitored in accordance with the procedures and schedule described in a Construction Quality Assurance (CQA) Plan in order to verify that the liner installation has been completed in accordance with the Construction Plans and Specifications and that the work meets applicable regulatory requirements.

The CQA Plan provides for inspection and testing of all critical components and construction work for the composite liner system, and LCRS, including visual inspection of subgrade preparation, material handling and placement, field testing of all seams, monitoring LCRS gravel placement, monitoring LCRS pipe installation, and field testing of the protective cover soil layer compaction.

The CQA Plan provides for independent laboratory testing for material conformance of all manufactured construction components including geotextiles and geomembranes. In addition, shear strength testing of the proposed side slope liner section will be completed to demonstrate that the actual product used in construction will exhibit a sufficient degree of interface and internal friction.

12.0 PROFESSIONAL CERTIFICATION

Current regulations require that a registered civil engineer or a certified engineering geologist prepare and certify the Design Report for a containment system.

Which the signature and seal below, the Phase I Liner System for the Tinian Landfill has been prepared in accordance with 40 CFR 258, as certified by Mr. Caleb H. Moore a Registered Civil Engineer in Commonwealth of Northern Marianas Islands, Registration Number 415.

"I certify under penalty of law, that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

Caleb H. Moore, P.E.

Registration No. 415

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