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Revision IV
Volume IV of IV Replacement
Amendment to Final Closure Plan
Lopez Canyon Sanitary Landfill
Lake View Terrace, California

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1. INTRODUCTION

1.1 Terms of Reference

This volume is the fourth (4th) revision of the amendment to the Final Closure Plan (FCP) and Final Post-Closure Maintenance Plan (FPCMP) for the Lopez Canyon Sanitary Landfill (LCSL), denoted Volume IV of IV and dated June 1996. This document was prepared by Geosyntec Consultants (Geosyntec) at the request of the City of Los Angeles Bureau of Sanitation (BOS). This document was prepared by Mr. Yonas Zemuy of Geosyntec and reviewed by Mr. Jeff Dobrowolski, P.E., also of Geosyntec, in accordance with the review policy of the firm.

1.2 Site Location and Background

The LCSL is an inactive California Class III municipal solid waste landfill owned and operated by BOS. The LCSL is located in the Lake View Terrace section of the City of Los Angeles, as shown in Figure 1-1. The LCSL covers approximately 399 acres, of which approximately 162 acres have been used for waste disposal. The landfill is divided into four Disposal Areas designated as Disposal Areas “A,” “B,” “AB+,” and “C.” Figure 1-2, titled Site Plan, shows the site topography, the landfill boundary, and the limits of the four disposal areas. Historically, the LCSL received waste from the mid-1970s until July 1996 and is currently undergoing closure.

1.3 Summary of Revisions

This Summary of Revisions outlines the amendments to the FCP and the FPCMP for the LCSL. The FCP is comprised of the Partial Closure Plan (PCP) (Volumes I through III) dated April 1993 and the Amendment to the PCP (Volume IV of IV). The initial Amendment (Volume IV of IV), transformed the PCP into the FCP. The FPCMP is comprised of the Partial Post-Closure Maintenance Plan (PPCMP) (Volume I) dated January 1993 and the Amendment to the PPCMP (Volume II of II) dated February 1994. The Amendment (Volume II of II) transformed the PPCMP into the FPCMP.

- Volume IV of IV Replacement Amendment to FCP was submitted in June 1996 (the 1996 FCP) to replace the February 1994 Volume IV of IV in its entirety and thereby amended the FCP and FPCMP (the 1994 FPCMP) for the LCSL. The objective of the first amendment was to incorporate FCP information on the closure of the deck of Disposal Areas “A” and “B” and the deck and slopes of Disposal Areas “AB+” and “C.” The 1996 FCP included revisions to the FCP necessitated by changes in the design of the landfill since

submission of the 1994 FPCMP. These changes required revisions to the final cover, the final grading plan, post-closure settlement estimates, surface water drainage controls, soil loss analysis, the landfill gas (LFG) control system, landscaping and irrigation, the closure cost estimate, closure implementation schedule, and the final cover construction quality assurance (CQA) plan for the landfill.

- Revision I to Volume IV of IV Replacement Amendment to FCP was submitted to the California Integrated Waste Management Board (CIWMB), Los Angeles Regional Water Quality Control Board (RWQCB), and Local Enforcement Agency (LEA) in March 1997 (the 1997 report) to address comments from the CIWMB and LEA on the 1996 FCP, prior to final approval of the revised closure plan being granted. Applicable sections of the amended FCP were revised to reflect these comments. Revised sections included the final cover design, LFG control system, the closure cost estimate, a final cover performance evaluation report and the CQA plan. Revision I to Volume IV of IV was prepared by the BOS.
- Revision II to Volume IV of IV Replacement Amendment to FCP was submitted October 1998 (the 1998 report) and included additional revisions of applicable sections to reflect the conditional approval of the evapotranspirative (ET) cover for the slopes of Disposal Areas “A” and “AB+” and the decks of Disposal Areas “A” and “B.” Revised sections include the final cover design, landscaping and irrigation, the closure cost estimate, the closure plan implementation schedule and the CQA plan, with new appendices added to address ET cover water balance analyses and the final cover performance evaluation. Revision II of Volume IV of IV was prepared by the BOS.
- Revision III to Volume IV of IV Replacement Amendment to FCP was submitted in October 2002 (the 2002 report) to reflect construction of a composting facility on the decks of Disposal Areas “A” and “B” and changes in the final cover in these areas. Revised sections include the final cover of the Decks of Disposal Areas “A” and “B,” closure cost estimate, closure plan implementation schedule, the CQA plan, and a new appendix added to address the Asphaltic Cement Concrete final cover configuration proposed for the composting area. Revision III to Volume IV of IV was prepared by Geosyntec on behalf of the BOS.

This document, Revision IV to Volume IV of IV Replacement Amendment, prepared by Geosyntec on behalf of the BOS, is being submitted in July 2008 (the 2008 report) as an additional revision of applicable sections to be incorporated into the June 1996 report, to reflect the following:

- Revising the design of the final cover for the slopes and deck of Disposal area “C” to use an ET cover instead of the currently proposed (in the June 1996 report) Title 27 prescriptive final cover;
- Revising the final cover stability evaluation for the Disposal Area “C” per Title 27 of the California Code of Regulations (Title 27) requirements to reflect the proposed ET cover;
- Updating the final closure cost estimate for the site to include disposal areas that have been closed and to reflect cost saving from the use of the proposed ET cover system for Disposal Area “C”; and
- Updating the closure schedule to complete closure activities of the remaining waste disposal areas.

1.4 Closure Activities

The FCP provides for closing the LCSL in two phases. Phase I includes closure of the slopes of Disposal Areas “A” and “B” and was completed in 2002. Phase II includes closure of the decks of Disposal Areas “A,” “B,” “AB+,” and “C” and the slopes of Disposal Areas “AB+” and “C” and is on-going. To date, Disposal Areas “A” and “B,” the deck of Disposal Area “AB+,” and a portion of the slopes of Disposal Area “AB+” have been closed. Closure of the remaining slopes of Disposal Area “AB+” is in progress. Figure 1-3 shows the limits of the four disposal areas and the stage of closure activities for each disposal area as of May 2008. The final cover has not yet been placed in Disposal Area “C.”

Disposal Areas “A,” “B,” and “AB+” were constructed and started accepting refuse prior to 1991 and are not lined. Disposal Area “C,” built in 1992, was designed and constructed with a composite liner to comply with Resource Conservation and Recovery Act (RCRA) Subtitle D.

1.5 Purpose of Amendment

The purpose of this amendment to the FCP is to provide the LEA, RWQCB and the CIWMB with the necessary information to consider approval of the proposed ET cover for the final closure of Disposal Area “C” in accordance with Title 27. Closure requirements for Municipal Solid Waste (MSW) landfills are contained in Title 27, RWQCB Order No. 93-062, and in §258 of Title 40 of the Code of Federal Regulations, commonly referred to as Subtitle D of the Resource Conservation and Recovery Act (RCRA).

1.6 Report Organization

The remainder of this report is organized as follows:

- Section 2, *Final Cover for Disposal Area “C,”* summarizes the regulations in effect for the design of prescription and alternative final cover systems. Section 2 also presents a description of the final cover configuration proposed in the 2002 FCP for the closure of Disposal Area “C.” Additionally, Section presents the revised final cover design for the decks and slopes of Disposal Area “C” and the performance evaluation conducted to compare the performance of the proposed ET cover and the Title 27 prescriptive final cover (PFC). Finally, Section 2 presents a brief discussion of the soil proposed borrow sources;
- Section 3, *Final Grading Plan for Disposal Area “C,”* presents the revised final grading plan for the decks and slopes of Disposal Area “C.”;
- Section 4, *Final Cover Stability Evaluation for Disposal Area “C,”* presents the final cover stability evaluation for Disposal Area “C” per Title 27 requirements. The revised stability evaluation include evaluation of relevant shear strength parameters, an update of the seismic hazard analysis, static and pseudostatic stability evaluations, and seismic deformation;
- Section 5, *Surface Water Drainage Design,* presents a brief discussion of the surface water drainage design for Disposal Area “C”;
- Section 6, *Revised Closure Cost Estimate,* presents revised cost estimates for implementing closure of the remaining disposal areas. The revised cost estimate includes changes in closure cost estimate resulting from the modifications described in Sections 1 through 5. Additionally, this section also presents approximate closure cost for the closed disposal areas;

- Section 7, *Revised Closure Schedule*, presents an updated closure implementation schedule;
- Appendix A- *White Paper – Alternative Cover for Disposal Area “C,”* presents justification for the use of ET cover at Disposal Area “C” based on evaluation and comparison of the short and long term performance, durability and reliability of the prescriptive cover and the proposed ET cover for Disposal Area “C”;
- Appendix B, *Revised Closure Cost Estimate*, presents the updated Closure Cost Estimates.
- Appendix C, *Drawing No. 1*, presents a drawing showing the final grading plan for the site;
- Appendix D, *Soil Test Laboratory Results of Selected Soil Borrow Sources*, presents soil test laboratory test results of selected soil borrow sources; and
- Appendix E, *Slope Stability Analysis*, presents both one-dimensional and two-dimensional slope stability analyses of the Disposal Area “C” ET final cover.

2. FINAL COVER FOR DISPOSAL AREA “C”

2.1 Regulatory Background

2.1.1 General

The regulations for closure of Class III municipal solid waste (MSW) landfills in California are contained in Title 27 of the California Code of Regulations (CCR) and in the federal regulations (Subtitle D) adopted under Title 40, Code of Federal Regulations, Part 258 (40 CFR 258). In 1993, the State Water Resources Control Board (SWRCB) incorporated Subtitle D final cover system design and performance requirements into the California state regulations through SWRCB Resolution No. 93-62.

Both Subtitle D and Title 27 provide prescriptive cover designs for landfills based on the type of liner system, if any, that is installed. In addition to these prescriptive standards, both federal and state regulations allow for the consideration of alternative final cover designs provided it can be demonstrated that the proposed alternative designs meet or exceed either the established performance standards or the performance of the prescriptive standard.

2.1.2 Prescriptive Final Cover Performance Requirements

State of California regulations for design and construction of final covers for closure of municipal solid waste landfills are found in Title 27. Section 21090(a) of Title 27 [27 CCR 21090(a)] provides the following prescriptive requirements for the prescriptive final cover.

- (1) *Foundation Layer – Closed landfills shall be provided with not less than two feet of appropriate materials as a foundation layer for the final cover. These materials may be soil, contaminated soil, incinerator ash, or other waste materials, provided that such materials have appropriate engineering properties to be used for a foundation layer. The foundation layer shall be compacted to the maximum density obtainable at optimum moisture content using methods that are in accordance with accepted civil engineering practice. A lesser thickness may be allowed for Units if the RWQCB finds that differential settlement of waste and ultimate land use will not affect the structural integrity of the final cover.*
- (2) *Low-Hydraulic-Conductivity Layer – In order to protect water quality by minimizing the generation of leachate and landfill gas, closed landfills*

shall be provided with a low-hydraulic-conductivity (or low through-flow rate) layer consisting of not less than one foot of soil containing no waste or leachate, that is placed on top of the foundation layer and compacted to attain a hydraulic conductivity of either 1×10^{-6} cm/s (i.e., 1 ft/yr) or less, or equal to the hydraulic conductivity of any bottom liner system or underlying natural geologic materials, whichever is less permeable, or another design which provides a correspondingly low through-flow rate throughout the post-closure maintenance period.

(3) *Erosion-Resistance Layer – The low-hydraulic-conductivity layer of (a)(2) shall be directly overlain by an erosion-resistant layer, as follows.*

(A) *Closed landfills shall be provided with an uppermost cover layer consisting of either:*

1. *Erosion-Resistance Via a Vegetative Layer – a vegetative layer consisting of not less than one foot of soil which:*

- a. contains no waste (including leachate);*
- b. is placed on top of all portions of the low-hydraulic-conductivity layer described in ¶(a)(2);*
- c. is capable of sustaining native, or other suitable, plant growth;*
- d. is initially planted – and is later replanted as needed to provide effective erosion resistance—with native or other suitable vegetation having a rooting depth not exceeding the depth to the top of the low-hydraulic conductivity layer described in ¶(a)(2).*

Regulations contained in 27 CCR 21090(a)(3) provide guidance on the materials that may be used in constructing the erosion control layer. Erosion resistance may be provided by constructing either a vegetative layer capable of sustaining plant growth or a mechanically erosion-resistant layer consisting of cobbles/gravel. The erosion-resistant layer must be capable of resisting wind-scour, rainfall impact, and surface water runoff.

2.1.3 Alternative Final Cover Performance Standards

State regulations allow for consideration of engineered alternatives to the Title 27 prescriptive final cover. Criteria are provided for both RWQCB and California Integrated Waste Management Board (CIWMB) approval of an engineered alternative final cover. Sections 20080(b) and (c) of Title 27 provide the criteria for approval of an engineered alternative final cover by the RWQCB. These criteria, as outlined in Section 20080(b) and (c) of Title 27, are:

- (1) *the construction or prescriptive standard is not feasible as provided in (c); and*
- (2) *there is a specific engineered alternative that:*
 - (A) *is consistent with the performance goal addressed by the particular construction or prescriptive standard; and*
 - (B) *affords equivalent protection against water quality impairment.*
 - (C) *Demonstration [for ¶(b)] – To establish that compliance with prescriptive standards in this subdivision is not feasible for the purposes of ¶(b), the discharger shall demonstrate that compliance with a prescriptive standard either:*
 - (1) *is unreasonably and unnecessarily burdensome and will cost substantially more than alternatives which meet the criteria in (b); or*
 - (2) *is impractical and will not promote attainment of applicable performance standards.*

Regulations contained in 27 CCR 21140 provide criteria for CIWMB approval. This section allows for alternative final covers provided the design will function with minimum maintenance and provide waste containment to protect public health and safety by controlling, at a minimum, vectors, fire, odor, litter, and LFG migration. The alternative final cover shall also be compatible with post-closure land use.

2.2 Final Cover Configuration for Disposal Area “C”

The final cover proposed in the 2002 FCP for closure of Disposal Area “C” was approved by the CIWMB on 10 October 1995. The final cover currently proposed in the

2002 FCP for the deck of Disposal Area “C” is shown on Figure 2-1 and consists of the following components (from top to bottom):

- a 24-in. (60-cm) thick (minimum) vegetation layer;
- 12-oz/yd² (410-g/m²) non-woven geotextile cushion;
- 40-mil (1-mm) thick very-flexible polyethylene (VFPE) geomembrane (smooth on the deck areas and textured on the bench areas);
- 12-in. (30-cm) thick barrier layer of compacted low-permeability soil, with a hydraulic conductivity no greater than 1×10^{-6} cm/s, or a geosynthetic clay liner (GCL) with a hydraulic conductivity no greater than 5×10^{-9} cm/s; and
- a 24-in. (60-cm) thick foundation layer.

The final cover currently proposed in the 2002 FCP for the slopes of Disposal Area “C” is shown on Figure 2-2 and consists of the following components (from top to bottom):

- a 24-in (60-cm) thick (minimum) vegetative layer;
- 12-in. (30-cm) thick barrier layer of compacted low-permeability soil with a hydraulic conductivity no greater than 1×10^{-6} cm/s; and
- 24-in. (60-cm) thick foundation soil layer.

The approved final cover designs for the decks and slopes of Disposal Area “C” discussed in the 2002 FCP will be collectively called, hereafter, the Title 27 prescriptive final cover (Title 27 PFC).

2.3 Revised Final Cover Configuration for Disposal Area “C”

Modifications to the FCP for the LCSL have been required by changes in post-closure development use, changes in regulations, and technological advances, and better understanding of final cover performances. Example FCP modifications include, but are not limited to:

- installation of a helipad on the deck of Disposal Area AB+ and construction of the GWCF on the deck of Disposal Area B;
- construction of the proposed truck driver training academy;

- changes in regulations, including promulgation of Subtitle D and Title 27, at both the federal and state levels; and
- a better understanding of the performance of ET covers since the promulgation of current regulations nearly 20 years ago.

An engineered alternative final cover was developed and is proposed for the closure of Disposal Area “C.” The engineered alternative final cover, mainly an ET cover, was developed on the basis of the performance evaluation. The following sections present the performance evaluation used to develop the proposed ET cover for closure of Disposal Area “C.”

2.3.1 Performance Evaluation of Alternative Final Cover for Disposal Area “C”

A performance evaluation to use an ET cover for closure of slopes and deck of Disposal Area “C” was conducted in a technical report titled *White Paper – Alternative Cover for Disposal Area “C”* (White Paper) in August 2007 [Geosyntec 2007]. The objective of the White Paper was to obtain approval from the RWQCB of an ET cover for closure of Disposal Area “C.” The White Paper presented justification for approval based on an evaluation and comparison of the short and long-term performance, and durability and reliability of the Title 27 PFC and the ET cover. A copy of the White Paper is included in Appendix A of this report.

The performance evaluations of the proposed ET cover and the Title 27 PFC for closure of Disposal Area “C” were compared with respect to the following criteria:

- Cover performance:
 - infiltration control;
 - cover slope stability;
 - effect of subsidence;
 - seismic activity response;
 - LFG control;
 - erosion control; and
 - effect of burrowing animals.
- Construction considerations:
 - material availability;
 - constructability; and
 - quality assurance and quality control (QA/QC).

- Cost;
- Post-closure use;
- Aesthetics;
- Regulatory acceptance (discussed in Section 3); and
- Case histories (discussed in Section 5).

Table 2-1 summarizes the performance evaluation criteria discussed in the white paper.

A water balance analysis, using UNSAT-H Version 3.0 [Fayer, 2000] computer program, was used to evaluate and compare the percolation performance of the ET cover to that of the Title 27 PFC. The analysis was conducted by using 10 years of daily weather data from nearby weather stations. It is assumed that soil properties similar to that of the soil material used for the construction of the ET cover in Disposal Area AB+ will be used to construct the ET cover in Disposal Area “C.” Therefore, the analysis uses the same hydraulic soil parameters and vegetation data used in the analysis of the ET cover for the deck of Disposal Area AB+. The cross section of the proposed ET cover analyzed is shown in Figure 2-3.

The results of the cumulative water balance analysis for the Title 27 PFC and the proposed ET cover for Disposal Area “C” are summarized in Table 2-2. The results of the evaluation show that the combined cumulative annual infiltration for the Title 27 PFC for Disposal Area “C” described in the 2002 FCP is approximately ten times greater than the cumulative annual infiltration for the ET cover.

The proposed ET cover for the deck and slopes of Disposal Area “C” consists of the following components (from top to bottom):

- vegetative layer at least 0.5-ft thick with a hydraulic conductivity no greater than 3.3×10^{-5} cm/s;
- 2.5-ft thick ET cover layer constructed with borrow soil with a hydraulic conductivity no greater than 3.3×10^{-5} cm/s; and
- 2-ft thick ET cover layer constructed with borrow soil with a hydraulic conductivity no greater than 5×10^{-6} cm/s.

A detailed presentation of the performance evaluation and discussion of the comparison criteria of the Title 27 PFC and the proposed ET cover contained in the White Paper is included in Appendix A of this report.

On the basis of the comparison criteria summarized in Table 2-1, the Proposed ET cover discussed in the white paper shows that the ET cover provides better infiltration control than the currently approved Title 27 PFC, thus providing better groundwater protection. Moreover, constructability of the Title 27 PFC is more burdensome, is more susceptible to cracking, involves more labor-intensive maintenance, and is significantly higher in cost of purchase and placement of material.

Based on the findings discussed in the White Paper, it was determined that the ET cover proposed for the slopes and deck of Disposal Areas “C” would be more practical and would better promote attainment of the Title 27 performance goals than the Title 27 PFC.

The White paper discussed above was submitted to the RWQCB as a request for approval of the proposed ET cover design for the slopes and deck of Disposal Area “C” on 17 August 2007. RWQCB staff informed Geosyntec in a telephone conversation that the RWQCB conceptually concurs with the use of an ET cover for final closure of Disposal Area “C.” However, for RWQCB to consider approval of the proposed ET cover for Disposal Area “C,” the RWQCB required submittal of a formal revision to the existing FCP for the LCSL and that the revised FCP for the LCSL should reflect the proposed ET cover and other proposed changes, if any.

2.4 Borrow Sources for the Proposed ET Cover

Approximately 189,561 cubic yards (CY) of suitable soil is necessary to construct the proposed ET soil cover for Disposal Area “C” closure (approximately 68,239 CY of suitable soil for the slopes and 121,322 CY of suitable soil for the deck of Disposal Area “C.”). Approximately 85,537 CY of suitable soil is also needed to complete construction of the proposed ET soil cover for slopes of Disposal Area “AB+.” (Approximately 51,466 CY of suitable soil for the North slopes and IT area and 34,071 CY of suitable soil for the South slopes (remaining area) of Disposal Area “AB+.”). The total soil volume of approximately 275,098, CY necessary to construct the proposed ET cover for Disposal Area “C” and complete closure of the slopes of Disposal Area “AB+”, will be obtained from on-site soil stockpiles and off-site soil borrow sources. As of July 2008, the total quantity of soil delivered to the site is approximately 170,000 CY. According to the weekly soil usage rate compiled by the BOS, approximately 45,000 CY, of the soil delivered to the site, was used to construct the ET cover for Disposal Area “AB+”. Therefore, the total soil stockpile available on site is approximately 125,000 CY. The imported quantity of ET cover soil (approximately 150,000 CY) will be obtained from construction contractors either free

of charge or through purchase orders. For example, in 2007, the following two suitable soil sources for ET cover construction were identified:

- A Hollywood, CA, development site, where approximately 300,000 CY of suitable soil for ET cover construction is available. No soil is yet available for import to LCSL due to developer permitting issues.
- A Tarzana, CA development site, where approximately 150,000 CY of suitable soil for ET cover construction is available. Approximately 40,000 CY was imported to LCSL as of May 2008. However, the remaining soil balance may not be available for import to the LCSL.

Table 2-3 presents a summary of the soil borrow sources. Table 2-3 includes information such as soil types, available quantities, actual quantities delivered to the site, and delivery status and other information about the soil borrow source.

BOS is also diligently pursuing additional soil borrow sources to secure adequate sources of suitable soils for ET cover construction.

Appendix D presents available evaluation data of borrow source materials for soils necessary for final cover construction.

3. FINAL GRADING PLAN FOR DISPOSAL AREA “C”

3.1 General

The final grading design was revised in 1994 to account for the reduction of the final deck elevation of Disposal Area C from the permitted elevation of 1,770 ft msl to the final closure elevation of 1,600 ft (top deck elevation) and 1,425 ft at the toe of the slopes of Disposal Area “C.” The grading plan for Disposal Area “C” has not been affected by the proposed ET cover for closure of Disposal Area “C.” The final grading plan showing the proposed use of the ET cover for closure of Disposal Area “C” is shown in Figure 3-1 and Drawing No. 1 included in Appendix C of this report.

3.2 Deck of Disposal Area C

The final grading design for the deck of Disposal Area “C” remains unchanged from the 1996 FCP, maintaining the top deck elevation at 1,600 ft msl. The deck area of Disposal Area C has a minimum three percent and a maximum five percent grade. Surface water runoff from the deck of Disposal Surface Area “C” is directed to existing downchutes.

3.3 Slope Areas

The final grading design for the west facing slopes of Disposal Area “C” have approximately a 2H:1V (horizontal:vertical) slope with 18-ft (6-m) wide benches spaced about every 40 ft (12 m) in height.

The benches on the slopes of Disposal Area “C” will be graded and banked to convey surface water drainage along the back of the benches. The surface water runoff collected on the benches is directed to downchutes and/or channels which empty into the existing debris basins located to the south of Disposal Area “C.”

4. FINAL COVER STABILITY EVALUATION FOR DISPOSAL AREA “C”

4.1 Final Cover Slope Stability

Both one-dimensional (infinite slope) and two-dimensional slope stability analyses of the Disposal Area “C” final cover were performed. Slope stability evaluations for Disposal Area “C” were conducted to demonstrate the stability of the proposed ET cover for final closure of Disposal Area “C” at the LCSL. The one-dimensional slope stability analyses were performed by using the methodology suggested by Matasovic [1991]. The stability analyses performed in support of the slope stability evaluation are included in Appendix E of this report.

5. SURFACE WATER DRAINAGE DESIGN

5.1 General

The surface water drainage system design for Disposal Area “C” will not be affected by the use of the proposed ET cover for closure of Disposal Area “C.” The layout of the surface water drainage system is shown on Figure 3-1 and Drawing No. 1 of this report and is described in the following subsections. The total watershed area and the relative proportions of deck and slope areas are essentially unchanged; hence, the total surface water run-off is also essentially unchanged from that presented in the 2002 FCP. The various components of the revised surface water drainage system are essentially the same as those presented in the 2002 FCP. However, descriptions of the various surface water drainage system components are included herein for completeness.

5.2 Deck of Disposal Area “C”

The deck area of Disposal Area C was designed to direct surface water runoff to two downchute inlet structures located along the southwest perimeter of the deck. The inlet structures are connected to Downchutes Y and Z which will convey the surface water runoff to either the upper twin debris basin or the lower twin debris basin.

5.3 Slopes of Disposal Area “C”

Surface water runoff from the slopes of Disposal Area “C” is collected on benches where it is conveyed to either: (i) three Downchutes (X, Y, and Z) which lead to the upper and lower twin debris basins, respectively; or (ii) directly into the existing perimeter channel and into the upper twin debris basin.

5.4 Surface Water Drainage Controls

5.4.1 Benches

Surface water runoff from the finished slopes will be collected by approximately 18-ft (6-m) wide benches constructed along the face of the slope at approximately 40-ft (12-m) vertical intervals. The benches will be graded so that surface water runoff will drain to the heel of the bench and then to either: (i) inlet structures at the downchutes; (ii) the existing perimeter channel; or (iii) the existing Downchute AA located southeast of Disposal Area “C.”

5.4.2 Downchutes

The design of the downchutes for Disposal Area “C” will remain unchanged from design presented in the 2002 FCP. The downchutes will be constructed of either corrugated metal and/or corrugated polyethylene pipe. Downchutes will be anchored to the slope. Downchutes will be designed with "slip collars" to accommodate settlement and will be capable of withstanding the anticipated differential movement between the benches.

5.4.3 Inlet Structures

The design of the inlet structures will also remain unchanged from the design presented in the 2002 FCP. Inlet structures will be used to direct surface water runoff from the benches and decks of Disposal Area “C” to the downchutes. The inlet structures will include a metal grating to retain debris and concrete or asphalt bases to control erosion in the vicinity of the inlet structures.

6. REVISED CLOSURE COST ESTIMATE

6.1 General

This section presents revised cost estimate to reflect the ET cover proposed for closure of Disposal Area “C” at the LCSL. This estimate presented here supersedes the March 1999 cost estimate. The cost estimate presented in this section includes modifications related to the final cover design and final grading, LFG control system, irrigation system, and surface water drainage system (if any). In addition, the City of Los Angeles maintains a fully funded trust fund for the entire value of the closure cost estimate.

6.2 Cost Estimate

Table 6-1 presents a summary of costs for the main closure categories. The revised total cost estimate to complete closure implementation of Disposal Area “C” at the LCSL including 20 percent contingency is \$4,645,884 in 2008 dollars. This total cost includes modifications related to the final cover design and final grading, LFG control system, irrigation system, and surface water drainage system (if any) for Disposal Area “C”. Table 6-1 presents a summary of the closure cost estimate. Any cost overruns that result from this cost estimate will be paid by the City. An updated closure cost estimate is included in Appendix B of this report.

7. REVISED CLOSURE SCHEDULE

7.1 General

The updated closure implementation schedule presented in Figure 7-1 reflects the most current closure schedule as of July 2008.

7.2 Closure Process

Since the adoption of the latest Waste Discharge Requirement (WDR) Order No R4-2004-0176 which was last revised on 2 November 2004, the following closure-related activities at the LCSL have been accomplished:

- completion of the final closure of the deck and slopes of Disposal Area “A”;
- completion of the final closure of the deck and slopes of Disposal Area “B”;
- completion of the final closure of the deck of Disposal Area “AB+” and approximately 16% completion of the slopes of AB+; and
- completion of LFG system modifications and corresponding hydroseeding.

As of May 2008, the BOS estimates that closure of approximately 66 percent of the total disposal area at the LCSL has been completed. Final closure construction activities are currently in progress in the remaining slopes of Disposal Area “AB+.” Final closure construction activities are also planned for the decks and slopes of Disposal Area “C.”

The new proposed final closure completion date is December 2010. As shown on Figure 7-1, closure construction activities of the remaining slopes of Disposal Area “AB+” will continue through July 2009. Final cover construction activities for the deck of Disposal Area “C” are scheduled to be completed in February 2010. Final cover construction activities for the slopes of Disposal Area “C” are scheduled to be completed by December 2010.

LFG system modifications for the remaining slopes of Disposal Area “AB+” will be performed between July 2008 and July 2009, during preparation of the slopes for final cover placement. Additionally, borrow material will continue to be transported and stockpiled on site during construction of the final cover for closure of the remaining disposal areas, as necessary.

The BOS will document and periodically inform the RWQCB of closure construction progress and potential delays due to suitable soil availability for construction of the ET cover, unforeseen weather events, necessary maintenance operations, or staff shortages (if any). The BOS will update the closure construction schedule, as appropriate, and submit it to the RWQCB.

LFG control system modifications will begin before placement of the final cover begins and will be conducted in a manner that will reduce system downtime as much as possible. Landscaping and irrigation will be installed after final cover placement has been initiated. The estimated time for completion of the LFG control system is built into the schedule shown on Figure 7-1.

8. CERTIFICATION

This certifies that the documented titled, "Revision IV Volume IV of IV Replacement Amendment to Final Closure Plan Lopez Canyon Sanitary Landfill Lake View Terrace, California" has been prepared in accordance with final closure plan and post-closure maintenance plan requirements contained in 27 CCR. The material and data contained in this Revision to the Final Closure Plan were prepared under my supervision and direction. My seal as a registered professional engineer licensed in the State of California is affixed below.



Jeffery G. Dobrowolski, P.E.

TABLES

Table 2-1: Performance Comparison of Evapotranspirative Covers and Proposed Prescriptive Final Cover
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California

Criteria	Proposed Prescriptive Final Cover	Evapotranspirative (ET) Cover System
Infiltration Control (mm/ year)	Defects in geomembrane will affect infiltration performance, especially in depressions caused by settlement. Required to meet material specifications, but not subjected to performance criteria.	Designed to reduce percolation.
Cover Stability (specifically on slopes)	Higher probabilities of veneer type failures because of lower soil geomembrane interface shear resistance when used on slopes.	Reduces the potential for cover failure. ET cover can be installed on steeper slopes than geomembrane and generally provides a higher factor of safety against veneer failure.
Effect of Subsidence	Addition of vegetative layer to maintain grade in response due to settlement of waste will result in increase overburden load on top of geomembrane. Increased overburden load will cause concentrated loads over some section of the liner which could cause liner failure and will create a below-grade bowl that will hold moisture.	General repair works due to waste settlement are performed by adding soil to restore grade. The added soil will increase ET cover thickness which will improve the cover’s performance.
Performance in Seismic regions	Damages due to seismic activities in geomembrane covers may not be easily detected. Damaged sections of geomembrane are costly to repair. Uncertainties of repair work results.	Damages related to seismic activities are easily detected and repaired. ET covers can also be considered “self healing” if extend of damage is limited.
Landfill gas control and management	Geomembrane cover system traps LFG. If adequate LFG extraction and recovery system is not available, LFG could migrate horizontally and vertically and could impact groundwater and vadose zone. Installation of extraction wells require complicated installation of boots around the well to maintain cover integrity and allow for waste settlement. Gas pressure generated by trapped LFG could help trigger veneer slope stability failure.	ET covers do not significantly affect landfill gas dynamics. This reduces the potential for impacts to groundwater in vadose zone. LFG management systems such as gas extraction (wells) can be easily installed after construction of the ET cover.
Erosion Control	Typically, only a 1-ft vegetative layer is placed on top of geomembrane cover systems. Vegetation roots are designed not to exceed 1-ft depth; therefore, plant communities’ effect to reduce erosion is limited. This 1-ft vegetative layer could be eroded during adverse weather conditions.	Deeper rooted plant communities provide substantial erosion resistance. Typically ET covers range in thickness from 3 to 5 ft. This provides more resilience to erosion.
Burrowing Animals	Typically, only 1 ft of vegetation layer is placed on top the liner material. Rodents have a greater ability to reach the liner. Damage caused by rodents may not be easily detected or repaired.	Thicker covers. (Typically, ET covers range in thickness from 3 to 5 ft) and limit rodent contact with the refuse. Damage caused by rodents is easily repaired.
Material Availability	Liner material needs to be purchased from off-site sources.	ET covers are usually constructed from on site or nearby soil sources.
Constructability and Construction damage	Placement of vegetative layer on top of geomembrane is delicate and may cause puncture of geomembrane. Installation and/or construction related damages can greatly hinder the performance of a geomembrane cover system.	ET cover is easier to build than a multi-component geomembrane cover. No significant potential for construction or installation related damage.
Quality Assurance and Quality Control (QA/QC)	QA/QC is more complicated due to the presence of the geomembrane. QA/QC activities require to confirm material specification, check for manufacturing, construction, and installation-related damage, and confirm installation and seaming per construction specifications. QA/QC personal required to have experience in both soil and geosynthetic QA/QC. QA/QC activities require good control of field personal and equipment (i.e., shoe and tire type for field personnel and construction equipment, speed and turning radius).	QA/QC activities only needed to monitor material suitability, compaction requirements, and cover thickness – only soil experience required for QA/QC personnel.
Construction Cost	Cost data contained in the AFCEE landfill survey reveal that construction costs for typical barrier covers is much greater than the construction cost of an ET cover.	The AFCEE landfill survey reveals that construction costs saving for ET exceeds \$200,000 per acre of Landfill.
Operation & Maintenance Cost	Relatively higher O&M cost in part due to more frequent erosion repair due to low plant communities. Shallow-rooted vegetation (which is usually required on these covers) typically requires more care in the long term than deep-rooted vegetation.	The AFCEE estimates indicate that repairs and O&M cost on ET cover are approximately 60 to 65% lower than that of conventional barrier type covers.
Aesthetics	Shallow-rooted typically requires more care and are hard to establish, which could hinder the use of native plants to blend with the surrounding areas.	Use of natural plants increases the aesthetic appeal of the site, especially in the winter.
Regulatory Acceptance	Some RWQCB regions are reluctant to approve geomembrane covers even for lined landfills.	Gaining increasing regulatory acceptance.
Case Histories lined Landfill proposed or approved for an ET cover		Spadra Landfill, Bradley Landfill Monterey Peninsula Landfill, Kiefer Landfill, Altamont Landfill, and Phase I of the BENA Landfill.

Notes: (1) AFCEE: Air Force Center for Environmental Excellence.

**Table 2-2: Calculated Cumulative Annual Infiltration
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California**

Landfill Portion	Surface Area (acres)	Title 27 Prescriptive Cover	Infiltration through Title 27 Prescriptive Cover (cm/year)	Infiltration through Evapotranspirative Soil Cover (cm/yr)
Disposal Area C – Deck	21	Composite Cover with geomembrane	0.627	1.09
Disposal Area C – Slopes	21	Compacted Clay Cover	23.98	1.09
CUMULATIVE ANNUAL INFILTRATION (cm/year)			24.607	2.180

Table 2-3: Soil Borrow Sources
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California

Submittal Date	Availability Date	Borrow Source Location	Contractor/Trucking Company	Date Delivered to the Site	Expected Soil Quantities Available at Borrow Source (CY)	Actual Soil Quantities Delivered to the Site (CY)	Delivery Status	Availability of Soils Report (Yes/No)	Comments
6/19/2007	Dec 2007	8687 Melrose Ave, West Hollywood	Tejeda Trucking	5/5/08, 5/7/08,	75,000	5,000	Currently being delivered	Yes	
2/19/2008	6/1/2008	Wilshire and Robertson, Beverly Hills	Padilla's/Tejeda	6/4/2008-6/6, week of 6/9/2008	40,000	-	Currently being delivered	Yes	
9/17/2007	10/02/07	4043 to 4027.5 N. Radford St, Sudio City	Star Stone	start week of 10/8, sent to Toyon 10/31, 11/2, 11/5, cont Lopez 11/26-12/	55,000	10,000	Delivered	Yes	
	07/09/07	10497 Wilshire Bl, Westwood	Tejeda Trucking		50,000	40,000	Delivered	Yes	
11/15/2007	May-08	8900 Beverly Blvd/Swall Drive, West Hollywood	Tejeda Trucking	5/22/2008, 6/5/08	36,000	-	Not delivered	Yes	
10/11/2007	10/15/2007	1252 Harper st (Hollywood)	Ibex Group/StarStone	week of 10/15,week of 10/22, almost done as of 10/29,11/2, 11/6, 11/19,11/26 done	20,000	20,000	Delivered	Yes	
8/22/2007	8/29/2007	1804 10th st, Santa Monica	Padilla's Co	week of 9/10, week of 9/17	4,000	4,000	Delivered	Yes	
8/27/2007	Sep-07	5026-5030 Santa Monica Bl, 1042-1050 Mariposa Ave, Hollywood	Tejeda Trucking	cancelled because too many trucks	4,000	2,000	Delivered	Yes	
10/2/2007	10/3/2007	238-239 La Cienega Bl Los Angeles	Padilla's Co	10/3/07	8,000	8,000	Delivered	Yes	
10/4/2007	10/9/2007	11346 Iowa Ave, Los Angeles	Padilla's Co	10/9/07,10/15/07	9,000	9,000	Delivered	Yes	
10/11/2007		20227-20237 Saticoy st, Winetka	Padilla's Co	start 11/28,	14,000	2,000	Delivered	Yes	
5/10/07	7/17/2007	1550 6th St, Santa Monica (6th and Colorado)	Tejeda Trucking	week of 7/17/2007, week of 7/23/2007, week of 7/30/2007, 08/07/07	15,000	15,000	Delivered	Yes	
7/18/2007	7/25/2007	1700 Sawtelle Blvd, Los Angeles	Padilla's/ Tejeda	7/25/2007, 7/27/2007, week of 7/30, 8/6, 8/8-10, 8/13-15, 8/17,8/21-22, 9/13	7,000	7,000	Delivered	Yes	
11/2/2007	11/26/2007	18660 Ventura Blvd,	Sakaida and Sons	Jan 08-Mar 08,	150,000	40,000	Delivered	Yes	Remaining soil was sold to others

Table 2-3: Calculated Cumulative Annual Infiltration (Continued)
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California

Submittal Date	Availability Date	Borrow Source Location	Contractor/Trucking Company	Date Delivered to the Site	Expected Soil Quantities Available at Borrow Source (CY)	Actual Soil Quantities Delivered to the Site (CY)	Delivery Status	Availability of Soils Report (Yes/No)	Comments
		Tarzana		received at least 40k yds					
May-07	6/12/2007	1241 5th street, Santa Monica (5th and Arizona)	Tejeda Trucking	week of 6/12/07, week of 6/18/07	15,000	15,000	Delivered	yes	accepted as fill
May-07	6/12/2007	Burnett (Sepulveda and Nordhoff)	Star Stone, Inc	week of 6/12/2007, stopped as of 6/26	9,000	9,000	Delivered	no	accepted as fill
June-07	Jun-07	1029-1033 South Hobart blvd, Los Angeles	Star Stone, Inc	1 day	1,000	1,000	Delivered	yes	accepted as general fill
Total quantity of soils delivered to the site						170,000	Delivered	yes	
Total quantity of soils used for construction						45,000			Used for the construction of ET cover for Disposal Area “AB+”
Total quantity of soils stockpile						125,000			
3/26/2008	3/27/2008	4211 Redwood ave, Los Angeles, Mar Vista	Padilla's Co		15,500		Potentially upcoming	Yes	
6/19/2007	Sep-07	11663 - 11675 Wilshire Blvd/Barrington, Los Angeles	Tejeda Trucking		15,000		Potentially upcoming	Yes	
7/19/2007		12837-12851 Moorpark Ave, Studio City	Padilla's Co, Inc		20,000		Potentially upcoming	Yes	
05/05/07	7/1/2008	Paseo Plaza mixed-used development, 5601 Santa Monica bl, Los Angeles	Ibex Group? (Suffolk)		300,000		Potentially upcoming	Yes	
8/9/2007	Jun-08	1724-1744 Highland Ave/1741 N. Mccadden Pl, Hollywood	Tejeda Trucking		65,000		Potentially upcoming	Yes	
6/13/2008	Jul-08	964 N. Harvard Blvd, Los Angeles	Sakaida and Sons	7/14/2008	8,000		Potentially upcoming	Yes	
6/13/2008	Jun-08	3673 San Fernando Road, Glendale	Sakaida and Sons		20,000		Potentially upcoming	Yes	
6/27/2008	7/2/2008	623 Mountain Drive, Beverly Hills	Sakaida and Sons	week of 7/7/2008, 7/14/08	4,000		Potentially upcoming	Yes	
8/14/2007	8/20/2007	Burbank and Kester	Star Stone, Inc		5,000		Potential source	no	Need soils report, sample has roots.
8/27/2007	9/5/2007	900 San Pascual and Lake Ave, Pasadena	Reds Construction		90,000		Potential source		Need testing and soil report
9/5/2007	1 week	Wilshire Westwood: Wilshire blvd and Manning	Tejeda Trucking		30,000		Potential source	yes	will check

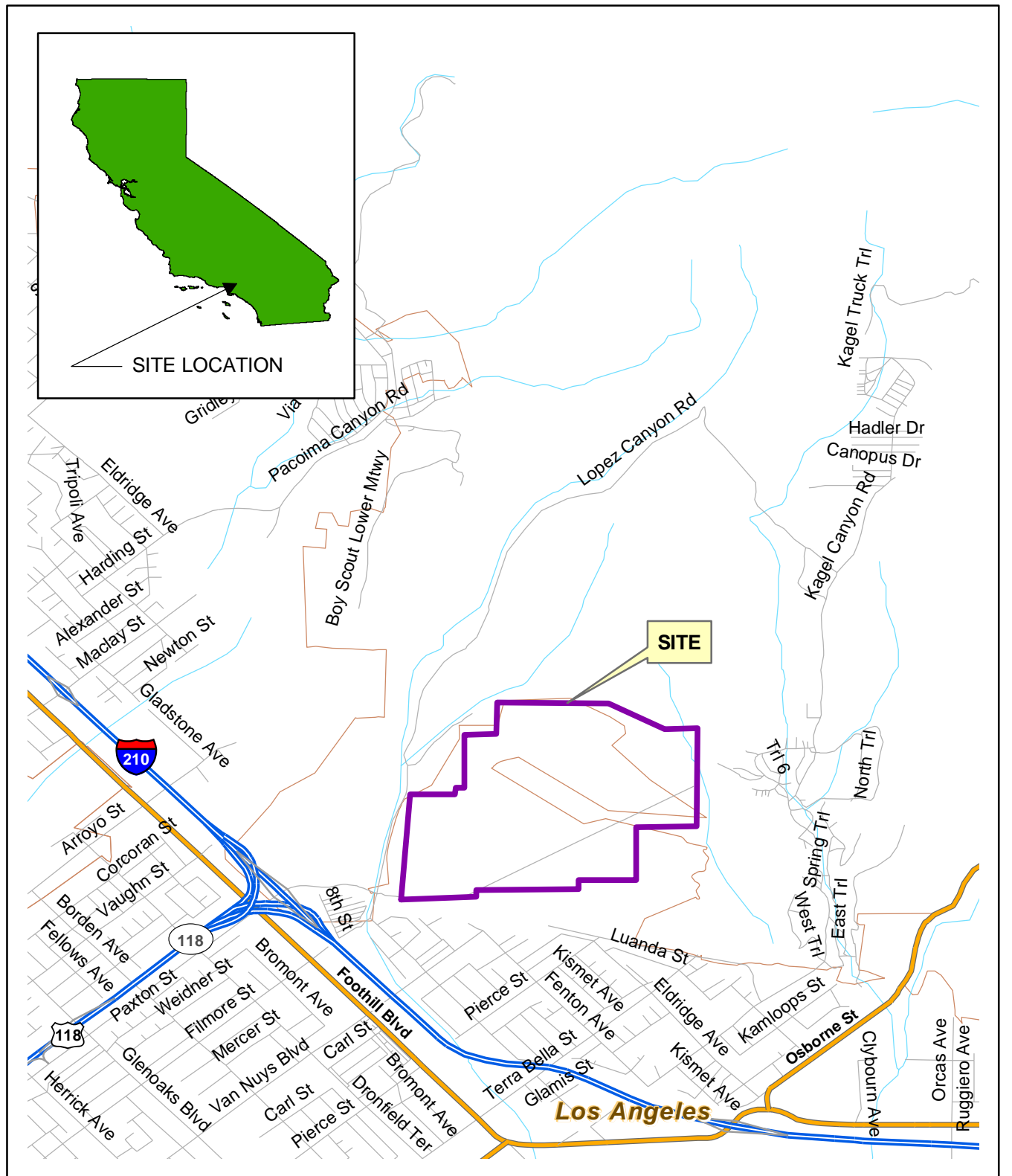
Table 2-3: Calculated Cumulative Annual Infiltration (Continued)
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California

Submittal Date	Availability Date	Borrow Source Location	Contractor/Trucking Company	Date Delivered to the Site	Expected Soil Quantities Available at Borrow Source (CY)	Actual Soil Quantities Delivered to the Site (CY)	Delivery Status	Availability of Soils Report (Yes/No)	Comments
		Ave							
9/11/2007		8950 Sunset Blvd, West Hollywood	Tejeda Trucking		30,000		Potential source	yes	
10/22/2007		North of Hollywood blvd and Highland ave	Ibex		100,000		Potential source	yes	half of the material is good for ET cover, can accept only have of the available material
2/19/2008		1730 N Highland Ave	Tejeda Trucking		106,000		Potential source		
11/29/2007		4741 Libbit Ave, Los Angeles	Tejeda Trucking		12,000		Potential source	yes	some gravel, rootlets
12/5/2007		Collins and Hazeltine, Van Nuys	Sakaida and Sons		8,000		Potential source	yes	mostly ML
12/26/2007		18425 W. Malden St.	Tejeda Trucking		10,000		Potential source	yes	
3/27/2008		4211 Redwood Ave, Los Angeles (Mar Vista)	Padilla's Co		155,000		Potential source	yes	
May-07	07/09/07	9618 Van Nuys Bl, Panorama city	Gates Ent.		18,000			yes	cancelled, potential fill
6/19/2007	8/1/2007	11150 W. La Maida st	Star Stone, Inc		13,000			yes	
7/3/2007	7/5/2007	Roxford and Glenoaks	Star Stone, Inc	7/5/2007	1,500			no	ok for fill
07/12/200	7/13/2007	Alvarado and Clinton	Star Stone, Inc	7/12-13/2007	1,500			no	ok for fill
7/23/2007	8/2/2007	Laurel Canyon and 101 freeway	Star Stone, Inc		9,000			no	silty sand, can be used for fill
7/23/2007	8/2/2007	Beverly Hills (need address)	Star Stone, Inc		5,000			no	Clayey sand, can be used for fill or possibly mixed to make mono cover
8/6/2007	8/7/2007	6716 Vineland Blvd, North Hollywood	Padilla's		20,000			yes	ok for fill
6/19/2007	7/16/2007	10878 W. Bloomfield st	Star Stone, Inc	7/19-20/2007, week of 7/23/2007, week of 7/30/2007	12,000			yes	Initially accepted as fill. Incoming fill dirt stopped on 8/2/07 ALL SAND, restarted after sample brought in 8/8-10 done.
7/16/2007	7/16/2007	St Andrews and Olympic	Star Stone, Inc	7/16/2007 - 8/13/2007	3,000			no	accepted as fill
9/6/2007		950 San Pasqual St, Pasadena	Southwestern Dirt Exchange		86,000			yes	Sample is testing as CL, 44.7%sand, 53.3%Silt-Clay, may request for deeper sample, can accept as fill
9/25/2007	Oct-07	Pierce College, Woodland Hills	Deconstruction Specialists Corp		3,000			yes	

**Table 6-1: Revised Summary of Closure Cost Estimate
Final Closure Plan Amendment
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California**

Closure Feature	Construction Cost	Status	Comments
Final Cover Construction for Deck of Disposal Area "C"	\$965,723	New estimated cost	Estimated based on total volume of 121,322 CY using \$5.19 procurement & \$2.77 placement
Final Cover Construction for Slopes of Disposal Area "C"	\$543,182	New estimated cost	Estimated based on total volume of 68,239 CY using \$5.19 procurement & \$2.77 placement
Drainage System Installation	\$611,685	No change in estimated cost	This is based on actual cost for areas that have been constructed and estimated cost for areas that has not been finalized or are in progress
Gas System Modifications	\$283,485	No change in estimated cost	This is based on actual cost for areas that have been constructed and estimated cost for areas that has not been finalized or are in progress
Construction Quality Assurance	\$287,973	No change in estimated cost	This is based on actual cost for areas that have been constructed and estimated cost for areas that has not been finalized or are in progress
Revegetation	\$ 504,710	No change in estimated cost	This is based on actual cost for areas that have been constructed and estimated cost for areas that has not been finalized or are in progress
Construction of Haul Road and Drainage Channel	\$258,360	No change in estimated cost	This is based on actual cost for areas that have been constructed and estimated cost for areas that has not been finalized or are in progress
Construction Management	\$416,452	No change in estimated cost	This is based on actual cost for areas that have been constructed and estimated cost for areas that has not been finalized or are in progress
Subtotal	\$3,871,570		
Contingency (20 percent)	\$774,314		
Total Closure Cost	\$4,645,884		

FIGURES



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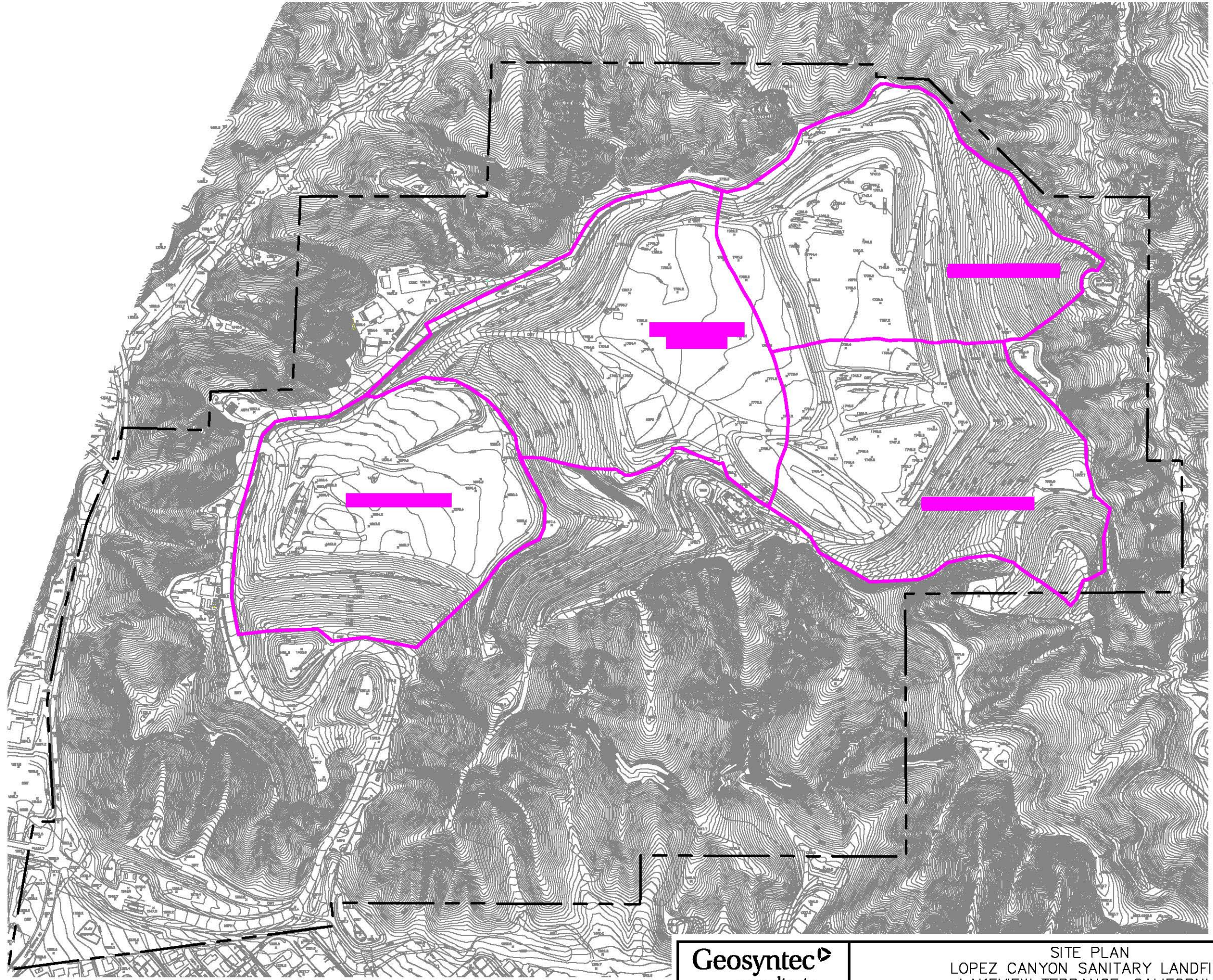


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Feet

**SITE LOCATION MAP
LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA**

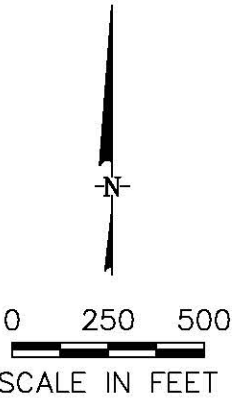
FIGURE NO.	1-1
PROJECT NO.	HL0800-18
DATE:	JULY 2008

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LEGEND

- LANDFILL BOUNDARY
- WASTE UNIT BOUNDARY

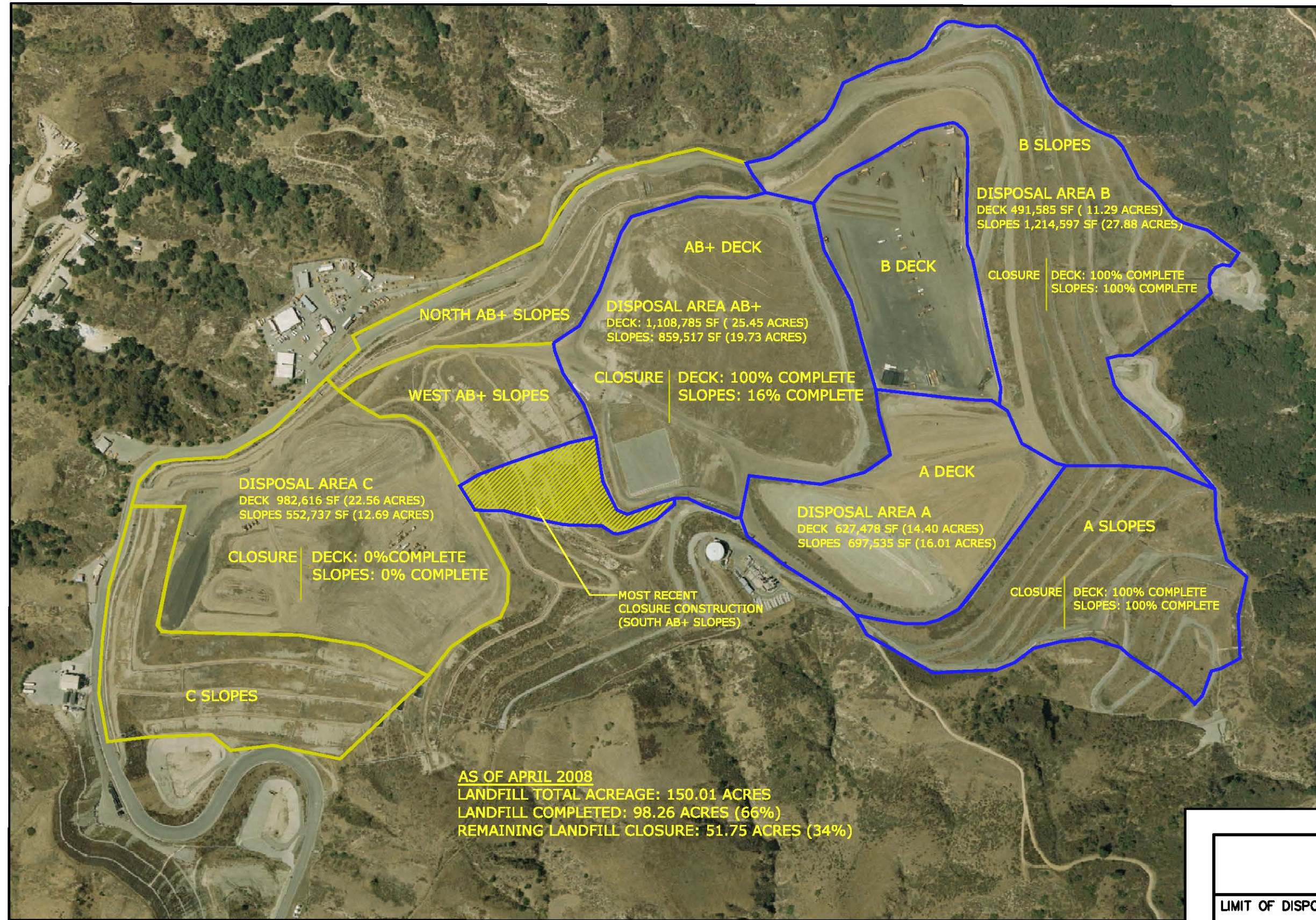


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SITE PLAN
LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRANCE, CALIFORNIA

FIGURE NO.	1-2
PROJECT NO.	HL0800-18
DATE:	JULY 2008

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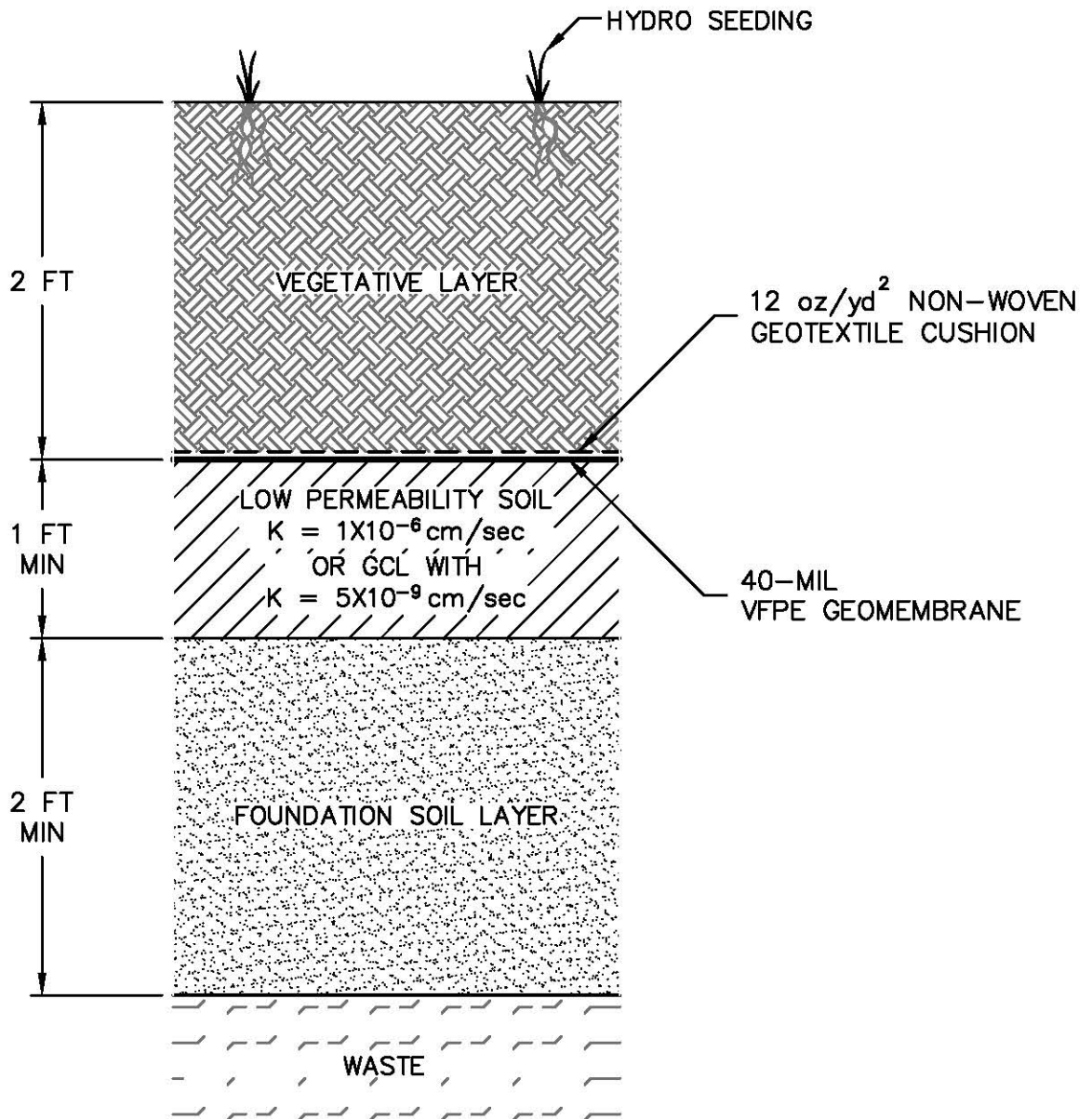
-  DISPOSAL AREAS WITH COMPLETED FINAL CLOSURE CONSTRUCTION
-  DISPOSAL AREAS WITH PLANED AND/OR IN-PROGRESS FINAL CLOSURE CONSTRUCTION
-  MOST RECENTLY COMPLETED FINAL CLOSURE CONSTRUCTION-SOUTH AB+ SLOPES



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LIMIT OF DISPOSAL AREAS AND FINAL CLOSURE COMPLETION STAGE
LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA

DATE:	JULY 2008	FILE NO.	0800F045
PROJECT NO.	HL0800-18	FIGURE NO.	1-3



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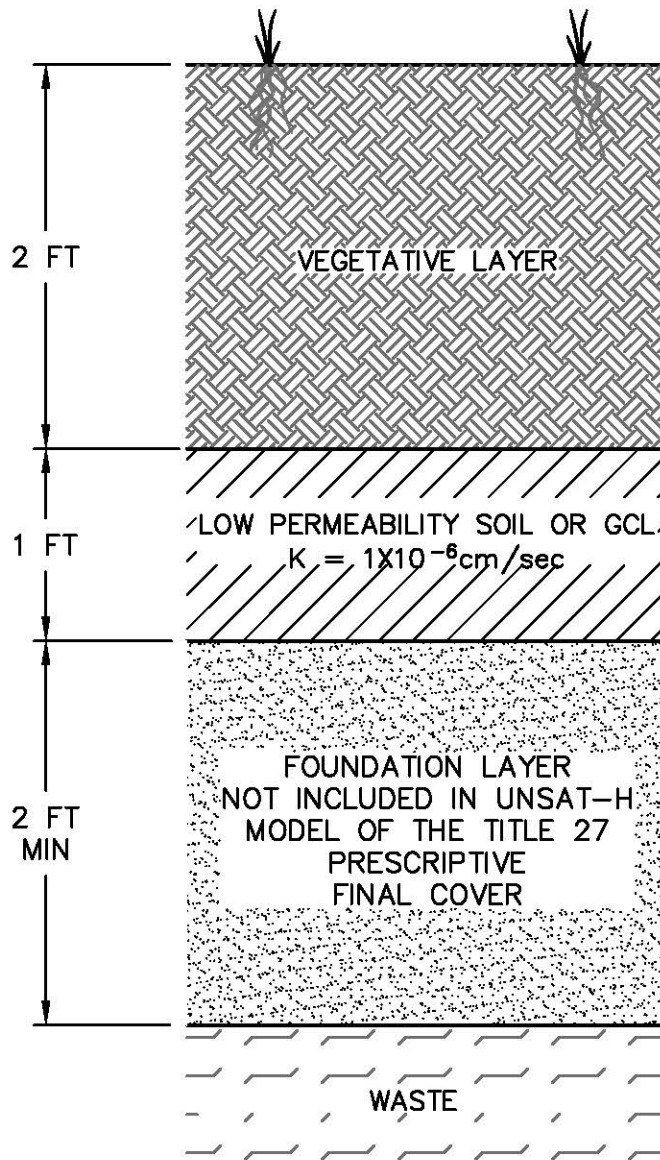


CITY OF LOS ANGELES
BUREAU OF SANITATION
LOS ANGELES, CALIFORNIA

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2002 FCP – PROPOSED TITLE 27
FINAL COVER FOR THE DECK OF
DISPOSAL AREA C
LOPEZ CANYON
SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA

FIGURE NO.	2-1
PROJECT NO.	HL0800-18
DATE:	JULY 2008



CITY OF LOS ANGELES
 BUREAU OF SANITATION
 LOS ANGELES, CALIFORNIA

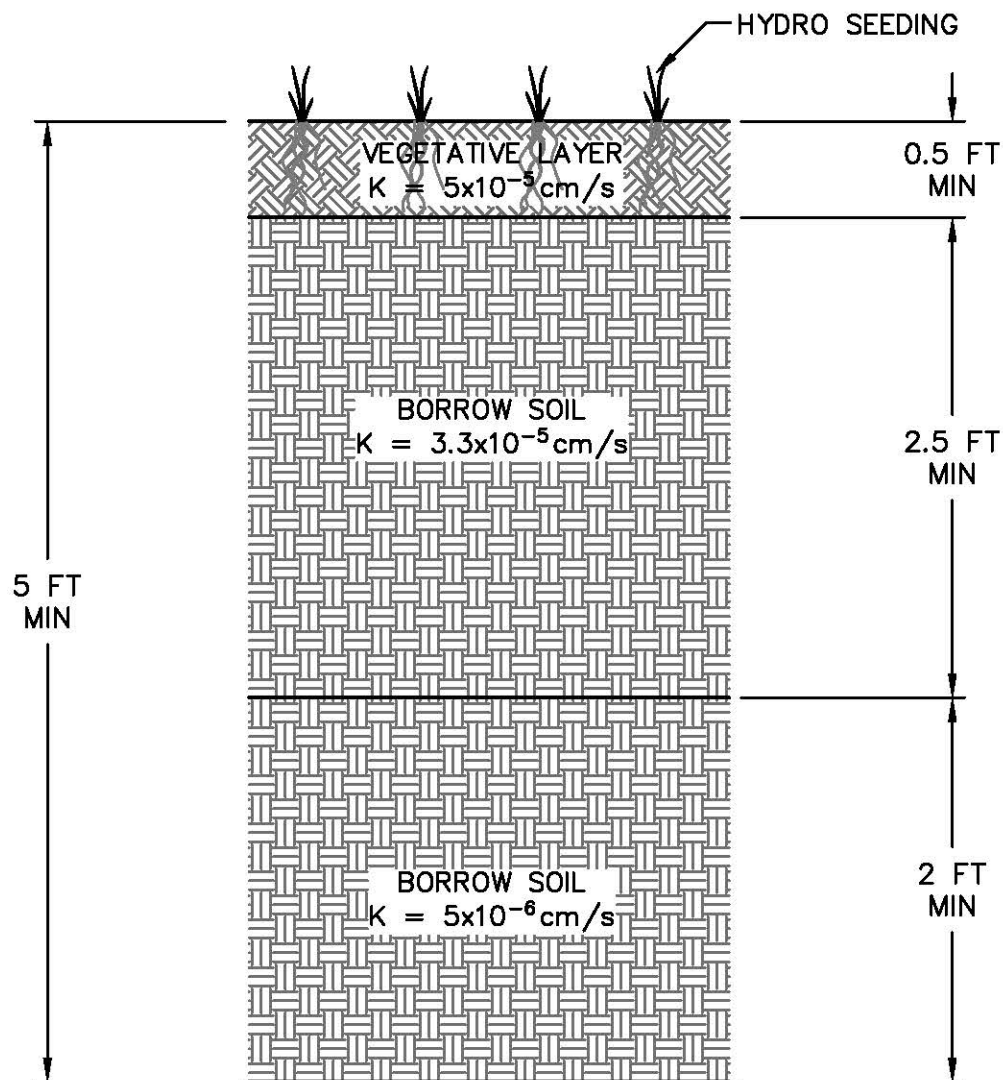
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2002 FCP – PROPOSED TITLE 27
 FINAL COVER FOR THE SLOPE OF
 DISPOSAL AREA C
 LOPEZ CANYON
 SANITARY LANDFILL
 LAKEVIEW TERRACE, CALIFORNIA

FIGURE NO. 2-2

PROJECT NO. HL0800-18

DATE: JULY 2008



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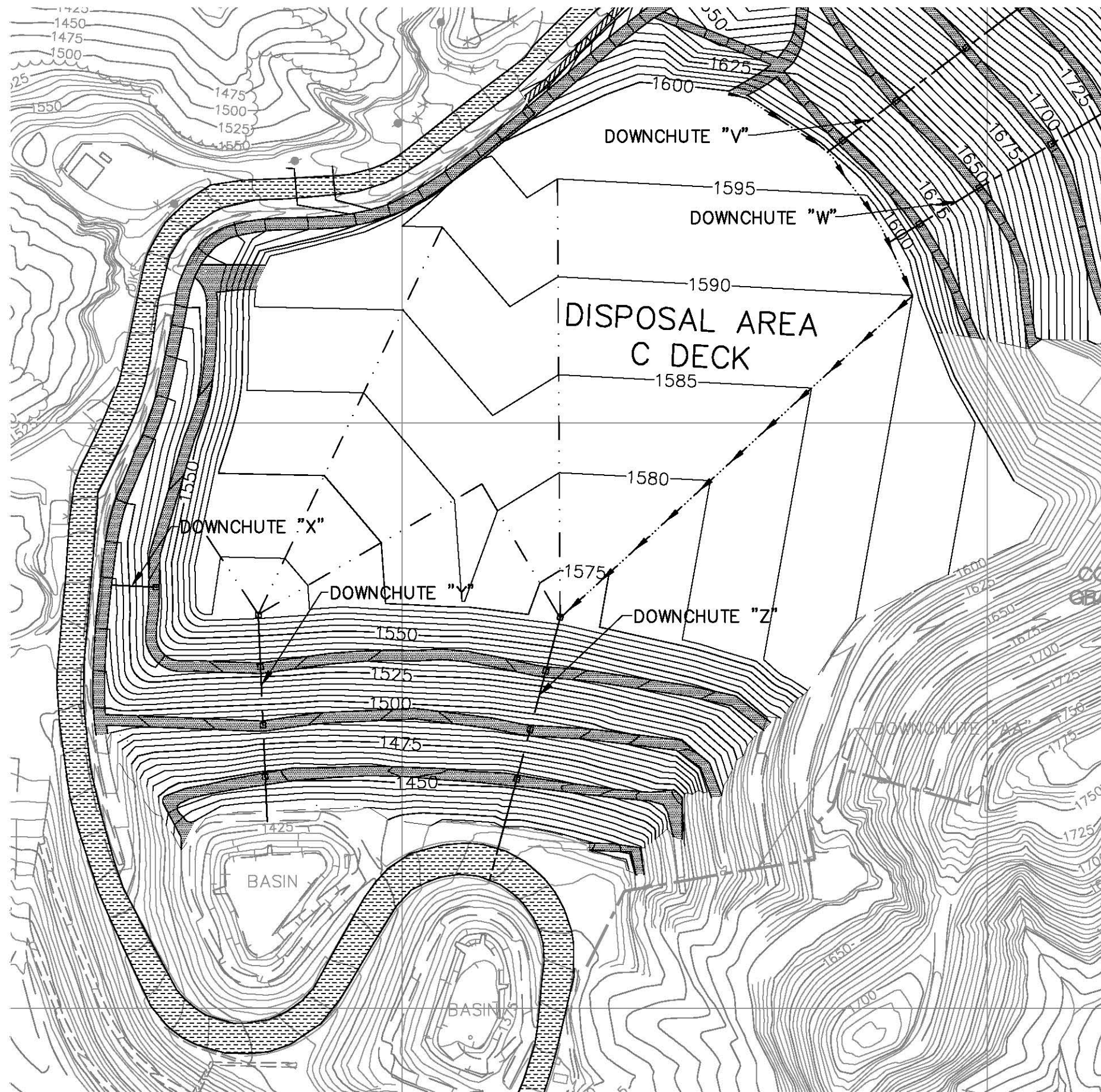
EVAPOTRANSPIRATIVE
 SOIL COVER CROSS-SECTION
 LOPEZ CANYON
 SANITARY LANDFILL
 LAKEVIEW TERRACE, CALIFORNIA

FIGURE NO. 2-3

PROJECT NO. HL0800-18

DATE: JULY 2008

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LEGEND

- 1725— EXISTING CONTOUR
- 1725— PROPOSED FINAL GRADE CONTOURS
- - - PROPOSED DOWNCHUTE
- - - EXISTING DOWNCHUTE
- PROPOSED DIVERSION CHANNEL
- - - FLOW LINE
- EXISTING ROAD / BENCH
- PROPOSED ROAD / BENCH
- ASPHALT ACCESS ROAD
- PERIMETER CHANNEL
- ASPHALTIC CONCRETE CHANNEL (NIC)
- PROPOSED INLET STRUCTURE
- - - LIMIT OF PHASE II CLOSURE

DISPOSAL AREA C

	MAXIMUM SLOPE	MINIMUM SLOPE
DECK	3.5%	3.0%
SLOPES	2.0:1	2.0:1
BENCHES	7.75%	2.9%

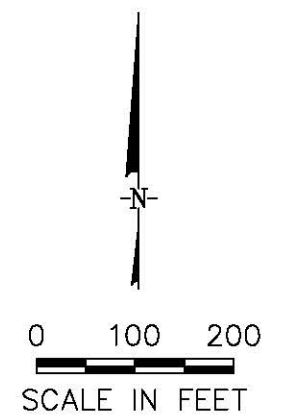
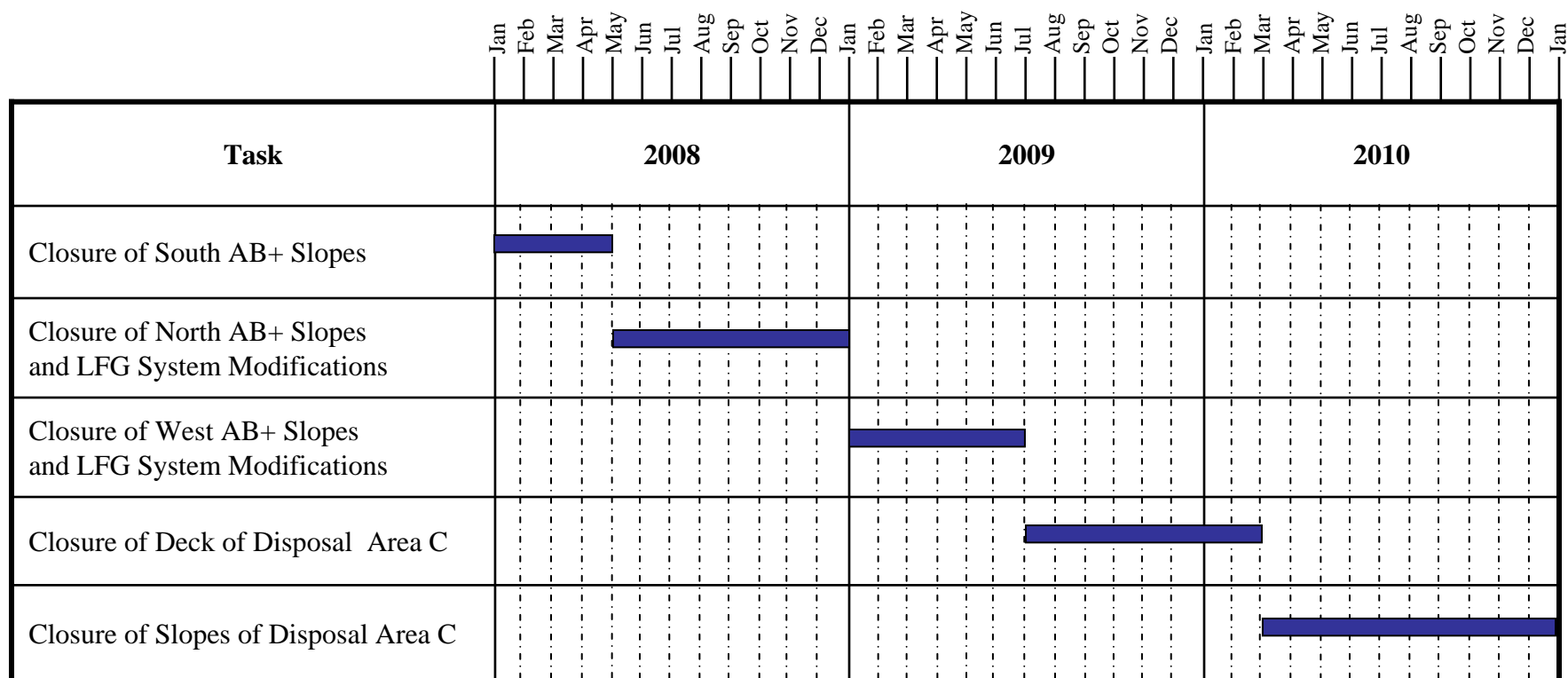


Figure 7-1
Proposed Revised Final Closure Completion Schedule
Lopez Canyon Sanitary Landfill
Lakeview Terrace, Torrance, California



APPENDIX A

WHITE PAPER –
ALTERNATIVE COVER FOR
DISPOSAL AREA “C”



Prepared for

**City of Los Angeles
Bureau of Sanitation**
Los Angeles, California

WHITE PAPER – ALTERNATIVE COVER FOR DISPOSAL AREA C

**LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA**

Prepared by

Geosyntec 
consultants

engineers | scientists | innovators

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Project Number HL0800-11

August 2007

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1. INTRODUCTION

1.1 Terms of Reference

This document was prepared to describe the merits of an evapotranspirative (ET) final soil cover as an alternative to the currently prescribed final cover for final closure of the deck and slopes of Disposal Area C at the Lopez Canyon Sanitary Landfill (LCSL) in Lake View Terrace, California. This document was prepared by Geosyntec Consultants (Geosyntec) at the request of the City of Los Angeles Bureau of Sanitation (BOS).

This document was prepared by Mr. Yonas B. Zemuy of Geosyntec and reviewed by Mr. Jeff Dobrowolski, P.E., and Dr. Bertrand Palmer, P.E., also of Geosyntec, in accordance with the review policy of the firm.

1.2 Site Location and Background

The LCSL is an inactive California Class III municipal solid waste landfill owned and operated by BOS. The LCSL is located in the Lake View Terrace section of the City of Los Angeles, as shown in Figure 1-1. The LCSL covers approximately 399 acres, of which approximately 162 acres have been used for landfilling. The landfill is divided into four Disposal Areas designated as Disposal Areas A, B, AB+, and C. Figure 1-2 shows the site topography, the landfill boundary, and the limits of the four disposal areas. The LCSL received waste from the mid-1970s until July 1996 and is currently undergoing closure.

Disposal Areas A, B, and AB+ were constructed and started accepting refuse prior to 1991 and are not lined. Disposal Area C, built in 1992, was designed and constructed with a composite liner to comply with Resource Conservation and Recovery Act (RCRA) Subtitle D.

The Final Closure Plan (FCP) and Post-Closure Maintenance Plan (PCMP) for the LCSL were first prepared in 1993 and 1994 and were subject to modifications and revisions, with the most recent revision dated in November 2002 [Geosyntec 2002c]. The FCP provides for closing the LCSL in two phases. Phase I includes closure of the slopes of Disposal Areas A and B and was completed in 2002. Phase II includes closure of the decks of Disposal Areas A, B, AB+, and C and the slopes of Disposal

Areas AB+ and C and is on-going. To date, Disposal Area B, the deck of Disposal Area AB+, and the slopes and deck of Disposal Area A have been closed. The closure of the slopes of Disposal Area AB+ is in progress. Figure 2-1 shows the limits of the four disposal areas and the stage of closure activities for each disposal area as of June 2007. The final cover has not yet been placed in Disposal Area C.

1.3 Objective

The currently approved design of the Disposal Area C cover is based on Subtitle D and Title 27 prescriptive requirements for lined landfills. The objective of the work presented in this technical report is to obtain approval of an alternative final cover, namely an ET final soil cover, for closure of Disposal Area C. This document provides the justification for approval of an ET final soil cover at Disposal Area C. The justification is based on an evaluation and comparison of the short- and long-term performance, durability, and reliability of the currently proposed prescriptive cover and the alternative ET final soil cover.

1.4 Report Organization

In addition to this introduction, this report contains the following sections:

- Section 2, *Background Information*, presents the historical background for the LCSL, summarizes the types of liners and cover systems that have been constructed, and discusses the proposed alternative final cover for Disposal Area C at the LCSL.
- Section 3, *Final Cover Design Basis*, summarizes the regulations in effect for design of the liner and cover systems at the LCSL.
- Section 4, *Cover Performance Comparison*, presents the cover evaluation criteria and describes the rationale for selecting an ET final soil cover as an alternative cover for use in Disposal Area C.

- Section 5, *Case Histories*, discusses cases where alternative final covers have been accepted or are proposed for lined waste cells at waste disposal landfills in California.
- Section 6, *Summary and Conclusions*, summarizes the work presented in the document and a set of conclusions supporting the installation of an ET final soil cover at Disposal Area C.

2. BACKGROUND INFORMATION

2.1 General

This section presents historical background information regarding the phasing implemented for the closure of the LCSL. This section also contains a brief description of the partial closure and final closure plans prepared in support of these closure activities. In addition, this section summarizes the existing liner systems for Disposal Areas A, B, AB+, and C. Finally, a description of the final cover systems that have been approved and/or constructed at the LCSL are presented in this section.

2.2 Historical Background

The LCSL has been operated by the BOS since 1975. Waste was accepted at the LCSL until July 1996. Closure construction started immediately upon cessation of waste acceptance. To facilitate closure of the LCSL, a closure plan that proposed a closure in two phases was developed by the BOS. Phase I included the slopes of Disposal Areas A and B, while Phase II included the top decks of Disposal Areas A, B, AB+, and C and the slopes of Disposal Areas AB+ and C. Phase I was completed in 2002, and Phase II closure is currently on-going.

A Partial Closure Plan, Volumes I through III (PCP) [BAS, 1993 I, II, and III], was submitted in January 1993, revised in April 1993, and approved by the RWQCB on 21 July 1993, by the Local Enforcement Agency (LEA) on 4 November 1993, and by the California Integrated Waste Management Board (CIWMB) on 16 December 1993. A first amendment to the PCP (Volume IV) was submitted in February 1994. The PCP and the amendment to the PCP constitute the four volumes (I through IV) of the Final Closure Plan (FCP).

Amendments and revisions to the FCP were submitted and approved by the regulatory agencies between 1994 and 2002. These amendments and revisions include the following:

- *Volume IV of IV Replacement Amendment* to the FCP was prepared in July 1996 to replace in whole the February 1994 Volume IV of IV of the FCP. The objective of this amendment was to incorporate into the FCP information

on the closure of the decks of Disposal Areas A and B and the deck and slopes of Disposal Areas AB+ and C sufficient to constitute an FCP for the entire landfill. This volume included revisions to the FCP necessitated by changes in the design of the landfill since submission of the FCP. These changes required revisions to the final cover design, final grading plan, post-closure settlement estimates, surface-water drainage controls, soil loss analysis, landfill gas (LFG) control system, landscaping and irrigation, closure cost estimate, closure implementation schedule, and final cover Construction Quality Assurance (CQA) Plan for the landfill.

- *Revision I to Volume IV of IV Replacement Amendment* to FCP was submitted to the CIWMB, RWQCB, and the LEA in March 1997 to address comments from the CIWMB and LEA prior to final regulatory approval of the FCP. Applicable sections of the amended FCP were revised to reflect these comments and were incorporated into the July 1996 document. Revised sections included the final cover design, LFG control system, closure cost estimate, final cover performance evaluation report, and CQA Plan.
- *Revision II to Volume IV of IV Replacement Amendment* to FCP was submitted on October 1998 [BOS, 1998d] as an additional revision of applicable sections to be incorporated into the March 1997-amended FCP to reflect a conditionally approved alternative final cover (i.e., an ET final soil cover) for a portion of the landfill. Revised sections include the final cover design, landscaping and irrigation, closure cost estimate, closure plan implementation schedule, and CQA Plan, with new appendices added to present the ET cover water balance analyses and the final cover performance evaluation.
- *Revision III to Volume IV of IV Replacement Amendment* to FCP was submitted on November 2002 [Geosyntec, 2002c]. The objective of this revision was to incorporate the construction of a green waste facility on top of the decks of Disposal Areas A and B (Figure 2-1). Revised sections include the final cover design based on the use of interlayered asphaltic cement concrete for the decks of Disposal Areas A and B and the approval of the alternative ET final soil cover on the slopes of Disposal Areas A and AB+.

The November 2002 version of the FCP is the current FCP and will be referenced in this report as the 2002 FCP.

The documents listed above provide a description of the liner system at each disposal area and the design of the constructed or proposed cover system at each disposal area. The following sections describe these liner and cover systems.

2.3 Existing Liner Systems

2.3.1 General

The liner system configurations installed at the base of Disposal Areas A, B, AB+, and C are summarized in Table 2-1 and described below.

2.3.2 Disposal Areas A, B, and AB+

Disposal Areas A, B, and AB+ were constructed and put into service prior to the promulgation of Subtitle D and Title 27. The base liner of Disposal Areas A, B, and AB+ consists of the local geologic formation.

2.3.3 Disposal Area C

Disposal Area C was constructed in 1992. Consequently, in accordance with Subtitle D regulations, Disposal Area C is lined with a composite liner system that incorporates a geomembrane liner. Disposal Area C is also equipped with a leachate collection and removal system, as described in Table 2-1.

2.4 Final Cover System

2.4.1 Approval of Alternative Covers

Final closure of the LCSL began in July 1996. As discussed previously, the FCP includes two phases of closure:

- Phase I: Closure of the slopes in Disposal Areas A and B; and

- Phase II: Closure of the decks of Disposal Areas A, B, AB+, and C and the slopes in Disposal Areas AB+ and C.

The original closure plans included the construction of a prescriptive final cover specified in Title 27 of the California Code of Regulations (the Title 27 prescriptive cover) for all disposal areas at the LCSL. Specifically, a final cover was required to include a low-permeability soil barrier for the unlined areas of the LCSL (slopes and decks of Disposal Areas A, B, and AB+) and constructing a final cover that includes a geomembrane overlying a low-permeability soil barrier for the lined area of the LCSL (slopes and deck of Disposal Area C). However, an engineering evaluation conducted by Geosyntec for Disposal Areas A, B, and AB+ [Geosyntec, 1998a,b] indicated that an ET final soil cover on the slopes and decks of Disposal Areas A and AB+ and partially on the deck of Disposal Area B would offer better performance and be more cost effective than the Title 27 prescriptive cover. Thus, BOS decided to proceed with construction of an ET final soil cover on these areas.

On 8 April 1998, BOS [BOS, 1998a] submitted an engineering evaluation demonstrating the superior performance of the ET final soil cover compared to the Title 27 prescriptive cover [Geosyntec, 1998a] to the RWQCB and requested their approval of the ET final soil cover on the decks of Disposal Areas A, B, and AB+ and the slopes of Disposal Areas A and AB+. Conditional approval of the ET final soil cover was formally granted on 23 July 1998 [RWQCB, 1998b]. The conditional requirement for final approval by the RWQCB of the ET final soil cover was monitoring and evaluation of the performance of the cover over a two-year period at three test stations. The objective of this performance monitoring was to calibrate and validate the theoretical water balance analyses used to demonstrate superior performance of the ET final soil cover compared to the Title 27 prescriptive cover. The performance monitoring program included [Geosyntec, 1998a]:

- installation and monitoring of three moisture monitoring stations (MMS) within the proposed ET final soil covers constructed on the slopes of Disposal Areas A and AB+ and on the deck of Disposal Area B to monitor east-facing and west-facing slopes as well as a deck at the maximum permitted elevation; and

- preparation of three reports for submission to the RWQCB for each MMS:
 - an installation report [Geosyntec, 2001];
 - a model calibration report [Geosyntec, 2002a]; and
 - a performance evaluation report [Geosyntec, 2002b].

The MMSs on the slopes of Disposal Areas A and AB+ were installed in May 1999 and November 1999, respectively. The two MMS were monitored for over two years, and the performance evaluation report for these two MMSs was submitted in October 2002. On 24 October 2002, the RWQCB gave unconditional approval of the ET final soil cover installed on the slopes of Disposal Areas A and AB+ and the ET final soil cover to be installed partially on the deck of Disposal Area B.

The third MMS was installed on the deck of Disposal Area AB+ in July 2004. The MMS was monitored for two years, and the data collected were used to prepare a calibration report [Geosyntec, 2006a] and a validation report [Geosyntec, 2007]. The calibration report was submitted to the regulatory agencies and indicated that the ET final soil cover behaved as expected. A performance evaluation report was submitted to the regulatory agencies on 16 April 2007 [Geosyntec, 2007]. The performance evaluation report confirmed the observations gathered during the calibration phase and the results of the monitoring program at Disposal Areas A and AB+ slopes, namely, that the ET final soil cover performs better in terms of infiltration control than the Title 27 prescriptive cover. On 5 July 2007, the RWQCB gave unconditional approval of the ET final soil cover installed on the deck of Disposal Area AB+.

2.4.2 Final Cover Designs

2.4.2.1 General

The final cover configurations approved and/or constructed and the approximate areas of Disposal Areas A, B, AB+, and C are summarized in Table 2-2. Details regarding the design and/or configuration of the final cover for each disposal area at the LCSL are presented in the following sections:

2.4.2.2 Slopes and Deck of Disposal Area A

The final cover for the slopes and deck of Disposal Area A consists of the existing interim soil cover, which consists of at least 6.5 ft (2 m) of silty sand or clayey sand with a hydraulic conductivity generally equal to 4.6×10^{-5} cm/s. It was successfully demonstrated [Geosyntec, 2002b] that the interim soil cover provided better percolation control than the Title 27 prescriptive cover.

2.4.2.3 Deck of Disposal Area B

Two different final cover configurations were approved and built for the deck of Disposal Area B. In the area of the deck to be occupied by the Green Waste Composting Facility (GWCF) (see Figure 2-1), an asphaltic cement concrete final cover was used.

The asphaltic cement concrete final cover includes the following components, from top to bottom:

- 3-in. (7.5-cm) thick Asphaltic Cement Concrete overlay;
- non-woven fabric geotextile;
- 40-mil (1-mm) thick tack coat;
- 3-in. (7.5-cm) thick Asphaltic Cement Concrete underlying pavement;
- 12-in. (30-cm) thick base course; and
- A minimum 1-ft (0.3-m) thick foundation layer of coarse soil.

Outside the GWCF, the final cover consists of a 3-ft (0.9-m) thick ET final soil cover overlying a 2-ft (0.6-m) thick (minimum) existing foundation layer.

2.4.2.4 Slopes of Disposal Area B

The approved final cover proposed in the 2002 FCP and built for the slope areas of Disposal Area B consists of the following components, from top to bottom:

- 24 in. (60-cm) thick (minimum) vegetative layer;

- 12-in. (30-cm) thick barrier layer of compacted low-permeability soil with a hydraulic conductivity no greater than 1×10^{-6} cm/s; and
- 24-in. (60-cm) thick foundation layer.

2.4.2.5 Slopes and Deck of Disposal Area AB+

The final cover in this area consists of a 3-ft (0.9-m) thick ET final soil cover overlying a 2-ft (0.6-m) thick (minimum) existing foundation layer.

2.4.2.6 Deck of Disposal Area C

The final cover currently proposed in the 2002 FCP for the deck area of Disposal Area C consists of the following components (from top to bottom):

- a 24-in. (60-cm) thick (minimum) vegetation layer;
- 12-oz/yd² (410-g/m²) non-woven geotextile cushion;
- 40-mil (1-mm) thick very-flexible polyethylene (VFPE) geomembrane (smooth on the deck areas and textured on the bench areas);
- 12-in. (30-cm) thick barrier layer of compacted low-permeability soil, with a hydraulic conductivity no greater than 1×10^{-6} cm/s, or a geosynthetic clay liner (GCL) with a hydraulic conductivity no greater than 5×10^{-9} cm/s; and
- a 24-in. (60-cm) thick foundation layer.

2.4.2.7 Disposal Area C Slope Areas

The final cover currently proposed in the 2002 FCP for the slope areas of the Disposal Area C consists of the following components (from top to bottom):

- a 24-in (60-cm) thick (minimum) vegetative layer;
- 12-in. (30-cm) thick barrier layer of compacted low-permeability soil with a hydraulic conductivity no greater than 1×10^{-6} cm/s; and

- 24-in. (60-cm) thick foundation soil layer.

The approved final cover designs for the decks and slopes of Disposal Area C discussed in the 2002 FCP will be collectively called, hereafter, the Title 27 prescriptive final cover (Title 27 PFC).

3. FINAL COVER DESIGN BASIS

3.1 Regulatory Background

3.1.1 General

The regulations for closure of Class III municipal solid waste (MSW) landfills in California are contained in Title 27 of the California Code of Regulations (CCR) and in the federal regulations (Subtitle D) adopted under Title 40, Code of Federal Regulations, Part 258 (40 CFR 258). In 1993, the State Water Resources Control Board (SWRCB) incorporated Subtitle D final cover system design and performance requirements into the California state regulations through SWRCB Resolution No. 93-62.

Both Subtitle D and Title 27 provide prescriptive cover designs for landfills based on the type of liner system, if any, that is installed. In addition to these prescriptive standards, both federal and state regulations allow for the consideration of alternative final cover designs provided it can be demonstrated that the proposed alternative designs meet or exceed either the established performance standards or the performance of the prescriptive standard.

3.1.2 Prescriptive Final Cover Performance Requirements

State of California regulations for design and construction of final covers for closure of municipal solid waste landfills are found in Title 27. Section 21090(a) of Title 27 [27 CCR 21090(a)] provides the following prescriptive requirements for the prescriptive final cover.

- (1) *Foundation Layer – Closed landfills shall be provided with not less than two feet of appropriate materials as a foundation layer for the final cover. These materials may be soil, contaminated soil, incinerator ash, or other waste materials, provided that such materials have appropriate engineering properties to be used for a foundation layer. The foundation layer shall be compacted to the maximum density obtainable at optimum moisture content using methods that are in accordance with accepted civil engineering practice. A lesser thickness may be allowed for Units if the*

RWQCB finds that differential settlement of waste and ultimate land use will not affect the structural integrity of the final cover.

- (2) *Low-Hydraulic-Conductivity Layer – In order to protect water quality by minimizing the generation of leachate and landfill gas, closed landfills shall be provided with a low-hydraulic-conductivity (or low through-flow rate) layer consisting of not less than one foot of soil containing no waste or leachate, that is placed on top of the foundation layer and compacted to attain a hydraulic conductivity of either 1×10^{-6} cm/s (i.e., 1 ft/yr) or less, or equal to the hydraulic conductivity of any bottom liner system or underlying natural geologic materials, whichever is less permeable, or another design which provides a correspondingly low through-flow rate throughout the post-closure maintenance period.*
- (3) *Erosion-Resistance Layer – The low-hydraulic-conductivity layer of ¶(a)(2) shall be directly overlain by an erosion-resistant layer, as follows.*
 - (A) *Closed landfills shall be provided with an uppermost cover layer consisting of either:*
 - 1. *Erosion-Resistance Via a Vegetative Layer – a vegetative layer consisting of not less than one foot of soil which:*
 - a. *contains no waste (including leachate);*
 - b. *is placed on top of all portions of the low-hydraulic-conductivity layer described in ¶(a)(2);*
 - c. *is capable of sustaining native, or other suitable, plant growth;*
 - d. *is initially planted – and is later replanted as needed to provide effective erosion resistance—with native or other suitable vegetation having a rooting depth not exceeding the depth to the top of the low-hydraulic conductivity layer described in ¶(a)(2).*

Regulations contained in 27 CCR 21090(a)(3) provide guidance on the materials that may be used in constructing the erosion control layer. Erosion resistance may be provided by constructing either a vegetative layer capable of sustaining plant growth or a mechanically erosion-resistant layer consisting of cobbles/gravel. The erosion-

resistant layer must be capable of resisting wind-scour, rainfall impact, and surface water runoff.

3.1.3 Alternative Final Cover Performance Standards

State regulations allow for consideration of engineered alternatives to the Title 27 prescriptive final cover. Criteria are provided for both RWQCB and California Integrated Waste Management Board (CIWMB) approval of an engineered alternative final cover. Sections 20080(b) and (c) of Title 27 provide the criteria for approval of an engineered alternative final cover by the RWQCB. These criteria, as outlined in Section 20080(b) and (c) of Title 27, are:

- (1) *the construction or prescriptive standard is not feasible as provided in ¶(c); and*
- (2) *there is a specific engineered alternative that:*
 - (A) *is consistent with the performance goal addressed by the particular construction or prescriptive standard; and*
 - (B) *affords equivalent protection against water quality impairment.*
 - (c) *Demonstration [for ¶(b)] – To establish that compliance with prescriptive standards in this subdivision is not feasible for the purposes of ¶(b), the discharger shall demonstrate that compliance with a prescriptive standard either:*
 - (1) *is unreasonably and unnecessarily burdensome and will cost substantially more than alternatives which meet the criteria in ¶(b); or*
 - (2) *is impractical and will not promote attainment of applicable performance standards.*

Regulations contained in 27 CCR 21140 provide criteria for CIWMB approval. This section allows for alternative final covers provided the design will function with minimum maintenance and provide waste containment to protect public health and safety by controlling, at a minimum, vectors, fire, odor, litter, and LFG migration. The alternative final cover shall also be compatible with post-closure land use.

3.2 Final Cover Design for Disposal Area C

3.2.1 Title 27 Prescriptive Final Cover

As summarized in Section 3.1.2, the prescriptive final cover must include a low-hydraulic conductivity layer with a hydraulic conductivity no less than that of the bottom liner system. Disposal Area C has a composite liner and a leachate collection system (Table 2-1). Therefore, the Title 27 PFC for Disposal Area C at the LCSL should also include a low-permeability barrier. The Title 27 PFC designs for the deck and slopes of Disposal Area C were presented in the 2002 FCP and are summarized in Sections 2.4.2.5 and 2.4.2.6, respectively.

3.2.2 Alternative Final Covers

3.2.2.1 General

Modifications to the FCP for the LCSL have been historically brought on by changes in post-closure development use, changes in regulations, and technological advances, namely:

- installation of a helipad on the deck of Disposal Area AB+ and construction of the GWCF on the deck of Disposal Area B;
- changes in regulations, including promulgation of Subtitle D and Title 27 at both the federal and state levels;
- a better understanding of the performance of ET final soil cover since the promulgation of current regulations nearly 20 years ago.

The FCP modifications include the use of ET final soil covers on the decks of Disposal Areas A and AB+ and the slopes of Disposal Areas A, B (partial), and AB+ (Sections 2.4.2.2, 2.4.2.3, 2.4.2.4, and 2.4.2.5 [Table 2-1]).

3.2.2.2 Disposal Area C

A Title 27 PCP is proposed for Disposal Area C in the 2002 FCP and is described in Section 2.4.2.6 (see Table 2-2) of this report. However, the BOS would like to use an ET final soil cover for the closure of Disposal Area C.

The remainder of this report presents a comparison of the performance of the Title 27 PFC proposed for final closure of Disposal Area C in the 2002 FCP and the proposed alternative final cover (i.e., an ET final soil cover). The following section presents a detailed discussion of the criteria used to compare the overall performance of both cover types.

4. COVER PERFORMANCE COMPARISON

4.1 General

In this section, the proposed ET final soil cover for Disposal Area C and the Title 27 PFC described in the 2002 FCP for Disposal Area C are compared with respect to the following criteria:

- a. Cover performance:
 - 1. infiltration control;
 - 2. cover slope stability;
 - 3. effect of subsidence;
 - 4. seismic activity response;
 - 5. LFG control;
 - 6. erosion control; and
 - 7. effect of burrowing animals.
- b. Construction considerations:
 - 1. material availability;
 - 2. constructability; and
 - 3. quality assurance and quality control (QA/QC)
- c. Cost;
- d. Post-closure use;
- e. Aesthetics;
- f. Regulatory acceptance (discussed in Section 3); and
- g. Case histories (discussed in Section 5).

The following sections present a detailed comparison of the Title 27 PFC and the proposed ET final soil cover for the LCSL for each of the criteria listed above. Table 4-1 contains a summary of this comparison.

4.2 Cover Performance

4.2.1 Infiltration Control

Regulatory criteria for acceptance of alternative final covers were discussed in Section 3.1.3 of this report. One criterion is that the alternative final cover must provide equal or better infiltration control than the Title 27 PFC (see Section 20080(b)2A of Title 27). The ability of both covers to control infiltration was evaluated by performing a water balance analysis of the covers when subjected to precipitation over time. The water balance equation was solved to evaluate how the amount of precipitation that falls onto the cover is partitioned into amounts that run off and infiltrate. The amount that infiltrates is further separated into amounts that evaporate from the cover surface, transpire through vegetation, remain in the soil matrix (storage), and percolate from the bottom of the cover. The water balance equation is as follows:

$$\text{PRC} = \text{P} - \text{OF} - \Delta\text{S} - (\text{E} + \text{T}) \quad (\text{Equation 1})$$

where:

PRC	=	percolation through the bottom of the cover
P	=	precipitation
OF	=	overland flow
ΔS	=	changes in soil moisture storage
E	=	evaporation
T	=	transpiration

Percolation through the cover is, therefore, the amount of water that infiltrated (i.e., the amount of precipitation that did not run off) the cover, but did not evaporate, transpire, or remain within the soil matrix. Percolation is the parameter evaluated to assess the degree of infiltration control provided by the final cover. Therefore:

- percolation through an earthen cover, such as the proposed ET final soil cover, is governed by the evapotranspiration potential, the storage capacity of the soil, and the run-off potential;

- percolation through the compacted low-permeability soil cover (i.e., the cover proposed in the 2002 FCP for the slopes of Disposal Area C) is governed by the barrier layer's ability to provide a low through-flow rate; and
- percolation through a cover that includes a geomembrane is governed by the leakage that may occur through the geomembrane due the presence of defects.

A water balance analysis, as coded in the UNSAT-H Version 3.0 [Fayer, 2000] computer program, was used to evaluate and compare the percolation performance of the ET final soil cover and the Title 27 PFC. UNSAT-H employs a finite difference algorithm to model one-dimensional unsaturated flow in soils and solve the water balance equation. The analyses were conducted by using 10 years of daily weather data from nearby weather stations. It is assumed that soil properties similar to that of the soil material used for the construction of the ET final soil cover in Disposal Area AB+ will be used to construct the ET final soil cover in Disposal Area C. Therefore, the analysis uses the same hydraulic soil parameters and vegetation data used in the analysis of the ET cover for the deck of Disposal Area AB+. The cross section of the ET final soil cover analyzed is shown in Figure 4-1.

Values for the dimensions of the defects and their frequencies per acre for the geomembrane included in the deck of Disposal Area C were based on those commonly used in landfill design, [Bonaparte et al 1989], [Giroud et al, 1989a, [Giroud et al 1989b], and [Giroud et al, 1992]. Percolation values through the defects are estimated by using the Giroud equation [Giroud et al., 1992]. Typical cross sections of the Title 27 PFC proposed in the 2002 FCP for the deck and slopes of Disposal Area C are shown in Figures 4-2 and 4-3 of this report.

The results of this cumulative water balance analysis for the Title 27 PFC and the proposed ET final soil cover for Disposal Area C are shown in Table 4-2. For each analyzed portion of Disposal Area C, the following data is listed: the total area; the Title 27 PFC cover; the annual infiltration through the Title 27 PFC; and the annual infiltration through the proposed ET final soil cover. The cumulative annual infiltration for each cover system is summarized at the bottom of the table. The results of the evaluation show that the cumulative annual infiltration for the Title 27 PFC for Disposal Area C described in the 2002 FCP is approximately ten times greater than the

cumulative annual infiltration for the ET final soil cover. UNSAT-H input and output files are presented in Appendix A of this report.

4.2.2 Cover Stability

A key factor in the final cover selection criteria at the LCSL deals with the stability of the cover under static and seismic loading. The cover stability issues discussed in this section are based on the concept of the infinite slope analysis, also commonly called “veneer” stability analysis, to evaluate the stability of the cover system. Landfill cover stability evaluations are performed by using the closed form equations developed for infinite slope methodology [Matasovic, 1991].

For a slope stability analysis of ET final covers, it is assumed that the slip critical plane will pass through the bottom of the cover (i.e., through the interface between the ET final cover and the existing interim cover). For a stability analysis of a final cover system that incorporates geosynthetics, the critical slip plane is selected by comparing the shearing resistance of the final cover materials and the interface.

Given the Title 27 PFC configurations for Disposal Area C in the 2002 FCP for the LCSL and the proposed ET final soil cover, there are no apparent cover stability issues at the LCSL for either cover system.

4.2.3 Effect of Subsidence

Landfills undergo significant settlement during operation and following closure. Settlement is a result of waste compression and decomposition. The expected total settlement for the LCSL has been estimated to be in excess of 30% of waste thickness over a 50-year period [Geosyntec, 1998b]. For Disposal Area C, this translates into settlement on the order of approximately 50 ft (15.2 m) over a 50-year period, or an average annual settlement on the order of approximately 1 ft (0.3 m).

Localized differential settlement might have a significant effect on the final cover. The differential settlement is a typical result of two factors: the variations in the waste thickness; and the heterogeneous composition of waste. Due to the highly heterogeneous composition of municipal solid waste, such as that placed at the LCSL,

localized differential settlement could be significant. Differential settlement might create depressions and a loss of positive drainage on the top deck.

The potential problems associated with differential settlement of the Title 27 PFC for Disposal Area C include accumulation of water in depressions and strains in the geomembrane. Differential settlement at landfills is addressed periodically to maintain positive surface water drainage. Differential settlement repair work is performed by filling the depression zone with compacted soil to the top of the final cover. The additional weight induced by the added soil could further increase the accumulation of strain in the geomembrane and the further development of differential settlements. Each of these problems, if developed, could reduce the final cover functionality and increase water percolation into the waste mass. The zone of the geomembrane under increasing strain is potentially more susceptible to the development of defects and the accumulation of water.

On the other hand, the additional soil placed during the maintenance work due to waste differential settlement for the ET final soil cover will increase the thickness of the ET cover which, in turn, could increase the performance of the ET cover.

4.2.4 Seismic Activity Response

The basis of the seismic stability criteria is that some limited deformation may result from the design earthquake after a seismic event and that the resulting damage should not jeopardize the overall cover performance.

Damage related to seismic activities in ET final soil covers can easily be detected and repaired. Minor damage may also be considered “self healing” and would have little effect, if any, on the performance of the ET cover.

On the other hand, visual inspection of the integrity of a final cover system that incorporates geosynthetics and/or a compacted low-permeability soil barrier is more difficult due to the presence of at least 1 ft (0.3 m) of vegetative soil cover over the infiltration barrier layer. Undetected/unrepaired damaged sections of the barrier layer may lead to an increase in the amount of percolation through the cover. In addition, even if damaged final cover barrier sections of the geomembrane are identified and

repaired, the inspection and repair process would be more expensive than repairing an ET final cover.

Hence, the performance of the proposed ET final soil cover for Disposal Area C with respect to damage induced by seismic activity is greater than that of the Title 27 PFC for Disposal Area C discussed in the 2002 FCP.

4.2.5 Landfill Gas Control and Management

Landfill gas (LFG) control is an important aspect of active and closed landfill management. LFG control and recovery systems installed and operated during the active life of the landfill may be upset when the landfill is closed and a final cover is installed on the landfill. ET covers do not contain a low-permeability layer that might trap LFG. ET covers typically do not significantly affect LFG dynamics and allow some LFG venting. This reduces the potential for impact to groundwater in the vadose zone. In contrast, landfill final covers with a geomembrane barrier trap LFG. If LFG is trapped underneath the geomembrane barrier, LFG pressure beneath the geomembrane barrier could increase. If LFG pressure beneath the geomembrane barrier is not adequately controlled by a gas venting layer or LFG extraction wells, gas pressure could build up, thereby decreasing the factor of safety for slope stability. Lower slope stability could trigger veneer slope stability failure. If an adequate LFG extraction and recovery system is not available in geomembrane covers, LFG could migrate horizontally and vertically, which could impact groundwater and the vadose zone.

If necessary, the capacity of an LFG control and management system in an ET cover can easily be increased by installing new gas extraction wells even after construction of the ET final soil cover. However, installation of LFG extraction wells in final covers with geomembrane requires complicated installation of boots around the wells to maintain cover integrity and allow for waste settlement. Therefore, the performance of an ET final cover with respect to LFG control and management is considered superior to that of the Title 27 PFC for Disposal Area C.

4.2.6 Erosion Control

Vegetation sustainability on the final cover is important for landfill closure. Areas with poor or no vegetation will have increased erosion, releasing more fine soil particles into the air and water and requiring more maintenance work.

ET final soil covers can support plants with deeper roots and, therefore, increased sustainability in the arid Southern California climate. Vegetation is planted on the ET final soil cover for two reasons: (i) to remove water from the cover by transpiration; and (ii) to reduce the potential for soil erosion. The soil available for plant roots in the ET final soil cover system is significantly thicker than that available in the cover systems that incorporate barrier geomembrane (which typically include approximately 1 to 2 ft (0.3 to 0.6 m) of vegetative soil layer placed on top of the geomembrane). Hence, the vegetation roots are designed not to exceed 1- to 2-ft (0.3- to 0.6-m) depth in composite covers with geomembrane. The limited root depth of the plant communities reduces their effect to limit erosion.

4.2.7 Burrowing Animals

Animal intrusion can create holes in the final cover, which can increase water flow into the landfill through the holes, increase LFG emission from the landfill, or concentrate storm-water flows that can cause progressive erosion. Animal intrusion is typically a problem near populations of burrowing animals.

The proposed thickness of the ET final soil cover for Disposal Area C is 5 ft [1.5 m]. Such thickness offers protection from animal intrusion and limits the potential of animal contact with waste. Furthermore, damage caused by burrowing animals can be repaired relatively easily and less costly on ET final soil covers compared to the cost and complexity of repairing buried geomembrane layers. Finally, damage caused by burrowing animals, such as rodents, to the geomembrane cover system may not be easily detected. If detected, repair work on damaged geomembrane sections can also be costly.

4.3 Construction Considerations

4.3.1 Material Availability

Materials available for the construction of ET final soil covers at the LCSL primarily consist of suitable on-site or imported soils that meet the technical specifications for the construction of an ET final soil cover for Disposal Area C. Soil materials that meet the technical specifications for the construction of an ET final soil cover are typically readily available from on-site and nearby off-site sources. The availability of the soil material translates into ease of construction and reduction in cost and material transportation-related impacts to the environment.

Construction materials required for the construction of the Title 27 PFC for Disposal Area C include a geomembrane layer for the deck of Disposal Area C and a low-permeability soil layer for the slope of Disposal Area C. The geomembrane materials are purchased from a geosynthetic manufacturer. Low-permeability soil required for the construction of the Title 27 PFC for the slopes of Disposal Area C are also usually purchased and transported from an off-site source. Purchasing and transporting of the geomembrane and low-permeability soil material increases the overall construction cost and requires special handling during transportation and on-site storage; thus, adding additional complexity and cost to the construction work. Therefore, an ET final soil cover for Disposal Area C is considered more efficient and cost effective from a material standpoint.

4.3.2 Constructability

An important key consideration in designing landfill final cover systems is constructability.

Construction of the Title 27 PFC described in the 2002 FCP for Disposal Area C involves the construction and placement of a low-permeability soil layer for the slopes of Disposal Area C per the design specifications and deployment of a geomembrane layer for the deck of Disposal Area C. The placement of the low-permeability soil, the deployment of geomembrane on a slope, and the placement of a vegetative/erosion control layer require significant construction skills.

Constructability considerations for the Title 27 PFC for Disposal Area C also include the placement of a vegetative layer on top of the geomembrane. The placement of the vegetative soil layer on top of the geomembrane is a delicate operation and may cause puncture to the geomembrane and could potentially result in installation and/or construction-related damage that could greatly hinder the performance of a geomembrane cover system. Additionally, the placement of vegetative soil layer on top of geomembrane on the slope section of the LCSL can be cumbersome due to the low-interface soil-geomembrane friction values.

On the other hand, ET final soil cover systems are easier to place because ET final soil covers consist of one soil type and can be placed in thicker lifts than that of the Title 27 PFC layers. Therefore, the construction and placement of an ET final soil cover are considered to be significantly easier than that of a multi-component geomembrane cover.

4.3.3 Quality Assurance and Quality Control

A construction quality control (QC) and construction quality assurance (QA) plan that satisfies the requirements established in Title 27 and Subtitle D is required to be implemented during the construction of landfill final cover systems.

QA/QC activities for ET final soil cover systems are only needed to verify material suitability, compaction requirements, and cover thickness. QA/QC personnel with good soil experience are required to oversee the implementation of the QA/QC program for ET final soil cover construction.

QA/QC activities for Title 27 PFC systems described in the 2002 FCP for Disposal Area C are required to confirm material specification, check for manufacturing, construction, and installation-related damage, and confirm installation and seaming per construction specifications. The most intensive QA/QC work for Title 27 PFC system construction is monitoring the deployment of the geomembrane component. Strict QA/QC programs need to be followed to reduce construction-related defects and ensure proper installation. QA/QC personnel are required to have experience in both soil and geosynthetic QA/QC. QA/QC activities for a Title 27 PFC system require good control of field personnel and equipment (e.g., shoe and tire type for field personnel and construction equipment, vehicle speed and turning radius).

Therefore, QC/QA programs for ET cover systems are considered relatively less complex and less costly than for a Title 27 PFC.

4.4 Cost

4.4.1 Construction Cost

Construction costs for ET final soil covers are generally lower than those for the Title 27 PFC systems proposed for Disposal Area C in the 2002 FCP for a number of reasons, including material, construction, and QA/QC costs. QA/QC requirements associated with the construction of a Title 27 PFC system are usually greater than for ET final soil covers. For example, strict construction equipment, geomembrane deployment methods, welding procedures of geomembrane panels, and even workers' shoe types are typically highly monitored and enforced. However, for an ET final soil cover consisting of a single vegetated soil layer, only soil type and placement requirements are monitored.

Cost data contained in the Air Force Center for Environmental Excellence (AFCEE) landfill survey reveal that construction costs for conventional covers (i.e., a Title 27 PFC) constructed on eight landfills ranged from \$319,000 to \$571,000 per acre of landfill and that using an ET final soil cover rather than a conventional barrier-type cover resulted in potential construction cost savings exceeding \$200,000 per acre of cover [Hauser et al., 2001].

Therefore, the construction cost of ET final soil covers at the LCSL will likely be much less than that for a Title 27 PFC system proposed in the 2002 FCP for Disposal Area C at the LCSL.

4.4.2 Operation and Maintenance Cost

Regular maintenance of the landfill final cover will be ongoing for the foreseeable future after completion of closure construction work. As previously stated, settlement may continue for up to 50 years or more, requiring regular maintenance to maintain a positive grade on the cover. The final cover configuration should satisfy the regulatory requirements, but also allow for simple and cost-effective maintenance. The Title 27 PFC proposed for Disposal Area C requires relatively higher operation and maintenance

(O&M) costs in part due to more frequent anticipated erosion repairs due to low-density plant communities and shallow-rooted vegetation (which are usually required on the Title 27 PFC). The AFCEE estimates indicate that O&M costs of ET final soil covers are approximately 60 to 65% lower than that of conventional barrier-type covers [Hauser et al., 2001].

In addition, to facilitate long-term final cover maintenance for Disposal Area C in part and for the LCSL, it would be preferable to use similar final cover configurations. Currently, approximately 65 percent of the total site is already covered with soil-only final covers (ET final soil cover – 55 percent; compacted clay cover – 10 percent). The area currently designated to be covered with a composite cover, the deck of Disposal Area C, comprises approximately 13 percent of the site. If an ET final soil cover was used for Disposal Area C, almost the entire landfill would be covered with soil-only final covers. This would improve the maintainability of the site and could, significantly, reduce post-closure maintenance cost.

4.5 Aesthetics

As already stated, the use of plant communities in ET final soil covers is highly encouraged. In fact, the use of plant communities is an integral part of the ET final soil cover's functionality. The use of native plants increases the aesthetic appeal of the site and could make the site blend with the surrounding area, decreasing the immediate site visibility to the general public.

In contrast, the Title 27 PFC system currently designated to be used for the deck of Disposal Area C is typically designed to accommodate shallow-rooted plants. These types of plants are, generally, hard to establish and typically require more care, which could hinder the use of native plants to blend with the surrounding areas. This, in turn, reduces the site's aesthetic appeal.

5. CASE HISTORIES

5.1 General

This section presents information on the design and field performance of monolithic final soil covers proposed or approved for use at California landfills that have composite liners. Specifically, this section discusses monolithic final soil covers at the Spadra Landfill, Bradley Landfill, Monterey Peninsula Landfill, Kiefer Landfill, Altamont Landfill, and the waste consolidation cell (WCC) at the Los Alamitos Joint Forces Training Base (LAJFTB).

5.2 Spadra Landfill

The Spadra Landfill is a closed landfill located in Los Angeles County, California. The landfill served the eastern San Gabriel Valley from 1957 through 2000. The Final Closure Plan for the Spadra Landfill was developed in 1997 and 1998 and submitted to the CRWQCB.

The final closure plan for the Spadra Landfill indicates that it is underlain by three distinct areas: an unlined area; a compacted soil liner area; and a geomembrane/compacted soil composite lined area (i.e., the Cal Poly Canyon area). The composite liner area encompasses approximately 70 acres [SWMD, 1998].

The approved final cover system for the Spadra Landfill waste disposal areas, including the Cal Poly Canyon area, is a monolithic final soil cover. Based on available data during three years of a post-construction monitoring program, the percolation control of the monolithic final soil final soil cover exceeded that of the Title 27 prescriptive final cover system originally proposed for the landfill. The average percolation rate for the monolithic final soil final soil cover over the three-year monitoring period was calculated to be 5.6 gallons per minute (gpm), compared to 42.6 gpm for the Title 27 prescriptive final cover [SWMD, 1998].

5.3 Bradley Landfill and Recycling Center

Bradley Landfill and Recycling Center (BLRC) is owned and operated by Waste Management Recycling and Disposal Services of California (WMRDSC) as a Class III landfill. The BLRC consists of three areas: Bradley East (BE); Bradley West (BW); and Bradley West Extension (BWE). The BLRC covers approximately 209 acres.

BW was developed in phases over time with multiple liner systems, including both geosynthetic and earthen liner systems. Approximately 84 acres of the 126 acres (approximately 67 percent) of BW is lined with geosynthetics and the remaining 33 percent of BW is lined with a low-permeability soil barrier layer.

The approved final soil cover system for BW at the BLRC is an alternative earthen final cover (i.e., a monolithic final soil final soil cover). The analysis performed by Geosyntec demonstrates that the monolithic final soil final soil cover will be superior to the Title 27 prescriptive final cover with respect to total percolation for BW. A monolithic final soil final soil cover was approved by the RWQCB in June 2006.

5.4 Monterey Peninsula Landfill

The Monterey Peninsula Landfill (MPL) is an active landfill located approximately 1.9 miles (3 km) north of Marina, California and within 3.1 miles (5 km) of Monterey Bay. MPL began accepting waste in 1966 and is expected to reach capacity in 2090 [ACDR].

MPL is currently divided into three modules. Two of these modules are unlined. The third module is approximately 25 acres (10 ha) and contains a composite liner that consists of 2 ft (0.6 m) of compacted clay with a saturated hydraulic conductivity less than 1×10^{-7} cm/s overlain by a 60-mil (1.5-mm) HDPE geomembrane [Benson et al., 2001].

Two test sections have been constructed at MPL simulating a monolithic final soil cover and a prescriptive final cover incorporating a composite barrier layer. The primary objective was to evaluate if percolation from the monolithic final soil cover is less than or equal to that from the prescriptive final cover [ACDR].

According to the Alternative Cover Design Report prepared for the Alternative Cover Assessment Program (ACAP), the results of the modeling predict that the soil cover will provide protection against water quality impairment equivalent to a prescriptive final cover.

5.5 Kiefer Landfill

Kiefer Landfill (KL) is a California Class III disposal site and receives municipal solid waste. KL is located in eastern Sacramento County, approximately 15.5 mi. (25 km) southeast of Sacramento, California. KL is expected to reach capacity in 2035.

The Kiefer site contains older unlined modules and newer-lined modules built with composite liners. The composite liners consist of a GCL overlain by a 60-mil (1.5-mm) HDPE geomembrane. An alternative soil cover has been considered as being intended for closure of the composite-lined modules.

Two side-by-side final cover performance tests were conducted at KL. The primary objective of the tests was to demonstrate that the performance of a monolithic final soil cover exceeds that of the prescriptive final cover system.

Results of the Alternative final cover performance modeling using HYDRUS-2D predicts that an annual percolation rate for the 4-ft (1.2-m) and 9.2-ft (2.8-m) cover designs to be 1.1 mm/yr and 0.0065 mm/yr, respectively, in contrast to the 3 mm/yr percolation rate, which is a common equivalency criterion used for sites where the prescriptive final cover employs a composite barrier layer, as established by Benson [Benson et al., 2001].

5.6 Altamont Landfill

The Altamont Landfill and Resource Recovery Facility (ALRRF) is an active industrial waste disposal facility. ALRRF is located the Altamont Hills of California near the City of Livermore and is approximately 40.4 mi. (65 km) east of San Francisco Bay.

The bottom liner for ALRRF is a composite liner consisting of 2 ft (0.6 m) of compacted clay having a hydraulic conductivity less than 1×10^{-7} cm/s overlain by a 60-mil (1.5-mm) thick high-density polyethylene geomembrane [Benson et al., 2001].

As part of the ACAP, an alternative soil cover and a RCRA Subtitle D cover are being evaluated at ALRRF. The objective of the evaluation is to analyze whether the percolation rate from the alternative cover will be less than either 3 mm/yr or the percolation rate from the prescriptive RCRA Subtitle D cover, for each year of a five-year test period [Benson et al., 2001]. By using a target percolation rate of 0.1 mm/year, the necessary thickness of 2.3 ft (0.7 m) of a monolithic vegetated soil cover was established. Initial monitoring results indicate that negligible amounts of percolation are detected from both the monolithic final soil cover and the prescriptive RCRA Subtitle D cover [HLA, 2000].

5.7 Bakersfield Metropolitan Sanitary Landfill

The Bakersfield Metropolitan (BENA) Sanitary Landfill is an active Class III municipal solid waste (MSW) landfill owned and operated by the Kern County Waste Management Department (KCWMD). The BENA Sanitary Landfill is located approximately 17 miles east of the City of Bakersfield, California.

The BENA Sanitary Landfill is divided into five waste Disposal Areas designated as Phase 1, Phase 2A, Phase 2B, Phase 3, and Phase 4 [Geosyntec, 1998c].

Phase 1 of the BENA Sanitary Landfill consists of four disposal networks (Networks 1 through 4) in which three networks (Networks 1 through 3) were constructed prior to “Subtitle D” requirements and the fourth network (Network 4) was constructed per “Subtitle D” requirements [JTD, 2000]. The base liner system for Network 4 of Phase 1 consists of the following components (from top to bottom):

- 2-ft (0.6-m) thick operations layer;
- geotextile filter;
- 1-ft (0.3-m) thick granular drainage layer;
- 80-mil high-density polyethylene (HDPE) geomembrane liner;
- 2-ft (0.6-m) thick clay liner; and
- prepared subgrade.

The concept of closing Phase 1 of the BENA Sanitary Landfill with an ET final soil cover as an alternative to the Title 27 prescriptive final cover was discussed in meetings with the Southern Section of the Central Valley RWQCB. Consequently, a study was

conducted by Geosyntec [Geosyntec 2006] to demonstrate that the performance of an ET final soil cover would exceed that of a Title 27 prescriptive final cover for Phase 1 of BENA Sanitary Landfill.

The results of the alternative final cover performance analysis indicated that the calculated percolation through the Title 27 prescriptive final cover obtained by using UNSAT-H and taking into consideration construction and installation defects is approximately 6.25 mm per year [Geosyntec 2006].

The results of the UNSAT-H analysis of the ET final soil cover demonstrate that the percolation through a 3-ft (0.9-m) monolithic final soil cover is approximately 1.19 mm per year [Geosyntec 2006].

The results of UNSAT-H analysis of the Title 27 prescriptive final cover and ET final cover systems proposed for closure of Phase 1 of BENA sanitary landfill clearly demonstrate that the performance of the 3-ft (0.9-m) ET final cover, in terms of percolation, exceeds that of the Title 27 prescriptive final cover.

5.8 Waste Consolidation Cell, Los Alamitos Joint Forces Training Base

The Los Alamitos Joint Forces Training Base (LAJFTB) occupies approximately 1,300 acres of primarily flat terrain and is located approximately one mile northeast of the intersection of the I-405 and I-605 freeways near the western edge of Orange County in Southern California.

Currently, there are approximately 12 unlined waste trenches located in a flat open field along the western boundary of the LAJFTB that were used for waste disposal from the 1940s through the 1980's. The LAJFTB intends to close the existing unlined waste trenches by excavating and consolidating waste from the waste trenches into a Waste Consolidation Cell (WCC) constructed in accordance with California Code of Regulations Title 27 (Title 27) under the oversight of the Santa Ana RWQCB.

The WCC is expected to occupy an area of approximately 10 acres. The liner system proposed for the WCC is as follows, listed from top to bottom:

- 12-in. (30.5-cm) thick operation layer;

- 200-mil (5-mm) geocomposite;
- 60-mil (1.5-mm) geomembrane (textured on both sides); and
- 1-ft (30.5-m) thick prepared foundation layer.

The approved final cover system for the lined WCC is a monolithic final soil cover. Based on the study conducted by Geosyntec [Geosyntec 2007] to demonstrate that the performance of a monolithic final soil cover would exceed that of a Title 27 prescriptive final cover prescribed for lined cell, the results demonstrated that the performance of a 4-ft (1.2-m) (thickness of the monocover proposed for the final closure of the WCC) monocover exceeds that of the Title 27 prescriptive final cover.

5.9 Summary and Conclusions of Case Histories

Based on the case histories presented above, the following conclusions can be made:

- The results of the unsaturated flow modeling data for several climatic regions in California indicates that the ET final soil cover works very well, and outperforms, in most cases, the Title 27 PFC;
- The approach of selecting an ET final soil cover over lined landfills has been approved by the regulatory agencies (e.g., RWQCBs); and
- The number of ET final soil cover projects over lined and unlined landfills are ongoing and growing in number over time.

6. SUMMARY AND CONCLUSIONS

This report presents a comparative study to evaluate an alternative final cover for Disposal Area C at the Lopez Canyon Sanitary Landfill, California that would meet or exceed the regulatory criteria for an engineered alternative to the Title 27 prescriptive final cover (Title 27 PFC) described in the 2002 FCP for Disposal Area C. The alternative final cover that meets and exceeds the overall performance of the prescriptive final cover is an evapotranspirative (ET) final soil cover. An ET final soil cover for Disposal Area C at the LCSL is appropriate because it provides:

- (i) better infiltration control;
- (ii) enhanced flexibility with respect to settlement;
- (iii) better seismic activity response;
- (iv) better LFG control and management;
- (v) improved erosion control;
- (vi) better protection from burrowing animals;
- (vii) lower construction and long-term maintenance costs; and
- (viii) increased aesthetics appeal.

Furthermore, the case histories provided in Section 5 of this document demonstrate that not only the performance of the ET final soil covers was found to be superior to that of the Title 27 PFC, but also that ET final soil covers are gaining increasing regulatory acceptance for lined and unlined landfills.

ET final soil covers are generally less costly to construct and generally require less maintenance than a Title 27 PFC. From this prospective, the Title 27 PFC proposed in the 2002 FCP is both burdensome (i.e., it costs more to build and maintain) and will not promote attainment of water quality goals (because of its tendency to crack due to sensitivity of geomembrane to defects and strains), satisfying the Title 27 criteria for use of an engineered alternative final cover.

Therefore, in general, the ET final soil cover is better suited than the Title 27 PFC for the semi-arid climate that is characteristic of the LCSL.

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Tables

Table 2-1: Base Liner System Configurations
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California

Disposal Area		Base Liner Configuration
Disposal Area A (33 acres) Disposal Area B (37 acres) Disposal Area AB+ (42 acres)		No Base Liner ⁽¹⁾
Disposal Area C (31 acres)	<i>Base</i>	Protective Soil Cover (2 ft min) 12 oz/yd ² Geotextile Geonet 80-mil HDPE Geomembrane Geosynthetic Clay Liner 3/8" Minus Backfill Material (6 in. thick min) Subgrade
	<i>Side Slopes</i>	Protective Soil Cover (2 ft min) 12 oz/yd ² Geotextile Geonet 80-mil HDPE Geomembrane Geosynthetic Clay Liner Reinforced Air Sprayed Slope Veneer (6 in. thick min) Subgrade

Notes: (1) Constructed prior to Resource Conservation and Recovery Act, Subtitle D.
Components listed from top to bottom.

**Table 2-2: Constructed and/or Approved Final Cover Configurations
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California**

Final Cover Configuration	Final Cover Elements	Area of Application
Compacted Clay Cover	<ul style="list-style-type: none"> • Vegetative layer (24 in. min) • Compacted low-permeability soil – hydraulic permeability no greater than 1×10^{-6} cm/s (12 in.) • Foundation layer (24 in.) 	<ul style="list-style-type: none"> • Disposal Area B (Slopes-Partial)⁽¹⁾ (18.5 acres) • Disposal Area C (Slopes) (21 acres)⁽³⁾
Asphaltic Concrete Cover	<ul style="list-style-type: none"> • Asphalt Concrete (6 in.) • Foundation layer (24 in.) 	<ul style="list-style-type: none"> • Disposal Area B – (Deck)⁽¹⁾ (15 acres) • Haul Road (completed)⁽¹⁾
Evapotranspirative Soil Cover	<ul style="list-style-type: none"> • Compacted soil (36 in.) • Foundation layer (24 in.) 	<ul style="list-style-type: none"> • Disposal Area A (Deck/Slopes)⁽¹⁾ (33 acres) • Disposal Area B (Slopes-Partial)⁽¹⁾ (5.5 acres) • Disposal Area AB+ (Deck/Slopes)⁽¹⁾ (42 acres)
Composite Cover	<ul style="list-style-type: none"> • Vegetative layer (24 in. min) • 12 oz/yd² non-woven geotextiles • 40-mil thick very flexible polyethylene geomembrane • Compacted low-permeability soil – hydraulic permeability no greater than 1×10^{-6} cm/s (12 in.) • Foundation layer (24 in.) 	<ul style="list-style-type: none"> • Disposal Area C (Deck/Benches Areas)⁽¹⁾ (21 acres)

Notes: (1) Approved.
(2) Constructed with Conditional Approval.
(3) Not yet constructed.

Table 4-1: Performance Comparison of Evapotranspirative Covers and Proposed Prescriptive Final Cover
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California

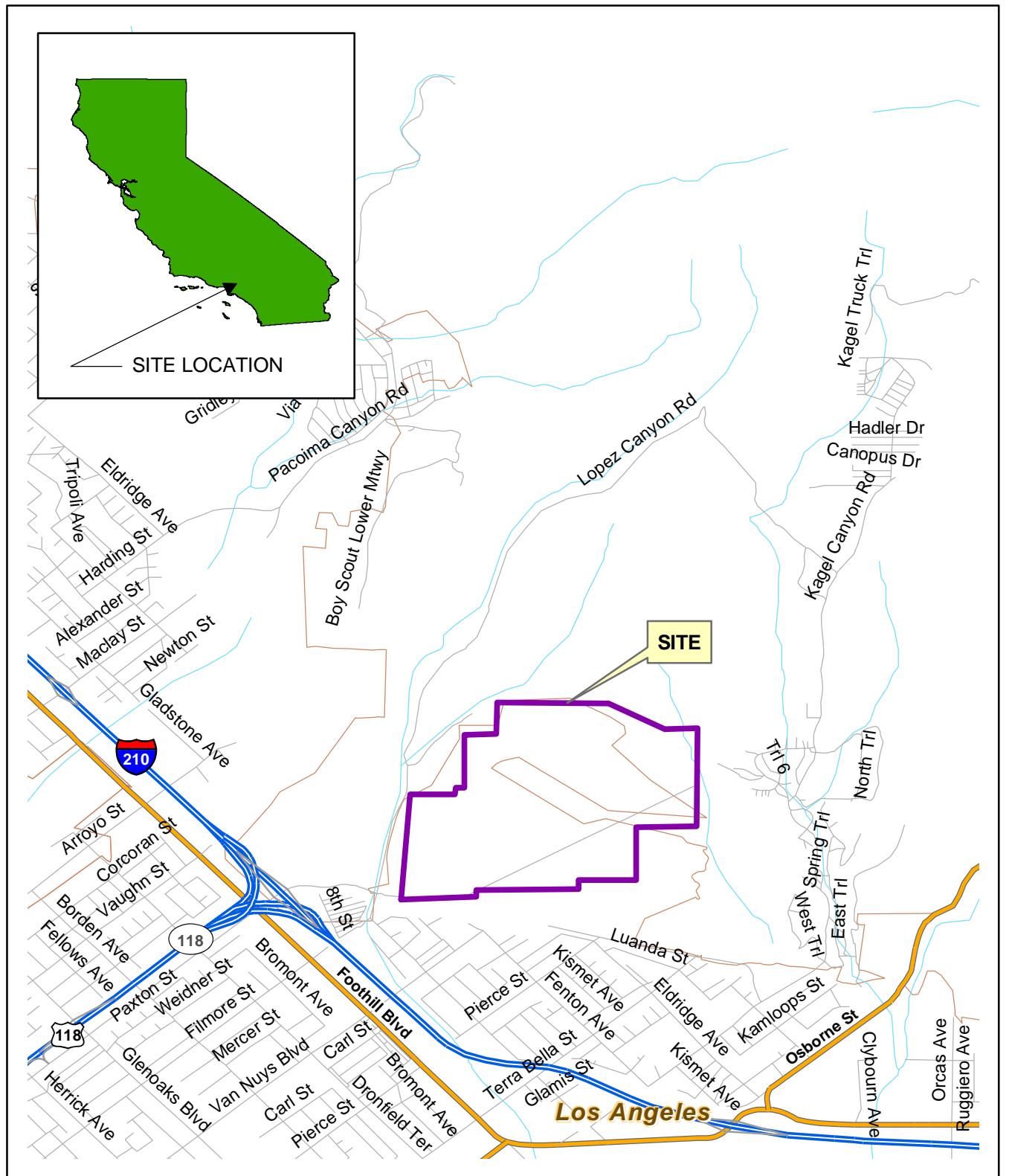
Criteria	Proposed Prescriptive Final Cover	Evapotranspirative (ET) Cover System
Infiltration Control (mm/ year)	Defects in geomembrane will affect infiltration performance, especially in depressions caused by settlement. Required to meet material specifications, but not subjected to performance criteria.	Designed to reduce percolation.
Cover Stability (specifically on slopes)	Higher probabilities of veneer type failures because of lower soil geomembrane interface shear resistance when used on slopes.	Reduces the potential for cover failure. ET cover can be installed on steeper slopes than geomembrane and generally provides a higher factor of safety against veneer failure.
Effect of Subsidence	Addition of vegetative layer to maintain grade in response due to settlement of waste will result in increase overburden load on top of geomembrane. Increased overburden load will cause concentrated loads over some section of the liner which could cause liner failure and will create a below-grade bowl that will hold moisture.	General repair works due to waste settlement are performed by adding soil to restore grade. The added soil will increase ET cover thickness which will improve the cover's performance.
Performance in Seismic regions	Damages due to seismic activities in geomembrane covers may not be easily detected. Damaged sections of geomembrane are costly to repair. Uncertainties of repair work results.	Damages related to seismic activities are easily detected and repaired. ET covers can also be considered “self healing” if extend of damage is limited.
Landfill gas control and management	Geomembrane cover system traps LFG. If adequate LFG extraction and recovery system is not available, LFG could migrate horizontally and vertically and could impact groundwater and vadose zone. Installation of extraction wells require complicated installation of boots around the well to maintain cover integrity and allow for waste settlement. Gas pressure generated by trapped LFG could help trigger veneer slope stability failure.	ET covers do not significantly affect landfill gas dynamics. This reduces the potential for impacts to groundwater in vadose zone. LFG management systems such as gas extraction (wells) can be easily installed after construction of the ET cover.
Erosion Control	Typically, only a 1-ft vegetative layer is placed on top of geomembrane cover systems. Vegetation roots are designed not to exceed 1-ft depth; therefore, plant communities' effect to reduce erosion is limited. This 1-ft vegetative layer could be eroded during adverse weather conditions.	Deeper rooted plant communities provide substantial erosion resistance. Typically ET covers range in thickness from 3 to 5 ft. This provides more resilience to erosion.
Burrowing Animals	Typically, only 1 ft of vegetation layer is placed on top the liner material. Rodents have a greater ability to reach the liner. Damage caused by rodents may not be easily detected or repaired.	Thicker covers. (Typically, ET covers range in thickness from 3 to 5 ft) and limit rodent contact with the refuse. Damage caused by rodents is easily repaired.
Material Availability	Liner material needs to be purchased from off-site sources.	ET covers are usually constructed from on site or nearby soil sources.
Constructability and Construction damage	Placement of vegetative layer on top of geomembrane is delicate and may cause puncture of geomembrane. Installation and/or construction related damages can greatly hinder the performance of a geomembrane cover system.	ET cover is easier to build than a multi-component geomembrane cover. No significant potential for construction or installation related damage.
Quality Assurance and Quality Control (QA/QC)	QA/QC is more complicated due to the presence of the geomembrane. QA/QC activities require to confirm material specification, check for manufacturing, construction, and installation-related damage, and confirm installation and seaming per construction specifications. QA/QC personal required to have experience in both soil and geosynthetic QA/QC. QA/QC activities require good control of field personal and equipment (i.e., shoe and tire type for field personnel and construction equipment, speed and turning radius).	QA/QC activities only needed to monitor material suitability, compaction requirements, and cover thickness – only soil experience required for QA/QC personnel.
Construction Cost	Cost data contained in the AFCEE landfill survey reveal that construction costs for typical barrier covers is much greater than the construction cost of an ET cover.	The AFCEE landfill survey reveals that construction costs saving for ET exceeds \$200,000 per acre of Landfill.
Operation & Maintenance Cost	Relatively higher O&M cost in part due to more frequent erosion repair due to low plant communities. Shallow-rooted vegetation (which is usually required on these covers) typically requires more care in the long term than deep-rooted vegetation.	The AFCEE estimates indicate that repairs and O&M cost on ET cover are approximately 60 to 65% lower than that of conventional barrier type covers.
Aesthetics	Shallow-rooted typically requires more care and are hard to establish, which could hinder the use of native plants to blend with the surrounding areas.	Use of natural plants increases the aesthetic appeal of the site, especially in the winter.
Regulatory Acceptance	Some RWQCB regions are reluctant to approve geomembrane covers even for lined landfills.	Gaining increasing regulatory acceptance.
Case Histories lined Landfill proposed or approved for an ET final cover		Spadra Landfill, Bradley Landfill Monterey Peninsula Landfill, Kiefer Landfill, Altamont Landfill, and Phase I of the BENA Landfill.

Notes: (1) AFCEE: Air Force Center for Environmental Excellence.

**Table 4-2: Calculated Cumulative Annual Infiltration
Lopez Canyon Sanitary Landfill
Lakeview Terrace, California**

Landfill Portion	Surface Area (acres)	Title 27 Prescriptive Cover	Infiltration through Title 27 Prescriptive Cover (cm/year)	Infiltration through Evapotranspirative Soil Cover (cm/yr)
Disposal Area C – Deck	21	Composite Cover with geomembrane	0.627	1.09
Disposal Area C – Slopes	21	Compacted Clay Cover	23.98	1.09
CUMULATIVE ANNUAL INFILTRATION (cm/year)			24.607	2.180

Figures



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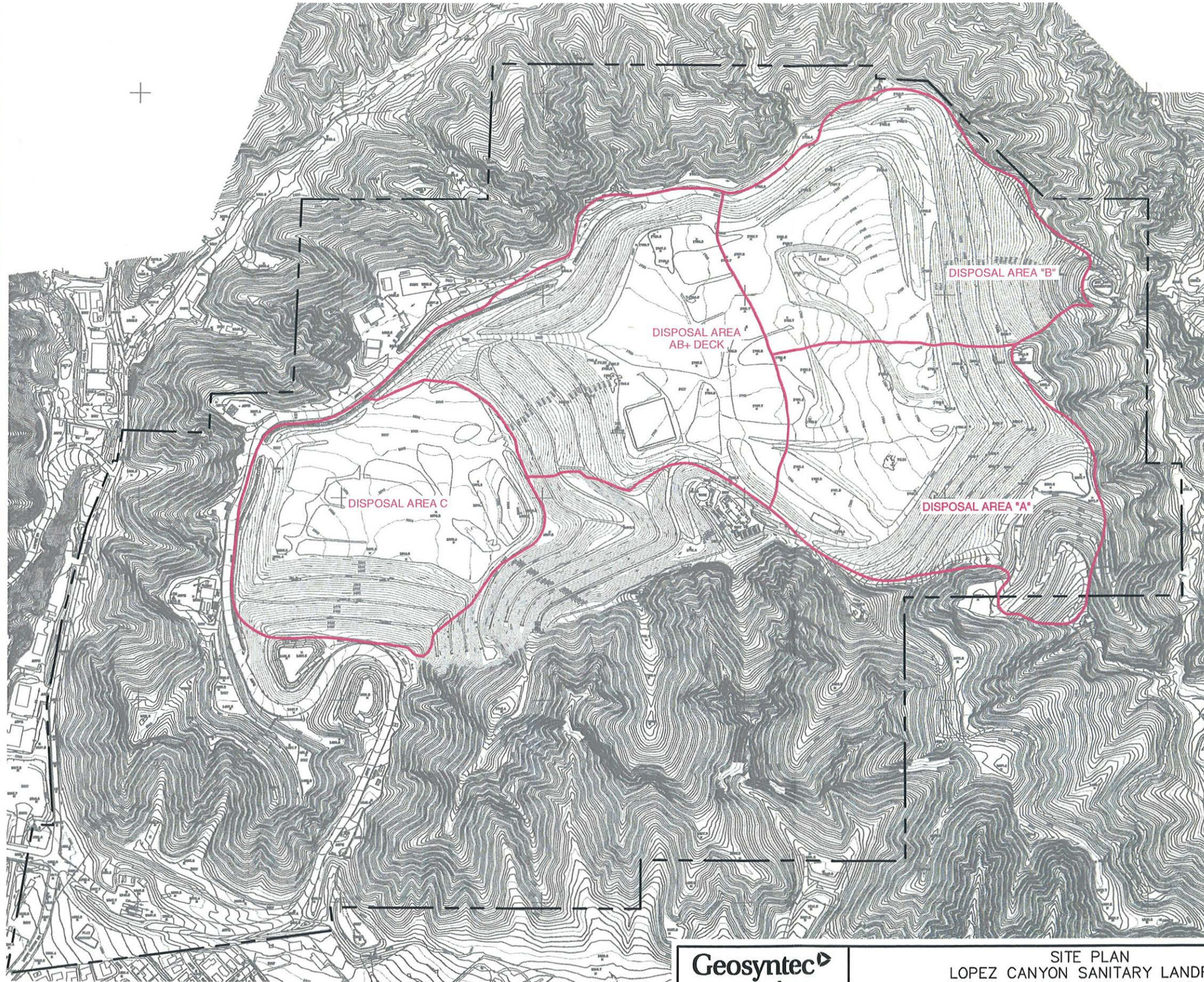


0 1,500 3,000
Feet

**SITE LOCATION MAP
LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA**

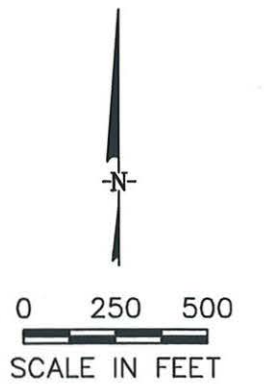
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PROJECT NO.	HL0800-02
DATE:	FEBRUARY 2007

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LEGEND

- LANDFILL BOUNDARY
- WASTE UNIT BOUNDARY

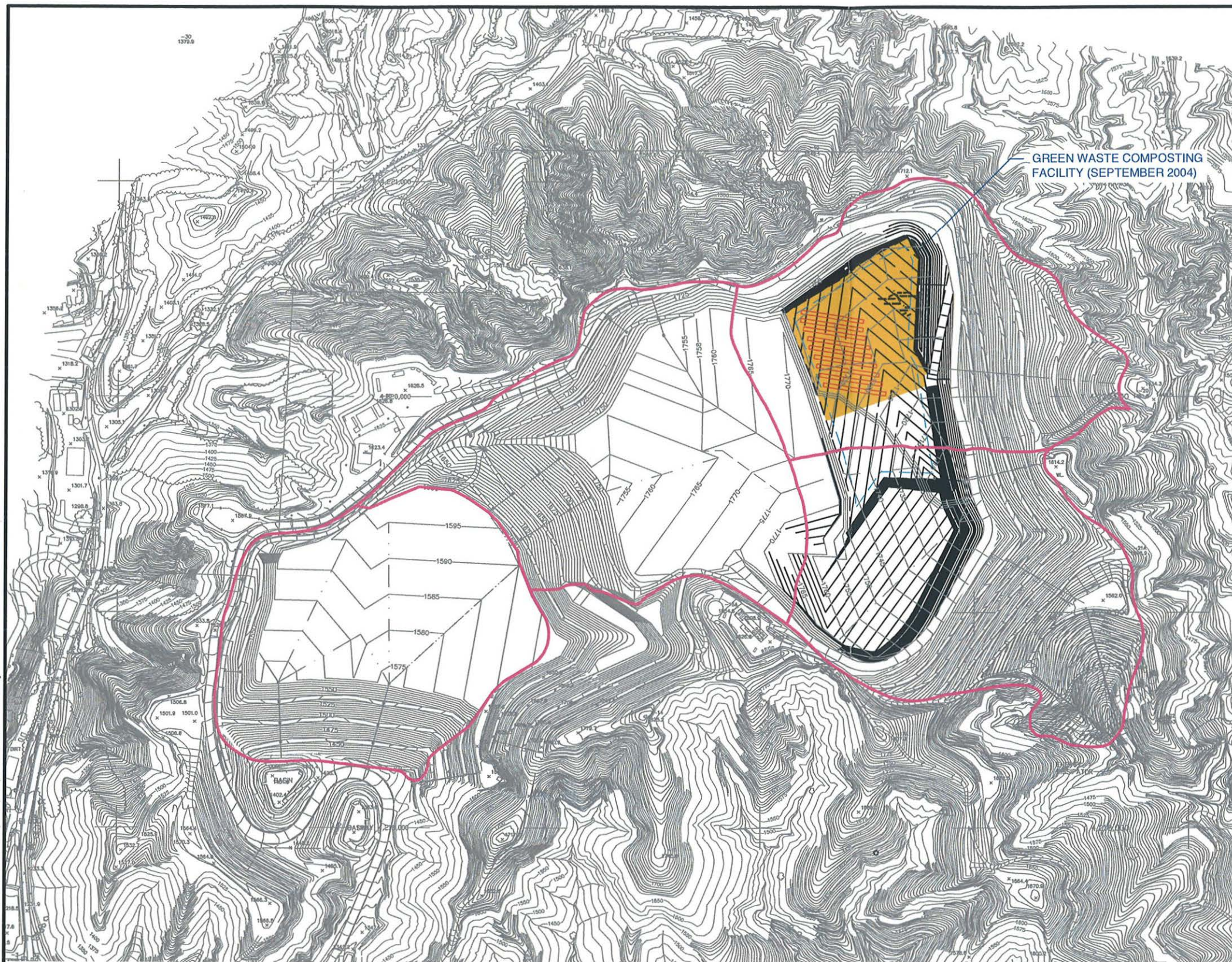


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SITE PLAN
LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRANCE, CALIFORNIA

FIGURE NO.	1-2
PROJECT NO.	HL0800-11
DATE:	MAY 2007

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LEGEND

-  EXISTING TOPOGRAPHY (FEET ABOVE M.S.L.)
-  APPROXIMATE LIMIT OF WASTE UNITS
-  APPROXIMATE LIMIT OF ASPHALT (SEPT 04)
-  COMPOSTING BAY

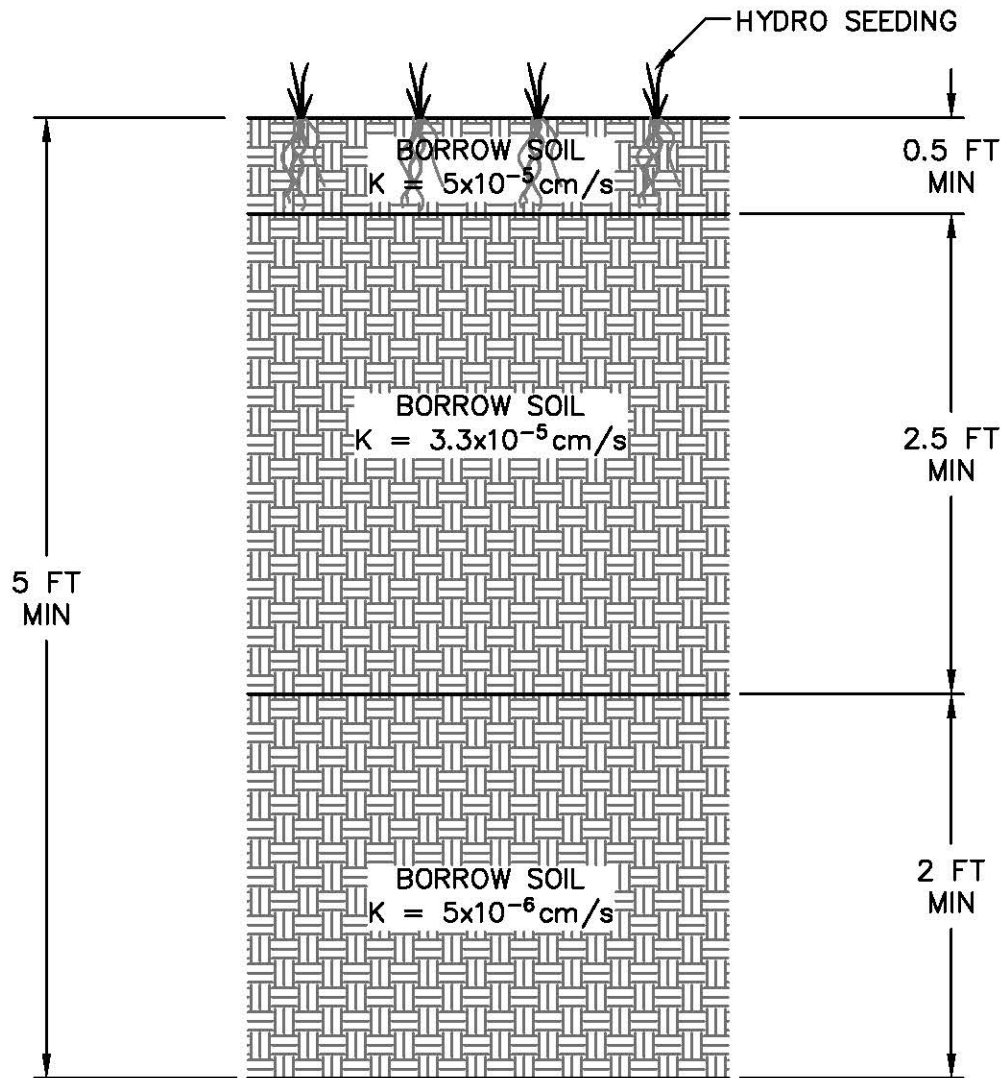


0 250 500
SCALE IN FEET

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LOCATION OF GREEN WASTE COMPOSTING FACILITY
LOPEZ CANYON SANITARY LANDFILL
LAKEVIEW TERRANCE, CALIFORNIA

FIGURE NO.	2-1
PROJECT NO.	HL0800-11
DATE:	MAY 2007

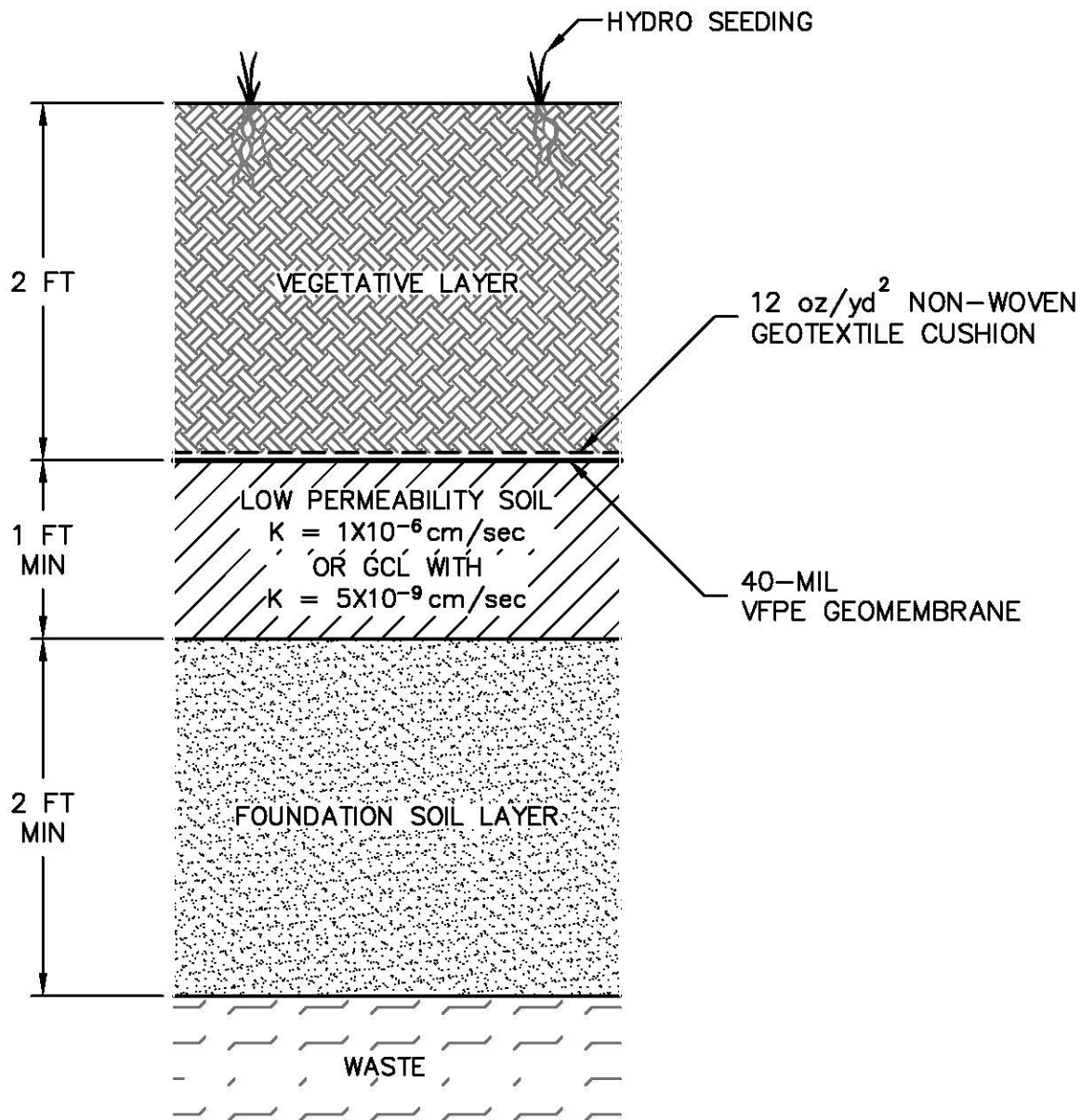


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EVAPOTRANSPIRATIVE
SOIL COVER CROSS-SECTION
LOPEZ CANYON
SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA

FIGURE NO.	4-1
PROJECT NO.	HL0800-01
DATE:	AUGUST 2007

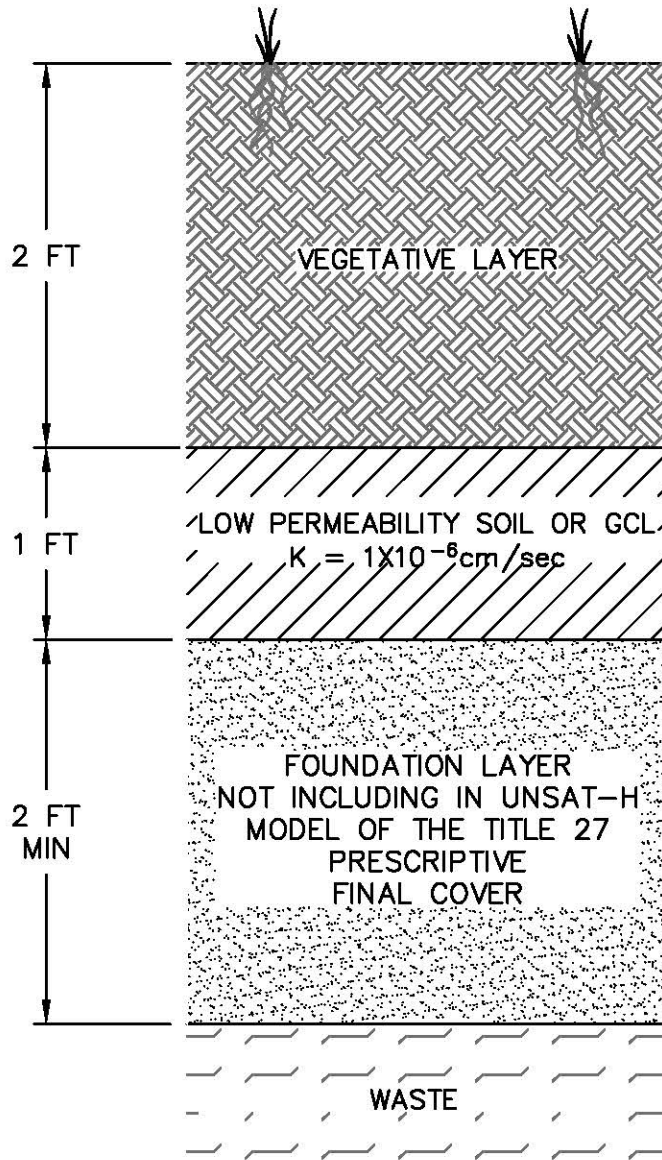


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2002 FCP – PROPOSED TITLE 27
FINAL COVER FOR THE DECK OF
DISPOSAL AREA C
LOPEZ CANYON
SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA

FIGURE NO.	4-2
PROJECT NO.	HL0800-01
DATE:	AUGUST 2007



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BUREAU OF SANITATION
LOS ANGELES, CALIFORNIA

Geosyntec
consultants

2002 FCP – PROPOSED TITLE 27
FINAL COVER FOR THE SLOPE OF
DISPOSAL AREA C
LOPEZ CANYON
SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA

FIGURE NO.	4-3
PROJECT NO.	HL0800-01
DATE:	AUGUST 2007

Appendix A: UNSAT H Analysis – Input and Output Files

wh1.inp

LPZwh107-06-- Disposal Area C + DECK -- LOPEZ CANYON SANITARY LANDFILL, 2'
Vegetative soil with Geomembrane liner

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0.25d+0,1.0d-14,0.0,	DELMAX,DELMIN,OUTTIM
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ALBEDO,ALT,ZU,PMB

wht1.out

Created using BSUM300 Version 3.01; all units are cm
 First file in series is wht11952.res

Year	Precip	PET	Transp	Evap	Runoff	Drain	Store	TimeStp	MasBalErr
Initial storage =							19.605		
1	41.580	170.405	3.567	11.789	24.546	0.000	21.012	66069	0.27057
2	89.992	172.001	6.826	14.282	67.155	0.000	22.734	84515	0.00759
3	44.933	191.454	6.131	11.385	30.276	0.000	19.692	64100	0.18130
4	37.123	187.494	4.369	11.896	20.573	0.000	19.692	65382	0.28512
5	38.081	188.117	4.075	8.776	27.238	0.000	17.481	66019	0.20261
6	48.133	183.203	5.060	13.370	27.731	0.000	19.145	68567	0.30792
7	50.724	193.985	7.332	10.668	33.672	0.000	18.003	65259	0.19314
8	29.972	195.858	3.092	6.504	20.383	0.000	17.836	62375	0.16024
9	28.829	194.354	3.636	8.514	16.840	0.000	17.468	64265	0.20645
10	50.292	265.873	4.818	8.483	37.311	0.000	17.002	76637	0.14621
SUM=	459.659	1942.744	48.906	105.669	305.726	0.000			1.96115

Flow Though Geomembrane Defects

Holes		Defects	
Numbers	0	Number	3
Radius (m)	0.00005	Radius	0.0005
Area (m2)	7.85398E-09	Area (m2)	7.854E-07

Total Hole and Defects Area 2.35619E-06
 ksoil 0.0000033 m/s 0.11225197 in/day
 Total area 1 acre 4046.85642 m²
 tsoil 1.5 ft 0.51075 m²
 kmembrane 4E-13 cm/sec
 tmembrane 0.04

OUTPUT SUMMARY	Inches	mm
avg (+) head	0.020	0.502
total drainage	0.247	6.267
avg annual	0.025	0.627

Giroud et al. 1989

Year	day	head	(+) head (in.)	Q(m ³ /s)	drainage (in)
1953	16	2.10E+02	9.85472441	3.771E-05	0.03169682
1953	17	2.09E+02	12.0850394	4.531E-05	0.03808543
1953	18	2.09E+02	8.77047244	3.3954E-05	0.02854016
1953	19	2.04E+02	7.08779528	2.8031E-05	0.02356111
1953	20	1.89E+02	5.07519685	2.0753E-05	0.01744389
1953	21	1.61E+02	3.77476378	1.5899E-05	0.013364
1953	22	1.27E+02	2.61858268	1.144E-05	0.00961602
1953	23	9.83E+01	1.52988189	7.0529E-06	0.00592827
1953	24	7.80E+01	2.75543307	1.1977E-05	0.01006715
1953	25	6.41E+01	2.74330709	1.1929E-05	0.01002727
1953	26	5.46E+01	1.68149606	7.6789E-06	0.00645449
1953	27	4.79E+01	0.47645669	2.4683E-06	0.00207471
1953	75	3.07E+01	0.17534646	1.0039E-06	0.00084381
1953	76	2.99E+01	3.96417323	1.6615E-05	0.01396603
1953	77	2.79E+01	3.2369685	1.3845E-05	0.01163752
1953	78	2.47E+01	3.10051181	1.3319E-05	0.01119504
1953	79	2.11E+01	2.33354331	1.0313E-05	0.00866862
1953	80	1.77E+01	0.86354331	4.2153E-06	0.00354316

wht2.inp
wht3- Disposal Area C + DECK -- LOPEZ CANYON SANITARY LANDFILL -- Title 27 2 ft
cover + 1 ft clay + 2 ft foundation-- White Paper

1,1,	IPLANT,NGRAV
365,1,365,	IFDEND,IDTBEG,IDTEND
1952,10,0,1,1,	IYS,NYEARS,ISTEAD,IFLIST,NFLIST
0,0,	NPRINT,STOPHR
0,4,1,2.0d-5,	ISMETH,INMAX,ISWDIF,DMAXBA
0.25d+0,1.0d-12,0.0,	DELMAX,DELMIN,OUTTIM
1.25,1.0d-05,0.0,0.0,0.0,	RFACT,RAINIF,DHTOL,DHMAX,DHFACT
4,3,0.0,	KOPT,KEST,WTF
0,1,2,1,	ITOPBC,IEVOPT,NFHOURL,LOWER
1.0d-05,1.0d+06,0.0,0.0,	HIRRI,HDRY,HTOP,RHA
1,0,1,	IETOPT,ICLOUD,ISHOPT
1,0.5,	IRAIN,HPR
0,0,0,0.0,0.0,0.0,	IHYS,AIRTOL,HYSTOL,HYSMXH,HYFILE
0,0,0.0,	IHEAT,ICONVH,DMAXHE
0,0,0,0.0,0.0,	UPPERH,TSMEAN,TSAMP,QHCTOP
0,0,0,0.0,	LOWERH,QHLEAK,TGRAD
1,0.66d+0,291.0d+0,0.256d+0,	IVAPOR,TORT,TSOIL,VAPDIF
3,128,	MATN,NPT

1,	0.00,	1,	0.10,	1,	0.20,	1,	0.30,
1,	0.40,	1,	0.50,	1,	0.60,	1,	0.70,
1,	0.80,	1,	0.90,	1,	1.00,	1,	1.25,
1,	1.50,	1,	1.75,	1,	2.00,	1,	3.00,
1,	4.00,	1,	5.00,	1,	6.00,	1,	8.00,
1,	10.00,	1,	13.00,	1,	16.00,	1,	19.00,
1,	22.00,	1,	25.00,	1,	28.00,	1,	31.00,
1,	34.00,	1,	37.00,	1,	40.00,	1,	42.00,
1,	44.00,	1,	46.00,	1,	48.00,	1,	50.00,
1,	52.00,	1,	54.00,	1,	56.00,	1,	58.00,
1,	60.00,	1,	60.10,	1,	60.20,	1,	60.30,
1,	60.40,	1,	60.50,	1,	60.60,	1,	60.70,
1,	60.80,	1,	60.90,	2,	61.00,	2,	61.10,
2,	61.20,	2,	61.30,	2,	61.40,	2,	61.50,
2,	61.60,	2,	62.00,	2,	63.00,	2,	66.00,
2,	69.00,	2,	72.00,	2,	75.00,	2,	78.00,
2,	80.00,	2,	82.00,	2,	84.00,	2,	86.00,
2,	88.00,	2,	88.50,	2,	90.00,	2,	91.00,
2,	91.10,	2,	91.20,	2,	91.30,	2,	91.40,
3,	91.50,	3,	91.60,	3,	91.70,	3,	91.80,
3,	91.90,	3,	92.00,	3,	92.25,	3,	92.50,
3,	92.75,	3,	93.00,	3,	94.00,	3,	95.00,
3,	96.00,	3,	97.00,	3,	99.00,	3,	101.00,
3,	104.00,	3,	107.00,	3,	110.00,	3,	113.00,
3,	116.00,	3,	119.00,	3,	122.00,	3,	125.00,
3,	128.00,	3,	131.00,	3,	133.00,	3,	135.00,
3,	137.00,	3,	139.00,	3,	141.00,	3,	143.00,
3,	145.00,	3,	147.00,	3,	148.75,	3,	150.80,
3,	150.90,	3,	151.00,	3,	151.10,	3,	151.20,
3,	151.30,	3,	151.40,	3,	151.50,	3,	151.60,
3,	151.70,	3,	151.80,	3,	151.90,	3,	152.00,
3,	152.10,	3,	152.20,	3,	152.30,	3,	152.40,

SOIL WATER CONTENT DATA, SAMPLED IN JAN-2005

0.4758,0.0000,0.0311,1.1931,

SOIL CONDUCTIVITY DATA, SOIL Ksat 5E-05(0.180)

2,0.180,0.0311,1.1931,0.5,

SOIL WATER CONTENT DATA, Lopez Canyon,

0.3800,0.0680,0.0080,1.0900,

THET,THTR,ALPHA,VGN

SOIL CONDUCTIVITY DATA, SAMPLE FC1SU, Ksat=1.00E-06 cm/sec (0.00360)

2,0.00360,0.0080,1.0900,0.5,

KMODEL,SK,ALPHA,VGN,EPIT

SOIL WATER CONTENT DATA, Lopez Canyon1,

0.7500,0.0300,0.0400,1.6000,

THET,THTR,ALPHA,VGN

SOIL CONDUCTIVITY DATA, SAMPLE FC1SU, Ksat=5.83E-05 cm/sec (0.2100)

wht2.inp

KMODEL,SK,ALPHA,VGN,EPIT

```
2,0.21000,0.0400,1.6000,0.5,
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```

[illegible]

Initial

1, 1, 1, 1, 287, 195,
LEAF,NFROOT,NUPTAK,NFPET,NSOW,NHRVST
0.50,

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BARE
NDLAI
IDLAI, VLAI
IDLAI, VLAI
AA,B1,B2

```

[illegible]

HW, HD, HN
HW, HD, HN
HW, HD, HN
ANKENY (RMA)

15400.00,	3400.00,	10.00,
15400.00,	3400.00,	10.00,
15400.00,	3400.00,	10.00,
0.0,	0.52,	0.5, 0.0, 3.0,

PARAMETERS

ALBEDO,ALT,ZU,PMB

PARAMETERS
0.2, 224.0, 3.0, 1012.0,
P:\PRJ4\CAWP\HL0800\white-Paper\UNSAT-H\
lpz

wht2.out

Created using BSUM300 Version 3.01; all units are cm
 First file in series is wht21952.res

Year	Precip	PET	Transp	Evap	Runoff	Drain	Store	TimeStp	MasBalErr
Initial storage =							73.057		
1	41.580	159.677	12.195	14.214	20.388	13.642	53.971	55692	0.22686
2	89.992	160.022	13.496	13.922	60.699	4.098	54.056	104948	-2.30753
3	44.933	177.670	12.872	11.648	25.850	2.275	46.572	58807	-0.22799
4	37.123	173.215	11.082	11.458	16.635	1.272	42.917	52071	0.33090
5	38.081	173.739	10.971	8.042	23.394	0.831	37.751	55144	0.00904
6	48.133	169.716	9.202	13.852	22.150	0.585	39.731	53515	0.36388
7	50.724	178.897	12.013	11.891	29.296	0.438	37.002	61585	-0.18337
8	29.972	180.804	7.370	6.241	17.076	0.341	35.811	50959	0.13466
9	28.829	180.087	5.397	9.093	13.713	0.275	35.991	50970	0.17147
10	50.292	241.153	11.638	8.505	32.848	0.225	33.831	71156	-0.76280
SUM=	459.659	1794.980	106.234	108.865	262.050	23.981			-2.24487

wht3.inp

LPZwht07-01-- Disposal Area C + DECK -- LOPEZ CANYON SANITARY LANDFILL -- Monocover
Disposal Area C + DECK-- White Paper

1,1,	IPLANT,NGRAV
365,1,365,	IFDEND,IDTBEG,IDENT
1952,10,0,1,1,	IYS,NYEARS,ISTEAD,IFLIST,NFLIST
0,0,	NPRINT,STOPHR
0,4,1,2.0d-5,	ISMETH,INMAX,ISWDIF,DMAXBA
0.25d+0,1.0d-08,0.0,	DELMAX,DELMIN,OUTTIM
1.25,1.0d-05,0.0,0.0,0.0,	RFACT,RAINIF,DHTOL,DHMAX,DHFACT
4,3,0.0,	KOPT,KEST,WTF
0,1,2,1,	ITOPBC,IEVOPT,NFHOURL,LOWER
1.0d-05,1.0d+06,0.0,0.0,	HIRRI,HDRY,HTOP,RHA
1,0,1,	IETOPT,ICLOUD,ISHOPT
1,1.0,	IRAIN,HPR
0,0,0,0.0,0.0,0.0,	IHYS,AIRTOL,HYSTOL,HYSMXH,HYFILE
0,0,0.0,	IHEAT,ICONVH,DMAXHE
0,0,0,0.0,0.0,	UPPERH,TSMEAN,TSAMP,QHCTOP
0,0,0,0.0,	LOWERH,QHLEAK,TGRAD
1,0.66d+0,291.0d+0,0.256d+0,	IVAPOR,TORT,TSOIL,VAPDIF
3,51,	MATN,NPT
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1, 1.50, 1, 3.10, 1, 5.10, 1, 7.62,	
1, 11.43, 2, 15.24, 2, 19.05, 2, 22.86,	
2, 26.67, 2, 30.48, 2, 34.29, 2, 38.10,	
2, 41.91, 2, 45.72, 2, 49.53, 2, 53.34,	
2, 57.15, 2, 60.96, 2, 64.77, 2, 68.58,	
2, 72.39, 2, 76.20, 2, 80.01, 2, 83.82,	
2, 87.63, 3, 91.44, 3, 95.25, 3, 99.06,	
3, 102.87, 3, 106.68, 3, 110.49, 3, 114.30,	
3, 118.11, 3, 121.92, 3, 125.73, 3, 129.54,	
3, 133.35, 3, 137.16, 3, 140.97, 3, 144.78,	
3, 147.30, 3, 149.30, 3, 150.90, 3, 151.70,	
3, 152.10, 3, 152.30, 3, 152.40,	

SOIL WATER CONTENT DATA, SAMPLED IN JAN-2005

0.4758,0.0000,0.0311,1.1931,
SOIL CONDUCTIVITY DATA, SOIL Ksat 5E-05(0.180)

2,0.180,0.0311,1.1931,0.5,
SOIL WATER CONTENT DATA, SAMPLED IN JAN-2005
0.4758,0.0000,0.0311,1.1931,
SOIL CONDUCTIVITY DATA, SOIL Ksat 3E-05(0.10800)

2,0.1080,0.0311,1.1931,0.5,
SOIL WATER CONTENT DATA, SAMPLED IN JAN-2005
0.4758,0.0000,0.0311,1.1931,
SOIL CONDUCTIVITY DATA, SOIL Ksat 5E-06(0.0180)

2,0.01800,0.0311,1.1931,0.5,
0, NDAY (toss.out file for day 3.65000E+02) ver 3.00

329054.0,	329054.0,	329054.0,	329054.0,	Initial Conditions
329054.0,	329100.0,	329100.0,	329100.0,	Initial Conditions
56300.0,	15200.0,	5298.0,	2211.0,	Initial Conditions
1375.0,	887.0,	590.0,	402.0,	Initial Conditions
620.0,	987.0,	1635.0,	2850.0,	Initial Conditions
3476.0,	4274.0,	5298.0,	6628.0,	Initial Conditions
4586.0,	3251.0,	2353.0,	1734.0,	Initial Conditions
1456.0,	1228.0,	1041.0,	887.0,	Initial Conditions
935.0,	987.0,	1041.0,	1100.0,	Initial Conditions
1100.0,	1100.0,	1100.0,	1100.0,	Initial Conditions
652.0,	402.0,	255.0,	164.0,	Initial Conditions
164.0,	164.0,	164.0,	164.0,	Initial Conditions
164.0,	164.0,	164.0,		Initial Conditions

1, 1, 1, 1, 287, 195,
LEAF,NFROOT,NUPTAK,NFPET,NSOW,NHRVST
0.55,
6,

BARE
NDLAI

```

                                wht3.inp
0,1.00,100,1.00,195,1.00,196,0.00,
282,0.00,287,1.00,
1.00,0.13,0.020,
1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1, 1, 1, 1, 1, 1, 1, 1, 365, 365,
365, 365, 365, 365, 365, 365, 365, 365, 365, 365,
365, 365, 365, 365, 365, 365, 365, 365, 365, 365,
365, 365, 365, 365, 365, 365, 365, 365, 365, 365,
365,
1.500E+04, 3.400E+03, 1.000E+01,
1.500E+04, 3.400E+03, 1.000E+01,
1.500E+04, 3.400E+03, 1.000E+01,
0.0, 0.52, 0.5, 0.1, 2.7,
0.2, 539.0, 3.0, 1017.0,
P:\PRJ4\CAWP\HL0800\White-Paper\UNSAT-H\
LPZ
CSV
                                IDLAI, VLAI
                                IDLAI, VLAI
                                AA,B1,B2
                                NTROOT
                                NTROOT
                                NTROOT
                                NTROOT
                                NTROOT
                                NTROOT
                                HW, HD, HN
                                HW, HD, HN
                                HW, HD, HN
                                ANKENY (RMA) PARAMETERS
                                ALBEDO,ALT,ZU,PMB

```

wht3.out

Created using BSUM300 Version 3.01; all units are cm
 First file in series is wht31952.res

Year	Precip	PET	Transp	Evap	Runoff	Drain	Store	TimeStp	MasBalErr
Initial storage =							34.133		
1	41.580	159.772	4.137	10.289	25.513	0.036	35.799	58863	-0.06086
2	89.992	160.134	10.336	11.849	68.005	0.017	35.838	104899	-0.25229
3	44.933	177.794	8.347	9.921	30.541	0.012	31.964	57369	-0.01402
4	37.123	173.348	4.490	10.330	21.417	0.009	32.861	56689	-0.02039
5	38.081	173.864	5.358	7.067	27.963	0.008	30.605	61394	-0.05940
6	48.133	169.834	5.039	12.173	28.675	0.007	32.868	59254	-0.02286
7	50.724	179.057	8.067	10.494	34.532	0.006	30.569	66279	-0.07627
8	29.972	180.951	2.751	5.651	21.039	0.005	31.105	52767	-0.00985
9	28.829	180.197	2.898	7.964	17.588	0.005	31.505	55232	-0.02672
10	50.292	241.574	5.852	7.736	38.440	0.005	29.949	88977	-0.18419
SUM=	459.659	1796.526	57.274	93.475	313.712	0.109			-0.72684

APPENDIX B

REVISED CLOSURE AND POST-CLOSURE COST ESTIMATE

REVISED COST ESTIMATE WORKSHEET

(JULY 2008)

SITE DESCRIPTION

The following questions will provide general information regarding the site description, the type of waste accepted at the site and basic geological information. This information will aid in assessing factors that may affect the initial cost estimates.

Prepared By: GeoSyntec Consultants

General Site Information: Revised Final Closure Plan

Name of Solid Waste Landfill Lopez Canyon Sanitary Landfill

Solid Waste Facilities Permit Number 19-AA-0820

Facility Operator City of Los Angeles Bureau of Sanitation

Site Owner City of Los Angeles, Bureau of Sanitation

Site Location (California coordinates, township & range or longitude/latitude, preferred)

Longitude: -118.390775° , Latitude: 34.294303°

Assessors Parcel Number _____

Site Address 11950 Lopez Canyon Road Lakeview Terrace, CA 91342

1. What is the existing State Water Resources Control Board classification of the solid waste landfill? (mark the appropriate response)

NEW
If Waste Discharge Requirements
(WDR) revised since 11-84

OLD

_____ Class I

_____ Class I

 X Class II-1

Note: The solid waste landfill is excluded from these requirements, if the facility is a hazardous waste facility or co-disposal facility of both hazardous and nonhazardous waste as a RCRA Subtitle C facility subject to specific closure plan requirements.

_____ Class II

_____ Class II-2

 X Class III

_____ Class III-2

2. What is the anticipated closing date for the existing permitted landfill? Proposed expansions which have not been approved by the Board and LEA are not to be included in these calculations. Include calculations supporting the estimate date. (Attach additional sheets as necessary.)

Month: December Year: 2010

Note: All facilities with an anticipated closure date of September 28, 1992, or earlier, will be required to submit their closure and postclosure maintenance plan no later than July 1, 1990.

Type of Fill

3. Type of Fill (check appropriate type)

 Trench

 X Canyon

 X Area

 Other (describe)

 Pit

Volume of Waste (Entire Landfill)

- | | |
|--|-------------------|
| 4. What is the estimated in-place volume of landfilled wastes at the site in cubic yards? | <u>13,320,000</u> |
| 5. What is the design capacity of the site in cubic yards? | <u>26,562,000</u> |
| 6. Minimum thickness of waste (ft)? | <u>25 ft</u> |
| 7. Average thickness of waste (ft)? | <u>120 ft</u> |
| 8. Maximum thickness of waste (ft)? | <u>245 ft</u> |
| 9. Average height above surrounding terrain (ft)? | <u>N/A</u> |
| 10. Typical inclination of side slopes, in slope ratio (horizontal:vertical)? (e.g., 5:1, 2:1) | <u>2:1</u> |

Note:

- | | |
|--|-----------------------------------|
| 11. Quantity of waste typically received (tons/day)? | <u>(Inactive Site) 0 tons/day</u> |
| 12. Total permitted site acreage? | <u>399 acres</u> |
| 13. Waste disposal area acreage? | <u>162 acres</u> |

Waste Description

14. Estimate of solid waste received (total of entries for residential, commercial, industrial, demolition and other should add up to 100%).

% Residential 85 % % Commercial

% Industrial _____ % Demolition _____

% Other (special waste streams, such as ash, auto shredder waste, infectious waste, sludge, asbestos) _____

Describe material under "other" and give its percentage.

Material	Percentage
<u>Street Sweeping</u>	<u>15 %</u>

Resid. + Indus. + Comm. + Demo. + Other = 100%

Site Geology and Groundwater Data

15. Briefly describe the underlying geology of the site. (Mark as many boxes that apply).

<u>X</u> Shallow Alluvium <50'	_____ Deep Alluvium >50'
<u>X</u> Sedimentary	_____ Igneous
_____ Metamorphic	

a. What is the name of the nearest major fault?	<u>San Fernando Zone</u>
b. Distance from site (miles)?	<u>Onsite</u>
c. On-site fault(s), if known?	<u>Yes</u>

16. What are the groundwater characteristics?

a. What is the depth to groundwater (ft)?	<u>A seasonal water table was obtained</u> <u>from MW 88-5 drilled to a depth of</u> <u>42 ft or 1429.7 ft MSL</u>
---	--

This will be the range of water levels, from well data, in a groundwater well network. Note: Consider seasonal variations from rainy to dry periods, wet and dry years, well locations and variations in the subsurface geology.

Highest recorded level (depth in ft)	ELEV. <u>42 ft, 1429.7 ft</u>
Well Number <u>MW-88-5</u>	Date Recorded <u>9 March 1988</u>
Lowest recorded level (depth in ft)	ELEV. <u>N/A</u>
Well Number <u>N/A</u>	Date Recorded <u>N/A</u>

- b. What direction does the groundwater flow? The apparent ground water flow direction is north to south
- c. What is the groundwater gradient? _____

CLOSURE COSTS

Final and Intermediate Cover

17. Area of Landfill for Final Cover (Evapotranspirative Cover)

- a. Area of top deck to be capped (ft²)
(The top deck area include the deck of Disposal Area "C")

$$A_d = (971,052 \text{ ft}^2) = \underline{971,052 \text{ ft}^2}$$

- b. Area of side slopes to be capped (ft²)
(The side slope areas includes the side slop areas of Disposal Area "C", and "AB+")

Slopes of Disposal Area "AB+" = Southwest slopes1 + Southwest slopes2 + North slopes and IT area)

Area of slopes of "AB+" = SW1 + SW2 + N(IT) = 334,457 ft² + 144,942 ft² + 339,311 ft² = 818,710 ft²

Area of slopes of "AB+" = 618,203 ft²

$$A_s = (618,203 + 818,710) = \underline{1,436,913 * 1.12 = 1,609,342 \text{ ft}^2}$$

Side Slopes Horizontal:Vertical	Conversion Factor (C)
5 : 1	1.02
4 : 1	1.03
3 : 1	1.05
2½: 1	1.08
2 : 1	1.12
1¾: 1	1.15

18. Final Cover Soil – Evapotranspirative Soil Cover (5-ft of soil)

- a. Thickness

1) Top deck (4 ft of soil) minimum 5 ft

2) Side slope (4 ft of soil) minimum 5 ft

b. Total Estimated Volume (To complete remaining earthwork) (yd³) 275,098 yd³

c. % Native soil from onsite borrow source 0%

d. Native material acquisition cost (excavation, hauling, etc.) (\$/yd³) \$0

e. Native soil cost (\$) (Line 18b x Line 18c x Line 18d)	<u>\$0</u>
f. % Imported soil	<u>100%</u>
g. Imported material acquisition cost (purchase, delivery, etc.) (\$/yd ³ delivered)	<u>\$5.17</u>
h. Imported soil cost (\$) (Line 18b x Line 18f x Line 18g)	<u>\$1,317,559</u>
i. Placement, grading and compaction (to achieve relative compaction of 90% per ASTM D-1557) unit cost (\$/yd ³)	<u>\$2.77</u>
j. Placement, grading and compaction cost (\$) (Line 18b x Line 18i)	<u>\$705,926</u>
k. Subtotal final cover soil (\$) (Line 18e + Line 18h + Line 18j)	<u>\$2,023,485</u>
19. Clay Layer	
a. Area to be capped (ft ²) (Line 17a + Line 17b x Con. Factor)	<u>0</u>
b. Thickness (ft) (minimum 1 foot)	<u>0</u>
c. Volume (yd ³) (Line 19a x Line 19b)/27	<u>0</u>
d. % On-site Clay	<u>0</u>
e. On-site material acquisition cost (excavation, hauling, etc.) (\$/yd ³)	<u>N/A</u>
f. On-site clay cost (\$) (Line 19c x Line 19d x Line 19e)	<u>0</u>
g. % Imported Clay	<u>0</u>
h. Imported material acquisition cost (purchase, delivery, etc.) (\$/yd ³)	<u>\$0</u>
i. Imported clay cost (\$) (Line 19c x Line 19g x Line 19h)	<u>\$0</u>
j. Placement/spreading, grading, compaction (to achieve permeability no greater than 1 x 10 ⁻⁶ cm/sec) unit costs (\$/yd ³)	<u>\$0</u>
k. Placement, grading and compaction cost (\$) (Line 19c x Line 19j)	<u>\$0</u>
l. Subtotal clay costs (\$) (Line 19f + Line 19i + Line 19k)	<u>\$0</u>
20. Synthetic Membrane	
Note: This item must be estimated in addition to the clay barrier layer unless/until an alternative final cover design has been approved in the closure plan.	
a. Type of membrane (e.g., HDPE, CPE, PVC)	<u>N/A</u>
Thickness (minimum 30 mils)	<u>N/A</u>

b.	Quantity (ft ²)	<u>0</u>
c.	Purchase, delivery and installation unit cost (\$/ft ²)	<u>\$0</u>
d.	Synthetic layer testing (percent of total synthetic membrane unit cost) (%/100)	<u>\$0</u>
e.	Synthetic layer costs (\$) (Line 20b x Line 20c x (1 +20d)	<u>\$0</u>

21. What other types of materials/layers are included in the design (e.g., asphalt-tar, gravel for gas venting)?

a.	Asphalt Pavement Cover (3 in. ACC top layer, 40-mil Tack Coat (Non-Woven Fabrick, 3 in ACC bottom layer)	
1)	Quantity (ft ²)	<u>442,591 ft²</u>
2)	Purchase, delivery, and installation unit cost (\$/ft ²)	<u></u>
3)	Subtotal Cost	<u>\$258,360</u>
b.	Spray Applied Geomembrane Cover (12 in. soil cover, 12 oz. geotextile, and spray-on liner)	
1)	Quantity (ft ²)	<u>0</u>
2)	Purchase, delivery, and installation unit cost (\$/ft ²)	<u>\$0</u>
3)	Subtotal Cost	<u>\$0</u>
c.	Concrete/Geomembrane Cover (6 in. concrete, 12 in. soil cover, 12 oz. geotextile, and 40 mil geomembrane)	
1)	Quantity (ft ²)	<u>0</u>
2)	Purchase, delivery, and installation unit cost (\$/ft ²)	<u>\$0</u>
3)	Subtotal Cost	<u>\$0</u>
d.	Sealed Aggregate Base (6 in. aggregate base, 12-in. soil cover, 12 oz. geotextile, and 40 mil geomembrane)	
1)	Quantity (ft ²)	<u>0</u>
2)	Purchase, delivery, and installation unit cost (\$/ft ²)	<u>\$0</u>
3)	Subtotal Cost	<u>\$0</u>
e.	4-inch diameter HDPE drain pipe	
1)	Quantity (linear feet)	<u>0</u>

2) Purchase, delivery, and installation unit cost (\$/linear foot)	<u>\$0</u>
3) Drainage layer cost	<u>\$0</u>
f. Geosynthetic Clay Liner (used with water conveyance and collection structures)	
1) Quantity (yd ²)	<u>0</u>
2) Purchase, delivery, and installation unit cost (\$/yd ²)	<u>\$0</u>
3) GCL Cost	<u>\$0</u>
g. Total cost of other types of layers (Line 21a.3 + 21b.3 + 21c.3 + 21d.3 + 21e.3+21f.3)	<u>\$258,360</u>
22. Construction Quality Assurance	
The following cost estimates apply to the quality assurance activities necessary to ensure that the final cover is installed properly, as specified in the design parameters, and fulfill the conditions mandated by regulations.	
a. Monitoring costs incurred while evaluating the final cover system components:	
1) Laboratory test fees (e.g., soil permeability, soil density, etc.) (\$)	<u>\$136,990</u>
2) Field test expenditures (e.g., test pad field permeability tests, relative compaction tests) (\$)	<u>\$125,000</u>
b. Inspections (e.g., initial inspection of native soil, visual check of completed cover) (\$)	<u>\$244,000</u>
c. Reporting costs (e.g., daily reporting procedures, corrective measure report, as-built reports) (\$)	<u>\$63,040</u>
d. Engineering design costs (\$)	<u>\$234,000</u>
e. Quality assurance costs (\$) (Line 22a1 + Line 22a2 + Line 22b + Line 22c + Line 22d)	<u>\$803,330</u>
23. Final Cover Subtotal (\$) (Line 18k + Line 19l + Line 20e + Line 21g + Line 22e)	<u>\$2,161,892</u>

Revegetation

24. Soil Preparation

- a. Area to be vegetated, including closed areas that need replanting (acres)
 $A_{veg} = 38$ acres

- b. Preparation unit cost (\$/acre)

- c. Soil preparation subtotal (\$) (Line 24a x Line 24b)

25. Planting

- a. Type of vegetation:

Annual and perennial native grasses and flowers

- b. Planting unit cost (e.g., seeding, sprigging, plugs) (include cost of seeds, sprigs, plugs) (\$/acre)

- c. Planting cost (\$) (Line 24a x Line 25b)

26. Fertilizing

- a. Type of fertilizer:

- b. Fertilizer unit cost (\$/acre)

- c. Fertilizing cost (\$) (Line 24a x Line 26b)

27. Mulching

- a. Mulch unit cost (\$/acre)

- b. Mulching cost (\$) (Line 24a x Line 27a)

28. Irrigation cost (\$) (temporary)

29. Revegetation Subtotal (\$)

(Line 24c + Line 25c + Line 26c + Line 27b + Line 28)

\$1,408,290

Landfill Gas System Modifications

30. Does the landfill have a gas monitoring network?

 X YES

 NO

If NO,

- a. What will be the spacing between monitoring wells (≤ 1000 ft)? N/A
- b. What criteria was used to select this spacing? N/A
- c. Total number of gas monitoring wells? N/A

Note: Depth of probes should equal at least 1 x depth of refuse within 1000'

- d. Number of probes per wellbore? N/A

Suggested minimum;

1. Surface (5-10 ft)
 2. Intermediate (half the depth of boring)
 3. Deep (to depth of boring)
- e. Cost of Design (\$) \$0
- f. Cost of drilling, materials (\$) \$0
- g. Cost of installation (\$) \$0
- h. Subtotal for monitoring network (\$) (Line 30e + Line 30f + Line 30g) \$0

If YES,

- i. How many gas monitoring wells are in place? 52
- j. How many deep nested gas monitoring probes are in place? 0
- k. What is the lateral spacing between gas monitoring wells? <1000 ft
- l. What is the number of probes per wellbore? One to four
- m. Additional monitoring wells required at closure? 0
- n. Number of probes per boring? N/A
- o. Cost to expand existing monitoring network (design, drilling, and installation)? \$ 0

31. Is there a gas control system operating at the landfill?

X YES

NO

If YES,

a. What type(s) (e.g., recovery, perimeter extraction, air injection, etc.) is/are in place? Extraction

b. What type of system will be installed during closure? N/A

Well field modifications to accommodate final cover

c. Cost of design (\$) \$0

d. Cost of materials (\$) \$0

e. Cost of relocation and extension (\$) \$0

f. Decommission Vertical Wells (\$) \$26,313

g. Abandonment Materials and Labor (\$) \$19,007

h. New Shallow Well Construction (\$) \$348,624

i. Well Disconnection (Horizontal) (\$) \$122,500

j. Well Connection (Material, labor and installation)(\$) \$348,624

k. Relocate and Replace header System (\$) \$232,640

l. Gas Well Protection (\$) \$74,081

32. Landfill Gas Modifications Subtotal (\$) \$829,209

(Line 31f + Line 31g + Line 31h + Line 31i + Line 31j + Line 31k + Line 31l)

Groundwater Monitoring Installations

33. Does the landfill have a ground-water monitoring network?

 X YES

 NO

If YES,

a. Number of upgradient (minimum 1) wells 4

b. Number of downgradient (minimum 3) wells 7
(number of background wells)

If less than minimum or NO,

c. Number of wells to be installed 4
(minimum 1 upgradient and minimum 3 downgradient).

d. Drilling total footage (ft) 310

- e. Cost of design (\$) _____
- f. Developing, installing, materials (\$) _____
34. Groundwater monitoring subtotal (\$) (Line 33e + Line 33f) _____

Drainage

35. Is there a surface water runoff and runoff control system existing at the site:

☒ YES ☐ NO

If NO,

- a. What will be the estimated cost of installation and construction of the drainage conveyance system to accommodate anticipated runoff (e.g., diversion ditches, downdrains, energy dissipators) and protection from runoff (e.g., dikes, levees, protective berms)? (\$) _____ **\$747,285**
- b. Cost of grading and drainage design (\$) _____ **\$82,585**
- c. Drainage subtotal (\$) (Line 35a + Line 35b) _____ **\$829,870**

Security

36. Is there a security system established at the landfill (e.g., fencing, access gates, locks on the gates, informational signs)?

☒ YES ☐ NO

- a. What is presently in place at the site? (mark appropriate boxes)

☒ Fencing ☒ Locks

☒ Gates ☐ Others (Inside Military Base)

☒ Signs

- b. What will be the estimated cost of installing a security fence, access gates with locks, and/or informational signs (e.g., either around site perimeter or around enclosures) to protect equipment and the public and is compatible with postclosure use? _____ **\$33,000**
- c. What will be the estimated cost of dismantling and removing security equipment not necessary after closure and incompatible with postclosure use? _____ **\$0**
- d. Security system costs (\$) (Line 36b + line 36c) _____ **\$33,000**

SUPPLEMENTAL DATA

37. Itemize cost for closure procedures specific to this solid waste disposal site.

a. Other Closure Costs (cost to develop the Final Closure Plan)	<u>\$803,530</u>
b. Administrative Costs - Construction Management	<u>\$1,162,025</u>
c. Removal of Structures	<u>\$0</u>
d. SUBTOTAL	<u>\$1,965,555</u>

SUMMARY OF COST ESTIMATES

Facility Name: Camp Roberts South Landfill and Closed Landfills

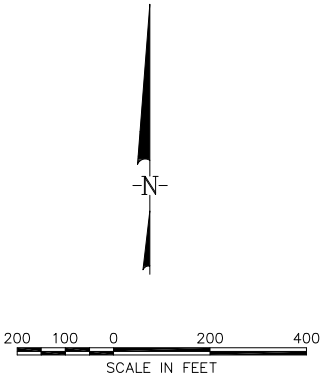
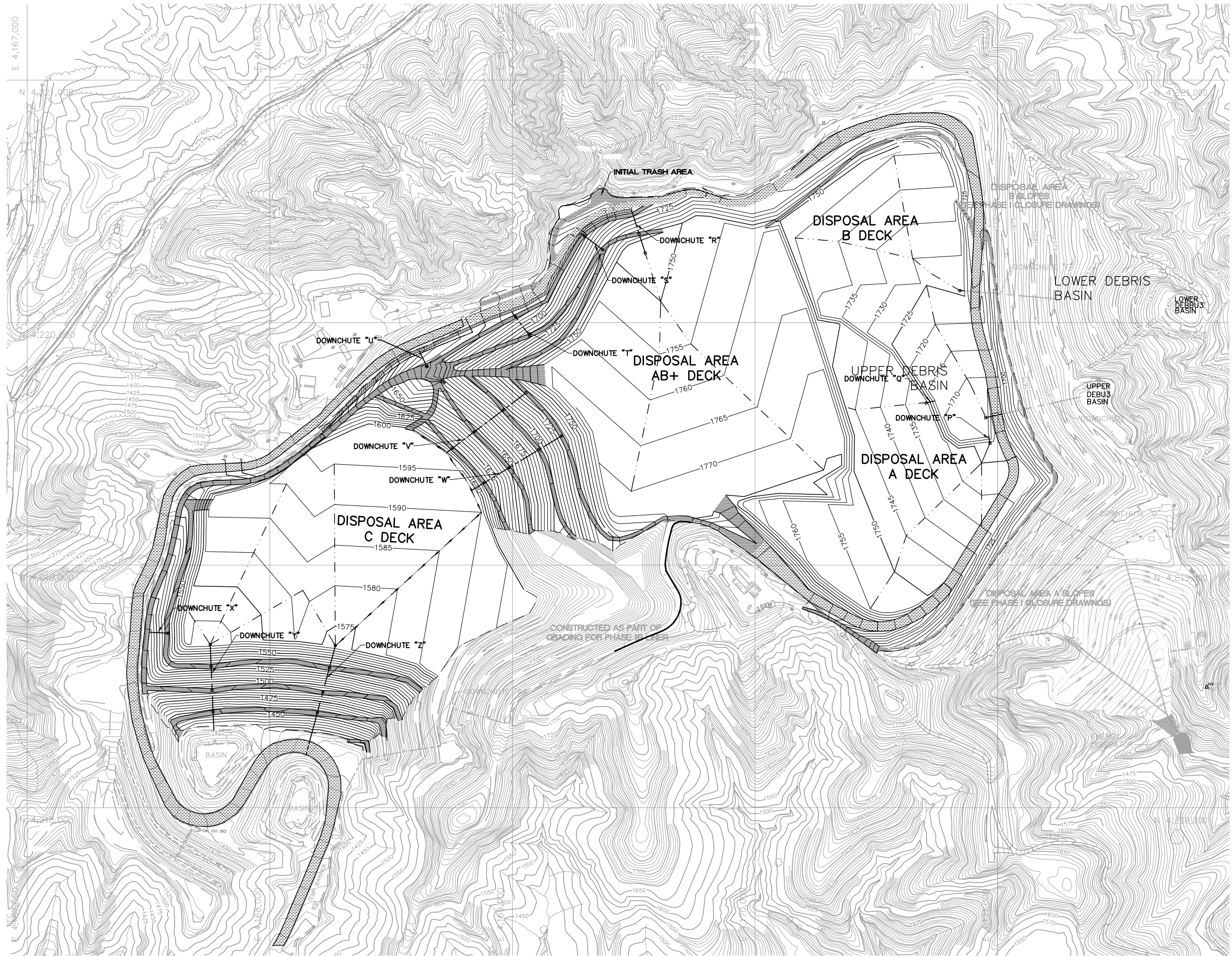
Closure

Final Cover Construction for Remaining Disposal Areas (Line 23)	<u>\$1,993,960</u>
Final Cover Construction for completed Disposal Areas (Line 23)	<u>\$3,019,139</u>
Construction of Haul Road and Drainage Channel	<u>\$258,360</u>
Revegetation (Line 29)	<u>\$1,408,290</u>
Landfill Gas Modifications (Line 32)	<u>\$829,213</u>
Drainage Installation (Line 35c)	<u>\$829,870</u>
Security Installation (Line 36d)	<u>\$33,000</u>
Other (Line 37d)	<u>\$1,965,555</u>
I. Subtotal Closure	<u>\$10,337,387</u>
II. Subtotal I x 20% Contingency Costs	<u>\$2,067,478</u>
Total Closure Cost	<u>\$12,404,865</u>

APPENDIX C

DRAWING NO. 1 FINAL GRADING PLAN FOR DISPOSAL AREA “C”

N:\CADD\N\0800\Figures\0800P052.dwg 7/18/08 13:19 Sberdy



LEGEND

- 1725 EXISTING CONTOUR
- 1725 PROPOSED FINAL GRADE CONTOURS
- PROPOSED DOWNCHUTE
- EXISTING DOWNCHUTE
- PROPOSED DIVERSION CHANNEL
- FLOW LINE
- EXISTING ROAD / BENCH
- PROPOSED ROAD / BENCH
- ASPHALT ACCESS ROAD
- PERIMETER CHANNEL
- ASPHALTIC CONCRETE CHANNEL (NIC)
- PROPOSED INLET STRUCTURE
- LIMIT OF PHASE II CLOSURE

DISPOSAL AREA A		
	MAXIMUM SLOPE	MINIMUM SLOPE
DECK	4.8%	3.2%
SLOPES	2.0:1	2.3:1
BENCHES	5.2%	2.5%

DISPOSAL AREA B		
	MAXIMUM SLOPE	MINIMUM SLOPE
DECK	4.4%	3.5%
SLOPES	2.0:1	3.0:1
BENCHES	6.2%	4.8%

DISPOSAL AREA AB+		
	MAXIMUM SLOPE	MINIMUM SLOPE
DECK	3.0%	3.0%
SLOPES	2.28:1	2.65:1
BENCHES	13%	2.8%

DISPOSAL AREA C		
	MAXIMUM SLOPE	MINIMUM SLOPE
DECK	3.5%	3.0%
SLOPES	2.0:1	2.0:1
BENCHES	7.75%	2.9%

NOTE:
1. THE FOLLOWING WORK IS NOT IN THE CONTRACT AND WILL BE PERFORMED BY THE CITY: ROUGH GRADING OF THE FOUNDATION LAYER, CONSTRUCTION OF THE VEGETATIVE LAYER, AND TRENCHING AND BACKFILLING FOR PIPE INSTALLATION.



CITY OF LOS ANGELES
BUREAU OF SANITATION
LOS ANGELES, CALIFORNIA

Geosyntec
consultants

OVERALL SITE PLAN
LOPEZ CANYON
SANITARY LANDFILL
LAKEVIEW TERRACE, CALIFORNIA

DRAWING NO.	1
PROJECT NO.	HL0800-18
DATE:	JULY 2008

APPENDIX D

SOIL TEST LABORATORY RESULTS
OF SELECTED SOIL BORROW
SOURCES

TABLE 1
SUMMARY OF LABORATORY RESULTS – METALS
SOIL BORING INVESTIGATION
VENTURA AND YOLANDA AVENUE
TARZANA, CALIFORNIA

Hydrocarbon Range	Sample ID					Reference Values	
	BH1-S3-15	BH1-S6-25	BH2-S4-20	BH4-S6-30	BH5-S2-10	CHHSLs ¹	EPA PRGs ²
Antimony	0.916	ND	ND	ND	ND	380	
Arsenic	4.37	4.68	3.23	4.66	3.18	0.24	0.25
Barium	133	145	120	170	120	63,000	67,000
Beryllium	0.455	0.519	0.446	0.539	0.387	1,700	1,900
Cadmium	0.697	1.52	0.655	1.07	0.816	7.5	450
Chromium	11.5	13.8	11.2	16.7	10.4	37	64
Cobalt	6.22	6.98	5.82	7.28	5.19	3,200	1,900
Copper	12.7	13.7	12.1	17.0	11.1	38,000	41,000
Lead	4.25	4.42	4.73	4.89	4.16	3,500	800
Mercury	ND	ND	ND	ND	ND	180	310
Molybdenum	1.40	1.07	1.01	1.12	1.33	4,800	5,100
Nickel	17.5	36.1	17.3	29.6	20.8	16,000	20,000
Selenium	ND	ND	ND	ND	ND	4,800	5,100
Silver	ND	ND	ND	ND	ND	4,800	5,100
Thallium	ND	ND	ND	ND	ND	63	
Vanadium	26.2	29.0	25.1	30.5	22.4	6,700	1,000
Zinc	41.2	34.8	39.7	41.6	35.9	100,000	100,000

Notes: 1- California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties

2- Environmental Protection Agency Preliminary Remediation Goals (PRGs)

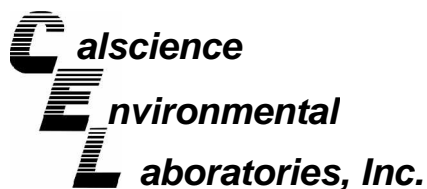
3 -All Units are mg/kg or Parts per million (PPM)

4- ND – not detected at concentration above laboratory reporting limit

TABLE 2
SUMMARY OF LABORATORY RESULTS – PETROLEUM HYDROCARBONS
SOIL BORING INVESTIGATION
VENTURA AND YOLANDA AVENUE
TARZANA, CALIFORNIA

Hydrocarbon Range	Sample ID				
	BH1-S3-15	BH1-S6-25	BH2-S4-20	BH4-S6-30	BH5-S2-10
C6	ND	ND	ND	ND	ND
C7	ND	ND	ND	ND	ND
C8	ND	ND	ND	ND	ND
C9-C10	ND	ND	ND	ND	ND
C11-C12	ND	ND	ND	ND	ND
C13-C14	0.15	0.059	0.12	0.16	0.17
C15-C16	0.63	0.68	0.55	0.34	0.72
C17-C18	0.82	0.64	0.54	0.61	0.50
C19-C20	0.74	1.9	1.7	0.85	1.3
C21-C22	0.68	1.8	2.6	1.3	2.0
C23-C24	0.43	0.43	0.50	0.47	0.72
C25-C28	0.22	0.12	0.17	0.097	0.26
C29-C32	ND	ND	ND	ND	ND
C33-C36	ND	ND	ND	ND	ND
C6-C36 Total	ND	5.5	6.1	ND	5.7

Notes: 1- California Human Health Screening Levels (CHHSLs) in Evaluation of Contaminated Properties for Commercial/Industrial Land Use
2- Environmental Protection Agency Preliminary Remediation Goals (PRGs)
3-Toxicity Criteria (including TTLC, STLC, TCLP) for Classifying Hazardous Waste
4 -All Units are mg/kg or Parts per million (PPM)
5- ND – not detected at concentration above laboratory reporting limit (numeric reporting limits for individual carbon chain ranges not available)



December 28, 2007

Yonas Zemuy
GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648-2460

Subject: **Calscience Work Order No.: 07-12-1651**
Client Reference: HL0800-02

Dear Client:

Enclosed is an analytical report for the above-referenced project. The samples included in this report were received 12/19/2007 and analyzed in accordance with the attached chain-of-custody.

Unless otherwise noted, all analytical testing was accomplished in accordance with the guidelines established in our Quality Systems Manual, applicable standard operating procedures, and other related documentation. The original report of subcontracted analysis, if any, is provided herein, and follows the standard Calscience data package. The results in this analytical report are limited to the samples tested and any reproduction thereof must be made in its entirety.

If you have any questions regarding this report, please do not hesitate to contact the undersigned.

Sincerely,

A handwritten signature in black ink, appearing to read 'S. Nowak'.

Calscience Environmental
Laboratories, Inc.
Stephen Nowak
Project Manager

Analytical Report



GeoSyntec Consultants
 2100 Main Street, Suite 150
 Huntington Beach, CA 92648-2460

Date Received: 12/19/07
 Work Order No: 07-12-1651
 Preparation: EPA 3050B / EPA 7471A Total
 Method: EPA 6010B / EPA 7471A
 Units: mg/kg

Project: HL0800-02

Page 1 of 2

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH1-S3-15	07-12-1651-1-A	12/17/07	Solid	ICP 5300	12/20/07	12/21/07	071220L05

Comment(s): -Mercury was analyzed on 12/20/2007 3:24:25 PM with batch 071220L05

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	0.916	0.750	1		Mercury	ND	0.0835	1	
Arsenic	4.37	0.750	1		Molybdenum	1.40	0.250	1	
Barium	133	0.500	1		Nickel	17.5	0.250	1	
Beryllium	0.455	0.250	1		Selenium	ND	0.750	1	
Cadmium	0.697	0.500	1		Silver	ND	0.250	1	
Chromium	11.5	0.250	1		Thallium	ND	0.750	1	
Cobalt	6.22	0.250	1		Vanadium	26.2	0.250	1	
Copper	12.7	0.500	1		Zinc	41.2	1.00	1	
Lead	4.25	0.500	1						

BH1-S6-25	07-12-1651-2-A	12/17/07	Solid	ICP 5300	12/20/07	12/21/07	071220L05
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Comment(s): -Mercury was analyzed on 12/20/2007 3:31:54 PM with batch 071220L05

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	ND	0.750	1		Mercury	ND	0.0835	1	
Arsenic	4.68	0.750	1		Molybdenum	1.07	0.250	1	
Barium	145	0.500	1		Nickel	36.1	0.250	1	
Beryllium	0.519	0.250	1		Selenium	ND	0.750	1	
Cadmium	1.52	0.500	1		Silver	ND	0.250	1	
Chromium	13.8	0.250	1		Thallium	ND	0.750	1	
Cobalt	6.98	0.250	1		Vanadium	29.0	0.250	1	
Copper	13.7	0.500	1		Zinc	34.8	1.00	1	
Lead	4.42	0.500	1						

BH2-S4-20	07-12-1651-3-A	12/17/07	Solid	ICP 5300	12/20/07	12/21/07	071220L05
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Comment(s): -Mercury was analyzed on 12/20/2007 3:34:08 PM with batch 071220L05

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	ND	0.750	1		Mercury	ND	0.0835	1	
Arsenic	3.23	0.750	1		Molybdenum	1.01	0.250	1	
Barium	120	0.500	1		Nickel	17.3	0.250	1	
Beryllium	0.446	0.250	1		Selenium	ND	0.750	1	
Cadmium	0.655	0.500	1		Silver	ND	0.250	1	
Chromium	11.2	0.250	1		Thallium	ND	0.750	1	
Cobalt	5.82	0.250	1		Vanadium	25.1	0.250	1	
Copper	12.1	0.500	1		Zinc	39.7	1.00	1	
Lead	4.73	0.500	1						

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Analytical Report



GeoSyntec Consultants
 2100 Main Street, Suite 150
 Huntington Beach, CA 92648-2460

Date Received: 12/19/07
 Work Order No: 07-12-1651
 Preparation: EPA 3050B / EPA 7471A Total
 Method: EPA 6010B / EPA 7471A
 Units: mg/kg

Project: HL0800-02

Page 2 of 2

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH4-S6-30	07-12-1651-4-A	12/17/07	Solid	ICP 5300	12/20/07	12/21/07	071220L05

Comment(s): -Mercury was analyzed on 12/20/2007 3:36:22 PM with batch 071220L05

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	ND	0.750	1		Mercury	ND	0.0835	1	
Arsenic	4.66	0.750	1		Molybdenum	1.12	0.250	1	
Barium	170	0.500	1		Nickel	29.6	0.250	1	
Beryllium	0.539	0.250	1		Selenium	ND	0.750	1	
Cadmium	1.07	0.500	1		Silver	ND	0.250	1	
Chromium	16.7	0.250	1		Thallium	ND	0.750	1	
Cobalt	7.28	0.250	1		Vanadium	30.5	0.250	1	
Copper	17.0	0.500	1		Zinc	41.6	1.00	1	
Lead	4.89	0.500	1						

BH5-S2-10	07-12-1651-5-A	12/17/07	Solid	ICP 5300	12/20/07	12/21/07	071220L05
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Comment(s): -Mercury was analyzed on 12/20/2007 3:38:35 PM with batch 071220L05

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	ND	0.750	1		Mercury	ND	0.0835	1	
Arsenic	3.18	0.750	1		Molybdenum	1.33	0.250	1	
Barium	120	0.500	1		Nickel	20.8	0.250	1	
Beryllium	0.387	0.250	1		Selenium	ND	0.750	1	
Cadmium	0.816	0.500	1		Silver	ND	0.250	1	
Chromium	10.4	0.250	1		Thallium	ND	0.750	1	
Cobalt	5.19	0.250	1		Vanadium	22.4	0.250	1	
Copper	11.1	0.500	1		Zinc	35.9	1.00	1	
Lead	4.16	0.500	1						

Method Blank	099-04-007-5,206	N/A	Solid	Mercury	12/20/07	12/20/07	071220L05
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Parameter	Result	RL	DF	Qual
Mercury	ND	0.0835	1	

Method Blank	097-01-002-10,223	N/A	Solid	ICP 5300	12/20/07	12/20/07	071220L05
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Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
Antimony	ND	0.750	1		Lead	ND	0.500	1	
Arsenic	ND	0.750	1		Molybdenum	ND	0.250	1	
Barium	ND	0.500	1		Nickel	ND	0.250	1	
Beryllium	ND	0.250	1		Selenium	ND	0.750	1	
Cadmium	ND	0.500	1		Silver	ND	0.250	1	
Chromium	ND	0.250	1		Thallium	ND	0.750	1	
Cobalt	ND	0.250	1		Vanadium	ND	0.250	1	
Copper	ND	0.500	1		Zinc	ND	1.00	1	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers

Analytical Report



GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648-2460

Date Received: 12/19/07
Work Order No: 07-12-1651
Preparation: EPA 3550B
Method: EPA 8015B (M)
Units: mg/kg

Project: HL0800-02

Page 1 of 2

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH1-S3-15	07-12-1651-1-A	12/17/07	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
C6	ND		1		C19-C20	0.74		1	
C7	ND		1		C21-C22	0.68		1	
C8	ND		1		C23-C24	0.43		1	
C9-C10	ND		1		C25-C28	0.22		1	
C11-C12	ND		1		C29-C32	ND		1	
C13-C14	0.15		1		C33-C36	ND		1	
C15-C16	0.63		1		C6-C36 Total	ND	5.0	1	
C17-C18	0.82		1						

Surrogates:	REC (%)	Control Limits	Qual
Decachlorobiphenyl	110	61-145	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH1-S6-25	07-12-1651-2-A	12/17/07	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
C6	ND		1		C19-C20	1.9		1	
C7	ND		1		C21-C22	1.8		1	
C8	ND		1		C23-C24	0.43		1	
C9-C10	ND		1		C25-C28	0.12		1	
C11-C12	ND		1		C29-C32	ND		1	
C13-C14	0.059		1		C33-C36	ND		1	
C15-C16	0.68		1		C6-C36 Total	5.5	5.0	1	
C17-C18	0.64		1						

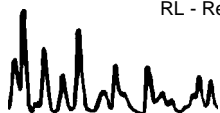
Surrogates:	REC (%)	Control Limits	Qual
Decachlorobiphenyl	110	61-145	

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH2-S4-20	07-12-1651-3-A	12/17/07	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
C6	ND		1		C19-C20	1.7		1	
C7	ND		1		C21-C22	2.6		1	
C8	ND		1		C23-C24	0.50		1	
C9-C10	ND		1		C25-C28	0.17		1	
C11-C12	ND		1		C29-C32	ND		1	
C13-C14	0.12		1		C33-C36	ND		1	
C15-C16	0.55		1		C6-C36 Total	6.1	5.0	1	
C17-C18	0.54		1						

Surrogates:	REC (%)	Control Limits	Qual
Decachlorobiphenyl	111	61-145	

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers



Analytical Report



GeoSyntec Consultants
 2100 Main Street, Suite 150
 Huntington Beach, CA 92648-2460

Date Received: 12/19/07
 Work Order No: 07-12-1651
 Preparation: EPA 3550B
 Method: EPA 8015B (M)
 Units: mg/kg

Project: HL0800-02

Page 2 of 2

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH4-S6-30	07-12-1651-4-A	12/17/07	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
C6	ND		1		C19-C20	0.85		1	
C7	ND		1		C21-C22	1.3		1	
C8	ND		1		C23-C24	0.47		1	
C9-C10	ND		1		C25-C28	0.097		1	
C11-C12	ND		1		C29-C32	ND		1	
C13-C14	0.16		1		C33-C36	ND		1	
C15-C16	0.34		1		C6-C36 Total	ND	5.0	1	
C17-C18	0.61		1						

Surrogates: REC (%) Control Limits Qual

Decachlorobiphenyl 110 61-145

Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
BH5-S2-10	07-12-1651-5-A	12/17/07	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	Result	RL	DF	Qual	Parameter	Result	RL	DF	Qual
C6	ND		1		C19-C20	1.3		1	
C7	ND		1		C21-C22	2.0		1	
C8	ND		1		C23-C24	0.72		1	
C9-C10	ND		1		C25-C28	0.26		1	
C11-C12	ND		1		C29-C32	ND		1	
C13-C14	0.17		1		C33-C36	ND		1	
C15-C16	0.72		1		C6-C36 Total	5.7	5.0	1	
C17-C18	0.50		1						

Surrogates: REC (%) Control Limits Qual

Decachlorobiphenyl 113 61-145

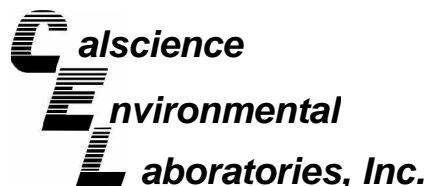
Client Sample Number	Lab Sample Number	Date Collected	Matrix	Instrument	Date Prepared	Date Analyzed	QC Batch ID
Method Blank	099-12-275-1,289	N/A	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	Result	RL	DF	Qual
TPH as Diesel	ND	5.0	1	

Surrogates: REC (%) Control Limits Qual

Decachlorobiphenyl 116 61-145

RL - Reporting Limit , DF - Dilution Factor , Qual - Qualifiers



Quality Control - Spike/Spike Duplicate



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Huntington Beach, CA 92648-2460

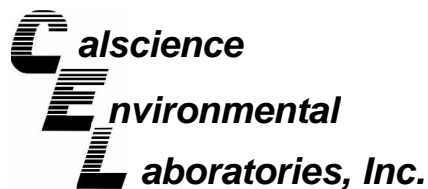
Date Received: 12/19/07
Work Order No: 07-12-1651
Preparation: EPA 3050B
Method: EPA 6010B

Project HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
BH1-S3-15	Solid	ICP 5300	12/20/07	12/21/07	071220S05

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Antimony	24	25	50-115	5	0-20	3
Arsenic	98	96	75-125	2	0-20	
Barium	4X	4X	75-125	4X	0-20	Q
Beryllium	98	98	75-125	0	0-20	
Cadmium	93	93	75-125	0	0-20	
Chromium	102	97	75-125	3	0-20	
Cobalt	93	92	75-125	1	0-20	
Copper	100	94	75-125	4	0-20	
Lead	93	92	75-125	1	0-20	
Molybdenum	90	90	75-125	0	0-20	
Nickel	100	93	75-125	4	0-20	
Selenium	85	86	75-125	1	0-20	
Silver	93	92	75-125	2	0-20	
Thallium	84	86	75-125	2	0-20	
Vanadium	105	96	75-125	4	0-20	
Zinc	106	88	75-125	7	0-20	

RPD - Relative Percent Difference , CL - Control Limit



Quality Control - PDS / PDSD



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Huntington Beach, CA 92648-2460

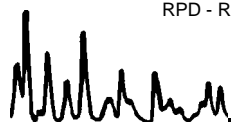
Date Received 12/19/07
Work Order No: 07-12-1651
Preparation: EPA 3050B
Method: EPA 6010B

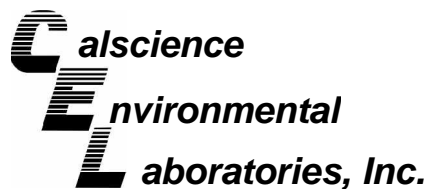
Project: HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	PDS/PDSD Batch Number
BH1-S3-15	Solid	ICP 5300	12/20/07	12/26/07	071220S05

Parameter	PDS %REC	PDSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Antimony	94	90	75-125	4	0-20	
Arsenic	103	101	75-125	2	0-20	
Barium	4X	4X	75-125	4X	0-20	Q
Beryllium	94	94	75-125	0	0-20	
Cadmium	97	97	75-125	0	0-20	
Chromium	103	104	75-125	1	0-20	
Cobalt	101	101	75-125	0	0-20	
Copper	111	109	75-125	2	0-20	
Lead	97	97	75-125	0	0-20	
Molybdenum	97	97	75-125	0	0-20	
Nickel	101	100	75-125	0	0-20	
Selenium	78	79	75-125	2	0-20	
Silver	98	96	75-125	1	0-20	
Thallium	96	96	75-125	0	0-20	
Vanadium	112	109	75-125	1	0-20	
Zinc	108	103	75-125	2	0-20	

RPD - Relative Percent Difference , CL - Control Limit





Quality Control - Spike/Spike Duplicate



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Huntington Beach, CA 92648-2460

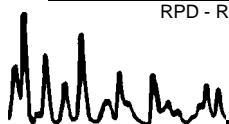
Date Received: 12/19/07
Work Order No: 07-12-1651
Preparation: EPA 3550B
Method: EPA 8015B (M)

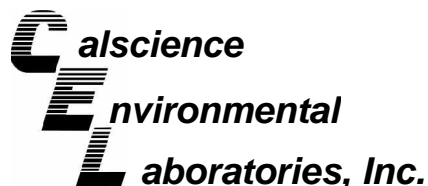
Project HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
BH4-S6-30	Solid	GC 3	12/21/07	12/21/07	071221S04

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
TPH as Diesel	95	96	64-130	1	0-15	

RPD - Relative Percent Difference , CL - Control Limit





Quality Control - Spike/Spike Duplicate



GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648-2460

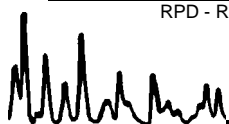
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Work Order No: 07-12-1651
Preparation: EPA 7471A Total
Method: EPA 7471A

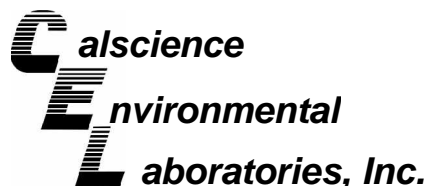
Project HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	MS/MSD Batch Number
07-12-1539-1	Solid	Mercury	12/20/07	12/20/07	071220S05

Parameter	MS %REC	MSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Mercury	91	96	84-138	6	0-7	

RPD - Relative Percent Difference , CL - Control Limit





Quality Control - LCS/LCS Duplicate



GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648-2460

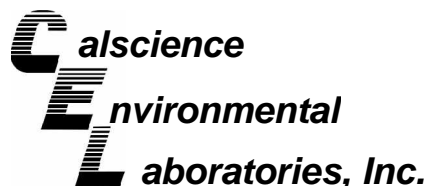
Date Received: N/A
Work Order No: 07-12-1651
Preparation: EPA 3050B
Method: EPA 6010B

Project: HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
097-01-002-10,223	Solid	ICP 5300	12/20/07	12/20/07	071220L05

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Antimony	88	91	80-120	4	0-20	
Arsenic	98	99	80-120	1	0-20	
Barium	100	103	80-120	2	0-20	
Beryllium	94	96	80-120	2	0-20	
Cadmium	100	100	80-120	1	0-20	
Chromium	100	101	80-120	1	0-20	
Cobalt	102	100	80-120	2	0-20	
Copper	95	93	80-120	3	0-20	
Lead	100	101	80-120	2	0-20	
Molybdenum	96	101	80-120	5	0-20	
Nickel	105	107	80-120	2	0-20	
Selenium	90	94	80-120	4	0-20	
Silver	94	94	80-120	0	0-20	
Thallium	97	98	80-120	1	0-20	
Vanadium	97	98	80-120	1	0-20	
Zinc	102	106	80-120	4	0-20	

RPD - Relative Percent Difference , CL - Control Limit



Quality Control - LCS/LCS Duplicate



GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648-2460

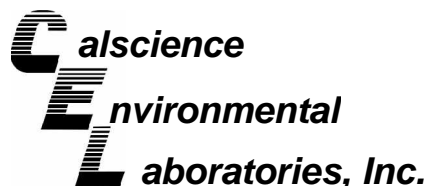
Date Received: N/A
Work Order No: 07-12-1651
Preparation: EPA 3550B
Method: EPA 8015B (M)

Project: HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-12-275-1,289	Solid	GC 3	12/21/07	12/21/07	071221B04

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
TPH as Diesel	107	108	75-123	1	0-12	

RPD - Relative Percent Difference , CL - Control Limit



Quality Control - LCS/LCS Duplicate



GeoSyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648-2460

Date Received: N/A
Work Order No: 07-12-1651
Preparation: EPA 7471A Total
Method: EPA 7471A

Project: HL0800-02

Quality Control Sample ID	Matrix	Instrument	Date Prepared	Date Analyzed	LCS/LCSD Batch Number
099-04-007-5,206	Solid	Mercury	12/20/07	12/20/07	071220L05

Parameter	LCS %REC	LCSD %REC	%REC CL	RPD	RPD CL	Qualifiers
Mercury	103	103	87-117	0	0-3	

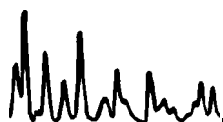
RPD - Relative Percent Difference , CL - Control Limit

Glossary of Terms and Qualifiers



Work Order Number: 07-12-1651

<u>Qualifier</u>	<u>Definition</u>
*	See applicable analysis comment.
1	Surrogate compound recovery was out of control due to a required sample dilution, therefore, the sample data was reported without further clarification.
2	Surrogate compound recovery was out of control due to matrix interference. The associated method blank surrogate spike compound was in control and, therefore, the sample data was reported without further clarification.
3	Recovery of the Matrix Spike (MS) or Matrix Spike Duplicate (MSD) compound was out of control due to matrix interference. The associated LCS and/or LCSD was in control and, therefore, the sample data was reported without further clarification.
4	The MS/MSD RPD was out of control due to matrix interference. The LCS/LCSD RPD was in control and, therefore, the sample data was reported without further clarification.
5	The PDS/PDSD associated with this batch of samples was out of control due to a matrix interference effect. The associated batch LCS/LCSD was in control and, hence, the associated sample data was reported with no further corrective action required.
A	Result is the average of all dilutions, as defined by the method.
B	Analyte was present in the associated method blank.
C	Analyte presence was not confirmed on primary column.
E	Concentration exceeds the calibration range.
H	Sample received and/or analyzed past the recommended holding time.
J	Analyte was detected at a concentration below the reporting limit and above the laboratory method detection limit. Reported value is estimated.
N	Nontarget Analyte.
ND	Parameter not detected at the indicated reporting limit.
Q	Spike recovery and RPD control limits do not apply resulting from the parameter concentration in the sample exceeding the spike concentration by a factor of four or greater.
U	Undetected at the laboratory method detection limit.
X	% Recovery and/or RPD out-of-range.
Z	Analyte presence was not confirmed by second column or GC/MS analysis.





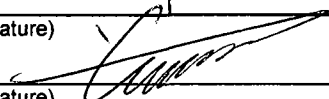
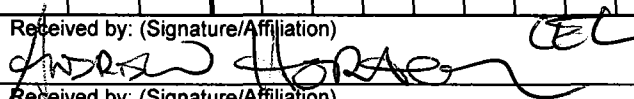
Calscience Environmental Laboratories, Inc.

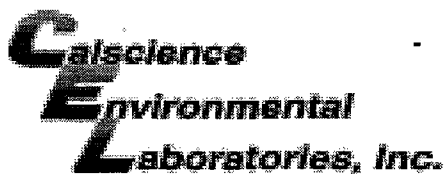
☒ SoCal Laboratory
7440 Lincoln Way
Garden Grove, CA 92841-1427
(714) 895-5494

☐ NorCal Service Center
5063 Commercial Circle, Suite H
Concord, CA 94520-8577
(925) 689-9022

CHAIN OF CUSTODY RECORD

Date 12/19/2007
Page 1 of 1

LABORATORY CLIENT: GEOSYNTEC CONSULTANTS							CLIENT PROJECT NAME / NUMBER: HL0800-02				P.O. NO.: HL0800-02										
ADDRESS: 2100 MAIN STREET, SUITE 150							PROJECT CONTACT: YONAS ZEMUY				LAB USE ONLY 1 2 - 1 6 5 1										
CITY HUNTINGTON BEACH STATE CA ZIP 92648							SAMPLER(S) (PRINT) YONAS ZEMUY				COELT LOG CODE <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>										
TEL: 714-465-1256 E-MAIL: yzemuy@geosyntec.com							COOLER RECEIPT TEMP= _____ °C														
TURNAROUND TIME: <input type="checkbox"/> SAME DAY <input type="checkbox"/> 24 HR <input type="checkbox"/> 48 HR <input type="checkbox"/> 72 HR <input checked="" type="checkbox"/> 5 DAYS <input type="checkbox"/> 10 DAYS							REQUESTED ANALYSES														
SPECIAL REQUIREMENTS (ADDITIONAL COSTS MAY APPLY) <input type="checkbox"/> RWQCB REPORTING FORMS <input type="checkbox"/> COELT EDF <input type="checkbox"/> _____																					
SPECIAL INSTRUCTIONS:																					
LAB USE ONLY	SAMPLE ID	FIELD POINT NAME (FOR COELT EDF)	SAMPLING DATE TIME		MATRIX	NO. OF CONT.	TPH (g)	TPH (d) or (C7-C36) or (C7-C44)	TPH (3015M (C7-C36))	BTEX / MTBE (8260B)	VOCs (8260B)	VOCs+Oxys (8260B)	Encore Prep (5035)	SVOCs (8270C)	Pesticides (8181A)	PCBs (8082)	PNAs (8310) or (8270C)	T22 Metals (6010B/747X)	Cr(VI) [7196A or 7199 or 218.6]	VOCs (TO-14A) or (TO-15)	TPH (g) [TO-3]+
	BH1-S3-15		12/17/07	9:30AM	SOIL	1			X									X			
	BH1-S6-25			10:00AM																	
	BH2-S4-20			10:30AM																	
	BH4-S6-30			1:15 PM																	
	BH5-S2-10			2:30PM																	
Relinquished by: (Signature) 							Received by: (Signature/Affiliation)  CEC							Date: 12/19/2007		Time: 13:03					
Relinquished by: (Signature)							Received by: (Signature/Affiliation)							Date:		Time:					
Relinquished by: (Signature)							Received by: (Signature/Affiliation)							Date:		Time:					


 WORK ORDER #: 0 7 - 1 2 - 1 6 5 1

 Cooler 0 of 0

SAMPLE RECEIPT FORM

 CLIENT: GEOSUNTEC

 DATE: 12/19/07
TEMPERATURE – SAMPLES RECEIVED BY:
CALSCIENCE COURIER:

- ☐ Chilled, cooler with temperature blank provided.
☐ Chilled, cooler without temperature blank.
☐ Chilled and placed in cooler with wet ice.
☐ Ambient and placed in cooler with wet ice.
☐ Ambient temperature.
☐ °C Temperature blank.

LABORATORY (Other than Calscience Courier):

- ☐ °C Temperature blank.
☐ °C IR thermometer.
☒ Ambient temperature.

 Initial: AA
CUSTODY SEAL INTACT:

 Sample(s): _____ Cooler: _____ No (Not Intact) : _____ Not Present: ✓

 Initial: AA
SAMPLE CONDITION:

	Yes	No	N/A
Chain-Of-Custody document(s) received with samples.....	<u>✓</u>		
Sampler's name indicated on COC.....	<u>✓</u>		
Sample container label(s) consistent with custody papers.....	<u>✓</u>		
Sample container(s) intact and good condition.....	<u>✓</u>		
Correct containers and volume for analyses requested.....	<u>✓</u>		
Proper preservation noted on sample label(s).....			<u>✓</u>
VOA vial(s) free of headspace.			<u>✓</u>
Tedlar bag(s) free of condensation.....			<u>✓</u>

 Initial: AA
COMMENTS:



KEANTAN LABORATORIES

www.keantanlabs.com
email: info@keantanlabs.com

December 24, 2007

Geosyntec Consultants
2100 Main Street, Suite 150
Huntington Beach, CA 92648

Attention: Mr. Yonas Zemuy

Subject: Report/Laboratory Test Results
Project Name: Carson
Project No.: HL 0800
KTL Project No.: 04-310-015

To Mr.: Yonas Zemuy

Enclosed are results of the laboratory testing program conducted on samples from the above referenced project. The testing performed for this program was conducted in general accordance with testing procedures as follows:

TYPE OF TEST
Grain Size Analysis
Atterberg Limit

TEST PROCEDURE
ASTM D 422
ASTM D 4318

Attached herewith is Summary of Grain Size Analysis Test Result (11), and Summary of Atterberg Limit Test Result (11).

We appreciate the opportunity to provide testing services to Geosyntec Consultants. If you have any questions regarding the test results, please contact us.

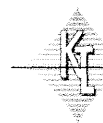
Very truly yours,
Keantan Laboratories

Jonathan Khaw
Laboratory Manager

Kean Tan
Principle (REC No. 50498)



Encls.



**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

KTL NO.: 04-310-015

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana

PROJECT NO.: HL0800

SAMPLE NO.: BH-1 S-3

DEPTH(FT) 15'

DATE: 12/23/2007

DESCRIPTION:

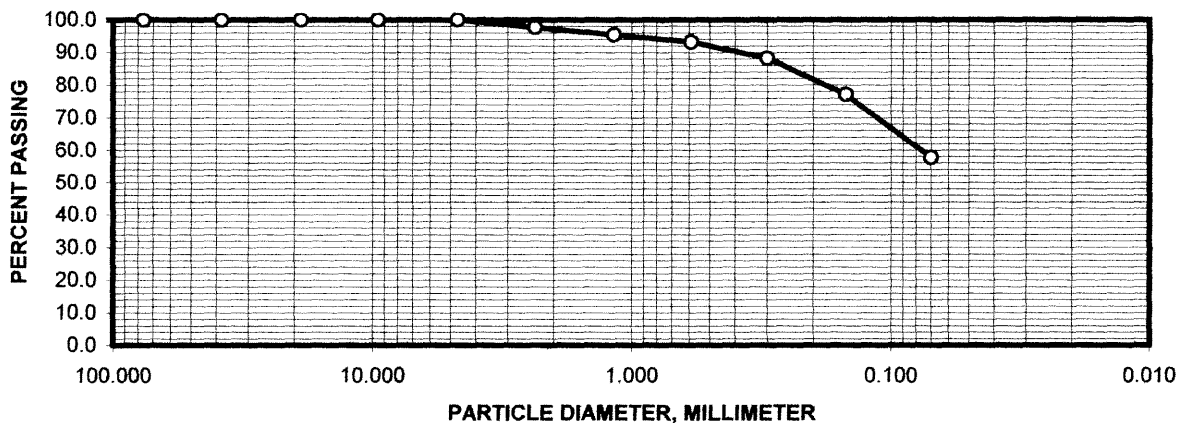
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	SM		
Moisture Content Determination:	9.97%		
Pan Number:	KB-32		
Pan + Dry Soil, gms.	735.1		
Wt. of Pan, gms.	85.1		
Wt. of Dry Soil, gms.	650.0		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	15.87	15.9	97.6
#20	0.046	1.17	14.04	29.9	95.4
#40	0.023	0.59	14.41	44.3	93.2
#60	0.012	0.30	32.26	76.6	88.2
#100	0.006	0.15	72.24	148.8	77.1
#200	0.003	0.07	126.06	274.9	57.7

Percent Passing

200 57%



87x93σw



KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

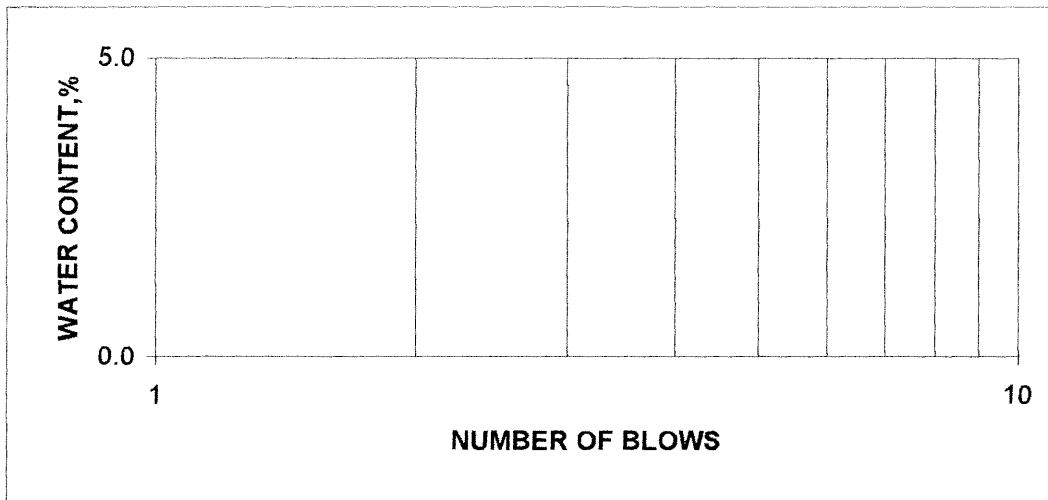
Project Name: 18620-18728 Ventura Blvd, Tarzana KTL No.: 04-310-015
Sample No.: BH-1 S-3 DEPTH: 15'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

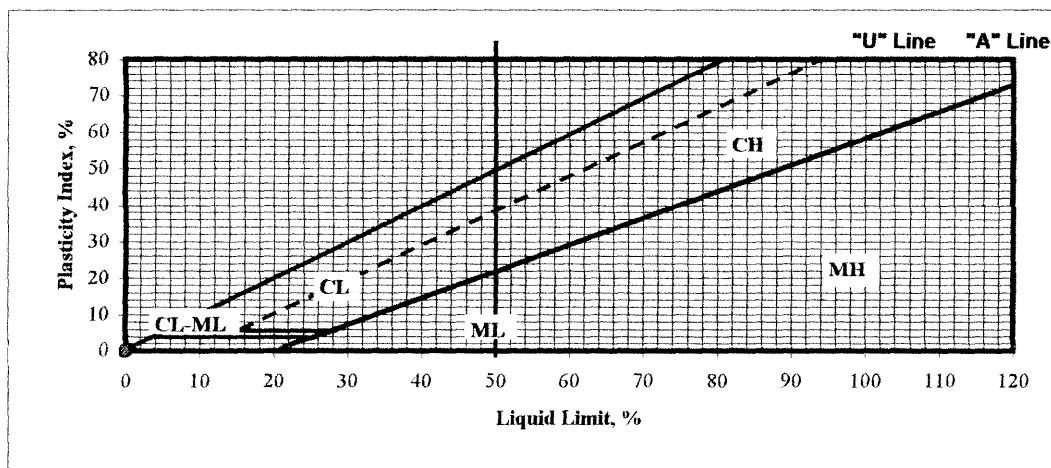
	Liquid Limit				Plastic Limit		
Can Number							
Weight of Can + Wet Soil, gms.							
Weight of Can + Dry Soil, gms.							
Weight of Can, gms.							
Weight of Dry Soil, gms.							
Weight of Water, gms.							
Water Content, %							
Number of Blows							

Non-Plastic

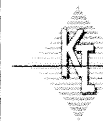
Unified Soil Classification



LL= 0 PL= 0 PI= 0



87793ar



**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-1 S-5 DEPTH(FT) 20'
DESCRIPTION:

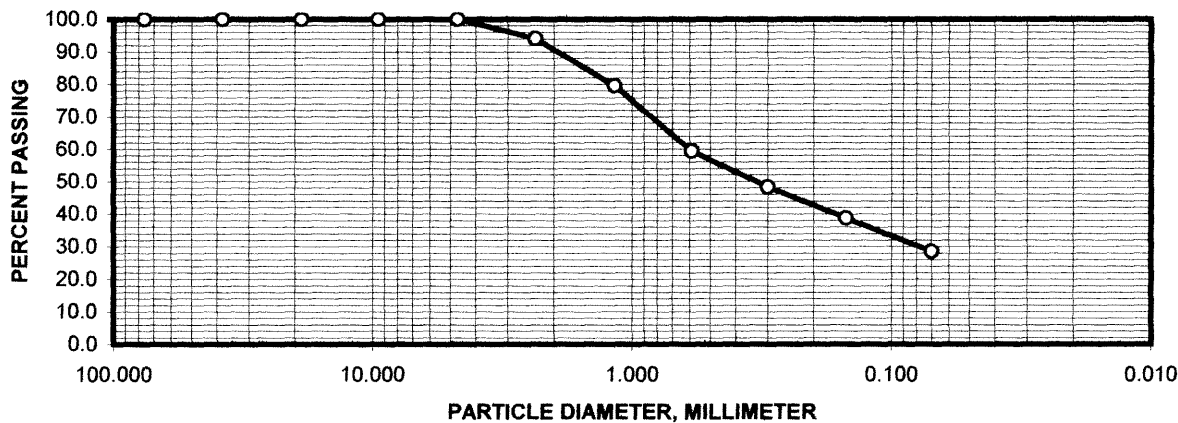
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	SM		
Moisture Content Determination:	6.80%		
Pan Number:	KB-2		
Pan + Dry Soil, gms.	1044.5		
Wt. of Pan, gms.	85.3		
Wt. of Dry Soil, gms.	959.2		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	15.87	15.9	94.1
#20	0.046	1.17	14.04	29.9	79.6
#40	0.023	0.59	14.41	44.3	59.4
#60	0.012	0.30	32.26	76.6	48.3
#100	0.006	0.15	72.24	148.8	38.8
#200	0.003	0.07	126.06	274.9	28.6

Percent Passing

200 28%



8779306



ATTERBERG LIMITS

ASTM D4318

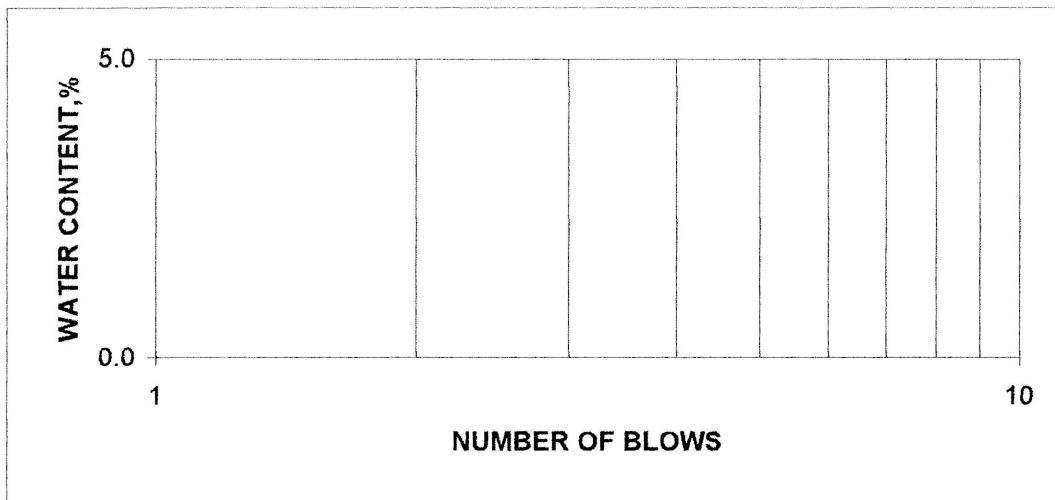
Project Name: 18620-18728 Ventura Blvd. Tarzana KTL No.: 04-310-015
Sample No.: BH1 S-5 DEPTH: 20'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

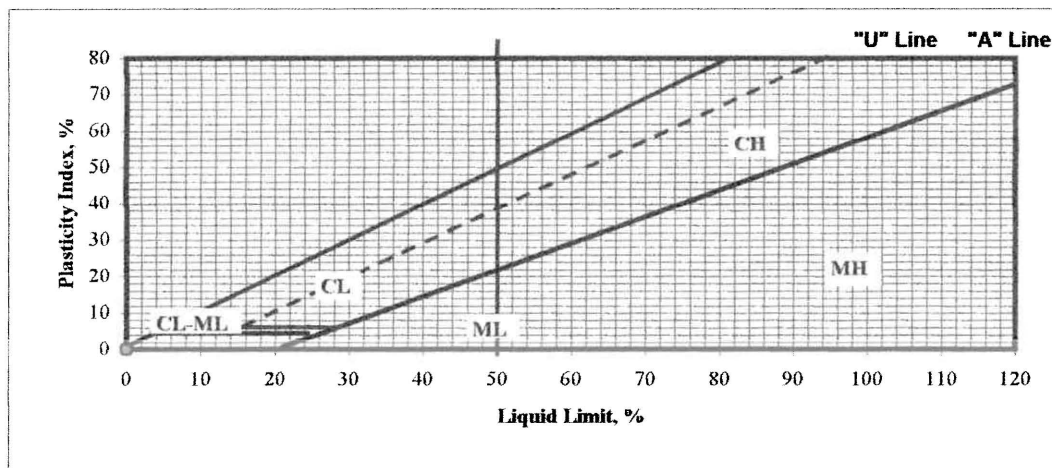
	Liquid Limit				Plastic Limit		
Can Number							
Weight of Can + Wet Soil, gms.							
Weight of Can + Dry Soil, gms.							
Weight of Can, gms.							
Weight of Dry Soil, gms.							
Weight of Water, gms.							
Water Content, %							
Number of Blows							

Non-Plastic

Unified Soil Classification



LL= 0 PL= 0 PI= 0



87793at



**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-1 S-5 DEPTH(FT) 25'
DESCRIPTION:

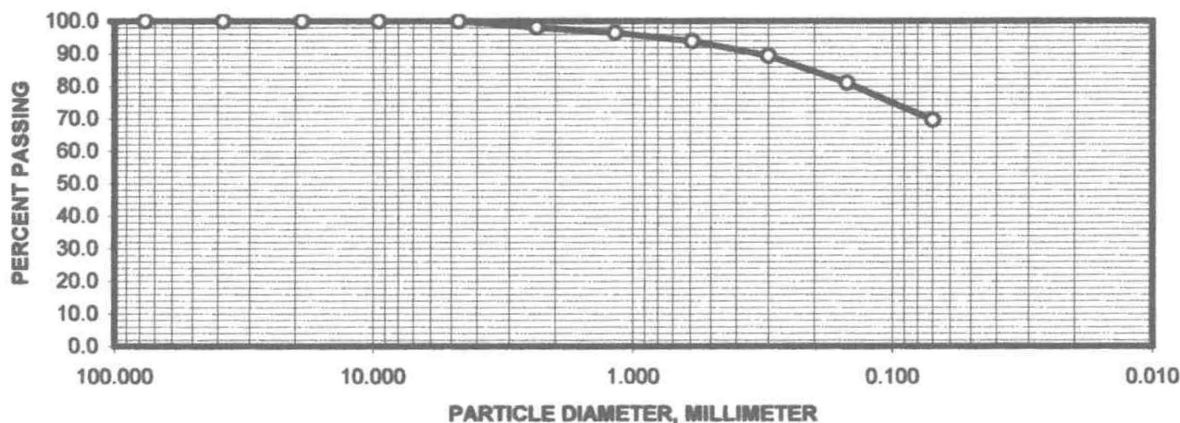
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	CL		
Moisture Content Determination:	16.30%		
Pan Number:	KB-28		
Pan + Dry Soil, gms.	874.2		
Wt. of Pan, gms.	85.2		
Wt. of Dry Soil, gms.	789.0		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	14.94	14.9	98.1
#20	0.046	1.17	12.30	27.2	96.5
#40	0.023	0.59	21.28	48.5	93.9
#60	0.012	0.30	34.77	83.3	89.4
#100	0.006	0.15	65.84	149.1	81.1
#200	0.003	0.07	90.39	239.5	69.6

Percent Passing

200 69%



87x93cm



KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

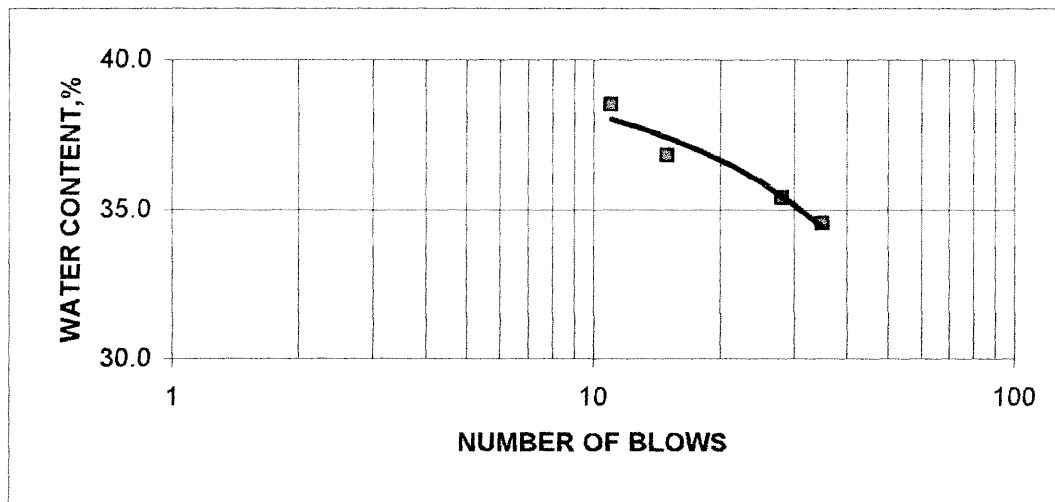
Project Name: 18620-18728 Ventura Blvd, Tarzana KTL No.: 04-310-015
Sample No.: BH-1 S-5 DEPTH: 25'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

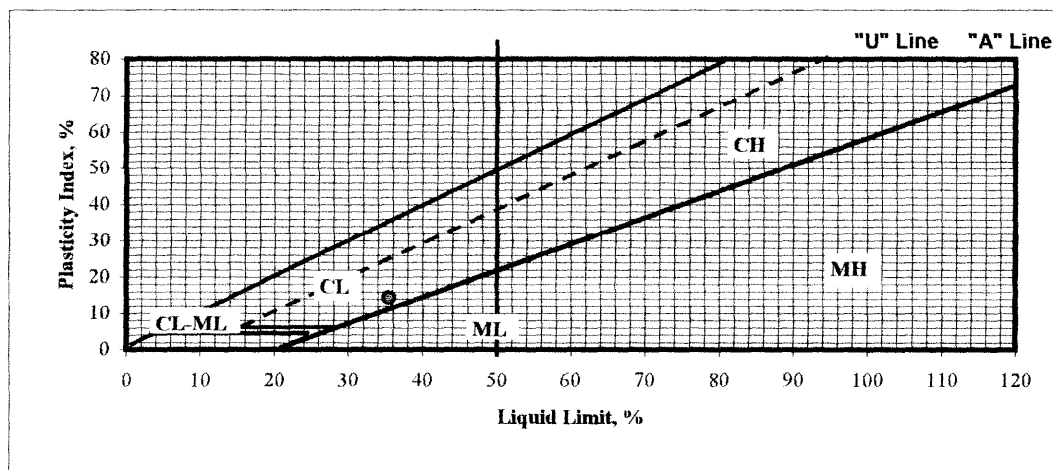
	Liquid Limit			
Can Number	C-7	B-10	B-17	HA-44
Weight of Can + Wet Soil, gms.	18.11	18.49	13.30	20.44
Weight of Can + Dry Soil, gms.	13.75	13.95	10.03	15.07
Weight of Can, gms.	1.13	1.13	1.15	1.13
Weight of Dry Soil, gms.	12.62	12.82	8.88	13.94
Weight of Water, gms.	4.36	4.54	3.27	5.37
Water Content, %	34.5	35.4	36.8	38.5
Number of Blows	35	28	15	11

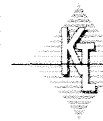
Plastic Limit	
8506	8501
5.29	6.54
4.56	5.61
1.13	1.16
3.43	4.45
0.73	0.93
21.3	20.9

Unified Soil Classification



LL= 35 PL= 21 PI= 14





**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

KTL NO.: 04-310-015

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana

PROJECT NO.: HL0800

SAMPLE NO.: BH-2 S-3

DEPTH(FT) 15'

DATE: 12/23/2007

DESCRIPTION:

TECH.: jk

UNIFIED SOIL CLASSIFICATION:

Moisture Content Determination: 16.30%

Pan Number: KB-4

Pan + Dry Soil, gms. 1198.4

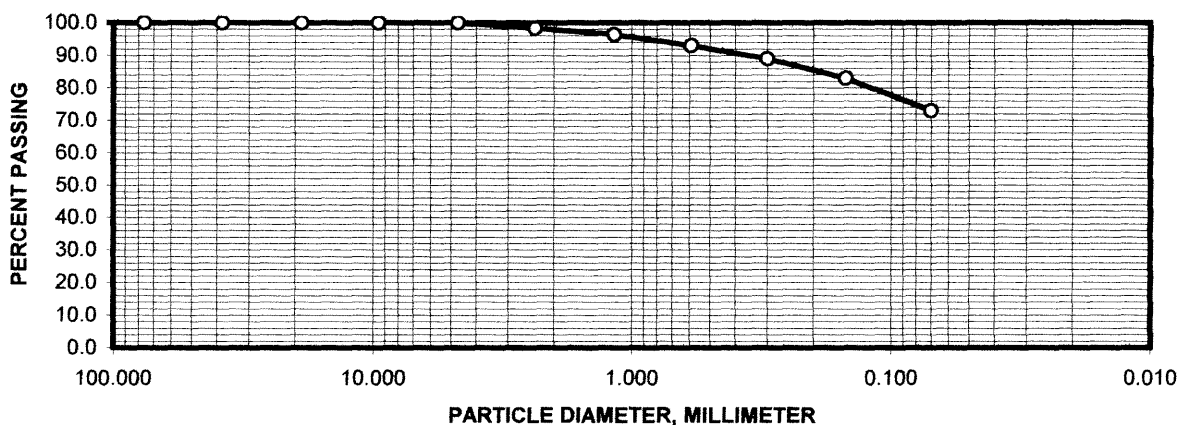
Wt. of Pan, gms. 84.9

Wt. of Dry Soil, gms. 1113.6

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	18.87	18.9	98.3
#20	0.046	1.17	21.05	39.9	96.4
#40	0.023	0.59	37.95	77.9	93.0
#60	0.012	0.30	44.47	122.3	89.0
#100	0.006	0.15	66.83	189.2	83.0
#200	0.003	0.07	111.27	300.4	73.0

Percent Passing

200 73%



87x93σ



KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

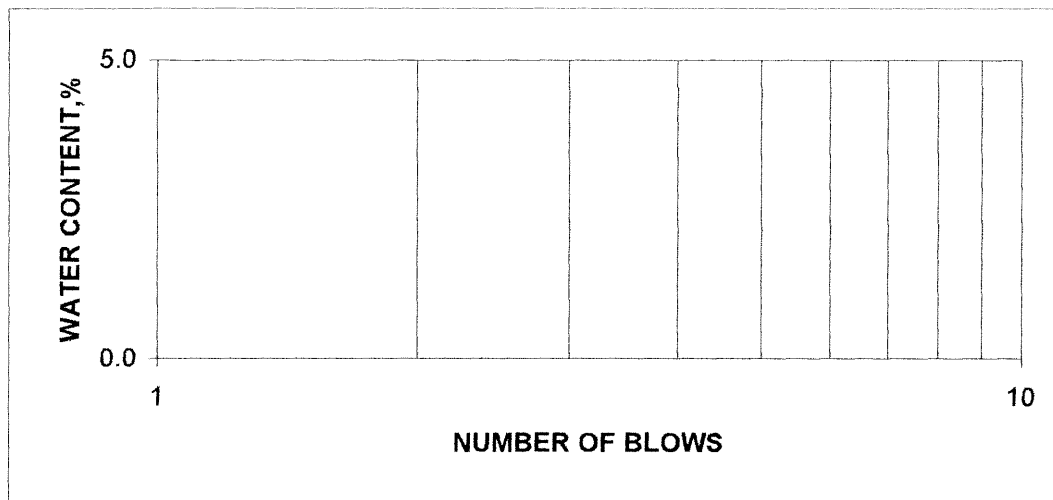
Project Name: 18620-18728 Ventura Blvd. Tarzana KTL No.: 04-310-015
Sample No.: BH-2 S-3 DEPTH: 15'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

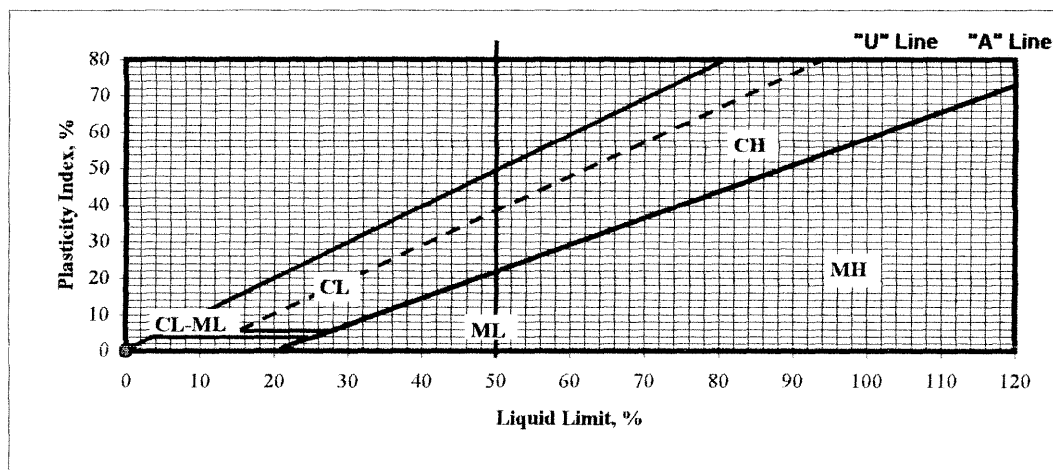
	Liquid Limit				Plastic Limit		
Can Number							
Weight of Can + Wet Soil, gms.							
Weight of Can + Dry Soil, gms.							
Weight of Can, gms.							
Weight of Dry Soil, gms.							
Weight of Water, gms.							
Water Content, %							
Number of Blows							

Non-Plastic

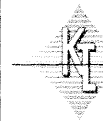
Unified Soil Classification



LL= 0 PL= 0 PI= 0



87793at



**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana

KTL NO.: 04-310-015

SAMPLE NO.: BH-2 S-6

DEPTH(FT) 25'

PROJECT NO.: HL0800

DESCRIPTION:

DATE: 12/23/2007

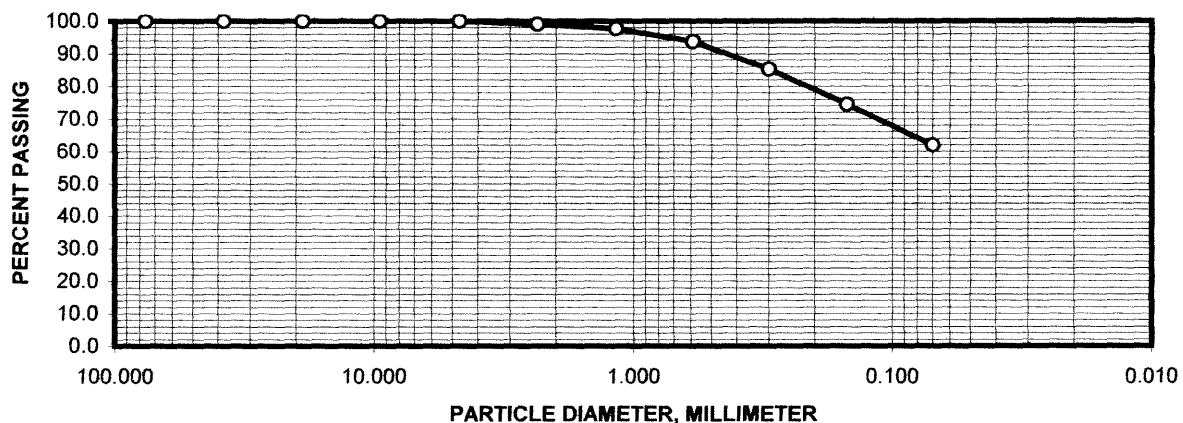
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	SM		
Moisture Content Determination:	11.20%		
Pan Number:	KB-29		
Pan + Dry Soil, gms.	844.6		
Wt. of Pan, gms.	84.4		
Wt. of Dry Soil, gms.	760.2		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	7.75	7.8	99.0
#20	0.046	1.17	10.44	18.2	97.6
#40	0.023	0.59	29.59	47.8	93.7
#60	0.012	0.30	64.26	112.0	85.3
#100	0.006	0.15	81.58	193.6	74.5
#200	0.003	0.07	96.17	289.8	61.9

Percent Passing

200 61%



δγχ93σσ

ATTERBERG LIMITS

ASTM D4318

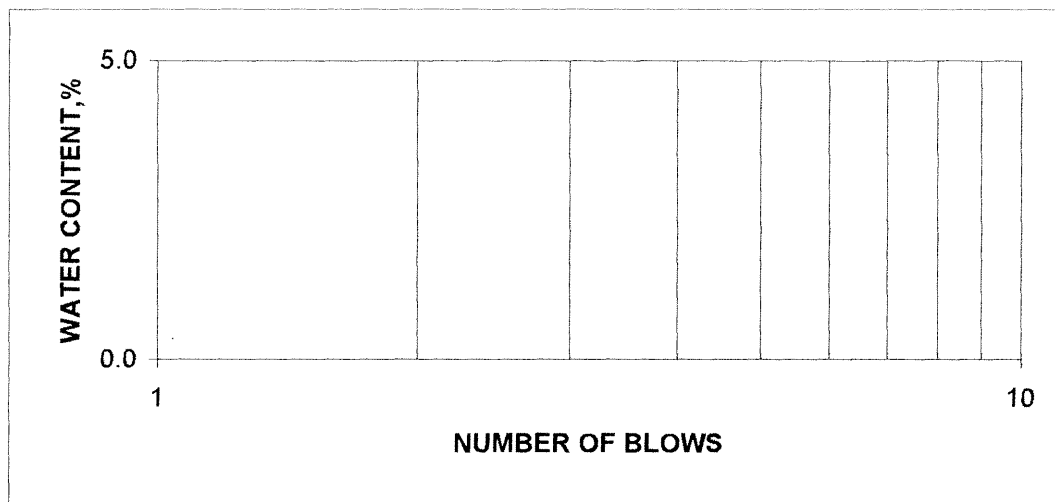
Project Name: 18620-18728 Ventura Blvd. Tarzana KTL No.: 04-310-015
Sample No.: BH-2 S-6 DEPTH: 25'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

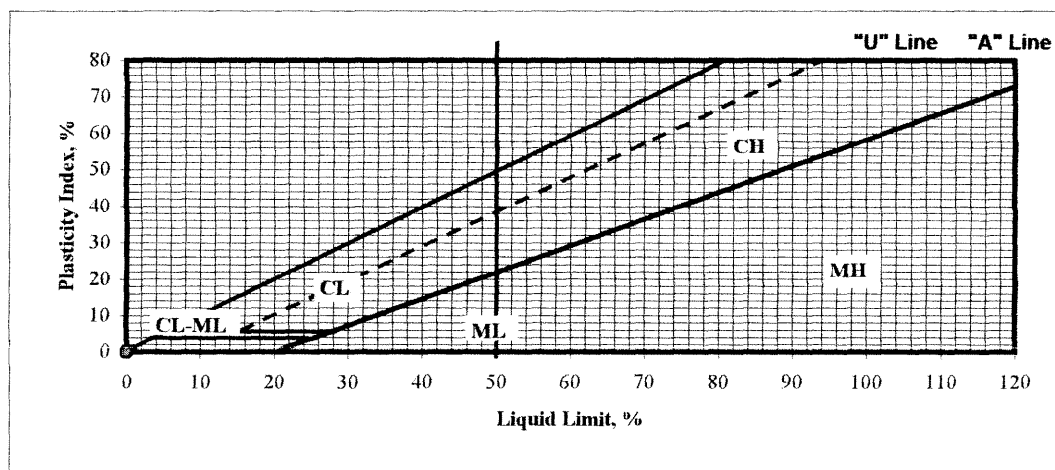
	Liquid Limit				Plastic Limit		
Can Number							
Weight of Can + Wet Soil, gms.							
Weight of Can + Dry Soil, gms.							
Weight of Can, gms.							
Weight of Dry Soil, gms.							
Weight of Water, gms.							
Water Content, %							
Number of Blows							

Non-Plastic

Unified Soil Classification



LL= 0 PL= 0 PI= 0





**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-3 S-4 DEPTH(FT) 20'
DESCRIPTION:

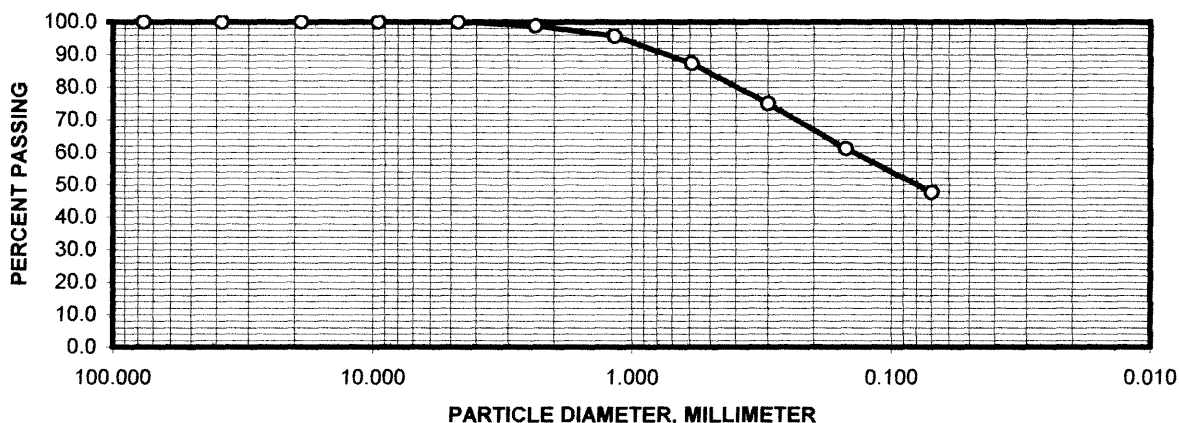
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	CL		
Moisture Content Determination:	11.20%		
Pan Number:	KB-30		
Pan + Dry Soil, gms.	1083.0		
Wt. of Pan, gms.	86.4		
Wt. of Dry Soil, gms.	996.6		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	11.84	11.8	98.8
#20	0.046	1.17	30.74	42.6	95.7
#40	0.023	0.59	83.55	126.1	87.3
#60	0.012	0.30	121.72	247.9	75.1
#100	0.006	0.15	140.26	388.1	61.1
#200	0.003	0.07	132.73	520.8	47.7

Percent Passing

200 47%



δγχ93σω



KEANTAN
LABORATORIES

ATTERBERG LIMITS

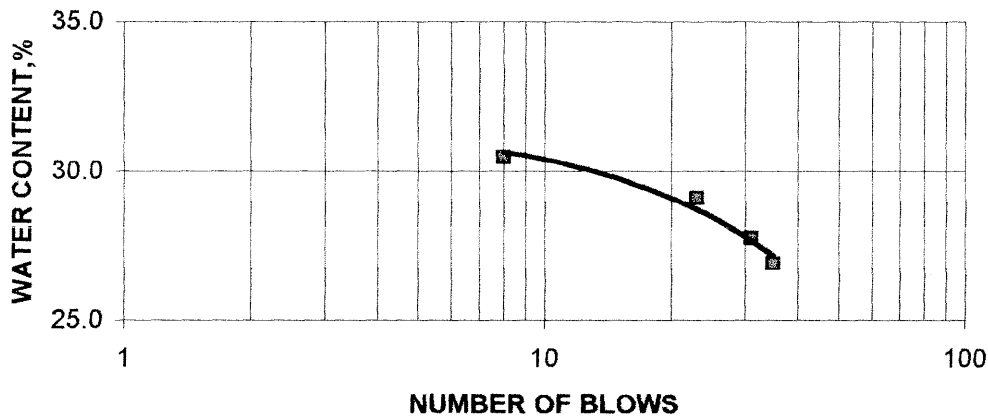
ASTM D4318

Project Name: 18620-18728 Ventura Blvd, Tarzana KTL No.: 04-310-015
Sample No.: BH-3 S-4 DEPTH: 20'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

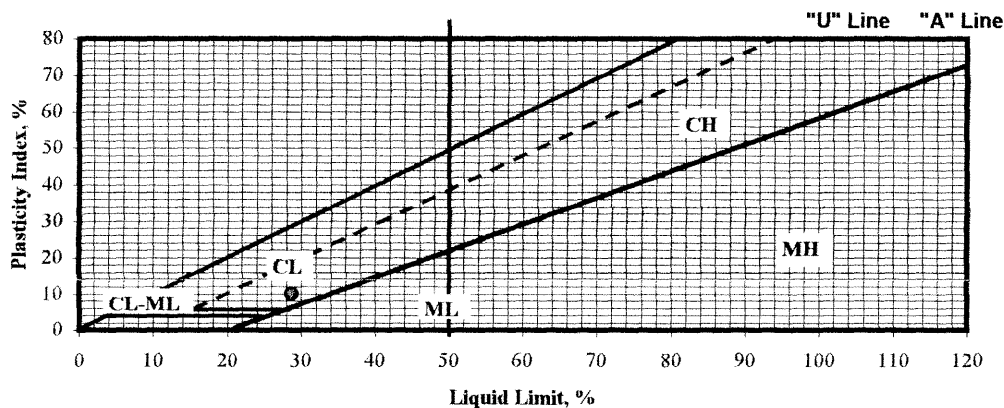
Can Number	Liquid Limit				Plastic Limit		
	B-54A	B-24	8602	HA-59	JC	33	
Weight of Can + Wet Soil, gms.	15.05	12.14	17.66	20.61	8.24	8.84	
Weight of Can + Dry Soil, gms.	12.10	9.75	13.94	16.06	7.13	7.62	
Weight of Can, gms.	1.13	1.14	1.16	1.13	1.11	1.13	
Weight of Dry Soil, gms.	10.97	8.61	12.78	14.93	6.02	6.49	
Weight of Water, gms.	2.95	2.39	3.72	4.55	1.11	1.22	
Water Content, %	26.9	27.8	29.1	30.5	18.4	18.8	
Number of Blows	35	31	23	8			

Unified Soil Classification

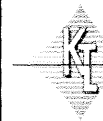


CL

LL= 29 PL= 19 PI= 10



δγγ93ατ



**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-3 S-6 DEPTH(FT) 30'
DESCRIPTION:

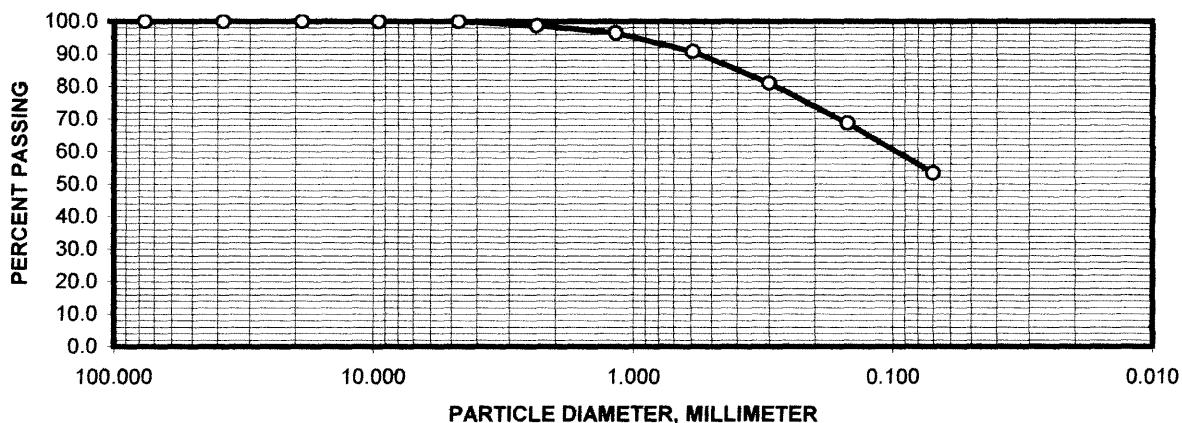
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	CL		
Moisture Content Determination:	14.30%		
Pan Number:	KB-30		
Pan + Dry Soil, gms.	1084.0		
Wt. of Pan, gms.	87.4		
Wt. of Dry Soil, gms.	996.6		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	12.53	12.5	98.7
#20	0.046	1.17	21.90	34.4	96.5
#40	0.023	0.59	57.41	91.8	90.8
#60	0.012	0.30	96.42	188.3	81.1
#100	0.006	0.15	123.37	311.6	68.7
#200	0.003	0.07	153.10	464.7	53.4

Percent Passing

200 53%



8793σσ



KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

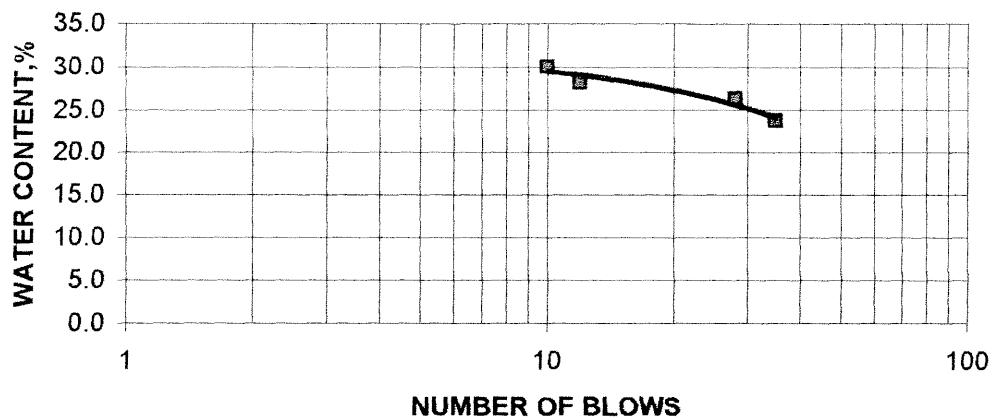
Project Name: 18620-18728 Ventura Blvd, Tarzana KTL No.: 04-310-015
Sample No.: BH-3 S-6 DEPTH: 30'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

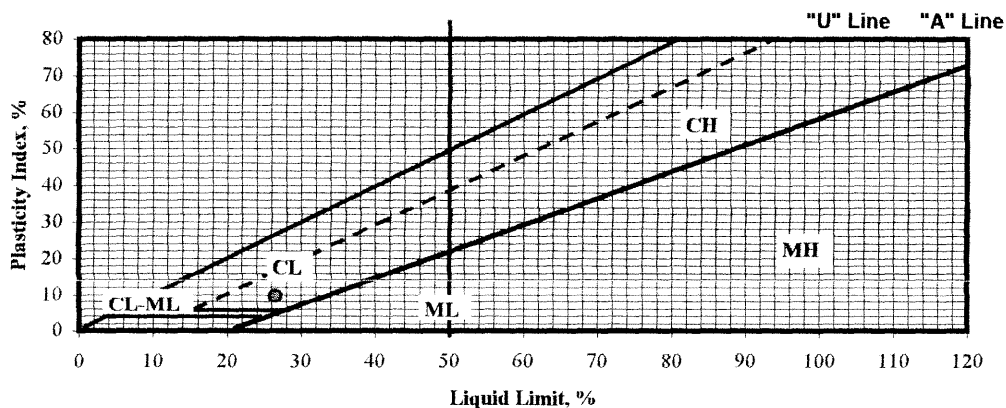
	Liquid Limit			
Can Number	8008	B-50A	C-50	8604
Weight of Can + Wet Soil, gms.	19.41	20.55	21.86	18.46
Weight of Can + Dry Soil, gms.	15.91	16.51	17.30	14.46
Weight of Can, gms.	1.13	1.15	1.13	1.12
Weight of Dry Soil, gms.	14.78	15.36	16.17	13.34
Weight of Water, gms.	3.50	4.04	4.56	4.00
Water Content, %	23.7	26.3	28.2	30.0
Number of Blows	35	28	12	10

Plastic Limit		
41	9A	
7.89	7.40	
6.93	6.47	
1.14	1.12	
5.79	5.35	
0.96	0.93	
16.6	17.4	

Unified Soil Classification



LL= 27 PL= 17 PI= 10





**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-4 S-4 DEPTH(FT) 20'
DESCRIPTION:

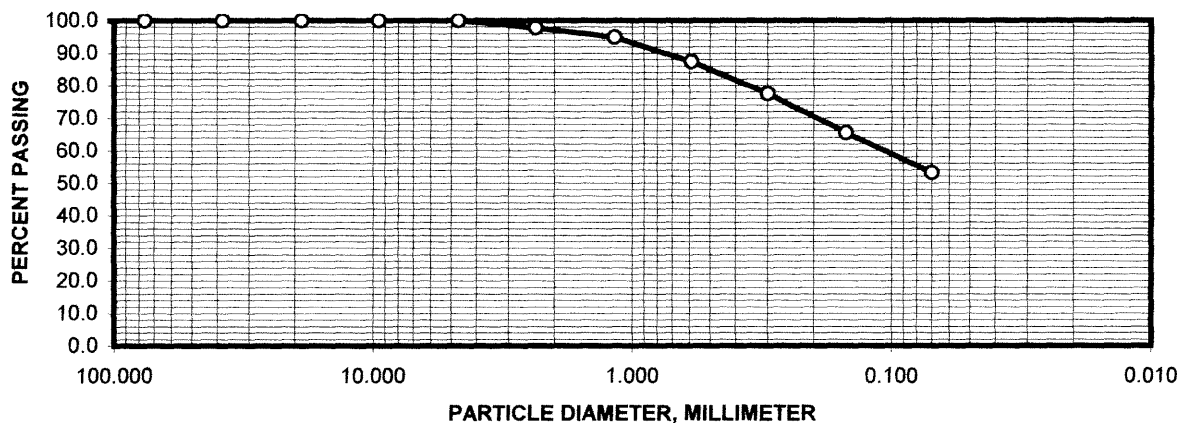
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	SM		
Moisture Content Determination:	10.90%		
Pan Number:	KB-49		
Pan + Dry Soil, gms.	1184.0		
Wt. of Pan, gms.	84.5		
Wt. of Dry Soil, gms.	1099.5		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	24.76	24.8	97.7
#20	0.046	1.17	30.94	55.7	94.9
#40	0.023	0.59	83.51	139.2	87.3
#60	0.012	0.30	108.68	247.9	77.5
#100	0.006	0.15	130.94	378.8	65.5
#200	0.003	0.07	135.40	514.2	53.2

Percent Passing

200 53%



8779300



KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

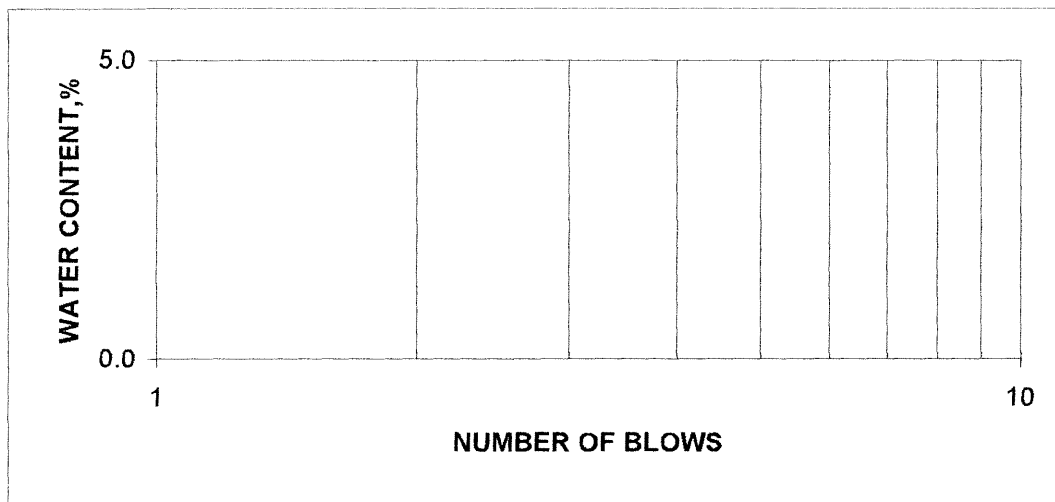
Project Name: 18620-18728 Ventura Blvd, Tarzana KTL No.: 04-310-015
Sample No.: BH-4 S-4 DEPTH: 20'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

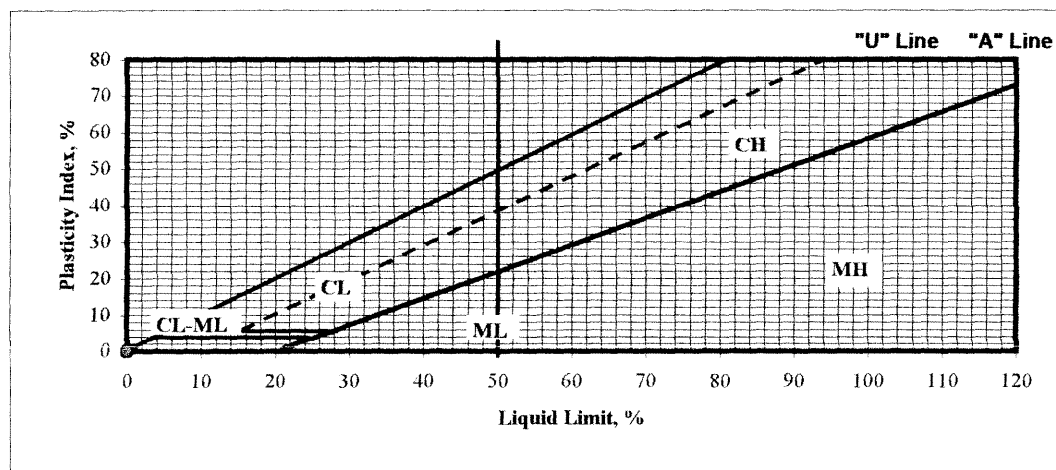
	Liquid Limit				Plastic Limit		
Can Number							
Weight of Can + Wet Soil, gms.							
Weight of Can + Dry Soil, gms.							
Weight of Can, gms.							
Weight of Dry Soil, gms.							
Weight of Water, gms.							
Water Content, %							
Number of Blows							

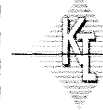
Non-Plastic

Unified Soil Classification



LL= 0 PL= 0 PI= 0





**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-4 S-6 DEPTH(FT) 30'
DESCRIPTION:

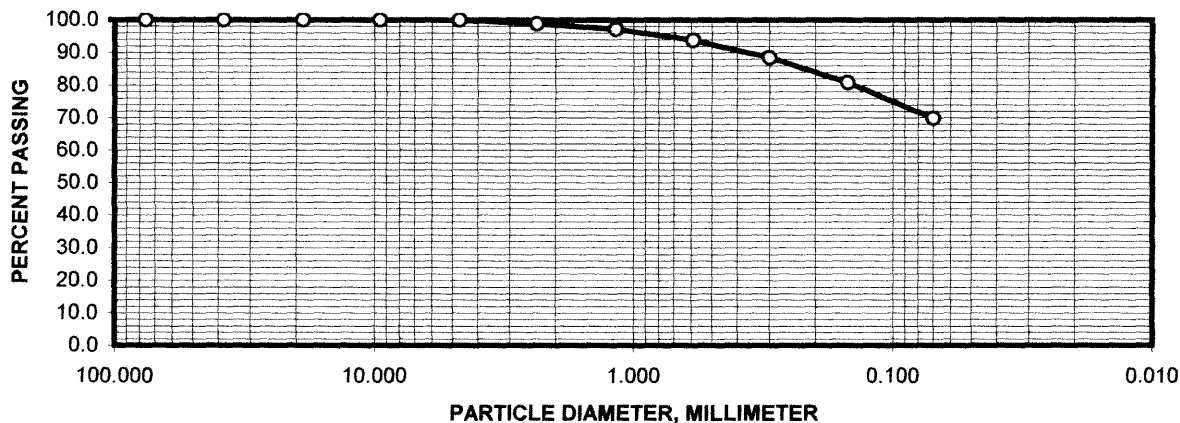
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	CL		
Moisture Content Determination:	15.30%		
Pan Number:	KB-6		
Pan + Dry Soil, gms.	909.2		
Wt. of Pan, gms.	84.8		
Wt. of Dry Soil, gms.	824.4		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	10.09	10.1	98.8
#20	0.046	1.17	13.02	23.1	97.2
#40	0.023	0.59	28.12	51.2	93.8
#60	0.012	0.30	43.93	95.2	88.5
#100	0.006	0.15	62.55	157.7	80.9
#200	0.003	0.07	90.34	248.1	69.9

Percent Passing

200 69%



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KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

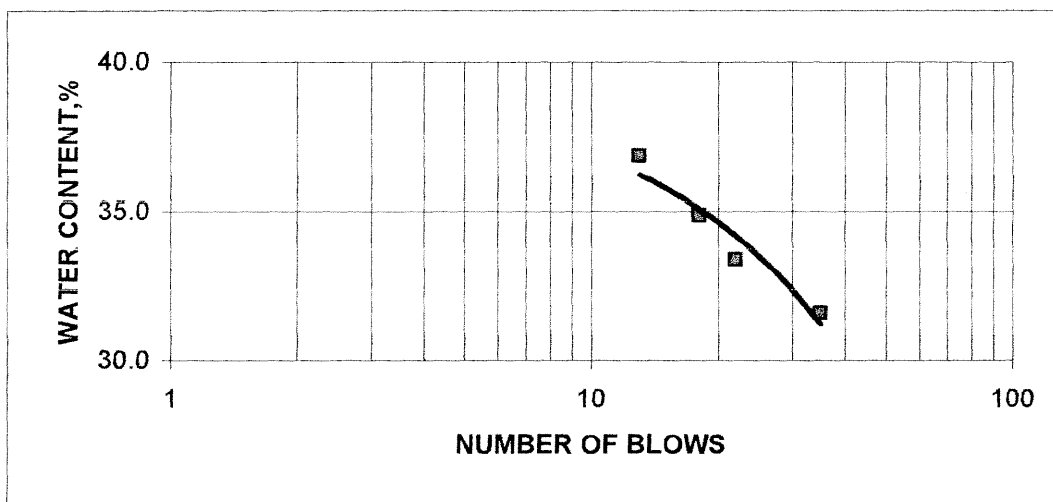
Project Name: 18620-18728 Ventura Blvd. Tarzana KTL No.: 04-310-015
Sample No.: BH-4 S-6 DEPTH: 30'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

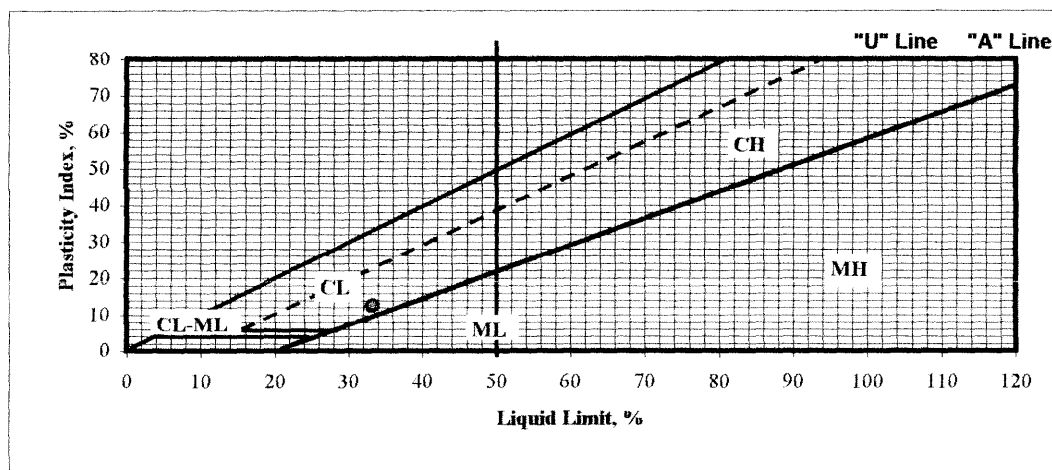
	Liquid Limit			
Can Number	B-13	301	1B	B51A
Weight of Can + Wet Soil, gms.	16.63	18.24	19.07	17.65
Weight of Can + Dry Soil, gms.	12.91	13.95	14.44	13.20
Weight of Can, gms.	1.14	1.10	1.16	1.13
Weight of Dry Soil, gms.	11.77	12.85	13.28	12.07
Weight of Water, gms.	3.72	4.29	4.63	4.45
Water Content, %	31.6	33.4	34.9	36.9
Number of Blows	35	22	18	13

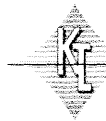
Plastic Limit		
909	k	
8.56	8.50	
7.31	7.23	
1.13	1.14	
6.18	6.09	
1.25	1.27	
20.2	20.9	

Unified Soil Classification



LL= 33 PL= 21 PI= 13





**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana
SAMPLE NO.: BH-5 S-3 DEPTH(FT) 15'
DESCRIPTION:

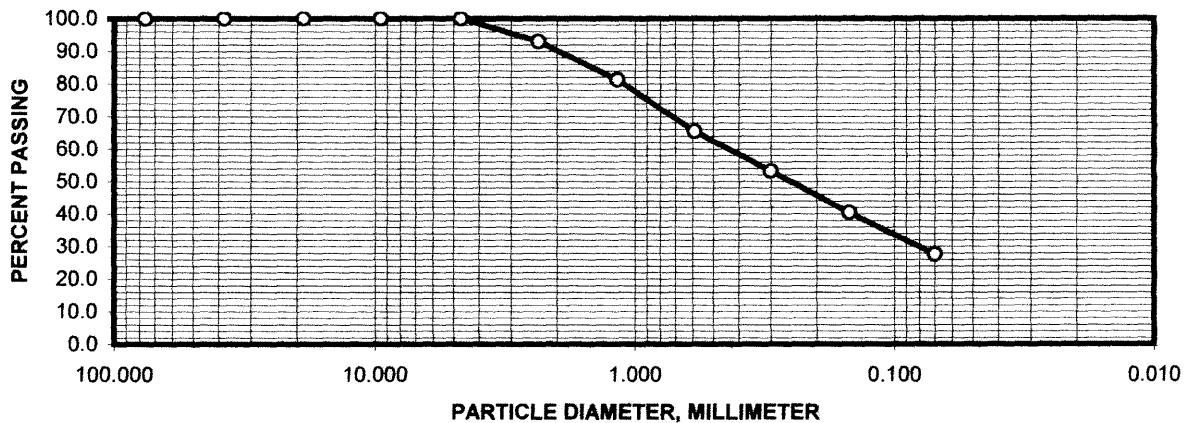
KTL NO.: 04-310-015
PROJECT NO.: HL0800
DATE: 12/23/2007
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	SM		
Moisture Content Determination:	8.60%		
Pan Number:	KB-10		
Pan + Dry Soil, gms.	1034.8		
Wt. of Pan, gms.	85.7		
Wt. of Dry Soil, gms.	949.1		

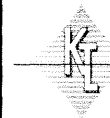
SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	0.0	0.0	100.0
#4	0.185	4.70	0.00	0.0	100.0
#10	0.093	2.36	66.50	66.5	93.0
#20	0.046	1.17	110.92	177.4	81.3
#40	0.023	0.59	150.21	327.6	65.5
#60	0.012	0.30	116.58	444.2	53.2
#100	0.006	0.15	121.70	565.9	40.4
#200	0.003	0.07	119.85	685.8	27.7

Percent Passing

200 27%



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**KEANTAN
LABORATORIES**

GRAIN SIZE DISTRIBUTION

ASTM D422

KTL NO.: 04-310-015

PROJECT NAME: 18620-18728 Ventura Blvd, Tarzana

PROJECT NO.: HL0800

SAMPLE NO.: BH-5 S-5

DEPTH(FT) 25'

DATE: 12/23/2007

DESCRIPTION:

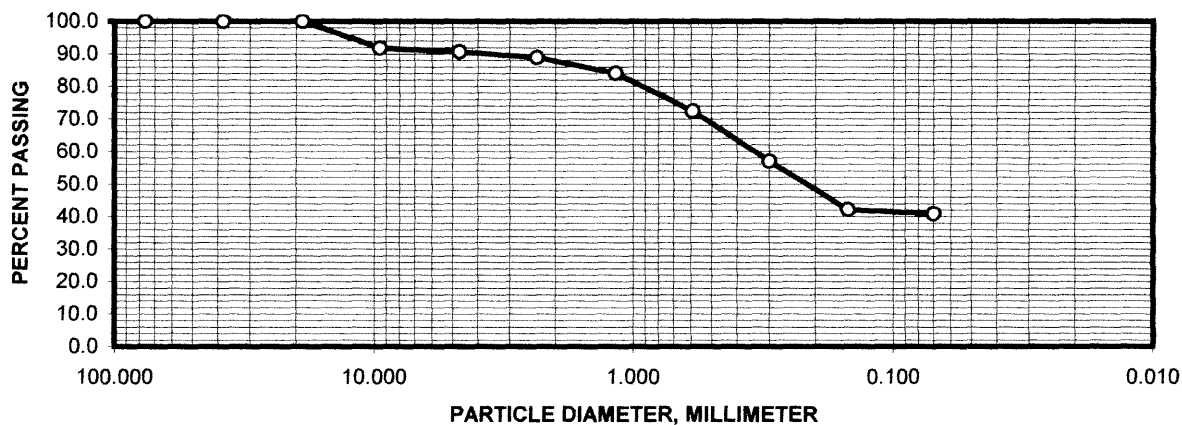
TECH.: jk

UNIFIED SOIL CLASSIFICATION:	CL		
Moisture Content Determination:	13.00%		
Pan Number:	KB-48		
Pan + Dry Soil, gms.	908.3		
Wt. of Pan, gms.	83.9		
Wt. of Dry Soil, gms.	824.4		

SIEVE SIZE (U.S. STANDARD)	PARTICLE SIZE, (inches)	PARTICLES DIAMETER, (mm)	WEIGHT RETAINED (gms)	ACCUMULATED WEIGHT RETAINED (gms)	PERCENT PASSING (%)
5"	5.000	127.00	0.0	0	100.0
3"	3.000	76.20	0.0	0	100.0
1 1/2"	1.500	38.10	0.0	0	100.0
3/4"	0.750	18.90	0.0	0.0	100.0
3/8"	0.375	9.52	61.27	61.3	91.9
#4	0.185	4.70	5.36	66.6	90.7
#10	0.093	2.36	10.33	77.0	88.9
#20	0.046	1.17	14.28	91.2	84.1
#40	0.023	0.59	39.88	131.1	72.4
#60	0.012	0.30	96.63	227.8	57.0
#100	0.006	0.15	126.46	354.2	42.2
#200	0.003	0.07	122.41	476.6	40.9

Percent Passing

200 41%



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KEANTAN
LABORATORIES

ATTERBERG LIMITS

ASTM D4318

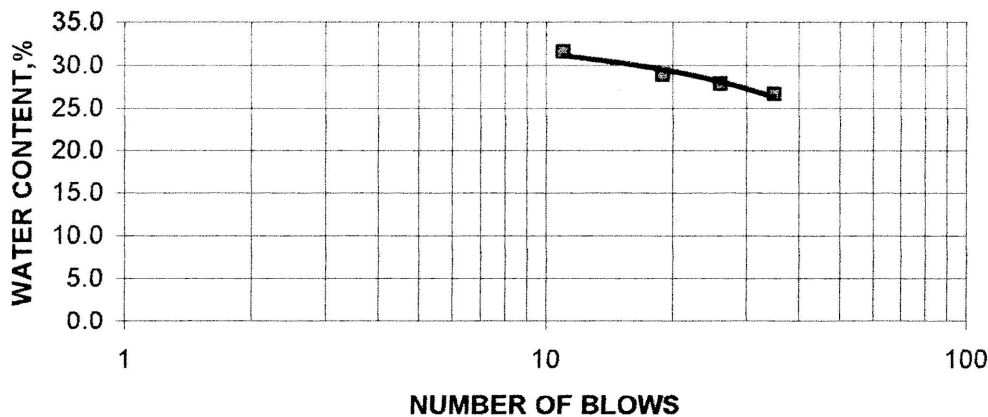
Project Name: 18620-18728 Ventura Blvd, Tarzana KTL No.: 04-310-015
Sample No.: BH-5 S-5 DEPTH: 25'
Description:

Proj. No.: HL0800
Date: 12/23/07
Tested By: JK
Checked By: KT

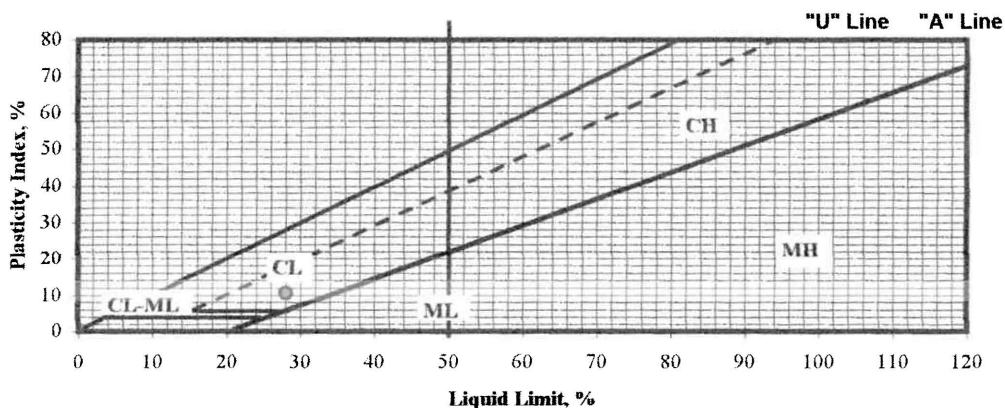
Can Number	Liquid Limit			
	HA-28	HA-65	B-29	C-38
Weight of Can + Wet Soil, gms.	15.93	17.51	16.12	14.07
Weight of Can + Dry Soil, gms.	12.82	13.97	12.76	10.97
Weight of Can, gms.	1.15	1.24	1.13	1.15
Weight of Dry Soil, gms.	11.67	12.73	11.63	9.82
Weight of Water, gms.	3.11	3.54	3.36	3.10
Water Content, %	26.6	27.8	28.9	31.6
Number of Blows	35	26	19	11

Plastic Limit		
9B	8704	
6.96	7.13	
6.09	6.26	
1.12	1.14	
4.97	5.12	
0.87	0.87	
17.5	17.0	

Unified Soil Classification



LL= 28 PL= 17 PI= 11



87793at

APPENDIX E

SLOPE STABILITY ANALYSIS

31 July 2008

Mr. Javier Polanco
City of Los Angeles, Bureau of Sanitation
1149 S. Broadway, Ste. 800
Los Angeles, California, 90015

**Subject: Updated Seismic Hazard and Seismic Deformation Evaluations
Evapotranspirative Final Cover, Disposal Area “C”
Lopez Canyon Landfill, Lakeview Terrace, California**

Dear Mr. Polanco:

GENERAL

This letter report was prepared for the City of Los Angeles, Bureau of Sanitation (BOS) by Geosyntec Consultants (Geosyntec). It was prepared to document evaluations required to demonstrate stability of the proposed Evapotranspirative (ET) Final Cover for Disposal Area “C” of the Lopez Canyon Sanitary Landfill (LCSL) in Lakeview Terrace, California.

SCOPE OF WORK

The BOS has requested Geosyntec to prepare a fourth revision to Volume IV of IV of the Final Closure Plan (FCP) for the LCSL per Title 27 requirements. The proposed revisions to the FCP include the following items documented herein:

- (i) an evaluation of relevant shear strength parameters;
- (ii) an update of the seismic hazard analysis based upon recently published NGA attenuation relationships;
- (iii) static and pseudostatic stability evaluations; and
- (iv) seismic deformation evaluations (based upon Bray and Travarasrou, 2007 charts).

EVALUATION OF RELEVANT SHEAR STRENGTH PARAMETERS

The final cover for the slopes and deck of Disposal Area “C” will be constructed as an ET final cover. Over the Disposal Area “C” side slopes, the cover will consist of the following elements (from top to bottom; minimum dimensions):

- 0.5-ft (150-mm) thick vegetative layer;
- 2.5 ft (750-mm) thick ET cover layer; and
- 2.0-ft (600-mm) thick foundation layer.

The ET cover will be inclined at 2H: 1V (Horizontal: Vertical). The cover will be constructed from locally available clayey and silty sands (SC and SM; Unified Soil Classification System). USBR [1998] provides shear strength parameters for these soils compacted to approximately 93% of maximum dry density as established by the Modified Proctor Compaction Test (ASTM D1557). The lowest-reported values are a friction angle of 33 degrees and cohesion of 400 psf (19.3 kPa).

Kavazanjian et al. [1995] developed low-bound shear strength envelope of Municipal Solid Waste (MSW). This bi-linear shear strength envelope is shown in Figure 1 below.

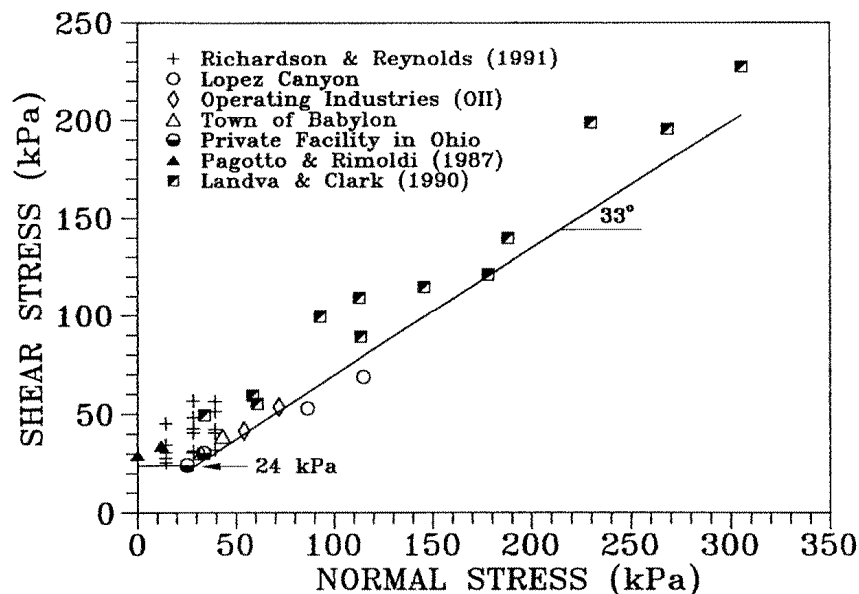


Figure 1 – Shear Strength of MSW [Kavazanjian et al., 1995]

Figure 1 shows that at low confining stress (i.e., at the confining stress that corresponds to the ET cover – waste interface), the shear strength of waste is represented by a cohesion intercept of approximately 500 psf (24 kPa).

Stability of this ET cover is governed by interface shear strength between the compacted soil and MSW. To provide a conservative basis for design, Geosyntec assumed that the interface shear strength equals 80% of shear strength of “weaker” material (commonly assumed interface efficiency of 80%; see e.g., Koerner, 1990). At the base of ET cover, shear strength of MSW is lower than shear strength of compacted soil. Shear strength of MSW at 80% efficiency equals to 400 psf).

AN UPDATE OF SEISMIC HAZARD ANALYSIS

The last update of the seismic hazard parameters for the LCSL is presented in the State of California Regional Water Quality Control Board, Los Angeles Region Order No. R4-2004-0176 (Order, 2004). Order 2004 established a M_w 6.5 event on the San Fernando Fault Zone (SFFZ) as both the Maximum Probable Earthquake (MPE) and the Maximum Credible Earthquake (MCE) for the LCSL site. For an unspecified site-to-source distance and attenuation relationship, Order (2004) stipulates that the “final cover of the landfill ... should be designed to withstand an earthquake of this magnitude and peak horizontal acceleration of 0.69 g.”

Seismic hazard maps for the State of California were updated in June 2003 [see CGS/USGS, 2003]. The update calls for increase of the MCE Moment Magnitude (M_w) for the SFFZ from M_w 6.5 to M_w 6.7. The magnitude of the 1971 San Fernando (Sylmar) historic event, relevant as it served as a basis for establishing the MPE for the site, has been upgraded from M_w 6.4 to M_w 6.6. The attenuation relationships used to evaluate Peak Horizontal Ground Acceleration (PHGA) in bedrock at the site have also been updated (the updated set is referred to as the New Generation Attenuation, NGA).

In order to accommodate for the recent update of the relevant seismic hazard parameters for the LCSL site, Geosyntec performed a supplemental seismic hazard evaluation as follows:

- Design earthquake level: MCE;
- Design earthquake Magnitude: M_w 6.7;
- Controlling Fault: San Fernando Fault Zone;
- Source mechanism and geometry: Reverse fault; Hanging wall; 45-degree dip;

- Site-to-source distance: 0.1 mi (0.2 km); and
- Source conditions: (southern California) weak rock (Shear wave velocity = 2,400 ft/s (731 m/s)).

Using the NGA attenuation model (which includes all five attenuation relationships listed in Figure 2 and included in the list of references), Geosyntec evaluated an updated bedrock (weak rock) acceleration response spectrum for LCSL final cover design. This acceleration response spectrum is indicated with thick solid line in Figure 2 below.

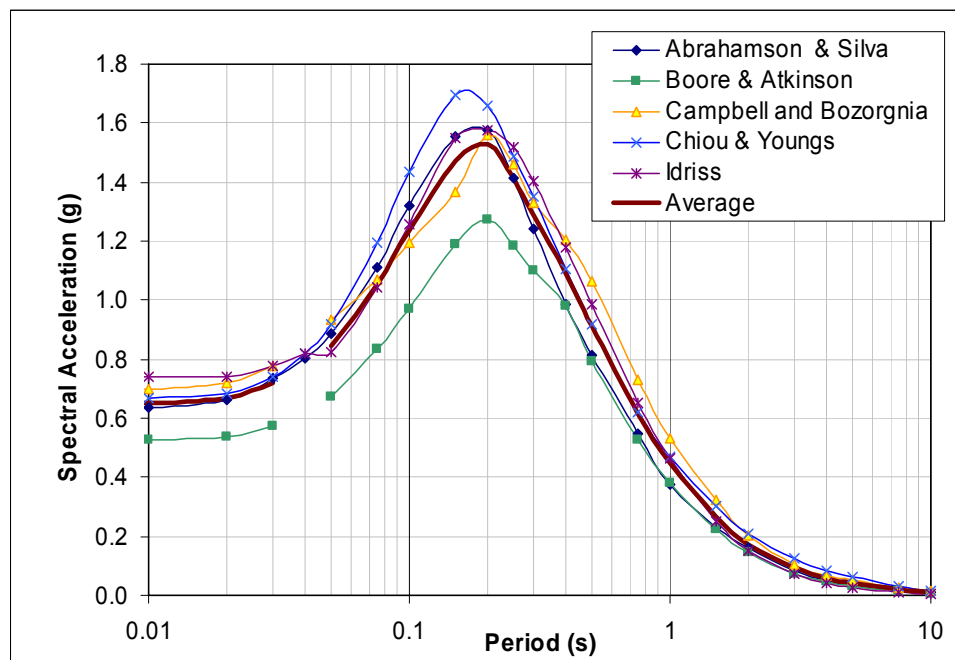


Figure 2 – Design Acceleration Response Spectra (Bedrock Conditions, 5% Damping).

Figure 2 shows that the design bedrock PHGA equals 0.65 g (average value of five attenuation relationships). This PHGA is approximately 6 percent lower than the PHGA previously estimated using lower magnitude and older attenuation models.

STATIC AND PSEUDOSTATIC STABILITY EVALUATIONS

Geosyntec evaluated static and pseudostatic stability of LCSL final ET cover using the infinite slope model by Matasovic [1991]. The analysis has been conducted assuming the following:

- Final ET cover thickness: 5 ft (1.5 m);
- Unit weight of final ET cover: 115 lb/ft³ (18.1 kN/m³);
- ET cover material: SM
- Stability of the final ET cover is governed by interface shear strength; and
- Assumed interface “efficiency:” 80% (cohesion = 400 psf (19.2 kPa)).

The results of our static and pseudostatic stability evaluations indicate that the lowest calculated static Factor of Safety (FS) equals 1.56 and the lowest calculated yield acceleration of sliding mass (k_y) equals 0.28 g.

SEISMIC DEFORMATION POTENTIAL EVALUATION

Seismic deformation potential of LCSL final cover was evaluated based upon the Newmark [1965] seismic displacement approach as implemented in the Bray and Travasarou [2007] method. The Bray and Travasarou [2007] method utilizes a nonlinear fully coupled stick-slip deformable sliding block model to capture the dynamic performance of landfill. This model, developed based upon processing of 688 recorded ground motions and a range of waste fill geometries, captures the primary influence of the landfill final cover system’s yield acceleration (k_y), its initial fundamental period (T_s), and the ground motion’s spectral acceleration at a degraded period equal to 1.5 T_s . The model separates the probability of “zero” displacement (i.e. < 1 cm) occurring from the distribution of “nonzero” displacement, so that very low values of calculated displacement do not bias the results. The use of the Bray and Travasarou [2007] seismic displacement model has been validated through re-examination of 16 case histories of earth dam and solid-waste landfill performances.

In order to accommodate for the recent update of the relevant seismic hazard parameters for the LCSL site, Geosyntec performed a supplemental seismic hazard evaluation as follows:

- Design earthquake level: MCE;

- Final cover thickness: $h = 5$ ft (1.5 m);
- Average shear wave velocity of final cover: $V_s = 820$ ft/s (250 m/s);
- Initial fundamental period of final cover: $T_s = 0.03$ s (calculated from h and V_s);
- Degraded period of final cover: $1.5 T_s = 0.05$ s; and
- Spectral acceleration at degraded period of waste fill: 0.8 g (from Figure 2).

The average shear wave velocity of landfill final cover was evaluated from the average recommended shear wave velocity profile for design of municipal solid waste landfills as established by Kavazanjian et al. [1996].

The results of the LCSL final cover seismic deformation potential evaluation are presented in Figure 3. By interpolation, Bray and Travasarou chart in Figure 3 indicates that the largest calculated maximum permanent displacement (mean value) is 3.6 in. (92 mm).

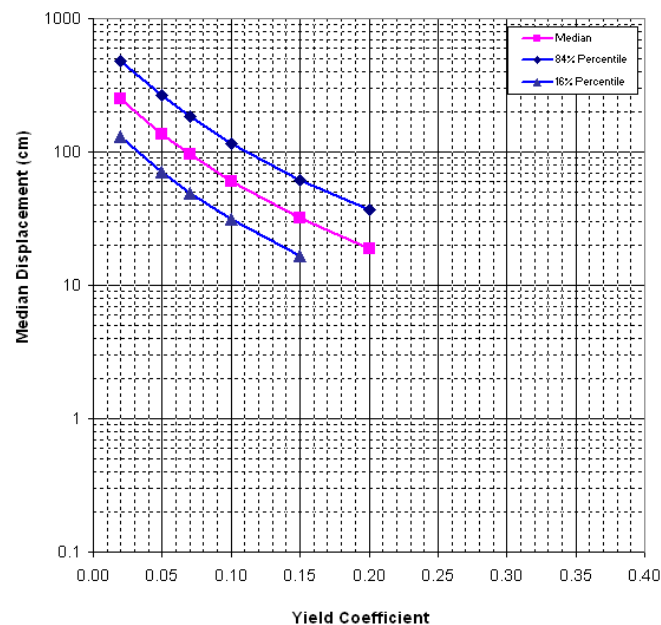


Figure 3 – Seismic Deformation Chart for LCSL Final Cover.

SUMMARY AND CONCLUSIONS

Geosyntec evaluated static and seismic stability of the Lopez Canyon Landfill Disposal Area “C” final ET cover. The static evaluations are based upon limit equilibrium principles and infinite slope model. The seismic evaluations are based upon the Newmark-type seismic deformation analysis as implemented in the Bray and Travarasrou (2007) charts. The design earthquake is MCE.

The results of our stability analyses indicate that, provided that design recommendations are adhered to, the stability criteria established for this site herein will be met. In particular, the lowest calculated static FS of 1.56 is higher than the Title 27-mandated stability criterion of $FS \geq 1.5$ and the largest calculated maximum permanent displacement of 3.6 in. (92 mm) is lower than the maximum allowable seismic displacement of 12 in. (300 mm).

LIMITATIONS

The professional opinions and recommendations expressed in this letter report are made in accordance with the generally accepted standards of practice. We are responsible for the conclusions and recommendations contained in this letter report based on the data relating only to the specific project and location discussed herein. We are not responsible for the accuracy of data produced by others and relied upon in the generation of this letter report. We are not responsible for the use of the information contained in this letter report for purposes other than those expressly stated in this report.

The scope of this report encompasses only LCSL Disposal Area “C” final cover slopes specifically evaluated herein. Please note that we are not responsible for stability of any other cut and/or fill slope that is (or will be) graded at this site. In the event that there are changes in the design or location of this project that do not conform to the project as described herein, we will not be responsible for these changes unless given the opportunity to review them and concur with them in writing. We are not responsible for any conclusions or recommendations made by others based upon the data or conclusions contained herein unless given the opportunity to review them and concur with them in writing.

CLOSURE

We appreciate the opportunity to continue our service to the City of Los Angeles, Bureau of Sanitation. If you have any questions about this letter report, or require additional explanation of

Mr. Javier Polanco
18 July 2008
Page 8

the information presented in this report, please do not hesitate to call the undersigned at (714) 969-0800.

Sincerely,



Christopher S. Conkle, P.E.
Engineer



Neven Matasovic, Ph.D., P.E., G.E.
Associate

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18 July 2008
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