CleanHarbors
ENVIRONMENTAL SERVICES®

Clean Harbors Lone Mountain, LLC.
40355 S. County Road 236
Waynoka, OK 73860

Tel: 580.697.3500
Fax: 580.697.3596
www.cleanharbors.com

RECEIVED
JUN 20 2025
LAND PROTECTION DIVISION
DEPT. OF ENVIRON. QLTY

RECEIVED
JUN 20 2025
LAND PROTECTION DIVISION
DEPT. OF ENVIRON. QLTY

June 16, 2025

Ms. Hillary Young, P.E.
Chief Engineer, Land Protection Division
Oklahoma Department of Environmental Quality
707 N Robinson
Oklahoma City, OK, 73102

RE: Clean Harbors Lone Mountain, LLC
Lone Mountain Facility
Waynoka, Oklahoma
EPA ID No. OKD065438376
Response to Technical Review – Notice of Deficiency
Class 3, Tier III Permit Modification Request – Landfill Cell 16 Engineering Report

Dear Ms. Young:

The Clean Harbors Lone Mountain Facility (Clean Harbors) is hereby submitting this response to the Technical Review – Notice of Deficiency (NOD) letter from Oklahoma Department of Environmental Quality (ODEQ) to Clean Harbors dated May 22, 2025, regarding the above-referenced Class 3, Tier III Permit Modification request.

Enclosed with this submittal, Clean Harbors is providing a response letter dated June 16, 2025 prepared on the facility's behalf by our consulting engineer-of-record on this modification request, Geosyntec Consultants. Geosyntec's letter includes a detailed response to each comment, along with related revisions to the Class 3, Tier III Permit Modification Request – Landfill Cell 16 Engineering Report.

Should you have any questions, please call me at (580) 697-3500.

Certification: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,
On behalf of Clean Harbors Lone Mountain, LLC

Michael Meriwether
Facility Manager

Attachment(s)

254890 CD___ #c___ c/o_____

CleanHarbors
ENVIRONMENTAL SERVICES®

Clean Harbors Lone Mountain, LLC.
40355 S. County Road 236
Waynoka, OK 73860

Tel: 580.697.3500
Fax: 580.697.3596
www.cleanharbors.com

June 16, 2025

Ms. Hillary Young, P.E.
Chief Engineer, Land Protection Division
Oklahoma Department of Environmental Quality
707 N Robinson
Oklahoma City, OK, 73102

RE: Clean Harbors Lone Mountain, LLC
Lone Mountain Facility
Waynoka, Oklahoma
EPA ID No. OKD065438376
Response to Technical Review – Notice of Deficiency
Class 3, Tier III Permit Modification Request – Landfill Cell 16 Engineering Report

Dear Ms. Young:

The Clean Harbors Lone Mountain Facility (Clean Harbors) is hereby submitting this response to the Technical Review – Notice of Deficiency (NOD) letter from Oklahoma Department of Environmental Quality (ODEQ) to Clean Harbors dated May 22, 2025, regarding the above-referenced Class 3, Tier III Permit Modification request.

Enclosed with this submittal, Clean Harbors is providing a response letter dated June 16, 2025 prepared on the facility's behalf by our consulting engineer-of-record on this modification request, Geosyntec Consultants. Geosyntec's letter includes a detailed response to each comment, along with related revisions to the Class 3, Tier III Permit Modification Request – Landfill Cell 16 Engineering Report.

Should you have any questions, please call me at (580) 697-3500.

Certification: I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,
On behalf of Clean Harbors Lone Mountain, LLC

Michael Meriwether
Facility Manager

Attachment(s)

Cc (cover letter only): Brigette Haley, ODEQ
James Wilkins, ODEQ
Jay Adair, Clean Harbors
Faizur Khan, Clean Harbors
Michael Crisenbery, Clean Harbors
Christine Sawyer, Clean Harbors
Jared Torstenson, Clean Harbors

Geosyntec consultants

8627 N Mopac Expy, Suite 300
Austin, Texas 78759
PH 512.451.4003
www.Geosyntec.com

16 June 2025

Mr. Michael Meriwether
General Manager
Clean Harbors Lone Mountain, LLC
40355 S County Rd 236
Waynoka, Oklahoma 73860

**Subject: Response to Technical Review - Notice of Deficiency
Class 3, Tier III Permit Modification Request
Landfill Cell 16 Engineering Report
Lone Mountain Facility
Waynoka, Oklahoma**

Dear Mr. Meriwether:

Geosyntec Consultants (Geosyntec) has prepared this letter in response to comments on the above-referenced facility Class 3, Tier III Permit Modification request, transmitted in a 22 May 2025 Technical Review - Notice of Deficiency (NOD) letter from the Oklahoma Department of Environmental Quality (ODEQ) to the Clean Harbors Lone Mountain Facility.

In the remainder of this letter, ODEQ's comments are presented in *italics*, with responses immediately following the comment in regular type. In some instances, as described herein, changes to the Class 3, Tier III Permit Modification – Landfill Cell 16 Engineering Report are necessary. In these instances, the resulting replacement pages to the permit modification documents are enclosed with this letter to replace the previously submitted versions of the applicable pages. These replacement pages have an updated date and note that the sheet is revised in the header or footer of each revised page. In other instances, when ODEQ has requested supplemental information, and the requested information is attached to this letter.

RESPONSE TO COMMENTS

Comment 1: In Section 3 of the Engineering Report – Landfill Cell 16 Leachate Collection and Leak Detection System Design, it is stated that the sumps are filled with gravel drainage material and have a perforated section of leachate riser pipe in the sumps, into which a submersible pump will be placed and operated to remove liquid from the sump. Please add a detailed description of how leachate will be managed once it is removed from the leachate collection sumps.

Response to Comment 1: The Engineering Report has been revised as requested. Specifically, new Section 3.9 – Leachate Management has been added, which provides the requested additional details on leachate management.

Comment 2: *In Exhibit G – Closure Plan, the Construction Quality Assurance ("CQA") Plan for Landfill Cells 15 and 16 describes the use of test pads during construction to ensure moisture, compaction, and hydraulic conductivity specifications are met for materials used as clay liner. However, there is no specific description of tests that will be performed to confirm that the finished, in-place clay liner meets the hydraulic conductivity specifications. The top twelve (12) inches of the finished clay liner should be tested to verify this. Please update the CQA Plan to include collection of in-situ samples (i.e., Shelby tubes) for laboratory testing, or an equivalent test method to verify hydraulic conductivity of the finished clay liner.*

Response to Comment 2: The CQA Plan has been revised as requested to add laboratory testing of undisturbed in-situ specimens taken via Shelby tubes from the top twelve (12) inches (i.e., the upper two lifts) of the finished clay liner. This change is provided in Table 2 on Page 38 of the CQA Plan.

Comment 3: *Section 4.1 of the Engineering Report – Final Cover System Description states that the final cover components were selected to have a barrier layer with a hydraulic conductivity less than or equal to the hydraulic conductivity of the bottom liner at the landfill. The bottom liner system includes a compacted clay layer with a hydraulic conductivity less than or equal to $1x10^{-7}$ cm/s. However, the clay bedding layer for the final cover system did not include a hydraulic conductivity specification. Please include this information or provide an explanation for not including it.*

Response to Comment 3: As background, the Section 4.1 criteria were taken from the requirements of 40 CFR 264.310(a). In response to the above comment, we note that the clay bedding layer is not intended to be the "barrier layer" (i.e., low-permeability) component of the final cover system. Rather, the proposed low-permeability barrier component is a *composite barrier layer system* composed of a 60-mil high-density polyethylene (HDPE) geomembrane overlying a geosynthetic clay liner (GCL). The specified final cover geomembrane is the same as the liner geomembrane, and the final cover GCL would have a hydraulic conductivity less than or equal to $5x10^{-9}$ cm/s based on its specified maximum hydraulic index flux of $1x10^{-6}$ cm^3/cm^2-s in Table 3 of the CQA Plan. From this, it is evident that the composite barrier of the final cover system will achieve the stated design criterion of having a hydraulic conductivity less than or equal to the hydraulic conductivity of the bottom liner. Based on the foregoing, no changes have been made.

As further clarification, to support this response it is noted that the hydraulic index flux of the GCL as specified in Table 3 of the CQA Plan is a parameter commonly reported for GCL products as a measure of the rate of flux (flow) through the GCL. The specified test method ASTM D5887 is a flexible wall permeameter test that obtains the necessary data to calculate both index flux and hydraulic conductivity from the same test. The current industry standard for GCLs is the Geosynthetic Institute's GRI-GCL3 Standard Specification, which specifies measuring either the permeability (which must be less than or equal to 5 x 10^{-9} cm/s, or the flux (which must be less than or equal to 1 x 10^{-8} m^3/m^2-s. Therefore, the Lone Mountain CQA Plan is consistent with this industry standard – and for clarity we note that the GRI specified flux value of 1 x 10^{-8} m^3/m^2-s is mathematically equivalent to 1 x 10^{-6} cm^3/cm^2-s (i.e., the Lone Mountain CQA Plan expresses flux units in centimeters instead of meters – and given the conversion of 1 m^3/m^2 = 100 cm^3/cm^2).

Comment 4: *Please provide monitoring well construction diagrams and anticipated depths for the Cell 16 groundwater monitoring well network. Construction of monitoring wells should be consistent with the requirements of the Oklahoma Water Resources Board.*

Response to Comment 4: A table of design information showing the anticipated depths of each monitoring well, along with a monitoring well construction diagram, has been added as requested. This is provided as a brief narrative in new Section 7 of the Engineering Report, plus the addition of "Exhibit I" where tabulated well design information and a typical well construction diagram is included.

Comment 5: *Please include the groundwater contours with a different format/color in Drawing 5 of 26 – Overall Cell 16 Top of Clay Liner Grading Plan of Exhibit A to be able to evaluate the 5-feet of separation from groundwater at the Sub-Cell sumps.*

Response to Comment 5: Drawing 5 of 26 has been revised as requested. We have also revised Drawing 1 (Title Sheet) to reflect the revision dates on the drawing index (list of drawings).

Comment 6: *Please include the location of the borrow source area and material stockpile locations.*

Response to Comment 6: For past landfill construction projects at this facility, Clean Harbors has obtained borrow soil from both on-site and off-site sources – with an assessment of potential borrow source(s) and decision of usage being made as part of the planning process that happens a few months before a given cell liner or final cover construction project. At the time of this modification request, detailed borrow studies have not been completed, and therefore it is not possible to designate borrow source locations. Similarly, material stockpile locations have not yet been planned, as the need for stockpiles and potential areas would depend on the borrow source location and related construction/logistics factors. For example, if suitable clay liner material can be sourced from cell construction areas of "cut" (e.g., where the natural bluff sideslopes need to be excavated to build the liner subgrade), it is likely this material could be directly-transported to the clay liner construction areas without the need for stockpiling. Similarly, if a soil material is coming from off-site, it also would likely be direct-placed (not stockpiled) to avoid the double-handling associated with stockpiling and then using the material. It is acknowledged that sometimes the contractor's production rates, timing of deliveries, or need for additional material processing necessitates use of stockpiles – however, the foregoing reasons, Clean Harbors respectfully requests that the provision of this information is beyond the scope of this modification request (no changes have been made).

Comment 7: Please include a section on Reporting/Documentation in the Engineering Report (similar to Section 5 – Closure Sequence, Schedule, and Notifications of the Closure Plan in Exhibit G) that includes the timing of submittals to DEQ and detailed contents of the verified and signed CQA reports for the "as built" constructed sub-cell liners. Please indicated whether these liner installation and testing reports will be submitted upon completion of each sub-cell or completion of several sub-cells as part of the phased construction approach.

Response to Comment 7: Section 6 of the Engineering Report has been revised to address this comment. We also note that Section 7 of the CQA Plan generally (but not exactly, as originally written) provides this information. Since the CQA Plan is the document that is implemented and directly-used by field personnel at the time of a construction project, most of the information requested by this comment (elaborate on the timing of submittals to ODEQ and CQA Report scope and contents) has been incorporated into updated Section 7 of the CQA Plan. The Engineering Report update mainly refers the reader to the CQA Plan where the specifics are provided.

As additional clarification, it is intended that the CQA Plan provided with this modification request would supersede the previous (Rev 2, June 2014) CQA Plan and be applicable to Cell 16 construction, as well as any remaining Cell 15 construction (for subcells/closure phases that have not yet started construction as of the date when this modification request is approved). It was accordingly labeled as "Rev 3" with an updated date. It was not intended to become part of Exhibit G (which is the Cell 16 Closure Plan). We apologize for the confusion, and propose to designate the CQA Plan as Exhibit H of this Engineering Report to help set it apart from the Closure Plan. We have updated the Engineering Report table of contents and Section 6 accordingly to refer to Exhibit H.

Comment 8: Please include a more detailed description in the Engineering Report of the procedures for the liner construction (e.g., how tie-ins as shown on Drawing 17 of 26 – Liner System Details II of Exhibit A will be constructed) as part of the phased sequencing of sub-cell construction.

Response to Comment 8: The Engineering Report has been revised as requested. New Section 2.9 has been added titled "Liner System Construction – Phased Sequencing of Subcells".

CLOSING

Geosyntec trusts that the above responses to ODEQ's comments provide the necessary information requested by ODEQ to complete their technical review of the Class 3, Tier III Permit Modification request - Engineering Report for Landfill Cell 16. If you have any questions regarding the information presented in this letter, please do not hesitate to contact the undersigned by telephone at (512) 354-3279, or by E-mail at sgraves@geosyntec.com.

Sincerely,

Scott M. Graves, P.E.
Senior Principal
Geosyntec Consultants – Oklahoma
Certificate of Authorization No. 1996
(Exp. 06/30/2026)

REDLINE/STRIKETHROUGH PAGES

To facilitate regulatory review, we have included "redline/strikethrough" versions of the narrative text on pages that were changed, to help readily identify those changes that were made.

Prepared for:
Clean Harbors Lone Mountain, LLC
Lone Mountain Facility
40355 S County Rd 236
Waynoka, OK 73860

ENGINEERING REPORT – LANDFILL CELL 16

LONE MOUNTAIN FACILITY
WAYNOKA, OKLAHOMA
EPA ID No. OKD065438376

Prepared by:

Geosyntec consultants
8627 N Mopac Expy, Suite 300
Austin, Texas 78759

Geosyntec Consultants
Oklahoma Certificate of Authorization No. 1996
Exp. 06/30/2026

Submitted November 2024
Revised June 2025

TABLE OF CONTENTS

TABLES

EXHIBITS

More specifically, the scope of this Engineering Report is to present the engineering design of the containment systems, collection systems, and related components and features associated with the new proposed landfill disposal unit (Landfill Cell 16). This report is accompanied by supporting documentation in the form of a set of engineering drawings (permit drawings); calculation packages covering liner design, leachate collection and leak detection system design, final cover design, geotechnical stability, and stormwater management (run-on/run-off controls at and around the landfill); a narrative Closure Plan with cost estimates; and incorporation by reference of a Construction Quality Assurance (CQA) Plan.

1.3 Report Organization

The remainder of this Engineering Report is organized as follows:

- An overview of the Cell 16 location, how it will be accessed, and comparison of the Cell 16 design vs. the current permitted and existing Cell 15 design is presented in the remainder of Section 1;
- the landfill cell and liner system design is presented in Section 2;
- the landfill leachate collection and recovery system and leak detection system design is presented in Section 3;
- the final cover system and closure design is presented in Section 4
- the stormwater management system design is presented in Section 5; and
- CQA of liner and final cover construction at Cell 16 is addressed in Section 6.

Further detailed information on the proposed Landfill Cell 16 design is included as Exhibits which are attached to this report and are organized as follows:

- Exhibit A – Engineering Drawings;
- Exhibit B – Geotechnical Investigation and Design;
- Exhibit C – Operational Storm Water Management Design;
- Exhibit D – Liner Design (Anchor Trench);
- Exhibit E – Leachate Collection System (LCS) and Leak Detection System (LDS) Design;
- Exhibit F – Final Closure Design with Run-on/Run-off Control Plan; ~~and~~
- Exhibit G –Closure Plan;
- Exhibit H – Construction Quality Assurance (CQA) Plan; and
- Exhibit I – Groundwater Monitoring Well Design.

1.4 Landfill Cell 16 Overview

1.4.1 Location and Access Route

A set of engineering drawings is presented in Exhibit A, included at the end of this report. Drawing 2 of Exhibit A presents an overall site plan showing the contiguous expanded permit boundary around the Lone Mountain Facility (after its now-approved inclusion of the 720-acre area to the calculated tensile strains due to differential settlement should not exceed tolerable strains for the liner system components.

Foundation soils beneath the landfill base are expected to compress somewhat as the load increases (i.e., as waste is placed in the landfill followed by closure). The foundation settlements will be affected by: (i) the thickness and properties of the soil strata beneath the landfill; and (ii) the variable loading of the foundation by the landfill, from zero at the perimeter (where there is no load), to a maximum near the center of the landfill where the waste thickness and final cover elevation will be at a maximum. Settlement of the clayey foundation strata beneath the landfill was calculated using equations for conventional one-dimensional compression settlement due to loading based on consolidation behavior.

Based on the analyses presented in Exhibit B-4, the calculated settlement magnitudes along the leachate collection corridors and associated post-settlement slopes are acceptable. Results also indicate that the predicted elongation strain is minimal, and much less than the yield strain (13 percent) for an HDPE geomembrane (i.e., acceptable).

Accordingly, the calculations show that the settlements are tolerable and the integrity of the geomembrane liner should not be adversely affected by total or differential settlement. Furthermore, the cover system is not expected to settle significantly for the reasons discussed in Exhibit B-4.

2.8 Anchor Trench Design

The anchor trench design is presented in Exhibit D. Loading of the geosynthetic materials are estimated, and the stresses transmitted by friction to the underlying geosynthetic materials are predicted based on a method presented in *Designing with Geosynthetics* by Koerner (1990 and 1998). The design is based on: (i) an evaluation of the anticipated stresses in the geosynthetic components of the liner system and resulting tensile forces (if any); and (ii) demonstration that the anchor trench configuration is adequately designed in the event excessive tensile loading is experienced. The prescribed anchor trench runout length, depth, and interface friction have been evaluated to verify that the geosynthetics will pull out of the anchor trench before tensile failure of the geosynthetics occurs, which is an appropriate condition.

2.9 Liner System Construction – Phased Sequencing of Subcells

As noted in Section 2.2, the lined Cell 16 Subcells 1 through 13 will be constructed incrementally over time in a phased manner. The subcells will be constructed (and then subsequently filled with waste) in ascending numerical order, consistent with the planned development progression over time as presented on Drawings 6 through 9 of Exhibit A.

When a given subcell is constructed, its liner system will permanently terminate at the final landfill perimeter of that subcell (i.e., along the final exterior of Cell 16), as well as temporarily terminate at inter-subcell berms (division berms) which are located on the floor areas of Cell 16 to separate subcells from each other to facilitate phasing, interim stormwater run-on and run-off management, and leachate management. When the next subcell in the sequence is constructed, its liner is tied to the adjacent existing subcell(s) liner to form a continuous liner system such that, once complete, the entire Cell 16 footprint is connected, tied-in, and lined.

Engineering details illustrating the inter-subcell berm and associated liner tie-in are presented on Drawing 17 of Exhibit A. Detail 4 on Drawing 17 shows the initial condition of an inter-subcell berm when it is first constructed for a given subcell. As shown, the liner system will extend "up and over" the berm and into the future subcell. As a result, a small "shelf" of about 15-ft width in the future subcell would be constructed to the liner design grades of that future subcell. This is for constructability, to provide a relatively flat shelf to facilitate more convenient future liner system tie-in. As shown, a sacrificial geomembrane will be placed over the top of the inter-subcell berm and onto the shelf of the future subcell; and also a temporary protective soil layer will be placed onto the shelf. This is to protect the liner during the interim time period before the future subcell is constructed.

Detail 6 on Drawing 17 picks up where Detail 4 leaves off, and shows the steps to making the liner system tie-in when it is time to build the future subcell. In Step 1, the temporary protective soil and sacrificial geomembrane will be removed, to expose the intact liner system. Also, the geosynthetics on the future subcell shelf will be rolled-back, to expose the 3-ft thick clay liner for making clay liner tie-in. In Step 2, the existing clay liner on the shelf will be cut-back in a benched manner, and then the new (future cell) 3-ft thick clay liner will be constructed and tied-in to the existing clay liner at the shelf. Next, each of the existing geosynthetic components of the liner system will be unrolled. As the geosynthetics installation of the future subcell progresses, each new geosynthetic component will be tied-in to the existing geosynthetic component. For the geomembranes, this tie-in will be a weld, so as to form contiguous lined components tying the existing liner to the new liner. Finally, once the geosynthetic components tie-ins are completed, protective cover will be placed over the inter-subcell berm and in the future subcell, so as to make the whole area ready for waste placement.

sideslopes, and extends out of each sump area to the landfill perimeter (along the side of the perimeter access road). Section 3.9 of this report provides further details on how leachate will be managed once it is removed from the leachate collection sumps.

3.2 Leachate Generation and Head on Upper Liner

The leachate collection rates and maximum leachate head on the upper liner system were estimated using the HELP computer model, Version 3.95D, developed by Dr. Klaus Berger of the University of Hamburg Institute of Soil Science and Dr. Paul Schroeder of the U.S. Army Corps of Engineers Waterways Experiment Station using the same methodology and computational algorithms as for the HELP model originally developed by the U.S. Environmental Protection Agency (USEPA). HELP simulates hydrologic processes for a landfill by performing daily, sequential water balance analyses using a quasi-two-dimensional, deterministic approach. The hydrologic processes considered in the HELP model include precipitation, surface-water evaporation, runoff, infiltration, plant transpiration, soil water evaporation, soil water storage, vertical drainage (saturated and unsaturated), lateral drainage (saturated), vertical drainage (saturated) through compacted soil liners and GCLs, and leakage through geomembranes.

Leachate generation rates were estimated for several operational scenarios expected in subcells. These scenarios range from initial conditions after a subcell has been recently opened, to final closure with a final cover system in-place. The leachate collection rate and maximum leachate head on the floor of the liner system were calculated for these typical operational conditions. Results from the HELP model are presented in Exhibit E-1, and include calculations of maximum peak daily leachate collection rates and maximum annual average leachate collection rates. The Exhibit E-1 calculations show that the maximum peak daily and the maximum annual average leachate collection rates are observed during the initial condition and the intermediate conditions, respectively, when the in-place waste thickness is relatively minimal as compared to final conditions. For all operational cases evaluated, the calculated head of leachate on the liner is less than the regulatory maximum of 30 cm (12 in.). Refer to Exhibit E-1 for a detailed description of the analyses, including approach, parameter selection, scenarios evaluated, and results.

3.3 LCS and LDS Geotextile Filter Design

The LCS and LDS layers are both composed of geocomposite drainage layers. A geocomposite refers to a geonet sandwiched between and bonded to two non-woven geotextiles. The geotextiles provide frictional strength against adjacent layers, and also serve as a filter or separator when adjacent to a soil layer. Since the LDS is located between geomembranes, filtration design is not applicable. However, for the LCS, the geocomposite is directly beneath the protective cover layer; therefore, the geotextile component on the upper side of the LCS geocomposite will serve to minimize the movement of fine-grained soils into the geocomposite's geonet component. The filtration characteristics of the geotextile were evaluated using a retention criterion, a permeability criterion, and an anti-clogging criterion, based on the methods presented in the technical literature. Survivability requirements (grab, tear, and puncture strengths) were also considered so that the geotextile will have adequate resistance to stresses applied on the geotextile during construction

3.9 Leachate Management

Leachate from the Cell 16 subcells will be removed at the riser pipes via submersible pumps placed and operated in each subcell sump to remove the collected liquid. Sideslope riser pipes will be installed as part of subcell construction, as illustrated on Drawing 21 of Exhibit A – one dedicated to each leachate collection sump, and a separate riser pipe dedicated to each leak detection sump. The riser pipes are perforated within the sumps and solid-wall on the sideslopes, and extend out of each sump area up the sideslopes to the landfill perimeter (along the side of the perimeter access road). The withdrawn leachate pumped out of the sumps via the riser pipes will be collected at the end of the riser pipes via a tanker-truck that would drive from individual sump to sump along the perimeter access road. Alternatively, a double-walled (dual-contained) forcemain pipe may be installed above ground or underground around the landfill perimeter to form a transmission system connected to the sumps and routed to a common end point. It is noted that the location of this common end point has not yet been designated, but in principle would be either a truck load-out where the pumped leachate would be collected in a tanker truck, or may be one or more leachate storage tanks.

Once collected via tanker truck or in a storage tank, leachate will be managed according to the following:

- The leachate may be recycled via application as dust suppression in the active landfill from which the leachate was generated in accordance with Volume 12, Section 6.7 of the RCRA/HSWA Permit Renewal (“Leachate Recycling SOP”).
- If not recycled per the above bullet point, the leachate will be managed via either: (i) transferring the liquids to the on-site wastewater treatment system, other facility storage tanks, collection areas, or other vessels (per Volume 10, Section 6.1 of the RCRA/HWSA Permit Renewal (“Landfill Operation Procedures”) and Volume 5, Section 5.0 of the RCRA/HSWA Permit Renewal (“Tank Storage and Treatment”); or (ii) transported off-site to a duly-authorized and appropriate facility for treatment and disposal.

6. CQA PLAN AND CONSTRUCTION REPORTING/DOCUMENTATION

6.1 CQA Plan

The currently-active landfill area at this facility – Landfill Cell 15 – has been following its "*Construction Quality Assurance Plan for Landfill Construction and Closure*" (CQA Plan) contained in Exhibit H of the Landfill Cell 15 Engineering Report.

Minor revisions have been made to this CQA Plan to make it applicable to both Landfill Cells 15 and 16 by tailoring certain cell-specific design requirements into the plan as applicable.

The revised CQA Plan being submitted with this Engineering Report as Exhibit H to cover both Landfill Cells 15 and 16 establishes the quality assurance and quality control monitoring, testing, and documentation activities that shall be implemented during construction of liner and final cover systems and related facilities (e.g., leak detection and leachate collection systems, etc.). Required material properties of the liner and final cover system components are also presented in the CQA Plan.

6.2 Construction Reporting/Documentation

For lined subcell construction, as described in Section 2.9 the Cell 16 Subcells 1 through 13 will be constructed incrementally over time in a phased manner. Each subcell will follow the reporting and associated submittals and documentation requirements of Section 7 of the CQA Plan, including but not limited to submittal of the final CQA Report for that subcell upon its completion of construction.

For final cover system construction, as described in Section 4.2, the Cell 16 closure through construction of the final cover system will occur incrementally in phases, as portions reach final waste grades. A plan showing the final cover system installation phases is presented on a figure included with the Landfill Cell 16 Closure Plan. Each closure phase will follow the "closure schedule and notifications" in Section 5 of the Closure Plan, as well as the "closure certification and submittal requirements" of Section 6 of the Closure Plan.

7. CELL 16 GROUNDWATER MONITORING

The proposed Cell 16 groundwater detection monitoring network of wells is provided on drawings in Exhibit A (e.g., See Drawing 3). A table of well design data (locations and anticipated depths) is provided in Exhibit I included at the end of this report.

Exhibit I also includes a typical monitoring well construction diagram – which is a copy of that presented in the Groundwater Detection Monitoring Program in Volume 2, Section 3.2 of the RCRA/HSWA Permit Renewal. Before the start of Landfill Cell 16 disposal operations, the upgradient monitoring well (MW 16-1) will be installed. As each subcell is constructed at Landfill Cell 16, the point of compliance (POC) groundwater monitoring well adjacent to the subcell will be installed and added to the detection monitoring program described in Volume 2, Section 3.2 of the RCRA/HSWA Permit Renewal.

The monitoring wells will be installed in accordance with applicable requirements of the Oklahoma Water Resources Board, consistent with the typical monitoring well construction diagram, and per the Monitoring Well Design and Installation Plan given in Volume 2, Section 3.5 of the RCRA/HSWA Permit Renewal.

EXHIBIT H

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

LONE MOUNTAIN FACILITY

CONSTRUCTION QUALITY ASSURANCE PLAN

FOR

LANDFILL CONSTRUCTION AND CLOSURE – CELLS 15 AND 16

Geosyntec Consultants
Oklahoma Certificate of Authorization No. 1996
Exp. 06/30/2026

Rev 0, July 2010
Rev 1, May 2012
Rev 2, June 2014
Rev 3, November 2024 and June 2025

TABLE OF CONTENTS

7. REPORTING AND DOCUMENTATION

7.1 Reporting

Liner Construction Projects. For liner system construction, the following schedule of notifications and submittals (reporting) will be followed for construction of each lined subcell at Cell 16:

- A "*Notification of Start of Construction"* will be sent to the ODEQ at least one week prior to the date that the start of the subcell construction is anticipated to begin. This notice will indicate which subcell will be constructed, will be accompanied by a copy of the construction plans (see below), and will indicate the date subcell construction activities are expected to commence.
- Applicable construction plans will accompany the above Notification, and the notice will indicate whether a modification is being requested. If a modification is being requested or the plans deviate from those previously approved, the subcell construction will not be implemented until approval by ODEQ or other authorized agencies has been received.
- Liner system construction of the specified subcell will then commence after the required notices have been made and any approvals have been received.
- Within 60 days of completion of the subcell construction project, the facility will submit the final CQA Report for that subcell to ODEQ, certified by the Lone Mountain Facility Manager; and including a certification by the CQA Officer that the CQA Plan has been successfully carried out, and that the unit meets the requirements of 40 CFR 264.301 (c) or (d); and certification of CQA activities by the CQA Certifying Engineer. The completion of the project will be defined as the date when the CQA Officer notifies the Facility Manager in writing that the project is complete.

Closure Construction Projects. For final cover system (i.e., incremental closure or final closure) construction projects, see Sections 5 and 6 of the Closure Plan for the required closure schedule, notifications, and certification/submittal requirements.

7.2 Documentation

General. Documentation of construction and inspection activities associated with the CQA Plan will consist of daily recordkeeping and a final report to be prepared under the direction of the CQA Officer. Daily reporting procedures associated with the CQA activities are described based on specific work elements in Table 1 of the inspection activities section and are to be performed in a timely manner.

The results of testing and observations as recorded on the daily construction reports will be reviewed and accepted by the CQA Officer or his designee. Acceptance of the daily construction reports will consist of either counter-signing the forms directly or having one of the CQA personnel sign the forms indicating that they have been reviewed and accepted on behalf of the CQA Officer. During the construction of the facility, the CQA Officer will be responsible for maintaining and storing the originals or copies of all data sheets and reports that are generated in carrying out the CQA Plan as identified herein. A complete copy of these reports will be maintained on-site during the course of construction.

The CQA Officer will direct the preparation of a final construction documentation report (collectively referred to as "the CQA Report") at the completion of ~~the~~ each lined subcell construction project and each closure phase construction project. The CQA Report will contain the results of the applicable construction quality control and quality assurance observations and tests specified by the CQA Plan. The CQA R~~r~~eport will provide the following general certification items (plus the specific CQA items applicable for liner or closure construction as detailed subsequently):

- A~~a~~ summary of CQA activities, and will demonstrate that the construction satisfied the CQA Plan and applicable State and Federal regulations.
- ~~The CQA report will provide~~ A~~a~~n evaluation of the degree of reconciliation between non-conforming work and the specifications as defined in the CQA Plan and the ability of the CQA program to meet the quality objectives of the CQA Plan.
- ~~The CQA Report will also include a~~An overall summary of construction activities associated with the project.
- ~~The~~A certification by the CQA Certifying Engineer ~~will certify~~ that construction within (at minimum) the inside edge of the anchor trench/liner limits or final cap limits was accomplished in accordance with the CQA Plan and any field design, engineering, or construction changes were made in accordance with the change control procedure and/or a Class 1 Permit Modification.

Liner Construction Projects. Liner construction projects at this facility have typically subdivided the CQA Report items into separate volumes for convenience of submittal timing and reviews, as follows: CQA Report Volume I - Pre-Geosynthetics Soils; CQA Report Volume II – Geosynthetics and Associated Soil Components; and Certifying Engineer's Report. Future projects are suggested (but not required) to subdivide the

CQA Report in this manner. Regardless of whether a CQA Report is subdivided or combined into a single submittal/report, the same information detailed herein must be provided. In addition to the above general documentation requirements of a CQA

Report(s), liner construction project CQA Report(s) will also contain, at a minimum, the following engineering plans and test results as applicable for the scope of the report being submitted:

- Scaled as-built record drawings showing: the subgrade (bottom of clay liner) and top of the clay liner, which accurately depict the area boundaries and dimensions of the lined subcell; minimum, maximum, and representative elevations and liner system clay liner layer to reflect its thickness and extent. A similar as-built record drawing will also be provided for the liner protective cover soil layer on the subcell floor, documenting its extents, elevations, and thickness.
- ~~The CQA Report will provide a~~For the soil components of the liner system (which includes leachate collection system and leak detection system granular/rock components, and liner protective cover soil), a summary of the soils observation and testing aspects of the construction ~~or closure~~ project – along with results of all required tests required, at the minimum frequencies specified, in ~~. The report will certify that the soils portions of the cell or closure cap were constructed in accordance with~~ the CQA Plan ~~and any field design, engineering, or construction changes made in accordance with the change control procedure and/or a Class 1 Permit Modification~~.
- ~~The CQA Report will include~~ For the geosynthetic components of the liner system, a summary of the geosynthetic liner observation and testing aspects of the construction project – along with results of all geosynthetics tests required (including manufacturer quality control (MQC) testing and conformance testing), at the minimum frequencies specified, in ~~. The report will certify that the geosynthetic liner portions of the cell are constructed in accordance with~~ the CQA Plan. For the HDPE geomembranes in particular, this includes the specified MQC testing, conformance testing, destructive and non-destructive testing, panel placement, calibration certificates, and pre-weld trial test logs – as well as as-built panel layout record drawings ~~and any field design, engineering, or construction changes made in accordance with the change control procedure and/or a Class 1 Permit Modification~~.

The ~~Final~~ CQA Report(s) will be certified and submitted as described above in Section 7.1. ~~by the Lone Mountain Facility Manager and will be submitted to the ODEQ within~~

~~sixty (60) days of completion of the project. The completion of the project will be defined as the date when the CQA Officer notifies the Facility Manager in writing that the project is complete. The CQA Officer must certify that the CQA Plan has been successfully carried out, and that the unit meets the requirements of 40 CFR 264.301 (c) or (d).~~

Closure Construction Projects. In addition to providing general consistency with the above documentation requirements of a CQA Report as applicable for final cover system construction projects, refer to Sections 5 and 6 of the Closure Plan for the required CQA Report of closure certification contents and submittal requirements.

TABLE 2 Continued
EARTHWORK CONFORMANCE TESTING

MATERIAL TYPE	TEST METHOD		MIN CQA FREQUENCY
Compacted Clay Liner	Nuclear Density/Moisture Content	ASTM D6938	1 per 8,000 sf
	Laboratory Hydraulic Conductivity[4] (undisturbed in-situ specimens taken via Shelby tube samples)	ASTM D5084	Testing required on top 12 inches (i.e., upper two 6-inch lifts) of clay liner layer at: 1 per acre per lift
Upper 6-inches of Re-worked/re-compacted Interim Clay Cover (Bedding Clay) Beneath Cap GCL	Grain Size Analyses	ASTM D422	1 per 10,000 cy (min 1 per material type)
	Nuclear Density/Moisture Content	ASTM D6938	1 per 12,000 sf per lift
	Standard Proctor	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
Protective Cover Soil for Cap	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
	Standard Proctor[3]	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Nuclear Density/Moisture Content[3]	ASTM D6938	See Note 3
Topsoil	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
Rip-Rap	Visual Classification	See Appendix A.1	Minimum 3 tests per construction project
Type I and Type II Granular Filter	Visual Classification	See Appendix A.1	1 per 1,000 cy

Notes:

1. Pre-construction laboratory hydraulic conductivity testing (ASTM D5084) of a clay borrow source shall be performed at a confining stress as directed by the Design Engineer at the following variable moisture content and density conditions: (i) five (5) tests remolded to the moisture/density conditions that were used to define the modified Proctor curve; and (ii) five (5) tests remolded to the moisture/density conditions that were used to define the standard Proctor curve. Each of the resulting ten (10) compacted (remolded) specimens shall be permeated per ASTM D5084. The CQA Consultant shall use the results to define the "Acceptable Zone", consistent with EPA Technical Guidance Document EPA/600/R-93/182, by plotting the dry unit weights, molding water contents, and permeability of each of the ten (10) moisture-density points. The "Acceptable Zone" will be determined based on the acceptable range of compaction criteria to obtain an as-compacted hydraulic conductivity of no greater than $1x10^{-7}$ cm/s.
2. Ongoing Laboratory hydraulic conductivity testing (during construction) of the clay borrow source for which the Acceptable Zone is already defined through pre-construction testing described in Note 1shall be performed. The confining stress shall be the same as used for the pre-construction hydraulic conductivity tests. A minimum of two (2) specimens shall be remolded to variable target moisture content and density conditions specified by the CQA Consultant. Each of the resulting two (2) compacted (remolded) specimens shall be permeated per ASTM D5084. The CQA Consultant will use the results to confirm the applicability of the previously-defined Acceptable Zone (i.e., the results are within an acceptable range of compaction criteria to obtain an as-compacted hydraulic conductivity of no greater than $1x10^{-7}$ cm/s).
3. Soil protective cover testing for field compaction is only required for cap shoulder construction (one per 300 linear feet) and for cell ramps (minimum 2 tests per lift) and leachate riser trenches (minimum one test per 30 feet of pipe).
4. As a new testing item added in June 2025 per ODEQ request, this testing requirement pertains to the Cell 16 subcells along with only any future Cell 15 subcells that commence construction after final approval of the Cell 16 Class 3, Tier III Permit Modification request.

TABLE 6
MATERIAL PROPERTIES AND CONFORMANCE TESTING
FOR FILTER FABRIC

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED(1) VALUES	TEST METHOD	MQC FREQUENCY	CQA FREQUENCY
Mass per Unit Area	Minimum	oz/yd^2	8	ASTM D5261	130,000 ft^2	Not Required
Grab Tensile Strength	Minimum	lbs	200	ASTM D4632	130,000 ft^2	1 test per 200,000 ft^2
CBR Puncture Strength	Minimum	lbs	315	ASTM D6241	130,000 ft^2	1 test per 200,000 ft^2
Permittivity	Minaximum	s^{-1}	1.3	ASTM D4491	540,000 ft^2	1 test per 200,000 ft^2
Apparent Opening Size	Maximum U.S. Standard Sieve	--	70	ASTM D4751	540,000 ft^2	1 test per 200,000 ft^2

REPLACEMENT PAGES

Portions of the Class 3, Tier III Permit Modification request have been changed. These replacement pages are enclosed to replace the previous versions of these items.

- Engineering Report – Complete replacement of all pages due to extensive repagination;
- Exhibit A, Engineering Drawings – Drawings 1 and 5;
- Exhibit H, CQA Plan – Cover page, table of contents, and Pages 13, 14, 14A (added), and 38; and
- Exhibit I, Groundwater Monitoring Well Design – New exhibit added.

CleanHarbors
ENVIRONMENTAL SERVICES®

Prepared for:
Clean Harbors Lone Mountain, LLC
Lone Mountain Facility
40355 S County Rd 236
Waynoka, OK 73860

ENGINEERING REPORT – LANDFILL CELL 16

LONE MOUNTAIN FACILITY
WAYNOKA, OKLAHOMA
EPA ID No. OKD065438376

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. GRAVES
19710
OKLAHOMA

6/16/2025

Geosyntec Consultants
Oklahoma Certificate of Authorization No. 1996
Exp. 06/30/2026

Prepared by:

Geosyntec consultants
8627 N Mopac Expy, Suite 300
Austin, Texas 78759

Submitted November 2024
Revised June 2025

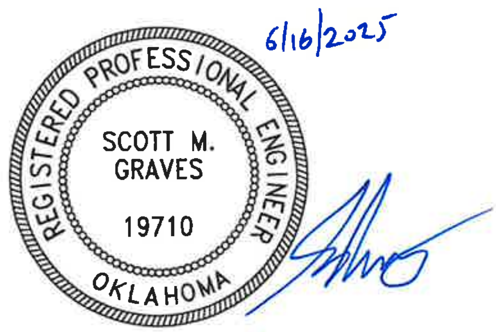
TABLE OF CONTENTS

6/16/2025

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. GRAVES
19710
OKLAHOMA

TABLES

EXHIBITS



1. INTRODUCTION

1.1 Background

The Lone Mountain Facility is a permitted treatment, storage, and disposal facility for hazardous waste located in northwest Major County, Oklahoma, approximately five miles east and one mile north of the junction of U.S. Highway 281 and U.S. Highway 412. Waynoka, Oklahoma is the nearest town, located on U.S. 281 approximately 14 miles north-northwest of the facility. The facility currently operates under USEPA and State of Oklahoma authority (EPA ID No. OKD065438376 and RCRA/HSWA Permit No. 3547005).

A new Resource Conservation and Recovery Act (RCRA) landfill disposal unit known as "Landfill Cell 16" ("Cell 16") is proposed to be added to the facility's RCRA permit. Cell 16 will be located within a portion of a 720-acre area of undeveloped ranch land to the west of the existing facility and recently added to the permit boundary and demonstrated to be suitable for use for additional hazardous waste landfill cells via an Oklahoma Department of Environmental Quality (ODEQ)-approved Class 3, Tier III Permit Modification [Envirotech, 2023[1]].

Cell 16 has been designed as detailed in this Engineering Report in accordance with applicable State and Federal regulations including the relevant hazardous waste landfill engineering design and closure requirements of Oklahoma Administrative Code (OAC) 252:205 for hazardous waste management, and the incorporated-by reference requirements to Title 40 of the Code of Federal Regulations (CFR) including but not limited to Parts 264 and 270. Landfill Cell 16 is designed to occupy a waste disposal plan footprint area of approximately 92.0 acres, and will be composed of thirteen (13) subcells.

As additional background, a pre-application meeting was held with representatives from ODEQ, the applicant, and Geosyntec, on March 19, 2024. This Engineering Report presents a Cell 16 landfill design consistent with the preliminary layout and information presented during the pre-application meeting, as supported by the engineering drawings and calculations included in this report.

1.2 Purpose and Scope of Engineering Report

The purpose for adding Cell 16 to the facility can be briefly stated as per the facility's goal of providing additional waste disposal capacity. Once constructed and operational, Cell 16 will receive the same types of waste as does current-operating Cell 15, and will be operated in a consistent manner (i.e., in accordance with the applicable permit provisions regarding things such as waste acceptance and analysis, personnel training, inspections, and the like). Accordingly, this Engineering Report focuses on the site-specific design & features of Cell 16.

1 Envirotech Engineering & Consulting, Inc. (Envirotech), "Clean Harbors Lone Mountain Facility – Proposed Land Addition", Tier III Permit Modification Request, last revised (2nd Update) April 7, 2023.

More specifically, the scope of this Engineering Report is to present the engineering design of the containment systems, collection systems, and related components and features associated with the new proposed landfill disposal unit (Landfill Cell 16). This report is accompanied by supporting documentation in the form of a set of engineering drawings (permit drawings); calculation packages covering liner design, leachate collection and leak detection system design, final cover design, geotechnical stability, and stormwater management (run-on/run-off controls at and around the landfill); a narrative Closure Plan with cost estimates; and incorporation by reference of a Construction Quality Assurance (CQA) Plan.

1.3 Report Organization

The remainder of this Engineering Report is organized as follows:

- An overview of the Cell 16 location, how it will be accessed, and comparison of the Cell 16 design vs. the current permitted and existing Cell 15 design is presented in the remainder of Section 1;
- the landfill cell and liner system design is presented in Section 2;
- the landfill leachate collection and recovery system and leak detection system design is presented in Section 3;
- the final cover system and closure design is presented in Section 4
- the stormwater management system design is presented in Section 5; and
- CQA of liner and final cover construction at Cell 16 is addressed in Section 6.

Further detailed information on the proposed Landfill Cell 16 design is included as Exhibits which are attached to this report and are organized as follows:

- Exhibit A – Engineering Drawings;
- Exhibit B – Geotechnical Investigation and Design;
- Exhibit C – Operational Storm Water Management Design;
- Exhibit D – Liner Design (Anchor Trench);
- Exhibit E – Leachate Collection System (LCS) and Leak Detection System (LDS) Design;
- Exhibit F – Final Closure Design with Run-on/Run-off Control Plan;
- Exhibit G –Closure Plan;
- Exhibit H – Construction Quality Assurance (CQA) Plan; and
- Exhibit I – Groundwater Monitoring Well Design.

1.4 Landfill Cell 16 Overview

1.4.1 Location and Access Route

A set of engineering drawings is presented in Exhibit A, included at the end of this report. Drawing 2 of Exhibit A presents an overall site plan showing the contiguous expanded permit boundary around the Lone Mountain Facility (after its now-approved inclusion of the 720-acre area to the west of the existing facility area). Drawing 2 also shows the access routes that will be used to access Cell 16. As shown, there is a proposed "internal" main access road that will be located within the overall facility boundary for the routing of waste disposal traffic going to Cell 16 from the existing facility area. There is also an additional proposed access point for waste disposal vehicles via a proposed roadway segment that will be constructed to extend from US Hwy 412 just south of the facility boundary and extending northward to join the internal main access road and continue onward to Cell 16.

1.4.2 Access Control

The existing facility area is surrounded by security fencing and lockable gates for access control. Likewise, prior to the start of Cell 16 waste disposal operations, security fencing will be installed to completely encircle the perimeter of the Cell 16 area. It is noted that the natural terrain in and around Cell 16 has topographic relief on the order of 140-feet between the existing bluffs (ridges) at higher elevations and canyons (valleys) at lower elevations – and thus this rugged terrain, along with the remoteness of the land without frontage on public roadways – serves as its own form of access control. The exact alignment of the Cell 16 security fencing has not yet been established; however, in general, the fencing will be situated along the bluffs located west, north, and east of Cell 16, and will be connected by also fencing across the opening of the canyon/valley on the south side of Cell 16, so as to completely surround the entirety of the full area of future Cell 16 and be in-place prior to the start of waste disposal operations. The facility access roads will be equipped with lockable gates that will be kept locked except when in use. Secondary access points for non-waste hauling vehicle use (e.g., small existing unpaved roads) will also be equipped with locked gates kept locked except when being used.

1.4.3 Comparison of Main Landfill Cell 16 Items to Approved Landfill Cell 15

The intent of the Cell 16 engineering design is to maintain consistency with the approved Cell 15 design. There are no changes proposed to the main containment systems (liner, leachate collection, leak detection, and final cover). The design analyses and computations contained herein are site-specific to the Cell 16 conditions, layout, and features. Table 1 presented below provides a comparison of the main attributes of Cell 16 vs. Cell 15, in order to provide a concise summary of the similarities and noting any minor differences.

TABLE 1
LANDFILL CELL 16 VS. CELL 15 COMPARISONS – MAIN ATTRIBUTES

Proposed Landfill Cell 16	Comparison to Approved Landfill Cell 15
Waste Acceptance and Landfill Operational Procedures	Same (no changes proposed)
Liner System Design – Triple Liner System	Same (no changes proposed)
Leachate Collection and Leak Detection System Design	Same (no changes proposed)
Final Cover System Design	Same (no changes proposed)

Proposed Landfill Cell 16	Comparison to Approved Landfill Cell 15
Operations Stormwater Management (Run-on/Run-off Control – Active Areas)	Consistent approach (tailored to site-specific Cell 16 conditions)
Final Closure Stormwater Management (Run-on/Run-off Control – Covered/Final Areas)	Consistent approach (tailored to site-specific Cell 16 conditions)
Closure Plan	Same framework (with phasing tailored to site-specific Cell 16 conditions)
Construction Quality Assurance (CQA) Plan	Consistent lined cell and final cover construction QA/QC procedures, testing methods/frequencies, and specified acceptance criteria/properties. Revisions to the existing CQA Plan are being submitted with minor changes to cover both Cell 15 and Cell 16.
Groundwater Monitoring Program	The hydrogeologic and groundwater conditions (conceptual site model and subsurface setting) beneath the Cell 16 area are consistent with the rest of the facility [Envirotech, 2023]. Since Cell 16 is a new and stand-alone disposal unit, a new (proposed) layout of monitoring wells is presented herein for Cell 16 based on the hydrogeologic characterization and groundwater flow directions. The monitoring parameters and sampling & analysis plan for its detection monitoring program will be the same as for the existing facility landfill units.

2. LANDFILL CELL 16 LAYOUT AND CONTAINMENT SYSTEM DESIGN

The layout and engineering details of the Cell 16 layout and liner system components are presented on the Engineering Drawings in Exhibit A. This section provides description of the engineering analyses and design calculations performed to support design of the landfill liner system and cell/subcell layout.

2.1 Buffer Zones

Cell 16 is designed with set-backs from the site perimeter (facility boundary) to the landfill unit (limit of liner, i.e., limit of disposal) to provide a minimum 200-ft buffer zone surrounding the entire landfill, as specified in OAC 252:205-9-3. By adhering to this buffer, no disposal in a landfill unit will occur within 200-ft of the site perimeter, and in fact, an even greater buffer than this regulatory minimum will be present. The closest distances between the limit of the landfill unit and the facility boundary are labeled on Drawing 3 in Exhibit A. As shown, the northwest portion of Cell 16 (Subcell 1 area) will have an approximately 325-ft (min) buffer zone at its closest point, and the northern portion of Cell 16 (Subcell 6 area) will have an approximately 350-ft (min) buffer at its closest point. The remaining portions of Cell 16 have a much larger distance to the facility boundary. The exact buffer set-back distance at any point can be scaled-off of Drawings 2 and/or 3 in Exhibit A.

2.2 Landfill Cell 16 Layout and Volume

Cell 16 will be situated in a natural canyon/valley, surrounded by bluffs on three sides (west, north, and east), and with an above-grade compacted soil (earthen) embankment constructed across the south side to enclose the landfill area. The engineering drawing set presented in Exhibit A attached to this report show the Cell 16 layout. In particular, Drawing 2 shows the overall site plan and where Cell 16 is situated relative to the rest of the existing facility and Drawing 3 shows the Cell 16 site plan at a zoomed-in scale. The base grades (liner grading plan) are shown on Drawing 5. The final cover grading plan is shown on Drawing 11. General statistics on the size, volume, and peak elevation of Cell 16 are presented below in Table 2.

TABLE 2
LANDFILL CELL 16 GENERAL STATISTICS

Proposed Landfill Cell 16
Lined Area = 92.0 Acres
Waste Disposal Volume = 10,909,365 cubic yards (CY)
Maximum Final Cover System Elevation = 1670 ft, MSL

As shown on the drawings in Exhibit A, Cell 16 will be subdivided into thirteen subcells (Subcells 1 through 13). These lined subcells will be constructed incrementally over time in a phased manner. All subcells will be tied together with a continuous liner system such that, once complete, the entire Cell 16 footprint is connected, tied-in, and lined. The lined floor areas of each subcell will be sloped at a 2% (minimum) grade towards a centerline/corridor that is in turn sloped to drain at 1% (minimum) to a designated low point (sump) of each subcell. The lined sideslopes of each subcell will be inclined at a maximum steepness of 3 horizontal to 1 vertical (3H:1V) (i.e., 33.33 percent). Lined berms called “inter-subcell berms” (also known as “division berms”) will be constructed between each subcell. Table 3, presented below, indicates the plan area of each subcell, along with the calculated waste disposal volumes provided by each subcell. It is noted that these waste disposal volumes are based on vertical projections of the subcell boundaries.

TABLE 3
LANDFILL CELL 16 SUBCELL AREAS AND WASTE DISPOSAL VOLUMES

Cell 16 Subcell No.	**Plan Area** (acres)	**Waste Disposal Volume** (cubic yards)
1	11.4	947,327
2	6.2	814,885
3	5.5	867,799
4	7.0	1,141,889
5	10.1	1,376,689
6	10.2	652,868
7	6.3	527,807
8	6.2	719,879
9	4.8	661,195
10	5.8	819,323
11	5.8	791,769
12	6.1	912,081
13	6.6	675,854
Totals:	92.0	10,909,365

The above areas and volumes were measured digitally using the Exhibit A drawings. In particular, the computer-aided design (CAD)-based drawings and Civil3D® volumetric computation tools in AutoCAD® were used to generate three-dimensional digital terrain model (3D DTM) surfaces of the design top of clay liner and top of waste elevations and compute volumes by the grid method. The volume between the top of clay liner surface and the top of waste surface represents the volume available for waste disposal.

As shown on the drawings in Exhibit A, a perimeter access road located next to and just outside of the limit of liner/limit of final cover will encircle the entire Cell 16. On the west, north, and east sides of Cell 16 – which is where the landfill perimeter is situated against the sides of the natural bluffs – a perimeter drainage channel will be constructed to provide both run-on and run-off control of stormwater. The perimeter channels will flow generally from north to south, and will continue around and down both sides of the earthen embankment (south side of Cell 16) and into stormwater detention ponds [note that the surface water management system design is discussed in more detail subsequently in this Engineering Report]. The final cover grades extend upward, generally at a ten percent (10%) slope to form a general "triangular prism" cover layout with a peak/ridgeline where the grades converge to their maximums. Around the perimeter edges of Cell 16, an initial short segment of the final cover grades is sloped at 3H:1V, where the grades then transition to the 10% cover slope.

2.3 Groundwater Separation Distance

As noted above, Landfill Cell 16 will be situated in a natural canyon/valley, surrounded by bluffs on three sides (west, north, and east), and with an above-grade earthen embankment spanning across the south side. The Cell 16 base (floor) grades will be constructed primarily above-ground. Because of the variability of the natural terrain elevations, some portions of certain subcells will have their low points at and adjacent to sumps slightly below-grade. At all locations of the waste disposal unit, the Cell 16 liner is designed to maintain a 5-ft minimum separation distance between the high-water table (groundwater) and the bottom most 60-mil geomembrane component of the liner system.

This layout with groundwater separation was designed using a "Seasonal High Groundwater Table Map" (Drawing 4 of Exhibit A). As explained in the note on this map, the drawing shows groundwater contours developed by Geosyntec in consideration of the hydrogeologic characterization presented in Envirotech (2023), along with factoring-in the elevations of the natural ground surface – and using the highest groundwater readings that were recorded historically in area piezometers between September 2021 and March 2024. The resulting map represents a conservatively-high surface (since not all highest groundwater readings occurred at the same time, and because groundwater conditions appear discontinuous beneath the site as evidenced by many borings that did not encounter saturated conditions/groundwater). The base grades were then designed accordingly such that a 5-ft minimum separation distance between the liner and groundwater is maintained, including at the lowest points of the landfill in the sumps.

2.4 Liner System Description (Containment System Design)

The proposed Cell 16 base liner system will be a triple lined-system (the same system as is being used for Cell 15), and will be composed of (from bottom to top):

- 3-ft thick compacted clay liner ($k \leq 1 \times 10^{-7}$ cm/s);
- bottom 60-mil HDPE textured geomembrane;
- bottom double-sided geocomposite leak detection drainage layer;
- middle 60-mil HDPE textured geomembrane;
- geosynthetic clay liner (GCL);
- upper 60-mil HDPE textured geomembrane;
- upper double-sided geocomposite leachate collection drainage layer; and
- 2-ft thick protective cover layer (screened waste or sand).

The proposed Cell 16 sideslope liner system is the same as the proposed base liner system, except that the middle geomembrane is absent, resulting in an upper and a bottom geomembrane liner, both of which form composite liners with their underlying liner low-permeability components. This is also the same sideslope liner design as is being used for Cell 15.

The liner system components have been selected and designed to prevent migration of wastes out of the landfill, using materials with sufficient chemical properties, strength, and thickness to prevent failure due to anticipated pressures and stresses.

2.5 <u>Overview of Subsurface Investigations and Conditions at Cell 16</u>

2.5.1 Site Subsurface Investigations

Subsurface conditions at existing portions of the Lone Mountain Facility have been extensively investigated and characterized as part of previous permitting activities through a series of site investigations in the past, allowing development of a geologic framework, or "conceptual site model," of the regional and site-specific subsurface.

More recently, as part of Envirotech's 2023 Class 3, Tier III Permit Modification to assess and demonstrate site suitability and add the 720-acre area of undeveloped ranch land west of the existing facility to the overall permit boundary, Envirotech conducted a subsurface exploration program of the expansion area. The focus of Envirotech's subsurface investigation, with field work performed in the 2021-timeframe, was to document site-specific geologic features, the depth of the confining layer within the Flowerpot (Shale) Formation, location of Terrace deposit locations (if any), and site-specific groundwater conditions. Eighty-three (83) borings at 72 locations were drilled for Envirotech's 2021 site investigation, the results of which are documented in Envirotech (2023). The boring depths ranged from 20 to 215 feet below ground surface. In addition, twenty (20) of the borings were converted to piezometers as part of Envirotech's 2021 investigation, and depth to groundwater was gauged to ascertain the depth to the water table and determine corresponding groundwater flow directions and the seasonal/historical high water table levels.

In 2024, a second and more targeted subsurface investigation of the Cell 16 area (also referred to as the "Phase II Geotechnical Investigation") was performed by Envirotech. Twenty (20) additional geotechnical borings were drilled and sampled, at depths ranging from 25 to 140 feet below ground surface. Geosyntec designed this Phase II investigation program, collaborating with Envirotech, with the intent of obtaining geotechnical data on the physical and strength properties of the strata beneath Cell 16, to use for the Cell 16 engineering design. Exhibit B of this Engineering Report includes a copy of Envirotech's Phase II Geotechnical Investigation for Cell 16, including narrative text, maps, boring logs, and laboratory test results (see Exhibit B-1). Additionally, Geosyntec prepared a Geotechnical Site Characterization Summary using the results of Envirotech's 2021 and 2024 investigations (and also considering relevant data from historical site investigations). Geosyntec's geotechnical summary is presented in Exhibit B-2 of this Engineering Report and focuses on the basis for the various selected geotechnical properties assigned to the subsurface layers for engineering design of Cell 16.

2.5.2 Overview of Subsurface Conditions

Geology. Based on information in Envirotech (2023), the northern portion of the 720-acre land addition that encompasses the Cell 16 area is composed of exposed caprock of the Blaine Formation. The Blaine Formation consists of massive gypsum beds separated by shale layers, with occasional thin dolomite layers. The Flowerpot Shale underlies the Blaine Formation. The Flowerpot Shale is the primary unit of interest in the area, as it is known to directly underlie the area of the land addition (including Cell 16 itself). The Flowerpot Shale is about 300-ft or more thick at the site, and consists of reddish-brown and greenish-gray shale with interbedded layers of gypsum and gypsum stringers. Site-specific conditions at the Lone Mountain Facility have found the "green shale layer," as a marker bed at about the middle of the Flowerpot Formation. The green shale layer of the Flowerpot is a continuous natural impermeable lower boundary (i.e., confining layer) beneath the site that forms a barrier between deeper regional aquifer systems and local (shallower) perched groundwater flow regimes. Envirotech (2023) provides a contour map of the green shale surface. Geosyntec's Cell 16 design is well above the green shale – and in fact, is almost entirely above-grade (i.e., the base grades will be mostly above the natural ground surface of the valley), with only minimal excavation into shallow soil below the ground surface.

Stratigraphy. For geotechnical characterization purposes, the subsurface stratigraphy at the Cell 16 area in the valley situated between the bluffs is divided into two main layers:

- a brownish-red residual soil layer termed the "upper clay" that is present at the ground surface and is up to about 12-ft thick; and

- underlying the clay layer, a slightly to highly weathered "shale" (also sometimes referred to as siltstone/claystone) that is also primarily brownish red in color but is more rock-like in its consistency, and that continued down to the termination depth of the Phase II geotechnical borings.

The Phase II borings were focused on obtaining geotechnical properties for engineering design. Accordingly, these boring were primarily an investigation to relatively shallower depths, to assess the strength and compressibility of the upper clay soil layer and any transitional more weathered shale prior to reaching what is, for geotechnical design purposes, "bedrock" (less weathered and thus stronger/harder). As such, by design, the Phase II borings did not extend deep enough to encounter the green shale marker bed (confining layer).

The tops of the bluffs are composed of hard gypsum that forms a weather-resistant cap to the mesas (flat tops of the bluffs). The sidewalls of the bluffs are shale with occasional interbedded gypsum, with the shaly sidewalls exhibiting varying degrees of weathering but generally hard material. Since the Cell 16 design layout has the lined cells founded against these sidewalls, the presence of the large, robust, and inherently stable bluffs will enhance the stability of the landfill unit. The geotechnical design focus is on stability of the landfill itself along with its constructed earthen embankment, and its foundation on the valley soils.

Groundwater. With respect to the presence of groundwater beneath the Cell 16 and adjacent area, Envirotech (2023) documented the hydrogeologic similarities of the 720-acres of added land with those of the rest of the existing facility. Envirotech's twenty (20) piezometers were installed in water-bearing strata perched above the green confining layer of shale (marker bed) of the Flowerpot Formation. Envirotech (2023) noted that the upper part of the Flowerpot Shale has water-bearing zones within its formation, but with groundwater of low yield and poor natural water quality. This perched groundwater does not appear to form an interconnected zone of saturation (i.e., it appears rather discontinuous), as evidenced by the absence of groundwater in many of the borings drilled.

Envirotech's (2023) piezometric data documented groundwater elevations the area of the land addition (including the now-designated Cell 16 area within this land addition) that is generally follows the surface topography trends, patterns, and gradients. In particular, Envirotech's (2023) Figure 14 presents a potentiometric map of groundwater contours that shows a groundwater flow divide (highest elevation of groundwater) generally following the bluff at the north side of the site (just north of the Cell 16 footprint), with groundwater contours and resulting flow directions going from north to south-southwest on the south side of this bluff. This north to south-southwest flow direction is also consistent with the regional gentle dip of the Flowerpot Formation. On the north side of this bluff, groundwater locally flows from south to north – consistent with the observed trends at the entire Lone Mountain Facility site area of groundwater generally flowing in directions consistent with surface topography. In relation to Cell 16, the groundwater flow direction is north to south-southwest across all of the landfill subcells except potentially Subcell 6 on the northeast side of Cell 16, which may be in an area on the other side of the groundwater divide (with groundwater flowing from south to north-northeast).

2.6 Slope Stability Analyses

2.6.1 Static Slope Stability

Part of the geotechnical evaluation and design of proposed Cell 16 includes analyzing the stability of the landfill itself, along with its sideslopes, embankment slopes, and the foundation beneath the landfill, for various critical cross-sections and sliding scenarios. These slope stability analyses for both static and seismic conditions are presented in Exhibit B-3. The calculations presented in Exhibit B-3 include a detailed discussion of the approach, sliding scenarios, critical cross sections, assumed parameters, and results. Comprehensive calculations are presented for the relevant sliding scenarios and critical landfill cross sections. The components of the landfill for which the slope stability analyses were performed are:

- perimeter embankment slopes and foundation soils after construction but before waste placement;
- liner system slopes prior to waste placement (i.e., liner system veneer);
- interim landfill slopes during waste placement operations;
- final cover system slopes (i.e., final cover system veneer); and
- final landfill slopes and foundation soils at the final closure condition (including post-construction and after final filling: embankment stability, waste mass stability including liner interfaces, and global/overall slope stability).

The static slope stability factor of safety for each component, mode, and sliding scenario was evaluated for cross sections that represent critical combinations of geometry and shear strength. The slope stability of the landfill components except for veneer sliding of the liner and final cover system was analyzed using a method of slices coded in the computer program SLIDE, Version 9.034 by Rocscience, Inc. The computer program was used to generate circular and non-circular (block-type) shear surfaces and calculate the factors of safety of these surfaces using Spencer's (1967) method (see Exhibit B-3 for list of references).

Veneer stability refers to sliding of the liner or cover system layers along the weakest interface of the sandwich (layering) of liner system or final cover system components. Liner system and final cover system veneer stability was evaluated using the force equilibrium method as further explained and referenced in Exhibit B-3.

For shear surfaces that pass through the liner system or final cover system, the approach generally taken is to conduct both a "forward-analysis" (using measured or published/typical strength parameters), as well as a "back-analysis" to back-calculate the minimum allowable secant effective-stress friction angle for the liner system and final cover system that yields the target calculated factor of safety for slope stability. The back-calculated minimum strength values for the liner system and final cover system are then incorporated into the material specifications for liner and final cover materials, which are part of the Construction Quality Assurance (CQA) Plan.

Refer to Exhibit B-3 for a detailed description of slope stability evaluation. In summary, the results indicate that the proposed Landfill Cell 16 has adequate calculated factor of safety against static slope stability sliding for the modes and scenarios analyzed at the critical cross sections.

2.6.2 Seismic Hazard Evaluation and Seismic Slope Stability

Exhibit B-3 also contains site-specific seismic analyses for Landfill Cell 16 – namely, a seismic hazard evaluation and seismic slope stability calculations. These were performed as part of the site-specific Cell 16 engineering design, and are updates to the preliminary seismic study included in Envirotech (2023). Geosyntec's seismic analyses presented herein (Exhibit B-3) follow a similar approach and rationale as the past studies by GeoLogic Associates (GLA) for the Lone Mountain Facility in 2016 and 2020, except using more recent (updated) guidance and technical literature that represent the latest standard of practice, and are more appropriate for Central U.S. (including Oklahoma-specific) earthquake history and seismicity. The resulting seismic hazard analysis and computed ground shaking (accelerations) were updated as compared to previous studies to assure that Cell 16 is designed consistent with the current standard of practice and latest available data on earthquakes and seismicity. This included the following:

- an updated shear wave velocity (VS30) estimate using the regional map by Zalachoris et al (2017), "VS30 Characterization of Texas, Oklahoma, and Kansas Using the P-Wave Seismogram Method";
- check/update of Oklahoma seismicity records up to the present (2024) to assure the latest earthquake history is considered, and use of Vs profiles for 28 seismograph stations near the Fairview, Pawnee, and Cushing epicentral areas in Oklahoma;
- seismic hazard from tectonic (natural) earthquakes for the 2,475-yr return period ground motions (i.e., 10% probability in 250 years) on the USGS 2023 National Seismic Hazard Model;
- consideration of potentially induced (human-activity) and tectonic earthquakes based on probabilistic ground motions computed per USGS 2017 and 2018 forecasts ("One-Year Seismic Hazard Forecast for the Central and Eastern United States from Induced and Natural Earthquakes"); and
- for the deterministic seismic hazard analysis for potentially induced earthquakes, a ground motion model appropriate for induced earthquakes in the Central and Eastern U.S. will used (Zalachoris and Rathje 2019, "Ground Motion Model for Small-to-Moderate Earthquakes in Texas, Oklahoma, and Kansas").

Refer to the calculations presented in Exhibit B-3 for a detailed discussion of the approach, method, scenarios and analysis, and results (and list of references). In brief, the results indicate that the proposed Landfill Cell 16 has adequate seismic stability. That is, the calculated earthquake-induced deformational performance (i.e., seismic slope stability) for the modes and scenarios analyzed at the critical cross sections under seismic conditions meets the specified criteria and is acceptable.

2.7 Settlement and Liner Stress Analyses

Another component of the geotechnical analysis of Cell 16 is an evaluation of settlement to assess the magnitude of settlements and whether the liner system would be expected to withstand the associated grade changes and stresses from settlement, and not experience grade reversals of drainage pipes/corridors. These settlement and liner stress analyses are presented in Exhibit B-4. The analyses evaluate the effect of one-dimensional consolidation of the upper (compressible) foundation layers composed of compacted fill soil and the underlying soil strata, on the post-settlement grades of liner system of Cell 16. Specifically, the settlements of the most critical portion of the liner grades along the leachate collection system corridors (flattest slopes) were evaluated. As a design criterion, the leachate corridors should be predicted to maintain positive drainage towards the leachate collection sumps after foundation settlements have occurred. Also, calculated tensile strains due to differential settlement should not exceed tolerable strains for the liner system components.

Foundation soils beneath the landfill base are expected to compress somewhat as the load increases (i.e., as waste is placed in the landfill followed by closure). The foundation settlements will be affected by: (i) the thickness and properties of the soil strata beneath the landfill; and (ii) the variable loading of the foundation by the landfill, from zero at the perimeter (where there is no load), to a maximum near the center of the landfill where the waste thickness and final cover elevation will be at a maximum. Settlement of the clayey foundation strata beneath the landfill was calculated using equations for conventional one-dimensional compression settlement due to loading based on consolidation behavior.

Based on the analyses presented in Exhibit B-4, the calculated settlement magnitudes along the leachate collection corridors and associated post-settlement slopes are acceptable. Results also indicate that the predicted elongation strain is minimal, and much less than the yield strain (13 percent) for an HDPE geomembrane (i.e., acceptable).

Accordingly, the calculations show that the settlements are tolerable and the integrity of the geomembrane liner should not be adversely affected by total or differential settlement. Furthermore, the cover system is not expected to settle significantly for the reasons discussed in Exhibit B-4.

2.8 Anchor Trench Design

The anchor trench design is presented in Exhibit D. Loading of the geosynthetic materials are estimated, and the stresses transmitted by friction to the underlying geosynthetic materials are predicted based on a method presented in *Designing with Geosynthetics* by Koerner (1990 and 1998). The design is based on: (i) an evaluation of the anticipated stresses in the geosynthetic components of the liner system and resulting tensile forces (if any); and (ii) demonstration that the anchor trench configuration is adequately designed in the event excessive tensile loading is experienced. The prescribed anchor trench runout length, depth, and interface friction have been evaluated to verify that the geosynthetics will pull out of the anchor trench before tensile failure of the geosynthetics occurs, which is an appropriate condition.

2.9 Liner System Construction – Phased Sequencing of Subcells

As noted in Section 2.2, the lined Cell 16 Subcells 1 through 13 will be constructed incrementally over time in a phased manner. The subcells will be constructed (and then subsequently filled with waste) in ascending numerical order, consistent with the planned development progression over time as presented on Drawings 6 through 9 of Exhibit A.

When a given subcell is constructed, its liner system will permanently terminate at the final landfill perimeter of that subcell (i.e., along the final exterior of Cell 16), as well as temporarily terminate at inter-subcell berms (division berms) which are located on the floor areas of Cell 16 to separate subcells from each other to facilitate phasing, interim stormwater run-on and run-off management, and leachate management. When the next subcell in the sequence is constructed, its liner is tied to the adjacent existing subcell(s) liner to form a continuous liner system such that, once complete, the entire Cell 16 footprint is connected, tied-in, and lined.

Engineering details illustrating the inter-subcell berm and associated liner tie-in are presented on Drawing 17 of Exhibit A. Detail 4 on Drawing 17 shows the initial condition of an inter-subcell berm when it is first constructed for a given subcell. As shown, the liner system will extend "up and over" the berm and into the future subcell. As a result, a small "shelf" of about 15-ft width in the future subcell would be constructed to the liner design grades of that future subcell. This is for constructability, to provide a relatively flat shelf to facilitate more convenient future liner system tie-in. As shown, a sacrificial geomembrane will be placed over the top of the inter-subcell berm and onto the shelf of the future subcell; and also a temporary protective soil layer will be placed onto the shelf. This is to protect the liner during the interim time period before the future subcell is constructed.

Detail 6 on Drawing 17 picks up where Detail 4 leaves off, and shows the steps to making the liner system tie-in when it is time to build the future subcell. In Step 1, the temporary protective soil and sacrificial geomembrane will be removed, to expose the intact liner system. Also, the geosynthetics on the future subcell shelf will be rolled-back, to expose the 3-ft thick clay liner for making clay liner tie-in. In Step 2, the existing clay liner on the shelf will be cut-back in a benched manner, and then the new (future cell) 3-ft thick clay liner will be constructed and tied-in to the existing clay liner at the shelf. Next, each of the existing geosynthetic components of the liner system will be unrolled. As the geosynthetics installation of the future subcell progresses, each new geosynthetic component will be tied-in to the existing geosynthetic component. For the geomembranes, this tie-in will be a weld, so as to form contiguous lined components tying the existing liner to the new liner. Finally, once the geosynthetic components tie-ins are completed, protective cover will be placed over the inter-subcell berm and in the future subcell, so as to make the whole area ready for waste placement.

3. LANDFILL CELL 16 LEACHATE COLLECTION AND LEAK DETECTION SYSTEM DESIGN

The leachate collection and recovery system and leak detection system (LCS and LDS, respectively) design is presented in Exhibit E. The LCS components have been designed to effectively collect and remove leachate. The LDS components have been designed to effectively collect and remove liquid collected by the bottom leak detection layer. The following LCS and LDS-related engineering analyses were performed and are presented in the sub-exhibits indicated:

- Exhibit E-1: Leachate Generation Rates (HELP Modeling) and Head on Liner;
- Exhibit E-2: LCS and LDS Geotextile Filter Design;
- Exhibit E-3: LCS and LDS Drainage Layer Design;
- Exhibit E-4: LCS and LDS Pipe Design;
- Exhibit E-5: LCS Sump Capacity Calculations; and
- Exhibit E-6: LDS Design and Action Leakage Rate (ALR) Calculations.

The remainder of this section discusses each of the above aspects of the LCS and LDS design in more detail.

3.1 LCS and LDS Layout and Components

Cell 16 is divided into 13 subcells which will be constructed sequentially over time. As previously described in this report, each of these new subcells will be separated from each other with lined inter-subcell berms (division berms) which are designed to allow for a temporary storm-water storage area in the active subcell, to contain precipitation runoff from the active face waste surfaces. These division berms will be lined in the same manner as the floor of the subcells.

As shown on the liner system details on the drawings in Exhibit A (e.g., see Drawings 16 and 20-22), the proposed liner system includes an LCS drainage layer above the upper geomembrane liner, to collect and convey leachate towards low spots (sumps) in each subcell. Similarly, the proposed liner system includes an LDS drainage layer above the bottom geomembrane liner, to collect and convey any liquid in the leak detection layer towards leak detection (bottom) sumps in each subcell. The LCS and LDS components are completely separate drainage systems that are not connected to each other. Each subcell will have an upper LCS sump and a lower LDS sump.

Thus, on the cell floor areas, the separate LCS and LDS drainage layers will each convey collected liquid towards a collection corridor typically located along the general centerline or middle portion of each subcell. Each subcell floor is sloped at 2% minimum towards the leachate collection corridor, which in turn slopes at 1% minimum towards each subcell's collection sump. The LCS and LDS collection corridors each have a perforated collection pipe surrounded by gravel drainage material, surrounded by a geotextile filter. The sumps are filled with gravel drainage material, and have a perforated section of leachate riser pipe in the sumps, into which a submersible pump will be placed and operated to remove liquid from the sump. The riser pipe is solid wall on the sideslopes, and extends out of each sump area to the landfill perimeter (along the side of the perimeter access road). Section 3.9 of this report provides further details on how leachate will be managed once it is removed from the leachate collection sumps.

3.2 Leachate Generation and Head on Upper Liner

The leachate collection rates and maximum leachate head on the upper liner system were estimated using the HELP computer model, Version 3.95D, developed by Dr. Klaus Berger of the University of Hamburg Institute of Soil Science and Dr. Paul Schroeder of the U.S. Army Corps of Engineers Waterways Experiment Station using the same methodology and computational algorithms as for the HELP model originally developed by the U.S. Environmental Protection Agency (USEPA). HELP simulates hydrologic processes for a landfill by performing daily, sequential water balance analyses using a quasi-two-dimensional, deterministic approach. The hydrologic processes considered in the HELP model include precipitation, surface-water evaporation, runoff, infiltration, plant transpiration, soil water evaporation, soil water storage, vertical drainage (saturated and unsaturated), lateral drainage (saturated), vertical drainage (saturated) through compacted soil liners and GCLs, and leakage through geomembranes.

Leachate generation rates were estimated for several operational scenarios expected in subcells. These scenarios range from initial conditions after a subcell has been recently opened, to final closure with a final cover system in-place. The leachate collection rate and maximum leachate head on the floor of the liner system were calculated for these typical operational conditions. Results from the HELP model are presented in Exhibit E-1, and include calculations of maximum peak daily leachate collection rates and maximum annual average leachate collection rates. The Exhibit E-1 calculations show that the maximum peak daily and the maximum annual average leachate collection rates are observed during the initial condition and the intermediate conditions, respectively, when the in-place waste thickness is relatively minimal as compared to final conditions. For all operational cases evaluated, the calculated head of leachate on the liner is less than the regulatory maximum of 30 cm (12 in.). Refer to Exhibit E-1 for a detailed description of the analyses, including approach, parameter selection, scenarios evaluated, and results.

3.3 LCS and LDS Geotextile Filter Design

The LCS and LDS layers are both composed of geocomposite drainage layers. A geocomposite refers to a geonet sandwiched between and bonded to two non-woven geotextiles. The geotextiles provide frictional strength against adjacent layers, and also serve as a filter or separator when adjacent to a soil layer. Since the LDS is located between geomembranes, filtration design is not applicable. However, for the LCS, the geocomposite is directly beneath the protective cover layer; therefore, the geotextile component on the upper side of the LCS geocomposite will serve to minimize the movement of fine-grained soils into the geocomposite's geonet component. The filtration characteristics of the geotextile were evaluated using a retention criterion, a permeability criterion, and an anti-clogging criterion, based on the methods presented in the technical literature. Survivability requirements (grab, tear, and puncture strengths) were also considered so that the geotextile will have adequate resistance to stresses applied on the geotextile during construction (i.e., when concentrated stresses should be the highest). This approach and the resulting specifications are presented in Exhibit E-2.

3.4 LCS Drainage Layer Design

The geonet core of the LCS drainage layer geocomposite will provide the hydraulic capacity (in-plane transmissivity) to properly drain the collected leachate. The geocomposite drainage layer hydraulic capacity design evaluation is performed using the design-by-function concept presented by Koerner (1998) and based on Darcy's equation (flow rate = hydraulic conductivity × hydraulic gradients × cross-sectional area of flow) for hydraulic flow in porous, saturated media. The approach then follows the design methodologies presented in technical literature to apply partial reduction factors and a global factor of safety to specify the required in-service transmissivity that accounts for factors such as creep, chemical clogging, biological clogging, intrusion, and long-term decrease in flow capacity behavior. The site-specific transmissivity design evaluation results showed a minimum required transmissivity for the LCS drainage layer at Cell 16 of 7.9×10^{-4} m^2/s. According to 40 CFR §264.301, the minimum transmissivity for a geosynthetic material used as a drainage layer in the liner system of a landfill disposing hazardous waste is 3×10^{-5} m^2/s; as shown, the site-specific required transmissivity is larger than the regulatory specified value, and therefore, the site-specific calculation governs. Details of the approach, assumptions, parameters, calculations, and results are presented in Exhibit E-3.

3.5 LDS Drainage Layer Design

The transmissivity of the geocomposite in the LDS is specified to be the same as the minimum transmissivity of the geocomposite of the LCS as calculated in Exhibit E-3. Note that the flows experienced by the LDS will be negligible since it is hydraulically isolated by being sandwiched between barrier layers both above (GM/GCL) and below (GM/clay liner), as well as by being above the seasonal/historical high groundwater table. Therefore, by adopting the same transmissivity as for the LCS, the resulting LDS transmissivity specification is a conservative worst-case and much more stringent than would actually be needed. With regard to filtration, as mentioned, the geocomposite of the LDS will be located between the middle and bottom geomembranes; hence there is no filtration requirement for the geotextiles of the geocomposite in the LDS. With regard to survivability, it is expected that the geocomposite of the LDS will be subjected to stresses similar to those acting on the geocomposite of the LCS. Therefore, the same survivability criterion outlined in Exhibit E-2 for the geocomposite of the LCS applies for the geocomposite of the LDS.

Based on the above discussion, it is evident that geocomposites that meets the minimum criteria for the LCS (Exhibits E-2 and E-3) are adequate for use in the LDS. Also note that the hydraulic capacity (transmissivity) of the LDS was used to calculate a Cell 16-specific Action Leakage Rate (ALR) consistent with 40 CFR §264.302(a) and also consistent with the approach used for existing Cell 15 at this facility. Further discussion on the ALR is provided subsequently in this report, with supporting calculations in Exhibit E-6.

3.6 LCS and LDS Pipe Design Hydraulic Capacity

3.6.1 Pipe Hydraulic Capacity

As mentioned, each new subcell will have a leachate collection corridor located along the centerline/middle portion of the subcell, composed of a perforated pipe surrounded by gravel. The perforated LCS pipe will be 6-in. diameter, standard dimension ratio (SDR)-11 HDPE pipe. In Exhibit E-4, the hydraulic capacity of the proposed 6-in. diameter LCS pipe was evaluated and compared to the anticipated leachate flow rates. The maximum flow rate of leachate entering the leachate collection corridor was calculated using impingement rates calculated in Exhibit E-1. The maximum flow rate expected from the peak daily impingement rate and at the largest subcell was compared to the capacity of the leachate corridor collector pipe to ensure that the calculated collector pipe flow capacity is greater than the calculated maximum expected flow rates. The 6-in. diameter pipe sloped at 1% minimum has a hydraulic capacity of 399,100 gpd using Manning's equation to calculate gravity flow in a pipe. The calculations demonstrate that the 6-in. diameter LCS pipe has adequate hydraulic capacity, with a substantial factor of safety. Details of the approach, assumptions, parameters, calculations, and results of the LCS pipe hydraulic capacity evaluation are presented in Exhibit E-4.

The LDS collection corridor will be composed of a 4-in. diameter SDR-11 HDPE pipe. Since the flows experienced by the LDS will be negligible, a detailed evaluation of LDS capacity is not necessary, and it can be concluded by inspection that the LDS pipe capacity will be adequate for the very small flows expected. Furthermore, as an additional capacity check the hydraulic capacity of the LDS pipe compared to the calculated Cell 16 ALR is provided in Exhibit E-6 – showing that the LDS pipe capacity exceeds the ALR (i.e., it has adequate capacity to convey the ALR).

3.6.2 Pipe Structural Strength

The structural capacity of both the LCS and LDS pipes was evaluated to assess whether the pipes could withstand the stresses caused by the overlying loads. As mentioned, the LCS pipes will be perforated 6-in. diameter SDR-11 HDPE, and the LDS pipes will be perforated 4-in. diameter SDR-11 HDPE. The riser pipes within the sumps will be 18-in. diameter SDR-17 (maximum) HDPE. The stability and integrity of these various HDPE pipes was analyzed under the expected loads.

Four potential strength failure mechanisms for plastic pipes are: (i) wall crushing; (ii) wall buckling; (iii) excessive ring deflection; and (iv) excessive bending strain. These mechanisms were evaluated using methods presented in the technical literature for flexible plastic pipes. Stresses applied to the pipes are estimated for the post-closure condition, when the waste height (thickness) and corresponding loads will be the greatest.

The analyses indicate that the various specified HDPE pipe components of the LCS and LDS have sufficient strength to withstand the expected loads. Exhibit E-4 presents additional details on the approach, methods, parameters, assumptions, calculations, and results of the pipe structural capacity design evaluation.

3.7 LCS Sump Design

A calculation was performed to evaluate the storage capacity of the LCS sumps at each subcell in Cell 16, and to recommend submersible pump capacities that would provide adequate removal with reasonable cycle times (on-off pumping cycles). Each subcell is designed to have the same nominal sump size/capacity, as shown on the engineering details on Drawings 20 through 22 of Exhibit A. As shown, these LCS sumps will have a typical, standard design layout. Based on the sump dimensions and assumed porosity of the gravel in the sump, each LCS sump has an estimated capacity of approximately 7,410 gallons. As an example, using an assumed submersible sump pump operation of 20 gallons per minute (gpm), the proposed leachate sump has adequate storage capacity to provide acceptable pump cycle times considering peak and average daily operation rates. The LCS sump pump flow rate is not intended to be a limiting parameter and is merely an example to give an estimate of the magnitude of typical operations; other pump operation flow rates can also provide adequate cycle times and prompt leachate removal. Details of the approach, assumptions, parameters, calculations, and results of the LCS sump design evaluation are presented in Exhibit E-5.

With respect to the LDS sumps, similar to the discussion above for LDS drainage layer and pipe hydraulic capacity design, the LDS sump should experience minimal flows since the entire LDS is isolated by barrier liners above and below. The pumping system in each LDS sump should be operated at a pumping frequency necessary to maintain acceptably low hydraulic heads in the LDS sump, and in recognition of the LDS monitoring requirements set forth in Exhibit E-6 in relation to the ALR quantities in each subcell and associated ALR response action tiers.

3.8 LDS Design and Action Leakage Rate (ALR)

The purpose of the LDS in each lined subcell of Cell 16 is to detect, collect, and remove any leachate leaks through the middle liner system at the earliest practicable time underneath all areas subject to waste or leachate throughout the life and post closure period of the landfill [40 CFR §264.301(c)].

Pursuant to 40 CFR §264.302(a), Cell 16 should have a specified ALR. The ALR, as defined in 40 CFR §264.302(a), is the maximum design flow rate that the LDS can remove without the fluid head on the bottom liner exceeding 1-foot. Also, the Federal Register preamble that accompanied the promulgation of these cited 40 CFR 264 regulations [USEPA (1992)] further described the ALR as being a leakage rate that requires implementation of a response action to prevent hazardous constituents from migrating out of the unit.

Exhibit E-6 presents a calculation of the Cell 16-specific ALR, according to its specified LDS hydraulic capacity (transmissivity) and corresponding ability to limit buildup of hydraulic head on the bottom liner to less than 1-ft. Included in Exhibit E-6 are associated design calculations to confirm that the hydraulic capacity of the LDS geocomposite and LDS corridor (pipe) is sized to adequately convey the calculated ALR.

3.9 Leachate Management

Leachate from the Cell 16 subcells will be removed at the riser pipes via submersible pumps placed and operated in each subcell sump to remove the collected liquid. Sideslope riser pipes will be installed as part of subcell construction, as illustrated on Drawing 21 of Exhibit A – one dedicated to each leachate collection sump, and a separate riser pipe dedicated to each leak detection sump. The riser pipes are perforated within the sumps and solid-wall on the sideslopes, and extend out of each sump area up the sideslopes to the landfill perimeter (along the side of the perimeter access road). The withdrawn leachate pumped out of the sumps via the riser pipes will be collected at the end of the riser pipes via a tanker-truck that would drive from individual sump to sump along the perimeter access road. Alternatively, a double-walled (dual-contained) forcemain pipe may be installed above ground or underground around the landfill perimeter to form a transmission system connected to the sumps and routed to a common end point. It is noted that the location of this common end point has not yet been designated, but in principle would be either a truck load-out where the pumped leachate would be collected in a tanker truck, or may be one or more leachate storage tanks.

Once collected via tanker truck or in a storage tank, leachate will be managed according to the following:

- The leachate may be recycled via application as dust suppression in the active landfill from which the leachate was generated in accordance with Volume 12, Section 6.7 of the RCRA/HSWA Permit Renewal (“Leachate Recycling SOP”).
- If not recycled per the above bullet point, the leachate will be managed via either: (i) transferring the liquids to the on-site wastewater treatment system, other facility storage tanks, collection areas, or other vessels (per Volume 10, Section 6.1 of the RCRA/HWSA Permit Renewal (“Landfill Operation Procedures”) and Volume 5, Section 5.0 of the RCRA/HSWA Permit Renewal (“Tank Storage and Treatment”); or (ii) transported off-site to a duly-authorized and appropriate facility for treatment and disposal.

4. LANDFILL CELL 16 WASTE FILLING AND CLOSURE DESIGN

The layout and engineering details of the Cell 16 interim waste filling grades, final waste grades, final cover grades, and details of related components are presented on the Engineering Drawings in Exhibit A. This section provides description of the engineering analyses and design calculations performed to support design of Cell 16 filling and closure.

4.1 Final Cover System Description

The proposed Cell 16 final cover system is depicted in a cross-sectional engineering detail on Drawing 23 of Exhibit A. As shown, the proposed Cell 16 final cover system is composed of (from bottom to top):

- 12-in. thick interim cover clay (bedding clay);
- GCL;
- 60-mil HDPE textured geomembrane;
- double-sided geocomposite drainage layer;
- 1.5-ft thick protective cover soil layer;
- 6-in. thick topsoil; and
- grassy vegetation on 10% cover slopes; and 6-in. thick riprap or grassy vegetation on 3H:1V cover slopes.

The final cover components have been selected to: (i) provide long-term minimization of liquid migration into and through the closed landfill; (ii) function with minimal maintenance; (iii) promote drainage and minimize erosion or abrasion of the cover; (iv) accommodate settling and subsidence so that the cover's integrity is maintained; and (v) have a barrier layer with a hydraulic conductivity less than or equal to the hydraulic conductivity of the bottom liner at the landfill.

4.2 Phased Waste Filling and Closure

The Cell 16 subcell construction and associated waste filling will take place incrementally, with Subcell 1 constructed and filled first, and subsequent subcells constructed and filled in ascending numerical order. A series of drawings showing the general planned progression of waste filling over time are presented on Drawings 6 through 9 of Exhibit A. It should be recognized that landfill development is a constantly-changing process as waste filling progresses, and therefore the interim filling plans presented are intended to provide typical "snap-shots" with a general level of detail of the interim landfill configuration at different points in time in the future.

Since waste filling will take place incrementally, Cell 16 closure through construction of the final cover system will also occur incrementally in phases, as portions reach final waste grades. Using the filling sequences, and in consideration of the final cover grades and the final landfill surface water management system (drainage features), a phased closure plan has been prepared. These closure phases are presented on a figure included with the Landfill Cell 16 Closure Plan (see Exhibit G) that accompanies this Engineering Report.

4.3 Final Cover and Overall Landfill Slope Stability

The slope stability of Cell 16 at final grades was evaluated as part of the geotechnical design seismic and static stability analyses discussed previously in this report (with calculations presented in Exhibit B-3). Final cover scenarios analyzed include the cover system components (i.e., "veneer stability"), along with the final landfill and embankment slopes. Refer to Exhibit B-3 for a detailed description of slope stability evaluation, including methodology, cross sections analyzed, parameters, and results. In summary, the results indicate that each of the critical cross sections, which were based on the proposed Landfill Cell 16 final slopes and final cover system, has an adequate minimum calculated factor of safety against slope stability sliding for the modes analyzed.

4.4 Final Cover Stormwater Management System Design

The run-on and runoff control systems that will be used at the landfill during operation and under final cover (closure/post-closure) conditions is described subsequently in Section 5 of this Engineering Report. Hydrology and hydraulics (H&H) analyses and calculations for routing of the design storm and sizing of stormwater management system conveyances specific to the landfill final cover itself are presented in Exhibit F-1. See Section 5 of this report and Exhibit F for further information.

4.5 Final Cover Drainage Layer Design

The final cover drainage layer design is presented in Exhibit F-2. The design is for the double-sided geocomposite (non-woven geotextiles bonded to geonet) drainage layer component of the final cover system. The items evaluated in the design evaluation include: (i) filtration capability and specifications for the geotextile component of the geocomposite drainage layer; (ii) survivability specifications for the geotextiles; and (iii) hydraulic capacities of the geosynthetic drainage layers and testing conditions for verifying that the required capacities are achieved.

The drainage layer hydraulic capacity design evaluation was performed using the design-by-function concept presented by Koerner (1998) and based on Darcy's equation (flow rate = hydraulic conductivity × hydraulic gradient × cross-sectional area of flow) for hydraulic flow in porous, saturated media. The predicted flow rates were obtained using the HELP model. The resulting required transmissivity was then calculated to be 5.9×10^{-4} m^2/sec. Refer to Exhibit F-2 for a detailed discussion of the approach, HELP model, input parameters, assumptions, and the results of the final cover drainage layer design.

4.6 Final Cover Erosion Analyses

The final cover erosion analysis of the vegetated topsoil surface of the final cover system is presented in Exhibit F-3. The erosion analysis of the final cover system to evaluate whether the design provides adequate resistance to erosion was performed using the Revised Universal Soil Loss Equation (RUSLE). The majority of the final cover system is sloped at ten percent (10%).

As shown on Drawing 23 of Exhibit A, a small portion of the perimeter of the final cover system around Cell 16 is sloped at 3 horizontal to 1 vertical (3H:1V). Both of these slopes were evaluated. Based on the erosion analysis, the calculated soil loss for the 10% slopes of the final cover system is 0.45 tons per acre per year. The calculated soil loss for the 3H:1V slopes of the final cover system, when vegetated (worst case for soil erosion) is 0.70 tons per acre per year. Both of these values are less than the allowable 2 tons/acre/year soil loss recommended by USEPA for landfill final covers. Therefore, the final cover system design provides adequate erosion loss resistance and is expected to need relatively minimal maintenance during the closure and post closure period. Refer to Exhibit F-3 for a detailed discussion of the approach, input parameters, assumptions, and the results of the erosion analysis.

4.7 Above-Grade Earthen Embankment Stability and Erosion Protection System

As previously explained, the south side of Landfill Cell 16 will be formed by constructing an above-grade compacted soil earthen embankment. This embankment will have 3H:1V sideslopes on the internal side (i.e., the liner system sideslope), a flat top for the perimeter access road, and external sideslopes varying from 2H:1V at its steepest portion, transitioning to flatter (either 3H:1V or 4H:1V depending on location) external sideslopes. The layout and grading configuration of the earthen embankment is seen on several drawings in Exhibit A (e.g., see Drawings 5 and 11). As shown, the exterior side of the embankment will have ramped access roads benched-in to the embankment, to connect the overall site access road coming from the existing facility area up to the perimeter access road that encircles all of Cell 16. The exterior slopes of the above-grade embankment will be armored with a granular and riprap-based erosion protection system that is the same design as is currently used at Cell 15 (and that has been successfully constructed on 2H:1V embankments at the facility, and has been observed to perform adequately).

Construction of the embankment will be in accordance with the CQA Plan. With respect to embankment stability, the geotechnical design calculations in Exhibit B-3 evaluate sliding scenarios involving the embankment and demonstrate that the embankment (along with the foundation bearing capacity, and global stability of the landfill adjacent to the embankment and in all areas) has adequate factors of safety against sliding (i.e., is adequately stable).

4.8 Closure Plan

A Closure Plan specific to Landfill Cell 16 has been prepared, and is presented in Exhibit G. This Cell 16 Closure Plan incorporates the Cell 16-specific phased closure approach, along with other relevant information on the closure activities and schedule, as well as associated cost estimates.

5. LANDFILL CELL 16 STORMWATER RUN-ON/RUN-OFF CONTROL SYSTEM

This section provides description of the engineering analyses and calculations performed to support design of the Cell 16 storm water management features. The Cell 16 storm water management system is designed to address both run-on and runoff controls – and as such it includes a system to manage and store run-off from active areas during landfill operations, and features to control and manage run-on and run-off from the landfill, adjoining embankment, and upgradient contributing drainage areas during operations and after closure. These systems are described in the remainder of this section.

5.1 Stormwater Management – Run-on and Runoff Control During Operations

5.1.1 Contact Water from Active Landfill Areas – Temporary Storage Areas

The storm water management design of temporary storage area "during operations" refers to the features used to control and store run-off from precipitation that falls on the waste in active areas of Cell 16. Such stormwater is potentially-contaminated since it is "contact water" that has been or may potentially have been in contact with waste. Accordingly, this collected stormwater will be directed to a temporary holding area inside of the lined limits of the currently-active subcell(s), and thereafter it will be removed and treated by the facility. This approach for runoff control from active landfill areas at Cell 16 is the same as is currently being implemented at Cell 15 of the facility.

Within active subcell(s), interior temporary conveyance channels on waste inside the lined area, along with other interim diversion berms/ditches on the interior of the active areas, will direct runoff that falls on active areas towards the temporary storage area. Examples of the temporary storage areas can be seen in the phased filling plans on the drawings in Exhibit A, where allowances for waste slope "set-backs" at the toe of the interim waste slope within a lined subcell are provided to form the storage area. Design calculations for sizing of the temporary storage areas of contaminated stormwater during operations, and corresponding inter-subcell berm heights needed, are provided in Exhibit C.

As described in Exhibit C, the storm water storage areas have been sized to collect and temporarily store storm water resulting from a 100-year, 24-hour storm event. The runoff volume was calculated assuming a very high percent runoff from the waste (90%). This is a conservative assumption because in reality (as observed by the facility during actual rain events at Cell 15), the waste mass is relatively permeable and much of the rainfall infiltrates into the waste. The resulting calculated runoff volume represents the required storage capacity. Storm water storage requirements for each subcell and contributing active areas were evaluated separately. The results, presented in Exhibit C, were used to calculate the required set-back areas and division berm heights in each subcell to provide the required storage volume. The calculations include provisions for achieving at least 1-ft of freeboard under these conservative conditions, as a margin of safety. Waste shall not be placed in a subcell any closer than the set-back distance specified in each subcell (see Exhibit C), so that the required storm water storage area is maintained until the next subcell is opened and its storm water storage area is made ready.

5.1.2 Non-Contact Stormwater from Upgradient Drainage Areas, Interim-Cover, and Final-Covered Landfill Areas

Overall, run-on control to protect active landfill areas against receiving flows from non-contact stormwater from adjacent areas will be provided by perimeter channels situated adjacent to the landfill to intercept and divert upgradient runoff around active areas. Similarly, with the landfill subcell floors being constructed almost entirely in fill (i.e., above-grade), and equipped with the inter-subcell division berms (and the large overall above-grade embankment, once constructed around the south side of Cell 16), run-on will be prevented from flowing onto the active subcells. The phased filling is generally from north to south, which represents going from high-to-low topography, and thus, stormwater from surrounding areas will not tend to flow towards the landfill, but naturally tends to flow away from the landfill area (supplemented by the aforementioned perimeter channels).

On the landfill itself, when final waste grades are reached in an area at Cell 16, a 1-ft thick interim cover layer will be installed on top of the final waste grades, thereby allowing stormwater runoff from these areas to be managed as uncontaminated water. The interim cover soil layer on final waste grades will also remain in place to serve as the bottom layer of the final cover system (bedding layer on which the GCL will be installed). Drainage berms will be installed on the covered surface, to manage flows and divert runoff around/away-from active areas, consistent with the final stormwater management drainage patterns (i.e., routed into the perimeter drainage system). A cross section depicting this situation is presented on Drawing 15 of the Engineering Drawings in Exhibit A.

5.2 <u>Stormwater Management Plan – Run-on/Run-off Control for Final Conditions</u>

The storm water management design for final landfill conditions is presented in Exhibit F-1. The layout of the drainage features on the Cell 16 cover and perimeter embankment is presented on Drawing 24 of Exhibit A. Engineering details of these drainage features are presented on Drawings 25 and 26 of Exhibit A. The storm water management features for Cell 16 are designed to efficiently remove storm water and minimize erosion and infiltration resulting from the peak intensity of a 100-yr design storm. The surface water management system is composed of the following components which will collect and convey storm water from the final cover system and embankments to the perimeter facility drainage system:

- On the final cover surface of Cell 16, a mid-slope and toe-of-slope drainage berm will intercept surface water runoff (i.e., sheet flow) from the final cover and will convey runoff to several low points along these berms.

- At the low points of the mid-slope drainage berm, “drainage down-channels” will convey the collected water towards drop inlets located at various points around the Cell 16 final cover toe-of-slope.

- These drop inlets will receive water from the toe-of-slope drainage berms and drainage down-channels, and will convey the water into pipes that either flow into the perimeter drainage channel, or that flow down the perimeter embankment slope via “downspout” pipes,

- The perimeter drainage system is composed by the perimeter drainage channel that will manage and control runoff from the landfill cover, and additionally will receive, manage, and control run-on from adjacent upgradient areas next to the landfill. The perimeter drainage channel will be lined with a geomembrane to prevent infiltration into the subsurface, as well as for robust erosion protection. The perimeter channel has a high-point on the north side of Subcell 1, and flows around the west and east sides of Cell 16, towards the south.

- Ultimately, the perimeter channels flow into concrete-lined downchute channels on each side of the earthen embankment, where stormwater flows into two stormwater detention ponds. The side-by-side detention ponds are situated in a location where natural stormwater runoff from the upgradient drainage areas of the bluffs and valley/canyon converges. Accordingly, natural drainage patterns will be maintained. The detention basins are sized to temporarily store and retard (attenuate) post-development (i.e., final closure) flows so as to release stormwater to the south (per natural drainage patterns) at a controlled discharge rate that is less than the flow rate under pre-development conditions.

Refer to Exhibit F-1 for a detailed discussion of the approach, input parameters, assumptions, and the results of the final storm water management system design of the features on the landfill itself, including the required size and location of such features.

With respect to the overall site-wide run-on/runoff control system around the Cell 16 perimeter and into/through the detention ponds, Exhibit F-4 presents the “Stormwater Drainage Master Plan” for Cell 16 and its surroundings, addressing both the run-on and runoff conditions at and contributing to the Cell 16 area and associated design features.

6. CQA PLAN AND CONSTRUCTION REPORTING/DOCUMENTATION

6.1 CQA Plan

The currently-active landfill area at this facility – Landfill Cell 15 – has been following its "*Construction Quality Assurance Plan for Landfill Construction and Closure*" (CQA Plan) contained in Exhibit H of the Landfill Cell 15 Engineering Report.

Minor revisions have been made to this CQA Plan to make it applicable to both Landfill Cells 15 and 16 by tailoring certain cell-specific design requirements into the plan as applicable.

The revised CQA Plan being submitted with this Engineering Report as Exhibit H to cover both Landfill Cells 15 and 16 establishes the quality assurance and quality control monitoring, testing, and documentation activities that shall be implemented during construction of liner and final cover systems and related facilities (e.g., leak detection and leachate collection systems, etc.). Required material properties of the liner and final cover system components are also presented in the CQA Plan.

6.2 Construction Reporting/Documentation

For lined subcell construction, as described in Section 2.9 the Cell 16 Subcells 1 through 13 will be constructed incrementally over time in a phased manner. Each subcell will follow the reporting and associated submittals and documentation requirements of Section 7 of the CQA Plan, including but not limited to submittal of the final CQA Report for that subcell upon its completion of construction.

For final cover system construction, as described in Section 4.2, the Cell 16 closure through construction of the final cover system will occur incrementally in phases, as portions reach final waste grades. A plan showing the final cover system installation phases is presented on a figure included with the Landfill Cell 16 Closure Plan. Each closure phase will follow the "closure schedule and notifications" in Section 5 of the Closure Plan, as well as the "closure certification and submittal requirements" of Section 6 of the Closure Plan.

7. CELL 16 GROUNDWATER MONITORING

The proposed Cell 16 groundwater detection monitoring network of wells is provided on drawings in Exhibit A (e.g., See Drawing 3). A table of well design data (locations and anticipated depths) is provided in Exhibit I included at the end of this report.

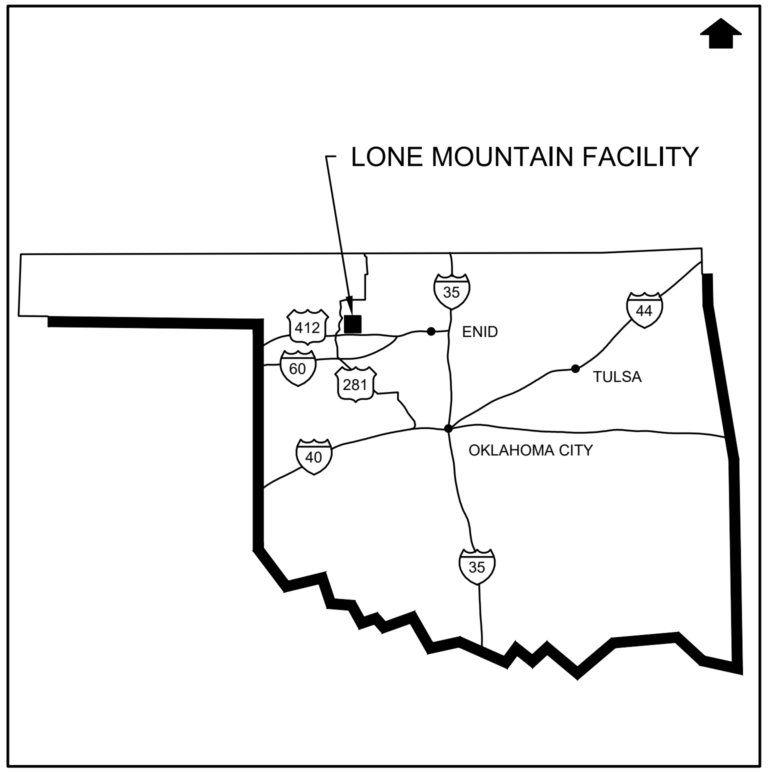
Exhibit I also includes a typical monitoring well construction diagram – which is a copy of that presented in the Groundwater Detection Monitoring Program in Volume 2, Section 3.2 of the RCRA/HSWA Permit Renewal. Before the start of Landfill Cell 16 disposal operations, the upgradient monitoring well (MW 16-1) will be installed. As each subcell is constructed at Landfill Cell 16, the point of compliance (POC) groundwater monitoring well adjacent to the subcell will be installed and added to the detection monitoring program described in Volume 2, Section 3.2 of the RCRA/HSWA Permit Renewal.

The monitoring wells will be installed in accordance with applicable requirements of the Oklahoma Water Resources Board, consistent with the typical monitoring well construction diagram, and per the Monitoring Well Design and Installation Plan given in Volume 2, Section 3.5 of the RCRA/HSWA Permit Renewal.

EXHIBIT A

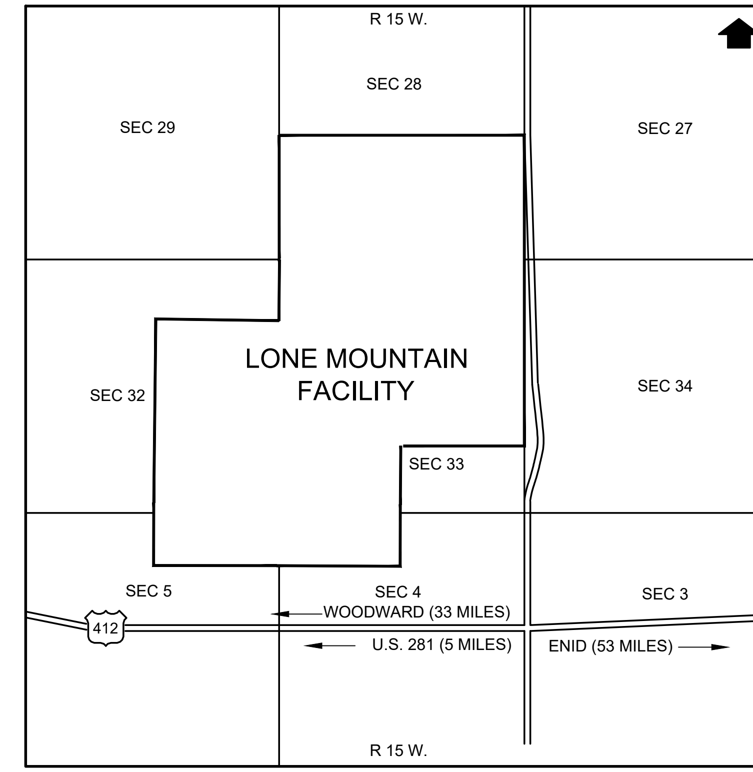
ENGINEERING DRAWINGS

LONE MOUNTAIN FACILITY
LANDFILL CELL 16
CLASS 3 PERMIT MODIFICATION
NOVEMBER 2024



LOCATION MAP
NOT TO SCALE

DRAWING INDEX



VICINITY MAP
NOT TO SCALE

PREPARED FOR:

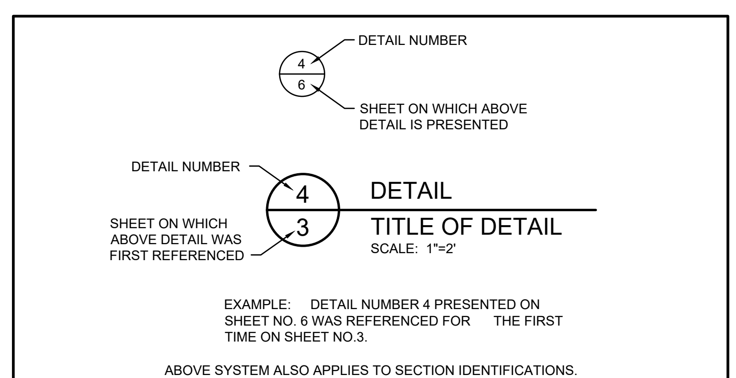
CleanHarbors ENVIRONMENTAL SERVICES, INC.

LONE MOUNTAIN FACILITY
40355 S. COUNTY RD. 236
WAYNOKA, OKLAHOMA 73860
PHONE: 580.697.3500

PREPARED BY:

Geosyntec consultants

8627 N. MOPAC EXPY, SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512.451.4003



DETAIL IDENTIFICATION LEGEND

6/16/2025

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. GRAVES
19710
OKLAHOMA

PERMIT DRAWING

REV	DATE	DESCRIPTION	DRN	APP
1	JUN 2025	RESPONSE TO NOD 1	KH	SMG

CleanHarbors ENVIRONMENTAL SERVICES, INC.
LONE MOUNTAIN FACILITY
40355 S. COUNTY RD. 236
WAYNOKA, OKLAHOMA 73860
PHONE: 580.697.3500

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
8627 N. MOPAC EXPY, SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512.451.4003

TITLE: TITLE SHEET

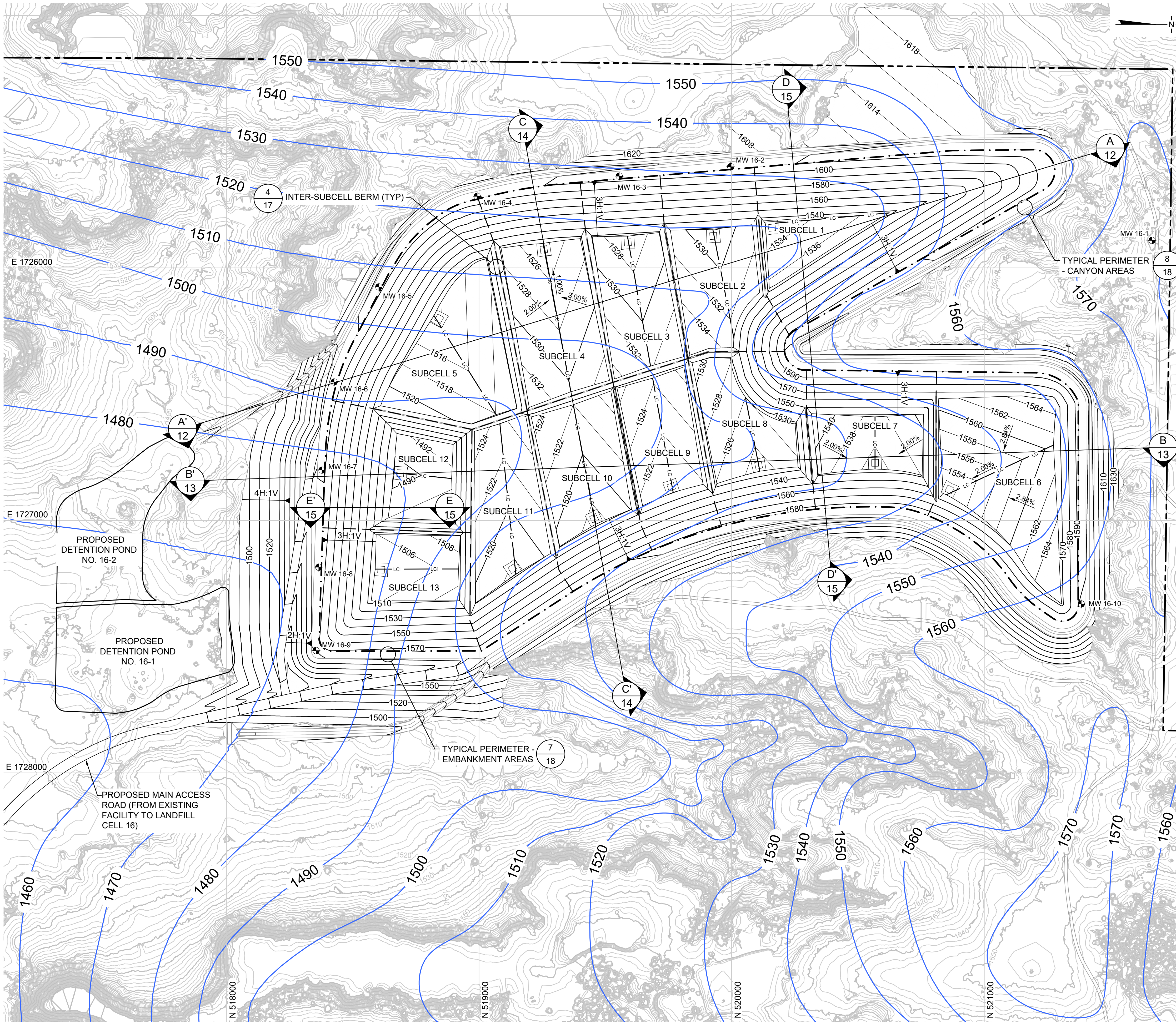
PROJECT: LANDFILL CELL 16
CLASS 3 PERMIT MODIFICATION

SITE: LONE MOUNTAIN FACILITY
WAYNOKA, OKLAHOMA

GEOSYNTEC CONSULTANTS
OKLAHOMA CERTIFICATE OF AUTHORIZATION
NO. 1996 EXP. 06/30/2026

DESIGN BY:	YB	DATE:	NOVEMBER 2024
DRAWN BY:	KH/JJV	PROJECT NO.:	GW9683
CHECKED BY:	SMG	FILE:	GW9683P01
REVIEWED BY:	SMG	DRAWING NO.:	
APPROVED BY:	SMG		1 OF 26

DRAWING: Austin C:_GEO-ACC\ACCDocs\Geosyntec\CLEAN HARBORS_LONE MTN\Project Files\PERMIT\01-CELL 16-RANCH PROPERTY(GW9683)\CADD\DRAWINGS\SHEETS\GW9683P01.dwg PLOTTED: Jun 02, 2025 - 1:55pm



LEGEND

1600	EXISTING GROUND ELEVATION (FEET) (NOTE 1)
	EXISTING ROAD
E 1728000 N 518000	HORIZONTAL COORDINATES (NOTE 2)
	PROPERTY BOUNDARY
	PROPOSED LIMIT OF WASTE
	PROPOSED SUBCELL BOUNDARY
1480	PROPOSED TOP OF CLAY LINER ELEVATION (FEET) (NOTE 3)
LC — LC	PROPOSED LEACHATE COLLECTION CORRIDOR
☐	PROPOSED LEACHATE COLLECTION SUMP
MW 16-1	PROPOSED CELL 16 GROUNDWATER MONITORING WELL (NOTE 4)
1 — 1550	SEASONAL HIGH GROUNDWATER TABLE ELEVATION (FEET, MSL) (NOTE 6)

NOTES:

1. THE TOPOGRAPHIC BASE MAP SHOWN ON THIS DRAWING IS BASED ON USGS LIDAR DATA (AUTOCAD DRAWING PROVIDED BY ENVIROTECH ENGINEERING & CONSULTING, INC.). ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (MSL).
2. HORIZONTAL NORTHING AND EASTING COORDINATES SHOWN IN THIS DRAWING SET ARE OKLAHOMA COORDINATE SYSTEM OF 1983 NORTH ZONE.
3. WITHIN THE LIMIT OF WASTE, CONTOURS REFER TO THE PROPOSED TOP OF COMPACTED CLAY LINER ELEVATIONS REPRESENTING THE SURFACE ON WHICH THE BOTTOM GEOMEMBRANE WILL BE PLACED. OUTSIDE THE LIMIT OF LINER WASTE, THE PROPOSED CONTOURS REFER TO FINISHED GRADE. 10-FT CONTOUR INTERVALS ARE SHOWN ON LINER SIDESLOPES, AND 2-FT CONTOUR INTERVALS ARE SHOWN ON LINER FLOOR GRADES.
4. PROPOSED GROUNDWATER MONITORING WELL NETWORK IS BASED ON HYDROGEOLOGIC CONDITIONS AND GROUNDWATER FLOW DIRECTION PRESENTED IN THE ENVIROTECH ENGINEERING & CONSULTING, INC. TIER 3 PERMIT MODIFICATION FOR PROPOSED LAND ADDITION, LAST REVISED APRIL 2023.
5. SUBCELL FLOOR (BASE) LINER GRADES ARE SLOPED AT 2% TOWARDS THE LEACHATE COLLECTION CORRIDOR & LOW POINT (SUMP) UNLESS LABELED OTHERWISE. LEACHATE COLLECTION CORRIDORS ARE SLOPED AT 1% TOWARDS THE SUMP UNLESS LABELED OTHERWISE.
6. SEASONAL HIGH GROUNDWATER TABLE COUNTOUR MAP TAKEN FROM DRAWING 4. SEE DRAWING 4 NOTE 3 FOR ADDITIONAL DESCRIPTION OF DATA SOURCES AND MAPPING BASIS.

0 200 400
SCALE IN FEET

REGISTERED PROFESSIONAL ENGINEER
SCOTT M. GRAVES
19710
OKLAHOMA
6/16/2025

REV	DATE	DESCRIPTION	DRN	APP
1	JUN 2025	RESPONSE TO NOD 1	KH	SMG

CleanHarbors
ENVIRONMENTAL SERVICES, INC.
LONE MOUNTAIN FACILITY
40355 S. COUNTY RD. 236
WAYNOKA, OKLAHOMA 73860
PHONE: 580.697.3500

Geosyntec consultants
GEOSYNTEC CONSULTANTS, INC.
8627 N. MOPAC EXPY, SUITE 300
AUSTIN, TEXAS 78759
PHONE: 512.451.4003

TITLE: OVERALL CELL 16 TOP OF CLAY LINER GRADING PLAN

PROJECT: LANDFILL CELL 16
CLASS 3 PERMIT MODIFICATION

SITE: LONE MOUNTAIN FACILITY
WAYNOKA, OKLAHOMA

GEOSYNTEC CONSULTANTS
OKLAHOMA CERTIFICATE OF AUTHORIZATION
NO. 1996 EXP. 06/30/2026

DESIGN BY:	YB	DATE:	NOVEMBER 2024
DRAWN BY:	KH/JJV	PROJECT NO.:	GW9683
CHECKED BY:	SMG	FILE:	GW9683P05
REVIEWED BY:	SMG	DRAWING NO.:	5 OF 26
APPROVED BY:	SMG		

PERMIT DRAWING

DRAWING: Austin C_GEO-ACC\ACCDocs\Geosyntec\CLEAN HARBORS_LONE MTN\Project Files\PERMIT\01-CELL 16-RANCH PROPERTY(GW9683)\CAD\DRAWINGS\SHEETS\GW9683P05.dwg PLOTTED: Jun 11, 2025 - 11:42am

EXHIBIT H

CONSTRUCTION QUALITY ASSURANCE (CQA) PLAN

LONE MOUNTAIN FACILITY

CONSTRUCTION QUALITY ASSURANCE PLAN

FOR

LANDFILL CONSTRUCTION AND CLOSURE – CELLS 15 AND 16

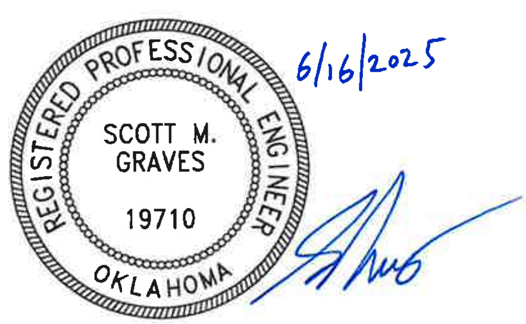
REGISTERED PROFESSIONAL ENGINEER
SCOTT M. GRAVES
19710
OKLAHOMA

6/16/2025

Geosyntec Consultants
Oklahoma Certificate of Authorization No. 1996
Exp. 06/30/2026

Rev 0, July 2010
Rev 1, May 2012
Rev 2, June 2014
Rev 3, November 2024 and June 2025

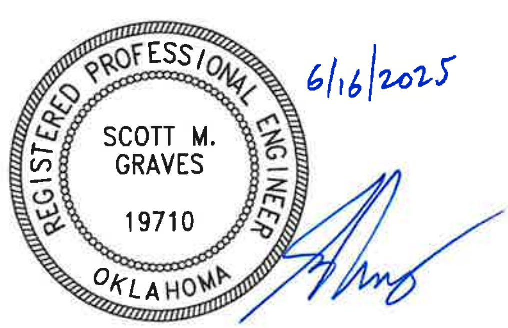
TABLE OF CONTENTS



TABLES

FIGURES

APPENDICES



7. REPORTING AND DOCUMENTATION

7.1 Reporting

Liner Construction Projects. For liner system construction, the following schedule of notifications and submittals (reporting) will be followed for construction of each lined subcell at Cell 16:

- A "*Notification of Start of Construction"* will be sent to the ODEQ at least one week prior to the date that the start of the subcell construction is anticipated to begin. This notice will indicate which subcell will be constructed, will be accompanied by a copy of the construction plans (see below), and will indicate the date subcell construction activities are expected to commence.
- Applicable construction plans will accompany the above Notification, and the notice will indicate whether a modification is being requested. If a modification is being requested or the plans deviate from those previously approved, the subcell construction will not be implemented until approval by ODEQ or other authorized agencies has been received.
- Liner system construction of the specified subcell will then commence after the required notices have been made and any approvals have been received.
- Within 60 days of completion of the subcell construction project, the facility will submit the final CQA Report for that subcell to ODEQ, certified by the Lone Mountain Facility Manager; and including a certification by the CQA Officer that the CQA Plan has been successfully carried out, and that the unit meets the requirements of 40 CFR 264.301 (c) or (d); and certification of CQA activities by the CQA Certifying Engineer. The completion of the project will be defined as the date when the CQA Officer notifies the Facility Manager in writing that the project is complete.

Closure Construction Projects. For final cover system (i.e., incremental closure or final closure) construction projects, see Sections 5 and 6 of the Closure Plan for the required closure schedule, notifications, and certification/submittal requirements.

7.2 Documentation

General. Documentation of construction and inspection activities associated with the CQA Plan will consist of daily recordkeeping and a final report to be prepared under the direction of the CQA Officer. Daily reporting procedures associated with the CQA activities are described based on specific work elements in Table 1 of the inspection activities section and are to be performed in a timely manner.

The results of testing and observations as recorded on the daily construction reports will be reviewed and accepted by the CQA Officer or his designee. Acceptance of the daily construction reports will consist of either counter-signing the forms directly or having one of the CQA personnel sign the forms indicating that they have been reviewed and accepted on behalf of the CQA Officer. During the construction of the facility, the CQA Officer will be responsible for maintaining and storing the originals or copies of all data sheets and reports that are generated in carrying out the CQA Plan as identified herein. A complete copy of these reports will be maintained on-site during the course of construction.

The CQA Officer will direct the preparation of a final construction documentation report (collectively referred to as “the CQA Report”) at the completion of each lined subcell construction project and each closure phase construction project. The CQA Report will contain the results of the applicable construction quality control and quality assurance observations and tests specified by the CQA Plan. The CQA Report will provide the following general certification items (plus the specific CQA items applicable for liner or closure construction as detailed subsequently):

- A summary of CQA activities, and will demonstrate that the construction satisfied the CQA Plan and applicable State and Federal regulations.
- An evaluation of the degree of reconciliation between non-conforming work and the specifications as defined in the CQA Plan and the ability of the CQA program to meet the quality objectives of the CQA Plan.
- An overall summary of construction activities associated with the project.
- A certification by the CQA Certifying Engineer that construction within (at minimum) the inside edge of the anchor trench/liner limits or final cap limits was accomplished in accordance with the CQA Plan and any field design, engineering, or construction changes were made in accordance with the change control procedure and/or a Class 1 Permit Modification.

<u>Liner Construction Projects.</u> Liner construction projects at this facility have typically subdivided the CQA Report items into separate volumes for convenience of submittal timing and reviews, as follows: CQA Report Volume I - Pre-Geosynthetics Soils; CQA Report Volume II – Geosynthetics and Associated Soil Components; and Certifying Engineer’s Report. Future projects are suggested (but not required) to subdivide the CQA Report in this manner. Regardless of whether a CQA Report is subdivided or combined into a single submittal/report, the same information detailed herein must be provided. In addition to the above general documentation requirements of a CQA

Report(s), liner construction project CQA Report(s) will also contain, at a minimum, the following engineering plans and test results as applicable for the scope of the report being submitted:

- Scaled as-built record drawings showing: the subgrade (bottom of clay liner) and top of the clay liner, which accurately depict the area boundaries and dimensions of the lined subcell; minimum, maximum, and representative elevations and liner system clay liner layer to reflect its thickness and extent. A similar as-built record drawing will also be provided for the liner protective cover soil layer on the subcell floor, documenting its extents, elevations, and thickness.
- For the soil components of the liner system (which includes leachate collection system and leak detection system granular/rock components, and liner protective cover soil), a summary of the soils observation and testing aspects of the construction project – along with results of all required tests required, at the minimum frequencies specified, in the CQA Plan.
- For the geosynthetic components of the liner system, a summary of the geosynthetic liner observation and testing aspects of the construction project – along with results of all geosynthetics tests required (including manufacturer quality control (MQC) testing and conformance testing), at the minimum frequencies specified, in the CQA Plan. For the HDPE geomembranes in particular, this includes the specified MQC testing, conformance testing, destructive and non-destructive testing, panel placement, calibration certificates, and pre-weld trial test logs – as well as as-built panel layout record drawings.

The CQA Report(s) will be certified and submitted as described above in Section 7.1.

Closure Construction Projects. In addition to providing general consistency with the above documentation requirements of a CQA Report as applicable for final cover system construction projects, refer to Sections 5 and 6 of the Closure Plan for the required CQA Report of closure certification contents and submittal requirements.

TABLE 2 Continued
EARTHWORK CONFORMANCE TESTING

MATERIAL TYPE	TEST METHOD		MIN CQA FREQUENCY
Compacted Clay Liner	Nuclear Density/Moisture Content	ASTM D6938	1 per 8,000 sf
	Laboratory Hydraulic Conductivity[4] (undisturbed in-situ specimens taken via Shelby tube samples)	ASTM D5084	Testing required on top 12 inches (i.e., upper two 6-inch lifts) of clay liner layer at: 1 per acre per lift
Upper 6-inches of Re-worked/re-compacted Interim Clay Cover (Bedding Clay) Beneath Cap GCL	Grain Size Analyses	ASTM D422	1 per 10,000 cy (min 1 per material type)
	Nuclear Density/Moisture Content	ASTM D6938	1 per 12,000 sf per lift
	Standard Proctor	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
Protective Cover Soil for Cap	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
	Standard Proctor[3]	ASTM D698	1 per 10,000 cy (min 1 per material type)
	Nuclear Density/Moisture Content[3]	ASTM D6938	See Note 3
Topsoil	Visual Classification	ASTM D2488	1 per 10,000 cy (min 1 per material type)
Rip-Rap	Visual Classification	See Appendix A.1	Minimum 3 tests per construction project
Type I and Type II Granular Filter	Visual Classification	See Appendix A.1	1 per 1,000 cy

Notes:

1. Pre-construction laboratory hydraulic conductivity testing (ASTM D5084) of a clay borrow source shall be performed at a confining stress as directed by the Design Engineer at the following variable moisture content and density conditions: (i) five (5) tests remolded to the moisture/density conditions that were used to define the modified Proctor curve; and (ii) five (5) tests remolded to the moisture/density conditions that were used to define the standard Proctor curve. Each of the resulting ten (10) compacted (remolded) specimens shall be permeated per ASTM D5084. The CQA Consultant shall use the results to define the "Acceptable Zone", consistent with EPA Technical Guidance Document EPA/600/R-93/182, by plotting the dry unit weights, molding water contents, and permeability of each of the ten (10) moisture-density points. The "Acceptable Zone" will be determined based on the acceptable range of compaction criteria to obtain an as-compacted hydraulic conductivity of no greater than $1x10^{-7}$ cm/s.
2. Ongoing Laboratory hydraulic conductivity testing (during construction) of the clay borrow source for which the Acceptable Zone is already defined through pre-construction testing described in Note 1shall be performed. The confining stress shall be the same as used for the pre-construction hydraulic conductivity tests. A minimum of two (2) specimens shall be remolded to variable target moisture content and density conditions specified by the CQA Consultant. Each of the resulting two (2) compacted (remolded) specimens shall be permeated per ASTM D5084. The CQA Consultant will use the results to confirm the applicability of the previously-defined Acceptable Zone (i.e., the results are within an acceptable range of compaction criteria to obtain an as-compacted hydraulic conductivity of no greater than $1x10^{-7}$ cm/s).
3. Soil protective cover testing for field compaction is only required for cap shoulder construction (one per 300 linear feet) and for cell ramps (minimum 2 tests per lift) and leachate riser trenches (minimum one test per 30 feet of pipe).
4. As a new testing item added in June 2025 per ODEQ request, this testing requirement pertains to the Cell 16 subcells along with only any future Cell 15 subcells that commence construction after final approval of the Cell 16 Class 3, Tier III Permit Modification request.

TABLE 6
MATERIAL PROPERTIES AND CONFORMANCE TESTING FOR FILTER FABRIC

PROPERTIES	QUALIFIERS	UNITS	SPECIFIED(1) VALUES	TEST METHOD	MQC FREQUENCY	CQA FREQUENCY
Mass per Unit Area	Minimum	oz/yd^2	8	ASTM D5261	130,000 ft^2	Not Required
Grab Tensile Strength	Minimum	lbs	200	ASTM D4632	130,000 ft^2	1 test per 200,000 ft^2
CBR Puncture Strength	Minimum	lbs	315	ASTM D6241	130,000 ft^2	1 test per 200,000 ft^2
Permittivity	Minimum	s^{-1}	1.3	ASTM D4491	540,000 ft^2	1 test per 200,000 ft^2
Apparent Opening Size	Maximum U.S. Standard Sieve	--	70	ASTM D4751	540,000 ft^2	1 test per 200,000 ft^2

EXHIBIT I

GROUNDWATER MONITORING WELL DESIGN – LANDFILL CELL 16

WELL DESIGN INFORMATION - DETECTION MONITORING WELL NETWORK
LANDFILL CELL 16, LONE MOUNTAIN FACILITY

MW ID	WELL DESIGNATION	EASTING (NAD-83, OCS NORTH)	NORTHING (NAD-83, OCS NORTH)	EXISTING GROUND ELEV (FT, MSL)	PROPOSED APPROXIMATE FINISHED GRADE ELEV (FT, MSL)	SEASONAL HIGH GW ELEV AT WELL LOCATION (FT, MSL)	TARGET BOTTOM OF WELL ELEV (FT, MSL)	TARGET BOTTOM OF WELL MINIMUM DEPTH BELOW EXISTING GROUND (FT, BGS)	TARGET BOTTOM OF WELL MINIMUM DEPTH BELOW PROPOSED FINISHED GRADE (FT, BGS)
MW 16-1	UPGRADIENT	1725890.9	521664.1	1660.1	1660.1	1570.0	1555	105	105
MW 16-2	POC	1725599.3	519996.3	1602.0	1607.2	1531.7	1515	87	92
MW 16-3	POC	1725636.8	519554.9	1621.7	1602.8	1528.4	1510	112	93
MW 16-4	POC	1725716.8	518993.0	1596.9	1597.1	1522.7	1505	92	92
MW 16-5	POC	1726075.4	518603.2	1599.7	1591.7	1506.5	1495	105	97
MW 16-6	POC	1726452.1	518426.2	1520.2	1586.2	1492.2	1480	40	106
MW 16-7	POC	1726800.7	518378.3	1494.2	1580.6	1477.3	1465	29	116
MW 16-8	POC	1727185.6	518365.6	1481.8	1574.9	1472.1	1460	22	115
MW 16-9	POC	1727515.4	518354.8	1480.0	1570.0	1472.5	1460	20	110
MW 16-10	POC	1727330.9	521384.0	1579.8	1589.8	1562.6	1540	40	50

Notes:

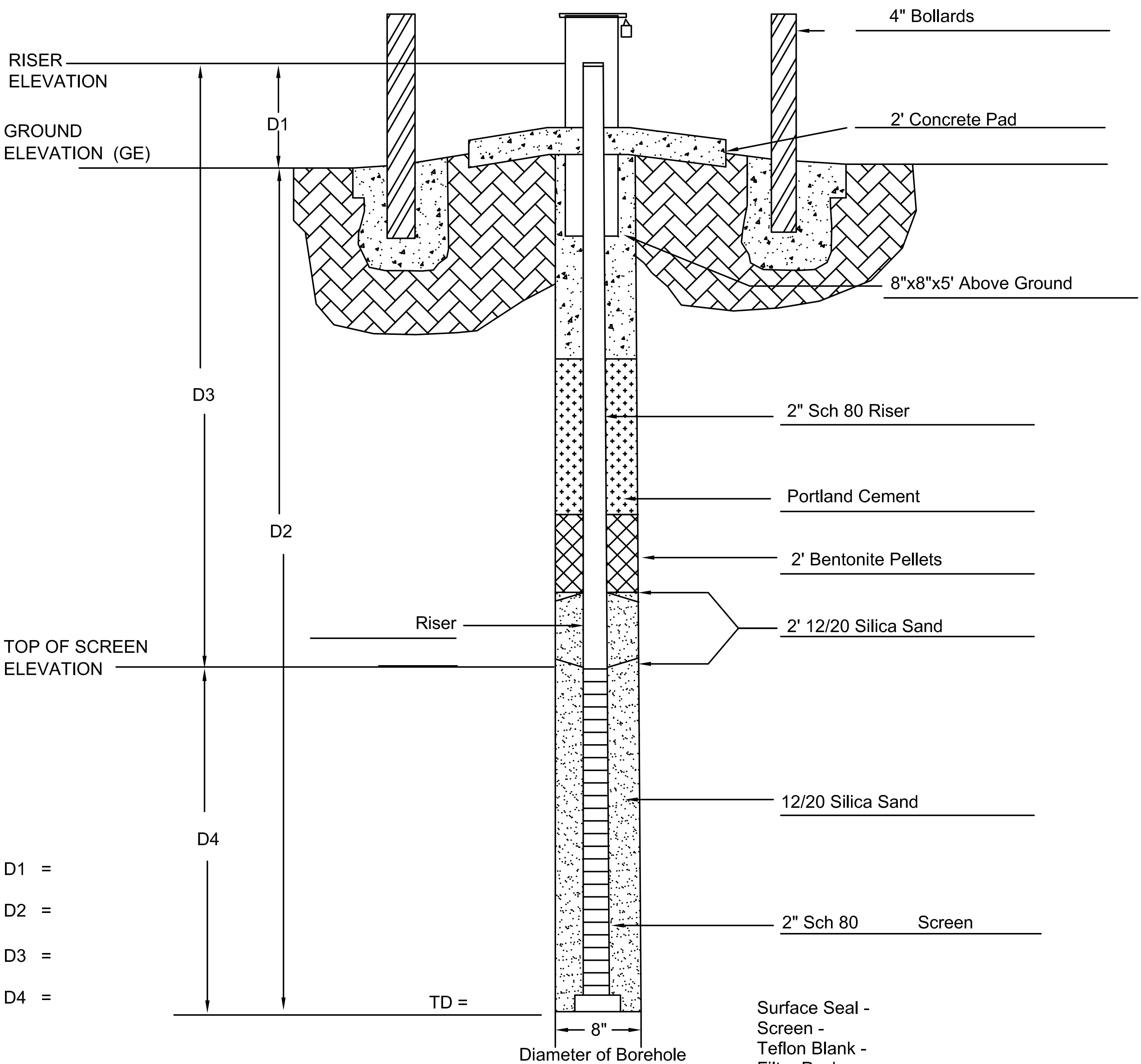
1. POC = Point of Compliance (located hydraulically downgradient from Landfill Cell 16)
2. NAD-83, OCS NORTH = North American Datum of 1983, Oklahoma Coordinate System, North Zone
3. ELEV (FT, MSL) = Elevation above mean sea level
4. FT, BGS = feet below ground surface
5. Seasonal High Groundwater Elevation taken from map presented on Geosyntec Drawing 4 of 26 in Exhibit A of Landfill Cell 16 Engineering Report)
6. Information for proposed Landfill Cell 16 groundwater monitoring well network is based on anticipated subsurface characterization of stratigraphy and groudwater at the given well location and should be considered approximate. Minor field adjustments to the well locations may be made in the field (e.g., for drill rig access). Actual installed depths and screened intervals should be based on actual subsurface conditions observed during drilling. Actual as-built installation data will be reported on the well construction reports. Monitoring wells will be constructed in accordance with the applicable requirements of the Oklahoma Water Resources Board, and consistent with the typical monitoring well construction diagram included in this Exhibit.

ENVIROTECH
ENGINEERING & CONSULTING, INC.

PROJECT NAME: Clean Harbors Lone Mountain Facility

Northing:	
Easting:	

MONITORING WELL NO.



NOTE: This figure is taken from Volume 2, Section 3.2 of the September 2020 RCRA/HSWA Permit Renewal; and is being included in Exhibit I of the Engineering Report for Landfill Cell 16.

NOT TO SCALE

Figure 3.16: Typical Well Construction Diagram

MONITORING WELL INFORMATION

DRILLING CONTRACTOR: ENVIROTECH		DRILLER:
DRILLING RIG TYPE:	DRILL METHOD:	
DATE STARTED:	DATE COMPLETED:	FORM COMPLETED BY: