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Part 36

PERMIT APPLICATION SWD Amendments Volume 2

June 11, 2020

Permit Application For Surface Waste Management and Salt Water Disposal Well Facility

North Ranch Disposal Facility:
Surface Waste Management Facility and Striker 4 Facility
Lea County, New Mexico

May 2020
Project No. 35187378

Prepared for:

NGL Waste Services, LLC
3773 Cherry Creek Dr., Suite 1000
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303-815-1010

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Volume 2 of 2

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Volume 2 of 2

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Appendix I
Hydrogeological Report

Hydrogeological Report

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Surface Waste Management Facility and Striker 4 Facility

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1.0 Introduction

This Hydrogeological Report documents investigations conducted for the proposed NGL Waste Services, LLC and NGL Water Solutions Permian, LLC (NGL) North Ranch Surface Waste Management Facility (NRSWMF) and North Ranch Striker 4 Facility (NRS4F) located near Jal, Lea County, New Mexico. Data were compiled by Terracon Consultants, Inc. (Terracon) and Lonquist and Co., LLC (Lonquist), in accordance with the Energy, Minerals and Natural Resources Department, Oil Conservation Division (NMOCD or Division) requirements and the *New Mexico Administrative Code (NMAC)* Section **19.15.36** and the NMOCD **Form C-108**. NGL owns the property proposed for the landfill and associated facilities.

Section 2.0-3.0 of this report was prepared by Terracon and describes the regional geologic and hydrogeological characterization for the area and the site-specific information gathered for the generation of this document for the NRSWMF. Section 4.0 of this report was prepared by Lonquist and describes the regional geological and hydrogeological characterization data specific to the NRS4F.

1.1 Site Location

The NRSWMF site is located within Section 9 and 10 of, T25S, R34E approximately 16 miles west of the City of Jal in Lea County, New Mexico.. The NRS4F site is located within Section 24 of T25S, R34E. See **Figure 1.**

1.2 Background

NGL is currently preparing a Permit Application to develop a new Surface Waste Management Facility (NRSWMF) and Salt Water Disposal Well Facility (NRS4F). The location of the site and the proposed development areas are shown on **Figure 1**. This application will establish an oil field solid waste landfill footprint area consisting of approximately 205 acres with a waste capacity of approximately 40,743,946 cubic yards. **Figure 2** illustrates the site layout within the permitted boundary. The NMOCD requires a review and summary of the hydrogeology and geology of the region and facility that illustrates the location of the SWMF facilities and Wells.

2.0 North Ranch Surface Waste Management Facility Regional Characterization

This section discusses the regional hydrogeologic setting of the area surrounding the SWMF including hydrology, geology, hydrogeology, and groundwater quality. This information was compiled from published sources including sections of the 1961 Geology and Ground-Water Condition in Southern Lea County, New Mexico report by the State Bureau of Mines and Mineral Resources, New Mexico Institute of Mining and Technology and Terracon's January 2019 Geotechnical Engineering Report of the site.

2.1 Regional Hydrology

The SWMF landfill is located within Pecos watershed ,a tributary to the Rio Grande Watershed. Surface drainage from the landfill property generally flows downward towards the east, see **Figure 3** for a regional watershed map. No integrated drainage is present in southern Lea County, thus there is no discharge to the Pecos River, which is located southwest of the area. Tributaries of the Pecos River are located approximately 20 miles southwest of the landfill site in southwestern Lea County. The Pecos River flows south and merges with the Rio Grande in southern Texas along the Texas-Mexico border.

2.2 Regional Geology

This section describes the geologic setting of the region, including soils, regional stratigraphy, and regional structural geology and geomorphology. A geologic map of the region around the NRSWMF is provided in **Figure 4.** A map showing the location of water wells within a one-mile radius of the site is presented in **Figure 5**, and a local depth to groundwater surface map is provided in **Figure 6**.

The New Mexico State Geologic Map (1:500 000) indicates the general surface geology of the landfill site consists of Quaternary eolian and piedmont deposits (Qep) (Holocene to middle Pleistocene). Qep is comprised of interlayered eolian sands and piedmont-slope deposits. The unconsolidated eolian sands consist of sands and loess; the piedmont-slope deposits include deposits of higher gradient tributaries near major stream valleys, alluvial veneers of the piedmont slope, and alluvial fans and may locally include uppermost Pliocene deposits.

2.2.1 Regional Soils

Based on the information provided by the Web Soil Survey (March 26, 2019) and the United States Department of Agriculture Soil Conservation Service (USDA SCS), the primary soils at the site are the Ratliff-Wink fine sandy loam in the southern portion (42%), the Wink loamy fine sand (WK) in the middle and southwestern portions (31%), and the Pyote and Maljamar fine sands (PU) in the northern portion (27%).

The Ratliff-Wink is a fine sandy loam from 0 to 4 inches overlying clay loam from 4 to 60 inches. The Wink loamy fine sand is described as a loamy fine sand from 0 to 12 inches and a sandy loam from 12 to 60 inches. Both the Ratliff-Wink and Wink loamy fine sand are well drained with a high capacity to transmit water (2.0 to 6.0 in/hr). The depth to water is greater than 80 inches.

The Pyote and Maljamar fine sands consist of fine sand from 0 to 24 inches, sandy clay loam from 24 to 50 inches, and cemented material from 50 to 60 inches. The Pyote is well drained with a very low to moderately low capacity to transmit water (0.00 to 0.06 in/hr). The depth to water is reported to be greater than 80 inches. See USDA SCS Web Soil Survey Report for the proposed site in **Attachment B.**

Based on the January 2019 Geotechnical Engineering report (**Attachment A**), encountered soils during drilling activities at the site were divided into three stratums: the first strata consisted of silty sand, silty sand with gravel, silty clayey sand, and poorly graded sand with interbedded layers of caliche and ranged in depths from 20 to 27 feet bgs; the second strata consisted of silty sand, poorly graded sand, interbedded caliche layers and ranged in depth from 27 to 65 feet bgs; the third strata ranged in depths between 40 to 65 feet bgs and consisted of fine-grained, poorly to moderately compacted sandstone.

The observed caliche materials are underlain by medium to finely weathered sandstone extending to boring-termination depths to 165 feet below existing grades. Soil porosity and permeability observed during drilling ranged from 0.34 to 0.36 and 1.12 x 10^{-12} to 6.72 x 10^{-11} cm^2, respectively, and hydraulic conductivity ranged from 1.09 x 10^{-07} to 5.56 x 10^{-06} cm/sec.

2.2.2 Regional Stratigraphy

The surface geology of the landfill site consists of the Quaternary Eolian and Piedmont Deposits (Qep) (Holocene to middle Pleistocene), which is the primary geologic formation at the surface in this area. Small outcrops of Quaternary Piedmont Alluvial Deposits (Qp) (Holocene to lower Pleistocene) are located to the north and east of the site and overlie the Qep deposits. Furthermore, Quaternary Older Alluvial Deposits of Upland Plains and Piedmont Areas (Qoa) (Middle to lower Pleistocene) are west of the site and typically underlie the Qep deposits. The Tertiary Ogallala Formation (To) (lower Pliocene and middle Miocene) underlies the Qoa and is exposed northwest and east of the site. The Ogallala consists of alluvial and eolian deposits and petrocalcic soils of the southern high plains.

Triassic rocks of the Chinle Formation and Santa Rosa Sandstone of the Dockum Group underlie southern Lea County and is exposed southwest of the site. The Chinle Formation is described as a red to green claystone with minor fine-grained sandstone and siltstones. The Chinle is present in all of the eastern part of southern Lea County but thins westward and is absent in extreme western portions. Thickness of the Chinle varies from 0 to 1,270 feet. The Santa Rosa Sandstone is described as a primarily red, fine-to-coarse grained sandstone, is exposed only in minor outcrops, and the thickness ranges from 140 to 300 feet.

Undifferentiated Paleozoic rocks, consisting of siltstone, shale and sandstone, underlie the Dockum Group in southern Lea County. Thickness of these undifferentiated rocks is approximately 90 to 400 feet.

2.2.3 Regional Structural Geology and Geomorphology

The major structure features of southern Lea County are the Permian age Delaware Basin and the Central Basin Platform in the subsurface. Few structural features are present in the area due to the lack of tectonic movement within the basin since the close of the Permian.

The landfill site is located within the Southern High Plains physiographic region of the state. The High Plains covers the eastern quarter of the state and consists of mildly deformed Permian and Triassic sedimentary rocks capped by the late Miocene-Pliocene Ogallala Formation and Quaternary deposits, which are exposed in the southeastern and east-central parts of the state. Furthermore, the northwest part of the oil and gas-rich Permian Basin underlies southeastern New Mexico. No major surface faults or structural features are located in the vicinity of the landfill site.

Geomorphic features consist of windblown eolian and loess deposits in generally flat terrain that lacks integrated drainage systems.

Figure 12 provides a structural geology map for the region surrounding the NRSWMF.

2.3 Regional Hydrogeology

Potable groundwater in southern Lea County comes from three principal geologic units: the Dockum Group, Tertiary Ogallala Formation, and Quaternary Alluvium. The Triassic Santa Rosa sandstone, or the basal unit of the Dockum Group, is the principal aquifer in the western third of southern Lea County, which includes the landfill area. The Ogallala Formation and Quaternary Alluvium aquifers are the principal aquifers in the eastern portion of Lea County and are considered unsaturated in the western portion.

According to published data, the Santa Rosa Sandstone yields an average of about 47 gallons per minute (gpm); however, some wells are reported to yield as much as 100 gpm in some areas. The Sandstone is recharged by precipitation on sand dunes, by precipitation and runoff on outcrops, and groundwater flow from the overlying Ogallala Formation and Quaternary Alluvium. Porosity of the Santa Rosa Sandstone is reported at around 13 percent with very low permeability, and incomplete well-test data indicate a specific capacity of less than 0.2 gpm per foot of drawdown. **Figure 7** provides a contour map of the approximated elevations of the top of the Chinle Formation below the NRSWMF. **Figure 8** provides a contour map of the approximated top of the Santa Rosa Sandstone formation below the NRSWMF. **Figure 9** provides a cross section of the geologic formation lithology as it relates to the NRSWMF's proposed base grades.

Depth to water reported for water wells within the Township and Range of the landfill vary from approximately 165 feet in the southern portion to 230 feet in the northern portion.

2.4 Regional Groundwater Quality

The Dockum Group is the principal potable aquifer in the landfill area. Several domestic and municipal wells penetrate this aquifer in the western portion of the region.

Groundwater from the Triassic rocks of the Dockum Group are typically low in silica, vary in range in calcium and magnesium, high in sodium, moderately high in sulfate, and moderately low in chloride. The dissolved solid concentrations are typically higher than water derived from the Ogallala Formation.

Geohydrology of the local aquifers was summarized in U.S. Geological Survey report 84-4077, 1985. Published water quality data from selected wells in the Santa Rosa Sandstone in Lea County ranged from 426 to 1950 ppm for Total Dissolved Solids. A value of 685 ppm was reported for wells in the Cenezoic Alluvium in Lea County.

3.0 North Ranch Surface Waste Management Facility Site Hydrogeologic Investigation

The material presented in this section describes site-specific information gathered for the generation of this document.

3.1 Geotechnical Engineering Report

A Geotechnical Engineering Report was prepared by Terracon to present subsurface exploration, geologic, hydrogeologic and geotechnical engineering findings. Several recommendations related to subsurface soil/rock conditions, groundwater conditions, seismic site classification, site preparation and earthwork and site excavation are presented and were generated in conformance with the Siting and Subsurface Investigation Work Plan dated October 17, 2018 submitted to and approved by the NMOCD. A copy of the Geotechnical Engineering Report is attached to this narrative in **Attachment A**.

3.2 Site Geology

The NGL North Ranch SWMF is located within an area of historical oil and gas production, largely in undeveloped ranch areas covered with creosote and mesquite trees. The area is underlain by interlayered eolian sands and piedmont-slope deposits which are underlain by the Dockum Group. Subsurface soil and rock are illustrated on geological cross-section figures attached to this report. **Figure 10** shows the alignments of the cross-sections on a NRSWMF map. **Figure 11a** through **Figure 11c** show geologic cross-sections based on the boring data collected in the Geotechnical Engineering Report in **Attachment A**.

3.3 Site Hydrogeology

Groundwater was not encountered at the site during the boring program which advanced seven borings to a depth of approximately 165 feet below ground surface. The uppermost aquifer is estimated to be encountered at depths of around 175 to 200 feet below ground surface. **Figure 6** shows the approximate depth to groundwater in the NRSWMF area.

4.0 North Ranch Striker 4 Facility Geology

The NRS4F shall inject liquids into the Bell Canyon and Cherry Canyon Formations of the Delaware Mountain Group in the Delaware Basin using an injection well (Striker 4 SWD #1). The following sections provide regional and site specific geology for the proposed operation.

4.1 Regional Geology

The Delaware Mountain Group (DMG) of the Delaware Basin comprises of Guadalupian-age arkosic to subarkosic sandstone, siltstone, and detrital limestone that was deposited in deep water, mainly during lowstand and early transgressive sea-level stages. The basin succession is formally divided into the Brushy Canyon, Cherry Canyon, and Bell Canyon Formations (descending order). Stratigraphic divisions within the Delaware Mountain Group are somewhat uncertain due to lithologic similarity and thus a lack of clear boundaries between the major formational intervals. The Delaware Basin during deposition of the Delaware Mountain Group was a deep-water basin bounded by carbonate-ramp (San Andres and Grayburg) and carbonate-rim (Goat Seep and Capitan) margins that developed on the western edge of the Central Basin Platform, the Northwest Shelf, and the Diablo Platform. The top of the interval is designated by another carbonate, the Lamar limestone included in the Bell Canyon Formation. The Bell Canyon contains carbonaceous silty sandstone along with clean, fine grained, massive friable sand. The Brushy Canyon and Cherry Canyon intervals consist of the following: (1) very fine to fine-grained arkosic to subarkosic sandstones, mostly massive in character, (2) very fine grained sandstones microlaminated with siltstones, (3) dark-colored organic siltstones (lutites), (4) carbonate beds (limestone or dolomite) more prevalent near shelf margins, and (5) black to dark gray, calcareous shales. Shale is notably rare in the section and is virtually absent from the Brushy Canyon Formation. Carbonate units (mainly limestone) are present in the upper Cherry Canyon and, especially, Bell Canyon intervals. Porosities and permeabilities in productive intervals range from 12–25% and 1–5 md, respectively, but occasional “streaks” of permeability of up to 200 md are sometimes present. These good porosities indicate a rock that is capable of taking water injection.

4.2 Injection Zone

The produced water and injection fluids to be accepted for disposal at the proposed well are not fit for use as domestic, stock, irrigation or other general uses. The injection zone is into the Bell Canyon/Cherry Canyon formation of the Permian Period; Guadalupe Series, which ranges in age of approximately 259-273 million years old. This is older than the Triassic Period which ranges from 201-251 million years old. **Table 1** below summarizes the depth to the injection zone and the three formations above and below the injection zone:

Table 1. Formation and Injection Zone Summary

Formation	Depth Below Ground Surface (feet)
Rustler Anhydrite (Ochoan Series)	810
Salado (Ochoan Series)	1,209
Castile (Ochoan Series)	5,384
Bell Canyon (Injection Zone)	5,489
Cherry Canyon (Injection Zone)	6,415
Brushy Canyon	8,091
Bone Spring (Leonardian Series)	9,297
Wolfcamp (Wolfcampian Series)	12,280

4.3 Drinking Water Aquifers

The most closely offsetting water wells were drilled to 610’ or shallower, generally producing from the Santa Rosa. Fresh water depth appears to vary from 40’ to 475’ (300’ on average) in the area in the form of sporadic alluvial sources and the Santa Rosa. In general, any USDWs (i.e. Upper Rustler) would be expected to fall above the salt and will be protected. The top of the Rustler Anhydrite is estimated at approximately 810’.

The only fresh water well within in one-mile of the well location is C-03580 as shown on **Figure 13** could not be located. As a result, fresh water samples were not obtained for analysis purposes.

4.4 Proposed Stimulation Program

NGL is not proposing a stimulation program at this time.

4.5 Logging and Test Data on the Well

There are no logs or test data on the well. During the process of drilling and completion resistivity, gamma ray, and density logs will be run.

5.0 References

New Mexico Bureau of Geology and Mineral Resources, Scholle, Peter A., State Geologist, Geologic Map of New Mexico (1:500 000), 2003.

New Mexico Bureau of Geology and Mineral Resources. Provinces of New Mexico – Geologic Tour of the High Plains, https://geoinfo.nmt.edu/tour/provinces/high_plains/home.html, accessed March 2019.

New Mexico Department of Agriculture. Watersheds in New Mexico - http://www.nmda.nmsu.edu/wp-content/uploads/2012/07/Watershed-info-and-NM-watersheds-7-9-2012-phd.pdf, accessed March 2019.

New Mexico Institute of Mining and Technology, State Bureau of Mines and Mineral Resources Division and the New Mexico State Engineer. Geology and Ground-Water Conditions in Southern Lea County, New Mexico – 1961

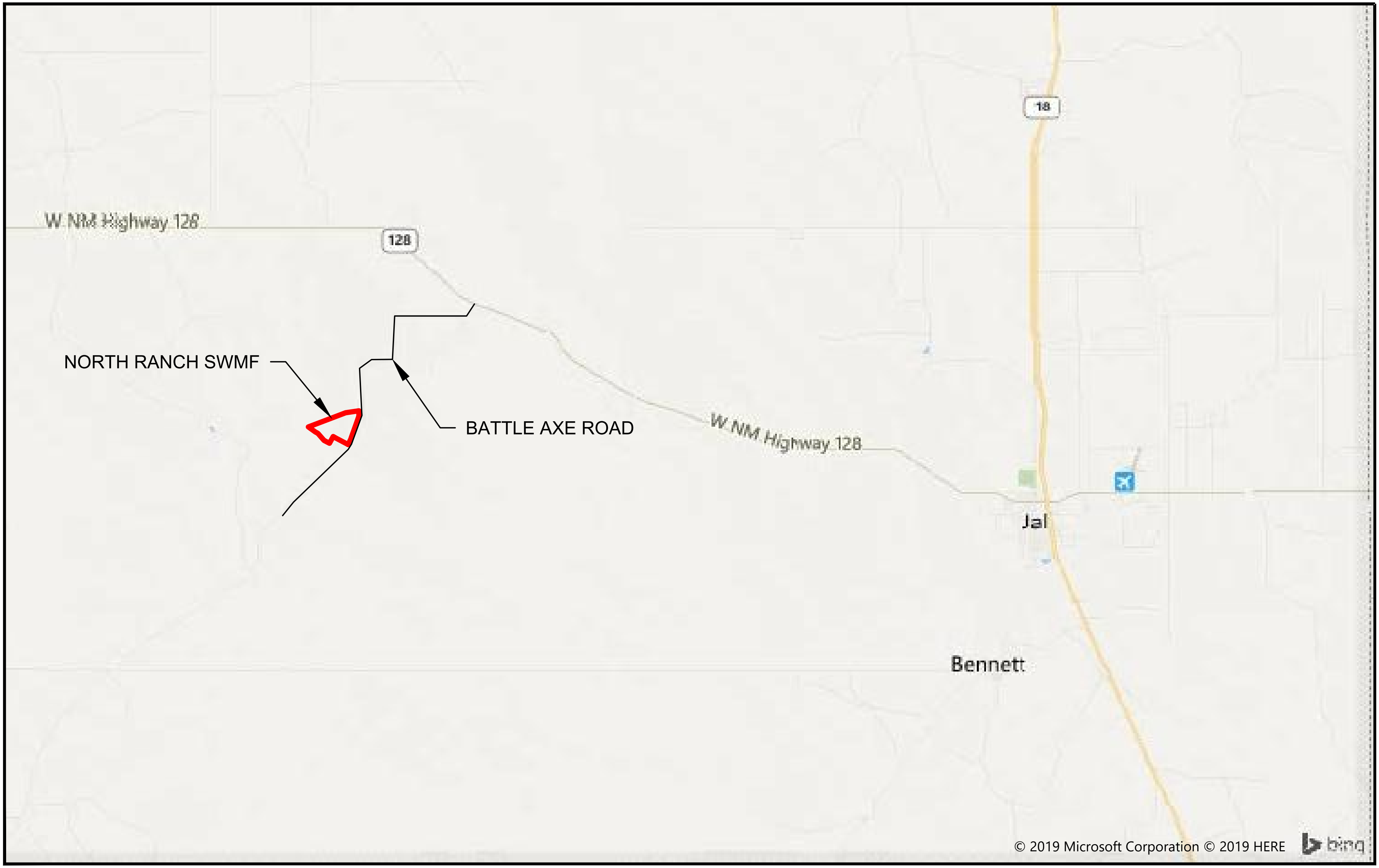
New Mexico Office of the State Engineer, New Mexico Water Rights Reporting System, http://nmwrrs.ose.state.nm.us/nmwrrs/meterReport.html, accessed March 2019.

Terracon, Geotechnical Engineering Report, McCloy Ranch Landfill – January 2019.

United State Department of Agriculture (USDA) Soil Conservation Service. Soil Survey of Lea County, New Mexico – March 2019.

U.S. Geological Survey. Geohydrology of the Delaware Basin and Vicinity, Texas and New Mexico – Water-Resources Investigations Report 84-4077, 1985.
Web Soil Survey, McCloy Ranch Landfill – March 2019.

Figures



REV.	DATE	BY	DESCRIPTION

Terracon
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25809 I-30 SOUTH BRYANT, AR 72022
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SITE LOCATION MAP

PERMIT APPLICATION FIGURE

SURFACE WASTE MANAGEMENT FACILITY

NORTH RANCH

LEA COUNTY NEW MEXICO

FIG. 1

DESIGNED BY:	-
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	1" = 100'
DATE:	SEPTEMBER 2019
JOB NO.	35187378
ACAD NO.	572/002
SHEET NO.:	1 OF 1

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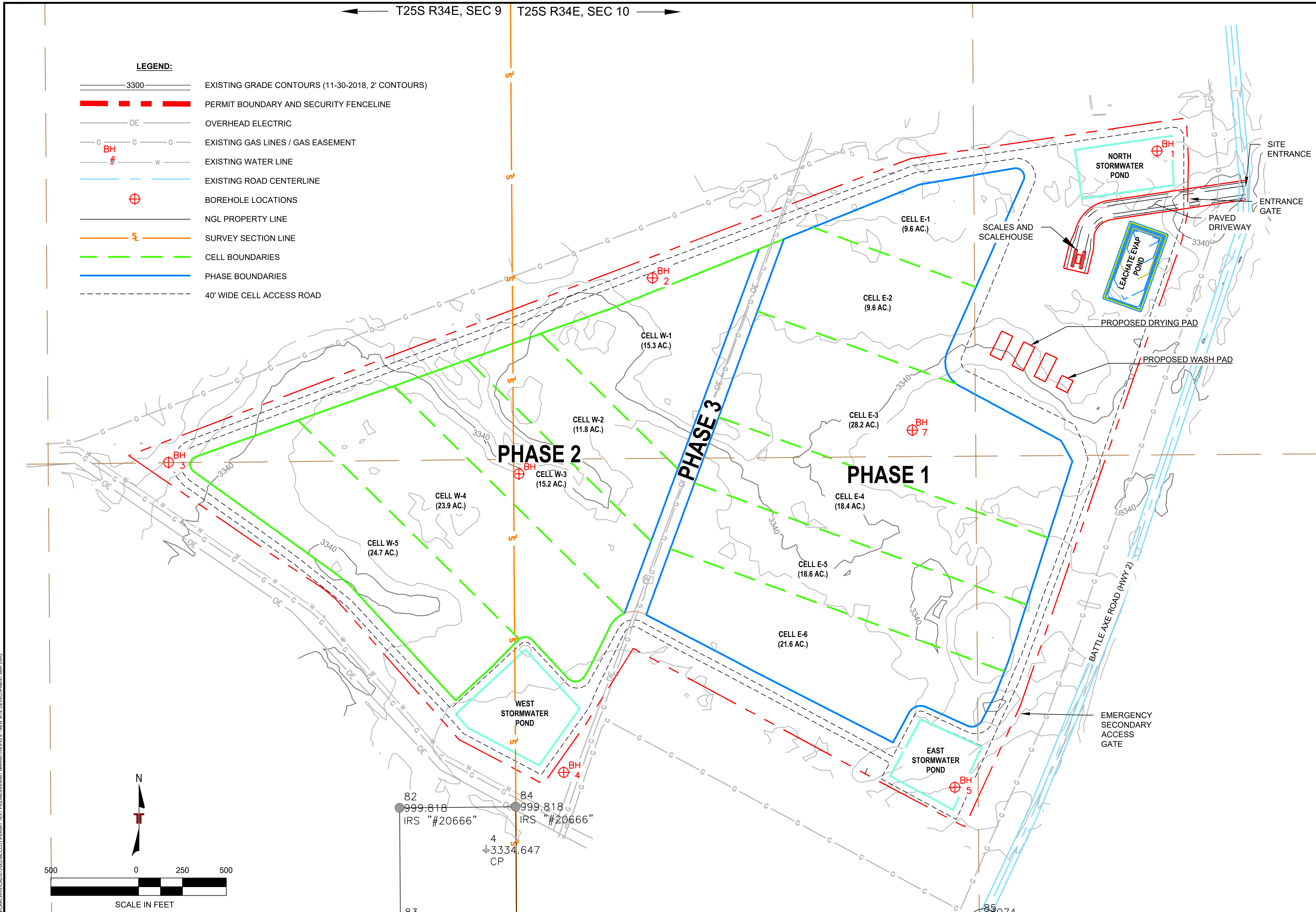

SITE DEVELOPMENT
PERMIT APPLICATION FIGURE
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

REV	DATE	BY	DESCRIPTION

Terracon
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FIGURE 2

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	APRIL 2019
JOB NO.	35187378
ACAD NO.	572/002
SHEET NO.:	OF

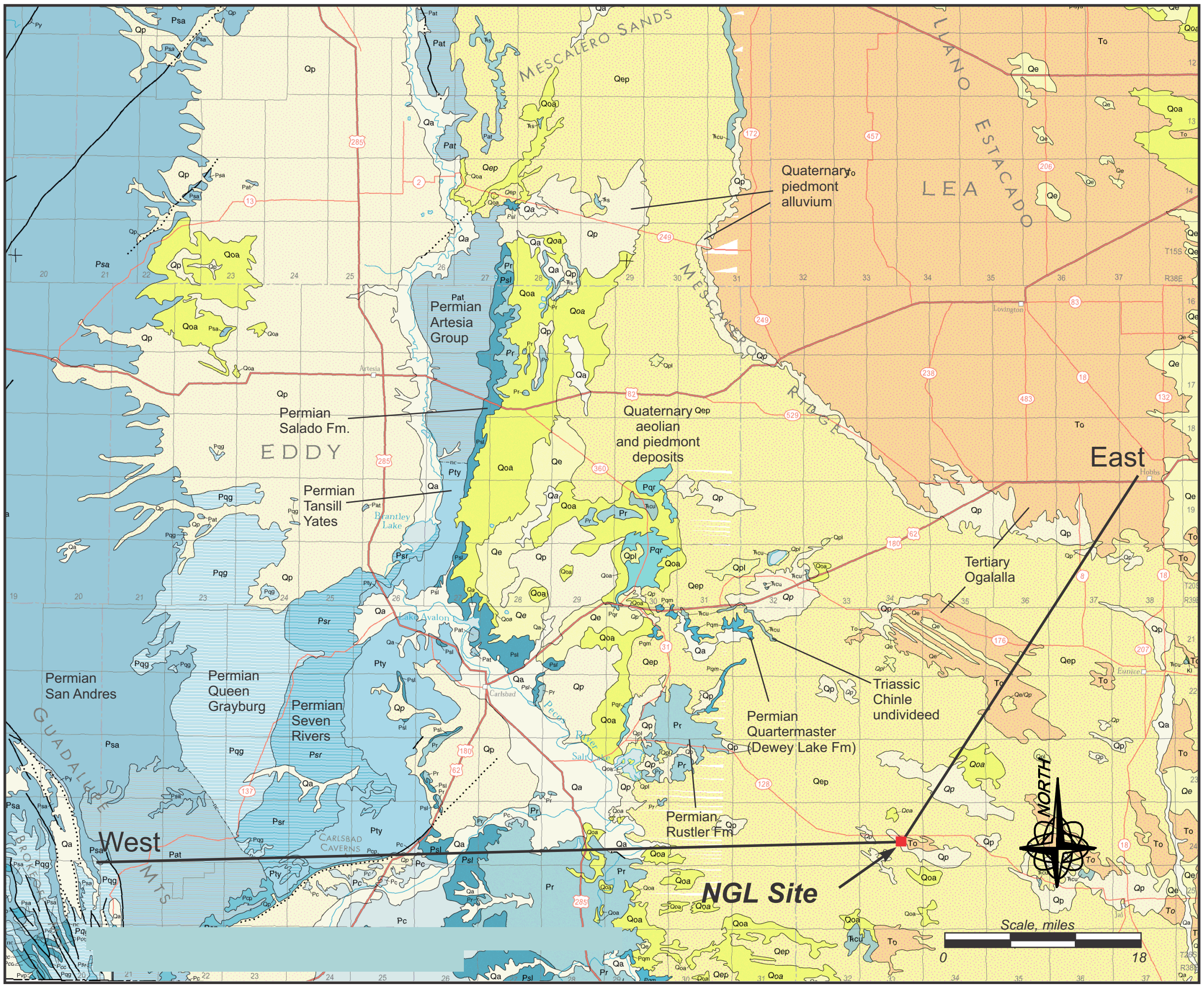
Rio Grande Watershed

IMAGE SOURCE: TEXAS COMMISSION OF ENVIRONMENTAL QUALITY
https://www.tceq.texas.gov/assets/public/comm_exec/pubs/sfr/057_16/RGMap.jpg

N:\GECARCHIVE\CAD\572002\MCCLOY\PERMIT TEXT FIGURES\HYDRO GEO\FIG 3 - WATERSHED MAP.DWG

Project Mngr: MPB	Project No. 35187378	Terracon Consulting Engineers and Scientists	RIO GRANDE WATERSHED
Drawn By: DEW	Scale: AS SHOWN	25809 INTERSTATE 30 S BRYANT, ARKANSAS 72022	PERMIT APPLICATION FIGURE
Checked By: MPB	File No. 572-002	PH. (501) 847-9292 FAX. (501) 847-2910	NGL WASTE SERVICES, LLC
Approved By: FOC	Date: SEPT. 2019		NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY LEA COUNTY NEW MEXICO

FIG. No. 3



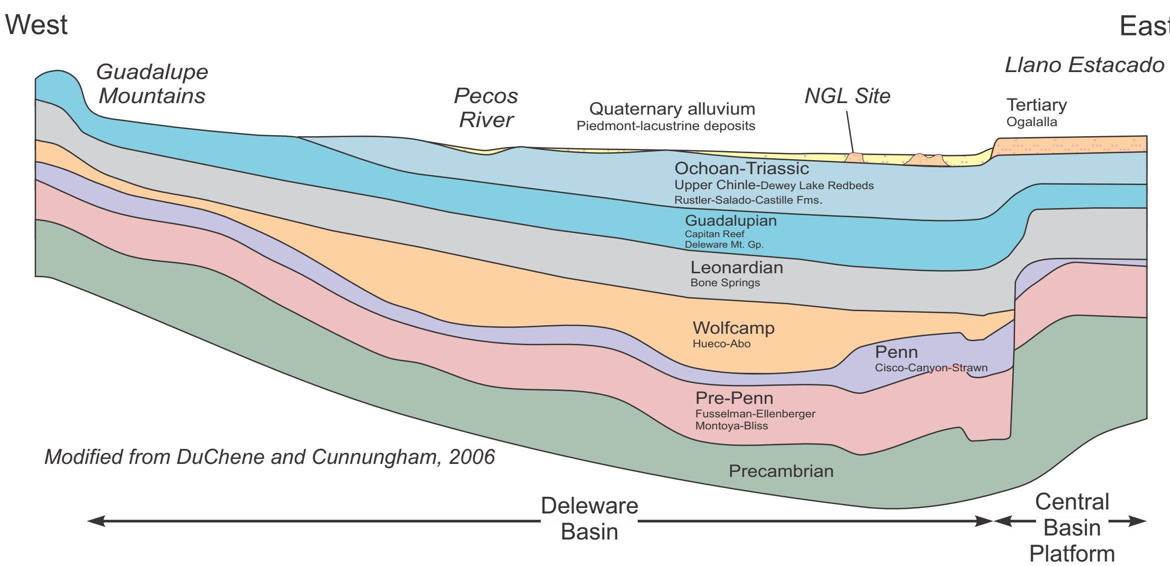


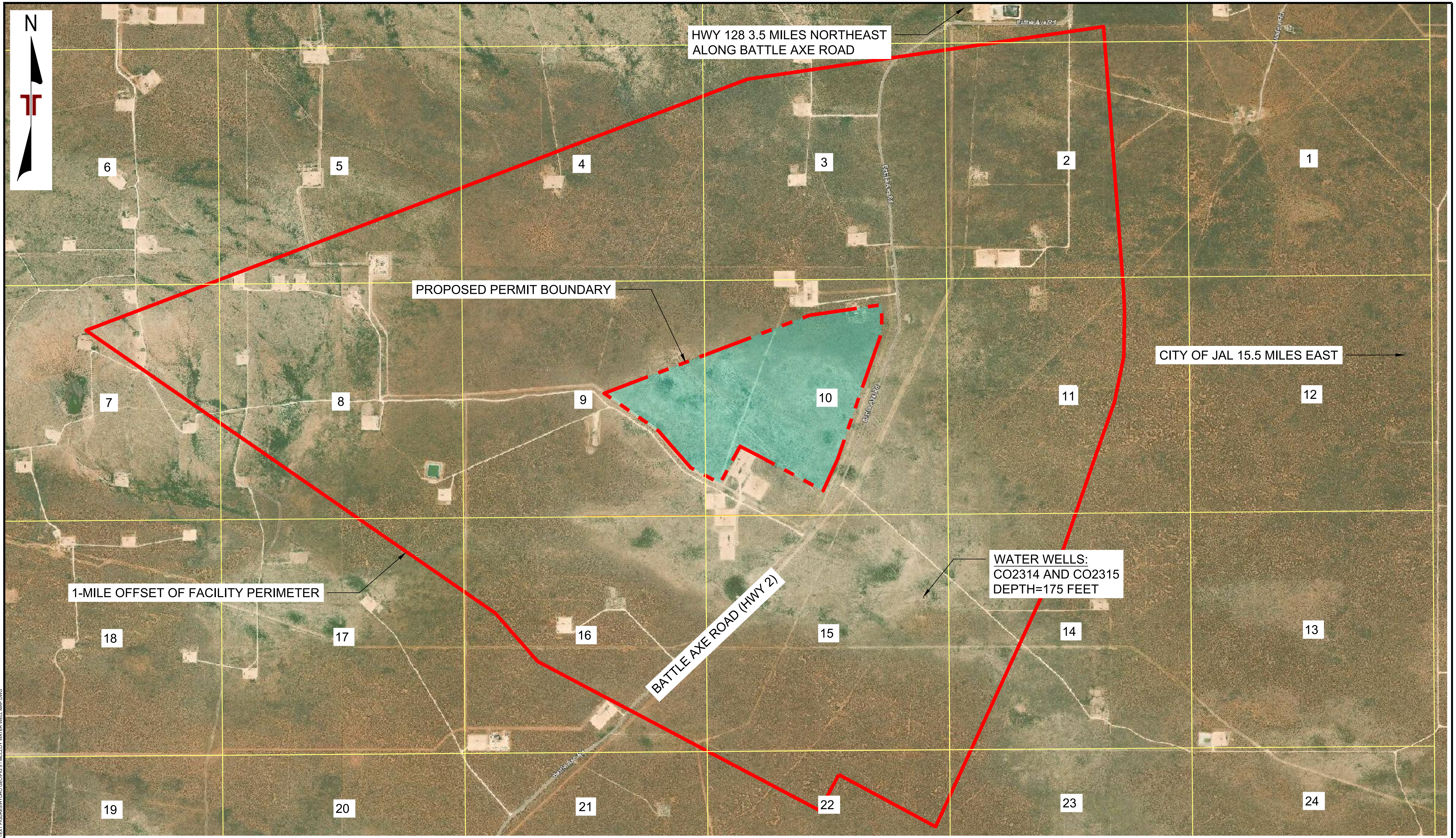
Fig 4

NGL North Ranch SWMF, Lea County, NM

Regional Surface Geology and Generalized Stratigraphy, Southeastern New Mexico

Modified from NM Bureau of Geology and Minerals, 2003
1:500,000 Geologic Map of New Mexico

Terracon



NOTE:
1. WATER WELL INFORMATION OBTAINED FROM NEW MEXICO OFFICE OF THE STATE ENGINEER POD LOCATION GIS APPLICATION.
3. SHOWN TOWNSHIP 25S RANGE 34 E, SECTIONS AS LABELED

Project Mngr:	MPB	Project No.	35187378
Drawn By:	JBM	Scale:	1"=2000'
Checked By:	MPB	File No.	572-002
Approved By:	MPB	Date:	APRIL 2019

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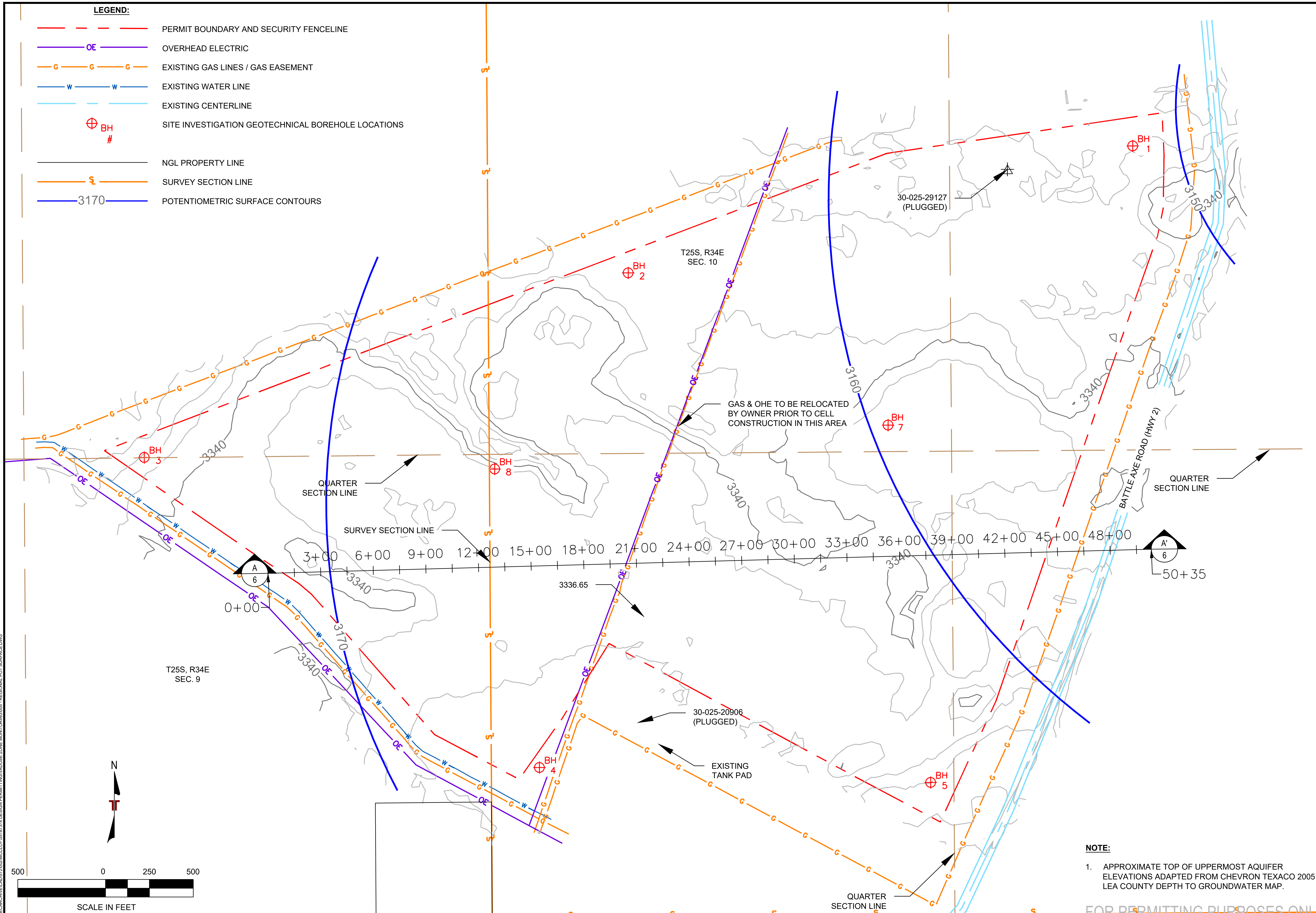
WATER WELLS WITHIN 1 MILE
PERMIT DRAWING
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

FIG. No.
5



REV	DATE	BY	DESCRIPTION

APPROXIMATE REGIONAL POTENTIOMETRIC SURFACE

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

LEA COUNTY NEW MEXICO

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FIGURE 6

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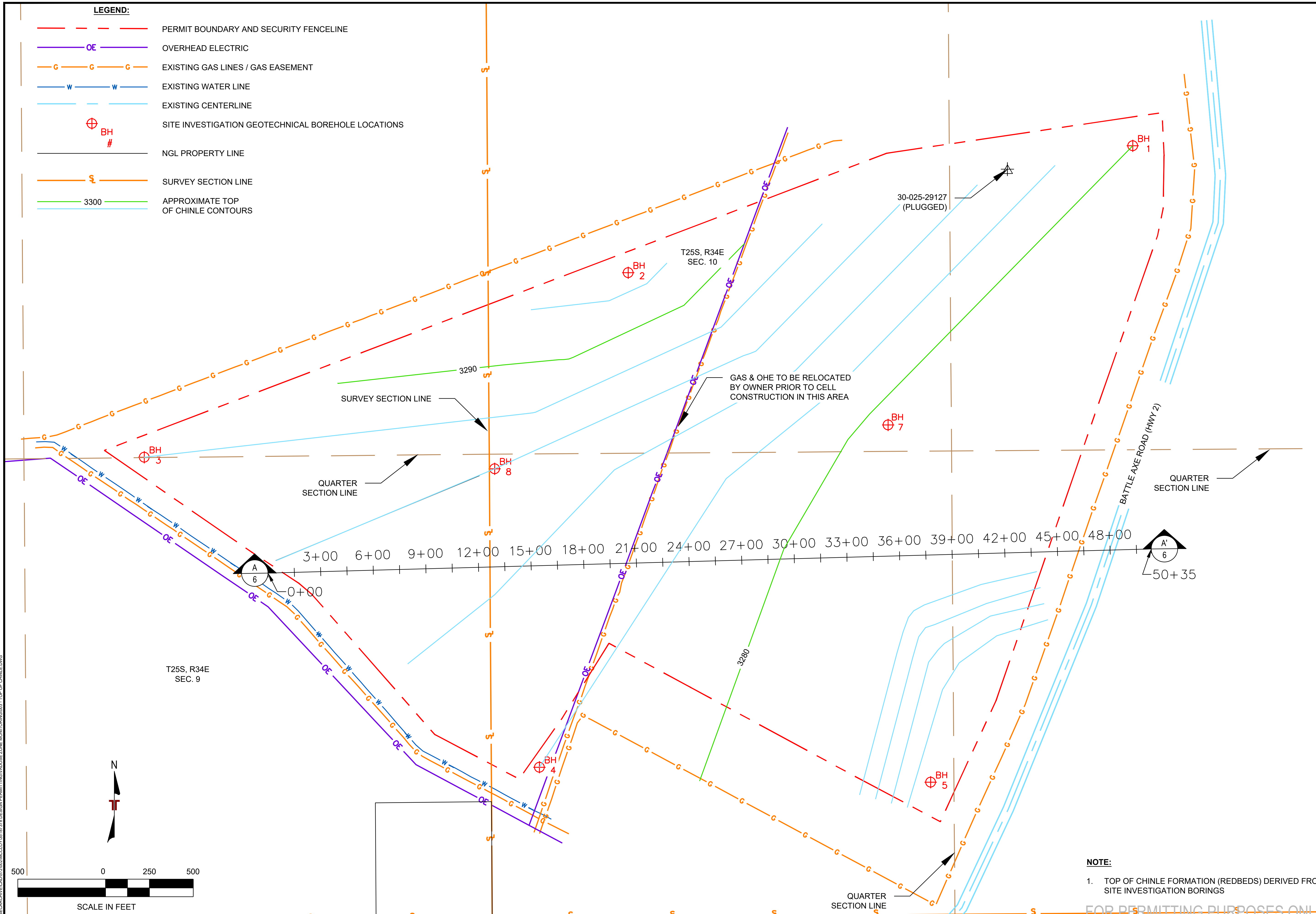

NOTE:

1. TOP OF CHINLE FORMATION (REDBEDS) DERIVED FROM SITE INVESTIGATION BORINGS

REV	DATE	BY	DESCRIPTION

APPROXIMATE TOP OF CHINLE FORMATION

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

LEA COUNTY NEW MEXICO

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FIGURE 7

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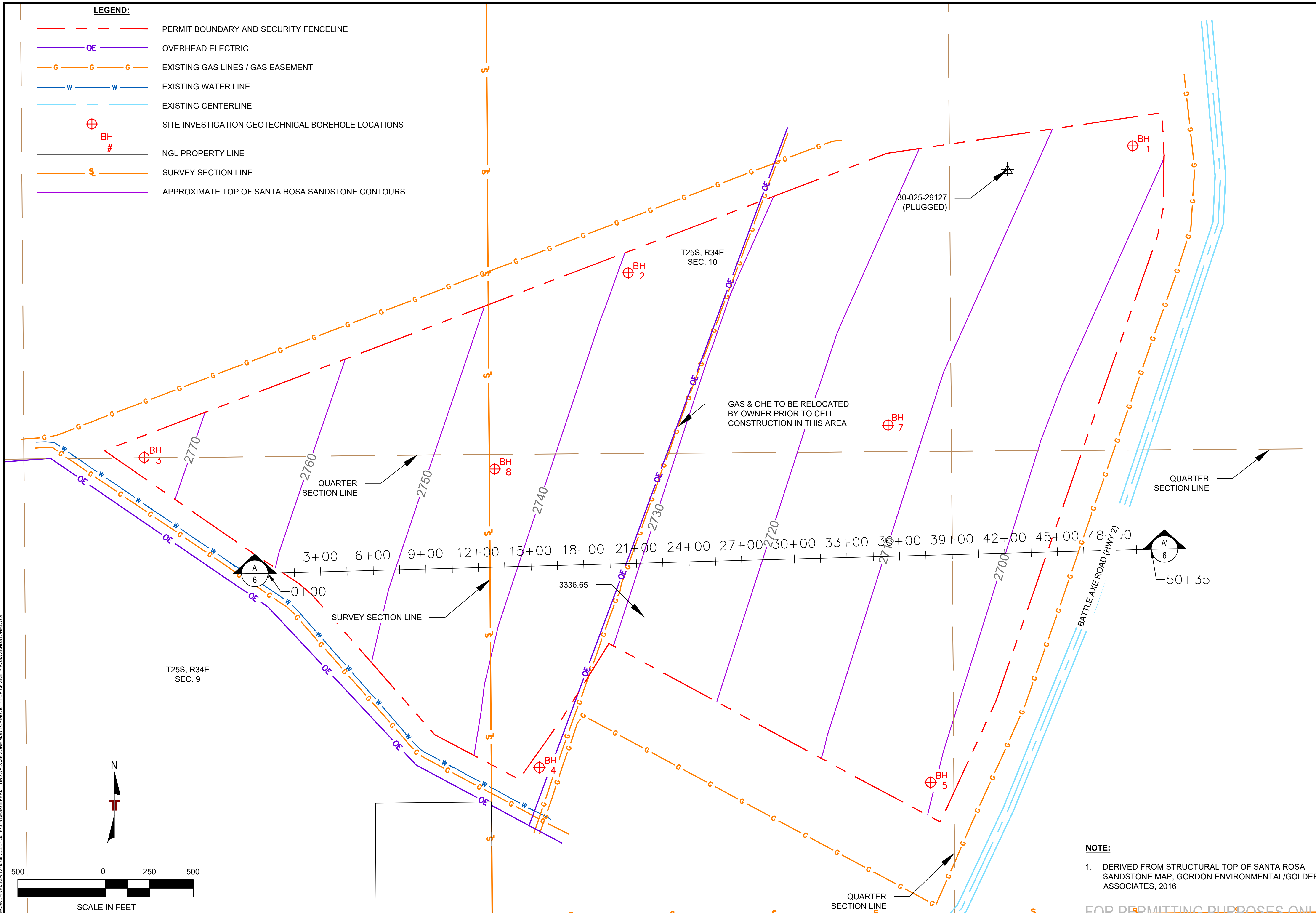

REV	DATE	BY	DESCRIPTION

APPROXIMATE TOP OF SANTA ROSA SANDSTONE

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

LEA COUNTY NEW MEXICO

Terracon

Consulting Engineers and Scientists

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FIGURE 8

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DATE:	SEPT. 2019
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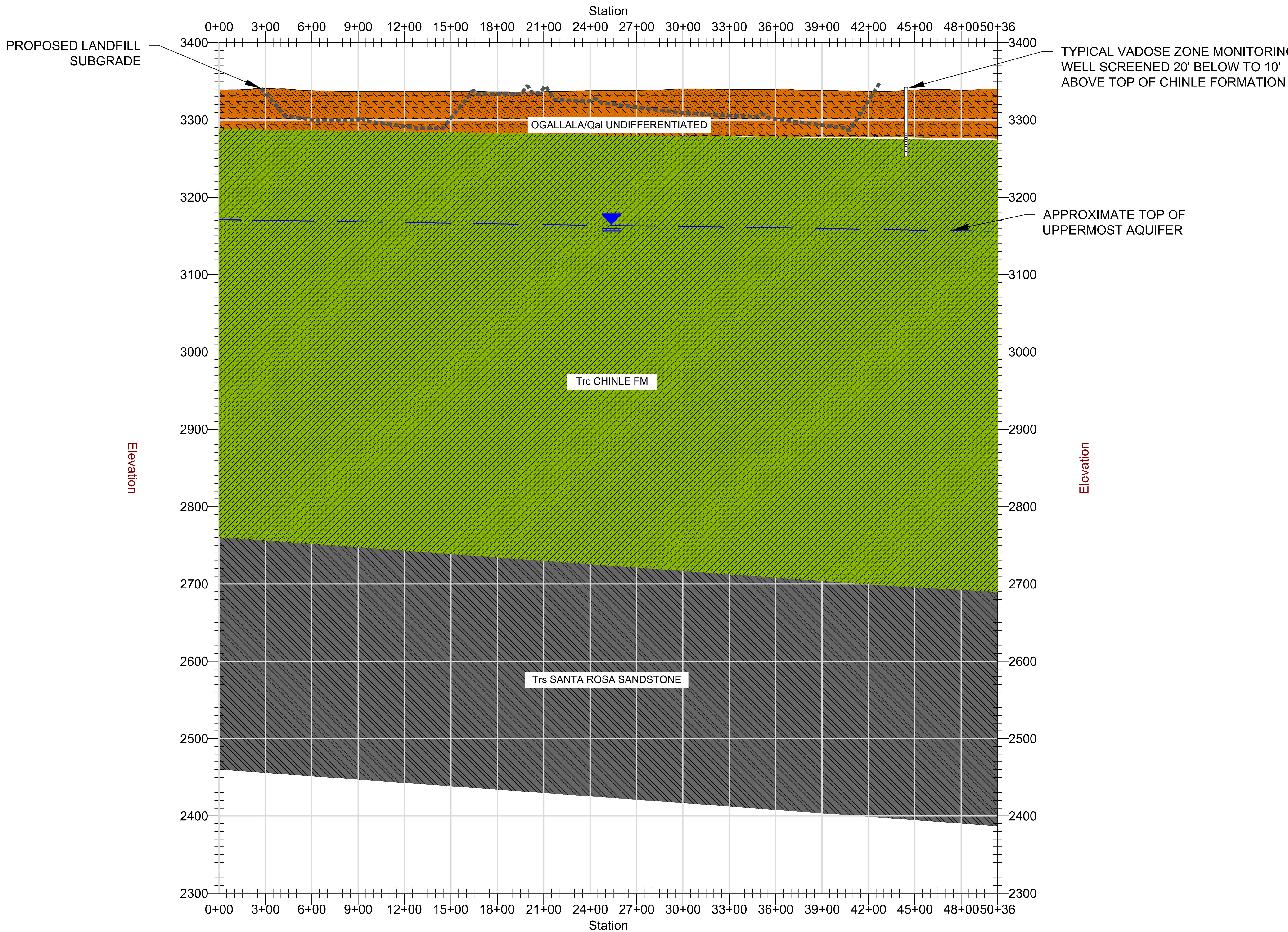
ACAD NO.	572-002
SHEET NO.:	4 OF 7

N:\GEARCHIVE\CAD\572\002\MCCLOY\35187378 DESIGN PERMITTING\VADOSE ZONE MONITORING\004 - TOP OF SANTA ROSA SANDSTONE.DWG



FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION

VADOSE ZONE CROSS SECTION

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

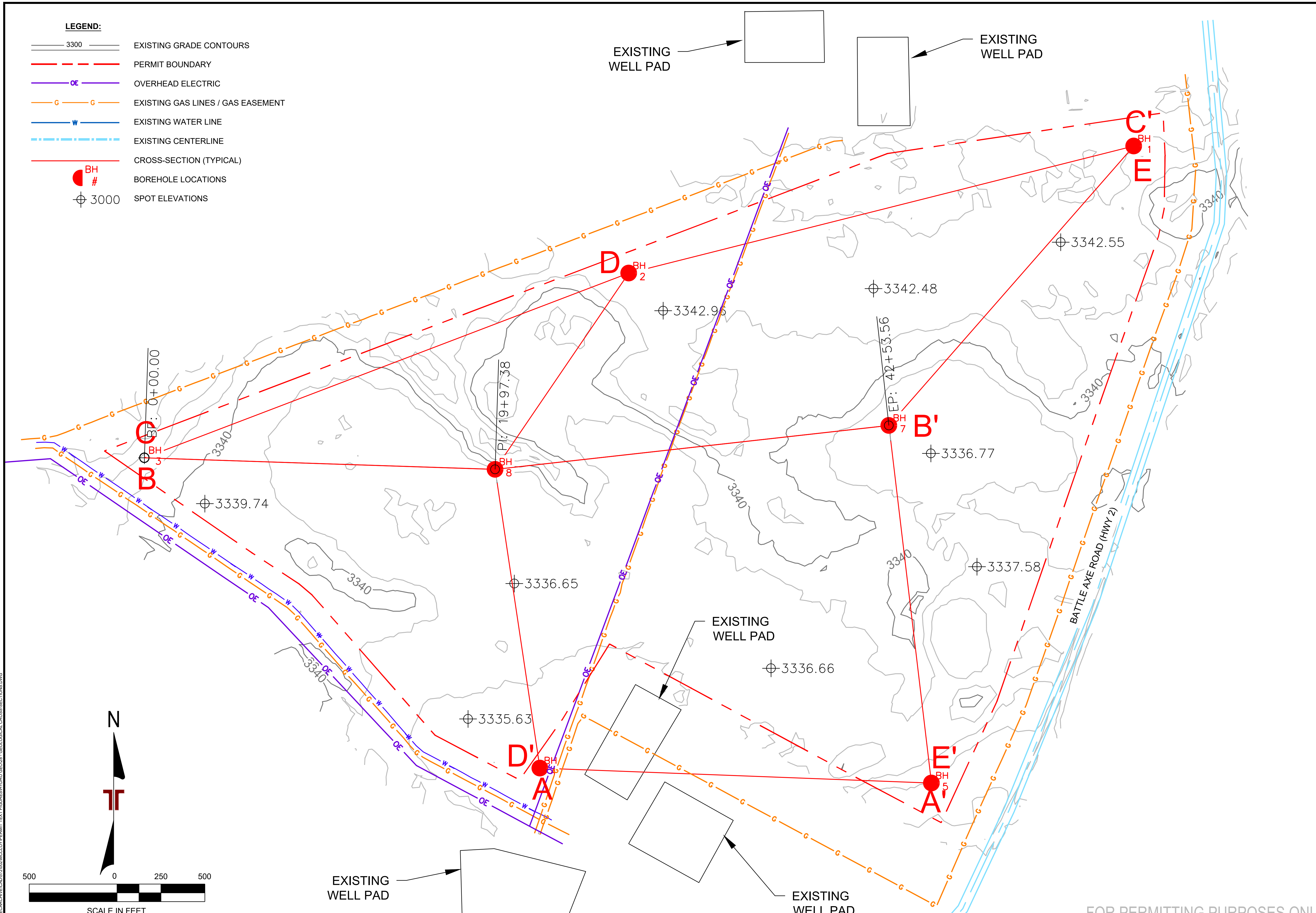
NGL WASTE SERVICES, LLC

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIGURE 9

DESIGNED BY:	FOC
DRAWN BY:	JBM
APPVD. BY:	FOC
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	6 OF 7



FOR PERMITTING PURPOSES ONLY

REV.	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

GEOLOGICAL CROSS-SECTIONS

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIGURE 10

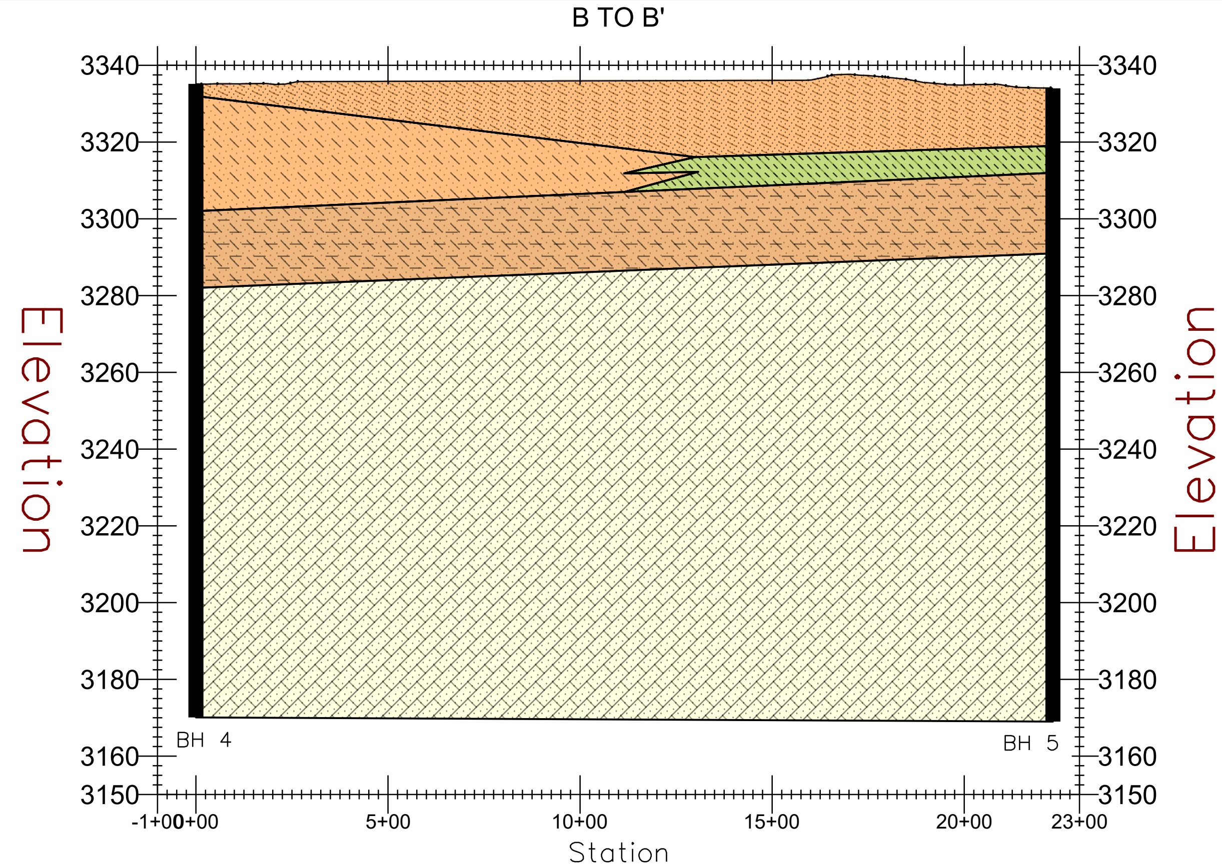
DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	OF

General Notes:

1. Lithologic information provided is based on field site investigation information collected by Terracon. Interpretations may change as additional information is gathered.
2. No groundwater was encountered during drilling.
3. Existing topography was performed November 30, 2018 and vertical elevations are based on the NAVD 88 NM_E.

Note:

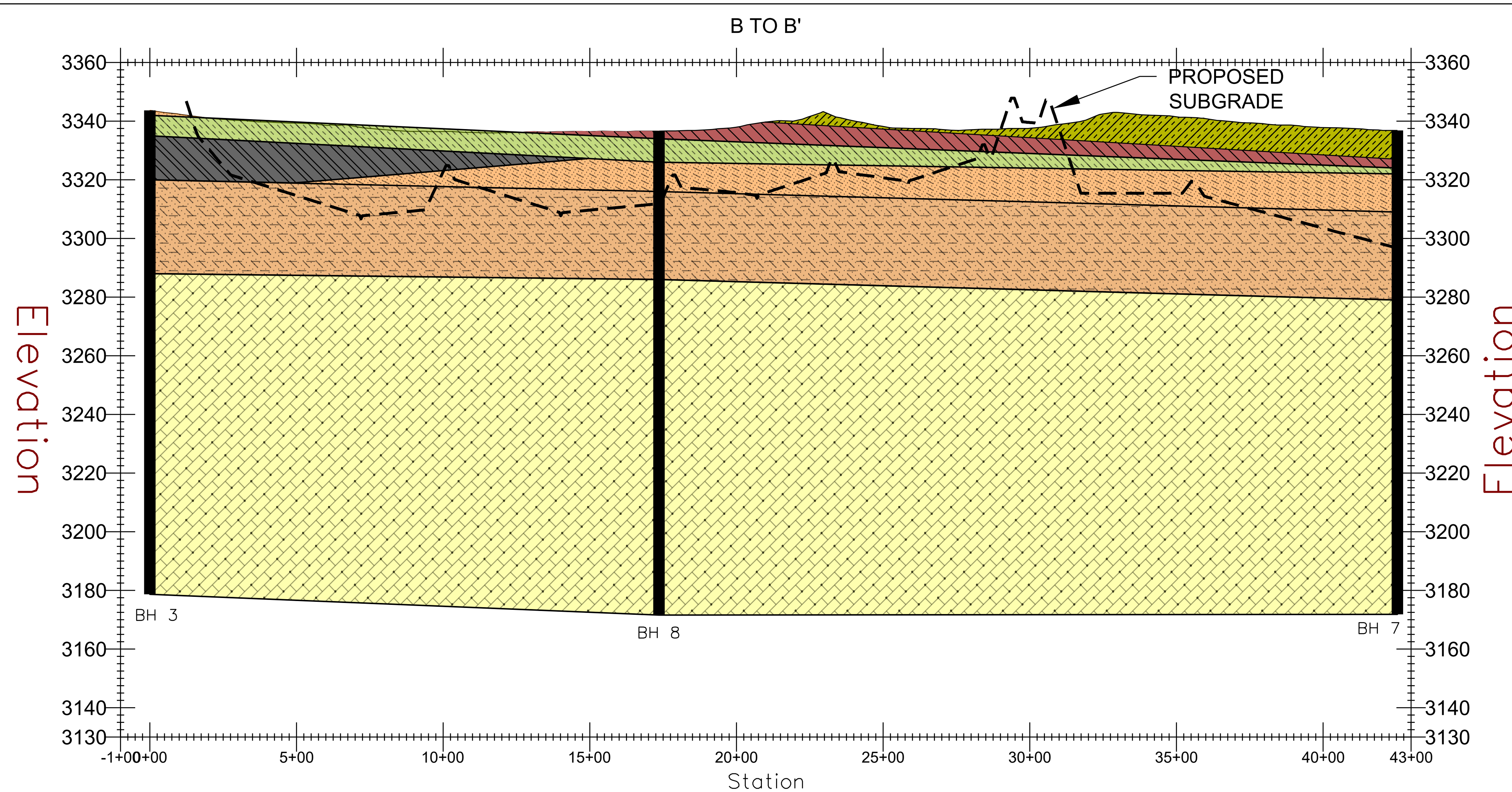
Information depicted in this lithology shown was derived from "Geotechnical Engineering Report - McCloy Ranch Landfill" dated January 18, 2019, and was prepared by Terracon Consultants, Inc.



LEGEND:

- Poorly Graded Sand with Silt
- Clayey Sand with Interbedded Caliche
- Caliche
- Silty Sand
- Sandstone
- Poorly Graded Sand
- Poorly Graded Sand with Interbedded Caliche
- Silty Sand with Interbedded Caliche
- Bore Hole (BH 8)

Horizontal Scale: 1" = 500'
Vertical Scale: 1" = 50'



FOR PERMITTING PURPOSES ONLY

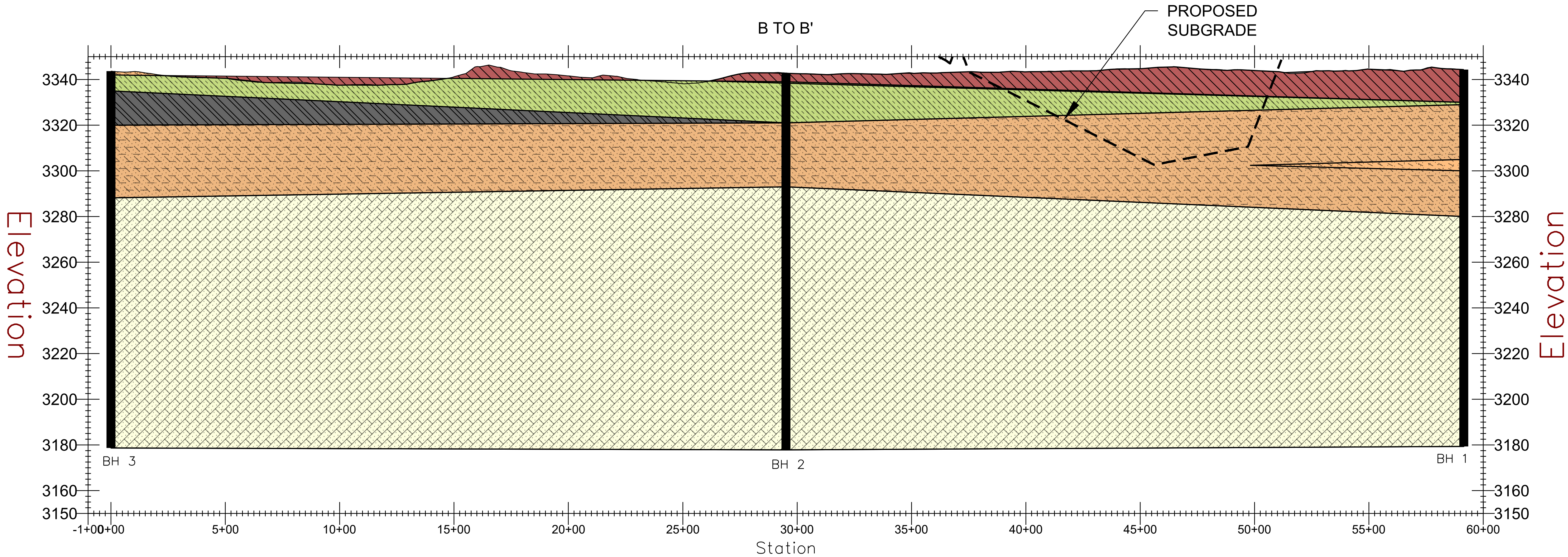
REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

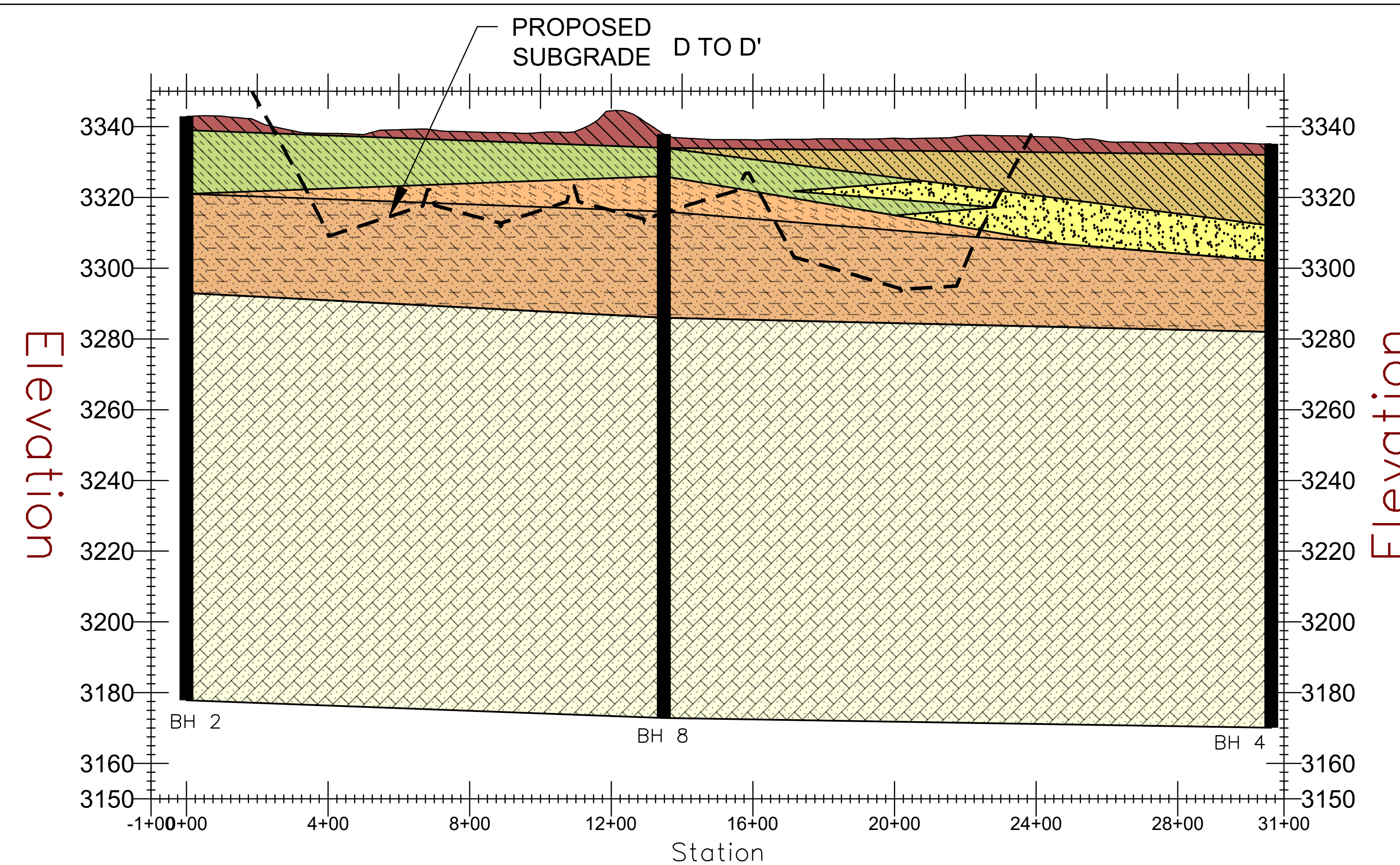
GEOLOGICAL CROSS-SECTION A - A' & B - B'
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIGURE 11A

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	OF





LEGEND:

- Poorly Graded Sand with Silt
- Clayey Sand with Interbedded Caliche
- Caliche
- Silty Sand
- Sandstone
- Poorly Graded Sand
- Poorly Graded Sand with Interbedded Caliche
- Silty Clayey Sand with Interbedded Caliche
- Silty Sand with Interbedded Caliche
- Bore Hole (BH 8)

Horizontal Scale: 1" = 500'
Vertical Scale: 1" = 50'

General Notes:

1. Lithologic information provided is based on field site investigation information collected by Terracon. Interpretations may change as additional information is gathered.
2. No groundwater was encountered during drilling.
3. Existing topography was performed November 30, 2018 and vertical elevations are based on the NAVD 88 NM_E.

Note:

Information depicted in this lithology shown was derived from "Geotechnical Engineering Report - McCloy Ranch Landfill" dated January 18, 2019, and was prepared by Terracon Consultants, Inc.

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

GEOLOGICAL CROSS-SECTION C - C' & D - D'
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

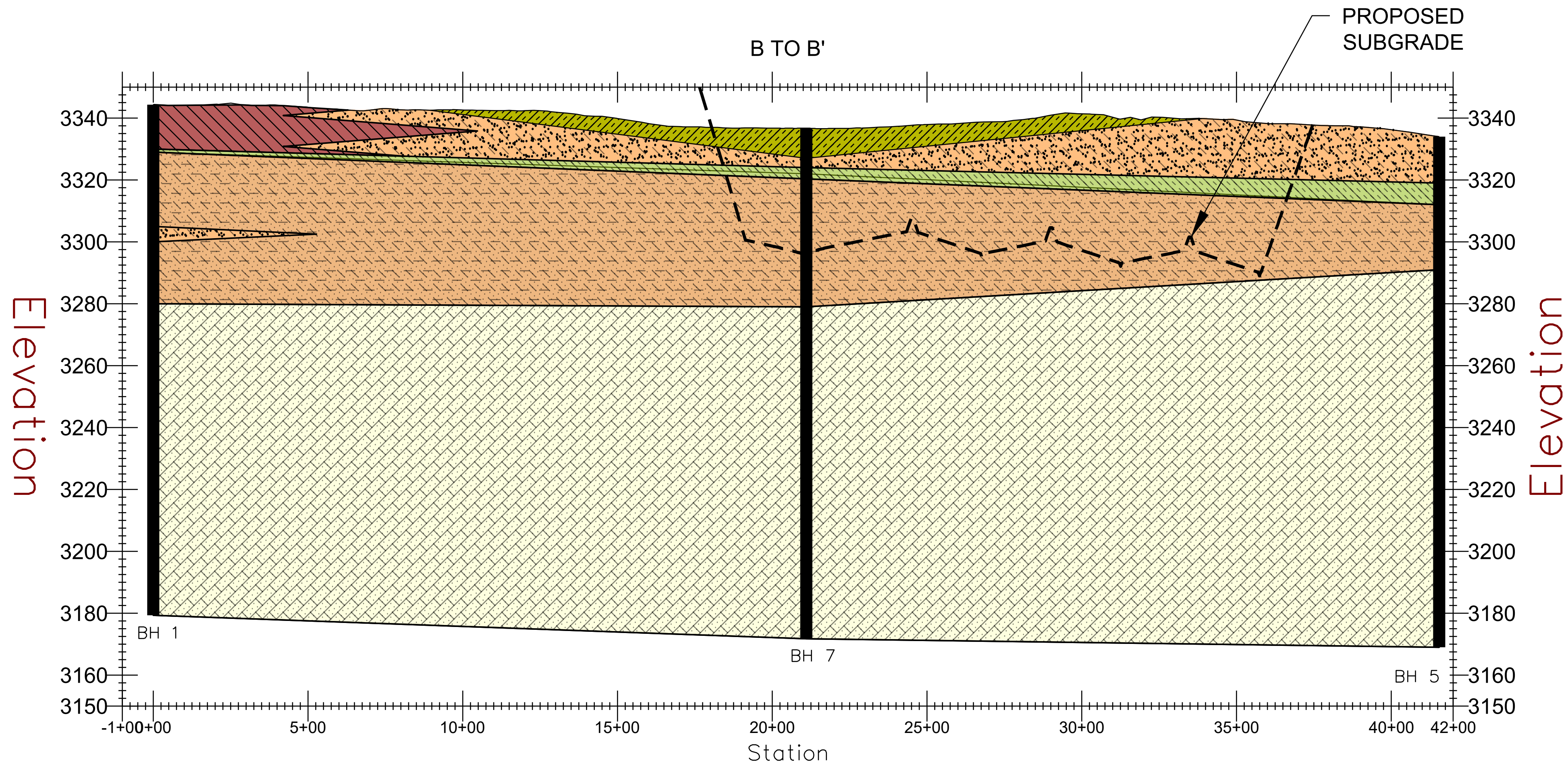
FIGURE 11B

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	OF

FOR PERMITTING PURPOSES ONLY

General Notes:

1. Lithologic information provided is based on field site investigation information collected by Terracon. Interpretations may change as additional information is gathered.
2. No groundwater was encountered during drilling.
3. Existing topography was performed November 30, 2018 and vertical elevations are based on the NAVD 88 NM_E.



LEGEND:

- Poorly Graded Sand with Silt
- Clayey Sand with Interbedded Caliche
- Caliche
- Silty Sand
- Sandstone
- Poorly Graded Sand
- Poorly Graded Sand with Interbedded Caliche
- Silty Sand with Interbedded Caliche
- Bore Hole (BH 8)

Horizontal Scale: 1" = 500'
Vertical Scale: 1" = 50'

Note:

Information depicted in this lithology shown was derived from "Geotechnical Engineering Report - McCloy Ranch Landfill" dated January 18, 2019, and was prepared by Terracon Consultants, Inc.

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

GEOLOGICAL CROSS-SECTION E - E'
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIGURE 11C

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	OF

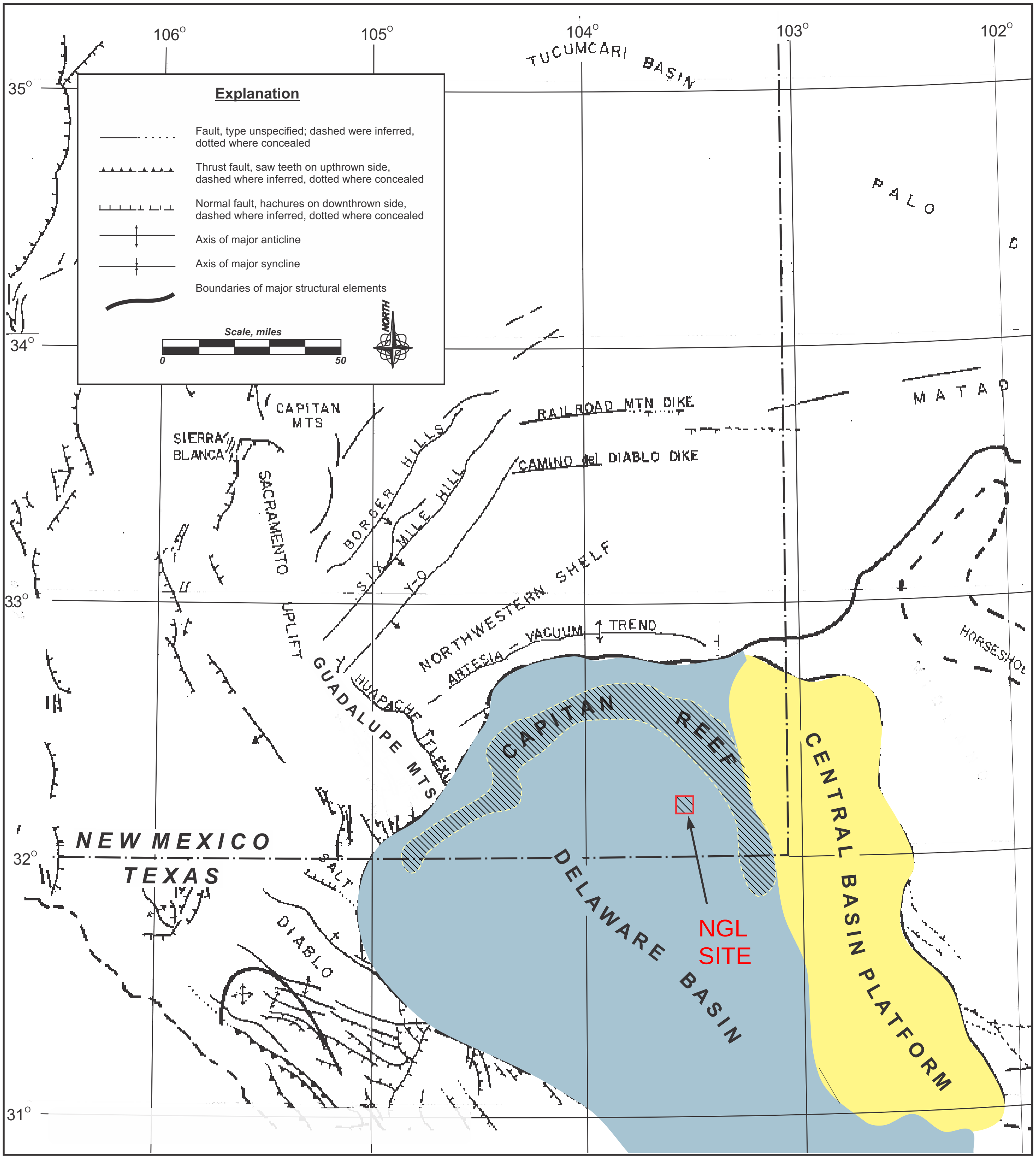


Fig 12

NGL North Ranch SWMF, Lea County, NM

Structures of the Delaware Basin,

Southeastern New Mexico and West Texas

Major Regional Structural Features of Southeastern New Mexico
Modified from Powers, 1978

Terracon

Striker 4 SWD #1
Offset Water Wells

Lea County, NM

NGL Water Solutions Permian, LLC

Projection: NAD 1983 State Plane NM East FIPS 3001		
Drawn by: SAH	Date: 9/6/2017	Approved by: NLB

LONQUIST & CO. LLC

PETROLEUM ENGINEERS | ENERGY ADVISORS

AUSTIN · HOUSTON · WICHITA · DENVER · CALGARY

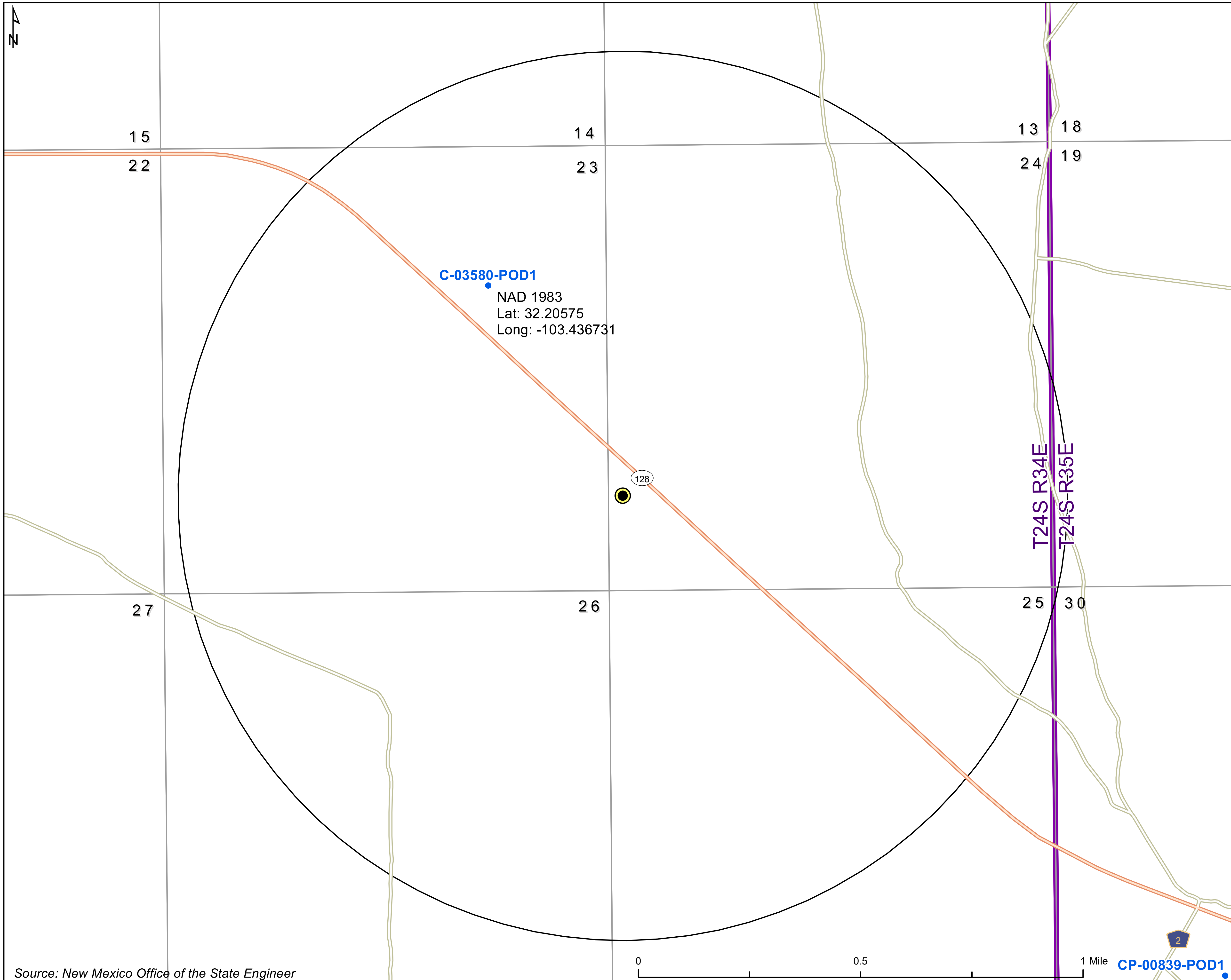
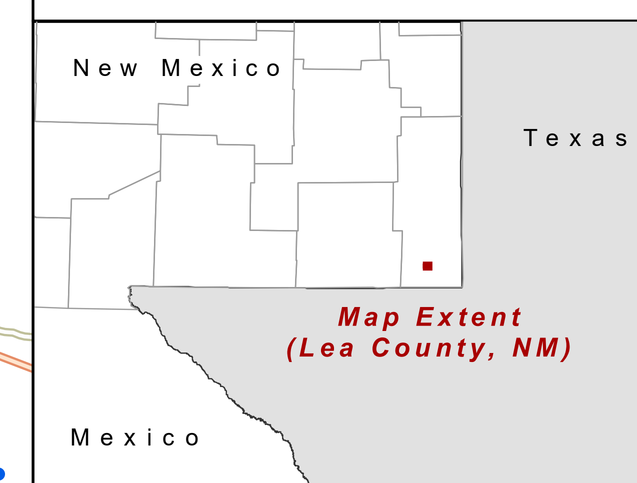


FIGURE 13



Attachment A

Geotechnical Engineering Report
(Terracon, January 2019)

Geotechnical Engineering Report

McCloy Ranch Landfill
Jal, Lea County, New Mexico

January 25, 2019
Terracon Project No. A4187129

Prepared for:
Trammco Environmental Solutions, LLC
Fernandina Beach, FL

Prepared by:
Terracon Consultants, Inc.
Midland, Texas

Terracon
GeoReport

January 25, 2019

Trammco Environmental Solutions, LLC
P.O. Box 2283
Fernandina Beach, FL 79760

Attn: Mr. Matthew Trammell
E: matt@trammco.com

Re: Geotechnical Engineering Report
McCloy Ranch Landfill
Lea County, New Mexico
Terracon Project No. A4187129

Dear Mr. Trammell:

We have completed the Hydrogeological/Geotechnical investigations for the above referenced project. This study was performed in general accordance with Terracon Proposal No. P35187312 dated October 17, 2018. This report presents the findings of the subsurface exploration and provides hydrological/geotechnical recommendations for the proposed project.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

JAMES D. COSPER, II
NEW MEXICO
14477
1-25-19
REGISTERED PROFESSIONAL ENGINEER

Naga Velpuri
Staff Geotechnical Engineer

J. Dan Cosper, P.E.
Senior Associate/Office Manager

Copy: file

REPORT TOPICS

REPORT SUMMARY I
INTRODUCTION 1
SITE CONDITIONS 1
PROJECT DESCRIPTION 2
DRILLING PROCEDURES 3
GEOTECHNICAL CHARACTERIZATION 3
GEOTECHNICAL OVERVIEW 5
EARTHWORK 5
SEISMIC CONSIDERATIONS 10
GENERAL COMMENTS 10

Note: This report was originally delivered in a web-based format. **Orange Bold** text in the report indicates a referenced section heading. The PDF version also includes hyperlinks which direct the reader to that section and clicking on the logo will bring you back to this page. For more interactive features, please view your project online at client.terracon.com.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
SUBSURFACE PROFILE (5 profiles)
EXPLORATION RESULTS (Boring Logs and Laboratory Data)
SUPPORTING INFORMATION (General Notes and Unified Soil Classification System and Description of Rock Properties)

REPORT SUMMARY

Topic [1]	Overview Statement [2]
Project Description	Landfill facility will be constructed on a 306-acre surface waste disposal facility within Section 9 and 10 of, T25S, R34E approximately 16 miles west of the City of Jal in Lea County, New Mexico.
Geotechnical Characterization	■ Based on the field exploration, we classified the soils we encountered into three soil stratums, first strata with depths ranging between 20 feet to 27 feet below grade surface (bgs) consisting of silty sand, silty sand with gravel, silty clayey sand, poorly graded sand with interbedded layers of caliche. The second strata was penetrated at depths ranging between 20 feet to 27 feet bgs consisting of silty sand, poorly graded sand, interbedded caliche layers classified as, silty sand, poorly graded sand. The third strata was penetrated at depths ranging between 40 feet to 65 feet bgs and consisted of fine-grain, poorly to moderately compacted sandstone. ■ Very dense/hard calcareous materials with varying degrees of cementation, or locally called "caliche" materials, which are typically classified as silty sand, poorly graded sand, were encountered in all the borings ranging from the upper approximately 2 to 65 feet of existing grades. Caliche interval thicknesses ranged from 1 inch to over 10 feet. The caliche materials are underlain by medium to finely weathered sandstone extending to boring-termination depths of 165 feet below existing grades. On-site subsurface soils are not expected to experience substantial volumetric changes (shrink/swell) with fluctuations in moisture content. Potential vertical rise (PVR) of on-site soils is estimated to be less than 1 inch. On-site soils are generally suitable for use as structural fill. ■ Caliche bears a strong resemblance to rock and is therefore difficult to excavate. Based on the conditions encountered, we believe landfill excavations in the upper 2 to 65 feet of existing grades will require a hoe ram, a heavy dozer equipped with a ripper, a rock saw or a jack hammer. Bedrock was encountered beneath caliche materials, thus rock excavation by means of ripping and blasting is expected. Recommendations regarding excavation conditions of on-site subsurface materials and definitions of rock in various conditions are included in section Excavations Conditions of this report. ■ The 2012 International Building Code (Section 1613.3.2) seismic site classification for this site is estimated to be C. ■ No groundwater was encountered in the borings within the drilling depths of 165 feet below existing grades at the time of drilling. Based on these data, we do not expect groundwater would impact the landfill development. ■ Laboratory permeability were measured on samples. Results of laboratory permeability measurements on samples collected from BH-1, and BH-4 were in a range of 1.09×10^{-6} to 6.5×10^{-5} cm/sec. Detailed permeability measurement results are presented in Geotechnical Characterization section of this report. ■ Bedrocks (sandstone) were encountered at depths of 30 to 165 feet below existing grades. Please refer to boring logs and subsurface profiles provided in the Appendices.

Topic [1]	Overview Statement [2]
Below Grade Structures	The landfill development itself is considered a below grade structure.
General Comments	This section contains important information about the limitations of this geotechnical engineering report.

1. If the reader is reviewing this report as a pdf, the topics above can be used to access the appropriate section of the report by simply clicking on the topic itself.
2. This summary is for convenience only. It should be used in conjunction with the entire report for design purposes.

Geotechnical Engineering Report

McCloy Ranch Landfill
IH-20 and FM-866
Jal, Lea County, New Mexico
Terracon Project No. A4187129
January 25, 2019

INTRODUCTION

This report presents the results of Terracon's subsurface exploration and geotechnical engineering services performed for the proposed Landfill to be located within Section 9 and 10 of, T25S, R34E approximately 16 miles west of the City of Jal in Lea County, New Mexico. The purpose of these services is to provide geologic and hydrogeologic findings and geotechnical engineering recommendations relative to:

- Subsurface soil (and rock) conditions
- Groundwater conditions
- Seismic site classification per IBC
- Site preparation and earthwork
- Excavation considerations

The geotechnical engineering scope of services for this project included the advancement of seven test borings (BH-1 to BH-5, BH-7 and BH-8) to depths approximately 165 feet below existing site grades. **Please note that boring BH-6 was mislabeled as BH-8.** Although the original scope of services consisted of a total of 14 geotechnical soil testing samples. Due to the homogeneity of soils and based on the project coordination with the client during the site exploration, a total of three samples were collected for lab testing.

Maps showing the site and boring locations are shown in the **Site Location** and **Exploration Plan** sections, respectively. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included on the boring logs and as separate graphs in the **Exploration Results** section of this report.

SITE CONDITIONS

The following description of site conditions is derived from Terracon's site visit in association with the field exploration and our review of publicly available geologic and topographic maps.

Item	Description
Parcel Information	The project site is located within Section 9 and 10 of, T25S, R34E approximately 16 miles west of the City of Jal in Lea County, New Mexico. See **Site Location** for site location information.
Existing Improvements	Undeveloped ranch covered with creosote and mesquite tress.
Current Ground Cover	Site covered with sparse vegetation and mesquite trees
Existing Topography	The site slopes downward towards the east.

Geology	▪ Expected Geologic Conditions:
	  ○ Pecos alluvium overlying Dockum Group
	▪ Geologic Map Details:
	  ○ Unconsolidated, interlayered eolian sands and piedmont-slope deposits:
	    ▪ Unconsolidated, interlayered eolian sands
	      • Sands, loesse
	    ▪ Piedmont-slope deposits
	      • Includes deposits of higher gradient tributaries bordering major stream valleys, alluvial veneers of the piedmont slope, and alluvial fans. May locally include uppermost Pliocene deposits.
	  ▪ Underlying Upper Chinle Group, Garita Creek through Redonda Formations, undivided (Upper Triassic)
	    ▪ Major mudstone, sandstone and minor conglometrate

PROJECT DESCRIPTION

Terracon's initial understanding of the project was provided in our proposal and was discussed in the project planning stage. A period of collaboration has transpired since the project was initiated, and our final understanding of the project conditions is as follows:

Item	Description
Project Description	One recycling and landfill facility will be constructed on a 306-acre tract of land.
Finished Floor Elevation	Elevation of deepest excavation is expected to be 65 feet below existing grade.
Below Grade Structures	Landfill

DRILLING PROCEDURES

▪ FIELD SUBSURFACE BORING INVESTIGATION WORK PLAN

Seven boring locations were identified for drilling within the property. The boring program was designed to evaluate the lithology and subsurface conditions throughout the property. Terracon mobilized a sonic drilling unit to the site. However, due to drilling requirements, rock coring and/or air rotary drilling was required to advance the borings to final depth.

The drilling at this location was completed by a State of New Mexico licensed well driller. Oversight of the drilling program and the logging of the lithology was conducted by a Terracon field geologist.

▪ Drilling Methodology

Soil borings were performed using sonic drilling methods to the proposed depth in accordance with ASTM D-6914/D6914M-16. The drilling rig was equipped with coring tools capable of providing a minimum borehole diameter of 6 inches with a core barrel 4 inches, 5 or 10 feet in length as drilling depth dictates. Borings BH-1, BH-5, and BH-7 were cored to a total depth of 165 feet bgs. Continuous cores were collected from the remaining borings (BH-2, BH-3, BH-4, and BH-8) to the depth of bedrock (40 to 67 feet below grade) where compressed air-rotary drilling was implemented after approval from the State of New Mexico.

▪ Soil Boring Advancement

Each soil boring was advanced to a depth of 165 feet below grade. This is over 100 feet below the proposed maximum depth of the landfill, if a landfill cell were to be located in the area of the soil boring. If a potential groundwater bearing zone (moist to saturated soils) was visible in any of the core samples, the depth would be noted and the drill casing would be raised to a depth 2 feet above the potential groundwater bearing zone. The boring would be gauged every hour for 3 hours, if no measurable amount of water had accumulated as measured with a water level meter (less than 0.01 feet) drilling would continue past this zone until either another potential groundwater bearing zone was encountered or the total depth of the boring was reached.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

Subsurface conditions encountered at the boring locations are indicated on the boring logs **Exploration Results**. Stratification boundaries on the boring logs represent the approximate locations of changes in soil types; in-situ, the transition between materials may be gradual. Details for the boring locations can be found on the boring logs of this report. Based on the results of the borings, subsurface conditions on the project site can be generalized as follows:

As noted in **General Comments**, the stratum characterization is based upon lithologic descriptions by a Terracon field geologist. The widely spaced exploration points across the site may result in lithologic variations.

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Encountered[1]	Consistency/Density
Stratum I	20 to 27	Silty sand, silty sand with gravel, silty clayey sand, poorly graded sand; brown; with interbedded layers of caliche	Loose to medium
Stratum II	40 to 65	Silty sand, poorly graded sand, interbedded caliche layers classified as, silty sand, poorly graded sand; brown, light brown, reddish brown	Medium dense to very dense
Stratum III	>165	Sandstone, light brown, brown, tannish brown, to tan, dark reddish brown	Fine to medium, poorly to well Cemented

Conditions encountered at each boring location are indicated on the individual boring logs shown in the **Exploration Results** section and are attached to this report. Stratification boundaries on the boring logs represent the approximate location of changes in native soil types; in situ the transition between materials may be gradual.

Groundwater Conditions

Groundwater was not identified during boring advancement. In addition, each boring was allowed to recharge for a period of 24 hours to determine if groundwater was present. Prior to plugging each boring, the boring was gauged with a water level probe to evaluate the boring for the presence of groundwater. No measurable groundwater infiltration (greater than 0.01 feet) was present; therefore, the installation of monitoring wells was not required.

Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

Laboratory Permeability Tests

Terracon conducted 3 laboratory permeability tests on cored stratum samples, the results are tabulated in the following table:

Test Number	Boring Number	Sample Depth (feet)	Permeability, K (cm/sec)
1	BH-1	0 to 65	6.56×10^{-6}
2	BH-4	0 to 20	1.09×10^{-7}
3	BH-4	20 to 52	6.56×10^{-6}

Laboratory Direct Shear Tests

Terracon conducted three laboratory direct shear tests on the samples and the results are tabulated in the following table:

Test Number	Boring Number	Sample Depth (feet)	Strain rate, (in./min.)
1	BH-1	0 to 65	0.004
2	BH-4	0 to 20	0.005
3	BH-4	20 to 52	0.005

GEOTECHNICAL OVERVIEW

On-site soils generally consist of fine to medium sandy soils and strongly cemented, calcareous interbedded caliche materials in the upper approximately 2 to 65 feet of existing grades, underlain by sandstone extending to boring termination depths of 165 feet bgs. On-site subsurface soils are not expected to experience substantial volumetric changes (shrink/swell) with fluctuations in moisture content. Potential vertical rise (PVR) of on-site soils is estimated to be less than 1 inch. On-site soils are generally suitable for use as structural fill.

The 2012 International Building Code (Section 1613.3.2) seismic site classification for this site is C.

No groundwater was encountered in any of the borings within the drilling depths at the time of drilling. Based on site exploration, we do not expect groundwater would impact the landfill development, provided expected depth of excavation (EDE) is kept at 65 feet below existing grades.

The **General Comments** section provides an understanding of the report limitations.

EARTHWORK

Earthwork will include clearing and grubbing, excavations and fill placement. The following sections provide recommendations for use in the preparation of specifications for the work.

Recommendations include critical quality criteria as necessary to render the site in the state considered in our geotechnical engineering evaluation for landfill construction.

Site Preparation

Any topsoil or vegetation within areas to receive new fill or structures foundation footprint should be stripped and grubbed and removed. Subsequently, the exposed subgrade should be proof-rolled prior to the placement of any fill or base materials. The proof-rolling should be performed with a fully loaded, tandem-axle dump truck or other equipment providing an equivalent subgrade loading. A minimum gross weight of 20 tons is recommended for the proof-rolling equipment. The proof-rolling should consist of several overlapping passes in mutually perpendicular directions over a given area. Any soft or pumping areas should be excavated to firm ground. Excavated areas should be backfilled with properly placed and compacted fill as discussed in Section **Fill Compaction Requirements**.

Fill Material Types

The on-site subsurface materials, which are free of vegetation, debris, and rocks greater than 4 inches in maximum dimension, are generally suitable to be used for structural fill. Cemented caliche materials that look like rock are present on the project site. Caliche materials need to be crushed into sizes less than 4 inches in maximum dimension and thoroughly mixed with soils before they can be used for structural fill. Structural fill should be clean soil with a Liquid Limit (LL) of less than 35 and a Plasticity Index (PI) less than 15.

Fill Compaction Requirements

Recommendations for compaction are presented in the following table. Terracon recommends that engineered fill be tested for moisture content and compaction during placement. Should the results of the in-place density tests indicate the specified moisture or compaction limits have not been met, the area represented by the test should be reworked and retested as required until the specified moisture and compaction requirements are achieved.

Item	Description
General subgrade preparation to receive fill	Surface scarified to a minimum depth of 6 inches, moisture conditioned and compacted
Lift thickness	9 inches or less lift thickness
Compaction	At least 95% maximum standard Proctor dry density (ASTM D 698) in the range of ±2 percentage points of optimum moisture

Utilities

Care should be taken that utility trenches are properly backfilled. Backfilling should be accomplished with properly compacted engineered fill with loose lift thickness of generally 9 inches except for the first lift above the utility pipes that can be relaxed to 12 inches. Compaction should be accomplished with a hand-held compaction device inside utility trenches. Engineered fill should be compacted to at least 95% maximum standard Proctor dry density (ASTM D 698) in the range of ±2 percentage points of optimum moisture for the engineered fill.

Excavation Conditions and Construction Slopes

Terracon understands that EDE in the landfill is expected to be 65 feet below ground surface and construction of the proposed waste facility will involve mass excavation of subsurface materials. For this reason, we aim to determine the expected excavation conditions and rippability of the on-site subsurface materials within approximately 25 feet of existing grades. We note that actual rippability will depend heavily on the equipment and tools used as well as the skill and experience of operators, among other factors. There is no method more effective to determine material rippability than a field production test with equipment similar or identical to that planned for use in project construction.

Caliche layers were encountered from existing grade to depths of approximately 2 to 65 feet bgs. Interbedded caliche and sand layers were underlain by sandstone bedrock extending to the borings termination depths of 165 feet bgs in the borings. Caliche bears a strong resemblance to rock and is therefore difficult to excavate. Based on the conditions encountered, we believe excavation of caliche may require a hoe ram, a heavy dozer equipped with a ripper, a rock saw or a jack hammer or with rock-excavation or blasting equipment. Excavation of rock, sandstone, will likely require controlled blasting.

Soils can generally be excavated by conventional scrapers and loaders. Caliche, partially weathered rock (PWR) or heavily fractured rock typically requires loosening by ripping with large dozers pulling single tooth rippers in mass excavation or blasting in confined (trench) excavation. Relatively sound, massive, rock typically requires blasting for removal in mass or trench excavation.

All excavations must comply with the applicable Federal, State, and local safety regulations and codes, and especially with the excavation standards of the Occupational Safety and Health Administration (OSHA). According to the OSHA soil classification, the on-site materials are generally classified as Type B soils. Temporary slopes of 1H:1V and permanent slopes of 3H:1V may be used. Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the mean, methods, and sequencing of construction operations.

These descriptions are a guide to conditions generally encountered. Excavation techniques will vary based on the weathering of the materials, fracturing and jointing in the rock, and the overall stratigraphy of the feature. Actual field conditions usually display a gradual weathering progression with poorly defined and uneven boundaries between layers of different materials.

Terracon recommends that the following definitions for rock in earthwork excavation construction be included in bid documents:

Mass Excavation: Any material occupying an original volume of more than 1 cubic yard which cannot be excavated with a single-toothed ripper drawn by a crawler tractor having a minimum draw bar pull rating of not less than 80,000 pounds (Caterpillar D-8 or larger).

Trench Excavation: Any material occupying an original volume of more than 1/2 cubic yard which cannot be excavated with a backhoe having a bucket curling rate of not less than 40,000 pounds, using a rock bucket and rock teeth (a John Deere 790 or larger).

In applicable areas, Terracon recommends that soils which can be excavated with conventional equipment be removed first. Then, if necessary, heavy-duty or oversized equipment can be used to excavate cemented caliche by ripping. Blasting should only be conducted where materials cannot be excavated by other trench excavation techniques such as ripping.

Grading and Drainage

All grades must provide effective drainage away from structures during and after construction and should be maintained throughout the life of the structures. Water retained next to structures can result in soil movements greater than those discussed in this report. Greater movements can result in unacceptable differential floor slab and/or foundation movements, cracked slabs and walls, and roof leaks. The roof should have gutters/drains with downspouts that discharge onto splash blocks at a distance of at least 10 feet from structures

Exposed ground should be sloped and maintained at a minimum 5 percent away from structures for at least 10 feet beyond the perimeter of the structures. Locally, flatter grades may be necessary to transition ADA access requirements for flatwork. After construction and landscaping, final grades should be verified to document effective drainage has been achieved. Grades around the structure should also be periodically inspected and adjusted as necessary as part of the structure's maintenance program. Where paving or flatwork abuts the structure a maintenance program should be established to effectively seal and maintain joints and prevent surface water infiltration.

Earthwork Construction Considerations

Shallow excavations, for the landfill structures and buildings, are anticipated to be accomplished with conventional construction equipment. Upon completion of filling and grading, care should be taken to maintain the subgrade water content prior to construction of floor slabs. Construction traffic over the completed subgrades should be avoided. The site should also be graded to prevent ponding of surface water on the prepared subgrades or in excavations. Water collecting over, or adjacent to, construction areas should be removed. If the subgrade freezes, desiccates, saturates, or is disturbed, the affected material should be removed, or the materials should be scarified, moisture conditioned, and recompacted, prior to floor slab construction.

As a minimum, excavations should be performed in accordance with OSHA 29 CFR, Part 1926, Subpart P, “Excavations” and its appendices, and in accordance with any applicable local, and/or state regulations.

Construction site safety is the sole responsibility of the contractor who controls the means, methods, and sequencing of construction operations. Under no circumstances shall the information provided herein be interpreted to mean Terracon is assuming responsibility for construction site safety, or the contractor's activities; such responsibility shall neither be implied nor inferred.

Construction Observation and Testing

The earthwork efforts should be monitored under the direction of the Geotechnical Engineer. Monitoring should include documentation of adequate removal of vegetation and top soil, proof-rolling and mitigation of areas delineated by the proof-roll to require mitigation.

Each lift of compacted fill should be tested, evaluated, and reworked as necessary until approved by the Geotechnical Engineer prior to placement of additional lifts. Each lift of fill should be tested for density and water content at a frequency of at least one test for every 2,500 square feet of compacted fill in the building areas and 5,000 square feet in pavement areas. One density and water content test for every 50 linear feet of compacted utility trench backfill.

In areas of foundation excavations, the bearing subgrade should be evaluated under the direction of the Geotechnical Engineer. In the event that unanticipated conditions are encountered, the Geotechnical Engineer should prescribe mitigation options.

In addition to the documentation of the essential parameters necessary for construction, the continuation of the Geotechnical Engineer into the construction phase of the project provides the continuity to maintain the Geotechnical Engineer’s evaluation of subsurface conditions, including assessing variations and associated design changes.

SEISMIC CONSIDERATIONS

Description	Value
2012 International Building Code Site Classification	C [1, 2]
Site Latitude	32.139862°
Site Longitude	- 103.465597°
S_{DS} Spectral Acceleration for a Short Period [3]	0.153g
S_{D1} Spectral Acceleration for a 1-Second Period [3]	0.052g

1. Seismic site classification in general accordance with the *2012 International Building Code*, which refers to ASCE 7-10.
2. The 2012 International Building Code (IBC) uses a site profile extending to a depth of 100 feet for seismic site classification. Borings at this site were extended to a maximum depth of 165 feet.
3. These values were obtained using online seismic design maps and tools provided by the USGS (http://earthquake.usgs.gov/hazards/designmaps/).

GENERAL COMMENTS

As the construction project progresses, we address assumptions by incorporating information provided by the design team, if any. Revised project information that reflects actual conditions important to our services is reflected in the final report. The design team should collaborate with Terracon to confirm these assumptions and to prepare the final design plans and specifications. This facilitates the incorporation of our opinions related to implementation of our geotechnical recommendations. Any information conveyed prior to the final report is for informational purposes only and should not be considered or used for decision-making purposes.

Our analysis and opinions are based upon our understanding of the project, the geotechnical conditions in the area, and the data obtained from our site exploration. Natural variations will occur between exploration point locations or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. Terracon should be retained as the Geotechnical Engineer, where noted in the final report, to provide observation and testing services during pertinent construction phases. If variations appear, we can provide further evaluation and supplemental recommendations. If variations are noted in the absence of our observation and testing services on-site, we should be immediately notified so that we can provide evaluation and supplemental recommendations.

Our scope of services does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

Our services and any correspondence or collaboration through this system are intended for the sole benefit and exclusive use of our client for specific application to the project discussed and are accomplished in accordance with generally accepted geotechnical engineering practices with no third party beneficiaries intended. Any third party access to services or correspondence is solely for information purposes to support the services provided by Terracon to our client. Reliance upon the services and any work product is limited to our client, and is not intended for third parties. Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

Site characteristics as provided are for design purposes and not to estimate excavation cost. Any use of our report in that regard is done at the sole risk of the excavating cost estimator as there may be variations on the site that are not apparent in the data that could significantly impact excavation cost. Any parties charged with estimating excavation costs should seek their own site characterization for specific purposes to obtain the specific level of detail necessary for costing. Site safety, and cost estimating including, excavation support, and dewatering requirements/design are the responsibility of others. If changes in the nature, design, or location of the project are planned, our conclusions and recommendations shall not be considered valid unless we review the changes and either verify or modify our conclusions in writing.

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES

Borings

As client requested, Terracon conducted a total of Seven (7) soil-testing borings as tabulated in the following table:

Boring Location	Number of Borings	Boring Depth (feet)[1]	Drilling Footage (feet)[1]
McCloy Ranch Landfill	7	165	1,155

[1] The borings at the proposed center were extended to auger refusal/rock depths, and then rock coring was conducted.

Boring Layout and Elevations: Location of soil borings are provided on our **Site Location and Exploration Plans**. Location is established in the field by Terracon's exploration team using a measuring wheel/tape and/or a hand-held GPS unit to establish boring location with reference to known points. The accuracy of the exploration points is usually within 10 feet of the noted location.

Subsurface Exploration Procedures: All borings will be performed using sonic drilling methods to the minimum depth of 50 feet bgs in accordance with ASTM D-6914/D6914M-16. The sonic drilling rig was equipped with coring tools capable of providing a minimum borehole diameter of 6 inches with a core barrel was be advanced into the subsurface and tocollect an undisturbed soil core. Prior to placing an additional core casing section onto the drill stem, the soil core was removed from the core barrel and the undisturbed soil core was extracted, characterized for geological lithology, and logged. The empty coring barrel was replaced inside the drill casing, and the drilling continued. This process was continued until either a boring depth of 165 feet bgs was achieved or until groundwater was encountered. Compressed air-rotary drilling and plain water was utilized to remove the cores and/or cuttings and speed up the operation further, depending on subsurface conditions.

The sampling depths, penetration distances, and other sampling information were recorded on the field boring logs. The samples were placed in appropriate containers and taken to our soil laboratory for testing and classification by a geotechnical engineer. Our exploration team prepared field boring logs as part of the drilling operations. These field logs include visual classifications of the materials encountered during drilling and our interpretation of the subsurface conditions between samples. Final boring logs are prepared from the field logs. The final boring logs represent the geotechnical engineer's interpretation of the field logs and include modifications based on observations and tests of the samples in our laboratory.

Laboratory Testing

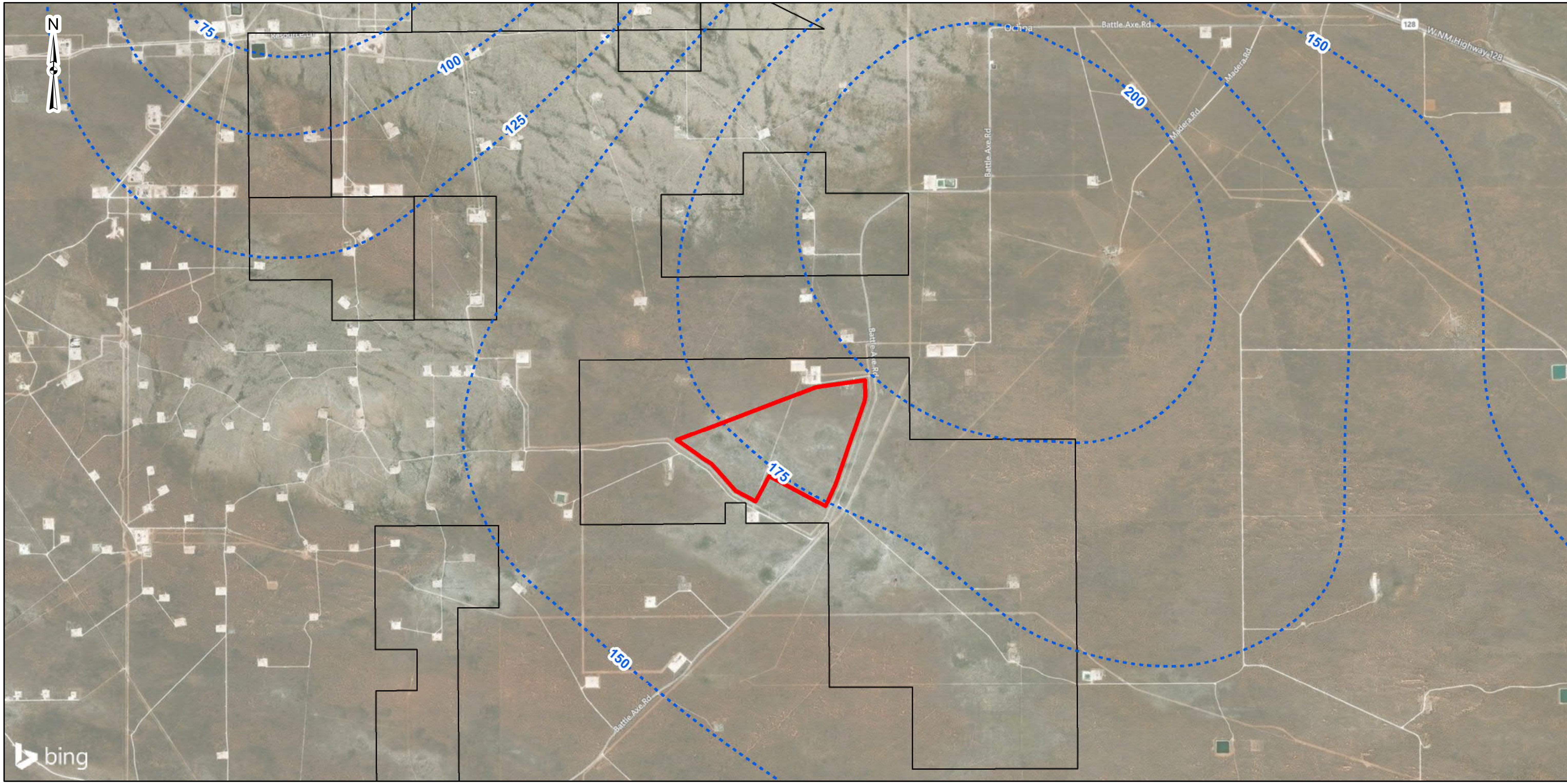
The project engineer reviews the field data and assigns various laboratory tests to better understand the engineering properties of the various soil and rock strata as necessary for this project. Procedural standards noted below are for reference to methodology in general. In some cases, variations to methods are applied because of local practice or professional judgment. Standards noted below include reference to other, related standards. Such references are not necessarily applicable to describe the specific test performed.

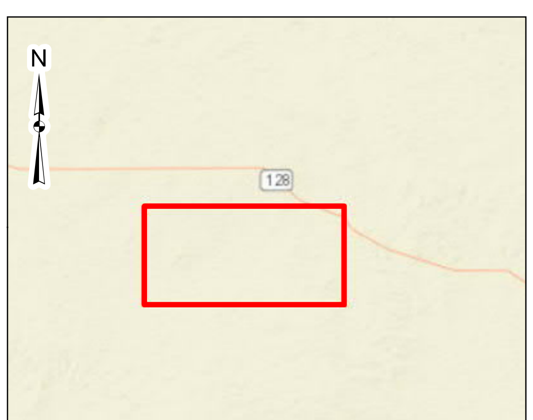
- Moisture Content (ASTM D854)
- Particle Size (ASTM D1140, D422)
- Atterburg Limits (ASTM D4318)
- Laboratory Compaction (ASTM D698)
- ASTM D5084 Standard Test Method for Permeability Tests
- Direct Shear of Soil (ASTM D3080)

The laboratory testing program often includes examination of soil samples by an engineer. Based on the material's texture and plasticity, we describe and classify the soil samples in accordance with the Unified Soil Classification System.

Rock classification is conducted using locally accepted practices for engineering purposes; petrographic analysis may reveal other rock types. Rock core samples typically provide an improved specimen for this classification. Boring log rock classification is determined using the Description of Rock Properties.

SITE LOCATION AND EXPLORATION PLANS





Proposed Landfill

Proposed Landfill

Inferred Depth to Water Contour (ft. bgs)

McCloy Ranch Boundaries

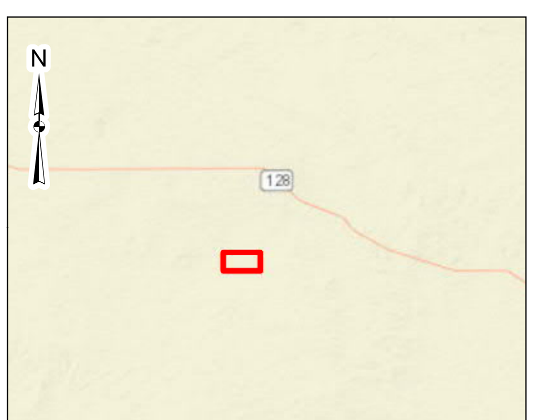
Notes:
-Exhibit is for general location only, is not indended for construction purposes, and should not be used seperatedly from original report.

0 0.5 1 2 Miles

Fractional Scale: 1:37,883

DATA SOURCES:
Bing Maps - Aerial Imagery, World Street Map

Project No.: 35187312 Date: Sep 2018 Drawn By: SW Reviewed By: MB	Terracon 10400 Highway 191 Midland, TX 79707 PH. (432) 684-9600 terracon.com	**Proposed Landfill Map** Project Name Client Name Project Address Project City, State GPS: 32.143736°, -103.461678°	**Exhibit** 1



Proposed Landfill

Soil Boring (BH)

Proposed Landfill

Notes:
-Exhibit is for general location only, is not indended for construction purposes, and should not be used seperatedly from original report.

Feet
0 500 1,000 2,000

Fractional Scale: 1:7,055

DATA SOURCES:
Bing Maps - Aerial Imagery, World Street Map

Project No.: A4187129 Date: Jan 2019 Drawn By: SW Reviewed By: DC	Terracon 10400 Highway 191 Midland, TX 79707 PH. (432) 684-9600 terracon.com	**Proposed Landfill Sample Location Map** Trammco Environmental Solutions McCloy Ranch - Proposed Landfill Lea County, New Mexico GPS: 32.143736°, -103.461678°	**Exhibit** **2**

C:\Users\jswagner\Desktop\GIS_Midland_Projects\LSI GIS Projects\A41870## NM_McCloyRanch_GIS\A41870## NM_McCloyRanch_Ex2_SampleLocMap.mxd

EXPLORATION RESULTS

BORING LOG NO. BH-1

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.15° Longitude: -103.4539°

Approximate Surface Elev.: 3345 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.0	**POORLY GRADED SAND (SP)**, brown, dry, -Loose to very dense	3344+/-						
5.0	**SILTY SAND (SM)**, brown to dark reddish brown, dry, -Medium dense to very dense	3340+/-	5					
10.0	**POORLY GRADED SAND (SP)**, brown, dry, -Medium dense to very dense	3335+/-	10					
15.0	**SILTY SAND (SM)**, light brown to gray, dry, -Medium dense to very dense	3330+/-	15					
16.0	**CALICHE**, white, dry	3329+/-						
18.0	**POORLY GRADED SAND (SP)**, brown, dry, -Medium dense to very dense	3327+/-						
40.0	**POORLY GRADED SAND (SP)**, brown to light brown, dry, -Medium dense to very dense	3305+/-	20, 25, 30, 35, 40		Hand sample (at approx. 30 ft)	7	20-17-3	23
45.0	**SILTY SAND (SM)**, brown to light brown, dry, -Medium dense to very dense	3300+/-	45					
	POORLY GRADED SAND WITH SILT (SP-SM), reddish brown to light brown, dry, -Medium dense to very dense		50, 55, 60					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-02-2018	Boring Completed: 11-06-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-1

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.15° Longitude: -103.4539°

Approximate Surface Elev.: 3345 (Ft.) +/-

GRAPHIC LOG	DEPTH / MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND WITH SILT (SP-SM), reddish brown to light brown, dry, -Medium dense to very dense *(continued)*							
	65.0	3280+/-	65					
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered		70					
			75					
			80					
			85					
			90					
			95					
			100					
			105					
			110					
			115					
			120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-02-2018	Boring Completed: 11-06-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-1

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.15° Longitude: -103.4539° Approximate Surface Elev.: 3345 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	125 130 135 140 145 150 155 160					
	165.0 3180+/-	165					
	Boring Terminated at 165 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-02-2018	Boring Completed: 11-06-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-2

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1481° Longitude: -103.4638°

Approximate Surface Elev.: 3343 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
4.0	**POORLY GRADED SAND (SP)**, light brownish gray to reddish brown, dry, -Loose to very dense	3339+/-						
22.0	**CALICHE**, white to light brown, dry, -Loose to moderately compacted	3321+/-	5, 10, 15, 20					
50.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, reddish brown to light brown, dry, -Medium dense to very dense	3293+/-	25, 30, 35, 40, 45					
	SANDSTONE, light brown to dark reddish brown, dry, -Moderately to highly weathered		50, 55, 60					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-26-2018	Boring Completed: 11-28-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-2

PROJECT: McCloy Ranch Landfill	CLIENT: Trammco Environmental Solutions, LLC Fermandina Beach, Florida
SITE: Section 9 and 10 of, T25S, R34E Jal, Lea County, New Mexico	

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1481° Longitude: -103.4638° Approximate Surface Elev.: 3343 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, light brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	65 70 75 80 85 90 95 100 105 110 115 120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Sonic/Coring Abandonment Method: Boring backfilled with bentonite chips upon completion.	See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations.	Notes:

WATER LEVEL OBSERVATIONS	Terracon	Boring Started: 11-26-2018	Boring Completed: 11-28-2018
No groundwater encountered during drilling	10400 State Highway 191	Drill Rig: CME 75	Driller: Alec
Dry after 24 hours of drilling	Midland, TX	Project No.: A4187129	

BORING LOG NO. BH-2

PROJECT: McCloy Ranch Landfill	**CLIENT: Trammco Environmental Solutions, LLC Fernandina Beach, Florida**
SITE: Section 9 and 10 of, T25S, R34E Jal, Lea County, New Mexico	

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1481° Longitude: -103.4638° Approximate Surface Elev.: 3343 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, light brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	125 130 135 140 145 150 155 160					
	165.0 / 3178+/-	165					
	Boring Terminated at 165 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-26-2018	Boring Completed: 11-28-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-3

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1451° Longitude: -103.4733°

Approximate Surface Elev.: 3345 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND (SM), reddish brown, dry, -Loose to very dense							
3.0		3342+/-						
	CALICHE, white, dry		5					
10.0		3335+/-	10					
	SILTY SAND, with interbedded CALICHE (SM), light brownish gray to reddish brown, dry, -Medium dense to very dense		15, 20					
25.0		3320+/-	25					
	POORLY GRADED SAND WITH SILT (SP-SM), brown to light brown, dry, -Medium dense to very dense		30, 35, 40, 45, 50, 55					
57.0		3288+/-						
	SANDSTONE, light brown to dark reddish brown, dry, -Moderately to highly weathered		60					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-26-2018	Boring Completed: 11-28-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-3

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1451° Longitude: -103.4733° Approximate Surface Elev.: 3345 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, light brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-26-2018	Boring Completed: 11-28-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-3

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1451° Longitude: -103.4733° Approximate Surface Elev.: 3345 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, light brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	125 130 135 140 145 150 155 160					
	165.0 — 3180+/-	165					
	Boring Terminated at 165 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-26-2018	Boring Completed: 11-28-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-4

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1399° Longitude: -103.4656°

Approximate Surface Elev.: 3332 (Ft.) +/-

DEPTH	Description	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	CLAYEY SAND with interbedded CALICHE (SC), light brownish gray to reddish brown, dry, -Loose to very dense		10			5	23-14-9	39
20.0	**SILTY CLAYEY SAND, with interbedded CALICHE (SC-SM)**, reddish brown to light brown, dry, -Medium dense to very dense	3312+/-						
30.0	**POORLY GRADED SAND (SP)**, brown, dry, -Dense	3302+/-	35			8	25-18-7	26
50.0	**SANDSTONE**, brown to dark reddish brown, dry, -Moderately to highly weathered, well cemented	3282+/-						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-15-2018	Boring Completed: 11-18-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-4

PROJECT: McCloy Ranch Landfill	CLIENT: Trammco Environmental Solutions, LLC Fermandina Beach, Florida
SITE: Section 9 and 10 of, T25S, R34E Jal, Lea County, New Mexico	

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1399° Longitude: -103.4656° Approximate Surface Elev.: 3332 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered, well cemented *(continued)*	65					
		70					
		75					
		80					
		85					
		90					
		95					
		100					
		105					
		110					
		115					
		120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Sonic/Coring Abandonment Method: Boring backfilled with bentonite chips upon completion.	See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations.	Notes:

WATER LEVEL OBSERVATIONS	Terracon		
No groundwater encountered during drilling *Dry after 24 hours of drilling*	10400 State Highway 191 Midland, TX	Boring Started: 11-15-2018 Drill Rig: CME 75 Project No.: A4187129	Boring Completed: 11-18-2018 Driller: Alec

BORING LOG NO. BH-4

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1399° Longitude: -103.4656° Approximate Surface Elev.: 3332 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered, well cemented *(continued)*	125 130 135 140 145 150 155 160					
	165.0 / 3167+/-	165					
	Boring Terminated at 165 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-15-2018	Boring Completed: 11-18-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-5

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1394° Longitude: -103.4584°

Approximate Surface Elev.: 3331 (Ft.) +/-

GRAPHIC LOG	DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	2.0	**POORLY GRADED SAND (SP)**, light brownish gray to reddish brown, dry, -Loose to very dense	3329+/-						
	12.0	**SILTY SAND (SM)**, reddish brown to light brown, dry, -Loose to very dense	3319+/-	5, 10					
	19.0	**CALICHE**, white, dry	3312+/-	15					
	40.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, brown to light brown, dry, -Medium dense to very dense	3291+/-	20, 25, 30, 35, 40					
		SANDSTONE, brown to dark reddish brown, dry, -Medium dense to very dense		45, 50, 55, 60					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-09-2018	Boring Completed: 11-14-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-5

PROJECT: McCloy Ranch Landfill	**CLIENT: Trammco Environmental Solutions, LLC Fernandina Beach, Florida**
SITE: Section 9 and 10 of, T25S, R34E Jal, Lea County, New Mexico	

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1394° Longitude: -103.4584° Approximate Surface Elev.: 3331 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Medium dense to very dense *(continued)*	65 70 75 80 85 90 95 100 105 110 115 120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method: Sonic/Coring Abandonment Method: Boring backfilled with bentonite chips upon completion.	See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any). See Supporting Information for explanation of symbols and abbreviations.	Notes:

WATER LEVEL OBSERVATIONS			
No groundwater encountered during drilling *Dry after 24 hours of drilling*	Terracon 10400 State Highway 191 Midland, TX	Boring Started: 11-09-2018 Drill Rig: CME 75 Project No.: A4187129	Boring Completed: 11-14-2018 Driller: Alec

BORING LOG NO. BH-5

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1394° Longitude: -103.4584°

Approximate Surface Elev.: 3331 (Ft.) +/-

GRAPHIC LOG	DEPTH / DESCRIPTION / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Medium dense to very dense *(continued)*	125, 130, 135, 140, 145, 150, 155, 160					
	165.0 — 3166+/-	165					
	Boring Terminated at 165 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-09-2018	Boring Completed: 11-14-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL A4187129 - MCCLOY SITE.GPJ MODELLAYER.GPJ 1/17/19

BORING LOG NO. BH-7

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1454° Longitude: -103.4585° Approximate Surface Elev.: 3334 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	POORLY GRADED SAND, with interbedded CALICHE (SP), light brownish gray to gray, dry, -Loose to very dense	5					
	7.0 — 3327+/-						
	SILTY SAND (SM), light brown to gray, dry, -Loose to very dense						
	10.0 — 3324+/-	10					
	CALICHE, white, dry						
	12.0 — 3322+/-						
	SILTY SAND (SM), light brown to gray, dry, -Medium dense to very dense	15 20					
	25.0 — 3309+/-	25					
	POORLY GRADED SAND WITH SILT (SP-SM), reddish brown, dry, -Medium dense to very dense	30 35 40 45 50					
	55.0 — 3279+/-	55					
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered	60					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-06-2018	Boring Completed: 11-08-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-7

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1454° Longitude: -103.4585° Approximate Surface Elev.: 3334 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	65 70 75 80 85 90 95 100 105 110 115 120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-06-2018	Boring Completed: 11-08-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-7

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1454° Longitude: -103.4585° Approximate Surface Elev.: 3334 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, dry, -Moderately to highly weathered *(continued)*	125 130 135 140 145 150 155 160					
	165.0 / 3169+/-	165					
	Boring Terminated at 165 Feet						

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-06-2018	Boring Completed: 11-08-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-8

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1448° Longitude: -103.4665°

Approximate Surface Elev.: 3336 (Ft.) +/-

GRAPHIC LOG	DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	2.0	**POORLY GRADED SAND (SP)**, light brownish gray to reddish brown, -Loose to very dense, dry	3334+/-						
	10.0	**CALICHE**, white	3326+/-	5					
	20.0	**SILTY SAND (SM)**, brown to light brown, -Medium dense to very dense, dry	3316+/-	10, 15					
	50.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, brown to dark reddish brown, -Medium dense to very dense, dry	3286+/-	20, 25, 30, 35, 40, 45					
		SANDSTONE, brown to dark reddish brown, -Moderately to highly weathered, dry		50, 55, 60					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-16-2018	Boring Completed: 11-16-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

BORING LOG NO. BH-8

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

GRAPHIC LOG	LOCATION See Exploration Plan Latitude: 32.1448° Longitude: -103.4665° Approximate Surface Elev.: 3336 (Ft.) +/- DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, -Moderately to highly weathered, dry *(continued)*	65 70 75 80 85 90 95 100 105 110 115 120					

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-16-2018	Boring Completed: 11-16-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL A4187129 - MCCLOY SITE.GPJ MODELLAYER.GPJ 1/17/19

BORING LOG NO. BH-8

PROJECT: McCloy Ranch Landfill

CLIENT: Trammco Environmental Solutions, LLC
Fermandina Beach, Florida

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1448° Longitude: -103.4665°

Approximate Surface Elev.: 3336 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SANDSTONE, brown to dark reddish brown, -Moderately to highly weathered, dry *(continued)*		125 130 135 140 145 150 155 160					
	165.0	3171+/-	165					
	Boring Terminated at 165 Feet							

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic

Advancement Method:
Sonic/Coring

Abandonment Method:
Boring backfilled with bentonite chips upon completion.

See Exploration and Testing Procedures for a description of field and laboratory procedures used and additional data (If any).

See Supporting Information for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

No groundwater encountered during drilling

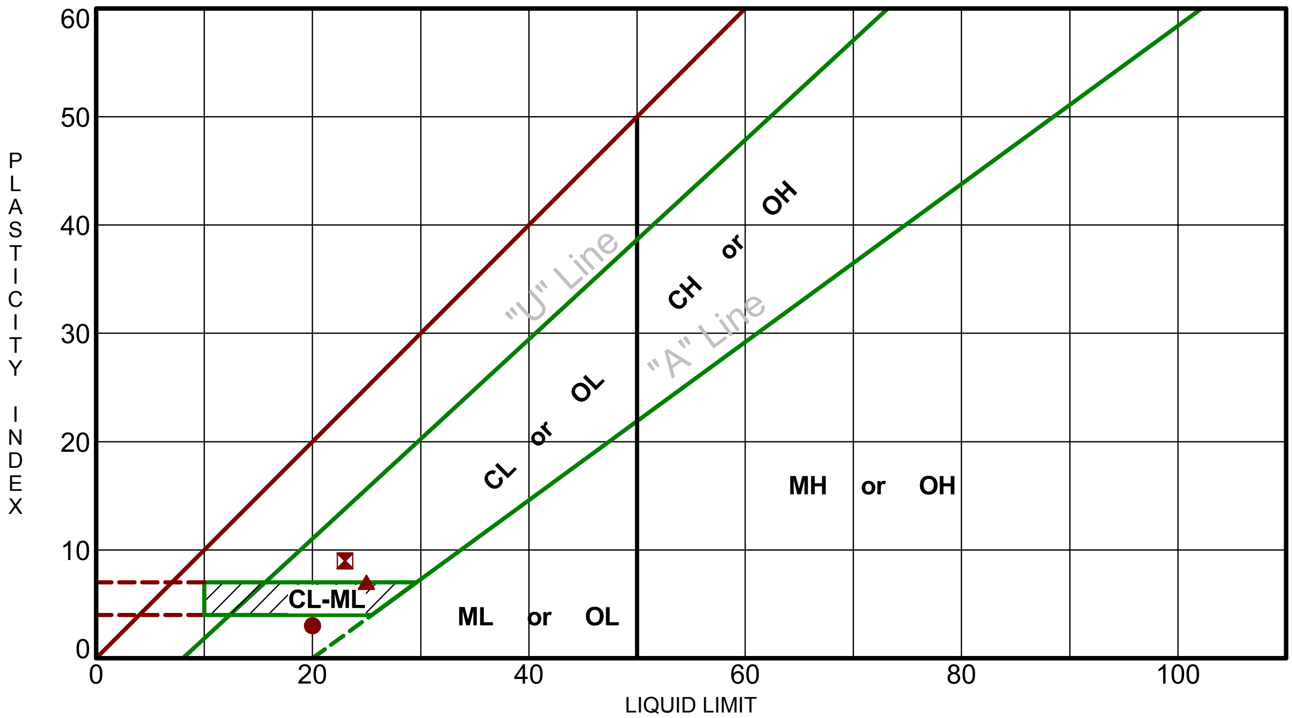
Dry after 24 hours of drilling

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 11-16-2018	Boring Completed: 11-16-2018
Drill Rig: CME 75	Driller: Alec
Project No.: A4187129	

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID		Depth	LL	PL	PI	Fines	USCS	Description
●	BH-1	0 - 65	20	17	3	23	SM	SILTY SAND with GRAVEL
⊠	BH-4	0 - 20	23	14	9	39	SC	CLAYEY SAND
▲	BH-4	20 - 52	25	18	7	26	SC-SM	SILTY, CLAYEY SAND

PROJECT: McCloy Ranch Landfill

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

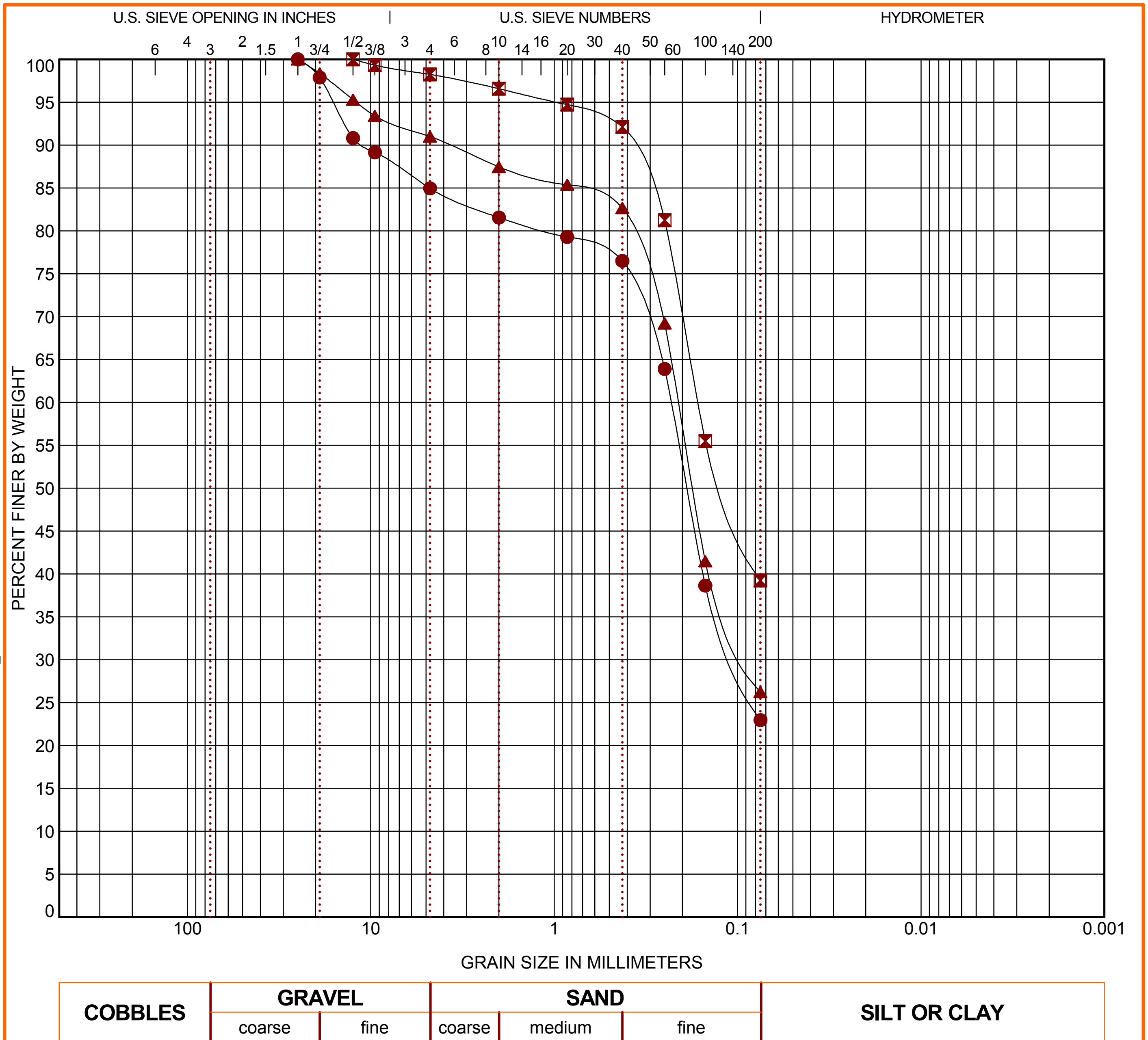
Terracon
10400 State Highway 191
Midland, TX

PROJECT NUMBER: A4187129

CLIENT: Trammco environmental Solutions, LLC
Fermandina Beach, Florida

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



	Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
●	BH-1	0 - 65	SILTY SAND with GRAVEL (SM)	7	20	17	3		
⊠	BH-4	0 - 20	CLAYEY SAND (SC)	5	23	14	9		
▲	BH-4	20 - 52	SILTY, CLAYEY SAND (SC-SM)	8	25	18	7		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
●	BH-1	0 - 65	25	0.231	0.102		15.0	62.0		23.0	
⊠	BH-4	0 - 20	12.5	0.164			1.8	59.0		39.2	
▲	BH-4	20 - 52	25	0.211	0.089		9.0	64.8		26.2	

PROJECT: McCloy Ranch Landfill

SITE: Section 9 and 10 of, T25S, R34E
Jal, Lea County, New Mexico

Terracon
10400 State Highway 191
Midland, TX

PROJECT NUMBER: A4187129

CLIENT: Trammco environmental Solutions, LLC
Fermandina Beach, Florida

Terracon

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project :	Beckham and McCloy Landfill							
Date:	12/21/2018		Panel Number :	P-1				
Project No. :	A4187129			Permometer Data				
Boring No.:	BH-4	a_p =	0.031416 cm^2		Set Mercury to Pipet Rp at beginning	Equilibrium	1.6	cm^3
Sample:	composite 1	a_a =	0.767120 cm^2			Pipet **Rp**	**16.8**	cm^3
Depth (ft):	0-20	M_1 =	0.030180	C =	0.0004288	Annulus **Ra**	1.0	cm^3
Other Location:	McCloy Site	M_2 =	1.040953	T =	0.0658646			

Material Description : light brown clayey sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			575.30	g					
Tare or ring Wt. :			0.0	g		Before Test		After Test	
Wet Wt: of Sample :			575.30	g		Tare No.:	102	Tare No.:	N/A
Diameter :	2.80	in	7.11	cm^2		Wet Wt.+tare:	115.70	Wet Wt.+tare:	578.70
Length :	2.80	in	7.11	cm		Dry Wt.+tare:	100.00	Dry Wt.+tare:	484.11
Area:	6.16	in^2	39.73	cm^2		Tare Wt:	0.00	Tare Wt:	0.00
Volume :	17.24	in^3	282.53	cm^3		Dry Wt.:	100	Dry Wt.:	484.11
Unit Wt.(wet):	**127.06**	pcf	**2.04**	g/cm^3		Water Wt.:	15.7	Water Wt.:	94.59
Unit Wt.(dry):	**109.82**	pcf	**1.76**	g/cm^3		% moist.:	**15.7**	% moist.:	**19.5**

Assumed Specific Gravity:	**2.70**	Max Dry Density(pcf) =	115.6	OMC =	13.7
		% of max =	95.0	+/- OMC =	2.00
Calculated % saturation:	98.63	Void ratio (e) =	**0.53**	Porosity (n)=	**0.35**

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 15.8 cm Hydraulic Gradient = 28.00

Date	elapsed t (seconds)	Z (pipet @ t)	DZp (cm)	temp (deg C)	a (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/20/2018	300	15.7	1.082666	21	0.977	1.03E-07	2.93E-04	
12/20/2018	600	14.6	2.182666	21	0.977	1.08E-07	3.07E-04	
12/20/2018	900	13.5	3.282666	21	0.977	1.13E-07	3.21E-04	
12/20/2018	1200	12.6	4.182666	21	0.977	1.12E-07	3.19E-04	

SUMMARY

ka = 1.09E-07 cm/sec Acceptance criteria = 50 %

ki			Vm	
k1 =	1.03E-07	cm/sec	5.6	%
k2 =	1.08E-07	cm/sec	0.9	%
k3 =	1.13E-07	cm/sec	3.7	%
k4 =	1.12E-07	cm/sec	2.8	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**1.09E-07**	cm/sec	**3.10E-04**	ft/day
Void Ratio	e =	**0.53**			
Porosity	n =	**0.35**			
Bulk Density	g =	**2.04**	g/cm^3	**127.1**	pcf
Water Content	W =	**0.28**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**1.12E-12**	cm^2	(at 20 deg C)	

Terracon

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Beckham and McCloy Landfill

Date: 12/21/2018 Panel Number : P-1

Project No. : A4187129 Permometer Data

Boring No.: BH-4	a_p = 0.031416 cm^2		Set Mercury to Pipet Rp at beginning	Equilibrium	1.6 cm^3
Sample: composite 2	a_a = 0.767120 cm^2			Pipet **Rp**	**16.8** cm^3
Depth (ft): 20.0-52.0	M_1 = 0.030180	C = 0.0004288		Annulus **Ra**	1.0 cm^3
Other Location: McCloy Site	M_2 = 1.040953	T = 0.0658646			

Material Description : light brown silty, clayey sand

SAMPLE DATA

Wet Wt. sample + ring or tare :			566.34	g				
Tare or ring Wt. :			0.0	g	Before Test		After Test	
Wet Wt: of Sample :			566.34	g	Tare No.:	103	Tare No.:	N/A
Diameter :	2.80	in	7.11	cm^2	Wet Wt.+tare:	115.70	Wet Wt.+tare:	579.47
Length :	2.80	in	7.11	cm	Dry Wt.+tare:	100.00	Dry Wt.+tare:	481.39
Area:	6.16	in^2	39.73	cm^2	Tare Wt:	0.00	Tare Wt:	0.00
Volume :	17.24	in^3	282.53	cm^3	Dry Wt.:	100	Dry Wt.:	481.39
Unit Wt.(wet):	**125.08**	pcf	**2.00**	g/cm^3	Water Wt.:	15.7	Water Wt.:	98.08
Unit Wt.(dry):	**108.11**	pcf	**1.73**	g/cm^3	% moist.:	**15.7**	% moist.:	**20.4**

Assumed Specific Gravity:	**2.70**	Max Dry Density(pcf) =	113.8	OMC =	13.7
		% of max =	95.0	+/- OMC =	2.00
Calculated % saturation:	98.38	Void ratio (e) =	**0.56**	Porosity (n)=	**0.36**

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 15.8 cm Hydraulic Gradient = 28.00

Date	elapsed t (seconds)	Z (pipet @ t)	DZp (cm)	temp (deg C)	a (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/20/2018	5	15.7	1.082666	21	0.977	6.20E-06	1.76E-02	
12/20/2018	10	14.6	2.182666	21	0.977	6.50E-06	1.84E-02	
12/20/2018	15	13.5	3.282666	21	0.977	6.80E-06	1.93E-02	
12/20/2018	20	12.6	4.182666	21	0.977	6.75E-06	1.91E-02	

SUMMARY

ka = 6.56E-06 cm/sec Acceptance criteria = 50 %

ki			Vm	
k1 =	6.20E-06	cm/sec	5.6	%
k2 =	6.50E-06	cm/sec	0.9	%
k3 =	6.80E-06	cm/sec	3.7	%
k4 =	6.75E-06	cm/sec	2.8	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**6.56E-06**	cm/sec	**1.86E-02**	ft/day
Void Ratio	e =	**0.56**			
Porosity	n =	**0.36**			
Bulk Density	g =	**2.00**	g/cm^3	**125.1**	pcf
Water Content	W =	**0.27**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**6.72E-11**	cm^2	(at 20 deg C)	

Terracon

HYDRAULIC CONDUCTIVITY DETERMINATION
FLEXIBLE WALL PERMEAMETER - CONSTANT VOLUME
(Mercury Permometer Test)

Project : Beckham and McCloy Landfill

Date: 12/21/2018 Panel Number : P-1

Project No. : A4187129

						Permometer Data		
Boring No.:	BH-1	a_p =	0.031416 cm^2			Set Mercury to Pipet Rp at beginning	Equilibrium	1.6 cm^3
Sample:	composite	a_a =	0.767120 cm^2				Pipet **Rp**	**16.8** cm^3
Depth (ft):	0-65	M_1 =	0.030180	C =	0.0004288		Annulus **Ra**	1.0 cm^3
Other Location:	McCloy Site	M_2 =	1.040953	T =	0.0658646			

Material Description : light brown silty sand with gravel

SAMPLE DATA

							Before Test		After Test
Wet Wt. sample + ring or tare :			575.26	g					
Tare or ring Wt. :			0.0	g					
Wet Wt: of Sample :			575.26	g		Tare No.:	101	Tare No.:	N/A
Diameter :	2.80	in	7.11	cm^2		Wet Wt.+tare:	114.70	Wet Wt.+tare:	586.52
Length :	2.80	in	7.11	cm		Dry Wt.+tare:	100.00	Dry Wt.+tare:	492.33
Area:	6.16	in^2	39.73	cm^2		Tare Wt:	0.00	Tare Wt:	0.00
Volume :	17.24	in^3	282.53	cm^3		Dry Wt.:	100	Dry Wt.:	492.33
Unit Wt.(wet):	**127.05**	pcf	**2.04**	g/cm^3		Water Wt.:	14.7	Water Wt.:	94.19
Unit Wt.(dry):	**110.77**	pcf	**1.78**	g/cm^3		% moist.:	**14.7**	% moist.:	**19.1**

Assumed Specific Gravity:	**2.70**	Max Dry Density(pcf) =	116.6	OMC =	12.7
		% of max =	95.0	+/- OMC =	2.00
Calculated % saturation:	99.01	Void ratio (e) =	**0.52**	Porosity (n)=	**0.34**

Test Pressures During Hydraulic Conductivity Test

Cell Pressure (psi) = 55.00 Back Pressure (psi) = 50.00 Confining Pressure = 5.00 psi

Note: The above value is Effective Confining Pressure

TEST READINGS

Z_1(Mercury Height Difference @ t_1): 15.8 cm Hydraulic Gradient = 28.00

Date	elapsed t (seconds)	Z (pipet @ t)	DZp (cm)	temp (deg C)	a (temp corr)	k (cm/sec)	k (ft./day)	Reset = *
12/20/2018	5	15.7	1.082666	21	0.977	6.20E-06	1.76E-02	
12/20/2018	10	14.6	2.182666	21	0.977	6.50E-06	1.84E-02	
12/20/2018	15	13.5	3.282666	21	0.977	6.80E-06	1.93E-02	
12/20/2018	20	12.6	4.182666	21	0.977	6.75E-06	1.91E-02	

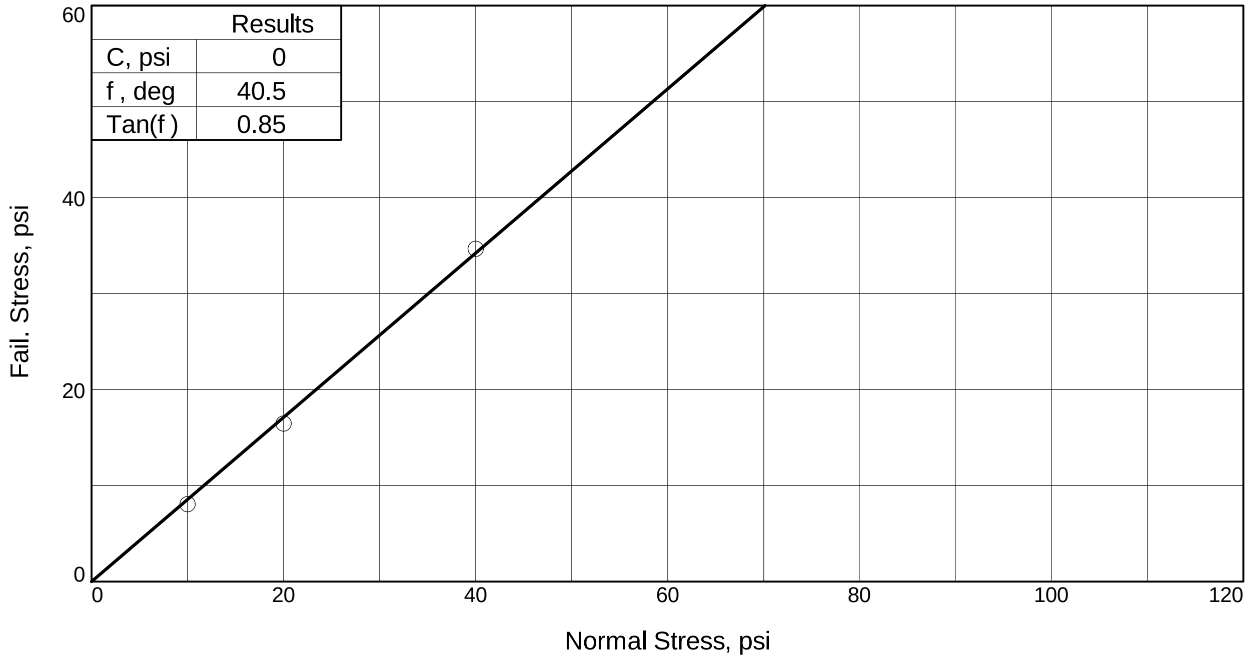
SUMMARY

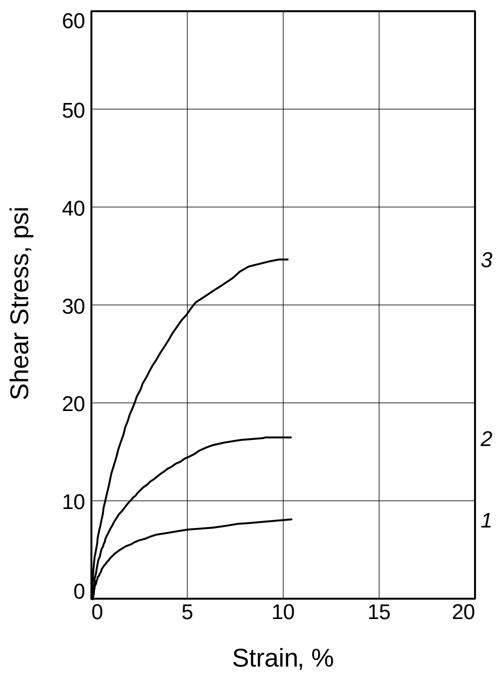
ka = 6.56E-06 cm/sec Acceptance criteria = 50 %

ki			Vm	
k1 =	6.20E-06	cm/sec	5.6	%
k2 =	6.50E-06	cm/sec	0.9	%
k3 =	6.80E-06	cm/sec	3.7	%
k4 =	6.75E-06	cm/sec	2.8	%

$$Vm = \frac{|ka-ki|}{ka} \times 100$$

Hydraulic conductivity	k =	**6.56E-06**	cm/sec	**1.86E-02**	ft/day
Void Ratio	e =	**0.52**			
Porosity	n =	**0.34**			
Bulk Density	g =	**2.04**	g/cm^3	**127.1**	pcf
Water Content	W =	**0.26**	cm^3/cm^3	(at 20 deg C)	
Intrinsic Permeability	k_{int} =	**6.72E-11**	cm^2	(at 20 deg C)	





Sample No.		1	2	3
Initial	Water Content, %	14.7	14.7	14.7
	Dry Density, pcf	110.8	110.8	110.8
	Saturation, %	76.1	76.1	76.1
	Void Ratio	0.5218	0.5218	0.5218
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	17.5	15.9	15.1
	Dry Density, pcf	114.3	117.8	119.5
	Saturation, %	99.7	99.5	99.2
	Void Ratio	0.4744	0.4312	0.4107
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.969	0.941	0.927
Normal Stress, psi		10.00	20.00	40.00
Fail. Stress, psi		8.08	16.43	34.65
Strain, %		10.4	9.1	10.2
Ult. Stress, psi				
Strain, %				
Strain rate, in./min.		0.004	0.004	0.004

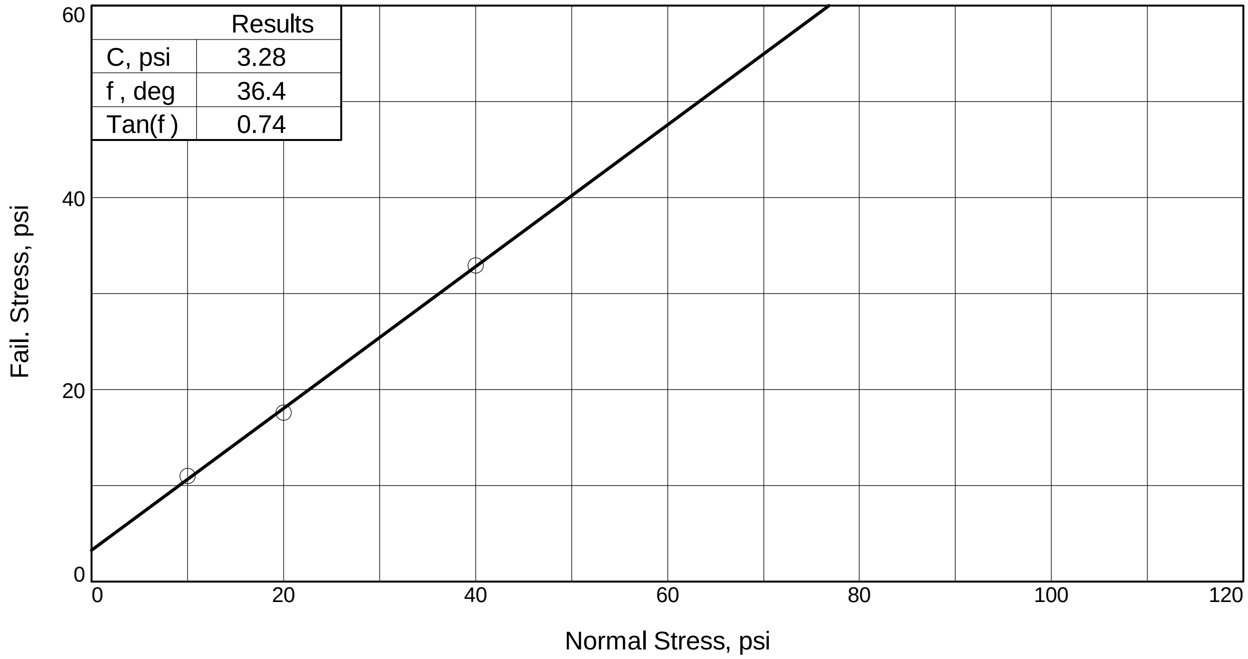
Sample Type: Remolded
Description: light brown silty sand with gravel (SM)
LL= 20 **PL=** 17 **PI=** 3
Assumed Specific Gravity= 2.7
Remarks: Compaction based on D698 efforts. Specimens remolded to 95% of maximum dry density and +2% of optimum moisture.

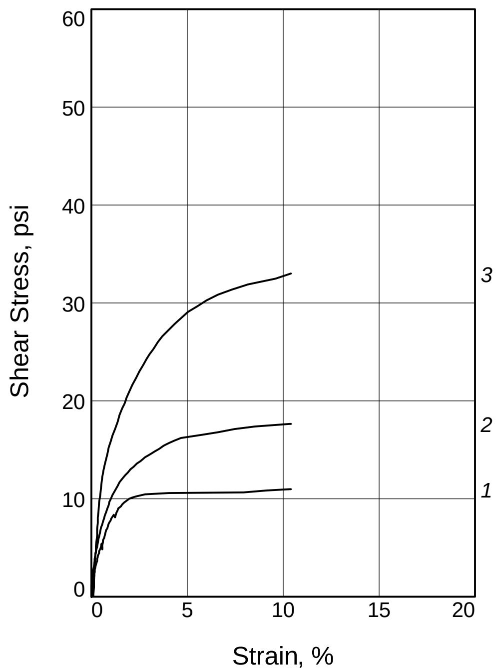
Client: Trammco Environmental Solutions LLC

Project: McCloy and Beckham Landfill

Source of Sample: BH-1 **Depth:** 0.0-65.0 ft
Sample Number: Composite
Proj. No.: A4187129 **Date Sampled:** N/A

DIRECT SHEAR TEST REPORT
Terracon Consultants, Inc.
Chattanooga, TN





Sample No.		1	2	3
Initial	Water Content, %	15.7	15.7	15.7
	Dry Density, pcf	109.8	109.8	109.8
	Saturation, %	79.2	79.2	79.2
	Void Ratio	0.5350	0.5350	0.5350
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	18.2	17.9	15.8
	Dry Density, pcf	112.4	113.6	117.5
	Saturation, %	98.2	100.0	98.1
	Void Ratio	0.4994	0.4833	0.4346
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.977	0.966	0.935
Normal Stress, psi		10.00	20.00	40.00
Fail. Stress, psi		10.96	17.61	32.97
Strain, %		10.4	10.3	10.4
Ult. Stress, psi				
Strain, %				
Strain rate, in./min.		0.005	0.005	0.005

Sample Type: Remolded
Description: light brown clayey sand (SC)

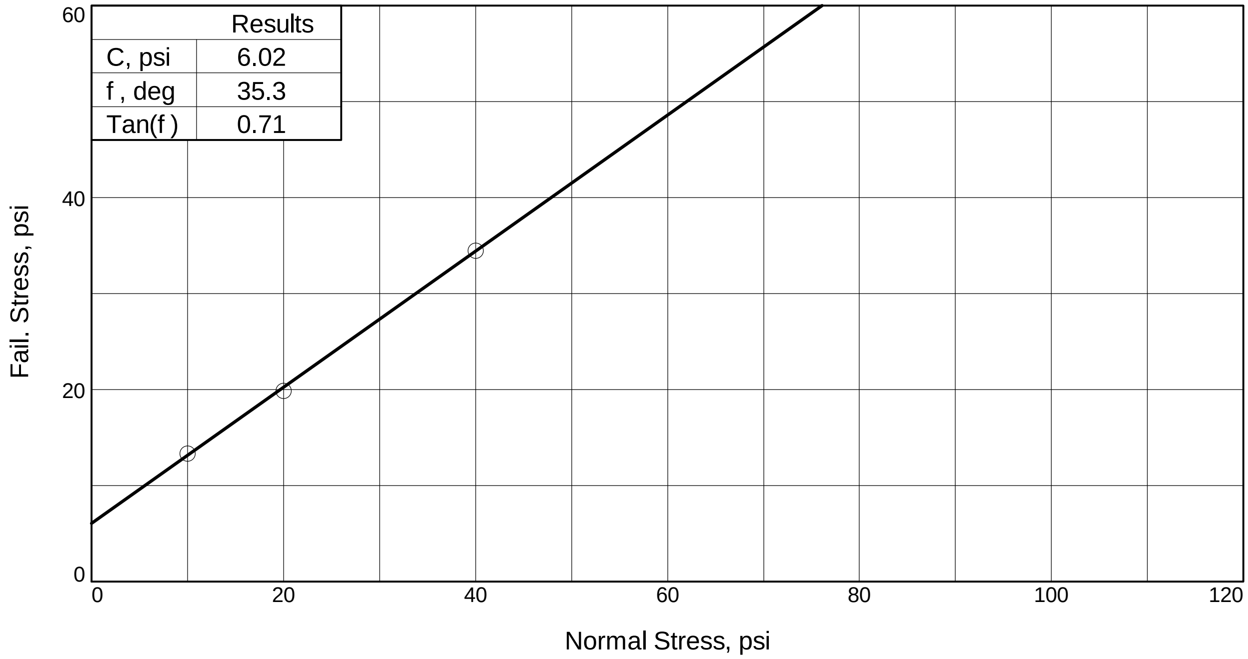
LL= 23 **PL=** 14 **PI=** 9
Assumed Specific Gravity= 2.7
Remarks: Compaction based on D698 efforts. Specimens remolded to 95% of maximum dry density and +2% of optimum moisture content.

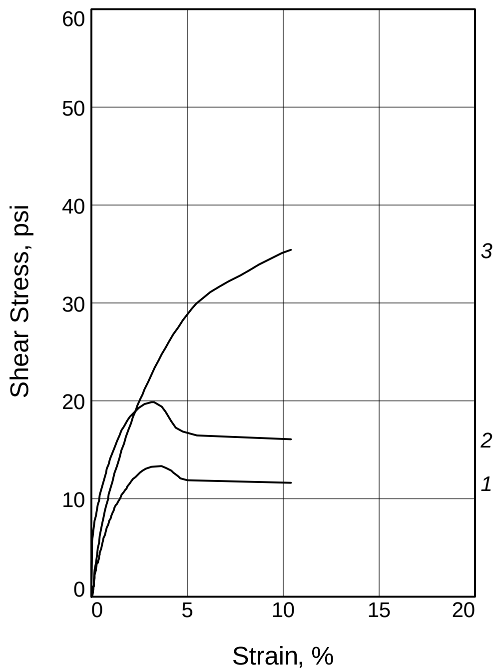
Client: Trammco Environmental Solutions LLC

Project: McCloy and Beckham Landfill

Source of Sample: BH-4 **Depth:** 0.0-20.0 ft
Sample Number: Composite 1
Proj. No.: A4187129 **Date Sampled:** N/A

DIRECT SHEAR TEST REPORT
Terracon Consultants, Inc.
Chattanooga, TN





Sample No.		1	2	3
Initial	Water Content, %	15.7	15.7	15.7
	Dry Density, pcf	108.1	108.1	108.1
	Saturation, %	75.7	75.7	75.7
	Void Ratio	0.5598	0.5598	0.5598
	Diameter, in.	2.500	2.500	2.500
	Height, in.	1.000	1.000	1.000
At Test	Water Content, %	19.8	18.8	16.0
	Dry Density, pcf	109.4	111.4	117.4
	Saturation, %	98.6	98.7	99.1
	Void Ratio	0.5409	0.5135	0.4355
	Diameter, in.	2.500	2.500	2.500
	Height, in.	0.988	0.970	0.920
Normal Stress, psi		10.00	20.00	40.00
Fail. Stress, psi		13.35	19.85	34.50
Strain, %		3.6	3.1	9.3
Ult. Stress, psi				
Strain, %				
Strain rate, in./min.		0.005	0.005	0.005

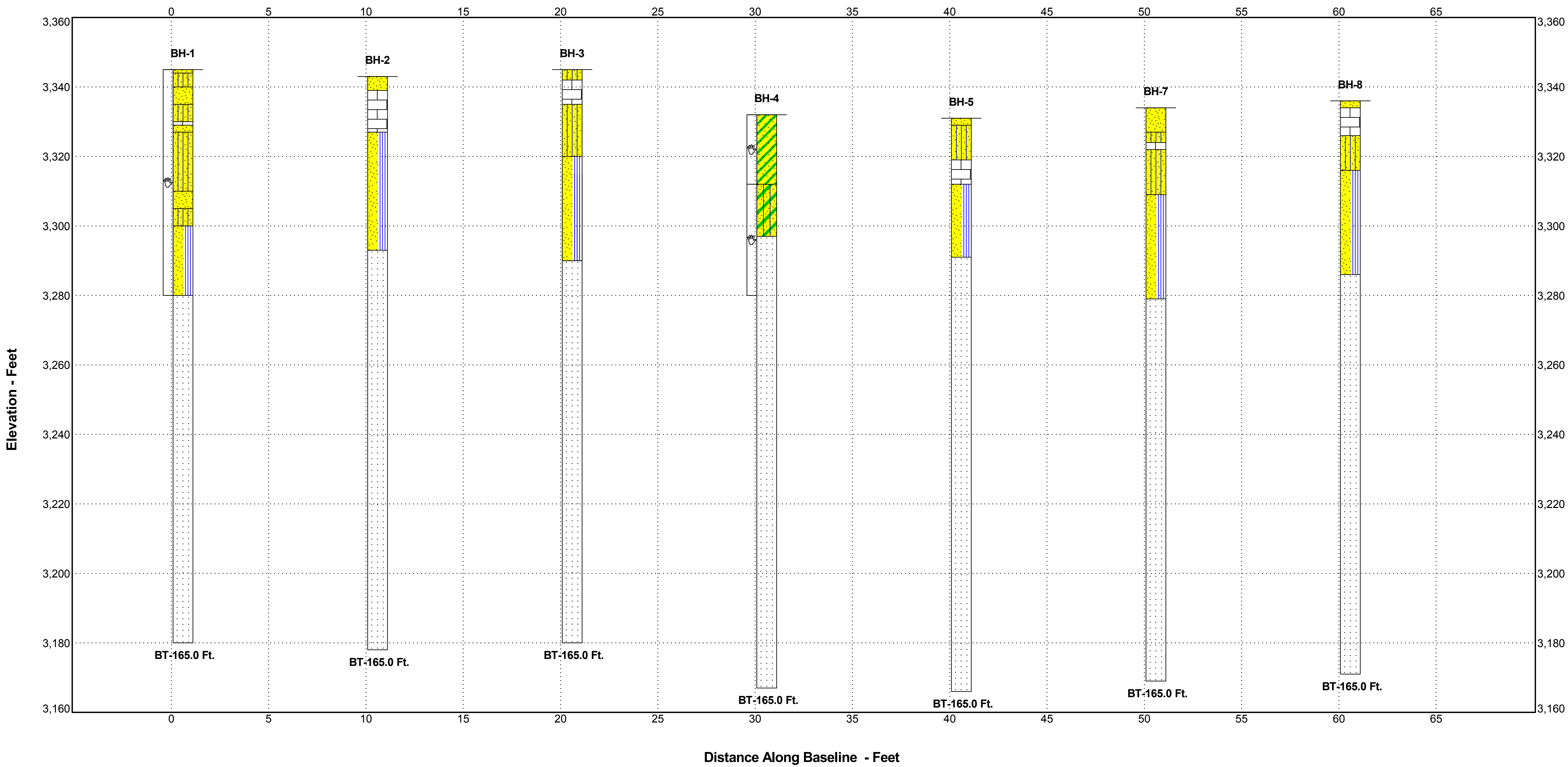
Sample Type: Remolded
Description: light brown silty, clayey sand (SC-SM)
LL= 25 **PL=** 18 **PI=** 7
Assumed Specific Gravity= 2.7
Remarks: Compaction based on D698 efforts. Specimens remolded to 95% maximum dry density and +2% of optimum moisture content.

Client: Trammco Environmental Solutions LLC

Project: McCloy and Beckham Landfill

Source of Sample: BH-4 **Depth:** 20.0-52.0 ft
Sample Number: Composite 2
Proj. No.: A4187129 **Date Sampled:** N/A

DIRECT SHEAR TEST REPORT
Terracon Consultants, Inc.
Chattanooga, TN



Poorly-graded Sand | Silty Sand | CALICHE - USGS Standard | Poorly-graded Sand with Silt | Sandstone

Clayey Sand | Silty Clayey Sand

Explanation

BH-1 — Borehole Number

Moisture Content — %w

LL PL — Liquid and Plastic Limits

Sampling (See General Notes)

Borehole Lithology

AR BT — Borehole Termination Type

Water Level Reading at time of drilling.

Water Level Reading after drilling.

NOTES:

See Exploration Plan for orientation of soil profile.
See General Notes in Supporting Information for symbols and soil classifications.
Soils profile provided for illustration purposes only.
Soils between borings may differ
AR - Auger Refusal
BT - Boring Termination

Project No.: A4187129	Terracon	**SUBSURFACE PROFILE**
Date: 1/15/2019	10400 State Highway 191 Midland, TX	MCCLOY RANCH LANDFILL SECTION 9 AND 10 OF, T25S, R34E JAL, LEA COUNTY, NEW MEXICO
Scale: N.T.S		

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. SMART FENCE A4187129 - MCCLOY SITE.GPJ TERRACON_DATATEMPLATE.GDT 1/15/19

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

McCloy Ranch Landfill ■ Jal, Lea County, New Mexico

January 25, 2019 ■ Terracon Project No. A4187129

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification: Group Symbol	Soil Classification: Group Name [B]
Coarse-Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3 [E]	GW	Well-graded gravel [F]
			Cu < 4 and/or 1 > Cc > 3 [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F, G, H]
			Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3 [E]	SW	Well-graded sand [I]
			Cu < 6 and/or 1 > Cc > 3 [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G, H, I]
			Fines classify as CL or CH	SC	Clayey sand [G, H, I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line	CL	Lean clay [K, L, M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K, L, M, N]
					Organic silt [K, L, M, O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K, L, M]
			PI plots below "A" line	MH	Elastic Silt [K, L, M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K, L, M, P]
					Organic silt [K, L, M, Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

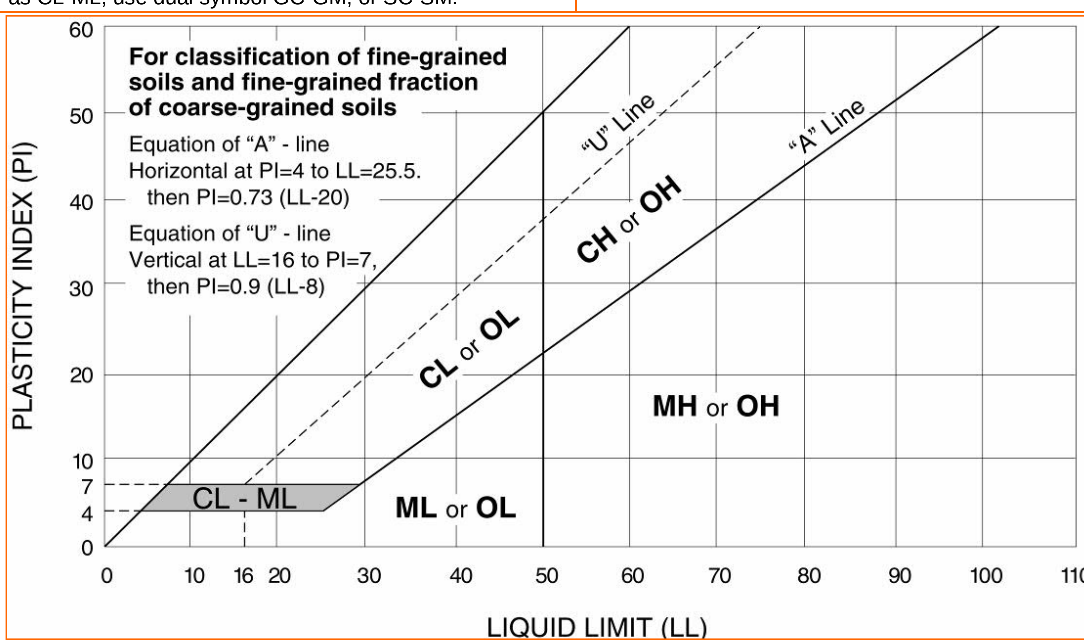
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



DESCRIPTION OF ROCK PROPERTIES

McCloy Ranch Landfill ■ Jal, Lea County, New Mexico

January 25, 2019 ■ Terracon Project No. A4187129

Terracon GeoReport

WEATHERING	
Term	**Description**
Unweathered	No visible sign of rock material weathering, perhaps slight discoloration on major discontinuity surfaces.
Slightly weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.
Moderately weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.
Residual soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.

STRENGTH OR HARDNESS		
Description	**Field Identification**	**Uniaxial Compressive Strength, psi (MPa)**
Extremely weak	Indented by thumbnail	40-150 (0.3-1)
Very weak	Crumbles under firm blows with point of geological hammer, can be peeled by a pocket knife	150-700 (1-5)
Weak rock	Can be peeled by a pocket knife with difficulty, shallow indentations made by firm blow with point of geological hammer	700-4,000 (5-30)
Medium strong	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer	4,000-7,000 (30-50)
Strong rock	Specimen requires more than one blow of geological hammer to fracture it	7,000-15,000 (50-100)
Very strong	Specimen requires many blows of geological hammer to fracture it	15,000-36,000 (100-250)
Extremely strong	Specimen can only be chipped with geological hammer	>36,000 (>250)

DISCONTINUITY DESCRIPTION			
Fracture Spacing (Joints, Faults, Other Fractures)		**Bedding Spacing (May Include Foliation or Banding)**	
Description	**Spacing**	**Description**	**Spacing**
Extremely close	< ¾ in (<19 mm)	**Laminated**	< ½ in (<12 mm)
Very close	¾ in – 2-1/2 in (19 - 60 mm)	**Very thin**	½ in – 2 in (12 – 50 mm)
Close	2-1/2 in – 8 in (60 – 200 mm)	**Thin**	2 in – 1 ft. (50 – 300 mm)
Moderate	8 in – 2 ft. (200 – 600 mm)	**Medium**	1 ft. – 3 ft. (300 – 900 mm)
Wide	2 ft. – 6 ft. (600 mm – 2.0 m)	**Thick**	3 ft. – 10 ft. (900 mm – 3 m)
Very Wide	6 ft. – 20 ft. (2.0 – 6 m)	**Massive**	> 10 ft. (3 m)

Discontinuity Orientation (Angle): Measure the angle of discontinuity relative to a plane perpendicular to the longitudinal axis of the core. (For most cases, the core axis is vertical; therefore, the plane perpendicular to the core axis is horizontal.) For example, a horizontal bedding plane would have a 0-degree angle.

ROCK QUALITY DESIGNATION (RQD) [1]	
Description	**RQD Value (%)**
Very Poor	0 - 25
Poor	25 – 50
Fair	50 – 75
Good	75 – 90
Excellent	90 - 100

1. The combined length of all sound and intact core segments equal to or greater than 4 inches in length, expressed as a percentage of the total core run length.

Reference: U.S. Department of Transportation, Federal Highway Administration, Publication No FHWA-NHI-10-034, December 2009 Technical Manual for Design and Construction of Road Tunnels – Civil Elements

DESCRIPTION OF ROCK PROPERTIES

McCloy Ranch Landfill ■ Jal, Lea County, New Mexico

January 25, 2019 ■ Terracon Project No. A4187129

Terracon GeoReport

WEATHERING	
Fresh	Rock fresh, crystals bright, few joints may show slight staining. Rock rings under hammer if crystalline.
Very slight	Rock generally fresh, joints stained, some joints may show thin clay coatings, crystals in broken face show bright. Rock rings under hammer if crystalline.
Slight	Rock generally fresh, joints stained, and discoloration extends into rock up to 1 in. Joints may contain clay. In granitoid rocks some occasional feldspar crystals are dull and discolored. Crystalline rocks ring under hammer.
Moderate	Significant portions of rock show discoloration and weathering effects. In granitoid rocks, most feldspars are dull and discolored; some show clayey. Rock has dull sound under hammer and shows significant loss of strength as compared with fresh rock.
Moderately severe	All rock except quartz discolored or stained. In granitoid rocks, all feldspars dull and discolored and majority show kaolinization. Rock shows severe loss of strength and can be excavated with geologist's pick.
Severe	All rock except quartz discolored or stained. Rock "fabric" clear and evident, but reduced in strength to strong soil. In granitoid rocks, all feldspars kaolinized to some extent. Some fragments of strong rock usually left.
Very severe	All rock except quartz discolored or stained. Rock "fabric" discernible, but mass effectively reduced to "soil" with only fragments of strong rock remaining.
Complete	Rock reduced to "soil". Rock "fabric" no discernible or discernible only in small, scattered locations. Quartz may be present as dikes or stringers.

HARDNESS (for engineering description of rock – not to be confused with Moh's scale for minerals)	
Very hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologist's pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately hard	Can be scratched with knife or pick. Gouges or grooves to ¼ in. deep can be excavated by hard blow of point of a geologist's pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16 in. deep by firm pressure on knife or pick point. Can be excavated in small chips to pieces about 1-in. maximum size by hard blows of the point of a geologist's pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces 1-in. or more in thickness can be broken with finger pressure. Can be scratched readily by fingernail.

Joint, Bedding, and Foliation Spacing in Rock [1]

Spacing	Joints	Bedding/Foliation
Less than 2 in.	Very close	Very thin
2 in. – 1 ft.	Close	Thin
1 ft. – 3 ft.	Moderately close	Medium
3 ft. – 10 ft.	Wide	Thick
More than 10 ft.	Very wide	Very thick

1. Spacing refers to the distance normal to the planes, of the described feature, which are parallel to each other or nearly so.

Rock Quality Designator (RQD) [1]

RQD, as a percentage	Diagnostic description
Exceeding 90	Excellent
90 – 75	Good
75 – 50	Fair
50 – 25	Poor
Less than 25	Very poor

1. RQD (given as a percentage) = length of core in pieces 4 inches and longer / length of run

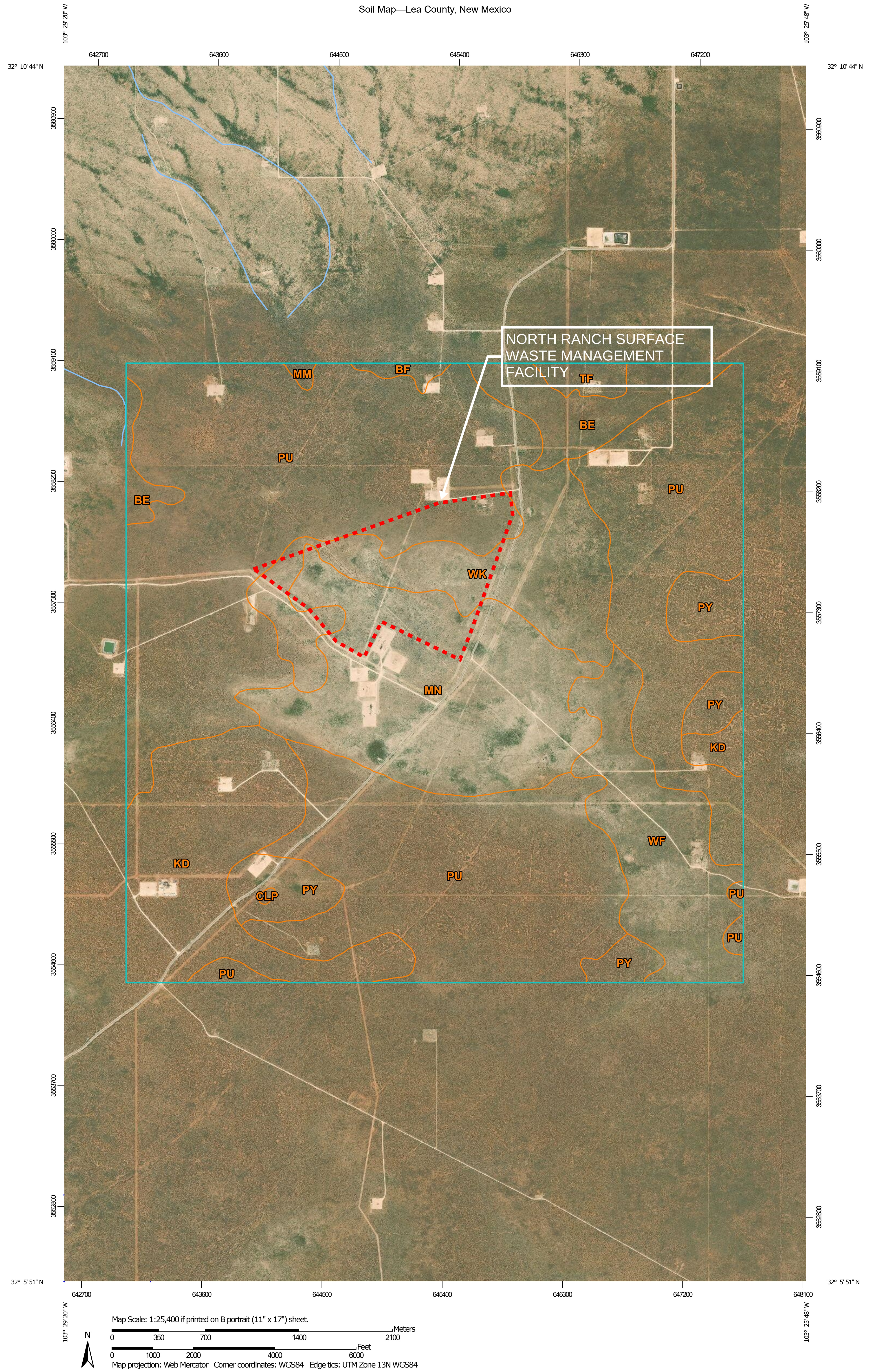
Joint Openness Descriptors

Openness	Descriptor
No Visible Separation	Tight
Less than 1/32 in.	Slightly Open
1/32 to 1/8 in.	Moderately Open
1/8 to 3/8 in.	Open
3/8 in. to 0.1 ft.	Moderately Wide
Greater than 0.1 ft.	Wide

References: American Society of Civil Engineers. Manuals and Reports on Engineering Practice - No. 56. Subsurface Investigation for Design and Construction of Foundations of Buildings. New York: American Society of Civil Engineers, 1976. U.S. Department of the Interior, Bureau of Reclamation, Engineering Geology Field Manual.

Attachment B

United States Department of Agriculture
Web Soil Survey Report


103° 29' 20" W
103° 25' 48" W
32° 10' 44" N
32° 5' 51" N
642700
643600
644500
645400
646300
647200
648100
3560900
3560000
3559100
3558200
3557300
3556400
3555500
3554600
3553700
3552800
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
MM
BF
TF
BE
PU
WK
PY
MN
KD
WF
CLP
Map Scale: 1:25,400 if printed on B portrait (11" x 17") sheet.
Meters
0 350 700 1400 2100
Feet
0 1000 2000 4000 6000
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Lea County, New Mexico
Survey Area Data: Version 15, Sep 12, 2018

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Sep 17, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BE	Berino-Cacique loamy fine sands association	195.6	3.7%
BF	Berino-Cacique fine sandy loams association	18.3	0.3%
CLP	Caliche pit	2.6	0.0%
KD	Kermit-Palomas fine sands, 0 to 12 percent slopes	547.4	10.4%
MM	Ratliff loam	7.4	0.1%
MN	Ratliff-Wink fine sandy loams	707.6	13.4%
PU	Pyote and maljamar fine sands	2,736.8	51.9%
PY	Pyote soils and dune land	222.3	4.2%
TF	Tonuco loamy fine sand, 0 to 3 percent slopes	36.0	0.7%
WF	Wink fine sand	372.4	7.1%
WK	Wink loamy fine sand	431.2	8.2%
Totals for Area of Interest		**5,277.6**	**100.0%**

Appendix J

North Ranch Surface Waste Management Facility Design and Construction Plan

Engineering Design Report

North Ranch Surface Waste Management Facility
Lea County, New Mexico

September 2019
Project No. 35187378

Prepared for:
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3773 Cherry Creek Dr., Suite 1000
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303-815-1010

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Attachments

Attachment A Run-on and Run-off Surface Water Management Report
Attachment B Revised Universal Soil Loss Equation (RUSLE) Calculation
Attachment C Leachate Evaporation Pond Sizing – Incidental Precipitation Volume
Attachment D Hydraulic Evaluation of Landfill Performance (HELP) Report
Attachment E Liner System Design Calculations
Attachment F Leachate Pipe Design Calculations
Attachment G Slope Stability Analysis
Attachment H Construction Quality Assurance Plan

1.0 INTRODUCTION

This engineering design report (EDR) was prepared by Terracon Consultants, Inc. (Terracon) for NGL Waste Services, LLC (NGL) to support the Permit Application for the proposed North Ranch Surface Waste Management Facility (Facility) located near Jal, Lea County, New Mexico. The following sections and appendices provide backup engineering calculations and documentation for the proposed landfill configuration as presented on the permit drawings in **Appendix K** of the Permit Application (PA).

1.1 Regulatory Oversight

Due to its function the Facility will be regulated by New Mexico Administrative Code, Title 19 – Natural Resources and Wildlife, Chapter 15 – Oil and Gas, Part 36 – Surface Waste Management Facilities, or 19.15.36. The Facility is defined as a commercial landfill facility by **19.15.36.7.A(2)** and **(4)** accepting exempt oil field waste from nearby oil field development customers. In general, this EDR will focus on providing the engineering calculations and documentation to satisfy design requirements specified in **19.15.36.14.C** – **19.15.36.14.F**. In addition, NGL proposes to manage and dispose of the Facility's leachate with an evaporation pond. Therefore, this EDR will also provide engineering calculations for the proposed evaporation pond in compliance with **19.15.36.17.A** and **19.15.36.17.B**.

1.2 General Facility Description

The Facility consists of approximately (~) 303 acres of which ~205 acres will be dedicated for lined landfill disposal cells. The remaining ~98 acres consists of a ~26-acre entrance and waste acceptance area including an ~2.2-acre leachate evaporation pond; ~12.5 acres making up three stormwater retention ponds; and ~57.3 acres of ancillary space for perimeter roadways, drainage channels and landfill structural berms.

The landfill area will be subdivided in to three phases. Phase 1 will have six disposal cells ranging in size from 9.6 acres to 28.2 acres for a total disposal area of ~111 acres. Phase 2 will have five disposal cells ranging in size from 11.8 acres, to 24.7 acres for a total disposal area ~88.5 acres. Phase 1 and 2 have maximum depths below existing grade of ~50-feet. Phase 1 and 2 are separated by ~100 feet. During operation of the Phase 1 and 2 this area will be used for roadways and drainage channels. However, upon completion of Phase 1 and 2 this separation area and the valley between the Phase 1 and 2 waste slopes will be developed into Phase 3. Phase 3 will fill the valley between Phases 1 and 2 and ultimately reach the proposed final elevations.

Each of the Phase 1 and 2 disposal cells will be separated by a 4-foot tall soil divider berm. All disposal areas will be lined with a multilayered geosynthetic liner system with both leachate collection and recovery and leak detection systems. Final waste surfaces will be covered with a geosynthetic and soil based final cover system. Full descriptions of the liner and cover systems are provided in this EDR. Ultimately the proposed configuration of the landfill area will result in a total design operational capacity (waste and routine soil) of ~40,264,324 Cubic Yards (CY).

Detailed design of the Facility is presented within this EDR and attached including supporting calculations and analyses.

2.0 PROPOSED FACILITY DESIGN

2.1 Landfill Geometry

In general compliance with **19.15.36.14.C** and **19.15.36.14.D**, all landfill cells have been designed with 3H:1V side slopes. Each cell floor will be graded at a minimum of 2% laterally to a center leachate collection pipeline which is sloped at 2% towards a central leachate collection sump. The liner system and leachate collection lines will be protected with 2-feet of protective soil, see Section 2.7 for greater details regarding the liner system design. Cell depths ranging from eight (8) at the high end of the cell to 71 feet at the leachate collection sump, the maximum excavation depth below existing grade is ~48 feet. The intermediate, final waste and final cover slopes will be nominally 4H:1V and the top deck will have a minimum grade of 4%. The final cover system will include 2.5 feet of soil over the liner system. The landfill will have a maximum final waste grade of 3,541.0 feet above mean sea level (AMSL), and maximum final cover grade will be 3,543.5 feet AMSL. See **Permit Drawings** in **Appendix K** of the PA for visual representation of the proposed geometry.

2.2 Landfill Design Capacity

The following Table 2.1 provides the design operational capacity (waste and routine and intermediate soil cover), routine and intermediate soil cover volume assuming 15% soil to waste ratio, and waste capacity of each disposal cell, phase and overall landfill. Per-cell capacities assume an intermediate waste fill slope of 4V:1H and that fill sequencing occurs as shown on **Drawing 24** of **Appendix K** of the PA. Operational capacities were calculated using AutoDesk© Civil3D® 2019 (Civil 3D) software.

designed to collect the peak flow from the design storm event for the entire potential run-off area.

Attachment A provides a detailed report of the SSA and TR-55 analysis, including figures and modeling results.

2.5 Erosion Loss (RUSLE)

The purpose of the erosion calculation is to determine potential soil losses due to rainfall erosion under closure conditions. Using the Revised Universal Soil Loss Equation (RUSLE), projected soil loss from rainfall is approximately 4.96 tons/acre/year (t/a/y), which is below the NRCS established criterion of 5.0 t/a/y. Detailed RUSLE calculations are provided in **Attachment B**.

2.6 Leachate Evaporation Pond Geometry and Sizing

Geometry
A proposed leachate evaporation pond (LEP) is to be located near the site entrance in the northeast portion of the Facility. In general, the LEP geometry is in compliance with **19.15.36.17.A** and **19.15.36.17.B** having 3H:1V side slopes and a floor sloped laterally at 2% towards a central leak detection sump. In addition, the LEP has a 2-3-foot-high perimeter berm to prevent external surface water intrusion. The LEP plan footprint is approximately 2.25 acres with depths varying from 3.25 feet – 13.3 feet, with a 2-foot deep leak detection sump at the lowest point.

The LEP was sized assuming a worst-case condition defined as follows:

- Assumes the Facility will only construct and operate one disposal cell at a time. In this case:
- The largest Cell (E-3, 28.2 acres) has been constructed and hasn't received waste.
- Run-off from the intermediate 4H:1V waste slope from the previous Cell (E-2) is draining into the new cell (E-3) leachate collection system.
- Little to no waste has been placed over the new cell's liner system.

Under this condition leachate generation is governed by incidental precipitation, thus two calculation methods to determine the require storage in the LEP are considered:

- 25-year, 24-hour precipitation volume incidental to the open area defined above, which totals to 37.3 acres.
- Leachate generation from the open cell (28.2 acres).

To be conservative, the LEP is sized to fully contain the greater of the volumes generated from the two sources. **Attachment C** provides a TR-55 run-off volume calculation from the 37.3-acre

Table 2.1 Design Capacity Summary

Cell	Operational Capacity (CY)	Routine and Intermediate Soil Cover [10% of Operational Waste Capacity] (CY)	Waste Capacity [90% of Operational Capacity] (CY)
	PHASE 1		
E-1	933,202	93,320	839,882
E-2	2,111,021	211,102	1,899,919
E-3	5,116,491	511,649	4,604,842
E-4	3,939,124	393,912	3,545,212
E-5	3,840,751	384,075	3,456,676
E-6	2,564,850	256,485	2,308,365
PHASE 1	**18,505,439**	**1,850,543**	**16,654,896**
	PHASE 2		
W-1	1,108,726	110,873	997,853
W-2	1,322,275	132,228	1,190,048
W-3	2,075,688	207,569	1,868,119
W-4	4,148,670	414,867	3,733,803
W-5	4,679,514	467,951	4,211,563
PHASE 2	**13,334,873**	**1,333,493**	**12,001,391**
PHASE 3	**8,424,012**	**842,401**	**7,581,611**
TOTAL	**40,264,324**	**4,026,432**	**36,237,892**

2.3 Site Soil Balance

Landfill cell construction, routine operations, and closure will require large quantities of soil over the life of the landfill. The proposed Facility-wide grading plan shown in the **Permit Drawings** in **Appendix K** of the PA, which includes all grading activities for landfill cells, roads, stormwater infrastructure (channels and ponds), and the leachate evaporation pond, will generate soils for these activities. Table 2.2 below summarizes the soil balance for known operational and construction activities through buildout of the Facility. All cut and fill volumes provided in Table 2.2 are calculated using Civil 3D.

Table 2.2 Soil Balance Summary

Area	Cut (CY)	Fill (CY)
Facility Wide Grading	8,166,740	514,465
Phase 1 Base Liner Protective Cover	0	357,923
Phase 2 Base Liner Protective Cover	0	292,892
Phase 3 Base Liner Protective Cover	0	19,522
Operational Cover (Routine and Intermediate, From Table 2.1)	0	4,026,432
Final Cover System	0	1,495,694
TOTALS	**8,166,740**	**6,706,928**
FACILITY SOIL BALANCE = +1,459,812 EXCESS SOIL		

2.4 Stormwater Management System

The proposed surface-water management system for both run-on and run-off for the Facility is shown on the **Permit Drawings** in **Appendix K** of the PA. The proposed configuration of the run-off management system was modeled in AutoDesk© Storm and Sanitary Analysis® 2019 (SSA) software. The run-on management system has been sized using the USDA, NRCS, Technical Release 55 (TR-55) method. Both the SAA and TR-55 simulated the 25-year, 24-hour storm (design storm) event for the Lea County, New Mexico area.

Facility Storm Run-off Management System Design

All proposed stormwater run-off conveyance structures (channels, berms, letdowns, culverts) have been designed to handle the peak flow from the design storm. The three stormwater ponds have been designed to retain at least the total run-off volume from the design storm. The Facility also has a 2-foot earth berm at the permit boundary to retain onsite any potential storm pond over flow during greater storm events. In short, the Facility has been designed to be a non-discharging facility.

Facility Run-on Management System Design

The run-on drainage area is potentially a 5,555-acre area northwest of the Facility. It is likely that only a small portion of the potential run-on area impacts the Facility perimeter. However, to area indicating that 8.5 acre-feet of storage is required to contain incidental precipitation volume. A Hydraulic Evaluation of Landfill Performance (HELP) analysis was performed to determine the leachate generation rate from the open cell. The HELP analysis indicated that ~2.8 acre-feet annually of leachate is collected over the liner and would be required to contain the leachate generation volume from the largest cell (Cell E-3) when it is open with no waste over the liner. This required capacity diminishes as waste thickness is increased over the liner system. A HELP analysis summary memo and results are provided in **Attachment D**. In either case, the LEP must also provide storage for incidental precipitation over the 2-acre pond footprint, requiring an additional 0.77 acre-feet.

Therefore, the LEP has a design storage capacity of 9.3 acre-feet. The LEP will also have three feet of freeboard above the design waterline which is not included in the design capacity. This complies with **19.15.36.17.B(12)** requiring three feet of freeboard and **19.15.36.17.B(12)** limiting the maximum size of evaporation ponds to 10 acre-feet.

2.7 Base Liner System

The Facility is proposing two base liner systems one for the landfill cells and one for the leachate evaporation pond. Details showing the bottom liner systems can be found in the **Permit Drawings** in **Appendix K** of the PA.

The typical landfill liner system will consist of (from bottom to top):

- A prepared subgrade layer on the cell floor and on the side slopes to provide a smooth surface for geosynthetic deployment;
- Low Permeability Clay Base Layer. The field geologic/hydrogeological investigation (See **Appendix I** of the PA) generally characterized the potential excavated soil as sandy with permeabilities ranging from 1.09×10^{-6} cm/sec to 6.5×10^{-5} cm/s. Thus, this soil is not favorable for a compacted clay liner. In addition, groundwater was not encountered within 100 feet of the lowest proposed landfill cell elevation. Therefore, NGL proposes to install a geosynthetic clay liner (GCL) in lieu of the prescriptive base layer (**19.15.36.14.C(1)**) two-feet of compacted clay with hydraulic conductivity of 1×10^{-7} cm/s or less. GCLs are commonly installed in landfill liner systems as an alternative to compacted clay in similar conditions, and have hydraulic conductivities as low as 1×10^{-8} – 1×10^{-10} cm/s (Daniel 1993)
- A secondary 60-mil thick textured high-density polyethylene (HDPE) geomembrane liner, in compliance with **19.15.36.14.C(2)**;
- Leak detection drainage layer. For ease of construction and to maximize potential landfill airspace, NGL proposes using a 200-mil HDPE bi-planar geonet composite (Geocomposite) leak detection drainage layer in lieu of the prescriptive (**19.15.36.14.C(3)**) two feet of compacted soil with a hydraulic

conductivity of $1x10^{-5}$ cm/s or greater. Drainage geocomposites consist of a biplanar geonet with geotextile filters heat bonded to both sides and are commonly installed in landfill liner leak detection systems as an alternative to a soil drainage layer due to their superior hydraulic performance obtaining hydraulic conductivities of up to 10 cm/s. The geocomposite, in conjunction with the textured geomembrane, also provides additional friction for greater slope stability;

- A primary 60-mil thick textured HDPE geomembrane liner in compliance with **19.15.36.14.C(4)**);
- Leachate collection and removal system. For ease of construction and to maximize potential landfill airspace, NGL proposes 200-mil HDPE bi-planar geocomposite leachate drainage layer in lieu of the prescriptive (**19.15.36.14.C(5)**) two-feet of compacted soil with a hydraulic conductivity of $1x10^{-2}$ cm/s or greater. This concept provides a high transmissivity (K up to 10 cm/s) blanket over the entire cell rather than intermittent collection laterals, giving greater leachate collection coverage;
- 2-feet of highly permeable protective cover soil, $1x10^{-2}$ cm/s or greater, in compliance with (**19.15.36.14.C(6)**).

The typical leachate evaporation pond liner system will consist of (from bottom to top):

- A prepared subgrade layer on the cell floor and on the side slopes to provide a smooth surface for geosynthetic deployment;
- Secondary 60-mil thick HDPE geomembrane liner, in compliance with **19.15.36.17.B(8)**.
- Leak detection drainage layer. For ease of construction, NGL proposes a 200-mil Geocomposite leak detection drainage layer in lieu of the prescriptive (**19.15.36.17.B(9)**) two-feet of compacted soil with a hydraulic conductivity of $1x10^{-5}$ cm/s or greater. Geocomposites are commonly installed in leak detection systems as an alternative to soil drainage layers due to their superior hydraulic performance obtaining hydraulic conductivities of up to 1-5 cm/s;
- Primary 60-mil thick textured HDPE geomembrane liner in compliance with **19.15.36.17.B(7)**).

See **Attachment D** for a HELP model demonstrating equivalent performance to the prescriptive base line system defined in **19.15.36.14.C**. The modeling was performed in two tiers as directed by the New Mexico Environmental Department guidance document; *Performance Demonstration for an Alternative Cover Design Under Section 502.A.2 of the New Mexico Solid Waste Regulations (20 NMAC 9.1) Using HELP Modeling.* Tier 1 of the modeling first demonstrates the alternative liner's equivalent performance to the prescriptive liner and compliance with maintaining no more than 12-inches over the liner under open cell conditions. Tier 2 of the modeling demonstrates the alternative liner's performance under four operational conditions: open, partially filled, completely filled and closed with no established vegetation, and completely filled and closed with established vegetation. Tier 2 demonstrates that in all conditions no liquids will percolate through the liner and into the subsurface, thus protective of groundwater.

See **Attachment E** for liner design calculations of the following:

- E1 - Foundation and Waste Settlement and resulting tensile stresses on the base liner and final cover systems
- E2 - Tensile Stress due to equipment loading
- E3 - Anchor trench pullout
- E4 - Geocomposite performance under overburden compression

2.8 Leachate and Leak Detection Collection and Recovery System

Landfill

The leachate and leak detection collection and recovery systems follow identical flow paths. Leachate generated from each landfill cell and leaks (if any) through the primary liner will flow through the associated lateral geocomposite drainage layer sloped at a minimum of 2% and directed towards a leachate and leak detection collection sump. The leachate collection system incorporates a perforated six-inch HDPE SDR-11 collection pipe embedded in a gravel trench one foot deep, generally along the cell centerline, with flow towards and terminating in the leachate collection sump.

The leachate collection sumps have a top dimension of 35 feet by 35 feet and are two feet deep with 3H:1V side slopes. The leak detection sumps sit directly below the leachate collection sumps and are a continuation of the leachate sump geometry another two feet deeper. The leachate sump and leak detection sump are separated by the 60-mil HDPE primary geomembrane. Each sump is equipped with an 18-inch HDPE SDR-17 leachate pump side-slope riser pipe, a 6-inch HDPE SDR-11 collection line cleanout riser, and a 12-inch HDPE SDR-17 leak detection witness riser. The riser pipes will be embedded into a side-slope trench for protection of the pipes and the liner system. The risers will daylight at the top of landfill cell slope and be protected by a concrete headwall and capped with blind flanges. The 18-inch riser will be equipped with a submersible pump that will transfer the liquids collected in the sump via a flexible hose to a 4-inch force main/carrier pipe. The force 4-inch main/carrier pipe will transfer the liquids to the on-site leachate evaporation pond. A typical pump cycle stroke that the operator may use is ON at 6-inches, OFF at 20-inches, HIGH ALARM at 22-inchs, and HIGH-HIGH ALARM at 24-inchs. The operator may alter this pump stroke as needed by operations. The HIGH ALARM typically will illuminate a beacon and/or sound an audible alarm until the level drops. The HIGH-HIGH ALARM will be equipped with an auto dialer that will notify the site manager so that the liquid level can be managed and reduced.

Leachate Evaporation Pond

The leak detection collection and recovery system for the leachate evaporation pond will collect leaks (if any) through the primary liner. Liquids collected will flow through the associated lateral geocomposite drainage layer sloped at a minimum of 2% and directly towards a leachate and leak detection collection sump.

The leak detection collection sump has a top dimension of 20-feet by 20-feet and is 2-feet deep with 3H:1V side slopes. The sump is equipped with a 12-inch HDPE SDR-17 leak detection witness riser.

Details I-O of the Permit Drawings in **Appendix K** of the PA depict the general configuration of the leachate and leak detection systems for both the landfill cells and the leachate evaporation pond.

See **Attachment E** for pipe design calculations of the following:

- Leachate Pipe Size and Perforation Design
- Drainage Rock sizing and Bedding Strain
- Pipe Ring Deflection
- HDPE pipe wall buckling under waste compression
- HDPE pipe wall crushing under waste compression

2.9 Final Cover System

Final waste slopes will be no steeper than 4H:1V. A final cover system will be installed over the final waste surface which will include surface-water control berms that will be constructed on the final cover system with approximately 25 ft. of vertical spacing between benches. While the interior of the berms will be 4H:1V, the exterior bench slope will be 3H:1V. The berms will be directed to rip-rap lined let-down structures built into the final cover system. The typical final cover system for the landfill will consist of (from top to bottom):

- A soil erosion/vegetation layer composed of at least 12-inches of vegetated soil. A 70% coverage of at least two native grasses shall be maintained in accordance with the post closure provisions of 19.15.36.18.C.2.b. The seed list shall conform to the most recent list from NMDOT Revegetation Zone 5 – Southern Desertic Basins, Plains, and Mountains.
- A compacted soil infiltration barrier layer composed of at least 36-inches of soil with a permeability of 1x10-5 cm/s or less.
- A compacted soil intermediate cover layer composed of at least 12-inches of soil with a permeability of 1x10 5 cm/s or less.

See **Attachment D** for a HELP model demonstrating equivalent performance to the prescriptive base line system defined in **19.15.36.14.C**. The modeling was performed in two tiers as directed by the New Mexico Environmental Department guidance document; *Performance Demonstration for an Alternative Cover Design Under Section 502.A.2 of the New Mexico Solid Waste Regulations (20 NMAC 9.1) Using HELP Modeling.* Tier 1 of the modeling first demonstrates the alternative liner's equivalent performance to the prescriptive liner and compliance with maintaining no more than 12-inches over the liner under open cell conditions. Tier 2 of the modeling demonstrates the alternative liner's performance under four operational conditions: open, partially filled, completely filled and closed with no established vegetation, and completely filled and closed with established vegetation. Tier 2 demonstrates that in all conditions no liquids will percolate through the liner and into the subsurface, thus protective of groundwater. All HELP model simulations assumed that native soils can achieve a compacted hydraulic conductivity of at least $1x10^{-5}$ cm/s based on the permeability testing results of onsite soils presented in **Attachment A of Appendix I** of the Permit Narrative. When approaching a closure selected stockpiles or borrow areas to be used for closure material will be sampled and tested. If testing results in a permeability greater than $1x10^{-5}$ cm/s the alternative cap thickness shall be adjusted accordingly at that time to maintain equivalent performance.

2.10 Slope Stability Analysis

Terracon has performed a comprehensive slope stability analysis of the cell excavation side slopes, base liner configuration, final waste slopes, and final cover system configuration as defined in previous sections. This analysis was performed using Geo-Slope International SLOPE-W® software. In summary, the 3H:1V excavation slope is stable upon placement of the base liner system with a minimum factor of safety of 1.6 in the Phase 2 critical slope. The 4H:1V waste fill slopes and final cover system are stable with a minimum factor of safety of 2.3 on the Phase 2 critical slope. Please see **Attachment G** for a comprehensive slope stability report and summary of modeling results.

3.0 19.15.36 DESIGN COMPLIANCE SUMMARY

The New Mexico design criteria for surface waste management landfills are contained in **19.15.36.14** and the design criteria for leachate evaporation ponds are contained in **19.15.36.17**. The following discussion lists the design criteria contained in these regulations and how the proposed Facility design complies.

Landfill Base Liner Design Requirements:

19.15.36.14.C Landfill Design Specification

As discussed in Sections 2.7 – 2.9, the proposed landfill has been designed with the required components.

19.15.36.14.C(1) Base Layer

As discussed in Section 2.7, due to the absence of suitable clayey materials onsite, and the groundwater setting, NGL proposes an alternative base layer consisting of a reinforced geosynthetic clay liner. Typical GCLs specified for landfill liner systems have hydraulic conductivities less than $1x10^{-9}$ cm/s (EPA 2001).

19.15.36.14.C(2) Lower Geomembrane

As discussed in Section 2.7, the lower membrane shall consist of 60-mil HDPE, in compliance with this regulation.

19.15.36.14.C(3) Leak Detection System

As discussed in Sections 2.6 - 2.8 NGL proposes to install an alternative leak detection system comprised of a 200-mil HDPE geocomposite blanket drainage collection system in lieu of soil and piping as prescribed. HDPE has high chemical resistance to oil field wastes and the leak detection system is sloped at 2% in the lateral direction compliant with this regulation.

19.15.36.14.C(4) Upper Geomembrane

As discussed in Sections 2.7 the upper membrane shall consist of 60-mil HDPE, in compliance with this regulation.

19.15.36.14.C(5) Leachate Collection and Removal System

As discussed in Sections 2.6 - 2.8 NGL proposes to install an alternative leachate collection and removal system comprised of a 200-mil HDPE Geocomposite blanket drainage collection system in lieu of soil and piping as prescribed.

In compliance with this regulation, HDPE is the material proposed for geomembrane and piping, which has high chemical resistance and is proven to withstand attack from oil field wastes. The leachate collection and removal systems are sloped at 2% in the lateral direction. The central collection trench pipe is a perforated 6-inch HDPE pipe, which will be protected by a drainage rock backfill and equipped with a solid cleanout riser embedded into a side slope riser trench. The leachate is collected in a centralized sump and conveyed to a leachate evaporation pond outside of landfill perimeter within a 4-inch double-walled HDPE force main.

19.15.36.14.C(6) Liner Protection Layer

As discussed Section 2.7 the liner system will be overlain with two-feet of protective soil cover with a saturated hydraulic conductivity of $1x10^{-2}$ cm/s or greater, in compliance with this regulation.

Landfill Final Cover System Design Requirements:

19.15.36.14.C(8) Final Cover System

As discussed in Section 2.6, 2.7, and 2.9, the final waste slopes shall not exceed 4H:1V or be less than 4% in compliance with this regulation. The final cover system shall include an alternative final cover system as defined in **Section 2.**

19.15.36.14.C(9) Alternative materials

NGL is proposing the use of reinforced GCL as the base foundation layer in place of two feet of compacted clay and 200-mil HDPE geocomposite in place of high permeability soils for drainage. **Attachment E** provides a demonstration of geocomposite hydraulic performance under these conditions.

19.15.36.14.C(10) External Piping

All leachate and leak detection riser piping will be installed along the side slopes of the cells in compliance with this regulation. Liner penetrations are not proposed.

19.15.36.14.D(1) Liner Specifications and Requirements - Geomembranes

(a) In compliance with this regulation, all geomembranes are specified as 60-mil textured HDPE. HDPE geomembranes have published permeabilities as low as $1x10^{-15}$ cm/s (Webber 2005) and have high chemical resistance with proven resistance to hydrocarbons, salts, acidic and alkaline solutions. HDPE also has a high UV resistance when exposed to sunlight.

(b) As provided in **Attachment E,** the membrane is designed to withstand projected stresses and settling from overlying waste and equipment operations.

(c) As designed, the base liner system maintains a minimum 2% lateral slope to promote positive drainage and to facilitate leachate collection and leak detection.

19.15.36.14.D(2) Liner Specifications and Requirements – Additional Geomembrane Requirements

(a) HDPE geomembranes have published and field proven high chemical resistance with resistance to chemical attack from oil field waste and resulting leachate.

(b) The base liner system has a maximum slope of 3H:1V which has been shown to be stable in the slope stability analysis in **Attachment G,** which considers the soil-geosynthetic and geosynthetic-geosynthetic interface friction angles.

(c) In general, all HDPE liner systems will be installed in compliance with this regulation as specified in the Construction Quality Assurance Plan provided in **Attachment H**.

19.15.36.14.E Requirements for Soil Components

(1) The prepared subgrade for the base liner system will be compacted to at least 90% standard Proctor (ASTM D-698), see **Attachment H**.

(2) All soil surfaces to receive geosynthetics will be prepared in compliance with this regulation, See **Attachment H.**

(3) As previously discussed, NGL proposes to replace the compacted clay foundation layer with a reinforced GCL, thus this regulation in not applicable.

19.15.36.14.F Soil Material Requirements for the Leachate Collection and Recovery System and Leak Detection System

(1) As previously discussed, NGL proposes to replace the prescribed soil drainage materials with a 200-mil HDPE geocomposite, thus this regulation in not applicable.

19.15.36.14.G Landfill Gas Control System

NGL is not required to, nor is proposing to install a landfill gas control system for this landfill at this time.

Leachate Evaporation Pond (LEP) Construction Standards:

19.15.36.17.A Engineering Design Plan

This EDR includes design information for the LEP and its liner system, which is certified by Michael Bradford, P.E. The overall PA for the Facility incorporates and integrates the LEP operation and maintenance procedures (**Appendices D** and **E** of the PA), closure planning (**Appendix G** of the PA), and hydrologic information (**Appendix I** of the PA). Thus, the overall PA demonstrates compliance with this regulation.

19.15.36.17.B Construction Standards

(1) The LEP has been designed as prescribed in the Regulations, thus protective of fresh water, public health, and the environment.

(2) The proposed LEP is designed with a primary and secondary 60-mil HDPE geomembrane with a leak detection layer between them.

(3) In compliance with this regulation, the primary and secondary liners are specified as 60-mil textured HDPE. HDPE geomembranes have published permeabilities as low as $1x10^{-15}$ cm/s (Webber 2005) and have high chemical resistance with proven resistance to hydrocarbons, salts, acidic and alkaline solutions. HDPE with carbon black also has a high UV resistance when exposed to sunlight.

(4) NGL is proposing to use 200-mil HDPE geocomposite in place of high permeability soils for drainage. **Attachment E** provides a demonstration of geocomposite hydraulic performance under these conditions.

(5) As discussed in Section 2.6 and **Attachment H,** the pond has been designed and will be constructed in compliance with this regulation.

(6) The discharge point of the leachate force main into the pond will be reinforced to protect the liner system from excessive hydrostatic force. No liner penetrations are proposed.

(7) As discussed in Section 2.7 the primary liner shall consist of 60-mil HDPE, in compliance with this regulation.

(8) As discussed in Section 2.7 the secondary liner shall consist of 60-mil HDPE, in compliance with this regulation.

(9) As discussed in Sections 2.6 - 2.8 NGL proposes to install an alternative leak detection system comprised of a 200-mil HDPE geocomposite blanket drainage collection system in lieu of soil and piping as prescribed. HDPE has high chemical resistance to oil field wastes and the leak detection system is sloped at 2% in the lateral direction, compliant with this regulation. Discharge from this pond is not proposed.

(10) Not applicable

(11) The LEP has been designed with 3-feet of freeboard under the worst-case leachate generation condition, See **Attachment C.**

(12) The LEP has a leachate storage capacity of approximately 9.3 acre-feet, in compliance with this regulation which limits the capacity of evaporation ponds to 10 acre-feet.

4.0 REFERENCES

Daniel, D.E. and Estornell P. (1991) “Hydraulic Conductivity of Three Geosynthetic Clay Liners” *Journal of Civil Engineering* 118(10) 2605.

U.S. EPA. 2001. **Geosynthetic Clay Liners Used in Municipal Solid Waste Landfills**. EPA530-F-97-002. Solid Waste and Emergency Response. December.

Weber, C.T., and Zornberg, J.G. (2005). Leakage through Liners under High Hydraulic Heads." Geosynthetics Research and Development in Progress, Eighteenth Geosynthetic Research Institute Conference (GRI-18), Austin, Texas, January 26

Attachment A
Run-on and Run-off Surface Water Management Report

CALCULATIONS BY: Michael P. Bradford, P.E. – Senior Project Manager
Terracon Consultants, Inc.
25809 Interstate 30 South
Bryant, Arkansas 72022
(501) 847-9292

I. RUN-OFF SURFACE WATER MODELING

MODELING METHOD

Autodesk Storm and Sanitary Analysis 2019 (SSA)

ANALYSIS

A detailed engineering analysis was performed on the components that comprise the stormwater management system for surface water run-off within the facility boundaries. The components analyzed for this permit modification include:

1. Stormwater Let-down Structures
2. Slope Integrated diversion channels
3. Perimeter Ditches
4. Stormwater Ponds

As required by ***NMAC 19.15.36***, the hydrologic analysis was performed utilizing a 25-year, 24-hour rainfall event. SSA was utilized to perform the engineering analysis to assure compliance with the above regulations. The analysis was performed for the post development conditions of the Facility. This is considered to be a conservative approach for the design capacity of the stormwater pond and other conveyance features.

SSA was utilized to illustrate the capacity of the stormwater let-down structures, slope integrated berms, and perimeter ditches. These results were generated to assure that the conveyance parameters of stormwater design elements are adequate.

PARAMETERS USED IN THE ANALYSES

The following are the lists of parameters that were considered for stormwater management:

Based on ***NMAC 19.15.36,*** a 25-year, 24-hour rainfall event was considered for design of the proposed landfill permit area. The proposed disposal area was first segregated into 69 sub-basins, 99 nodes, and 102 links, then the areas were determined. It was concluded that the Landfill would fall into the Type II rainfall distribution as published by the Nation Resource Conservation Service (NRCS). The 25-year, 24-hour rainfall data for Lea

County was available within the SSA. The EPA SWMM hydrology method was used due to its flexibility, such as allowances for existing soil moisture and evaporation.

For each element in the design, the following parameters, if applicable, were input or calculated using the SSA software and dialogue box selections, typical values or site design information:

- Run-off Curve Number
  - Data gathered from NRCS Web Soil Survey and TR-55 Tables
    - Ratliff-Wink Fine Sandy Loams and Kermit-Palomas Fine Sands.
      - Hydraulic Soil Group B.
    - CN = 86 from Table 2-2a of the TR-55 Manual for “Newly Graded, Pervious Areas, No Vegetation”
- Area (Ac);
  - Automatically calculated based on site design
- Impervious Area (%);
  - 0% assumed globally this site is not expected to have significant areas of pavement
- Drying Time (days);
  - 2 days assumed globally
- Average Slope (%);
  - 1% for side slope berms
  - 1.5% min for perimeter channels
  - 4 horizontal to 1 vertical for waste side slopes
  - 4% waste top deck
  - 0.5% for entrance/admin/staging area
- Equivalent Width (ft)
  - Critical flow path as determined by site design
- Pervious Area Manning’s Roughness, taken from SSA databases;
  - 0.22 for Landfill – “poor grass cover, moderately rough surface”
  - 0.15 for Entrance/Admin/Staging area – “Gravel”
  - 0.35 for Let-down Structures, “rip-rap”
- Link Invert Information (elevation)
  - Taken from site design
- Link Cross Section
  - V-ditch for all side slope diversion channels
  - Trapezoidal ditch for all let-down structures and perimeter ditches
  - Circular for all culverts

SUMMARY OF RESULTS

Stormwater Let-down Structures

Four (4) stormwater let-down structures are planned for the final landfill configuration, beginning with let-down structure 1 in the northeast landfill face of the finished landfill and distributed clockwise around the landfill to let-down structure 4 on the northwest face of the landfill. Each of these let-down structures has been designed with a 10-foot bottom width, 2' depth, 3:1 side slopes, and 25% flowline slope. The flow capacity of these let-down structures is approximately 850 cubic feet per second (cfs). The SSA calculated maximum peak flow values from a 25-year, 24-hour rainfall event for lower most design segments of the let-down structures range from 150 CFS to 280 cfs. The SSA generated output tables for the stormwater analysis can be found in **Exhibit A.2, also see Figures depicting links, junctions, basins, and storage nodes for visual reference in Exhibit A.1**.

Slope Integrated Berms

The landfill slope integrated berms were designed assuming that the berms would collect and transfer the entire area of each let-down sub-basin run-off volume. With this assumption, the maximum flow to be carried in a slope integrated berm is ~24 cubic feet per second (cfs). Each let-down has at least seven slope integrated berms with contributing drainage areas varying in size. The slope integrated berms will be sloped at 1 percent and have a depth of 1.5-feet, providing a maximum flow capacity of approximately ~42 cfs. The side slopes of the berms will be 4:1 (using the 4:1 final cover system of the landfill for the interior side) and 3H:1V on the exterior slope.

Perimeter Ditches

The perimeter channels along the west, south, and north sides have been designed with a 10-foot bottom width, 3-foot depth, 4:1 side slopes, and a flowline slope of 1.5% minimum. The perimeter channel along the east side has been designed with a 6-foot bottom width, 3-foot depth and 4:1 side slopes.

- West Ditch (Link 9 and Link 28)
    - Design Capacity ~415 cfs
    - Peak Flow during design storm ~304 cfs
- South Ditch – 1 (Link 48)
    - Design Capacity ~585 cfs
    - Peak Flow during design storm ~14 cfs
- South Ditch – 2 (Link 51)
    - Design Capacity ~400 cfs
    - Peak Flow during design storm ~34 cfs
- East Ditch (Link 18 and Link 50)
    - Design Capacity ~310 cfs
    - Peak Flow during design storm ~297 cfs
- Northeast Ditch (Link 26 and Link 49)

- Design Capacity ~395 cfs
- Peak Flow during design storm ~196 cfs

- Northwest Ditch (Link 27)
  - Design Capacity ~714 cfs
  - Peak Flow during design storm ~553 cfs

See **Exhibit A.1** for results

Culverts

Each of the perimeter ditches must transition through a culvert below the main access/haul roads prior to entering one of the three retention ponds. Culverts are size to flow approximately half full at peak discharge. To minimize entrance losses and surcharging, the culverts will be installed with approximately half of the pipe installed below the flow line of the channel. The following is a summary of the culverts proposed:

- Northeast Culvert (Link 99)
  - 3 barrel, 36-inch concrete pipe
  - Design Flow = 223 cfs
  - Peak Flow during design storm = 164 cfs
- Northwest Culvert (Link 100)
  - 3 barrel, 36-inch concrete pipe
  - Design Flow = 222 cfs
  - Peak Flow during design storm = 195 cfs
- East Culvert (Link 40)
  - 2 barrel, 48-inch concrete pipe
  - Design Flow = 375 cfs
  - Peak Flow during design storm = 297 cfs
- Southeast Culvert (Link 39)
  - 2 barrel, 36-inch concrete pipe
  - Design Flow = 204 cfs
  - Peak Flow during design storm = 34 cfs
- Southwest Culvert (Link 38)
  - 2 barrel, 24-inch concrete pipe
  - Design Flow = 55 cfs
  - Peak Flow during design storm = 13 cfs
- West Culvert (Link 37)
  - 2 barrel, 48-inch concrete pipe
  - Design Flow = 350 cfs
  - Peak Flow during design storm = 304 cfs

Stormwater culvert sizing is presented in **Exhibit A.1, also see Figures depicting links, junctions, basins, and storage nodes for visual reference**.

Stormwater/Sedimentation Ponds

The facility will be required to hold the run-off from a 25-year, 24-hour storm. As shown in **Exhibit A.2,** the three proposed ponds will provide sufficient capacity to retain the entire run-off volume from their associated contributing basins from the 25-year, 24-hour storm event. Each pond has been size to be 10-feet deep with 3:1 side slopes in order to maximize borrow soil generation. These ponds will each have a minimum of 3' freeboard, and some additional capacity in the case that the pond is retaining some liquids already at the time of the design storm event.

II. RUN-ON SURFACE WATER MODELING

MODELING METHOD

USDA, NRCS, Technical Release 55 (TR-55) via Microsoft Excel Spreadsheet

ANALYSIS

A detailed engineering analysis was performed on the stormwater run-on management system. The run-on area is assumed to flow perpendicularly to the Northwest permit boundary. Thus a stormwater run-on diversion channel is proposed along the north boundary that will intercept run-on flow and divert it around the north east and southwest permit boundary corners. Once the flow has passed these corners, the diversion channel will daylight and allow the collected stormwater run-on to dissipate to native ground. The components analyzed for this permit modification include:

1. Run-on Control Diversion Ditch

As required by ***NMAC 19.15.36***, the hydrologic analysis was performed utilizing a 25-year, 24-hour rainfall event. TR-55 manual was utilized to perform the engineering analysis to assure compliance with the above regulations. The analysis was performed for the undeveloped current conditions of the assumed run-on area. This is considered to be a conservative approach for the design capacity of the stormwater pond and other conveyance features.

TR-55 modeled through Microsoft Excel spreadsheet was utilized to illustrate the capacity of the run-on control ditch. These results were generated to assure that the conveyance parameters of stormwater design elements are adequate.

PARAMETERS USED IN THE ANALYSIS

Stormwater Run-on Drainage Basin

The assumed stormwater run-on contributing drainage basin is bound by the Northwest permit boundary and the Highway 128 North of the site. The stormwater run-on contributing drainage basin is approximately 5,555 acres in size. See Figure 1A for a map of the approximated run-on drainage area.

Overland Gradient

It is determined based on USGS Quadrangle Maps and site-specific topographic survey of this facility that the natural surface water gradient is Northwest to Southeast at 0.9%.

Run-off Curve Number

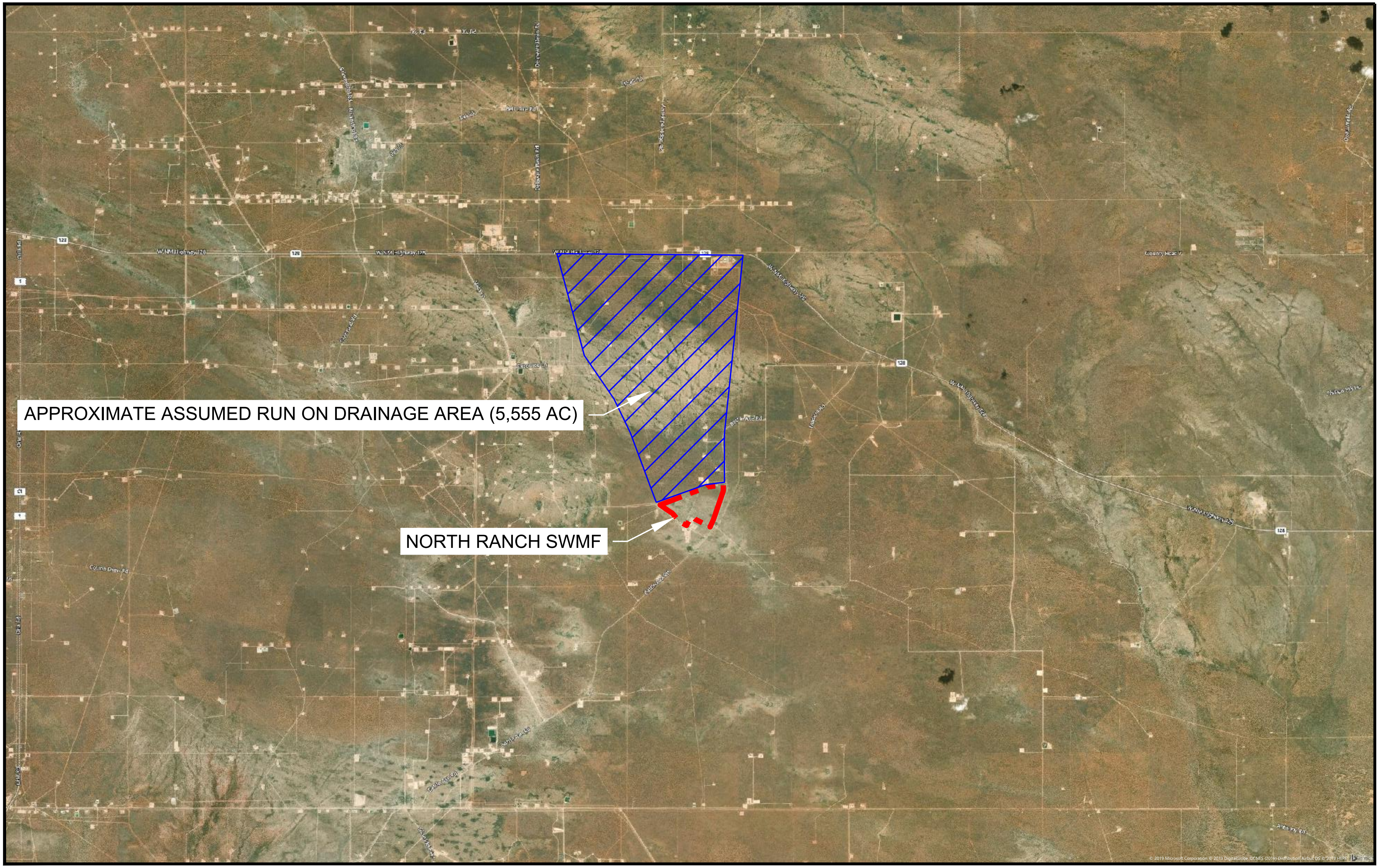
A composite curve number (CN) was generated using the approximate assumed run-on drainage area, and hydraulic soil group, CN information, and approximate areas as calculated using the NRCS web soil survey. Using this information, a composite CN of 42 was calculated for the assumed run-on control area.

SUMMARY OF RESULTS

The TR-55 calculation summarized in **Exhibit A.3** demonstrates that a run-on diversion channel with a 7-foot bottom width, 2 feet deep, with 3:1 side slopes will control the peak discharge from a 25-year, 24-hour storm event from the run-on drainage basin.

In general, a channel with these dimensions, with a traverse slope of 0.1% will have a design capacity of 67cfs. The peak flow from the run-on drainage basin is 132 cfs. However, this flow is split and diverted north and south, thus each channel must have a design capacity of 66 cfs. The proposed run-on diversion ditch will also provide an additional 0.3-feet of freeboard.

Figure A-1
Approximate Run-on Drainage Basin Map



N:\GECARCHIVE\CAD\572\002\MCCLOY\PERMIT TEXT FIGURES\STORMWATER\FIG 1 - SITE LOCATION MAP.DWG

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists

25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

APPROXIMATE RUN-ON DRAINAGE BASIN MAP

PERMIT APPLICATION FIGURE

SURFACE WASTE MANAGEMENT FACILITY

NORTH RANCH

LEA COUNTY NEW MEXICO

FIG. A-1

DESIGNED BY:	-
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	1" = 100'
DATE:	SEPTEMBER 2019
JOB NO.	35187378
ACAD NO.	572/002
SHEET NO.:	1 OF 1

Exhibit A.1
Run-off Design Figures

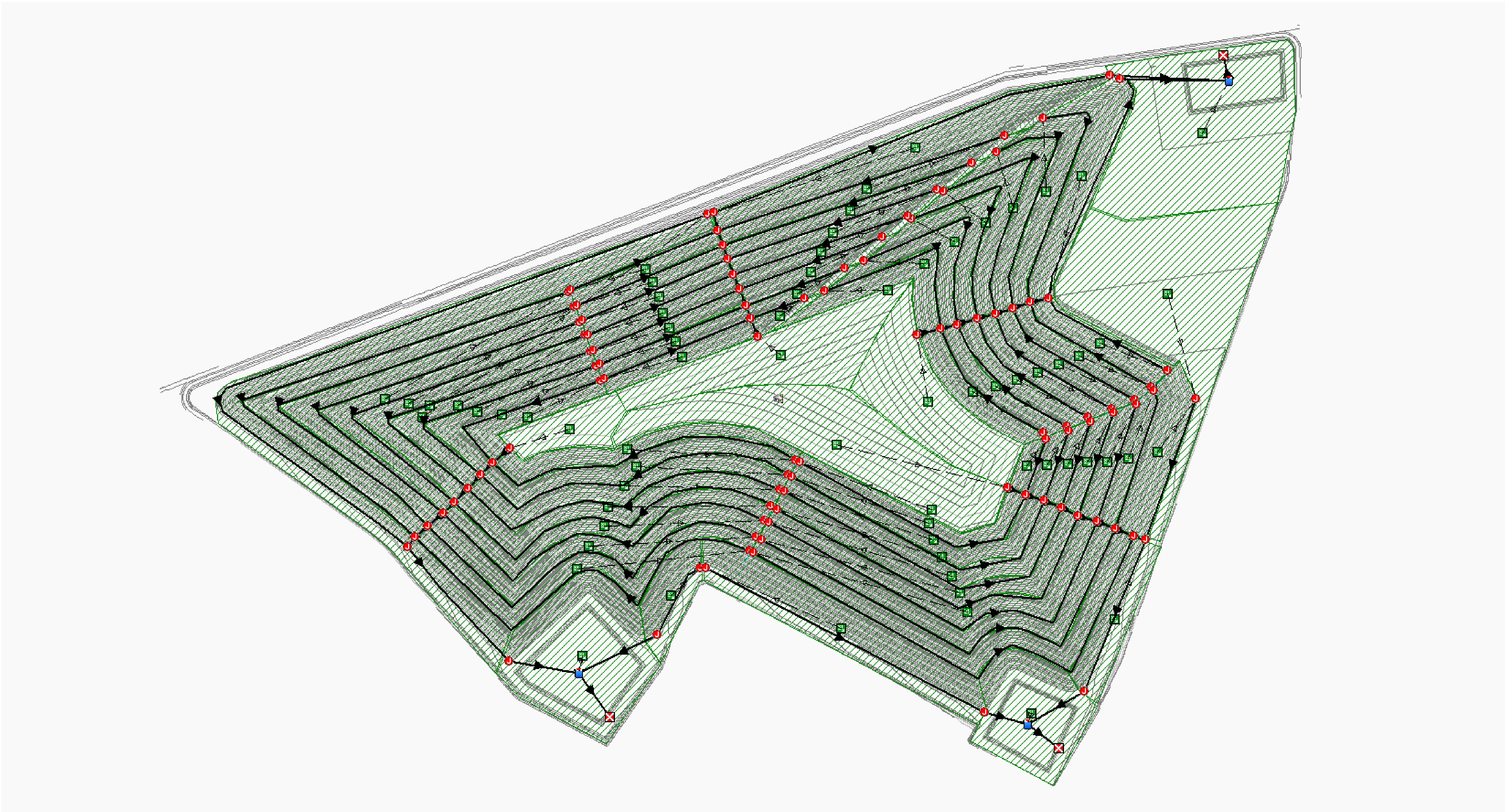
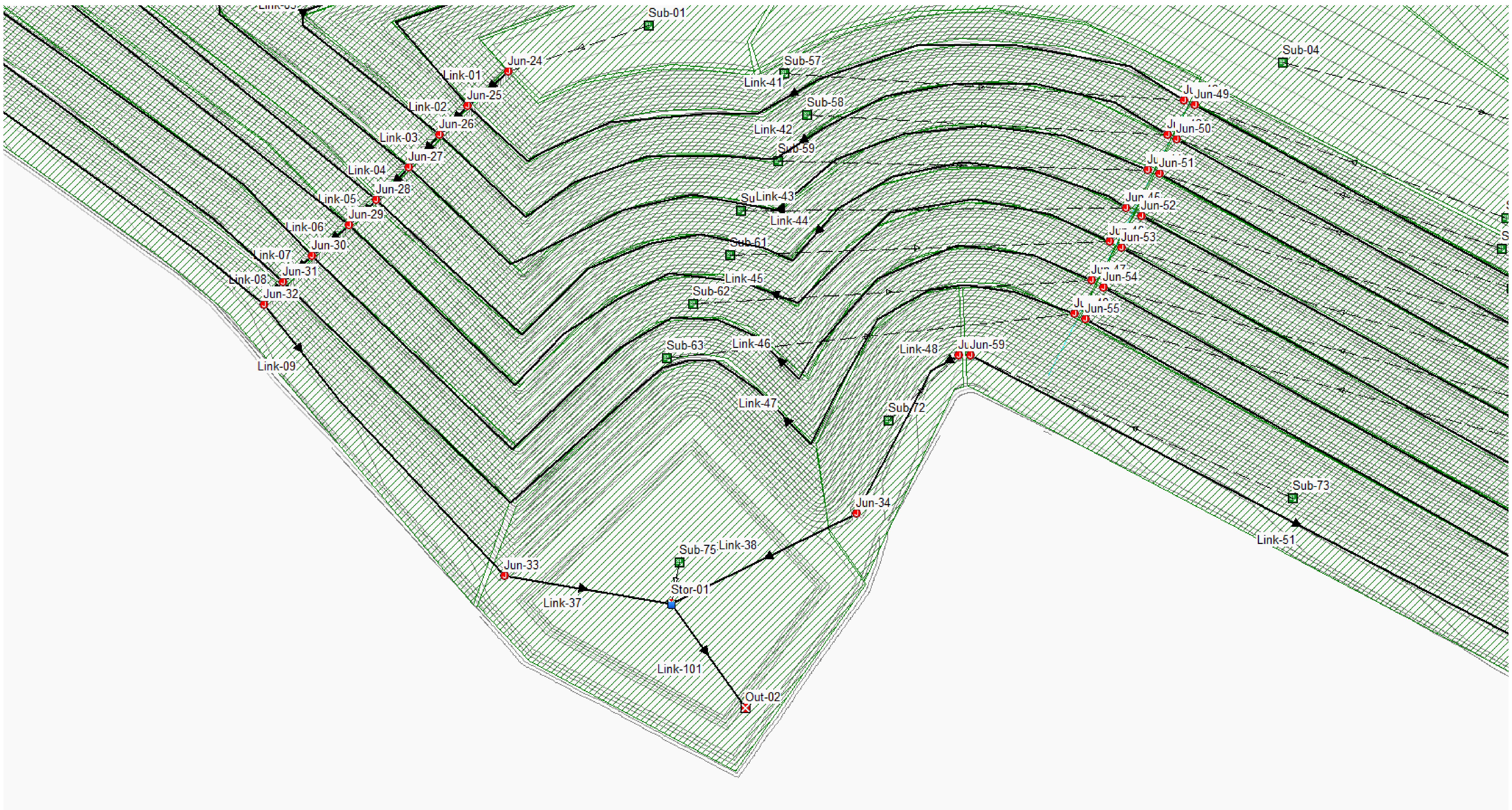


FIGURE 1 - WHOLE SITE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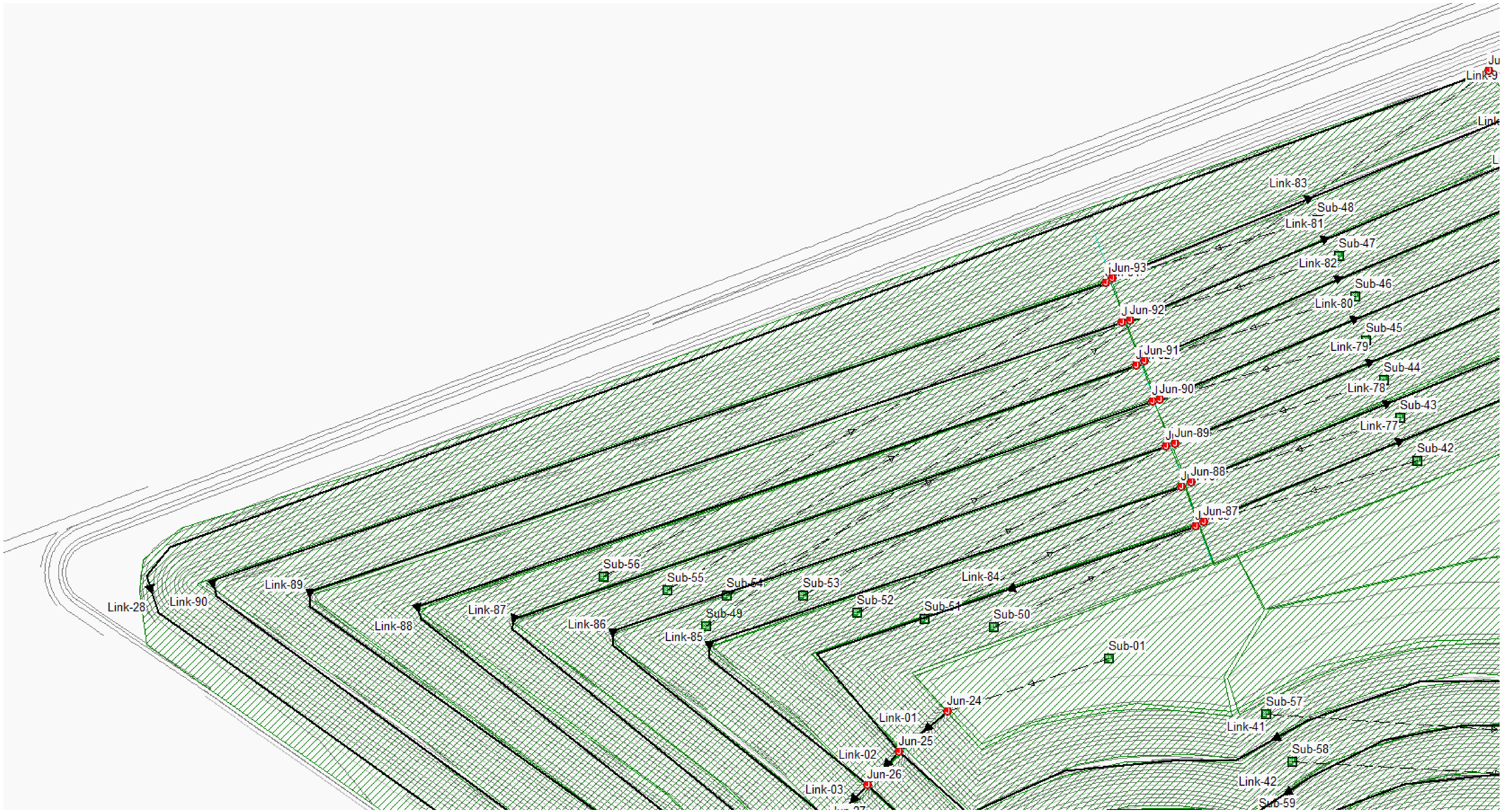
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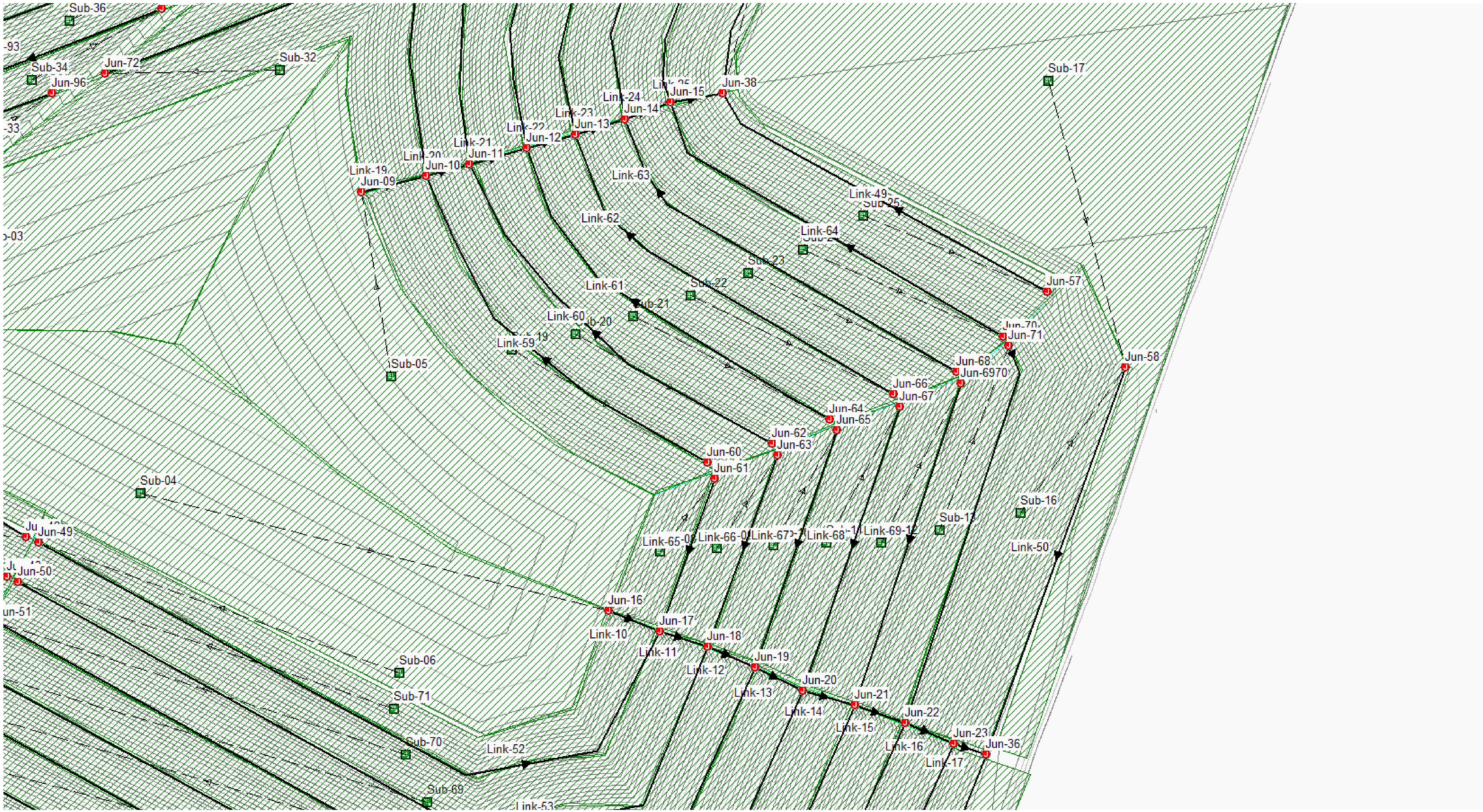
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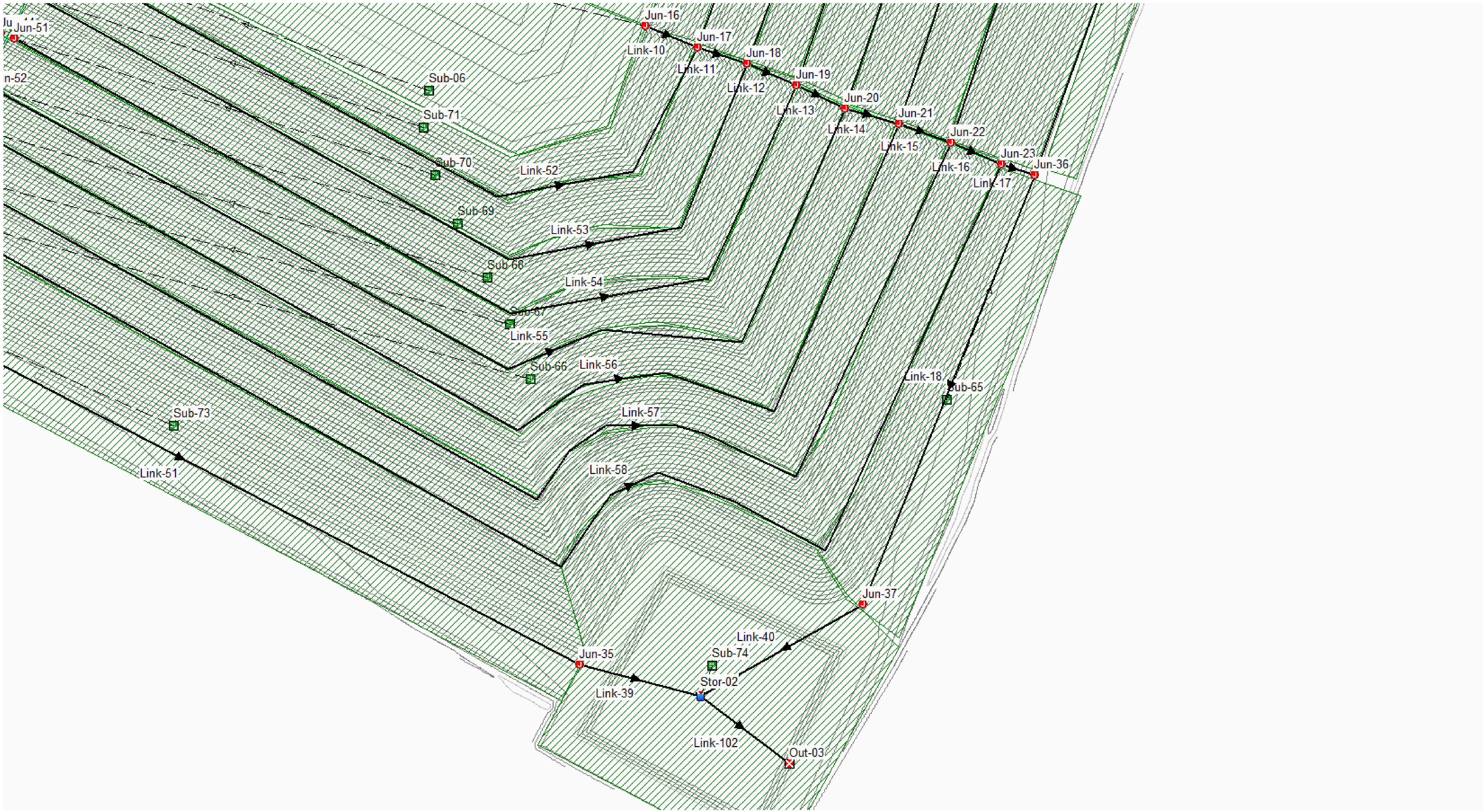
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Exhibit A.2
Run-off Design Results
Storm and Sanitary Analysis Results

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (inches)	Pipe Width (inches)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	Lengthening Factor	Peak Flow (cfs)	Time of Peak Flow Occurrence (days hh:mm)	Max Flow Velocity (ft/sec)	Travel Time (min)	Design Flow Capacity (cfs)	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged (min)	Max Flow Depth (ft)	Reported Condition
1	Link-100		64	Stor-03	576.94	3342.70	0.00	3333.20	0.00	9.50	1.6500	CIRCULAR	36.000	36.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	194.92	0 12:09	11.90	0.81	222.53	0.88	0.73	0.00	2.14	Calculated
2	Link-37		64	Stor-01	375.70	3330.40	0.00	3323.00	0.00	7.40	1.9700	CIRCULAR	48.000	48.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	303.60	0 12:11	15.68	0.40	349.43	0.87	0.72	0.00	2.85	Calculated
3	Link-38		64	Stor-01	459.60	3332.00	0.00	3323.00	0.00	9.00	1.9600	CIRCULAR	20.040	20.04	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	13.25	0 12:02	7.30	1.05	33.74	0.39	0.44	0.00	0.70	Calculated
4	Link-39		64	Stor-02	233.95	3328.30	0.00	3321.00	0.00	7.30	3.1200	CIRCULAR	20.040	20.04	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	33.74	0 12:09	10.84	0.36	42.60	0.79	0.67	0.00	1.12	Calculated
5	Link-40		64	Stor-02	348.09	3328.90	0.50	3321.00	0.00	7.90	2.2700	CIRCULAR	48.000	48.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	297.37	0 12:08	16.57	0.35	375.09	0.79	0.67	0.00	2.63	Calculated
6	Link-99		64	Stor-03	632.04	3343.60	0.00	3333.20	0.00	10.40	1.6500	CIRCULAR	36.000	36.00	0.0150	0.5000	0.5000	0.0000	0.00	NO	1.00	163.61	0 12:11	11.54	0.91	222.45	0.74	0.64	0.00	1.90	Calculated

SN	Element ID	Description	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Inlet Invert Offset	Outlet Invert Elevation	Outlet Invert Offset	Total Drop	Average Slope	Channel Type	Channel Height	Channel Width	Left Overbank Manning's Roughness	Channel Manning's Roughness	Right Overbank Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow	Flap Gate	Lengthening Factor	Peak Flow	Time of Peak Flow Occurrence	Max Flow Velocity	Travel Time	Design Flow Capacity	Max Flow / Design Flow Ratio	Max Flow Depth / Total Depth Ratio	Total Time Surcharged	Max Flow Depth	Reported Condition
					(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(%)		(ft)	(ft)							(cfs)			(cfs)	(days hh:mm)	(ft/sec)	(min)	(cfs)			(min)	(ft)	
1	Link-01		64	64	120.88	3527.50	0.00	3495.50	0.00	32.00	26.4700	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	12.86	0 12:00	6.75	0.30	880.17	0.01	0.09	0.00	0.18	Calculated
2	Link-02		64	64	88.42	3495.50	0.00	3471.70	0.00	23.80	26.9200	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	34.62	0 12:05	9.75	0.15	887.52	0.04	0.16	0.00	0.32	Calculated
3	Link-03		64	64	99.97	3471.70	0.00	3447.80	0.00	23.90	23.9100	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	69.88	0 12:07	12.02	0.14	836.43	0.08	0.25	0.00	0.50	Calculated
4	Link-04		64	64	102.50	3447.80	0.00	3423.90	0.00	23.90	23.3200	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	101.11	0 12:07	13.52	0.13	826.04	0.12	0.31	0.00	0.62	Calculated
5	Link-05		64	64	83.29	3423.90	0.00	3401.60	0.00	22.30	26.7700	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	134.26	0 12:07	15.55	0.09	885.16	0.15	0.36	0.00	0.69	Calculated
6	Link-06		64	64	106.97	3401.60	0.00	3375.90	0.00	25.70	24.0300	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	167.57	0 12:08	16.11	0.11	838.50	0.20	0.42	0.00	0.81	Calculated
7	Link-07		64	64	87.17	3375.90	0.00	3353.30	0.00	22.60	25.9300	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	238.39	0 12:08	18.50	0.08	871.04	0.27	0.50	0.00	0.98	Calculated
8	Link-08		64	64	65.76	3353.30	0.00	3334.90	0.00	18.40	27.9800	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	279.75	0 12:09	19.96	0.05	904.89	0.31	0.53	0.00	1.06	Calculated
9	Link-09		64	64	808.14	3334.90	0.00	3330.40	0.00	4.50	0.5600	Trapezoidal	3.000	34.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	303.85	0 12:11	5.94	2.27	415.80	0.73	0.86	0.00	2.57	Calculated
10	Link-10		64	64	105.66	3527.50	0.00	3498.00	0.00	29.50	27.9200	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	69.95	0 12:00	12.64	0.14	903.90	0.08	0.24	0.00	0.48	Calculated
11	Link-101		Stor-01	Out-02	40.00	3333.00	10.00	3330.00	0.00	3.00	7.5000	Trapezoidal	3.000	58.00	0.0000	0.0320	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	0.00	0 00:00	0.00		3436.82	0.00	0.00	0.00	0.00	Calculated
12	Link-102		Stor-02	Out-03	207.25	3331.00	10.00	3328.00	0.00	3.00	1.4500	Trapezoidal	3.000	58.00	0.0000	0.0320	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	0.00	0 00:00	0.00		1509.87	0.00	0.00	0.00	0.00	Calculated
13	Link-103		Stor-03	Out-04	139.10	3343.20	10.00	3340.20	0.00	3.00	2.1600	Trapezoidal	4.000	72.00	0.0000	0.0320	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	0.00	0 00:00	0.00		3226.20	0.00	0.00	0.00	0.00	Calculated
14	Link-11		64	64	97.41	3498.00	0.00	3473.00	0.00	25.00	25.6600	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	80.38	0 12:00	12.91	0.13	866.63	0.09	0.27	0.00	0.53	Calculated
15	Link-12		64	64	100.65	3473.00	0.00	3448.00	0.00	25.00	24.8400	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	94.85	0 12:01	13.51	0.12	852.57	0.11	0.30	0.00	0.59	Calculated
16	Link-13		64	64	100.50	3448.00	0.00	3423.00	0.00	25.00	24.8800	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	112.58	0 12:02	14.31	0.12	853.21	0.13	0.33	0.00	0.64	Calculated
17	Link-14		64	64	105.53	3423.00	0.00	3398.00	0.00	25.00	23.6900	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	133.13	0 12:03	14.88	0.12	832.62	0.16	0.37	0.00	0.73	Calculated
18	Link-15		64	64	102.02	3398.00	0.00	3373.00	0.00	25.00	24.5000	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	155.39	0 12:04	15.83	0.11	846.83	0.18	0.40	0.00	0.79	Calculated
19	Link-16		64	64	102.31	3373.00	0.00	3348.00	0.00	25.00	24.4400	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	179.79	0 12:07	16.58	0.10	845.62	0.21	0.43	0.00	0.86	Calculated
20	Link-17		64	64	65.85	3348.00	0.00	3333.30	0.50	14.70	22.3200	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	200.85	0 12:07	16.65	0.07	808.25	0.25	0.47	0.00	0.93	Calculated
21	Link-18		64	64	864.47	3332.80	0.00	3328.40	0.00	4.40	0.5100	Trapezoidal	3.000	30.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	297.54	0 12:08	5.83	2.47	308.70	0.96	0.98	0.00	2.92	Calculated
22	Link-19		64	64	128.77	3527.50	0.00	3492.95	0.00	34.55	26.8300	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	38.96	0 12:00	10.19	0.21	886.10	0.04	0.17	0.00	0.35	Calculated
23	Link-20		64	64	86.14	3492.95	0.00	3468.80	0.00	24.15	28.0400	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	60.14	0 12:02	12.02	0.12	905.78	0.07	0.22	0.00	0.43	Calculated
24	Link-21		64	64	115.25	3468.80	0.00	3444.60	0.00	24.20	21.0000	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	79.62	0 12:02	12.04	0.16	783.89	0.10	0.28	0.00	0.56	Calculated
25	Link-22		64	64	95.83	3444.60	0.00	3420.40	0.00	24.20	25.2500	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	100.53	0 12:03	13.85	0.12	859.65	0.12	0.31	0.00	0.61	Calculated
26	Link-23		64	64	100.32	3420.40	0.00	3396.20	0.00	24.20	24.1200	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	122.61	0 12:03	14.57	0.11	840.20	0.15	0.35	0.00	0.69	Calculated
27	Link-24		64	64	94.59	3396.20	0.00	3372.70	0.00	23.50	24.8400	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	144.28	0 12:03	15.52	0.10	852.66	0.17	0.38	0.00	0.75	Calculated
28	Link-25		64	64	101.09	3372.70	0.00	3349.20	0.00	23.50	23.2500	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	167.57	0 12:04	15.94	0.11	824.80	0.20	0.42	0.00	0.84	Calculated
29	Link-26		64	64	1297.91	3349.20	0.00	3342.70	0.00	6.50	0.5000	Trapezoidal	3.000	34.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	195.17	0 12:08	5.36	4.04	394.32	0.49	0.71	0.00	2.11	Calculated
30	Link-27		64	64	2239.31	3354.40	0.00	3343.60	0.00	10.80	0.4800	Trapezoidal	4.000	42.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	163.94	0 12:10	5.37	6.95	716.40	0.23	0.48	0.00	1.90	Calculated
31	Link-28		64	64	4070.59	3354.40	0.00	3334.90	0.00	19.50	0.4800	Trapezoidal	3.000	34.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	34.06	0 12:17	3.39	20.01	385.66	0.09	0.28	0.00	0.83	Calculated
32	Link-29		64	64	104.08	3527.50	0.00	3497.50	0.00	30.00	28.8200	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	28.28	0 12:06	9.26	0.19	918.42	0.03	0.14	0.00	0.28	Calculated
33	Link-30		64	64	73.45	3497.50	0.00	3476.90	0.00	20.60	28.0500	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	38.91	0 12:06	10.30	0.12	905.95	0.04	0.17	0.00	0.34	Calculated
34	Link-31		64	64	90.85	3476.90	0.00	3456.30	0.00	20.60	22.6700	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	51.28	0 12:04	10.61	0.14	814.59	0.06	0.21	0.00	0.43	Calculated
35	Link-32		64	64	86.06	3456.30	0.00	3435.70	0.00	20.60	23.9400	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	67.05	0 12:04	11.86	0.12	836.95	0.08	0.25	0.00	0.49	Calculated
36	Link-33		64	64	86.06	3435.70	0.00	3416.40	0.00	19.30	22.4300	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	83.47	0 12:03	12.51	0.11	810.11	0.10	0.28	0.00	0.57	Calculated
37	Link-34		64	64	78.65	3416.40	0.00	3394.00	0.00	22.40	28.4800	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	101.47	0 12:04	14.46	0.09	912.94	0.11	0.30	0.00	0.59	Calculated
38	Link-35		64	64	81.77	3394.00	0.00	3374.60	0.00	19.40	23.7300	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	121.43	0 12:04	14.45	0.09	833.24	0.15	0.35	0.00	0.69	Calculated
39	Link-41		64	64	1723.57	3514.90	0.00	3495.50	0.00	19.40	1.1300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	14.28	0 12:08	4.59	6.26	42.51	0.34	0.65	0.00	0.97	Calculated
40	Link-42		64	64	1797.17	3492.00	0.00	3471.70	0.00	20.30	1.1300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	15.92	0 12:08	4.67	6.41	42.59	0.37	0.68	0.00	1.01	Calculated
41	Link-43		64	64	1836.80	3468.70	0.00	3447.80	0.00	20.90	1.1400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	17.50	0 12:08	4.73	6.47	42.74	0.41	0.70	0.00	1.05	Calculated
42	Link-44		64	64	1967.89	3446.00	0.00	3423.90	0.00	22.10	1.1200	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	17.77	0 12:08	4.75	6.90	42.46	0.42	0.71	0.00	1.06	Calculated
43	Link-45		64	64	2033.88	3424.30	0.00	3401.60	0.00	22.70	1.1200	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	16.40	0 12:08	4.72	7.18	42.33	0.39	0.68	0.00	1.02	Calculated
44	Link-46		64	64	2205.75	3400.20	0.00	3375.90	0.00	24.30	1.1000	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	20.60	0 12:09	4.83	7.61	42.06	0.49	0.75	0.00	1.12	Calculated
45	Link-47		64	64	2345.80	3379.00	0.00	3353.30	0.00	25.70	1.1000	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	19.44	0 12:09	4.81	8.13	41.94	0.46	0.73	0.00	1.09	Calculated
46	Link-48		64	64	429.05	3336.70	0.00	3332.00	0.00	4.70	1.1000	Trapezoidal	3.000	34.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	13.36	0 12:01	2.89	2.47	583.20	0.02	0.13	0.00	0.40	Calculated
47	Link-49		64	64	741.37	3352.90	0.00	3349.20	0.00	3.70	0.5000	Trapezoidal	3.000	34.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	10.92	0 12:04	2.37	5.21	393.64	0.03	0.15	0.00	0.44	Calculated
48	Link-50		64	64	792.86	3336.75	0.00	3332.80	0.00	3.95	0.5000	Trapezoidal	3.000	30.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	84.55	0 12:07	4.26	3.10	305.41	0.28	0.55	0.00	1.64	Calculated
49	Link-51		64	64	1661.72	3336.70	0.00	3328.30	0.00	8.40	0.5100	Trapezoidal	3.000	34.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	33.76	0 12:09	3.37	8.22	396.17	0.09	0.27	0.00	0.81	Calculated
50	Link-52		64	64	1455.37	3514.90	0.00	3498.00	0.00	16.90	1.1600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	10.62	0 12:07	4.39	5.53	43.18	0.25	0.58	0.00	0.87	Calculated
51	Link-53		64	64	1667.38	3492.00	0.00	3473.00	0.00	19.00	1.1400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	15.17	0 12:08	4.61	6.03	42.77	0.35	0.66	0.00	1.00	Calculated
52	Link-54		64	64	1830.27	3468.70	0.00	3448.00	0.00	20.70	1.1300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	16.97	0 12:08	4.71	6.48	42.61	0.40	0.69	0.00	1.04	Calculated
53	Link-55		64	64	2025.36	3446.00	0.00	3423.00	0.00	23.00	1.1400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	18.10	0 12:08	4.79	7.05	42.70	0.42	0.71	0.00	1.06	Calculated
54	Link-56		64	64	2275.01	3424.30	0.00	3398.00	0.00	26.30	1.1600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	19.33	0 12:09	4.89	7.75	43.08	0.45	0.72	0.00	1.08	Calculated
55	Link-57		64	64	2512.72	3400.20	0.00	3373.00	0.00	27.20	1.0800	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	20.76	0 12:09	4.82	8.69	41.69	0.50	0.75	0.00	1.11	Calculated
56	Link-58		64	64	2758.84	3379.00	0.00	3348.00	0.00	31.00	1.1200	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	23.37	0 12:10	4.96	9.27	42.48	0.55	0.78	0.00	1.15	Calculated
57	Link-59		64	64	801.43	3503.10	0.00	3492.95	0.00	10.15	1.2700	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	10.35	0 12:03	3.95	3.38	45.10	0.23	0.57	0.00	0.85	Calculated
58	Link-60		64	64	813.64	3479.00	0.00	3468.80	0.00	10.20	1.2500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	9.00	0 12:03	3.88	3.50	44.87	0.20	0.55	0.00	0.81	Calculated
59	Link-61		64	64	812.50	3454.90	0.00	3444.60	0.00	10.30	1.2700	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	9.37	0 12:03	3.91	3.46	45.12	0.21	0.55	0.00	0.82	Calculated
60	Link-62		64	64	820.78	3430.70	0.00	3420.40	0.00	10.30	1.2500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	9.48	0 12:03	3.91	3.50	44.89	0.21	0.56	0.00	0.82	Calculated
61	Link-63		64	64	827.27	3406.60	0.00	3396.20	0.00	10.40	1.2600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	9.28	0 12:03	3.91	3.53	44.93	0.21	0.55	0.00	0.81	Calculated
62	Link-64		64	64	807.16	3382.90	0.00	3372.70	0.00	10.20	1.2600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	9.29	0 12:03	3.90	3.45	45.05	0.21	0.55	0.00	0.81	Calculated
63	Link-65		64	64	312.43	3503.10	0.00	3498.00	0.00	5.10	1.6300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	3.39	0 12:01	2.94	1.77	51.20	0.07	0.36	0.00	0.54	Calculated
64	Link-66		64	64	393.21	3479.00	0.00	3473.00	0.00	6.00	1.5300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	4.51	0 12:01	3.12	2.10	49.50	0.09	0.41	0.00	0.61	Calculated
65	Link-67		64	64	484.40	3454.90	0.00	3448.00	0.00	6.90	1.4200	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	5.31	0 12:01	3.30	2.45	47.82	0.11	0.44	0.00	0.65	Calculated
66	Link-68		64	64	577.71	3430.70	0.00	3423.00	0.00	7.70	1.3300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	6.66	0 12:02	3.49	2.76	46.26	0.14	0.48	0.00	0.72	Calculated
67	Link-69		64	64	653.38	3406.60	0.00	3398.00	0.00	8.60	1.3200	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	7.30	0 12:02	3.63	3.00	45.97	0.16	0.50	0.00	0.74	Calculated
68	Link-70		64	64	765.64	3382.90	0.00	3373.00	0.00	9.90	1.2900	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.47	0 12:02	3.83	3.33	45.57	0.19	0.53	0.00	0.78	Calculated
69	Link-71		64	64	1072.75	3505.80	0.00	3492.95	0.00	12.85	1.2000	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	13.05	0 12:04	4.27	4.19	43.86	0.30	0.63	0.00	0.94	Calculated
70	Link-72		64	64	1185.76	3482.30	0.00	3468.80	0.00	13.50	1.1400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	11.08	0 12:04	4.21	4.69	42.76	0.26	0.60	0.00	0.89	Calculated
71	Link-73		64	64	1233.29	3458.90	0.00	3444.60	0.00	14.30	1.1600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	11.89	0 12:07	4.30	4.78	43.15	0.28	0.61	0.00	0.91	Calculated
72	Link-74		64	64	1380.13	3435.40	0.00	3420.40	0.00	15.00	1.0900	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	13.40	0 12:07	4.36	5.28	41.77	0.32	0.64	0.00	0.96	Calculated
73	Link-75		64	64	1293.75	3411.10	0.00	3396.20	0.00	14.90	1.1500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	12.82	0 12:07	4.37	4.93	43.00	0.30	0.63	0.00	0.94	Calculated
74	Link-76		64	64	1303.59	3387.60	0.00	3372.70	0.00	14.90	1.1400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	14.58	0 12:07	4.42	4.92	42.84	0.34	0.66	0.00	0.99	Calculated
75	Link-77		64	64	836.21	3508.00	0.00	3497.50	0.00	10.50	1.2600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.85	0 12:03	3.90	3.57	44.90	0.20	0.54	0.00	0.80	Calculated
76	Link-78		64	64	834.19	3487.40	0.00	3476.90	0.00	10.50	1.2600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.42	0 12:03	3.88	3.58	44.96	0.19	0.53	0.00	0.78	Calculated
77	Link-79		64	64	835.49	3466.70	0.00	3456.30	0.00	10.40	1.2400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.01	0 12:03	3.84	3.63	44.71	0.18	0.52	0.00	0.77	Calculated
78	Link-80		64	64	831.84	3446.10	0.00	3435.70	0.00	10.40	1.2500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.54	0 12:03	3.87	3.58	44.80	0.19	0.53	0.00	0.79	Calculated
79	Link-81		64	64	835.12	3404.50	0.00	3394.00	0.00	10.50	1.2600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.26	0 12:03	3.87	3.60	44.93	0.18	0.53	0.00	0.78	Calculated
80	Link-82		64	64	833.23	3426.80	0.00	3416.40	0.00	10.40	1.2500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	8.09	0 12:03	3.85	3.61	44.77	0.18	0.52	0.00	0.77	Calculated
81	Link-83		64	64	837.57	3385.00	0.00	3374.60	0.00	10.40	1.2400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	7.43	0 12:03	3.81	3.66	44.65	0.17	0.51	0.00	0.75	Calculated
82	Link-84		64	64	1019.14	3508.00	0.00	3495.50	0.00	12.50	1.2300	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	9.17	0 12:03	4.08	4.16	44.38	0.21	0.55	0.00	0.81	Calculated

83	Link-85	64	64	1376.77	3487.40	0.00	3471.70	0.00	15.70	1.1400	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	19.97	0	12:07	4.62	4.97	42.79	0.47	0.74	0.00	1.11	Calculated
84	Link-86	64	64	1693.36	3466.70	0.00	3447.80	0.00	18.90	1.1200	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	14.07	0	12:08	4.56	6.19	42.33	0.33	0.65	0.00	0.97	Calculated
85	Link-87	64	64	2022.22	3446.10	0.00	3423.90	0.00	22.20	1.1000	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	15.83	0	12:08	4.68	7.20	41.98	0.38	0.68	0.00	1.01	Calculated
86	Link-88	64	64	2326.22	3426.80	0.00	3401.60	0.00	25.20	1.0800	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	17.31	0	12:09	4.74	8.18	41.71	0.42	0.70	0.00	1.04	Calculated
87	Link-89	64	64	2678.46	3404.50	0.00	3375.90	0.00	28.60	1.0700	Triangular	2.000	16.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	52.54	0	12:10	5.29	8.44	89.17	0.59	0.81	0.00	1.60	Calculated
88	Link-90	64	64	2987.76	3385.00	0.00	3353.30	0.00	31.70	1.0600	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	22.85	0	12:11	4.84	10.29	41.27	0.55	0.77	0.00	1.15	Calculated
89	Link-91	64	64	99.73	3374.60	0.00	3354.40	0.00	20.20	20.2500	Trapezoidal	2.000	22.00	0.0000	0.0350	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	141.21	0	12:04	14.39	0.12	769.89	0.18	0.40	0.00	0.79	Calculated
90	Link-92	64	64	305.54	3501.20	0.00	3497.50	0.00	3.70	1.2100	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	3.21	0	12:01	2.61	1.95	44.10	0.07	0.37	0.00	0.56	Calculated
91	Link-93	64	64	559.36	3482.80	0.00	3476.90	0.00	5.90	1.0500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	4.66	0	12:02	3.11	3.00	41.15	0.11	0.44	0.00	0.65	Calculated
92	Link-94	64	64	810.33	3464.35	0.00	3456.30	0.00	8.05	0.9900	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	7.92	0	12:03	3.58	3.77	39.94	0.20	0.54	0.00	0.80	Calculated
93	Link-95	64	64	970.22	3445.90	0.00	3435.70	0.00	10.20	1.0500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	7.94	0	12:03	3.80	4.26	41.09	0.19	0.54	0.00	0.79	Calculated
94	Link-96	Jun-100	64	1169.17	3428.70	0.00	3416.40	0.00	12.30	1.0500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	10.03	0	12:04	4.06	4.80	41.10	0.24	0.59	0.00	0.87	Calculated
95	Link-97	Jun-101	64	1387.08	3408.80	0.00	3394.00	0.00	14.80	1.0700	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	12.25	0	12:07	4.30	5.38	41.39	0.30	0.62	0.00	0.93	Calculated
96	Link-98	Jun-102	64	1602.60	3391.40	0.00	3374.60	0.00	16.80	1.0500	Triangular	1.500	12.00	0.0000	0.0270	0.0000	0.5000	0.5000	0.0000	0.00	NO	1.00	13.50	0	12:08	4.41	6.06	41.03	0.33	0.65	0.00	0.97	Calculated

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (ft)	Boundary Type	Flap Gate	Fixed Water Elevation (ft)	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Maximum HGL Depth Attained (ft)	Maximum HGL Elevation Attained (ft)
1	Out-02	809866.45	415888.87		3330.00	NORMAL	NO		0.00	0.00	0.00	3330.00
2	Out-03	812235.52	415724.82		3328.00	NORMAL	NO		0.00	0.00	0.00	3328.00
3	Out-04	813106.52	419384.56		3340.20	NORMAL	NO		0.00	0.00	0.00	3340.20

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation (ft)	Max (Rim) Elevation (ft)	Max (Rim) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft^2)	Evaporation Loss	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Peak Outflow (cfs)	Peak Exfiltration Flow Rate (cfm)	Maximum HGL Elevation Attained (ft)	Maximum HGL Depth Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Maximum HGL Occurrence (days hh:mm)	Total Exfiltration Volume ($1000\text{-}ft^3$)	Total Flooded Volume (ac-inches)	Total Time Flooded (minutes)	Total Retention Time (seconds)
1	Stor-01	809701.38	416120.10		3323.00	3333.00	10.00	0.00	-3323.00	0.00	0.00	336.93	32.25	0.00	0.00	3326.59	3.59	3324.58	1.58	1 00:00	0.00	0.00	0.00	0.00
2	Stor-02	812070.74	415850.52		3321.00	3331.00	10.00	0.00	-3321.00	0.00	0.00	351.60	24.20	0.00	0.00	3326.36	5.36	3323.37	2.37	1 00:00	0.00	0.00	0.00	0.00
3	Stor-03	813137.03	419248.84		3333.20	3343.20	10.00	0.00	-3333.20	0.00	0.00	405.50	65.95	0.00	0.00	3339.65	6.45	3336.06	2.86	1 00:00	0.00	0.00	0.00	0.00

SN	Element ID	X Coordinate	Y Coordinate	Description	Invert Elevation	Ground/Rim (Max) Elevation	Ground/Rim (Max) Offset	Initial Water Elevation	Initial Water Depth	Surcharge Elevation	Surcharge Depth	Ponded Area	Minimum Pipe Cover	Peak Inflow	Peak Lateral Inflow	Maximum HGL Elevation Attained	Maximum HGL Depth Attained	Maximum Surcharge Depth Attained	Minimum Freeboard Attained	Average HGL Elevation Attained	Average HGL Depth Attained	Time of Maximum HGL Occurrence	Time of Peak Flooding Occurrence	Total Flooded Volume	Total Time Flooded
					(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft²)	(inches)	(cfs)	(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(days hh:mm)	(days hh:mm)	(ac-inches)	(minutes)
1	64	810645.90	417896.29		3527.50	3529.50	2.00	0.00	-3527.50	0.00	-3529.50	0.00	0.00	28.35	28.35	3527.78	0.28	0.00	1.72	3527.53	0.03	0 12:06	0 00:00	0.00	0.00
2	64	810607.24	417992.93		3497.50	3499.50	2.00	0.00	-3497.50	0.00	-3499.50	0.00	0.00	38.92	0.00	3498.32	0.82	0.00	1.18	3497.63	0.13	0 12:03	0 00:00	0.00	0.00
3	64	810583.39	418062.39		3476.90	3478.90	2.00	0.00	-3476.90	0.00	-3478.90	0.00	0.00	51.27	0.00	3477.70	0.80	0.00	1.20	3477.03	0.13	0 12:03	0 00:00	0.00	0.00
4	64	810549.41	418146.65		3456.30	3458.30	2.00	0.00	-3456.30	0.00	-3458.30	0.00	0.00	67.05	0.00	3457.12	0.82	0.00	1.18	3456.43	0.13	0 12:03	0 00:00	0.00	0.00
5	64	810518.16	418226.83		3435.70	3437.70	2.00	0.00	-3435.70	0.00	-3437.70	0.00	0.00	83.49	0.00	3436.51	0.81	0.00	1.19	3435.83	0.13	0 12:03	0 00:00	0.00	0.00
6	64	810486.90	418307.02		3416.40	3418.40	2.00	0.00	-3416.40	0.00	-3418.40	0.00	0.00	101.46	0.00	3417.28	0.88	0.00	1.12	3416.55	0.15	0 12:04	0 00:00	0.00	0.00
7	64	810462.44	418381.76		3394.00	3396.00	2.00	0.00	-3394.00	0.00	-3396.00	0.00	0.00	121.43	0.00	3394.95	0.95	0.00	1.05	3394.16	0.16	0 12:07	0 00:00	0.00	0.00
8	64	810432.54	418457.87		3374.60	3376.60	2.00	0.00	-3374.60	0.00	-3376.60	0.00	0.00	141.24	0.00	3375.59	0.99	0.00	1.01	3374.76	0.16	0 12:08	0 00:00	0.00	0.00
9	64	811490.32	417908.37		3527.50	3529.50	2.00	0.00	-3527.50	0.00	-3529.50	0.00	0.00	39.17	39.17	3527.85	0.35	0.00	1.65	3527.53	0.03	0 12:00	0 00:00	0.00	0.00
10	64	811615.35	417939.17		3492.95	3494.95	2.00	0.00	-3492.95	0.00	-3494.95	0.00	0.00	60.12	0.00	3493.90	0.95	0.00	1.05	3493.11	0.16	0 12:04	0 00:00	0.00	0.00
11	Jun-100	811594.50	418673.95		3428.70	3429.70	1.00	0.00	-3428.70	0.00	-3429.70	0.00	0.00	11.20	11.20	3429.62	0.92	0.00	0.58	3428.85	0.15	0 12:00	0 00:00	0.00	0.00
12	Jun-101	811779.40	418817.18		3408.80	3409.80	1.00	0.00	-3408.80	0.00	-3409.80	0.00	0.00	13.55	13.55	3409.79	0.99	0.00	0.51	3408.96	0.16	0 12:00	0 00:00	0.00	0.00
13	Jun-102	811953.88	418961.71		3391.40	3392.40	1.00	0.00	-3391.40	0.00	-3392.40	0.00	0.00	14.87	14.87	3392.43	1.03	0.00	0.47	3391.57	0.17	0 12:00	0 00:00	0.00	0.00
14	64	811698.70	417960.92		3468.80	3470.80	2.00	0.00	-3468.80	0.00	-3470.80	0.00	0.00	79.64	0.00	3469.70	0.90	0.00	1.10	3468.95	0.15	0 12:04	0 00:00	0.00	0.00
15	64	811809.23	417993.53		3444.60	3446.60	2.00	0.00	-3444.60	0.00	-3446.60	0.00	0.00	100.55	0.00	3445.53	0.93	0.00	1.07	3444.75	0.15	0 12:07	0 00:00	0.00	0.00
16	64	811901.65	418018.90		3420.40	3422.40	2.00	0.00	-3420.40	0.00	-3422.40	0.00	0.00	122.61	0.00	3421.38	0.98	0.00	1.02	3420.56	0.16	0 12:07	0 00:00	0.00	0.00
17	64	811997.69	418047.89		3396.20	3399.20	3.00	0.00	-3396.20	0.00	-3399.20	0.00	12.00	144.31	0.00	3397.15	0.95	0.00	2.05	3396.36	0.16	0 12:07	0 00:00	0.00	0.00
18	64	812086.48	418080.51		3372.70	3374.70	2.00	0.00	-3372.70	0.00	-3374.70	0.00	0.00	167.57	0.00	3373.70	1.00	0.00	1.00	3372.87	0.17	0 12:07	0 00:00	0.00	0.00
19	64	811966.88	417102.01		3527.50	3529.50	2.00	0.00	-3527.50	0.00	-3529.50	0.00	0.00	70.26	70.26	3527.98	0.48	0.00	1.52	3527.54	0.04	0 12:00	0 00:00	0.00	0.00
20	64	812064.73	417062.14		3498.00	3500.00	2.00	0.00	-3498.00	0.00	-3500.00	0.00	0.00	80.32	0.00	3498.89	0.89	0.00	1.11	3498.15	0.15	0 12:07	0 00:00	0.00	0.00
21	64	812157.15	417031.34		3473.00	3475.00	2.00	0.00	-3473.00	0.00	-3475.00	0.00	0.00	94.75	0.00	3474.02	1.02	0.00	0.98	3473.17	0.17	0 12:08	0 00:00	0.00	0.00
22	64	812249.56	416991.48		3448.00	3450.00	2.00	0.00	-3448.00	0.00	-3450.00	0.00	0.00	112.57	0.00	3449.06	1.06	0.00	0.94	3448.18	0.18	0 12:08	0 00:00	0.00	0.00
23	64	812340.16	416947.99		3423.00	3425.00	2.00	0.00	-3423.00	0.00	-3425.00	0.00	0.00	133.16	0.00	3424.09	1.09	0.00	0.91	3423.18	0.18	0 12:08	0 00:00	0.00	0.00
24	64	812441.64	416918.99		3398.00	3400.00	2.00	0.00	-3398.00	0.00	-3400.00	0.00	0.00	155.38	0.00	3399.11	1.11	0.00	0.89	3398.19	0.19	0 12:09	0 00:00	0.00	0.00
25	64	812537.67	416884.56		3373.00	3375.00	2.00	0.00	-3373.00	0.00	-3375.00	0.00	0.00	179.68	0.00	3374.15	1.15	0.00	0.85	3373.20	0.20	0 12:09	0 00:00	0.00	0.00
26	64	812631.90	416844.70		3348.00	3351.00	3.00	0.00	-3348.00	0.00	-3351.00	0.00	12.00	200.90	0.00	3349.20	1.20	0.00	1.80	3348.21	0.21	0 12:10	0 00:00	0.00	0.00
27	64	809339.43	417308.58		3527.50	3529.50	2.00	0.00	-3527.50	0.00	-3529.50	0.00	0.00	12.87	12.87	3527.68	0.18	0.00	1.82	3527.52	0.02	0 12:00	0 00:00	0.00	0.00
28	64	809247.01	417230.66		3495.50	3497.50	2.00	0.00	-3495.50	0.00	-3497.50	0.00	0.00	34.63	0.00	3496.50	1.00	0.00	1.00	3495.67	0.17	0 12:08	0 00:00	0.00	0.00
29	64	809185.40	417167.24		3471.70	3473.70	2.00	0.00	-3471.70	0.00	-3473.70	0.00	0.00	69.86	0.00	3472.83	1.13	0.00	0.87	3471.89	0.19	0 12:07	0 00:00	0.00	0.00
30	64	809116.54	417094.76		3447.80	3449.80	2.00	0.00	-3447.80	0.00	-3449.80	0.00	0.00	101.07	0.00	3448.87	1.07	0.00	0.93	3447.98	0.18	0 12:08	0 00:00	0.00	0.00
31	64	809044.06	417022.28		3423.90	3425.90	2.00	0.00	-3423.90	0.00	-3425.90	0.00	0.00	134.30	0.00	3424.98	1.08	0.00	0.92	3424.08	0.18	0 12:08	0 00:00	0.00	0.00
32	64	808984.27	416964.29		3401.60	3403.60	2.00	0.00	-3401.60	0.00	-3403.60	0.00	0.00	167.59	0.00	3402.68	1.08	0.00	0.92	3401.78	0.18	0 12:09	0 00:00	0.00	0.00
33	64	808900.91	416897.25		3375.90	3377.90	2.00	0.00	-3375.90	0.00	-3377.90	0.00	0.00	238.43	0.00	3377.54	1.64	0.00	0.36	3376.22	0.32	0 12:10	0 00:00	0.00	0.00
34	64	808837.49	416837.45		3353.30	3355.30	2.00	0.00	-3353.30	0.00	-3355.30	0.00	0.00	279.72	0.00	3354.50	1.20	0.00	0.80	3353.51	0.21	0 12:11	0 00:00	0.00	0.00
35	64	808795.12	416787.17		3334.90	3337.90	3.00	0.00	-3334.90	0.00	-3337.90	0.00	0.00	305.84	0.00	3337.49	2.59	0.00	0.41	3335.20	0.30	0 12:09	0 00:00	0.00	0.00
36	64	809331.04	416183.29		3330.40	3333.40	3.00	0.00	-3330.40	0.00	-3333.40	0.00	0.00	303.85	0.00	3333.29	2.89	0.00	1.11	3330.73	0.33	0 12:11	0 00:00	0.00	0.00
37	64	810113.85	416322.82		3332.00	3334.50	2.50	0.00	-3332.00	0.00	-3334.50	0.00	0.00	13.36	0.00	3332.73	0.73	0.00	2.27	3332.08	0.08	0 12:01	0 00:00	0.00	0.00
38	64	811844.39	415909.67		3328.30	3330.80	2.50	0.00	-3328.30	0.00	-3330.80	0.00	0.00	33.76	0.00	3329.42	1.12	0.00	1.88	3328.43	0.13	0 12:09	0 00:00	0.00	0.00
39	64	812694.57	416824.47		3332.80	3335.80	3.00	0.00	-3332.80	0.00	-3335.80	0.00	0.00	298.48	16.89	3335.76	2.96	0.00	0.04	3333.43	0.63	0 12:07	0 00:00	0.00	0.00
40	64	812373.83	416021.70		3328.40	3331.40	3.00	0.00	-3328.40	0.00	-3331.40	0.00	0.00	297.54	0.00	3331.59	3.19	0.00	1.31	3329.20	0.80	0 12:08	0 00:00	0.00	0.00
41	64	812185.97	418098.40		3349.20	3352.20	3.00	0.00	-3349.20	0.00	-3352.20	0.00	0.00	199.97	22.60	3351.36	2.16	0.00	0.84	3349.41	0.21	0 12:03	0 00:00	0.00	0.00
42	64	812560.18	419259.53		3342.70	3345.70	3.00	0.00	-3342.70	0.00	-3345.70	0.00	0.00	195.17	0.00	3344.88	2.18	0.00	0.82	3342.92	0.22	0 12:08	0 00:00	0.00	0.00
43	64	810383.10	418542.24		3354.40	3356.40	2.00	0.00	-3354.40	0.00	-3356.40	0.00	0.00	47.25	47.25	3355.43	1.03	0.00	1.97	3354.51	0.11	0 12:06	0 00:00	0.00	0.00
44	64	812505.82	419281.27		3343.60	3346.60	3.00	0.00	-3343.60	0.00	-3346.60	0.00	0.00	163.94	0.00	3345.57	1.97	0.00	2.03	3343.82	0.22	0 12:10	0 00:00	0.00	0.00
45	64	810845.21	417243.24		3514.90	3516.40	1.50	0.00	-3514.90	0.00	-3516.40	0.00	0.00	15.68	15.68	3515.93	1.03	0.00	0.47	3515.07	0.17	0 12:00	0 00:00	0.00	0.00
46	64	810808.77	417166.45		3492.00	3493.00	1.00	0.00	-3492.00	0.00	-3493.00	0.00	0.00	17.32	17.32	3493.07	1.07	0.00	0.43	3492.18	0.18	0 12:00	0 00:00	0.00	0.00
47	64	810763.22	417088.36		3468.70	3481.70	13.00	0.00	-3468.70	0.00	-3481.70	0.00	138.00	18.87	18.87	3469.80	1.10	0.00	11.90	3468.88	0.18	0 12:00	0 00:00	0.00	0.00
48	64	810716.36	417003.76		3446.00	3447.00	1.00	0.00	-3446.00	0.00	-3447.00	0.00	0.00	19.22	19.22	3447.11	1.11	0.00	0.39	3446.18	0.18	0 12:00	0 00:00	0.00	0.00
49	64	810678.62	416928.28		3424.30	3425.30	1.00	0.00	-3424.30	0.00	-3425.30	0.00	0.00	17.96	17.96	3425.39	1.09	0.00	0.41	3424.48	0.18	0 12:00	0 00:00	0.00	0.00
50	64	810639.57	416841.08		3400.20	3401.20	1.00	0.00	-3400.20	0.00	-3401.20	0.00	0.00	22.12	22.12	3401.38	1.18	0.00	0.32	3400.40	0.20	0 12:00	0 00:00	0.00	0.00
51	64	810601.40	416766.88		3379.00	3380.00	1.00	0.00	-3379.00	0.00	-3380.00	0.00	0.00	21.18	21.18	3380.16	1.16	0.00	0.34	3379.19	0.19	0 12:00	0 00:00	0.00	0.00
52	64	810868.64	417232.83		3514.90	3515.90	1.00	0.00	-3514.90	0.00	-3515.90	0.00	0.00	11.88	11.88	3515.82	0.92	0.00	0.58	3515.05	0.15	0 12:00	0 00:00	0.00	0.00
53	64	810828.29	417157.34		3492.00	3493.00	1.00	0.00	-3492.00	0.00	-3493.00	0.00	0.00	16.53	16.53	3493.05	1.05	0.00	0.45	3492.17	0.17	0 12:00	0 00:00	0.00	0.00
54	64	810789.25	417079.25		3468.70	3469.70	1.00	0.00	-3468.70	0.00	-3469.70	0.00	0.00	18.36	18.36	3469.79	1.09	0.00	0.41	3468.88	0.18	0 12:00	0 00:00	0.00	0.00
55	64	810748.90	416985.54		3446.00	3447.00	1.00	0.00	-3446.00	0.00	-3447.00	0.00	0.00	19.58	19.58	3447.12	1.12	0.00	0.38	3446.19	0.19	0 12:00	0 00:00	0.00	0.00
56	64	810705.95	416915.26		3424.30	3425.30	1.00	0.00	-3424.30	0.00	-3425.30	0.00	0.00	20.95	20.95	3425.44	1.14	0.00	0.36	3424.49	0.19	0 12:00	0 00:00	0.00	0.00
57	64	810664.30	416826.76		3400.20	3401.20	1.00	0.00	-3400.20	0.00	-3401.20	0.00	0.00	22.61	22.61	3401.39	1.19	0.00	0.31	3400.40	0.20	0 12:00	0 00:00	0.00	0.00
58	64	810624.83	416755.17		3379.00	3380.00	1.00	0.00	-3379.00	0.00	-3380.00	0.00	0.00	25.29	25.29	3380.23	1.23	0.00	0.27	3379.21	0.21	0 12:00	0 00:00	0.00	0.00
59	64	810342.27	416673.93		3336.70	3339.20	2.50	0.00	-3336.70	0.00	-3339.20	0.00	0.00	13.82	13.82	3337.11	0.41	0.00	2.59	3336.73	0.03	0 12:00	0 00:00	0.00	0.00
60	64	812811.29	417716.54		3352.90	3355.90	3.00	0.00	-3352.90	0.00	-3355.90	0.00	0.00	12.03	12.03	3353.37	0.47	0.00	2.53	3352.94	0.04	0 12:00	0 00:00	0.00	0.00
61	64	812962.28	417570.76		3336.75	3339.75	3.00	0.00	-3336.75	0.00	-3339.75	0.00	0.00	83.59	83.59	3338.40	1.65	0.00	1.35	3336.93	0.18	0 12:06	0 00:00	0.00	0.00
62	64	810369.35	416674.89		3336.70	3339.20	2.50	0.00	-3336.70	0.00	-3339.20	0.00	0.00	35.39	35.39	3337.57	0.87	0.00	2.13	3336.78	0.08	0 12:06	0 00:00	0.00	0.00
63	64	812156.81	417387.65		3503.10	3504.10	1.00	0.00	-3503.10	0.00	-3504.10	0.00	0.00	11.06	11.06	3503.99	0.89	0.00	0.61	3503.24	0.14	0 12:00	0 00:00	0.00	0.00
64	64	812170.02	417356.30		3503.10	3504.10	1.00	0.00	-3503.10	0.00	-3504.10	0.00	0.00	3.46	3.46	3503.65	0.55	0.00	0.95	3503.19	0.09	0 12:00	0 00:00	0.00	0.00
65	64	812281.98	417422.69		3479.00	3480.00	1.00	0.00	-3479.00	0.00	-3480.00	0.00	0.00	9.66	9.66	3479.84	0.84	0.00	0.66	3479.13	0.13	0 12:00	0 00:00	0.00	0.00
66	64	812292.39	417400.56		3479.00	3480.00	1.00	0.00	-3479.00	0.00	-3480.00	0.00	0.00	4.65	4.65	3479.62	0.62	0.00	0.88	3479.10	0.10	0 12:00	0 00:00	0.00	0.00
67	64	812392.64	417470.86		3454.90	3455.90	1.00	0.00	-3454.90	0.00	-3455.90	0.00	0.00	10.05	10.05	3455.75	0.85	0.00	0.65	3455.04	0.14	0 12:00	0 00:00	0.00	0.00

68	64	812405.66	417450.03	3454.90	3455.90	1.00	0.00	-3454.90	0.00	-3455.90	0.00	0.00	5.52	5.52	3455.57	0.67	0.00	0.83	3455.00	0.10	0 12:00	0 00:00	0.00	0.00
69	64	812515.01	417517.73	3430.70	3431.70	1.00	0.00	-3430.70	0.00	-3431.70	0.00	0.00	10.17	10.17	3431.56	0.86	0.00	0.64	3430.84	0.14	0 12:00	0 00:00	0.00	0.00
70	64	812528.03	417494.29	3430.70	3431.70	1.00	0.00	-3430.70	0.00	-3431.70	0.00	0.00	7.00	7.00	3431.44	0.74	0.00	0.76	3430.82	0.12	0 12:00	0 00:00	0.00	0.00
71	64	812636.08	417561.99	3406.60	3407.60	1.00	0.00	-3406.60	0.00	-3407.60	0.00	0.00	9.97	9.97	3407.45	0.85	0.00	0.65	3406.74	0.14	0 12:00	0 00:00	0.00	0.00
72	64	812645.19	417539.86	3406.60	3407.60	1.00	0.00	-3406.60	0.00	-3407.60	0.00	0.00	7.74	7.74	3407.37	0.77	0.00	0.73	3406.72	0.12	0 12:00	0 00:00	0.00	0.00
73	64	812727.21	417629.68	3382.90	3383.90	1.00	0.00	-3382.90	0.00	-3383.90	0.00	0.00	9.96	9.96	3383.75	0.85	0.00	0.65	3383.04	0.14	0 12:00	0 00:00	0.00	0.00
74	64	812737.62	417611.46	3382.90	3383.90	1.00	0.00	-3382.90	0.00	-3383.90	0.00	0.00	9.05	9.05	3383.72	0.82	0.00	0.68	3383.03	0.13	0 12:00	0 00:00	0.00	0.00
75	64	810997.81	418136.69	3505.80	3506.80	1.00	0.00	-3505.80	0.00	-3506.80	0.00	0.00	14.21	14.21	3506.78	0.98	0.00	0.52	3505.96	0.16	0 12:00	0 00:00	0.00	0.00
76	64	811209.58	418299.86	3482.30	3483.30	1.00	0.00	-3482.30	0.00	-3483.30	0.00	0.00	12.30	12.30	3483.24	0.94	0.00	0.56	3482.45	0.15	0 12:00	0 00:00	0.00	0.00
77	64	811459.54	418518.58	3458.90	3459.90	1.00	0.00	-3458.90	0.00	-3459.90	0.00	0.00	13.18	13.18	3459.86	0.96	0.00	0.54	3459.05	0.15	0 12:00	0 00:00	0.00	0.00
78	64	811627.92	418664.39	3435.40	3436.40	1.00	0.00	-3435.40	0.00	-3436.40	0.00	0.00	14.70	14.70	3436.41	1.01	0.00	0.49	3435.56	0.16	0 12:00	0 00:00	0.00	0.00
79	64	811909.13	418870.95	3411.10	3412.10	1.00	0.00	-3411.10	0.00	-3412.10	0.00	0.00	14.11	14.11	3412.09	0.99	0.00	0.51	3411.26	0.16	0 12:00	0 00:00	0.00	0.00
80	64	812155.61	419049.74	3387.60	3388.60	1.00	0.00	-3387.60	0.00	-3388.60	0.00	0.00	15.86	15.86	3388.63	1.03	0.00	0.47	3387.77	0.17	0 12:00	0 00:00	0.00	0.00
81	64	809790.19	417741.30	3487.40	3488.40	1.00	0.00	-3487.40	0.00	-3488.40	0.00	0.00	20.95	20.95	3488.55	1.15	0.00	0.35	3487.59	0.19	0 12:00	0 00:00	0.00	0.00
82	64	809760.89	417818.93	3466.70	3467.70	1.00	0.00	-3466.70	0.00	-3467.70	0.00	0.00	15.45	15.45	3467.73	1.03	0.00	0.47	3466.87	0.17	0 12:00	0 00:00	0.00	0.00
83	64	809734.67	417906.40	3446.10	3447.10	1.00	0.00	-3446.10	0.00	-3447.10	0.00	0.00	17.39	17.39	3447.18	1.08	0.00	0.42	3446.28	0.18	0 12:00	0 00:00	0.00	0.00
84	64	809704.50	417974.92	3426.80	3427.80	1.00	0.00	-3426.80	0.00	-3427.80	0.00	0.00	19.11	19.11	3427.92	1.12	0.00	0.38	3426.99	0.19	0 12:00	0 00:00	0.00	0.00
85	64	809675.21	418057.68	3404.50	3405.50	1.00	0.00	-3404.50	0.00	-3405.50	0.00	0.00	57.89	57.89	3406.20	1.70	0.00	0.30	3404.82	0.32	0 12:06	0 00:00	0.00	0.00
86	64	809645.18	418134.57	3385.00	3386.00	1.00	0.00	-3385.00	0.00	-3386.00	0.00	0.00	25.15	25.15	3386.25	1.25	0.00	0.25	3385.21	0.21	0 12:00	0 00:00	0.00	0.00
87	64	809817.99	417665.11	3508.00	3509.00	1.00	0.00	-3508.00	0.00	-3509.00	0.00	0.00	10.06	10.06	3508.86	0.86	0.00	0.64	3508.14	0.14	0 12:00	0 00:00	0.00	0.00
88	64	809834.37	417673.68	3508.00	3509.00	1.00	0.00	-3508.00	0.00	-3509.00	0.00	0.00	9.53	9.53	3508.84	0.84	0.00	0.66	3508.13	0.13	0 12:00	0 00:00	0.00	0.00
89	64	809809.96	417749.85	3487.40	3488.40	1.00	0.00	-3487.40	0.00	-3488.40	0.00	0.00	9.08	9.08	3488.22	0.82	0.00	0.68	3487.53	0.13	0 12:00	0 00:00	0.00	0.00
90	64	809778.72	417824.06	3466.70	3467.70	1.00	0.00	-3466.70	0.00	-3467.70	0.00	0.00	8.64	8.64	3467.51	0.81	0.00	0.69	3466.83	0.13	0 12:00	0 00:00	0.00	0.00
91	64	809749.42	417909.01	3446.10	3447.10	1.00	0.00	-3446.10	0.00	-3447.10	0.00	0.00	9.20	9.20	3446.93	0.83	0.00	0.67	3446.23	0.13	0 12:00	0 00:00	0.00	0.00
92	64	809719.15	417983.22	3426.80	3427.80	1.00	0.00	-3426.80	0.00	-3427.80	0.00	0.00	8.73	8.73	3427.61	0.81	0.00	0.69	3426.93	0.13	0 12:00	0 00:00	0.00	0.00
93	64	809690.83	418062.31	3404.50	3405.50	1.00	0.00	-3404.50	0.00	-3405.50	0.00	0.00	8.91	8.91	3405.32	0.82	0.00	0.68	3404.63	0.13	0 12:00	0 00:00	0.00	0.00
94	64	809656.66	418142.38	3385.00	3386.00	1.00	0.00	-3385.00	0.00	-3386.00	0.00	0.00	8.04	8.04	3385.79	0.79	0.00	0.71	3385.12	0.12	0 12:00	0 00:00	0.00	0.00
95	64	810415.50	418556.13	3354.40	3357.40	3.00	0.00	-3354.40	0.00	-3357.40	0.00	0.00	172.72	31.69	3356.42	2.02	0.00	1.98	3354.60	0.20	0 12:04	0 00:00	0.00	0.00
96	64	810893.99	418098.44	3501.20	3502.20	1.00	0.00	-3501.20	0.00	-3502.20	0.00	0.00	3.29	3.29	3501.77	0.57	0.00	0.93	3501.29	0.09	0 12:00	0 00:00	0.00	0.00
97	64	811106.23	418261.20	3482.80	3483.80	1.00	0.00	-3482.80	0.00	-3483.80	0.00	0.00	4.94	4.94	3483.48	0.68	0.00	0.82	3482.91	0.11	0 12:00	0 00:00	0.00	0.00
98	64	811304.14	418423.96	3464.35	3465.35	1.00	0.00	-3464.35	0.00	-3465.35	0.00	0.00	8.59	8.59	3465.19	0.84	0.00	0.66	3464.48	0.13	0 12:00	0 00:00	0.00	0.00
99	64	811438.25	418534.63	3445.90	3446.90	1.00	0.00	-3445.90	0.00	-3446.90	0.00	0.00	8.76	8.76	3446.74	0.84	0.00	0.66	3446.03	0.13	0 12:00	0 00:00	0.00	0.00

SN	Element ID	Description	Data Source	Data Source ID	Rainfall Type	Rain Units	State	County	Return Period	Rainfall Depth	Rainfall Distribution
									(years)	(inches)	
1	Rain Gage-04		Time Series	NEW MEXICO, LEA COUNTY 25Y-24H	Cumulative	inches					User Defined

SN	Element ID	Description	Area	Drainage Node ID	Weighted Curve Number	Conductivity	Drying Time	Average Slope	Equivalent Width	Impervious Area	Impervious Area No Depression	Impervious Area Depression Depth	Impervious Area Manning's Roughness	Pervious Area Depression Depth	Pervious Area Manning's Roughness	Curb & Gutter Length	Rain Gage ID	Total Precipitation	Total Runon	Total Evaporation	Total Infiltration	Total Runoff	Peak Runoff	Time of Concentration
			(acres)			(inches/hr)	(days)	(%)	(ft)	(%)	(%)	(inches)		(inches)		(ft)		(inches)	(inches)	(inches)	(inches)	(inches)	(cfs)	(days hh:mm:ss)
1	Sub-01		2.88	64	86.00	0.1500	2.00	4.0000	616.95	0.00	0.00	0.0800	0.0150	0.2000	0.1000	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	12.87	0 00:28:26
2	Sub-03		8.47	64	86.00	0.1500	2.00	4.0000	554.59	0.00	0.00	0.0800	0.0150	0.2000	0.1000	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.38	28.35	0 00:57:57
3	Sub-04		13.13	64	86.00	0.1500	2.00	4.0000	1697.95	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	70.26	0 00:15:31
4	Sub-05		7.96	64	86.00	0.1500	2.00	4.0000	571.63	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	39.17	0 00:22:07
5	Sub-06		2.26	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	11.88	0 00:17:03
6	Sub-08		0.61	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.46	3.46	0 00:07:45
7	Sub-09		0.82	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.46	4.65	0 00:09:18
8	Sub-10		0.98	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.46	5.52	0 00:10:21
9	Sub-11		1.26	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	7.00	0 00:12:01
10	Sub-12		1.41	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	7.74	0 00:12:49
11	Sub-13		1.67	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.05	0 00:14:12
12	Sub-16		3.69	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	17.96	0 00:22:54
13	Sub-17		16.94	64	86.00	0.1500	2.00	0.5000	959.36	0.00	0.00	0.0800	0.0150	0.2000	0.0150	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.41	67.80	0 00:37:48
14	Sub-18		18.06	Stor-03	86.00	0.1500	2.00	0.5000	666.62	0.00	0.00	0.0800	0.0150	0.2000	0.0150	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.39	65.95	0 00:48:52
15	Sub-19		2.08	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	11.06	0 00:16:14
16	Sub-20		1.79	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.66	0 00:14:50
17	Sub-21		1.87	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	10.05	0 00:15:14
18	Sub-22		1.90	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	10.17	0 00:15:21
19	Sub-23		1.85	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.97	0 00:15:09
20	Sub-24		1.85	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.96	0 00:15:08
21	Sub-25		2.29	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	12.03	0 00:17:12
22	Sub-26		4.97	64	86.00	0.1500	2.00	25.0000	100.00	0.00	1.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	22.60	0 00:27:22
23	Sub-27		3.17	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	15.86	0 00:20:53
24	Sub-28		2.76	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	14.11	0 00:19:13
25	Sub-29		2.90	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	14.70	0 00:19:47
26	Sub-30		2.54	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	13.18	0 00:18:19
27	Sub-31		2.35	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	12.30	0 00:17:28
28	Sub-32		2.78	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	14.21	0 00:19:18
29	Sub-33		0.58	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.46	3.29	0 00:07:31
30	Sub-34		0.88	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.46	4.94	0 00:09:39
31	Sub-36		1.57	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	8.59	0 00:13:44
32	Sub-37		1.61	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	8.76	0 00:13:54
33	Sub-38		2.11	Jun-100	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	11.20	0 00:16:23
34	Sub-39		2.63	Jun-101	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	13.55	0 00:18:40
35	Sub-40		2.94	Jun-102	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	14.87	0 00:19:57
36	Sub-41		7.82	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.41	31.69	0 00:35:55
37	Sub-42		1.76	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.53	0 00:14:42
38	Sub-43		1.67	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.08	0 00:14:14
39	Sub-44		1.59	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	8.64	0 00:13:47
40	Sub-45		1.70	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	9.20	0 00:14:21
41	Sub-46		1.60	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	8.73	0 00:13:52
42	Sub-47		1.64	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	8.91	0 00:14:03
43	Sub-48		1.47	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	8.04	0 00:13:09
44	Sub-49		12.89	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.39	47.25	0 00:48:30
45	Sub-50		1.87	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.45	10.06	0 00:15:14
46	Sub-51		4.49	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	20.95	0 00:25:46
47	Sub-52		3.07	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	15.45	0 00:20:30
48	Sub-53		3.55	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	17.39	0 00:22:22
49	Sub-54		3.99	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	19.11	0 00:24:00
50	Sub-55		17.26	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.38	57.89	0 00:57:46
51	Sub-56		5.75	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.42	25.15	0 00:29:51
52	Sub-57		3.13	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	15.68	0 00:20:43
53	Sub-58		3.53	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	17.32	0 00:22:17
54	Sub-59		3.93	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	18.87	0 00:23:46
55	Sub-60		4.02	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	19.22	0 00:24:06
56	Sub-61		3.69	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	17.96	0 00:22:54
57	Sub-62		4.83	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	22.12	0 00:26:54
58	Sub-63		4.56	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	21.18	0 00:25:59
59	Sub-65		3.42	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	16.89	0 00:21:53
60	Sub-66		5.79	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.42	25.29	0 00:30:00
61	Sub-67		4.97	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	22.61	0 00:27:22
62	Sub-68		4.49	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	20.95	0 00:25:46
63	Sub-69		4.12	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	19.58	0 00:24:27
64	Sub-70		3.80	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.43	18.36	0 00:23:17
65	Sub-71		3.33	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	16.53	0 00:21:32
66	Sub-72		2.69	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.44	13.82	0 00:18:56
67	Sub-73		8.91	64	86.00	0.1500	2.00	25.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.41	35.39	0 00:38:51

68	Sub-74	6.98	Stor-02	86.00	0.1500	2.00	5.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.38	24.20	0	00:54:24
69	Sub-75	11.06	Stor-01	86.00	0.1500	2.00	5.0000	100.00	0.00	0.00	0.0800	0.0150	0.2000	0.0220	0.00	Rain Gage-04	4.88	0.00	0.0000	1.2210	3.35	32.25	0	01:11:42

Exhibit A.3
Run-on Design Results
TR-55 Method Calculations

North Ranch Surface Waste Management Facility
Run-On Diversion Channel Design

	Parameter	Symbol	Value	Unit	Source
A. PEAK DISCHARGE (TR-55 Method)					

1. Site Data

Composite N Based on USGS Web Soil Survey - Approximate Upstream AOI

Soil Type ID[2]	Soil Type Description[2]	Hydraulic Soil Group[2]	CN[1]	Area (Acres)[2]	CN x Area
BE	Berino-Cacique loamy fine sands association	B	35	467.5	16362.5
BF	Berino-Cacique fine sandy loams association	B	35	228.3	7990.5
BH	Berino-Cacique association, hummocky	B	35	306.8	10738
MM	Ratliff loam	B	35	79.2	2772
MN	Ratliff-Wink fine sandy loams	B	35	40.2	1407
MW	Mobeetie-Potter association, 1 to 15 percent slopes	A	30	93.3	2799
PU	Pyote and maljamar fine sands	A	30	1,890.50	56715
SE	Simona fine sandy loam, 0 to 3 percent slopes	D	55	0.9	49.5
SR	Simona-Upton association	D	55	2,422.20	133221
TF	Tonuco loamy fine sand, 0 to 3 percent slopes	D	55	22.4	1232
WK	Wink loamy fine sand	A	30	4.5	135
			Totals	5555.8	233421.5

Composite CN (Total CN x Area / Total Area) 42.0

[1]TR-55 Manual, Table 2-2d for "Sage brush with Grass Understory - Good Conditions"
[2] From USDA Web Soil Survey for Site AOI includes area north of site up to New Mexico State Highway 128.

Parameter	Symbol	Value	Unit	Source
Hydraulic Soil Group		Variable	Unitless	
Curve Number	CN	42	Unitless	
Drainage Area (Assume Whole Site to One Channel)				
- Site Area	A1	5555.8	Acres	AutoCAD
2 year-24 hour Rainfall Depth	P_2	2.24	Inches	NOAA Atlas 14, Volume 1, Version 5. Jal, New Mexico, USA
25 year-24 hour Rainfall Depth	P_{25}	4.59	Inches	NOAA Atlas 14, Volume 1, Version 5. Jal, New Mexico, USA
25 year-24 hour Rainfall Intensity	I_{25}	0.191	In/hour	NOAA Atlas 14, Volume 1, Version 5. Jal, New Mexico, USA

2. Direct Run-off Calculation

Parameter	Symbol	Value	Unit	Source
Direct Run-off	Q	0.2	Inches	TR-55 Manual, Figure 2-1 using CN and P above.

3. Time of Concentration

Equations:

$$Sheet\ Flow\ (T_1) = 0.007(\frac{(n_1 L_1)^{0.8}}{P_2{}^{0.5} s_1{}^{0.4}})$$

TR-55 Manual Chapter 3, eq. 3-3

$$Shallow\ Concentrated\ (T_2) = \frac{L_2}{3600 V_{sc}}$$

where: Velocity (V2) is taken from Figure 3-1 of the TR-55 Manual

Sheet Flow Time of Concentration:TOP DECK				
Mannings	n_1	0.011	unitless	TR-55 Manual, Table 3-1 for bare soil
Flow Length	L_1	150	Feet	Maximum shallow flow length
2 year-24 hour Rainfall Depth	P_2	2.24	Inches	NOAA Atlas 14, Volume 1, Version 5. Jal, New Mexico, USA
Slope	s_1	0.04	ft/ft	Assumed
Shallow Flow Time of Concentration (TOP DECK):	T_1	0.03637046	Hour	

Shallow Concentrated Time of Concentration: (TOP DECK)_				
Flow Length	L_2	23000	Feet	From GoogleEarth, no decernable channelization
Slope	s_1	0.009	ft/ft	USGS Quadrangle Map
Velocity	V_{sc1}	1.5	feet per second	TR-55 Manual, Figure 3-1 for unpaved surface
Shallow Concentrated Time of Concentration (TOP DECK):	T_2	4.259259259	Hour	

TOTAL TIME OF CONCENTRATION	T_C	4.296	Hour

4. Peak Discharge Calculation

Equations:

$$Peak\ Discharge\ (q_p) = q_u A_m Q F_p$$

TR-55 Manual Chapter 3, eq. 4-1

where

q_u = unit peak discharge (csm/in)

A_m = Drainage Area (mi^2)

Q = Direct Runoff (in)

F_p = pond and swamp adjustment factor

Data:					
Total Drainage Area ($A_1 + A_2$)	A_m		8.6809375	mi^2	summed from above converted to square miles
Curve Number	CN		42	unitless	from above
Time of Concentration	T_C		4.30	hour	calculated above
Rainfall Distribution	-	II		unitless	TR-55 Manual Figure B-2
Swamps in Area	-	none		unitless	site data
Initial Abstraction	I_a		2.762	in	TR-55 Manual Table 4-1
Initial Abstraction / Rainfall Depth	I_a / P_{25}		0.50	unitless	calculated
Unit Peak Discharge	q_u		76	csm/in	TR-55 Manual Exhibit 4-II
Direct Runoff	Q		0.2	in	calculated above
Pond and Swamp Adjustment Factor	F_p		1	unitless	TR-55 Manual Figure 4-2
q_p (peak discharge)	=		132.0	cubic feet per second (CFS)	
Half Peak Discharge, flow split along Northwest property boundary			66.0	cfs	

B. STORMWATER CONVEYANCE CHANNEL SIZING

Section Data				
Mannings Coefficient	n_2	0.022	unitless	https://www.lmnoeng.com/manningn.htm, Excavated Earth Channel - Clean
Channel Slope	s_5	0.001	ft/ft	Design Minimum
Hydraulic Radius	R_n			
Flow Depth(d)	d	2.00	ft	
Side Slope	Z	3.00	H:V	
Bottom Width	b	7.00	ft	
Hydraulic Radius	R	1.323	FT	
Note: assumed cross section				
Velocity	V_{oc3}	2.58	feet per second	

1. Size Channel Check — Mannings Equation for V-ditch

Channel Discharge Check	Q_n	67.1	Cubic Feet Per Second	$Q_n = V_n A$

Design Depth	2.30	ft
Design Freeboard	0.30	Ft

Attachment B

Revised Universal Soil Loss Equation (RUSLE) Calculation

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
REVISED UNIVERSAL SOIL LOSS EVALUATION (RUSLE)

ASSUMPTIONS:
- 2 areas or basin types to consider top deck of landfill and side slope of landfill between collection at diversion berms
- There is 1 top deck area and 38 areas between letdowns subdivided by side slope diversion berms

Basin Type Definition

Basin	Description	Slope (%)	Length (ft)
1	Top Deck	4	400
2	Side Slope Area Between Diversion Berms and Letdowns	25	100

C - Factor Calculation

C	=	$C_{PLU}*C_{CC}*C_{SC}*C_{SR}*C_{SM}$		
C_{PLU}	-	Prior Land Use Subfactor		
	=	1	For Rangeland	
C_{CC}	-	Canopy Cover Subfactor		
	=	1-FC*exp(-0.1*H)		Equation 5-11, NRCS Agricultural Handbook #703
		F_C = Fraction Land Covered by Canopy		
		F_C = 0.5	Conservative Estimate	
		H = Canopy Cover Height		
		H = 1	Conservative Estimate	
	=	0.55		
C_{SC}	-	Surface Cover Subfactor		
	=	$\exp[-b*S_P(0.24/R_U)^{.08}]$		Equation 5-12, NRCS Agricultural Handbook #703
		b = 0.39	Simanton et. al (1984)	
		$S_P = [1-\exp(-\alpha*B_S)]*100$		Equation 5-13, NRCS Agricultural Handbook #703
		α = 0.00055	Table 5-1, NRCS Agricultural Handbook #703	
		B_S = 5 ton/acre^{-1}		
		S_P = 93.61		
		R_U = 0.8	Short Grass, Desert	Table 5-6, NRCS Agricultural Handbook #703
	=	0.036		
C_{SR}	-	Surface Roughness Subfactor		
	=	$\exp[-0.66*(R_U-0.24)]$		Equation 5-23, NRCS Agricultural Handbook #703
	=	0.691		
C_{SM}	-	Soil Moisture Subfactor		
	=	1	Rangeland	
C	=	0.014		

RUSLE Equation Calculation

R	-	Rainfall Value Factor		
	=	45		Fig 2-1 & 2-2, NRCS Agricultural Handbook #703
K	-	Soil Erodibility Factor		
	=	0.13		Soil Type Poorly Graded Silty Sand
LS	-	Slope Length Factor		
	=	Basin	LS	Table 4-3, NRCS Agricultural Handbook #703
		1	1.14	
		2	1.56	
C	-	Covering Management Factor		
	=	0.014		see C factor calculation sheet
P	-	Support Practices Factor		
	=	1		Conservative Estimate
A	-	Calculated Soils Loss in tons/acre-year		
		Basin	A (tons/acrea-year)	
		1	0.093	
		2	0.128	

Total Soil Loss

Basin Type	Calculated Soil Loss A per Basin Type (tons/acre-year)	Number of Basins Types	Total Soil Loss (tons/acre-year)
1	0.093	1	0.093
2	0.128	38	4.864
Total Side Wide Soil Loss			4.957

Attachment C
Leachate Evaporation Pond Sizing – Incidental Precipitation Volume

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
LEACHATE EVAPORATION POND SIZING - INCIDENTAL PRECIPITATION VOLUME

ASSUMPTIONS:
- Area Assumes Largest Cell Open, Cell E-3, and Waste Slope in from Cell C-2
- Incidental precipitation from 25-year, 24-hour storm event

HYDROLOGY PARAMETERS SCS METHOD	VALUE	SOURCE
Precipitation (25-YEAR/24-HOUR EVENT, INCHES)	4.59	NOAA Atlas 14, Volume 1, Version 5. Jal, New Mexico, USA
Curve Number (unitless)	83	TR-55 Manual, Table 2-2a for "Streets/Roads-Dirt" for Hydraulic Soil Group B
Direct Runoff (inches)	2.75	TR-55 Manual, Figure 2-1 using CN and P above.
RUNOFF VOLUME		
Area (acres)	37.3	CALCULATED IN CAD
Runoff Volume (Ac-ft^3)	8.5	calculated
Runoff Volume (CY)	13790.6	calculated
INCIDENTAL RAINFALL OVER POND		
- Area From Site Development Design		
HYDROLOGY PARAMETERS SCS METHOD	VALUE	SOURCE
Precipitation (25-YEAR/24-HOUR EVENT, INCHES)	4.59	NOAA Atlas 14, Volume 1, Version 5. Jal, New Mexico, USA
Curve Number (unitless)	100	Exposed HDPE Impervious Surface
Direct Runoff (inches)	4.59	TR-55 Manual, Figure 2-1 using CN and P above.
RUNOFF VOLUME		
Area (acres)	2	CALCULATED IN CAD
Runoff Volume (Ac-ft^3)	0.765	calculated
Runoff Volume (CY)	1234.2	calculated
TOTAL Runoff Volume (Ac-ft3)	9.3	
TOTAL Runoff Volume (CY)	15024.8	
TOTAL Runoff Volume (CF)	405670.7	

Attachment D
Hydraulic Evaluation of Landfill Performance (HELP) Report

CALCULATIONS BY: Kyle Jackson – Staff Engineer
Michael P. Bradford, P.E. – Senior Project Manager

SOFTWARE: HELP Version 3.95D,
Hydrologic Evaluation of the Landfill Performance - A USACOE model for predicting landfill hydrologic and infiltration processes and testing of effectiveness of landfill designs that was updated by Institute of Soil Science, University of Hamburg, Germany dated August 10, 2012.

METHODOLOGY: *Guidance Document for Performance for an Alternate Cover/Liner Design Under Section 502.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling, New Mexico Environmental Department Solid Waste Bureau Permit Section, April 1, 1998 (Guidance)*
Provided in Exhibit I.

INTRODUCTION:

The following document comprises the HELP modeling for the NGL Water Solutions Permian, LLC (NGL) North Ranch Surface Waste Management Facility (Facility). The site is located 16 miles west Jal, New Mexico and is approximately 303 acres in size. The primary waste accepted by the Facility will be oil field waste.

The applicant proposes to permit, construct and operate the Facility and associated leachate evaporation pond and appurtenances. The facility design is split into Phase 1 and Phase 2, with a centrally located temporary road running between the phases. Each phase is divided into cells ranging from 15 acres to 23 acres in size with a total waste disposal size of 205 acres. The proposed disposal area design is expected to yield approximately 40,264,324 cubic yards of airspace. The weather data was obtained from NOAA using monthly averages for precipitation of the 5 wettest consecutive years (manually entered) and the monthly averages for temperature of the corresponding years (manually entered) (see **Exhibit J**) and solar inputs based on the corresponding years. The weather data used was the more complete data set from the Roswell Industrial Air Park station.

ANALYSIS:

The HELP Model version 3.95D was used to calculate approximate leachate flow rates and liquid heads above the liner system under eight different scenarios. The scenarios were to compare the alternate cover/liner systems proposed by Terracon and the prescriptive cover/liner system defined by NMAC 19.15.36.14.

Final Cover Demonstration – Tier 1 Analysis

- Scenario 1 portrays the prescriptive final cover system outlined in NMAC 19.15.36.14. See **Table D.1,** and **Exhibit A** for modeling results.
- Scenario 2 portrays the alternate final cover system designed by Terracon. See **Table D.2,** and **Exhibit B** for modeling results.

Base Liner Demonstration – Tier 1 Analysis

- Scenario 3 portrays the prescriptive liner system set forth by NMAC 19.15.36.14 of the largest cell in the disposal area. See **Table D.3,** and **Exhibit C** for modeling results.
- Scenario 4 portrays the alternate liner system designed by Terracon of the largest cell in the disposal area prior to waste being placed over the cell. See **Table D.4,** and **Exhibit D** for modeling results.

Base Liner Demonstration – Tier 2 Analysis

- Scenario 5 portrays the alternate liner system designed by Terracon of the largest cell in the disposal area prior to waste being placed over the cell. See **Table D.4,** and **Exhibit E** for modeling results.
- Scenario 6 portrays the alternate liner system of the entire disposal area with 20' of waste placed. See **Table D.5,** and **Exhibit F** for modeling results.
- Scenario 7 portrays the alternate liner system of the entire disposal area completely filled with alternative final cover placed but with no vegetation developed. See **Table D.6,** and **Exhibit G** for modeling results.
- Scenario 8 portrays the alternate liner system of the entire disposal area completely filled with alternative final cover placed with vegetation developed. See **Table D.7,** and **Exhibit H** for modeling results.

The layers for each scenario analyzed using the HELP Model are described below in **the following tables.**

Table D.1 Scenario 1 - Prescriptive Final Cover Design

Layer	Description	Thickness	K_{sat} (cm/se)
1	Erosion Layer	12-in	1×10^{-5}
2	Final Cover	12-in	1×10^{-5}
3	Drainage Sand	12-in	1×10^{-2}
4	Geomembrane	60-mil	2×10^{-13}
5	Drainage Sand	12-in	1×10^{-2}
6	Intermediate Cover	12-in	1×10^{-5}

Table D.2 Scenario 2 - Alternate Final Cover

Layer	Description	Thickness	K_{sat} (cm/se)
1	Erosion Layer	12-in	1×10^{-5}
2	Final Cover	36-in	1×10^{-5}
3	Intermediate Cover	12-in	1×10^{-5}

Table D.3 Scenario 3 - Prescriptive Liner

Layer	Description	Thickness	K_{sat} (cm/se)
1	Protective/Drainage Soil	24-in	1×10^{-2}
2	Geomembrane	60-mil	2×10^{-13}
3	On-Site Soil	24-in	1×10^{-5}
4	Geomembrane	60-mil	2×10^{-13}
5	Compacted Clay Liner	24-in	1×10^{-7}

Table D.4 Scenario 4 and 5 - Alternate Liner System Design

Layer	Description	Thickness	K_{sat} (cm/se)
1	Protective/Drainage Soil	24-in	1×10^{-5}
2	Geocomposite	200-mil	10
3	Geomembrane	60-mil	2×10^{-13}
4	Geocomposite Leak Detection	200-mil	10
5	Geomembrane	60-mil	2×10^{-13}
6	Geosynthetic Clay Liner	240-mil	3×10^{-9}

Table D.5 Scenario 6 - Alternate Liner - 20' Filled

Layer	Description	Thickness	K_{sat} (cm/se)
1	Waste	20-ft	1×10^{-3}
2	Protective/Drainage Soil	24-in	1×10^{-5}
3	Geocomposite	200-mil	10
4	Geomembrane	60-mil	2×10^{-13}
5	Geocomposite Leak Detection	200-mil	10
6	Geomembrane	60-mil	2×10^{-13}
7	Geosynthetic Clay Liner	240-mil	3×10^{-9}

Table D.6 Scenario 7 - Alternate Liner - Filled with Final Cover No Vegetation

Layer	Description	Thickness	K_{sat} (cm/se)
1	Erosion Layer	12-in	1×10^{-5}
2	Final Cover	36-in	1×10^{-5}
3	Intermediate Cover	12-in	1×10^{-5}
4	Waste	227-ft	1×10^{-3}
5	Protective/Drainage Soil	24-in	1×10^{-5}
6	Geocomposite	200-mil	10
7	Geomembrane	60-mil	2×10^{-13}

8	Geocomposite Leak Detection	200-mil	10
9	Geomembrane	60-mil	2×10^{-13}
10	Geosynthetic Clay Liner	240-mil	3×10^{-9}

Table D.7 Scenario 8 - Alternate Liner - Filled Established Vegetation

Layer	Description	Thickness	K_{sat} (cm/se)
1	Erosion Layer	12-in	1×10^{-5}
2	Final Cover	36-in	1×10^{-5}
3	Intermediate Cover	12-in	1×10^{-5}
4	Waste	227-ft	1×10^{-3}
5	Protective/Drainage Soil	24-in	1×10^{-5}
6	Geocomposite	200-mil	10
7	Geomembrane	60-mil	2×10^{-13}
8	Geocomposite Leak Detection	200-mil	10
9	Geomembrane	60-mil	2×10^{-13}
10	Geosynthetic Clay Liner	240-mil	3×10^{-9}

Site specific soil and climate conditions and parameters are established using HELP Model predefined input data. The cell floor is modeled assuming a 600 ft maximum lateral drainage length at 2% grade. The final cover is modeled with a maximum lateral drainage length of 750 ft at 4% grade. Initial moisture of soil components is calculated using the 25% rule stated in the Guidance. The individual HELP Model evaluation results stating the various conditions of the different scenarios can be found in **Exhibit A-H**.

SUMMARY OF RESULTS:
The following **Table D.8** is a summary of the HELP modeling results as related to the Guidance and NMAC requirements.

Table D.8 Summary of HELP Modeling Results

Scenario	Critical Layer	Percolation Through Critical Layer (inches)	Maximum Head on Primary Liner (Inches)	Comments
Tier I - Alternative Final Cover Equivalency Demonstration				
1 - Prescriptive Final Cover (NMAC 19.15.36.14.C(8))	Layer 4	0.0	n/a	none
2 – Alternative Final Cover	Layer 3	0.0	n/a	Equivalent hydraulic performance to prescriptive final cover system

Scenario	Critical Layer	Percolation Through Critical Layer (inches)	Maximum Head on Primary Liner (Inches)	Comments
Tier I – Alternative Base Liner Equivalency Demonstration				
3 – Prescriptive Liner Over Largest Cell (NMAC 19.15.26.14.C)	Layer 5	0.0	26.4	none
4 – Alternative Liner Over Largest Cell	Layer 6	0.0	0.257	Performance exceeds performance of the prescriptive line system. Is in compliance with NMAC 19.15.36.14.F as head over the liner does not exceed 1-ft.
Tier II – Alternative Base Liner Groundwater Protection Demonstration				
5 – Alternative Liner Over Entire Landfill, Prior to Waste Placement	Layer 6	0.0	0.025	No percolation through the clay barrier, thus protective of groundwater.
6 – Alternative Liner Over Entire Landfill, with 20' of Waste Placement	Layer 7	0.0	0.0	No percolation through the clay barrier, thus protective of groundwater.
7 – Alternative Liner Over Entire Landfill, Filled to Final Grade with Alternative Final Cover with no vegetation established	Layer 10	0.0	0.0	No percolation through the clay barrier, thus protective of groundwater.
8 – Alternative Liner Over Entire Landfill, Filled to Final Grade with Alternative Final Cover with poor cover vegetation established	Layer 10	0.0	0.0	No percolation through the clay barrier, thus protective of groundwater.

In conclusion, the proposed alternative final cover and base liner systems have demonstrated equivalent or better hydraulic performance to that of the NMAC prescriptive systems. In addition, as shown there is no percolation anticipated through the proposed alternative final cover system. The cap is designed to remove moisture from the cap by either evaporation or plant transpiration before moving through the cap's thickness. Therefore, the final cover system effectively prevents the "bathtub effect" and is in compliance with NMAC 19.15.39.14.C.(9).

Exhibit A
SCENARIO 1 HELP MODEL RESULTS

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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      3    RUNOFF (INCH)
      4    POTENTIAL EVAPOTRANSPIRATION (INCH)
      5    ACTUAL EVAPOTRANSPIRATION (INCH)
      6    DRAIN #1: LATERAL DRAINAGE FROM LAYER  3 (INCH)
      7    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  4 (INCH)
      8    LEAK  #2: PERCOLATION/LEAKAGE THROUGH LAYER  5 (INCH)
      9    CHANGE IN TOTAL WATER STORAGE (INCH)
     10    CHANGE IN SOIL WATER STORAGE (INCH)
     11    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
     12    CHANGE IN SNOW WATER STORAGE (INCH)
     13    ANNUAL WATER BUDGET BALANCE (INCH)


******************************************************************************

      TITLE:  Prescriptive Final Cover

******************************************************************************


                           WEATHER DATA SOURCES
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.35	0.72	0.30	0.67	2.01	3.48
1.90	2.74	1.83	1.90	0.81	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.40	45.20	52.50	61.00	69.50	76.10
79.30	78.50	71.00	61.10	50.00	40.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO
AND STATION LATITUDE = 33.24 DEGREES

****

LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1340 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1720 VOL/VOL

```
          EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                                  LAYER  3
                                  --------

                      TYPE 2 - LATERAL DRAINAGE LAYER
                        MATERIAL TEXTURE NUMBER   1
          THICKNESS                  =     12.00   INCHES
          POROSITY                   =      0.4170 VOL/VOL
          FIELD CAPACITY             =      0.0450 VOL/VOL
          WILTING POINT              =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT  =     0.0250 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-01 CM/SEC
          SLOPE                      =      4.00   PERCENT
          DRAINAGE LENGTH            =    750.0    FEET


                                  LAYER  4
                                  --------

                      TYPE 4 - FLEXIBLE MEMBRANE LINER
                        MATERIAL TEXTURE NUMBER  35
          THICKNESS                  =      0.06   INCHES
          EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
          FML PINHOLE DENSITY        =      4.00   HOLES/ACRE
          FML INSTALLATION DEFECTS   =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY      =  3 - GOOD


                                  LAYER  5
                                  --------

                    TYPE 1 - VERTICAL PERCOLATION LAYER
                        MATERIAL TEXTURE NUMBER   1
          THICKNESS                  =     12.00   INCHES
          POROSITY                   =      0.4170 VOL/VOL
          FIELD CAPACITY             =      0.0450 VOL/VOL
          WILTING POINT              =      0.0180 VOL/VOL
          INITIAL SOIL WATER CONTENT  =     0.1720 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-01 CM/SEC


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                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                              VALID FOR   5 YEARS


        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                 SOIL DATA BASE USING SOIL TEXTURE # 7 WITH A
                 POOR STAND OF GRASS, A SURFACE SLOPE OF  4.%
                 AND A SLOPE LENGTH OF  750. FEET.

       SCS RUNOFF CURVE NUMBER             =     82.43
       FRACTION OF AREA ALLOWING RUNOFF    =    100.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE  =    205.000  ACRES
       EVAPORATIVE ZONE DEPTH              =     24.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE   =      3.672  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE  =     11.352  INCHES
       FIELD CAPACITY OF EVAPORATIVE ZONE  =      5.328  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE  =      2.496  INCHES
       SOIL EVAPORATION ZONE DEPTH         =     24.000  INCHES
       INITIAL SNOW WATER                  =      0.000  INCHES
       INITIAL INTERCEPTION WATER          =      0.000  INCHES
```

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      INITIAL WATER IN LAYER MATERIALS    =      6.036  INCHES
      TOTAL INITIAL WATER                 =      6.036  INCHES
      TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


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                        EVAPOTRANSPIRATION DATA   1
------------------------------------------------------------------------------

                            VALID FOR   5 YEARS


       NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
               ROSWELL              NEW MEXICO
           STATION LATITUDE                       = 33.24 DEGREES
           MAXIMUM LEAF AREA INDEX                =  1.20
           START OF GROWING SEASON (JULIAN DATE)  =    76
           END OF GROWING SEASON (JULIAN DATE)    =   310
           EVAPORATIVE ZONE DEPTH                 = 24.0  INCHES
           AVERAGE ANNUAL WIND SPEED              =  8.70 MPH
           AVERAGE 1ST QUARTER RELATIVE HUMIDITY  = 49.0  %
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY  = 40.0  %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY  = 53.0  %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY  = 52.0  %

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                          ANNUAL TOTALS FOR YEAR    1
-------------------------------------------------------------------------------

                                           INCHES         CU. FEET     PERCENT
                                          --------       ----------    -------
  PRECIPITATION                            12.67        9428383.000    100.00

  RUNOFF                                    2.440       1815890.500     19.26

  POTENTIAL EVAPOTRANSPIRATION             76.038      56583840.000

  ACTUAL EVAPOTRANSPIRATION                10.243       7622132.000     80.84

  DRAINAGE COLLECTED FROM LAYER  3          0.0000            0.000      0.00

  PERC./LEAKAGE THROUGH LAYER  4            0.000000          0.000      0.00

  AVG. HEAD ON TOP OF LAYER  4              0.0000

  PERC./LEAKAGE THROUGH LAYER  5            1.327622     987949.812     10.48

  CHANGE IN WATER STORAGE                  -1.341       -997593.688    -10.58

  SOIL WATER AT START OF YEAR               6.336       4714927.000

  SOIL WATER AT END OF YEAR                 4.995       3717333.250

  INTERCEPTION WATER AT START OF YEAR       0.000             0.000

  INTERCEPTION WATER AT END OF YEAR         0.000             0.000

  SNOW WATER AT START OF YEAR               0.000             0.000      0.00

  SNOW WATER AT END OF YEAR                 0.000             0.000      0.00

  ANNUAL WATER BUDGET BALANCE               0.0000            3.548      0.00
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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.13	16468041.000	100.00
RUNOFF	6.346	4722008.500	28.67
POTENTIAL EVAPOTRANSPIRATION	75.116	55897788.000	
ACTUAL EVAPOTRANSPIRATION	14.357	10683393.000	64.87
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 5	0.063343	47136.418	0.29
CHANGE IN WATER STORAGE	1.365	1015503.750	6.17
SOIL WATER AT START OF YEAR	4.995	3717333.250	
SOIL WATER AT END OF YEAR	6.360	4732837.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.710	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.51	13774217.000	100.00
RUNOFF	4.117	3063777.250	22.24
POTENTIAL EVAPOTRANSPIRATION	75.152	55924352.000	
ACTUAL EVAPOTRANSPIRATION	14.163	10539217.000	76.51
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 5	0.033784	25140.037	0.18

CHANGE IN WATER STORAGE	0.196	146084.109	1.06
SOIL WATER AT START OF YEAR	6.360	4732837.000	
SOIL WATER AT END OF YEAR	6.244	4646806.500	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.312	232114.266	1.69
ANNUAL WATER BUDGET BALANCE	0.0000	-1.153	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.91	11095278.000	100.00
RUNOFF	4.511	3356853.000	30.25
POTENTIAL EVAPOTRANSPIRATION	75.777	56389536.000	
ACTUAL EVAPOTRANSPIRATION	11.845	8814219.000	79.44
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 5	0.022665	16865.910	0.15
CHANGE IN WATER STORAGE	-1.468	-1092660.125	-9.85
SOIL WATER AT START OF YEAR	6.244	4646806.500	
SOIL WATER AT END OF YEAR	5.088	3786261.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.312	232114.266	2.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.444	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.18	14272800.000	100.00
RUNOFF	5.755	4282273.500	30.00
POTENTIAL EVAPOTRANSPIRATION	74.468	55415588.000	
ACTUAL EVAPOTRANSPIRATION	12.905	9603489.000	67.29
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
PERC./LEAKAGE THROUGH LAYER 5	0.016789	12493.663	0.09
CHANGE IN WATER STORAGE	0.503	374542.531	2.62
SOIL WATER AT START OF YEAR	5.088	3786261.000	
SOIL WATER AT END OF YEAR	5.591	4160803.750	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.306	0.00

****

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	3.1436	0.2620
2	1.2480	0.1040
3	0.3000	0.0250
4	0.0000	0.0000
5	0.5998	0.0500

TOTAL WATER IN LAYERS	5.291
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	5.291

****

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.22	2396163.000
RUNOFF	2.565	1908494.6250
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	
MAXIMUM HEAD ON TOP OF LAYER 4	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 3 (DISTANCE FROM DRAIN)	0.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.436997	325191.65625
SNOW WATER	2.39	1774816.8750
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2385	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.25	0.43	0.33	0.48	2.06	2.41
	2.29	2.42	1.75	1.44	2.05	1.57
STD. DEVIATIONS	0.28	0.11	0.29	0.39	1.94	2.94
	1.07	1.68	1.12	1.68	2.50	1.09
RUNOFF						
TOTALS	0.028	0.000	0.000	0.037	0.661	1.365
	0.481	0.491	0.127	0.529	0.630	0.284
STD. DEVIATIONS	0.063	0.000	0.000	0.036	0.887	1.950
	0.366	0.445	0.238	1.016	0.947	0.364
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.006	3.630	5.121	7.372	9.278	10.074
	10.034	8.741	6.610	5.205	3.692	2.548
STD. DEVIATIONS	0.194	0.200	0.191	0.353	0.460	0.188
	0.100	0.266	0.307	0.177	0.178	0.242

```
  ACTUAL EVAPOTRANSPIRATION
  -------------------------
    TOTALS                 0.475    0.346    0.279    0.471    2.406    1.509
                           1.759    1.935    1.260    0.739    0.810    0.712

    STD. DEVIATIONS        0.171    0.087    0.097    0.182    1.017    1.562
                           0.726    1.058    0.675    0.455    0.506    0.291

  LATERAL DRAINAGE COLLECTED FROM LAYER  3
  ----------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  4
  ------------------------------------
    TOTALS                 0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

  PERCOLATION/LEAKAGE THROUGH LAYER  5
  ------------------------------------
    TOTALS                 0.2098   0.0202   0.0134   0.0093   0.0077   0.0062
                           0.0056   0.0050   0.0043   0.0041   0.0037   0.0035

    STD. DEVIATIONS        0.4606   0.0380   0.0224   0.0140   0.0105   0.0078
                           0.0065   0.0054   0.0044   0.0039   0.0033   0.0030


-------------------------------------------------------------------------------
               AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)
-------------------------------------------------------------------------------


  DAILY AVERAGE HEAD ON TOP OF LAYER  4
  -------------------------------------
    AVERAGES               0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

    STD. DEVIATIONS        0.0000   0.0000   0.0000   0.0000   0.0000   0.0000
                           0.0000   0.0000   0.0000   0.0000   0.0000   0.0000

*******************************************************************************


*******************************************************************************

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                                      INCHES            CU. FEET      PERCENT
                               -------------------  -------------  ---------
 PRECIPITATION                  17.48    (   3.719)  13007743.0     100.00

 RUNOFF                          4.634   (  1.5231)   3448160.75     26.509

 POTENTIAL EVAPOTRANSPIRATION   75.310   (  0.6175)  56042220.00

 ACTUAL EVAPOTRANSPIRATION      12.702   (  1.7099)   9452490.00     72.668

 LATERAL DRAINAGE COLLECTED      0.00000 (  0.00000)        0.000    0.00000
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH     0.00000 (  0.00000)        0.000     0.00000
   LAYER  4
```

AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.29284	(0.57874)	217917.188	1.67529
CHANGE IN WATER STORAGE	-0.149	(1.2244)	-110824.68	-0.852

****
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Exhibit B
SCENARIO 2 HELP MODEL RESULTS

```
******************************************************************************
 ******************************************************************************
 **                                                                          **
 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
 **                                                                          **
 **              HELP Version 3.95 D          (10 August 2012)               **
 **                              developed at                                **
 **        Institute of Soil Science, University of Hamburg, Germany         **
 **                                based on                                  **
 **              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
 **                    USAE WATERWAYS EXPERIMENT STATION                     **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************


 TIME:  16.29     DATE:  24.09.2019


 PRECIPITATION DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\PRECCOV-.D4
 TEMPERATURE DATA FILE:         N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\TEMPCOV-.D7
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Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\SOLCOV-.D13
 EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\EVAPCOV-.D11
 SOIL AND DESIGN DATA FILE  1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExB-FinalCoverAlternate\Soil and Design.d10
 OUTPUT DATA FILE:              N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExB-FinalCoverAlternate\Summary Output Files.out
 YEARLY OUTPUT DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExB-FinalCoverAlternate\Summary Output Files.YR

 COLUMNS OF YEARLY OUTPUT DATA FILE:

      1    DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
      2    PRECIPITATION (INCH)
      3    RUNOFF (INCH)
      4    POTENTIAL EVAPOTRANSPIRATION (INCH)
      5    ACTUAL EVAPOTRANSPIRATION (INCH)
      6    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  3 (INCH)
      7    CHANGE IN TOTAL WATER STORAGE (INCH)
      8    CHANGE IN SOIL WATER STORAGE (INCH)
      9    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
     10    CHANGE IN SNOW WATER STORAGE (INCH)
     11    ANNUAL WATER BUDGET BALANCE (INCH)


 ******************************************************************************

      TITLE:  Alternate Final Cover

 ******************************************************************************


                           WEATHER DATA SOURCES
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```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
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1.90	2.74	1.83	1.90	0.81	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.40	45.20	52.50	61.00	69.50	76.10
79.30	78.50	71.00	61.10	50.00	40.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO
AND STATION LATITUDE = 33.24 DEGREES

****

LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3210 VOL/VOL
WILTING POINT	=	0.2210 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2460 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4750 VOL/VOL
FIELD CAPACITY	=	0.3780 VOL/VOL
WILTING POINT	=	0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2930 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 3

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4750 VOL/VOL
FIELD CAPACITY	=	0.3780 VOL/VOL
WILTING POINT	=	0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2930 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

****

GENERAL DESIGN AND EVAPORATIVE ZONE DATA 1

VALID FOR 5 YEARS

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #13 WITH A POOR STAND OF GRASS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 750. FEET.

SCS RUNOFF CURVE NUMBER	=	91.59	
FRACTION OF AREA ALLOWING RUNOFF	=	100.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	205.000	ACRES
EVAPORATIVE ZONE DEPTH	=	24.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	6.468	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	10.860	INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE	=	8.388	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	5.832	INCHES
SOIL EVAPORATION ZONE DEPTH	=	24.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL INTERCEPTION WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	17.016	INCHES
TOTAL INITIAL WATER	=	17.016	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

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EVAPOTRANSPIRATION DATA 1

VALID FOR 5 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM ROSWELL NEW MEXICO

STATION LATITUDE	=	33.24 DEGREES
MAXIMUM LEAF AREA INDEX	=	1.20
START OF GROWING SEASON (JULIAN DATE)	=	76
END OF GROWING SEASON (JULIAN DATE)	=	310
EVAPORATIVE ZONE DEPTH	=	24.0 INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70 MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	49.0 %
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	40.0 %
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	53.0 %
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	52.0 %

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.67	9428383.000	100.00
RUNOFF	2.573	1914555.500	20.31
POTENTIAL EVAPOTRANSPIRATION	76.038	56583840.000	
ACTUAL EVAPOTRANSPIRATION	10.036	7468518.500	79.21
PERC./LEAKAGE THROUGH LAYER 3	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.061	45305.766	0.48
SOIL WATER AT START OF YEAR	17.016	12662415.000	
SOIL WATER AT END OF YEAR	17.077	12707720.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.129	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.13	16468041.000	100.00
RUNOFF	7.130	5306129.500	32.22
POTENTIAL EVAPOTRANSPIRATION	75.116	55897788.000	
ACTUAL EVAPOTRANSPIRATION	13.297	9895285.000	60.09
PERC./LEAKAGE THROUGH LAYER 3	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	1.702	1266625.375	7.69
SOIL WATER AT START OF YEAR	17.077	12707720.000	
SOIL WATER AT END OF YEAR	18.779	13974345.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.129	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.51	13774217.000	100.00
RUNOFF	4.766	3546614.750	25.75
POTENTIAL EVAPOTRANSPIRATION	75.152	55924352.000	
ACTUAL EVAPOTRANSPIRATION	13.899	10342769.000	75.09
PERC./LEAKAGE THROUGH LAYER 3	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	-0.155	-115164.930	-0.84
SOIL WATER AT START OF YEAR	18.779	13974345.000	
SOIL WATER AT END OF YEAR	18.312	13627067.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.312	232114.266	1.69
ANNUAL WATER BUDGET BALANCE	0.0000	-1.419	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.91	11095278.000	100.00
RUNOFF	4.913	3655879.750	32.95
POTENTIAL EVAPOTRANSPIRATION	75.777	56389536.000	
ACTUAL EVAPOTRANSPIRATION	11.153	8299259.500	74.80
PERC./LEAKAGE THROUGH LAYER 3	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	-1.155	-859862.812	-7.75
SOIL WATER AT START OF YEAR	18.312	13627067.000	
SOIL WATER AT END OF YEAR	17.469	12999317.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.312	232114.266	2.09

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	1.419	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.18	14272800.000	100.00
RUNOFF	6.201	4614677.000	32.33
POTENTIAL EVAPOTRANSPIRATION	74.468	55415588.000	
ACTUAL EVAPOTRANSPIRATION	12.973	9653585.000	67.64
PERC./LEAKAGE THROUGH LAYER 3	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.006	4534.834	0.03
SOIL WATER AT START OF YEAR	17.469	12999317.000	
SOIL WATER AT END OF YEAR	17.475	13003852.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.839	0.00

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	3.7468	0.3122
2	10.2119	0.2837
3	3.5160	0.2930
TOTAL WATER IN LAYERS	17.475	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	17.475	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.22	2396163.000
RUNOFF	2.561	1905583.0000
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.000000	0.00000
SNOW WATER	2.39	1774816.8750
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.3582	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.2430	

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.25	0.43	0.33	0.48	2.06	2.41
	2.29	2.42	1.75	1.44	2.05	1.57
STD. DEVIATIONS	0.28	0.11	0.29	0.39	1.94	2.94
	1.07	1.68	1.12	1.68	2.50	1.09
RUNOFF						
TOTALS	0.033	0.000	0.000	0.064	0.747	1.434
	0.546	0.555	0.151	0.575	0.688	0.324
STD. DEVIATIONS	0.073	0.000	0.000	0.061	0.915	2.014
	0.415	0.502	0.243	1.004	1.055	0.388
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.006	3.630	5.121	7.372	9.278	10.074
	10.034	8.741	6.610	5.205	3.692	2.548
STD. DEVIATIONS	0.194	0.200	0.191	0.353	0.460	0.188
	0.100	0.266	0.307	0.177	0.178	0.242
ACTUAL EVAPOTRANSPIRATION						
TOTALS	0.489	0.362	0.415	0.435	2.219	0.993
	1.777	1.921	1.216	0.764	0.908	0.774
STD. DEVIATIONS	0.248	0.087	0.295	0.124	0.989	1.105
	0.815	1.274	0.837	0.539	0.556	0.292
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.48 (3.719)	13007743.0	100.00
RUNOFF	5.117 (1.7225)	3807571.25	29.272
POTENTIAL EVAPOTRANSPIRATION	75.310 (0.6175)	56042220.00	
ACTUAL EVAPOTRANSPIRATION	12.272 (1.6156)	9131883.00	70.203
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00000 (0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	0.092 (1.0269)	68287.65	0.525

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Exhibit C
SCENARIO 3 HELP MODEL RESULTS

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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 TIME:  15.39     DATE:  24.09.2019


 PRECIPITATION DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\PRECIP~-.D4
 TEMPERATURE DATA FILE:         N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\TEMPER~-.D7
 SOLAR RADIATION DATA FILE:     N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\SOLARR~-.D13
 EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\EVAPOT~-.D11
 SOIL AND DESIGN DATA FILE  1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExC-PrescriptiveLiner\Soil and Design Data.d10
 OUTPUT DATA FILE:              N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExC-PrescriptiveLiner\Summary Output.out
 YEARLY OUTPUT DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExC-PrescriptiveLiner\Summary Output.YR

 COLUMNS OF YEARLY OUTPUT DATA FILE:

      1    DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
      2    PRECIPITATION (INCH)
      3    RUNOFF (INCH)
      4    POTENTIAL EVAPOTRANSPIRATION (INCH)
      5    ACTUAL EVAPOTRANSPIRATION (INCH)
      6    DRAIN #1: LATERAL DRAINAGE FROM LAYER  1 (INCH)
      7    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  2 (INCH)
      8    LEAK  #2: PERCOLATION/LEAKAGE THROUGH LAYER  4 (INCH)
      9    LEAK  #3: PERCOLATION/LEAKAGE THROUGH LAYER  5 (INCH)
     10    CHANGE IN TOTAL WATER STORAGE (INCH)
     11    CHANGE IN SOIL WATER STORAGE (INCH)
     12    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
     13    CHANGE IN SNOW WATER STORAGE (INCH)
     14    ANNUAL WATER BUDGET BALANCE (INCH)


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      TITLE:  Prescriptive Liner

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WEATHER DATA SOURCES

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.35	0.72	0.30	0.67	2.01	3.48
1.90	2.74	1.83	1.90	0.81	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.40	45.20	52.50	61.00	69.50	76.10
79.30	78.50	71.00	61.10	50.00	40.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO AND STATION LATITUDE = 33.24 DEGREES

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LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 1

THICKNESS	=	24.00	INCHES
POROSITY	=	0.4170	VOL/VOL
FIELD CAPACITY	=	0.0450	VOL/VOL
WILTING POINT	=	0.0180	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0250	VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-01	CM/SEC
SLOPE	=	2.00	PERCENT
DRAINAGE LENGTH	=	600.0	FEET

LAYER 2

TYPE 4 - FLEXIBLE MEMBRANE LINER
MATERIAL TEXTURE NUMBER 35

THICKNESS	=	0.06	INCHES
EFFECTIVE SAT. HYD. CONDUCT.	=	0.2000E-12	CM/SEC

```
FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.5010 VOL/VOL
FIELD CAPACITY              =      0.2840 VOL/VOL
WILTING POINT               =      0.1350 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2930 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  16
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4270 VOL/VOL
FIELD CAPACITY              =      0.4180 VOL/VOL
WILTING POINT               =      0.3670 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3800 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-06 CM/SEC


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                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
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                              VALID FOR   5 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                  SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE
                  GROUND CONDITIONS, A SURFACE SLOPE OF  2.% AND
                  A SLOPE LENGTH OF  600. FEET.

           SCS RUNOFF CURVE NUMBER            =     71.76
           FRACTION OF AREA ALLOWING RUNOFF   =      0.0    PERCENT
           AREA PROJECTED ON HORIZONTAL PLANE =     24.000  ACRES
           EVAPORATIVE ZONE DEPTH             =     14.0    INCHES
           INITIAL WATER IN EVAPORATIVE ZONE  =      0.350  INCHES
           UPPER LIMIT OF EVAPORATIVE STORAGE =      5.838  INCHES
           FIELD CAPACITY OF EVAPORATIVE ZONE =      0.630  INCHES
           LOWER LIMIT OF EVAPORATIVE STORAGE =      0.252  INCHES
           SOIL EVAPORATION ZONE DEPTH        =     11.722  INCHES
           INITIAL SNOW WATER                 =      0.000  INCHES
           INITIAL INTERCEPTION WATER         =      0.000  INCHES
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INITIAL WATER IN LAYER MATERIALS    =     16.752  INCHES
TOTAL INITIAL WATER                 =     16.752  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
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                        EVAPOTRANSPIRATION DATA   1
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                            VALID FOR   5 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  ROSWELL              NEW MEXICO
             STATION LATITUDE                         =  33.24 DEGREES
             MAXIMUM LEAF AREA INDEX                  =   0.00
             START OF GROWING SEASON (JULIAN DATE)    =     76
             END OF GROWING SEASON (JULIAN DATE)      =    310
             EVAPORATIVE ZONE DEPTH                   =  14.0  INCHES
             AVERAGE ANNUAL WIND SPEED                =   8.70 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY    =  49.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY    =  40.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY    =  53.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY    =  52.0  %

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                          ANNUAL TOTALS FOR YEAR    1
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	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.67	1103810.625	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	76.038	6624449.500	
ACTUAL EVAPOTRANSPIRATION	8.888	774333.812	70.15
DRAINAGE COLLECTED FROM LAYER 1	1.2060	105063.555	9.52
PERC./LEAKAGE THROUGH LAYER 2	0.062961	5485.164	0.50
AVG. HEAD ON TOP OF LAYER 2	1.7421		
PERC./LEAKAGE THROUGH LAYER 4	0.001302	113.420	0.01
AVG. HEAD ON TOP OF LAYER 4	0.9239		
PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	2.576	224413.000	20.33
SOIL WATER AT START OF YEAR	24.828	2163015.000	
SOIL WATER AT END OF YEAR	27.404	2387428.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.125	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.13	1927965.875	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.116	6544130.500	
ACTUAL EVAPOTRANSPIRATION	12.436	1083456.750	56.20
DRAINAGE COLLECTED FROM LAYER 1	6.3987	557453.562	28.91
PERC./LEAKAGE THROUGH LAYER 2	0.324183	28242.811	1.46
AVG. HEAD ON TOP OF LAYER 2	9.2551		
PERC./LEAKAGE THROUGH LAYER 4	0.001808	157.552	0.01
AVG. HEAD ON TOP OF LAYER 4	1.3247		
PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	3.295	287055.406	14.89
SOIL WATER AT START OF YEAR	27.404	2387428.000	
SOIL WATER AT END OF YEAR	30.699	2674483.250	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.166	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.51	1612591.375	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.152	6547241.500	
ACTUAL EVAPOTRANSPIRATION	11.720	1021062.312	63.32

DRAINAGE COLLECTED FROM LAYER 1	6.4143	558813.438	34.65
PERC./LEAKAGE THROUGH LAYER 2	0.324821	28298.393	1.75
AVG. HEAD ON TOP OF LAYER 2	9.3013		
PERC./LEAKAGE THROUGH LAYER 4	0.002970	258.735	0.02
AVG. HEAD ON TOP OF LAYER 4	2.2782		
PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.376	32715.861	2.03
SOIL WATER AT START OF YEAR	30.699	2674483.250	
SOIL WATER AT END OF YEAR	30.762	2680024.750	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.312	27174.352	1.69
ANNUAL WATER BUDGET BALANCE	0.0000	-0.457	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.91	1298959.375	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.777	6601701.500	
ACTUAL EVAPOTRANSPIRATION	8.401	731919.438	56.35
DRAINAGE COLLECTED FROM LAYER 1	6.3879	556517.500	42.84
PERC./LEAKAGE THROUGH LAYER 2	0.323517	28184.820	2.17
AVG. HEAD ON TOP OF LAYER 2	9.2427		
PERC./LEAKAGE THROUGH LAYER 4	0.004641	404.294	0.03
AVG. HEAD ON TOP OF LAYER 4	3.6860		
PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	0.121	10522.437	0.81
SOIL WATER AT START OF YEAR	30.762	2680024.750	
SOIL WATER AT END OF YEAR	31.195	2717721.750	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	

SNOW WATER AT START OF YEAR	0.312	27174.352	2.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.042	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.18	1670962.000	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	74.468	6487678.500	
ACTUAL EVAPOTRANSPIRATION	13.799	1202167.750	71.94
DRAINAGE COLLECTED FROM LAYER 1	6.5856	573738.438	34.34
PERC./LEAKAGE THROUGH LAYER 2	0.333020	29012.693	1.74
AVG. HEAD ON TOP OF LAYER 2	9.5428		
PERC./LEAKAGE THROUGH LAYER 4	0.006290	548.008	0.03
AVG. HEAD ON TOP OF LAYER 4	5.1238		
PERC./LEAKAGE THROUGH LAYER 5	0.000000	0.000	0.00
CHANGE IN WATER STORAGE	-1.205	-104944.695	-6.28
SOIL WATER AT START OF YEAR	31.195	2717721.750	
SOIL WATER AT END OF YEAR	29.991	2612777.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.499	0.00

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	4.3941	0.1831
2	0.0000	0.0000
3	8.3835	0.3493

4	0.0000	0.0000
5	9.1370	0.3807

TOTAL WATER IN LAYERS	21.915
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	21.915

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.22	280526.406
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 1	0.03383	2947.16040
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.001691	147.28467
AVERAGE HEAD ON TOP OF LAYER 2	17.908	
MAXIMUM HEAD ON TOP OF LAYER 2	26.376	
LOCATION OF MAXIMUM HEAD IN LAYER 1 (DISTANCE FROM DRAIN)	158.0 FEET	
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000020	1.71703
AVERAGE HEAD ON TOP OF LAYER 4	5.916	
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.000000	0.00000
SNOW WATER	2.39	207783.4375
MAXIMUM VEG. SOIL WATER (VOL/VOL)		0.2869
MINIMUM VEG. SOIL WATER (VOL/VOL)		0.0187

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

JAN/JUL FEB/AUG MAR/SEP APR/OCT MAY/NOV JUN/DEC

PRECIPITATION						
TOTALS	0.25	0.43	0.33	0.48	2.06	2.41
	2.29	2.42	1.75	1.44	2.05	1.57
STD. DEVIATIONS	0.28	0.11	0.29	0.39	1.94	2.94
	1.07	1.68	1.12	1.68	2.50	1.09
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.006	3.630	5.121	7.372	9.278	10.074
	10.034	8.741	6.610	5.205	3.692	2.548
STD. DEVIATIONS	0.194	0.200	0.191	0.353	0.460	0.188
	0.100	0.266	0.307	0.177	0.178	0.242
ACTUAL EVAPOTRANSPIRATION						
TOTALS	0.550	0.318	0.275	0.368	1.234	0.905
	1.492	1.594	1.407	0.939	1.128	0.838
STD. DEVIATIONS	0.331	0.106	0.129	0.210	1.223	0.814
	0.607	1.011	0.674	0.710	0.740	0.425
LATERAL DRAINAGE COLLECTED FROM LAYER 1						
TOTALS	0.4670	0.3633	0.3406	0.2808	0.2827	0.3999
	0.5049	0.5231	0.5429	0.5407	0.5675	0.5852
STD. DEVIATIONS	0.3065	0.2387	0.2225	0.1837	0.1897	0.2805
	0.3627	0.3196	0.2190	0.1860	0.1887	0.1957
PERCOLATION/LEAKAGE THROUGH LAYER 2						
TOTALS	0.0236	0.0184	0.0174	0.0145	0.0146	0.0203
	0.0255	0.0264	0.0275	0.0274	0.0287	0.0296
STD. DEVIATIONS	0.0153	0.0120	0.0112	0.0093	0.0096	0.0141
	0.0181	0.0159	0.0107	0.0091	0.0092	0.0096
PERCOLATION/LEAKAGE THROUGH LAYER 4						
TOTALS	0.0002	0.0002	0.0003	0.0003	0.0003	0.0003
	0.0003	0.0003	0.0003	0.0003	0.0003	0.0003
STD. DEVIATIONS	0.0002	0.0001	0.0002	0.0002	0.0002	0.0002
	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
PERCOLATION/LEAKAGE THROUGH LAYER 5						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 2

AVERAGES	7.9744	6.7955	5.8165	4.9546	4.8278	7.0561
	8.6216	8.9336	9.5805	9.2329	10.0144	9.9938
STD. DEVIATIONS	5.2343	4.4419	3.8000	3.2408	3.2393	4.9506
	6.1944	5.4581	3.8647	3.1764	3.3294	3.3415

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	2.1288	2.2304	2.3441	2.4670	2.5877	2.6799
	2.7518	2.8147	2.8821	2.9605	3.0403	3.1205
STD. DEVIATIONS	1.5464	1.5660	1.5931	1.6249	1.6600	1.7046
	1.7476	1.7951	1.8444	1.8941	1.9292	1.9684

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.48 (3.719)	1522857.6	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	75.310 (0.6175)	6561040.00	
ACTUAL EVAPOTRANSPIRATION	11.049 (2.3247)	962588.00	63.209
LATERAL DRAINAGE COLLECTED FROM LAYER 1	5.39850 (2.34509)	470317.281	30.88386
PERCOLATION/LEAKAGE THROUGH LAYER 2	0.27370 (0.11787)	23844.775	1.56579
AVERAGE HEAD ON TOP OF LAYER 2	7.817 (3.398)		
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00340 (0.00206)	296.402	0.01946
AVERAGE HEAD ON TOP OF LAYER 4	2.667 (1.737)		
PERCOLATION/LEAKAGE THROUGH LAYER 5	0.00000 (0.00000)	0.000	0.00000
CHANGE IN WATER STORAGE	1.033 (1.8553)	89952.40	5.907

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Exhibit D
SCENARIO 4 HELP MODEL RESULTS

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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 TIME:  15.57     DATE:  24.09.2019


 PRECIPITATION DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\PRECIP~-.D4
 TEMPERATURE DATA FILE:         N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\TEMPER~-.D7
 SOLAR RADIATION DATA FILE:     N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\SOLARR~-.D13
 EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\From Edward\EVAPOT~-.D11
 SOIL AND DESIGN DATA FILE  1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExD-Alternate Liner\Soil and Design Data.d10
 OUTPUT DATA FILE:              N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExD-Alternate Liner\Summary Output.out
 YEARLY OUTPUT DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExD-Alternate Liner\Summary Output.YR

 COLUMNS OF YEARLY OUTPUT DATA FILE:

      1    DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
      2    PRECIPITATION (INCH)
      3    RUNOFF (INCH)
      4    POTENTIAL EVAPOTRANSPIRATION (INCH)
      5    ACTUAL EVAPOTRANSPIRATION (INCH)
      6    DRAIN #1: LATERAL DRAINAGE FROM LAYER  2 (INCH)
      7    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  3 (INCH)
      8    DRAIN #2: LATERAL DRAINAGE FROM LAYER  4 (INCH)
      9    LEAK  #2: PERCOLATION/LEAKAGE THROUGH LAYER  6 (INCH)
     10    CHANGE IN TOTAL WATER STORAGE (INCH)
     11    CHANGE IN SOIL WATER STORAGE (INCH)
     12    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
     13    CHANGE IN SNOW WATER STORAGE (INCH)
     14    ANNUAL WATER BUDGET BALANCE (INCH)


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     TITLE:  Alternate Liner

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WEATHER DATA SOURCES

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.35	0.72	0.30	0.67	2.01	3.48
1.90	2.74	1.83	1.90	0.81	0.86

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
39.40	45.20	52.50	61.00	69.50	76.10
79.30	78.50	71.00	61.10	50.00	40.40

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO AND STATION LATITUDE = 33.24 DEGREES

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LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0250 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL

```
           INITIAL SOIL WATER CONTENT  =      0.0250 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
           SLOPE                       =      2.00   PERCENT
           DRAINAGE LENGTH             =    600.0    FEET


                                LAYER  3
                                --------

                        TYPE 4 - FLEXIBLE MEMBRANE LINER
                          MATERIAL TEXTURE NUMBER  35
           THICKNESS                   =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
           FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
           FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
           FML PLACEMENT QUALITY       =  3 - GOOD


                                LAYER  4
                                --------

                        TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER  20
           THICKNESS                   =      0.20   INCHES
           POROSITY                    =      0.8500 VOL/VOL
           FIELD CAPACITY              =      0.0100 VOL/VOL
           WILTING POINT               =      0.0050 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
           SLOPE                       =      2.00   PERCENT
           DRAINAGE LENGTH             =    600.0    FEET


                                LAYER  5
                                --------

                        TYPE 4 - FLEXIBLE MEMBRANE LINER
                          MATERIAL TEXTURE NUMBER  35
           THICKNESS                   =      0.06   INCHES
           EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
           FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
           FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
           FML PLACEMENT QUALITY       =  3 - GOOD


                                LAYER  6
                                --------

                          TYPE 3 - BARRIER SOIL LINER
                          MATERIAL TEXTURE NUMBER  17
           THICKNESS                   =      0.24   INCHES
           POROSITY                    =      0.7500 VOL/VOL
           FIELD CAPACITY              =      0.7470 VOL/VOL
           WILTING POINT               =      0.4000 VOL/VOL
           INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


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                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
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                             VALID FOR   5 YEARS
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NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 2.% AND A SLOPE LENGTH OF 600. FEET.

SCS RUNOFF CURVE NUMBER	=	71.76	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	24.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.350	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.838	INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE	=	0.630	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.252	INCHES
SOIL EVAPORATION ZONE DEPTH	=	14.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL INTERCEPTION WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	0.786	INCHES
TOTAL INITIAL WATER	=	0.786	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

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EVAPOTRANSPIRATION DATA 1

VALID FOR 5 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ROSWELL NEW MEXICO

STATION LATITUDE	=	33.24	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	76	
END OF GROWING SEASON (JULIAN DATE)	=	310	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	49.0	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	40.0	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	53.0	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	52.0	%

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.67	1103810.625	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	76.038	6624449.500	
ACTUAL EVAPOTRANSPIRATION	9.453	823558.688	74.61
DRAINAGE COLLECTED FROM LAYER 2	0.0013	115.256	0.01
PERC./LEAKAGE THROUGH LAYER 3	0.001679	146.256	0.01
AVG. HEAD ON TOP OF LAYER 3	0.0000		
DRAINAGE COLLECTED FROM LAYER 4	0.0009	76.550	0.01

PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.010	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	3.215	280060.156	25.37
SOIL WATER AT START OF YEAR	0.791	68928.914	
SOIL WATER AT END OF YEAR	4.006	348989.062	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.047	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	22.13	1927965.875	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.116	6544130.500	
ACTUAL EVAPOTRANSPIRATION	18.113	1578003.500	81.85
DRAINAGE COLLECTED FROM LAYER 2	0.4908	42761.152	2.22
PERC./LEAKAGE THROUGH LAYER 3	0.845434	73654.188	3.82
AVG. HEAD ON TOP OF LAYER 3	0.0007		
DRAINAGE COLLECTED FROM LAYER 4	0.8454	73654.008	3.82
PERC./LEAKAGE THROUGH LAYER 6	0.000002	0.146	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0012		
CHANGE IN WATER STORAGE	2.681	233547.109	12.11
SOIL WATER AT START OF YEAR	4.006	348989.062	
SOIL WATER AT END OF YEAR	6.687	582536.188	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.036	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	18.51	1612591.375	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.152	6547241.500	
ACTUAL EVAPOTRANSPIRATION	14.649	1276185.125	79.14
DRAINAGE COLLECTED FROM LAYER 2	2.6341	229479.203	14.23
PERC./LEAKAGE THROUGH LAYER 3	2.079291	181147.859	11.23
AVG. HEAD ON TOP OF LAYER 3	0.0038		
DRAINAGE COLLECTED FROM LAYER 4	2.0748	180756.109	11.21
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.253	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0030		
CHANGE IN WATER STORAGE	-0.847	-73829.203	-4.58
SOIL WATER AT START OF YEAR	6.687	582536.188	
SOIL WATER AT END OF YEAR	5.527	481532.594	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.312	27174.352	1.69
ANNUAL WATER BUDGET BALANCE	0.0000	-0.312	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.91	1298959.375	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.777	6601701.500	
ACTUAL EVAPOTRANSPIRATION	10.638	926813.562	71.35
DRAINAGE COLLECTED FROM LAYER 2	1.8845	164181.453	12.64
PERC./LEAKAGE THROUGH LAYER 3	2.002334	174443.344	13.43
AVG. HEAD ON TOP OF LAYER 3	0.0027		

DRAINAGE COLLECTED FROM LAYER 4	2.0047	174645.422	13.45
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.253	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0029		
CHANGE IN WATER STORAGE	0.382	33318.848	2.57
SOIL WATER AT START OF YEAR	5.527	481532.594	
SOIL WATER AT END OF YEAR	6.222	542025.812	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.312	27174.352	2.09
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.208	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	19.18	1670962.000	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	74.468	6487678.500	
ACTUAL EVAPOTRANSPIRATION	16.005	1394371.125	83.45
DRAINAGE COLLECTED FROM LAYER 2	1.6368	142594.156	8.53
PERC./LEAKAGE THROUGH LAYER 3	2.021057	176074.484	10.54
AVG. HEAD ON TOP OF LAYER 3	0.0024		
DRAINAGE COLLECTED FROM LAYER 4	2.0225	176200.438	10.54
PERC./LEAKAGE THROUGH LAYER 6	0.000003	0.255	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0029		
CHANGE IN WATER STORAGE	-0.484	-42204.152	-2.53
SOIL WATER AT START OF YEAR	6.222	542025.812	
SOIL WATER AT END OF YEAR	5.737	499821.656	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.125	0.00

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	5.5474	0.2311
2	0.0020	0.0100
3	0.0000	0.0000
4	0.0027	0.0136
5	0.0000	0.0000
6	0.1800	0.7500

TOTAL WATER IN LAYERS	5.732
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	5.732

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	3.22	280526.406
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.24451	21301.91602
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.052686	4589.96191
AVERAGE HEAD ON TOP OF LAYER 3	0.129	
MAXIMUM HEAD ON TOP OF LAYER 3	0.257	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	5.1 FEET	
DRAINAGE COLLECTED FROM LAYER 4	0.04531	3947.60962
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00144
AVERAGE HEAD ON TOP OF LAYER 5	0.024	
MAXIMUM HEAD ON TOP OF LAYER 5	0.043	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	2.39	207783.4375

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3807

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0180

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 5

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.25	0.43	0.33	0.48	2.06	2.41
	2.29	2.42	1.75	1.44	2.05	1.57
STD. DEVIATIONS	0.28	0.11	0.29	0.39	1.94	2.94
	1.07	1.68	1.12	1.68	2.50	1.09
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.006	3.630	5.121	7.372	9.278	10.074
	10.034	8.741	6.610	5.205	3.692	2.548
STD. DEVIATIONS	0.194	0.200	0.191	0.353	0.460	0.188
	0.100	0.266	0.307	0.177	0.178	0.242
ACTUAL EVAPOTRANSPIRATION						
TOTALS	0.579	0.352	0.301	0.472	1.620	1.691
	1.954	2.011	1.430	1.208	1.270	0.883
STD. DEVIATIONS	0.350	0.145	0.174	0.322	1.417	2.149
	1.304	1.042	0.807	0.819	0.872	0.476
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.1090	0.0592	0.0423	0.0268	0.0163	0.0173
	0.1894	0.0901	0.0598	0.0903	0.3797	0.2494
STD. DEVIATIONS	0.1155	0.0780	0.0427	0.0256	0.0153	0.0195
	0.2918	0.1217	0.0814	0.1130	0.4915	0.4263
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.1339	0.0954	0.0903	0.0716	0.0549	0.0460
	0.1613	0.1210	0.0944	0.1267	0.2031	0.1914
STD. DEVIATIONS	0.1263	0.1013	0.0844	0.0660	0.0501	0.0413
	0.1801	0.1267	0.0987	0.0924	0.2150	0.2229

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.1334	0.0957	0.0905	0.0717	0.0550	0.0457
	0.1600	0.1216	0.0946	0.1248	0.2019	0.1946
STD. DEVIATIONS	0.1260	0.1022	0.0847	0.0662	0.0502	0.0413
	0.1782	0.1273	0.1001	0.0895	0.2163	0.2270

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0019	0.0011	0.0007	0.0005	0.0003	0.0003
	0.0032	0.0015	0.0011	0.0015	0.0067	0.0043
STD. DEVIATIONS	0.0020	0.0015	0.0007	0.0005	0.0003	0.0003
	0.0050	0.0021	0.0014	0.0019	0.0087	0.0073

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0023	0.0018	0.0015	0.0013	0.0009	0.0008
	0.0027	0.0021	0.0017	0.0021	0.0036	0.0033
STD. DEVIATIONS	0.0022	0.0019	0.0014	0.0012	0.0009	0.0007
	0.0030	0.0022	0.0018	0.0015	0.0038	0.0039

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	17.48 (3.719)	1522857.6	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	75.310 (0.6175)	6561040.00	
ACTUAL EVAPOTRANSPIRATION	13.772 (3.6425)	1199786.38	78.785
LATERAL DRAINAGE COLLECTED FROM LAYER 2	1.32950 (1.06909)	115826.242	7.60585
PERCOLATION/LEAKAGE THROUGH LAYER 3	1.38996 (0.93170)	121093.227	7.95171
AVERAGE HEAD ON TOP OF LAYER 3	0.002 (0.002)		
LATERAL DRAINAGE COLLECTED FROM LAYER 4	1.38965 (0.93180)	121066.500	7.94995
PERCOLATION/LEAKAGE THROUGH	0.00000 (0.00000)	0.183	0.00001

```
  LAYER  6

AVERAGE HEAD ON TOP              0.002   (    0.001)
  OF LAYER  5

CHANGE IN WATER STORAGE          0.989   (  1.8525)      86178.55      5.659

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Exhibit E
SCENARIO 5 HELP MODEL RESULTS

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 ******************************************************************************
 **                                                                          **
 **                                                                          **
 **              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
 **                                                                          **
 **              HELP Version 3.95 D          (10 August 2012)               **
 **                               developed at                               **
 **        Institute of Soil Science, University of Hamburg, Germany         **
 **                                 based on                                 **
 **              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
 **                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
 **                    USAE WATERWAYS EXPERIMENT STATION                     **
 **             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
 **                                                                          **
 **                                                                          **
 ******************************************************************************
 ******************************************************************************


 TIME:   9.27     DATE:  19.09.2019


 PRECIPITATION DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Precipitation Data.d4
 TEMPERATURE DATA FILE:         N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Temperature Data.d7
 SOLAR RADIATION DATA FILE:     N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Solar Radiation Data.d13
 EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Evapotranspiration Parameters.d11
 SOIL AND DESIGN DATA FILE  1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Soil and Design Data.d10
 OUTPUT DATA FILE:              N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Summary Output.out
 YEARLY OUTPUT DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D -
HELP\ATT D2 - Results\Alternate Liner - Open\Summary Output.YR

 COLUMNS OF YEARLY OUTPUT DATA FILE:

      1    DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
      2    PRECIPITATION (INCH)
      3    RUNOFF (INCH)
      4    POTENTIAL EVAPOTRANSPIRATION (INCH)
      5    ACTUAL EVAPOTRANSPIRATION (INCH)
      6    DRAIN #1: LATERAL DRAINAGE FROM LAYER  2 (INCH)
      7    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  3 (INCH)
      8    DRAIN #2: LATERAL DRAINAGE FROM LAYER  4 (INCH)
      9    LEAK  #2: PERCOLATION/LEAKAGE THROUGH LAYER  6 (INCH)
     10    CHANGE IN TOTAL WATER STORAGE (INCH)
     11    CHANGE IN SOIL WATER STORAGE (INCH)
     12    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
     13    CHANGE IN SNOW WATER STORAGE (INCH)
     14    ANNUAL WATER BUDGET BALANCE (INCH)


 ******************************************************************************

      TITLE:  Alternate Liner

 ******************************************************************************


                           WEATHER DATA SOURCES
```

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.24	0.28	0.27	0.37	0.77	0.91
1.38	2.17	1.72	0.99	0.33	0.27

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.40	45.90	52.80	61.90	70.30	79.00
81.40	79.20	72.30	61.70	49.10	42.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO
AND STATION LATITUDE = 33.24 DEGREES

****

LAYER DATA 1

VALID FOR 2 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0250 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 2

TYPE 2 - LATERAL DRAINAGE LAYER
MATERIAL TEXTURE NUMBER 20

THICKNESS	=	0.20 INCHES
POROSITY	=	0.8500 VOL/VOL
FIELD CAPACITY	=	0.0100 VOL/VOL
WILTING POINT	=	0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0250 VOL/VOL

```
          EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
          SLOPE                       =      2.00   PERCENT
          DRAINAGE LENGTH             =    600.0    FEET


                                LAYER  3
                                --------

                     TYPE 4 - FLEXIBLE MEMBRANE LINER
                       MATERIAL TEXTURE NUMBER  35
          THICKNESS                   =      0.06   INCHES
          EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
          FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
          FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY       =  3 - GOOD


                                LAYER  4
                                --------

                     TYPE 2 - LATERAL DRAINAGE LAYER
                       MATERIAL TEXTURE NUMBER  20
          THICKNESS                   =      0.20   INCHES
          POROSITY                    =      0.8500 VOL/VOL
          FIELD CAPACITY              =      0.0100 VOL/VOL
          WILTING POINT               =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
          SLOPE                       =      2.00   PERCENT
          DRAINAGE LENGTH             =    600.0    FEET


                                LAYER  5
                                --------

                     TYPE 4 - FLEXIBLE MEMBRANE LINER
                       MATERIAL TEXTURE NUMBER  35
          THICKNESS                   =      0.06   INCHES
          EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
          FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
          FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY       =  3 - GOOD


                                LAYER  6
                                --------

                       TYPE 3 - BARRIER SOIL LINER
                       MATERIAL TEXTURE NUMBER  17
          THICKNESS                   =      0.24   INCHES
          POROSITY                    =      0.7500 VOL/VOL
          FIELD CAPACITY              =      0.7470 VOL/VOL
          WILTING POINT               =      0.4000 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


******************************************************************************

                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                             VALID FOR   2 YEARS


        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
```

SOIL DATA BASE USING SOIL TEXTURE # 1 WITH BARE
GROUND CONDITIONS, A SURFACE SLOPE OF 2.% AND
A SLOPE LENGTH OF 600. FEET.

SCS RUNOFF CURVE NUMBER	=	71.76	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	205.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	0.350	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	5.838	INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE	=	0.630	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	0.252	INCHES
SOIL EVAPORATION ZONE DEPTH	=	14.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL INTERCEPTION WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	0.786	INCHES
TOTAL INITIAL WATER	=	0.786	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 2 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ROSWELL NEW MEXICO

STATION LATITUDE	=	33.24	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	76	
END OF GROWING SEASON (JULIAN DATE)	=	310	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	49.0	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	40.0	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	53.0	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	52.0	%

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.70	6474105.500	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	77.421	57612976.000	
ACTUAL EVAPOTRANSPIRATION	6.515	4848156.500	74.89
DRAINAGE COLLECTED FROM LAYER 2	0.0013	984.471	0.02
PERC./LEAKAGE THROUGH LAYER 3	0.001677	1247.987	0.02
AVG. HEAD ON TOP OF LAYER 3	0.0000		
DRAINAGE COLLECTED FROM LAYER 4	0.0009	652.646	0.01
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.022	0.00

AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	2.183	1624312.375	25.09
SOIL WATER AT START OF YEAR	0.791	588767.812	
SOIL WATER AT END OF YEAR	2.974	2213080.250	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.248	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.35	7701953.500	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	76.577	56984972.000	
ACTUAL EVAPOTRANSPIRATION	10.126	7535160.500	97.83
DRAINAGE COLLECTED FROM LAYER 2	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 3	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 3	0.0000		
DRAINAGE COLLECTED FROM LAYER 4	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 6	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 5	0.0000		
CHANGE IN WATER STORAGE	0.224	166794.609	2.17
SOIL WATER AT START OF YEAR	2.974	2213080.250	
SOIL WATER AT END OF YEAR	3.198	2379874.750	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-1.419	0.00

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FINAL WATER STORAGE AT END OF YEAR 2

LAYER	(INCHES)	(VOL/VOL)
1	3.0091	0.1254
2	0.0020	0.0100
3	0.0000	0.0000
4	0.0020	0.0100
5	0.0000	0.0000
6	0.1800	0.7500
TOTAL WATER IN LAYERS	3.193	
SNOW WATER	0.000	
INTERCEPTION WATER	0.000	
TOTAL FINAL WATER	3.193	

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 2

	(INCHES)	(CU. FT.)
PRECIPITATION	1.05	781357.438
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 2	0.00132	984.47137
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.001677	1247.98718
AVERAGE HEAD ON TOP OF LAYER 3	0.001	
MAXIMUM HEAD ON TOP OF LAYER 3	0.025	
LOCATION OF MAXIMUM HEAD IN LAYER 2 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 4	0.00059	437.39902
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.000000	0.00520
AVERAGE HEAD ON TOP OF LAYER 5	0.000	
MAXIMUM HEAD ON TOP OF LAYER 5	0.001	
LOCATION OF MAXIMUM HEAD IN LAYER 4 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.61	455364.3438
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2295	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.0180	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS   1 THROUGH   2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.22	0.18	0.22	0.44	0.76	0.92
	1.18	2.13	2.15	0.21	0.61	0.48
STD. DEVIATIONS	0.31	0.01	0.28	0.16	1.05	1.30
	0.21	0.62	1.04	0.30	0.39	0.52
RUNOFF						
TOTALS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
STD. DEVIATIONS	0.000	0.000	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.000	0.000	0.000
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.103	3.653	5.266	7.550	9.144	10.440
	10.356	8.756	6.951	5.374	3.675	2.733
STD. DEVIATIONS	0.354	0.277	0.005	0.400	0.417	0.399
	0.128	0.512	0.288	0.004	0.184	0.297
ACTUAL EVAPOTRANSPIRATION						
TOTALS	0.489	0.200	0.166	0.195	0.676	1.049
	0.798	1.687	1.738	0.575	0.395	0.354
STD. DEVIATIONS	0.553	0.176	0.128	0.022	0.832	1.371
	0.662	0.470	0.989	0.210	0.147	0.206
LATERAL DRAINAGE COLLECTED FROM LAYER 2						
TOTALS	0.0007	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 3						
TOTALS	0.0008	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0012	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 4

TOTALS	0.0004	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0006	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 3

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 5

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.53 (1.167)	7088030.0	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	76.999 (0.5962)	57298972.00	
ACTUAL EVAPOTRANSPIRATION	8.320 (2.5532)	6191658.00	87.354
LATERAL DRAINAGE COLLECTED FROM LAYER 2	0.00066 (0.00094)	492.236	0.00694
PERCOLATION/LEAKAGE THROUGH LAYER 3	0.00084 (0.00119)	623.994	0.00880
AVERAGE HEAD ON TOP OF LAYER 3	0.000 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 4	0.00044 (0.00062)	326.323	0.00460
PERCOLATION/LEAKAGE THROUGH LAYER 6	0.00000 (0.00000)	0.011	0.00000
AVERAGE HEAD ON TOP	0.000 (0.000)		

OF LAYER 5

```
 CHANGE IN WATER STORAGE         1.203   (  1.3850)     895553.50     12.635

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Exhibit F
SCENARIO 6 HELP MODEL RESULTS

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**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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TIME: 9.20 DATE: 19.09.2019

PRECIPITATION DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Precipitation Data.d4
TEMPERATURE DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Temperature Data.d7
SOLAR RADIATION DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Solar Radiation Data.d13
EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Evapotranspiration Parameters.d11
SOIL AND DESIGN DATA FILE 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Soil and Design Data.d10
OUTPUT DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Summary Output.out
YEARLY OUTPUT DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\10-Appendix J\Attachment D - HELP\ATT D2 - Results\Alternate Liner - 20' Filled\Summary Output.YR

COLUMNS OF YEARLY OUTPUT DATA FILE:

1 DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
2 PRECIPITATION (INCH)
3 RUNOFF (INCH)
4 POTENTIAL EVAPOTRANSPIRATION (INCH)
5 ACTUAL EVAPOTRANSPIRATION (INCH)
6 DRAIN #1: LATERAL DRAINAGE FROM LAYER 3 (INCH)
7 LEAK #1: PERCOLATION/LEAKAGE THROUGH LAYER 4 (INCH)
8 DRAIN #2: LATERAL DRAINAGE FROM LAYER 5 (INCH)
9 LEAK #2: PERCOLATION/LEAKAGE THROUGH LAYER 7 (INCH)
10 CHANGE IN TOTAL WATER STORAGE (INCH)
11 CHANGE IN SOIL WATER STORAGE (INCH)
12 CHANGE IN INTERCEPTION WATER STORAGE (INCH)
13 CHANGE IN SNOW WATER STORAGE (INCH)
14 ANNUAL WATER BUDGET BALANCE (INCH)

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TITLE: Alternate Liner - 20' Filled

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WEATHER DATA SOURCES

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.24	0.28	0.27	0.37	0.77	0.91
1.38	2.17	1.72	0.99	0.33	0.27

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.40	45.90	52.80	61.90	70.30	79.00
81.40	79.20	72.30	61.70	49.10	42.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING COEFFICIENTS FOR ROSWELL NEW MEXICO AND STATION LATITUDE = 33.24 DEGREES

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LAYER DATA 1

VALID FOR 5 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 18

THICKNESS	=	240.00 INCHES
POROSITY	=	0.6710 VOL/VOL
FIELD CAPACITY	=	0.2920 VOL/VOL
WILTING POINT	=	0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2000 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-02 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0450 VOL/VOL
WILTING POINT	=	0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0250 VOL/VOL

```
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  3
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    600.0    FEET


                        LAYER  4
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  5
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    600.0    FEET


                        LAYER  6
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                        LAYER  7
                        --------

              TYPE 3 - BARRIER SOIL LINER
              MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
```

INITIAL SOIL WATER CONTENT = 0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.= 0.3000E-08 CM/SEC

****

GENERAL DESIGN AND EVAPORATIVE ZONE DATA 1

VALID FOR 5 YEARS

NOTE: SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT SOIL DATA BASE USING SOIL TEXTURE #18 WITH BARE GROUND CONDITIONS, A SURFACE SLOPE OF 4.% AND A SLOPE LENGTH OF 750. FEET.

SCS RUNOFF CURVE NUMBER	=	79.20	
FRACTION OF AREA ALLOWING RUNOFF	=	0.0	PERCENT
AREA PROJECTED ON HORIZONTAL PLANE	=	205.000	ACRES
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
INITIAL WATER IN EVAPORATIVE ZONE	=	2.800	INCHES
UPPER LIMIT OF EVAPORATIVE STORAGE	=	9.394	INCHES
FIELD CAPACITY OF EVAPORATIVE ZONE	=	4.088	INCHES
LOWER LIMIT OF EVAPORATIVE STORAGE	=	1.078	INCHES
SOIL EVAPORATION ZONE DEPTH	=	14.000	INCHES
INITIAL SNOW WATER	=	0.000	INCHES
INITIAL INTERCEPTION WATER	=	0.000	INCHES
INITIAL WATER IN LAYER MATERIALS	=	48.782	INCHES
TOTAL INITIAL WATER	=	48.782	INCHES
TOTAL SUBSURFACE INFLOW	=	0.00	INCHES/YEAR

****

EVAPOTRANSPIRATION DATA 1

VALID FOR 5 YEARS

NOTE: EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
ROSWELL NEW MEXICO

STATION LATITUDE	=	33.24	DEGREES
MAXIMUM LEAF AREA INDEX	=	0.00	
START OF GROWING SEASON (JULIAN DATE)	=	76	
END OF GROWING SEASON (JULIAN DATE)	=	310	
EVAPORATIVE ZONE DEPTH	=	14.0	INCHES
AVERAGE ANNUAL WIND SPEED	=	8.70	MPH
AVERAGE 1ST QUARTER RELATIVE HUMIDITY	=	49.0	%
AVERAGE 2ND QUARTER RELATIVE HUMIDITY	=	40.0	%
AVERAGE 3RD QUARTER RELATIVE HUMIDITY	=	53.0	%
AVERAGE 4TH QUARTER RELATIVE HUMIDITY	=	52.0	%

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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.70	6474105.500	100.00
RUNOFF	0.000	0.000	0.00

POTENTIAL EVAPOTRANSPIRATION	77.421	57612976.000	
ACTUAL EVAPOTRANSPIRATION	8.016	5964840.500	92.13
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.684	509261.219	7.87
SOIL WATER AT START OF YEAR	48.784	36302292.000	
SOIL WATER AT END OF YEAR	49.468	36811552.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	3.548	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.35	7701953.500	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	76.577	56984972.000	
ACTUAL EVAPOTRANSPIRATION	9.421	7010889.500	91.03
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.929	691066.188	8.97
SOIL WATER AT START OF YEAR	49.468	36811552.000	
SOIL WATER AT END OF YEAR	50.397	37502620.000	

INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-2.129	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.33	7687068.500	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	76.472	56906980.000	
ACTUAL EVAPOTRANSPIRATION	10.757	8004682.500	104.13
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	-0.427	-317614.406	-4.13
SOIL WATER AT START OF YEAR	50.397	37502620.000	
SOIL WATER AT END OF YEAR	49.970	37185004.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	0.710	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.25	6883389.500	100.00

RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	77.070	57351340.000	
ACTUAL EVAPOTRANSPIRATION	9.044	6730242.500	97.78
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.206	153145.406	2.22
SOIL WATER AT START OF YEAR	49.970	37185004.000	
SOIL WATER AT END OF YEAR	50.176	37338148.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.129	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.68	7203372.000	100.00
RUNOFF	0.000	0.000	0.00
POTENTIAL EVAPOTRANSPIRATION	75.845	56440384.000	
ACTUAL EVAPOTRANSPIRATION	9.039	6726316.500	93.38
DRAINAGE COLLECTED FROM LAYER 3	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 4	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 4	0.0000		
DRAINAGE COLLECTED FROM LAYER 5	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 6	0.0000		
CHANGE IN WATER STORAGE	0.641	477056.031	6.62
SOIL WATER AT START OF YEAR	50.176	37338148.000	

SOIL WATER AT END OF YEAR	50.817	37815204.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.710	0.00

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FINAL WATER STORAGE AT END OF YEAR 5

LAYER	(INCHES)	(VOL/VOL)
1	50.0330	0.2085
2	0.6000	0.0250
3	0.0012	0.0060
4	0.0000	0.0000
5	0.0012	0.0060
6	0.0000	0.0000
7	0.1800	0.7500

TOTAL WATER IN LAYERS	50.815
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	50.815

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 5

	(INCHES)	(CU. FT.)
PRECIPITATION	1.17	870655.500
RUNOFF	0.000	0.0000
DRAINAGE COLLECTED FROM LAYER 3	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	
MAXIMUM HEAD ON TOP OF LAYER 4	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 3		

```
       (DISTANCE FROM DRAIN)               0.0 FEET

 DRAINAGE COLLECTED FROM LAYER  5          0.00000          0.00000

 PERCOLATION/LEAKAGE THROUGH LAYER  7      0.000000         0.00000

 AVERAGE HEAD ON TOP OF LAYER  6           0.000

 MAXIMUM HEAD ON TOP OF LAYER  6           0.000

 LOCATION OF MAXIMUM HEAD IN LAYER  5
       (DISTANCE FROM DRAIN)               0.0 FEET

 SNOW WATER                                0.61        455364.3438

 MAXIMUM VEG. SOIL WATER (VOL/VOL)                 0.3367

 MINIMUM VEG. SOIL WATER (VOL/VOL)                 0.0965

  ***  Maximum heads are computed using McEnroe's equations.  ***

       Reference:  Maximum Saturated Depth over Landfill Liner
                   by Bruce M. McEnroe, University of Kansas
                   ASCE Journal of Environmental Engineering
                   Vol. 119, No. 2, March 1993, pp. 262-270.

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         AVERAGE MONTHLY VALUES IN INCHES FOR YEARS    1 THROUGH    5
-------------------------------------------------------------------------------

                          JAN/JUL  FEB/AUG  MAR/SEP  APR/OCT  MAY/NOV  JUN/DEC
                          -------  -------  -------  -------  -------  -------
  PRECIPITATION
  -------------
    TOTALS                  0.18     0.17     0.29     0.26     0.78     0.63
                            1.66     1.91     1.64     0.79     0.84     0.49

    STD. DEVIATIONS         0.19     0.04     0.26     0.21     0.74     0.77
                            0.78     1.32     1.04     0.91     1.02     0.34

  RUNOFF
  ------
    TOTALS                  0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

    STD. DEVIATIONS         0.000    0.000    0.000    0.000    0.000    0.000
                            0.000    0.000    0.000    0.000    0.000    0.000

  POTENTIAL EVAPOTRANSPIRATION
  ----------------------------
    TOTALS                  3.134    3.701    5.148    7.467    9.389   10.427
                           10.279    8.815    6.728    5.253    3.633    2.703

    STD. DEVIATIONS         0.197    0.192    0.191    0.353    0.446    0.205
                            0.101    0.268    0.309    0.179    0.177    0.208

  ACTUAL EVAPOTRANSPIRATION
  -------------------------
    TOTALS                  0.339    0.298    0.301    0.221    0.756    0.752
                            0.928    1.885    1.461    1.022    0.694    0.599

    STD. DEVIATIONS         0.073    0.079    0.062    0.024    0.736    0.669
                            0.809    1.387    0.690    0.595    0.533    0.269
```

LATERAL DRAINAGE COLLECTED FROM LAYER 3

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 4

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 5

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 4

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 6

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

****

AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.66 (0.710)	7189978.0	100.00
RUNOFF	0.000 (0.0000)	0.00	0.000
POTENTIAL EVAPOTRANSPIRATION	76.677 (0.6011)	57059340.00	

ACTUAL EVAPOTRANSPIRATION	9.255	(0.9887)	6887394.00	95.792
LATERAL DRAINAGE COLLECTED FROM LAYER 3	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 4	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 4	0.000	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 5	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 6	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.407	(0.5338)	302582.88	4.208

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****

Exhibit G
SCENARIO 7 HELP MODEL RESULTS

```
******************************************************************************
******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                               developed at                               **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                 based on                                 **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
******************************************************************************
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```

TIME: 15.44   DATE: 24.09.2019

PRECIPITATION DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Precipitation Data.d4
TEMPERATURE DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Temperature Data.d7
SOLAR RADIATION DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Solar Radiation Data.d13
EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Evapotranspiration Parameters.d11
SOIL AND DESIGN DATA FILE 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Soil and Design Data.d10
OUTPUT DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Summary Output.out
YEARLY OUTPUT DATA FILE: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering Report\AttD-HELP\exhibits a-i\ExG-AltLiner-FilledBare\Summary Output.YR

COLUMNS OF YEARLY OUTPUT DATA FILE:

```
     1    DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
     2    PRECIPITATION (INCH)
     3    RUNOFF (INCH)
     4    POTENTIAL EVAPOTRANSPIRATION (INCH)
     5    ACTUAL EVAPOTRANSPIRATION (INCH)
     6    DRAIN #1: LATERAL DRAINAGE FROM LAYER  6 (INCH)
     7    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  7 (INCH)
     8    DRAIN #2: LATERAL DRAINAGE FROM LAYER  8 (INCH)
     9    LEAK  #2: PERCOLATION/LEAKAGE THROUGH LAYER 10 (INCH)
    10    CHANGE IN TOTAL WATER STORAGE (INCH)
    11    CHANGE IN SOIL WATER STORAGE (INCH)
    12    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
    13    CHANGE IN SNOW WATER STORAGE (INCH)
    14    ANNUAL WATER BUDGET BALANCE (INCH)
```

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     TITLE:  Alternate Liner

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WEATHER DATA SOURCES

NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.24	0.28	0.27	0.37	0.77	0.91
1.38	2.17	1.72	0.99	0.33	0.27

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.40	45.90	52.80	61.90	70.30	79.00
81.40	79.20	72.30	61.70	49.10	42.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO
AND STATION LATITUDE = 33.24 DEGREES

****

LAYER DATA 1

VALID FOR 2 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1340 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL

```
INITIAL SOIL WATER CONTENT  =      0.1340 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     12.00   INCHES
POROSITY                    =      0.4730 VOL/VOL
FIELD CAPACITY              =      0.2220 VOL/VOL
WILTING POINT               =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1340 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                   =   2724.00   INCHES
POROSITY                    =      0.6710 VOL/VOL
FIELD CAPACITY              =      0.2920 VOL/VOL
WILTING POINT               =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2000 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4170 VOL/VOL
FIELD CAPACITY              =      0.0450 VOL/VOL
WILTING POINT               =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0250 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  6
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    600.0    FEET


                        LAYER  7
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
```

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          FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY       =  3 - GOOD


                                  LAYER  8
                                  --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                         MATERIAL TEXTURE NUMBER  20
          THICKNESS                   =      0.20   INCHES
          POROSITY                    =      0.8500 VOL/VOL
          FIELD CAPACITY              =      0.0100 VOL/VOL
          WILTING POINT               =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
          SLOPE                       =      2.00   PERCENT
          DRAINAGE LENGTH             =    600.0    FEET


                                  LAYER  9
                                  --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER  35
          THICKNESS                   =      0.06   INCHES
          EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
          FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
          FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY       =  3 - GOOD


                                  LAYER 10
                                  --------

                         TYPE 3 - BARRIER SOIL LINER
                         MATERIAL TEXTURE NUMBER  17
          THICKNESS                   =      0.24   INCHES
          POROSITY                    =      0.7500 VOL/VOL
          FIELD CAPACITY              =      0.7470 VOL/VOL
          WILTING POINT               =      0.4000 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


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                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                            VALID FOR   2 YEARS


        NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                 SOIL DATA BASE USING SOIL TEXTURE # 7 WITH BARE
                 GROUND CONDITIONS, A SURFACE SLOPE OF  4.% AND
                 A SLOPE LENGTH OF  750. FEET.

       SCS RUNOFF CURVE NUMBER              =     87.89
       FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE   =    205.000  ACRES
       EVAPORATIVE ZONE DEPTH               =     14.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE    =      1.876  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE   =      6.622  INCHES
       FIELD CAPACITY OF EVAPORATIVE ZONE   =      3.108  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE   =      1.456  INCHES
       SOIL EVAPORATION ZONE DEPTH          =     14.000  INCHES
       INITIAL SNOW WATER                   =      0.000  INCHES
```

```
INITIAL INTERCEPTION WATER          =      0.000  INCHES
INITIAL WATER IN LAYER MATERIALS    =    553.622  INCHES
TOTAL INITIAL WATER                 =    553.622  INCHES
TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR
```

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EVAPOTRANSPIRATION DATA 1

VALID FOR 2 YEARS

```
NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
         ROSWELL             NEW MEXICO
     STATION LATITUDE                        =  33.24 DEGREES
     MAXIMUM LEAF AREA INDEX                 =   0.00
     START OF GROWING SEASON (JULIAN DATE)   =     76
     END OF GROWING SEASON (JULIAN DATE)     =    310
     EVAPORATIVE ZONE DEPTH                  =  14.0  INCHES
     AVERAGE ANNUAL WIND SPEED               =   8.70 MPH
     AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  49.0  %
     AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  40.0  %
     AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  53.0  %
     AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  52.0  %
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ANNUAL TOTALS FOR YEAR 1

	INCHES	CU. FEET	PERCENT
PRECIPITATION	8.70	6474105.500	100.00
RUNOFF	1.489	1108083.750	17.12
POTENTIAL EVAPOTRANSPIRATION	77.421	57612976.000	
ACTUAL EVAPOTRANSPIRATION	6.051	4502638.500	69.55
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	1.160	863375.688	13.34
SOIL WATER AT START OF YEAR	553.624	411979008.000	
SOIL WATER AT END OF YEAR	554.784	412842368.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00

SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	7.452	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.35	7701953.500	100.00
RUNOFF	1.657	1233255.375	16.01
POTENTIAL EVAPOTRANSPIRATION	76.577	56984972.000	
ACTUAL EVAPOTRANSPIRATION	8.419	6264959.500	81.34
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.274	203751.047	2.65
SOIL WATER AT START OF YEAR	554.784	412842368.000	
SOIL WATER AT END OF YEAR	555.058	413046144.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-12.065	0.00

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FINAL WATER STORAGE AT END OF YEAR 2

LAYER	(INCHES)	(VOL/VOL)
1	3.1020	0.2585
2	4.7640	0.1323
3	1.6080	0.1340

4	544.8000	0.2000
5	0.6000	0.0250
6	0.0012	0.0060
7	0.0000	0.0000
8	0.0012	0.0060
9	0.0000	0.0000
10	0.1800	0.7500

TOTAL WATER IN LAYERS	555.056
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	555.056

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 2

	(INCHES)	(CU. FT.)
PRECIPITATION	1.05	781357.438
RUNOFF	0.644	479548.8438
DRAINAGE COLLECTED FROM LAYER 6	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
MAXIMUM HEAD ON TOP OF LAYER 7	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.61	455364.3438
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.2898	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1078	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas

ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 2

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.22	0.18	0.22	0.44	0.76	0.92
	1.18	2.13	2.15	0.21	0.61	0.48
STD. DEVIATIONS	0.31	0.01	0.28	0.16	1.05	1.30
	0.21	0.62	1.04	0.30	0.39	0.52
RUNOFF						
TOTALS	0.041	0.000	0.000	0.000	0.000	0.197
	0.130	0.707	0.353	0.012	0.079	0.055
STD. DEVIATIONS	0.058	0.000	0.000	0.000	0.000	0.278
	0.180	0.093	0.439	0.017	0.111	0.077
POTENTIAL EVAPOTRANSPIRATION						
TOTALS	3.103	3.653	5.266	7.550	9.144	10.440
	10.356	8.756	6.951	5.374	3.675	2.733
STD. DEVIATIONS	0.354	0.277	0.005	0.400	0.417	0.399
	0.128	0.512	0.288	0.004	0.184	0.297
ACTUAL EVAPOTRANSPIRATION						
TOTALS	0.261	0.195	0.151	0.256	0.667	0.839
	0.533	1.313	1.545	0.518	0.561	0.398
STD. DEVIATIONS	0.007	0.001	0.051	0.242	0.800	1.058
	0.628	0.686	0.313	0.258	0.394	0.037
LATERAL DRAINAGE COLLECTED FROM LAYER 6						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
PERCOLATION/LEAKAGE THROUGH LAYER 7						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LATERAL DRAINAGE COLLECTED FROM LAYER 8						
TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

****

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 2

	INCHES		CU. FEET	PERCENT
PRECIPITATION	9.53	(1.167)	7088030.0	100.00
RUNOFF	1.573	(0.1189)	1170669.62	16.516
POTENTIAL EVAPOTRANSPIRATION	76.999	(0.5962)	57298972.00	
ACTUAL EVAPOTRANSPIRATION	7.235	(1.6746)	5383798.50	75.956
LATERAL DRAINAGE COLLECTED FROM LAYER 6	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000	(0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00000	(0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000	(0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	(0.000)		
CHANGE IN WATER STORAGE	0.717	(0.6268)	533563.31	7.528

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Exhibit H
SCENARIO 8 HELP MODEL RESULTS

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**              HELP Version 3.95 D          (10 August 2012)               **
**                              developed at                                **
**        Institute of Soil Science, University of Hamburg, Germany         **
**                                based on                                  **
**              US HELP MODEL VERSION 3.07  (1 NOVEMBER 1997)               **
**                  DEVELOPED BY ENVIRONMENTAL LABORATORY                   **
**                    USAE WATERWAYS EXPERIMENT STATION                     **
**             FOR USEPA RISK REDUCTION ENGINEERING LABORATORY              **
**                                                                          **
**                                                                          **
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 TIME:  15.46     DATE:  24.09.2019


 PRECIPITATION DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Precipitation Data.d4
 TEMPERATURE DATA FILE:         N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Temperature Data.d7
 SOLAR RADIATION DATA FILE:     N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Solar Radiation Data.d13
 EVAPOTRANSPIRATION DATA F. 1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Evapotranspiration Parameters.d11
 SOIL AND DESIGN DATA FILE  1: N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Soil and Design Data.d10
 OUTPUT DATA FILE:              N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Summary Output.out
 YEARLY OUTPUT DATA FILE:       N:\Projects\2018\35187378\Working Files\DRAFTS (Proposal-Reports-
Communications)\McCloy Permit Narrative\092019 FINAL SUBMITTAL to OCD\VOLUME 2\App J - Engineering
Report\AttD-HELP\exhibits a-i\ExH-AltLiner-FilledPoor\Summary Output.YR

 COLUMNS OF YEARLY OUTPUT DATA FILE:

      1    DATE OF ULTIMO (yyyy1231, years 2101 to 2200 from weather generator)
      2    PRECIPITATION (INCH)
      3    RUNOFF (INCH)
      4    POTENTIAL EVAPOTRANSPIRATION (INCH)
      5    ACTUAL EVAPOTRANSPIRATION (INCH)
      6    DRAIN #1: LATERAL DRAINAGE FROM LAYER  6 (INCH)
      7    LEAK  #1: PERCOLATION/LEAKAGE THROUGH LAYER  7 (INCH)
      8    DRAIN #2: LATERAL DRAINAGE FROM LAYER  8 (INCH)
      9    LEAK  #2: PERCOLATION/LEAKAGE THROUGH LAYER 10 (INCH)
     10    CHANGE IN TOTAL WATER STORAGE (INCH)
     11    CHANGE IN SOIL WATER STORAGE (INCH)
     12    CHANGE IN INTERCEPTION WATER STORAGE (INCH)
     13    CHANGE IN SNOW WATER STORAGE (INCH)
     14    ANNUAL WATER BUDGET BALANCE (INCH)


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     TITLE:  Alternate Liner

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                            WEATHER DATA SOURCES
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NOTE: PRECIPITATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
0.24	0.28	0.27	0.37	0.77	0.91
1.38	2.17	1.72	0.99	0.33	0.27

NOTE: TEMPERATURE DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO

NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
41.40	45.90	52.80	61.90	70.30	79.00
81.40	79.20	72.30	61.70	49.10	42.50

NOTE: SOLAR RADIATION DATA WAS SYNTHETICALLY GENERATED USING
COEFFICIENTS FOR ROSWELL NEW MEXICO
AND STATION LATITUDE = 33.24 DEGREES

****

LAYER DATA 1

VALID FOR 28 YEARS

NOTE: INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER
WERE SPECIFIED BY THE USER.

LAYER 1

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1340 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.	=	0.1000E-04 CM/SEC

LAYER 2

TYPE 1 - VERTICAL PERCOLATION LAYER
MATERIAL TEXTURE NUMBER 0

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4730 VOL/VOL
FIELD CAPACITY	=	0.2220 VOL/VOL
WILTING POINT	=	0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1340 VOL/VOL

```
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  3
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     12.00   INCHES
POROSITY                   =      0.4730 VOL/VOL
FIELD CAPACITY             =      0.2220 VOL/VOL
WILTING POINT              =      0.1040 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1340 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  4
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER  18
THICKNESS                  =   2724.00   INCHES
POROSITY                   =      0.6710 VOL/VOL
FIELD CAPACITY             =      0.2920 VOL/VOL
WILTING POINT              =      0.0770 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.2000 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-02 CM/SEC


                        LAYER  5
                        --------

          TYPE 1 - VERTICAL PERCOLATION LAYER
              MATERIAL TEXTURE NUMBER   0
THICKNESS                  =     24.00   INCHES
POROSITY                   =      0.4170 VOL/VOL
FIELD CAPACITY             =      0.0450 VOL/VOL
WILTING POINT              =      0.0180 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0250 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.1000E-04 CM/SEC


                        LAYER  6
                        --------

            TYPE 2 - LATERAL DRAINAGE LAYER
              MATERIAL TEXTURE NUMBER  20
THICKNESS                  =      0.20   INCHES
POROSITY                   =      0.8500 VOL/VOL
FIELD CAPACITY             =      0.0100 VOL/VOL
WILTING POINT              =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
SLOPE                      =      2.00   PERCENT
DRAINAGE LENGTH            =    600.0    FEET


                        LAYER  7
                        --------

            TYPE 4 - FLEXIBLE MEMBRANE LINER
              MATERIAL TEXTURE NUMBER  35
THICKNESS                  =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY        =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS   =      4.00   HOLES/ACRE
```

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FML PLACEMENT QUALITY       =  3 - GOOD


                         LAYER  8
                         --------

             TYPE 2 - LATERAL DRAINAGE LAYER
               MATERIAL TEXTURE NUMBER  20
THICKNESS                   =      0.20   INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0060 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=       10.00     CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    600.0    FEET


                         LAYER  9
                         --------

             TYPE 4 - FLEXIBLE MEMBRANE LINER
               MATERIAL TEXTURE NUMBER  35
THICKNESS                   =      0.06   INCHES
EFFECTIVE SAT. HYD. CONDUCT.=      0.2000E-12 CM/SEC
FML PINHOLE DENSITY         =      4.00   HOLES/ACRE
FML INSTALLATION DEFECTS    =      4.00   HOLES/ACRE
FML PLACEMENT QUALITY       =  3 - GOOD


                         LAYER 10
                         --------

               TYPE 3 - BARRIER SOIL LINER
               MATERIAL TEXTURE NUMBER  17
THICKNESS                   =      0.24   INCHES
POROSITY                    =      0.7500 VOL/VOL
FIELD CAPACITY              =      0.7470 VOL/VOL
WILTING POINT               =      0.4000 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.7500 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      0.3000E-08 CM/SEC


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                 GENERAL DESIGN AND EVAPORATIVE ZONE DATA   1
------------------------------------------------------------------------------

                             VALID FOR  28 YEARS


          NOTE:  SCS RUNOFF CURVE NUMBER WAS COMPUTED FROM DEFAULT
                   SOIL DATA BASE USING SOIL TEXTURE #13 WITH A
                   POOR STAND OF GRASS, A SURFACE SLOPE OF  4.%
                   AND A SLOPE LENGTH OF  750. FEET.

         SCS RUNOFF CURVE NUMBER            =     91.59
         FRACTION OF AREA ALLOWING RUNOFF   =    100.0    PERCENT
         AREA PROJECTED ON HORIZONTAL PLANE =    205.000  ACRES
         EVAPORATIVE ZONE DEPTH             =     24.0    INCHES
         INITIAL WATER IN EVAPORATIVE ZONE  =      3.216  INCHES
         UPPER LIMIT OF EVAPORATIVE STORAGE =     11.352  INCHES
         FIELD CAPACITY OF EVAPORATIVE ZONE =      5.328  INCHES
         LOWER LIMIT OF EVAPORATIVE STORAGE =      2.496  INCHES
         SOIL EVAPORATION ZONE DEPTH        =     24.000  INCHES
         INITIAL SNOW WATER                 =      0.000  INCHES
         INITIAL INTERCEPTION WATER         =      0.000  INCHES
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      INITIAL WATER IN LAYER MATERIALS    =    553.622  INCHES
      TOTAL INITIAL WATER                 =    553.622  INCHES
      TOTAL SUBSURFACE INFLOW             =      0.00   INCHES/YEAR


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                        EVAPOTRANSPIRATION DATA   1
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                            VALID FOR  28 YEARS


       NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                ROSWELL             NEW MEXICO
           STATION LATITUDE                        =  33.24 DEGREES
           MAXIMUM LEAF AREA INDEX                 =   1.20
           START OF GROWING SEASON (JULIAN DATE)  =     76
           END OF GROWING SEASON (JULIAN DATE)    =    310
           EVAPORATIVE ZONE DEPTH                  =  24.0  INCHES
           AVERAGE ANNUAL WIND SPEED               =   8.70 MPH
           AVERAGE 1ST QUARTER RELATIVE HUMIDITY  =  49.0  %
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY  =  40.0  %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY  =  53.0  %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY  =  52.0  %

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                          ANNUAL TOTALS FOR YEAR    1
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                                         INCHES          CU. FEET     PERCENT
                                        --------        ----------    -------
  PRECIPITATION                            8.70         6474105.500   100.00

  RUNOFF                                   0.896         666436.812    10.29

  POTENTIAL EVAPOTRANSPIRATION            77.421       57612976.000

  ACTUAL EVAPOTRANSPIRATION                7.845        5837720.000    90.17

  DRAINAGE COLLECTED FROM LAYER  6         0.0000             0.000     0.00

  PERC./LEAKAGE THROUGH LAYER  7           0.000000           0.000     0.00

  AVG. HEAD ON TOP OF LAYER  7             0.0000

  DRAINAGE COLLECTED FROM LAYER  8         0.0000             0.000     0.00

  PERC./LEAKAGE THROUGH LAYER 10           0.000000           0.000     0.00

  AVG. HEAD ON TOP OF LAYER  9             0.0000

  CHANGE IN WATER STORAGE                 -0.040         -30022.164    -0.46

  SOIL WATER AT START OF YEAR            553.624      411979008.000

  SOIL WATER AT END OF YEAR              553.583      411948960.000

  INTERCEPTION WATER AT START OF YEAR      0.000              0.000

  INTERCEPTION WATER AT END OF YEAR        0.000              0.000

  SNOW WATER AT START OF YEAR              0.000              0.000     0.00
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SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-29.097	0.00

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ANNUAL TOTALS FOR YEAR 2

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.35	7701953.500	100.00
RUNOFF	0.875	650883.688	8.45
POTENTIAL EVAPOTRANSPIRATION	76.577	56984972.000	
ACTUAL EVAPOTRANSPIRATION	9.244	6878927.500	89.31
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.231	172139.188	2.24
SOIL WATER AT START OF YEAR	553.583	411948960.000	
SOIL WATER AT END OF YEAR	553.815	412121120.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	3.548	0.00

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ANNUAL TOTALS FOR YEAR 3

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.33	7687068.500	100.00
RUNOFF	0.542	403351.406	5.25
POTENTIAL EVAPOTRANSPIRATION	76.472	56906980.000	
ACTUAL EVAPOTRANSPIRATION	9.527	7089696.000	92.23

DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.261	194031.297	2.52
SOIL WATER AT START OF YEAR	553.815	412121120.000	
SOIL WATER AT END OF YEAR	554.075	412315136.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-9.935	0.00

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ANNUAL TOTALS FOR YEAR 4

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.25	6883389.500	100.00
RUNOFF	1.576	1172830.250	17.04
POTENTIAL EVAPOTRANSPIRATION	77.070	57351340.000	
ACTUAL EVAPOTRANSPIRATION	8.161	6072664.500	88.22
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.487	-362128.156	-5.26
SOIL WATER AT START OF YEAR	554.075	412315136.000	
SOIL WATER AT END OF YEAR	553.589	411953024.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	

SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	22.710	0.00

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ANNUAL TOTALS FOR YEAR 5

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.68	7203372.000	100.00
RUNOFF	0.474	353023.469	4.90
POTENTIAL EVAPOTRANSPIRATION	75.845	56440384.000	
ACTUAL EVAPOTRANSPIRATION	8.282	6162752.500	85.55
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.924	687557.562	9.54
SOIL WATER AT START OF YEAR	553.589	411953024.000	
SOIL WATER AT END OF YEAR	554.513	412640608.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0001	38.323	0.00

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ANNUAL TOTALS FOR YEAR 6

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.14	4569081.000	100.00
RUNOFF	0.036	26800.961	0.59
POTENTIAL EVAPOTRANSPIRATION	77.114	57384016.000	

ACTUAL EVAPOTRANSPIRATION	6.951	5172790.500	113.21
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.847	-630465.438	-13.80
SOIL WATER AT START OF YEAR	554.513	412640608.000	
SOIL WATER AT END OF YEAR	553.665	412010112.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0001	-45.064	0.00

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ANNUAL TOTALS FOR YEAR 7

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.91	8118676.500	100.00
RUNOFF	1.570	1168274.375	14.39
POTENTIAL EVAPOTRANSPIRATION	76.817	57163692.000	
ACTUAL EVAPOTRANSPIRATION	9.108	6777628.000	83.48
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.232	172729.641	2.13
SOIL WATER AT START OF YEAR	553.665	412010112.000	
SOIL WATER AT END OF YEAR	553.898	412182816.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	

INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0001	45.419	0.00

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ANNUAL TOTALS FOR YEAR 8

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.25	6883388.000	100.00
RUNOFF	1.531	1139458.625	16.55
POTENTIAL EVAPOTRANSPIRATION	77.523	57688988.000	
ACTUAL EVAPOTRANSPIRATION	7.651	5693326.000	82.71
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.068	50642.531	0.74
SOIL WATER AT START OF YEAR	553.898	412182816.000	
SOIL WATER AT END OF YEAR	553.966	412233472.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0001	-39.032	0.00

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ANNUAL TOTALS FOR YEAR 9

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.01	7448942.000	100.00
RUNOFF	1.880	1399259.625	18.78

POTENTIAL EVAPOTRANSPIRATION	76.850	57187568.000	
ACTUAL EVAPOTRANSPIRATION	8.270	6153983.500	82.62
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.140	-104328.156	-1.40
SOIL WATER AT START OF YEAR	553.966	412233472.000	
SOIL WATER AT END OF YEAR	553.825	412129152.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	26.968	0.00

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ANNUAL TOTALS FOR YEAR 10

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.96	5179284.000	100.00
RUNOFF	1.010	751703.250	14.51
POTENTIAL EVAPOTRANSPIRATION	77.489	57663276.000	
ACTUAL EVAPOTRANSPIRATION	6.420	4777680.500	92.25
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.470	-350092.031	-6.76
SOIL WATER AT START OF YEAR	553.825	412129152.000	
SOIL WATER AT END OF YEAR	553.355	411779072.000	

INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-7.097	0.00

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ANNUAL TOTALS FOR YEAR 11

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.58	8617257.000	100.00
RUNOFF	1.473	1095850.250	12.72
POTENTIAL EVAPOTRANSPIRATION	77.254	57488208.000	
ACTUAL EVAPOTRANSPIRATION	9.658	7186683.500	83.40
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.450	334694.906	3.88
SOIL WATER AT START OF YEAR	553.355	411779072.000	
SOIL WATER AT END OF YEAR	553.805	412113760.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	28.387	0.00

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ANNUAL TOTALS FOR YEAR 12

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.55	7850782.000	100.00

RUNOFF	1.304	970393.500	12.36
POTENTIAL EVAPOTRANSPIRATION	76.673	57056368.000	
ACTUAL EVAPOTRANSPIRATION	9.011	6705824.500	85.42
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.235	174591.828	2.22
SOIL WATER AT START OF YEAR	553.805	412113760.000	
SOIL WATER AT END OF YEAR	554.039	412288352.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-28.387	0.00

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ANNUAL TOTALS FOR YEAR 13

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.66	7932641.500	100.00
RUNOFF	2.074	1543183.125	19.45
POTENTIAL EVAPOTRANSPIRATION	77.232	57471952.000	
ACTUAL EVAPOTRANSPIRATION	9.097	6769792.500	85.34
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.511	-380341.344	-4.79
SOIL WATER AT START OF YEAR	554.039	412288352.000	

SOIL WATER AT END OF YEAR	553.528	411908000.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	7.097	0.00

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ANNUAL TOTALS FOR YEAR 14

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.01	8193092.500	100.00
RUNOFF	1.548	1151899.000	14.06
POTENTIAL EVAPOTRANSPIRATION	75.901	56481776.000	
ACTUAL EVAPOTRANSPIRATION	9.126	6791020.000	82.89
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.336	250214.984	3.05
SOIL WATER AT START OF YEAR	553.528	411908000.000	
SOIL WATER AT END OF YEAR	553.864	412158208.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0001	-41.161	0.00

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ANNUAL TOTALS FOR YEAR 15

	INCHES	CU. FEET	PERCENT

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PRECIPITATION	10.43	7761484.500	100.00
RUNOFF	2.205	1641222.375	21.15
POTENTIAL EVAPOTRANSPIRATION	78.085	58106976.000	
ACTUAL EVAPOTRANSPIRATION	8.243	6134048.500	79.03
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.019	-13852.891	-0.18
SOIL WATER AT START OF YEAR	553.864	412158208.000	
SOIL WATER AT END OF YEAR	553.846	412144384.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0001	66.000	0.00

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ANNUAL TOTALS FOR YEAR 16

	INCHES	CU. FEET	PERCENT
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PRECIPITATION	7.36	5476944.500	100.00
RUNOFF	0.929	691114.188	12.62
POTENTIAL EVAPOTRANSPIRATION	77.147	57409100.000	
ACTUAL EVAPOTRANSPIRATION	7.177	5340730.000	97.51
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.746	-554887.688	-10.13

SOIL WATER AT START OF YEAR	553.846	412144384.000	
SOIL WATER AT END OF YEAR	553.100	411589504.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-12.065	0.00

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ANNUAL TOTALS FOR YEAR 17

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.70	4985805.000	100.00
RUNOFF	1.405	1045202.812	20.96
POTENTIAL EVAPOTRANSPIRATION	78.052	58082228.000	
ACTUAL EVAPOTRANSPIRATION	5.298	3942235.250	79.07
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.002	-1589.676	-0.03
SOIL WATER AT START OF YEAR	553.100	411589504.000	
SOIL WATER AT END OF YEAR	553.098	411587872.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0001	-43.645	0.00

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ANNUAL TOTALS FOR YEAR 18

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.77	5782045.500	100.00
RUNOFF	1.201	893559.688	15.45
POTENTIAL EVAPOTRANSPIRATION	77.282	57509108.000	
ACTUAL EVAPOTRANSPIRATION	6.259	4657980.000	80.56
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.310	230503.000	3.99
SOIL WATER AT START OF YEAR	553.098	411587872.000	
SOIL WATER AT END OF YEAR	553.408	411818400.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	2.484	0.00

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ANNUAL TOTALS FOR YEAR 19

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.21	4621171.500	100.00
RUNOFF	1.203	895374.188	19.38
POTENTIAL EVAPOTRANSPIRATION	75.597	56255460.000	
ACTUAL EVAPOTRANSPIRATION	4.779	3555970.750	76.95
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		

CHANGE IN WATER STORAGE	0.228	169822.797	3.67
SOIL WATER AT START OF YEAR	553.408	411818400.000	
SOIL WATER AT END OF YEAR	553.636	411988224.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	3.903	0.00

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ANNUAL TOTALS FOR YEAR 20

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.13	5305789.500	100.00
RUNOFF	0.636	473141.250	8.92
POTENTIAL EVAPOTRANSPIRATION	78.745	58597860.000	
ACTUAL EVAPOTRANSPIRATION	6.670	4963255.000	93.54
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.176	-130625.938	-2.46
SOIL WATER AT START OF YEAR	553.636	411988224.000	
SOIL WATER AT END OF YEAR	553.460	411857568.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	19.161	0.00

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ANNUAL TOTALS FOR YEAR 21

	INCHES	CU. FEET	PERCENT
PRECIPITATION	10.95	8148443.500	100.00
RUNOFF	3.359	2499398.500	30.67
POTENTIAL EVAPOTRANSPIRATION	77.824	57912380.000	
ACTUAL EVAPOTRANSPIRATION	7.733	5754294.500	70.62
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.141	-105236.539	-1.29
SOIL WATER AT START OF YEAR	553.460	411857568.000	
SOIL WATER AT END OF YEAR	553.319	411752352.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-13.484	0.00

ANNUAL TOTALS FOR YEAR 22

	INCHES	CU. FEET	PERCENT
PRECIPITATION	7.16	5328114.000	100.00
RUNOFF	0.746	555316.750	10.42
POTENTIAL EVAPOTRANSPIRATION	76.666	57050800.000	
ACTUAL EVAPOTRANSPIRATION	6.168	4589947.500	86.15
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00

AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.246	182812.734	3.43
SOIL WATER AT START OF YEAR	553.319	411752352.000	
SOIL WATER AT END OF YEAR	553.565	411935200.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	36.903	0.00

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ANNUAL TOTALS FOR YEAR 23

	INCHES	CU. FEET	PERCENT
PRECIPITATION	6.48	4822092.500	100.00
RUNOFF	0.858	638535.500	13.24
POTENTIAL EVAPOTRANSPIRATION	77.183	57436084.000	
ACTUAL EVAPOTRANSPIRATION	5.565	4141166.000	85.88
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.057	42421.637	0.88
SOIL WATER AT START OF YEAR	553.565	411935200.000	
SOIL WATER AT END OF YEAR	553.622	411977600.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-31.226	0.00

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ANNUAL TOTALS FOR YEAR 24

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.13	8282390.000	100.00
RUNOFF	2.192	1630820.500	19.69
POTENTIAL EVAPOTRANSPIRATION	77.005	57303156.000	
ACTUAL EVAPOTRANSPIRATION	8.662	6445582.000	77.82
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.277	205976.578	2.49
SOIL WATER AT START OF YEAR	553.622	411977600.000	
SOIL WATER AT END OF YEAR	553.898	412183552.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	10.645	0.00

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ANNUAL TOTALS FOR YEAR 25

	INCHES	CU. FEET	PERCENT
PRECIPITATION	12.07	8981895.000	100.00
RUNOFF	1.561	1161613.250	12.93
POTENTIAL EVAPOTRANSPIRATION	75.945	56514708.000	
ACTUAL EVAPOTRANSPIRATION	10.626	7907093.500	88.03
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00

PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.117	-86796.305	-0.97
SOIL WATER AT START OF YEAR	553.898	412183552.000	
SOIL WATER AT END OF YEAR	553.782	412096768.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-15.613	0.00

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ANNUAL TOTALS FOR YEAR 26

	INCHES	CU. FEET	PERCENT
PRECIPITATION	11.66	8676789.000	100.00
RUNOFF	2.070	1540065.875	17.75
POTENTIAL EVAPOTRANSPIRATION	77.882	57955628.000	
ACTUAL EVAPOTRANSPIRATION	9.942	7398248.500	85.26
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.351	-261524.391	-3.01
SOIL WATER AT START OF YEAR	553.782	412096768.000	
SOIL WATER AT END OF YEAR	553.430	411835264.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0000	-0.710	0.00

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ANNUAL TOTALS FOR YEAR 27

	INCHES	CU. FEET	PERCENT
PRECIPITATION	14.86	11058069.000	100.00
RUNOFF	1.860	1384078.375	12.52
POTENTIAL EVAPOTRANSPIRATION	77.591	57739340.000	
ACTUAL EVAPOTRANSPIRATION	12.460	9272262.000	83.85
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		
DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	0.540	401688.375	3.63
SOIL WATER AT START OF YEAR	553.430	411835264.000	
SOIL WATER AT END OF YEAR	553.970	412236928.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	0.0001	41.161	0.00

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ANNUAL TOTALS FOR YEAR 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	13.54	10075791.000	100.00
RUNOFF	1.323	984453.438	9.77
POTENTIAL EVAPOTRANSPIRATION	74.171	55194268.000	
ACTUAL EVAPOTRANSPIRATION	12.523	9318839.000	92.49
DRAINAGE COLLECTED FROM LAYER 6	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 7	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 7	0.0000		

DRAINAGE COLLECTED FROM LAYER 8	0.0000	0.000	0.00
PERC./LEAKAGE THROUGH LAYER 10	0.000000	0.000	0.00
AVG. HEAD ON TOP OF LAYER 9	0.0000		
CHANGE IN WATER STORAGE	-0.306	-227459.922	-2.26
SOIL WATER AT START OF YEAR	553.970	412236928.000	
SOIL WATER AT END OF YEAR	553.665	412009472.000	
INTERCEPTION WATER AT START OF YEAR	0.000	0.000	
INTERCEPTION WATER AT END OF YEAR	0.000	0.000	
SNOW WATER AT START OF YEAR	0.000	0.000	0.00
SNOW WATER AT END OF YEAR	0.000	0.000	0.00
ANNUAL WATER BUDGET BALANCE	-0.0001	-42.581	0.00

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FINAL WATER STORAGE AT END OF YEAR 28

LAYER	(INCHES)	(VOL/VOL)
1	2.0089	0.1674
2	4.4640	0.1240
3	1.6080	0.1340
4	544.8000	0.2000
5	0.6000	0.0250
6	0.0012	0.0060
7	0.0000	0.0000
8	0.0012	0.0060
9	0.0000	0.0000
10	0.1800	0.7500

TOTAL WATER IN LAYERS	553.663
SNOW WATER	0.000
INTERCEPTION WATER	0.000
TOTAL FINAL WATER	553.663

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PEAK DAILY VALUES FOR YEARS 1 THROUGH 28

	(INCHES)	(CU. FT.)
PRECIPITATION	2.28	1696662.000
RUNOFF	1.704	1268329.1250
DRAINAGE COLLECTED FROM LAYER 6	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000	
MAXIMUM HEAD ON TOP OF LAYER 7	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 6 (DISTANCE FROM DRAIN)	0.0 FEET	
DRAINAGE COLLECTED FROM LAYER 8	0.00000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.000000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000	
MAXIMUM HEAD ON TOP OF LAYER 9	0.000	
LOCATION OF MAXIMUM HEAD IN LAYER 8 (DISTANCE FROM DRAIN)	0.0 FEET	
SNOW WATER	0.61	455364.3438
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.1941	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1040	

*** Maximum heads are computed using McEnroe's equations. ***

Reference: Maximum Saturated Depth over Landfill Liner
by Bruce M. McEnroe, University of Kansas
ASCE Journal of Environmental Engineering
Vol. 119, No. 2, March 1993, pp. 262-270.

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 1 THROUGH 28

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	0.25	0.29	0.23	0.37	0.72	0.80
	1.32	2.24	1.49	1.07	0.45	0.37
STD. DEVIATIONS	0.24	0.20	0.22	0.42	0.79	0.63
	0.69	1.60	0.90	1.04	0.55	0.30
RUNOFF						
TOTALS	0.001	0.000	0.000	0.061	0.115	0.089
	0.098	0.425	0.296	0.240	0.014	0.028
STD. DEVIATIONS	0.005	0.000	0.000	0.146	0.242	0.160

	0.174	0.596	0.364	0.367	0.045	0.092

POTENTIAL EVAPOTRANSPIRATION

TOTALS	3.125	3.589	5.452	7.559	9.413	10.513
	10.027	8.928	6.935	5.169	3.497	2.769
STD. DEVIATIONS	0.193	0.240	0.300	0.309	0.281	0.270
	0.251	0.283	0.253	0.271	0.194	0.206

ACTUAL EVAPOTRANSPIRATION

TOTALS	0.226	0.187	0.182	0.336	1.273	0.872
	1.214	1.598	1.057	0.618	0.384	0.285
STD. DEVIATIONS	0.104	0.064	0.119	0.167	0.555	0.631
	0.653	0.953	0.556	0.377	0.259	0.156

LATERAL DRAINAGE COLLECTED FROM LAYER 6

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 7

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

LATERAL DRAINAGE COLLECTED FROM LAYER 8

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

PERCOLATION/LEAKAGE THROUGH LAYER 10

TOTALS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

AVERAGES OF MONTHLY AVERAGED DAILY HEADS (INCHES)

DAILY AVERAGE HEAD ON TOP OF LAYER 7

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

DAILY AVERAGE HEAD ON TOP OF LAYER 9

AVERAGES	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
STD. DEVIATIONS	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 1 THROUGH 28

	INCHES	CU. FEET	PERCENT
PRECIPITATION	9.60 (2.272)	7144638.0	100.00
RUNOFF	1.369 (0.6754)	1018830.19	14.260
POTENTIAL EVAPOTRANSPIRATION	76.979 (0.9113)	57283916.00	
ACTUAL EVAPOTRANSPIRATION	8.230 (1.9033)	6124720.00	85.725
LATERAL DRAINAGE COLLECTED FROM LAYER 6	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 7	0.00000 (0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 7	0.000 (0.000)		
LATERAL DRAINAGE COLLECTED FROM LAYER 8	0.00000 (0.00000)	0.000	0.00000
PERCOLATION/LEAKAGE THROUGH LAYER 10	0.00000 (0.00000)	0.000	0.00000
AVERAGE HEAD ON TOP OF LAYER 9	0.000 (0.000)		
CHANGE IN WATER STORAGE	0.001 (0.3981)	1088.44	0.015

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Exhibit I
HELP MODEL GUIDANCE DOCUMENT

Guidance Document

for

Performance Demonstration for an Alternate Cover Design under Section 502.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

and

Performance Demonstration for an Alternate Liner Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

This document is for guidance only and is subject to change. However, any deviations from this document must be fully justified to the satisfaction of the Department.

Prepared by the
New Mexico Environment Department
Solid Waste Bureau
Permit Section
April 1, 1998

Performance Demonstration for an Alternative Cover Design under Section 502.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

1. Existing Solid Waste Landfills without a Liner System:

A prescriptive landfill cover system must, in accordance with Section 502.A.1, consist of an infiltration layer comprised of a minimum of 18 inches of earthen material with the required hydraulic conductivity (K) and a minimum of 6 inches of soil that is capable of sustaining native plant growth as an erosion layer (Figure 1). The cover component of 18 inches of earthen material must be equivalent to the least hydraulically conductive natural subsoils or a saturated hydraulic conductivity of no greater than 1 x 10^{-5} cm/sec. For example, if the hydraulic conductivity of the natural subsoils is 5 x 10^{-6} cm/sec, then the K of the infiltration layer material must be equivalent to these soils. *However, this example is for modeling purposes only. If the K of the underlying subsoils is less than 1 x 10^{-5} cm/sec (e.g., 5 x 10^{-6} cm/sec), then an alternative cover design must be proposed since 1 x 10^{-5} cm/sec is the lowest acceptable actual K for soils used in covers due to desiccation and root penetration (see example below).* If the hydraulic conductivity of the natural subsoils is greater than 1 x 10^{-5} cm/sec (e.g., 1 x 10^{-4} cm/sec), the K of the infiltration layer material must equate to the 1 x 10^{-5} cm/sec requirement.

If the infiltration layer meets the minimum hydraulic conductivity of 1 x 10^{-5} cm/sec or that of the natural subsoils and the minimum 18 inch condition then a Hydrologic Evaluation of Landfill Performance (HELP) Model simulation is not required. If an alternative cover design is proposed, it must achieve an equivalent reduction in infiltration as the infiltration layer specified in Section 502.A.1.a. Therefore, a HELP Model simulation is required to demonstrate that the design of such a cover provides equivalent reduction in infiltration as the prescriptive cover design. If the natural subsoils have a hydraulic conductivity of less than 1 x 10^{-5} cm/sec (e.g., 5 x 10^{-6} cm/sec), then the cover must achieve equivalent reduction in infiltration as that of the prescriptive cover but with an 18 inch infiltration layer with a hydraulic conductivity of 5 x 10^{-6} cm/sec.

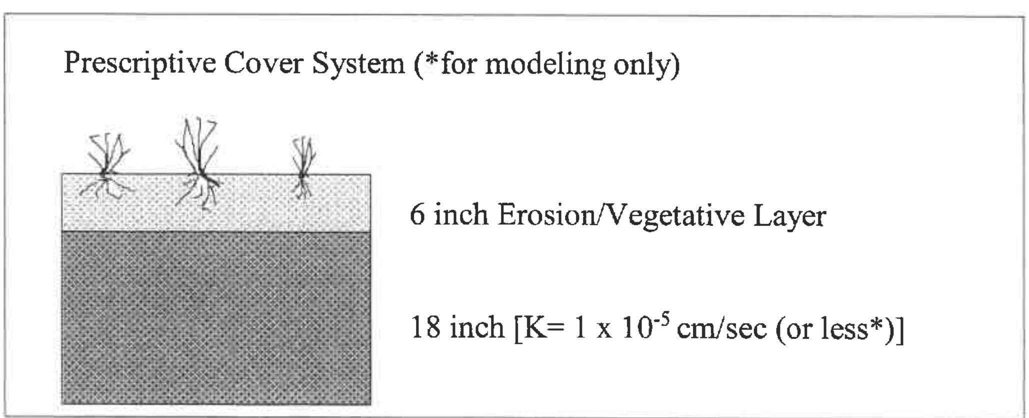

Figure 1. Prescriptive Cover System

A demonstration of equivalent reduction in infiltration is determined by using the EPA HELP Model. The HELP Model simulations need to compare the prescriptive cover and the alternative cover design (Figure 2). The simulation for the prescriptive cover must include the erosion, infiltration and intermediate cover layers. The alternative cover design simulation includes the intermediate and alternative cover layers. The two designs are to be simulated for years 1 through 5 with "poor" vegetation during the post-closure care period to demonstrate equivalency (Simulations #1 & #2). In New Mexico, it is assumed for a conservative value that the vegetation will be between "bare ground" and "fair vegetation" designated as "poor vegetation". Precipitation (wettest 5 consecutive year period using Climatedata CD or NOAA data files: discs or manual entry), evapotranspiration, temperature (use values associated with wettest 5 consecutive years of precipitation), and solar radiation data must be site specific and identical for both alternative and prescriptive cover designs simulations. Provide justification for all input parameters in the model utilizing the attached forms. Indicate characteristics of on-site or other sources of soil proposed for the construction of cover and the parameter values in the model. It is anticipated that the entire area of the landfill or cell will be modeled. The Department recommends initializing the soil moisture content to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point]. Other values deviating from this range may be used but must be fully justified. The leaf area index may be between 0.8 and 1.6 depending on the site location. The evaporative zone depth may be between 18" and 28" depending on the site location.

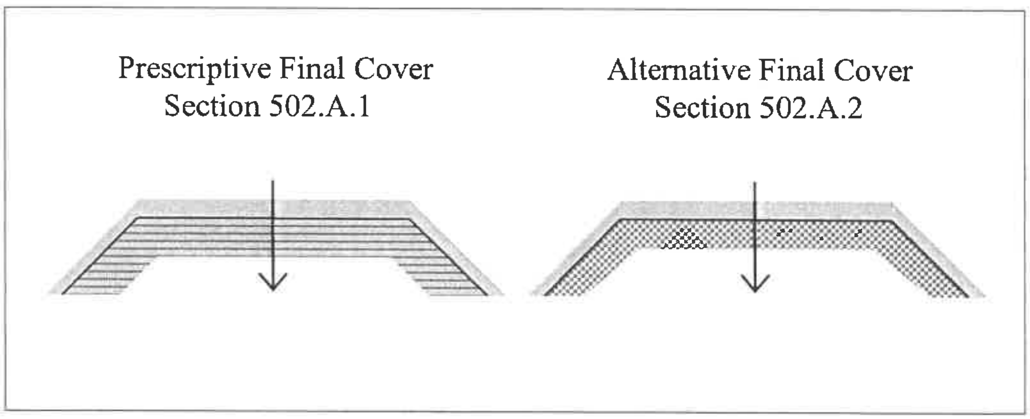

Figure 2

For example, comparing the prescriptive cover of:

1) 6 inches of topsoil
2) 18 inches of compacted soil ($K = 5 \times 10^{-6}$ cm/sec* - to meet natural subsoils $K = 5 \times 10^{-6}$)
3) Intermediate cover layer (optional* for modeling purposes) [*unless an intermediate cover layer is used for modeling purposes with a proposed alternative cover system (see below), then an intermediate cover layer must be used for modeling purposes]

with a proposed alternative cover system of:

1) 6 inches of topsoil
2) 30 inches of compacted ($K = 1 \times 10^{-5}$ cm/sec*)
3) Intermediate cover layer (optional for modeling purposes)

* $K = 5 \times 10^{-6}$ cm/sec is for modeling purposes only since 1×10^{-5} cm/sec is the lowest acceptable actual K for soils used in covers. Even if soils with $K = 5 \times 10^{-6}$ cm/sec are available for use in the cover, over time the K will increase to 1×10^{-5} cm/sec due to desiccation and root penetration.

Input Parameters for HELP Simulation #1 (Prescriptive Cover)

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; “closed”

Surface area: entire disposal area of landfill

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6” of topsoil, 18” of infiltration layer, 12” of intermediate cover layer* [*optional for modeling purposes (unless an intermediate cover layer is used for modeling purposes with a proposed alternative cover system in Simulation #2, then an intermediate cover layer must be used for modeling purposes)]

Layer type: “1” vertical percolation layer for all cover materials

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User’s Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): The K of the infiltration layer must be the greatest actual value (unless greater than 1x 10^{-5} cm/sec*) of the underlying soil [e.g., If the actual (two tested samples - different locations) K of the underlying soil = 1x 10^{-6} cm/sec and 2 x 10^{-6}, then model 18” of 2 x 10^{-6} cm/sec for the infiltration layer; *If the K of the underlying soil = 5 x 10^{-5} cm/sec, then model 18” of 1x 10^{-5} cm/sec].

Input Parameters for HELP Simulation #2 (Proposed Alternate Cover)

Weather data (must be the same as Simulation #1)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, 18" to proposed thickness of infiltration layer, 12" of intermediate cover layer* (*optional for modeling purposes)

Layer type: "1" vertical percolation layer for all* cover materials including GCLs used (*consult with the Department if a FML is proposed to be used in the cover)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1×10^{-5} cm/sec* (e.g., If the tested K is 5×10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5×10^{-5} cm/sec. However, if the tested K is 2×10^{-6}, the lowest value to be modeled would be 1×10^{-5} cm/sec). *1×10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3×10^{-9} cm/sec).

2. New Solid Waste Landfills:

As in the above case, the cover for the proposed landfill with a prescriptive or alternative liner must achieve an equivalent protection as the liner. If an alternative final cover is proposed for the landfill, then a demonstration must be submitted to the Bureau for approval pursuant to Section 502.A. It must be determined by this demonstration that the proposed final cover design includes an infiltration layer that achieves an equivalent reduction in infiltration as the bottom liner (Figure 3). A HELP Model simulation comparison is acceptable for this demonstration for a 5 year period with vegetation. Precipitation (wettest 5 consecutive year period using Climatedata CD or NOAA data files: discs or manual entry), evapotranspiration, temperature (use values associated with wettest 5 consecutive years of precipitation) , and solar radiation data must be site specific and identical for both liner and cover design simulations. Provide justification for all input parameters in the model utilizing the attached forms. Demonstrate the relationship of the characteristics of on-site or other sources of soil proposed for the construction of cover or liner and the parameter values in the model. It is anticipated that the entire area of the landfill or cell will be modeled. The Department recommends initializing the soil moisture content to be at least the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point]. Other values deviating from this range may be used but must be fully justified.

For example, the comparison must include a HELP Model simulation for the liner and the proposed final cover systems as below (see Simulations #4 & #3, respectively).

The simulation for an alternative liner system* could include:

1) the drainage/protective layer of the liner with leachate collection system,
2) the 60-mil HDPE FML,
3) the 0.25 inch ($K = 3 \times 10^{-9}$) GCL (geosynthetic clay liner),
4) the 6 inches of compacted in situ soil used as the prepared subgrade, and
5) with the solid waste cell open and no runoff.

*Any alternative liner system must meet the demonstration as described in the "Performance Demonstration For An Alternative Liner Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling".

A liner system is compared with a HELP Model simulation for a proposed final cover:

1) 18 inches non-compacted material (6 inches of topsoil with poor grass and 12 inches of non-compacted soil),
2) the 0.25 inch GCL ($K = 3 \times 10^{-9}$),
3) 12 inches of intermediate cover (6 inches of compacted soil and 6 inches of non-compacted soil), and
4) with the solid waste cell closed and final placement of the cover to include runoff.

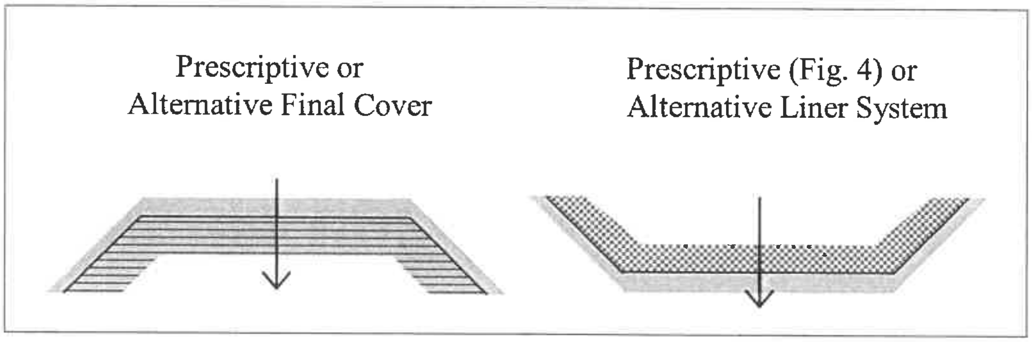

Figure 3

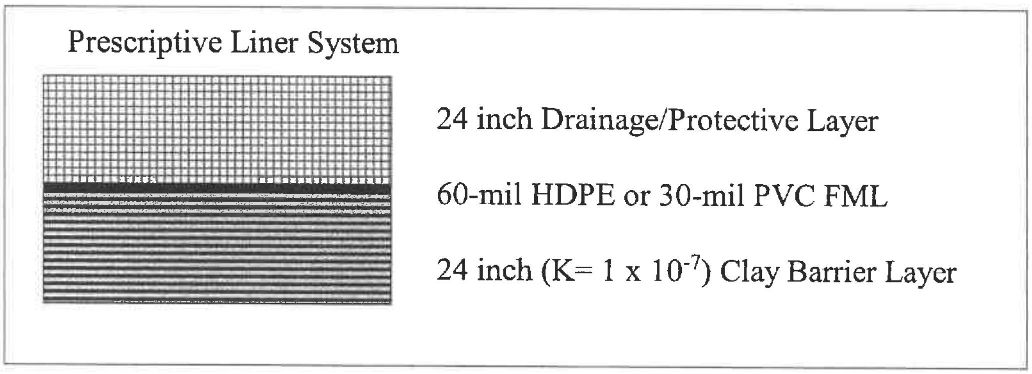

Figure 4

Input Parameters for HELP Simulation #3 (Proposed Alternate Cover)

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, Proposed thickness of infiltration layer or rooting medium or drainage layer, Possible GCL (0.24") or FML, subgrade thickness for GCL or FML (minimum of 6"), 12" of intermediate cover layer* (*optional for modeling purposes)

Layer type: Type "1" - vertical percolation layer for all* cover materials including GCLs used (*consult with the Department if a FML is proposed to be used in the cover)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1 x 10^{-5} cm/sec* (e.g., If the tested K is 5 x 10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5 x 10^{-5} cm/sec. However, if the tested K is 2 x 10^{-6}, the lowest value to be modeled would be 1 x 10^{-5} cm/sec). *1 x 10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3 x 10^{-9} cm/sec).

Input Parameters for HELP Simulation #4 (Prescriptive Liner or Proposed Alternate Liner - Tier I)

Weather data (must be the same as Simulation #3)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12" to 18" corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14"; Las Cruces, Albuquerque, and Farmington would be 18")

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from the wettest 5 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with the wettest 5 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 1 for "bare ground"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 0%; "open"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 24" of drainage/protection layer, possible geonet*, FML, 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner. (*A demonstration that no more than one foot of head will be on the liner must be made for this simulation. Therefore, a geonet may be necessary if the 24" drainage layer material is incapable of transmitting leachate so 12" of head is not on the liner.)

Layer type: Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): For the 24" of drainage/protection layer use the tested K* for modeling the prescriptive liner design and for a proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K* value which is the greatest value from the manufacture's specifications; 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner. (*must be the same value in both Simulation #5 & #6)

Performance Demonstration for an Alternate <u>Liner</u> Design under Section 306.A.2 of the New Mexico Solid Waste Management Regulations (20 NMAC 9.1) Using HELP Modeling

1. Permit applicants proposing an alternate liner in accordance with Section 306.A.2 must demonstrate the liner "... provides equivalent protection as the composite liner ... <u>and</u> ensures concentration values listed in Section 1110 will not be exceeded in the uppermost aquifer ... ". This requires that a two tier demonstration be made:

Tier 1 - the alternative liner provides equivalent protection, <u>and</u>

Tier 2 - the alternate liner ensures the uppermost aquifer will be protected.

The first tier of this demonstration may be satisfied through mathematical modeling using the EPA Hydrologic Evaluation of Landfill Performance (HELP) model. Two computer modeling analyses must be performed - (1) an analysis of the composite liner as specified in Section 306.A.1 and (2) an analysis of the proposed alternate liner as specified in Section 306.A.2. Each of these analyses must be performed under identical hydrologic and climatologic loading conditions of five years with no solid waste in the landfill (see Simulations #5 & 6). This time period is necessary to adequately evaluate the performance of the two liners. A successful demonstration of equivalent protection has been made when the analyses show equal or less percolation/leakage through the bottom layer of the proposed alternate liner than the percolation/leakage through the bottom layer of the Section 306.A.1 composite liner (Figure 5).

annual average

The second tier of the demonstration must include HELP modeling of the actual design conditions and the entire operational development of the landfill as closely as possible by doing a succession of model simulations which consider the factors in Section 306.A.2.a. To aid in accomplishing this, each successive computer simulation must use the previous simulation's moisture content output as the input for the following simulation (Figure 6). The modeling design method must be fully described. If no leakage is indicated at the end of the second simulation (#8) and subsequent simulations (#9 & #10) continue to indicate no leakage, then a successful demonstration has been made that the uppermost aquifer will be protected as required by Section 306.A.2 and it will not be necessary to perform a fate and transport modeling.

2. Justification for all input parameters in the HELP modeling must be provided utilizing the attached forms. Demonstrate the relationship of the characteristics of the soil proposed for the construction and operation of the landfill and the parameter values used in the model. Show justification for the soil and waste moisture content parameters as well as geomembrane liner data and storm water runoff fractions. The initial moisture content of the soil should be initialized by the use in the HELP model. The Department recommends initializing the soil moisture content to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point]. Other values deviating from this range may be used but must be fully justified.

3(1) First Tier of the Demonstration

Two simulations must be made, one of the Section 306.A.1 specified liner and one of the proposed alternate liner, both using the same precipitation (wettest 5 consecutive year period using Climatedata or NOAA tapes), temperature (use values associated with 5 wettest consecutive years), solar radiation, and evapotranspiration data (see Simulations #5 & #6). Current historic NOAA weather data from the nearest representative weather station as published by the National Climatic Data Center in Asheville, North Carolina must be used for the precipitation and temperature files. Both simulations must be made for the landfill in the open condition with no run-off and a Leaf Area Index of zero. *Simulations:*

#5 A simulation for the specified liner design must be performed using a 24 inch protective layer, a lateral drainage layer (which may be integral with the protective layer), an FML, and a 24 inch barrier layer of soil with a saturated hydraulic conductivity of 1 x 10^{-7} cm/sec. This simulation must be performed using no solid waste and for a five year period.

#6 A simulation for the proposed alternate liner design must be performed using a 24 inch protective layer, a lateral drainage layer (which may be integral with the protective layer), and the other proposed liner layer (the bottom layer must be modeled as a barrier layer). This simulation must be performed using no solid waste and for a five year period.

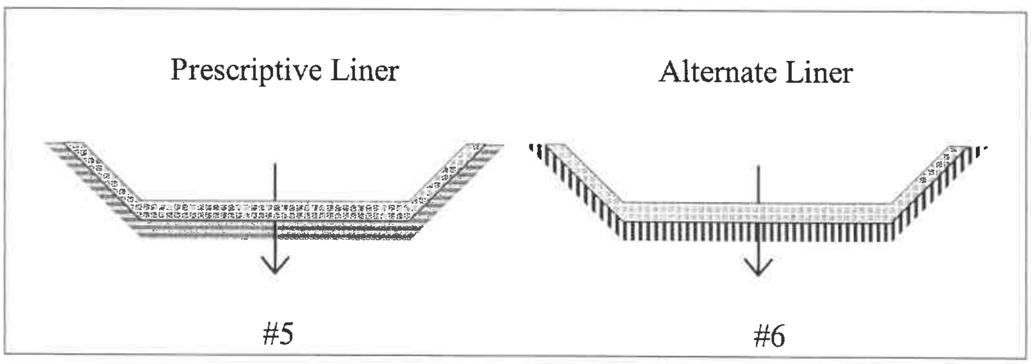

Figure 5

Compare the average annual percolation from the bottom layer of the two simulations. If the percolation is equivalent, a successful demonstration has been made for the first tier.

Input Parameters for HELP Simulation #5* (Prescriptive Liner - Tier I)

same as Simulation #4 with prescriptive liner design

Input Parameters for HELP Simulation #6* (Proposed Alternate Liner - Tier I)

same as Simulation #4 with proposed alternate liner design

*One of these simulations will also serve for the alternate cover design equivalency demonstration.

3(2) Second Tier of the Demonstration

Four simulations encompassing the entire life cycle of the facility to model actual design conditions and operational development as closely as possible must be performed (see Simulations #7, #8, #9 & #10). This is accomplished through a succession of four model simulations: one simulation of the open landfill, a second with the landfill partially filled with solid waste, a third with the landfill in the closed condition with bare ground, and a fourth with the landfill in the closed condition with "poor" vegetation. *Simulations:*

#7 The initial simulation must model the open landfill at start-up when the landfill contains no solid waste. The time period should extend for the anticipated duration of this condition (a minimum of two years).

#8 A succeeding simulation to model conditions of the partially filled landfill for a five year period*. This would incorporate daily and intermediate covers. (*This period may vary in accordance with anticipated operations.)

#9 Model the landfill in the closed condition with bare ground (a minimum of a two years).

#10 Finally, perform a simulation to model the landfill in the closed condition with poor vegetation for remainder of the post-closure care period (a minimum of 28 years).

If the simulations indicate no leakage after the third simulation (#9) and the subsequent simulation (#10), then the simulations have served to demonstrate the concentration values delineated in Section 1110 of the Regulations will not be exceeded in the uppermost aquifer at the relative point of compliance. Therefore, a successful demonstration has been made for the second tier.

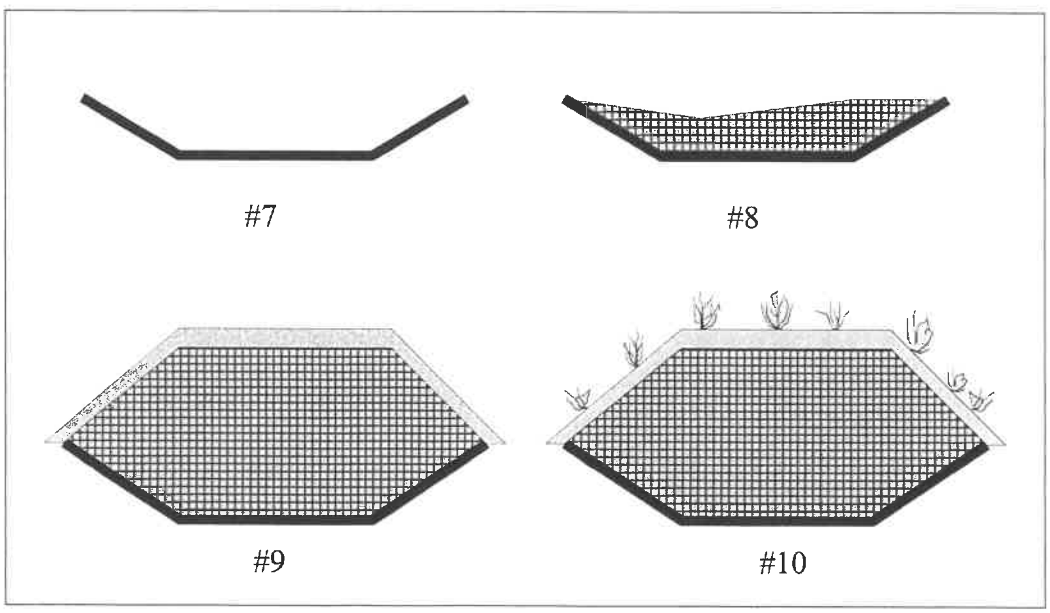

Figure 6

Input Parameters for HELP Simulation #7 (Proposed Alternate Liner - Tier II)

Weather data (must be the same as Simulation #3)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12" to 18" corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14"; Las Cruces, Albuquerque, and Farmington would be 18")

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 2 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with 2 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 1 for "bare ground"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 0%; "open"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 24" of drainage/protection layer, possible geonet, FML, 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content should be initialized to be the value of the wilting point plus 25% of the difference between the wilting point and the field capacity [i.e., (field capacity - wilting point) x 0.25 + wilting point].

Saturated hydraulic conductivity (K): For the 24" of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K value which is the greatest value from the manufacture's specifications; GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

Input Parameters for HELP Simulation #8 (Proposed Alternate Liner - Tier II)

Weather data (must be the same as Simulation #3)

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12" to 18" corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14"; Las Cruces, Albuquerque, and Farmington would be 18")

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 2 to 5* consecutive years for the appropriate weather reporting station (*may vary with landfill operations)

Temperature: daily* minimum and maximum temperatures corresponding with 2 to 5 years (same years as precipitation) for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: bare ground

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 0%; "open"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 240" of solid waste (this thickness may vary depending on landfill operations); 24" of drainage/protection layer; possible geonet*; FML; 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type "1", vertical percolation layer, must be used for solid waste. Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content must be initialized to be the value of the previous simulation's (from Simulation #7) moisture content output as the input for the following simulation (Simulation #8). For compacted municipal solid waste with a HELP soil texture number of "18" use 20%* by volume/volume (which is greater than per mass basis - see EPA HELP User's Guide for Version 3 for conversion) (*a lower value may be used if justified)

Saturated hydraulic conductivity (K): For compacted municipal solid waste with a HELP soil texture number of "18" will have a K of 1 x 10^{-3} cm/sec. For the 24" of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K value which is the greatest value from the manufacture's specifications; GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

Input Parameters for HELP Simulation #9 (Proposed Alternate Liner - Tier II)

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 12" to 18" corresponding with bare ground (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Santa Fe and Roswell would be 14"; Las Cruces, Albuquerque, and Farmington would be 18")

Maximum leaf area index: 0.0 corresponding with bare ground

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 2 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with 2 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 1 for "bare ground"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

3710
3490
220

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, Proposed thickness of infiltration layer or rooting medium or drainage layer, Possible GCL (0.24") or FML, subgrade thickness for GCL or FML (minimum of 6"), 12" of intermediate cover layer* (*optional for modeling); Proposed thickness of solid waste (this thickness will vary depending on landfill design); 24" of drainage/protection layer; possible geonet*; FML; 24" of 1 x 10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type "1" - vertical percolation layer for all* cover materials including GCLs used in the cover (*consult with the Department if a FML is proposed to be used in the cover).Type "1", vertical percolation layer, must be used for solid waste. Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content must be initialized to be the value of the previous simulation's (from Simulation #8) moisture content output as the input for the following simulation (Simulation #9).

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1 x 10^{-5} cm/sec* (e.g., If the tested K is 5 x 10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5 x 10^{-5} cm/sec. However, if the tested K is 2 x 10^{-6}, the lowest value to be modeled would be 1 x 10^{-5} cm/sec). *1 x 10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3 x 10^{-9} cm/sec). For compacted municipal solid waste with a HELP soil texture number of "18" will have a K of 1 x 10^{-3} cm/sec. For the 24" of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K value which is the greatest value from the manufacture's specifications; GCL (3 x 10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

Input Parameters for HELP Simulation #10 (Proposed Alternate Liner - Tier II)

Weather data

City/State: The weather data should be from the nearest reporting station that has at least 40 years of data.

Latitude: The latitude must be specific for the site to use in synthesizing solar radiation data.

Evaporative zone depth: 18" to 28" corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 5 - e.g., Clovis would be 20"; Santa Fe and Roswell would be 24"; Las Cruces, Albuquerque, and Farmington would be 28")

Maximum leaf area index: 0.8 to 1.6 corresponding with "poor" vegetation (see EPA Engineering Documentation for Version 3, Figure 3 - e.g., Clovis would be 1.6; Santa Fe and Roswell would be 1.2; Farmington would be 1.0; Las Cruces and Albuquerque would be 0.8)

Growing season start and end day: from solar radiation data (default)

Average wind speed: from solar radiation data (default)

Relative humidity: from solar radiation data (default)

Precipitation: daily precipitation from 28 consecutive years for the appropriate weather reporting station

Temperature: daily* minimum and maximum temperatures corresponding with 28 consecutive years for the appropriate weather reporting station
(*may be monthly averages if manual entry is used)

Solar radiation data: synthetically generated using coefficients for the appropriate* default (HELP) weather reporting station (*should be the closest by distance or latitude - consult with the Department if the appropriate station is not obvious)

Landfill Cover Data

Type of vegetation: Type 2 for "poor"

SCS Runoff curve #: may be generated from HELP or user specified* (*must be justified)

% of area allowing runoff: 100%; "closed"

Surface area: entire disposal area of landfill or cell (leachate collection basin)

Soil and Design Data

Source of soil characteristics: geotechnical data should be obtained from the source material.

Number of layers: There should be a layer for each type of material used (or compacted v. non-compacted)

Layer Number: (There should be a justification sheet for each layer.)

Thickness: 6" of topsoil, Proposed thickness of infiltration layer or rooting medium or drainage layer, Possible GCL (0.24") or FML, subgrade thickness for GCL or FML (minimum of 6"), 12" of intermediate cover layer* (*optional for modeling); Proposed thickness of solid waste (this thickness will vary depending on landfill design); 24" of drainage/protection layer; possible geonet*; FML; 24" of 1×10^{-7} cm/sec clay barrier layer for prescriptive liner or GCL or other proposed thickness of clay barrier layer for an alternate liner.

Layer type: Type "1" - vertical percolation layer for all* cover materials including GCLs used (*consult with the Department if a FML is proposed to be used in the cover). Type "1", vertical percolation layer, must be used for solid waste. Type "2" for lateral drainage layer - slope (minimum of 2%) and drainage length must be designated (consult with the Department if leachate recirculation is proposed); Type "4" for geomembrane liners - geomembrane pinhole density of 1/acre, geomembrane installation defects of 4/acre and liner installation quality of "good"; Type "3" for barrier soil layers including GCLs (any soil layer underlying a geomembrane must be considered to be a barrier soil layer)

Soil texture: The texture # should approximate the geotechnical characteristics (see EPA HELP User's Guide for Version 3, Table 4).

Total porosity: If the actual porosity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Field capacity: If the actual field capacity is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Wilting point: If the actual wilting point is not known, then the default value may be used that most closely approximates the geotechnical characteristics.

Moisture content: The moisture content must be initialized to be the value of the previous simulation's (from Simulation #9) moisture content output as the input for the following simulation (Simulation #10).

Saturated hydraulic conductivity (K): The K must be tested for the actual value unless the K is less than 1×10^{-5} cm/sec* (e.g., If the tested K is 5×10^{-5} cm/sec, then model the proposed thickness of the infiltration layer at 5×10^{-5} cm/sec. However, if the tested K is 2×10^{-6}, the lowest value to be modeled would be 1×10^{-5} cm/sec). *1×10^{-5} cm/sec is the lowest acceptable K for soils used in covers due to desiccation and root penetration; unless a GCL is proposed, then the actual K may be modeled for the GCL layer (i.e., 0.24" at 3×10^{-9} cm/sec). For compacted municipal solid waste with a HELP soil texture number of "18" will have a K of 1×10^{-3} cm/sec. For the 24" of drainage/protection layer use the tested K for modeling the proposed alternate liner design; for a possible geonet use the lowest value from the manufacture's specifications; for the FML use a K value which is the greatest value from the manufacture's specifications; GCL (3×10^{-9} cm/sec) or other proposed soil barrier layer for an alternate liner.

Equivalency Demonstrations

Typical "New" Landfill:

Alternate Cover Design Equivalency Demonstration (two simulations)

Simulation #3 & (either Simulation #5 or #6)

Average Annual Percolation from bottom layer of Simulation #3 must be less than or equal to (equivalent*) the Average Annual Percolation from the bottom layer of Simulation #5 or #6 (depending on the proposed liner design).

Alternate Liner Design Equivalency Demonstration

Tier I (two simulations) - Simulation #5 & Simulation #6

Average Annual Percolation from bottom layer of Simulation #6 must be less than or equal to (equivalent*) the Average Annual Percolation from the bottom layer of Simulation #5.

Tier II (four simulations) - Simulations #7, #8, #9, #10

Average Annual Percolation from bottom layer of Simulation #7 must decrease to zero for Simulations #9 & #10.

For closing an "old" (no liner system) landfill:

Alternate Cover Design Equivalency Demonstration (two simulations)

Simulation #1 & Simulation #2

Average Annual Percolation from bottom layer of Simulation #2 must be less than or equal to (equivalent*) the Average Annual Percolation from the bottom layer of Simulation #1

Submit hardcopies of all output files and submit all input files on 3.5" diskette.

*If the two Average Annual Percolation values are within 0.00001" of each other, then the demonstration is successful since these values are practically equal (the definition of equivalent) and well within modeling uncertainty.

Exhibit J
NOAA Data for 5 Wettest Consecutive Years

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Global Summary of the Month for 1984

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3664 ft. Lat: 33.4594° N Lon: -104.4041° W
Station: **BITTER LAKES WL REFUGE, NM US USC00290992**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	36.2	52.2	20.2	748	0	73	30	0	19	0	3	26	1	0.04	0.04	18	1.3	2	18	1	0	0
Feb	43.4	64.6	22.2	568	0	77	15	14	29	0	0	23	0	0.03	0.03	27	0.0	0	29	1	0	0
Mar	49.9	68.7	31.1	413	0	86	17	15	06	0	0	17	0	0.20	0.15	05	1.5	2	05	2	1	0
Apr	57.7	77.0	38.4	238	29	92	18	24	04	2	0	6	0	0.22	0.18	08	0.0	0	30	2	1	0
May														1.99	1.10	16	0.0	0	31	3	3	1
Jun	76.0	89.9	62.2	0	276	99	11	52	06	14	0	0	0	5.83	1.81	28	0.0	0	30	13	9	2
Jul	77.6	92.3	62.9	0	353	98	21	59	19	22	0	0	0	2.05	1.10	28	0.0	0	31	7	4	1
Aug	75.8	88.6	63.0	0	281	97	01	58	16	15	0	0	0	5.82	1.73	10	0.0	0	31	9	7	3
Sep														0.82	0.73	28	0.0	0	30	4	1	0
Oct	56.1	70.8	41.4	238	8	86	15	28	19	0	0	2	0	3.17	1.24	04	0.0	0	31	12	8	1
Nov	48.5	65.9	31.2	444	0	84	09	21	11	0	0	14	0	1.81	0.00	30	0.0	0	30	0	0	0
Dec	40.9	54.2	27.7	722	0	72	09	14	05	0	2	21	0	1.52	0.65	14	4.5	3	14	7	5	0

Notes

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A Accumulated amount.

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T Trace Amount.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Global Summary of the Month for 1985

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3664 ft. Lat: 33.4594° N Lon: -104.4041° W
Station: **BITTER LAKES WL REFUGE, NM US USC00290992**

Date	**Temperature (F)**													**Precipitation (Inches)**								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	36.7	54.2	19.2			75	20	8	31	0	1	26	0	0.31	0.15	27	1.5	1	13	4	1	0
Feb	39.3	57.0	21.5	598	0	75	26	-1	02	0	2	23	1	0.16	0.10	02				4	1	0
Mar	53.9	72.4	35.4			85	28	16	05	0	0	12	0	0.82	0.61	20	0.0	0	31	3	3	0
Apr	62.7	81.8	43.6	92	37	93	16	26	02	2	0	1	0	1.52	1.26	28	0.0	0	30	4	2	1
May	68.8	87.1	50.4	28	134	100	31	35	15	9	0	0	0	0.57	0.25	19	0.0	0	31	4	2	0
Jun	75.4	91.3	59.5	7	298	101	22	45	06	18	0	0	0	4.38	1.82	06	0.0	0	30	7	6	2
Jul	78.9	96.3	61.5	0	389	109	15	53	02	26	0	0	0	3.51	1.63	26	0.0	0	31	10	7	1
Aug	79.4	96.9	61.9	0	432	104	23	52	30	29	0	0	0	0.28	0.22	12	0.0	0	31	3	1	0
Sep	70.4	86.6	54.3	33	186	103	04	41	29	12	0	0	0	2.44	0.66	15	0.0	0	30	12	7	0
Oct	59.1	75.0	43.3	169	15	93	08	33	05	2	0	0	0	1.07	0.37	09	0.0			6	3	0
Nov	51.0	71.1	31.0	359	0	84	10	15	21	0	0	14	0	0.11	0.08	04	0.0	0	30	3	0	0
Dec	38.5	59.6	17.4	687	0	78	08	3	14	0	1	26	0	0.00	0.00	31	0.0	0	31	0	0	0

Notes

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Global Summary of the Month for 1986

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3664 ft. Lat: 33.4594° N Lon: -104.4041° W
Station: **BITTER LAKES WL REFUGE, NM US USC00290992**

Date	**Temperature (F)**													**Precipitation (Inches)**								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number of Days				Total	Greatest Observed		Snow, Sleet			Number of Days		
										Max >= 90	Max <= 32	Min <= 32	Min <= 0		Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	42.0	62.6	21.3	663	0	78	29	10	08	0	0	30	0	0.54	0.54	07	4.0	4	07	1	1	0
Feb	45.6	63.5	27.6	533	0	89	21	12	10	0	3	19	0	0.44	0.27	10	5.3			3	2	0
Mar	53.5	73.1	33.9	328	2	86	09	22	21	0	0	17	0	0.08	0.05	20	0.0	0	31	2	0	0
Apr	63.8	83.0	44.6	90	59	94	08	28	20	6	0	4	0	0.15	0.10	09	0.0	0	30	4	1	0
May	69.0	88.6	49.3	25	145	102	22	32	18	15	0	1	0	2.11	0.91	31	0.0	0	31	5	4	0
Jun	74.3	89.2	59.4	4	233	105	17	49	10	17	0	0	0	3.48	1.67	25	0.0	0	30	11	5	1
Jul	77.8	93.5	62.2	0	357	103	28	58	25	23	0	0	0	2.05	1.84	02	0.0	0	31	3	2	1
Aug	78.1	93.2	63.0	0	342	103	21	55	20	22	0	0	0	6.13	1.66	22	0.0	0	31	13	10	3
Sep	70.6	85.7	55.4	4	138	93	20	42	27	5	0	0	0	2.76			0.0	0	30			
Oct	57.9	72.2	43.6	202	6	88	02	31	15	0	0	4	0	2.69	1.25	10	0.0	0	31	11	5	1
Nov														1.87	0.90	03	0.0	0	30	6	2	0
Dec	38.7	52.2	25.2	762	0	68	03	17	31	0	1	27	0	1.44	0.58	22	0.0	0	31	6	5	0

Notes

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Global Summary of the Month for 1987

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3664 ft. Lat: 33.4594° N Lon: -104.4041° W
Station: **BITTER LAKES WL REFUGE, NM US USC00290992**

Date	**Temperature (F)**													**Precipitation (Inches)**								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number of Days				Total	Greatest Observed		Snow, Sleet			Number of Days		
										Max >= 90	Max <= 32	Min <= 32	Min <= 0		Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	39.0	56.5	21.5			74	28	8	21	0	1	26	0	0.46	0.21	21	5.8	6	21	3	3	0
Feb	44.8	61.3	28.4	519	0	78	12	7	22	0	0	19	0	1.39	0.91	22	0.0	5	20	3	2	0
Mar														0.37	0.15	29	1.0	0	31	3	3	0
Apr														0.18	0.18	06	0.0	0	30	1	1	0
May														2.32	1.15	06	0.0	0	31	6	4	1
Jun	75.1	92.0	58.3	0	254	102	24	51	23	17	0	0	0	3.09	1.70	04	0.0	0	30	4	3	1
Jul	79.5	96.8	62.2	0	402	108	05	57	06	26	0	0	0	0.24	0.05	28	0.0	0	31	1	0	0
Aug	77.8	93.4	62.2	0	371	103	02	51	31	19	0	0	0	3.23	1.66	10	0.0	0	31	11	6	1
Sep	68.9	85.5	52.2	16	125	95	14	43	25	5	0	0	0	1.04	0.31	15	0.0	0	30	7	3	0
Oct	60.9	79.9	41.9	117	11	93	09	35	17	1	0	0	0	0.30	0.30	15	0.0	0	31	1	1	0
Nov			28.4					9	19			18	0	0.58	0.48	02	0.0	0	30	4	1	0
Dec	35.8	53.7	18.0	776	0	78	12	-8	15	0	5	28	3	0.58	0.39	14	13.0			3	2	0

Notes

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Global Summary of the Month for 1988

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3664 ft. Lat: 33.4594° N Lon: -104.4041° W
Station: **BITTER LAKES WL REFUGE, NM US USC00290992**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Number of Days Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Greatest Observed Amount	Date	Snow, Sleet Total Fall	Max Depth	Max Date	Number of Days >=.01	>=.10	>=1.0
Jan														0.05	0.00	31	0.0	0	31	0	0	0
Feb	42.5	60.8	24.2	616	0	79	29	6	08	0	1	24	0	1.45	1.43	05	16.0	16	05	2	1	1
Mar														0.00	0.00	31	0.0	0	31	0	0	0
Apr	57.5	77.3	37.7	198	11	90	09	24	16	1	0	8	0	0.34	0.11	01	0.0	0	30	3	1	0
May														2.24	0.67	20	0.0	0	31	6	3	0
Jun														1.04	0.72	29	0.0	0	30	4	3	0
Jul														3.03	1.22	20	0.0	0	31	9	6	2
Aug														0.47	0.24	19	0.0	0	31	7	1	0
Sep																	0.0	0	30			
Oct														0.04	0.04	08	0.0	0	31	1	0	0
Nov														0.01	0.01	15	0.0	0	30	1	0	0
Dec														0.45	0.28	09	3.3	3	09	2	2	0

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Global Summary of the Month for 1984

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3649 ft. Lat: 33.3075° N Lon: -104.5083° W
Station: **ROSWELL INDUSTRIAL AIR PARK, NM US USW00023009**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	38.5	50.5	26.5	822	0	72	29	8	18	0	4	24	0	0.04	0.02	18	0.5	1	18	3	0	0
Feb	46.5	61.7	31.3	537	0	74	14	22	29	0	0	17	0	0.00	0.00	26	0.0	0	29	0	0	0
Mar	51.7	66.8	36.6	414	2	83	17	19	06	0	0	9	0	0.46	0.42	05	4.8	1	06	2	1	0
Apr	60.1	75.9	44.4	171	24	89	17	32	04	0	0	1	0	0.03	0.03	07	0.0	0	30	1	0	0
May	72.4	86.1	58.8	21	251	98	27	41	08	13	0	0	0	1.62	0.89	15	0.0	0	31	4	3	0
Jun	75.8	87.4	64.2	0	324	97	10	57	04	15	0	0	0	4.51	0.91	19	0.0	0	30	13	9	0
Jul	79.0	90.8	67.2	0	434	96	15	63	26	24	0	0	0	0.85	0.78	24	0.0	0	31	3	1	0
Aug	76.2	86.8	65.6	0	347	94	29	63	29	13	0	0	0	5.03	2.45	08	0.0	0	31	12	6	2
Sep	69.3	82.0	56.5	57	186	97	09	44	30	10	0	0	0	1.05	0.74	28	0.0	0	30	6	2	0
Oct	57.6	69.4	45.9	233	6	82	14	36	19	0	0	0	0	2.74	0.86	03	0.0	0	31	9	5	0
Nov	48.5	61.1	35.8	497	0	83	07	25	28	0	0	11	0	1.57	0.74	24	0.0	0	30	4	3	0
Dec	42.1	53.1	31.0	711	0	72	08	20	16	0	1	19	0	0.85	0.31	13	5.4	4	15	7	3	0

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3649 ft. Lat: 33.3075° N Lon: -104.5083° W

Station: **ROSWELL INDUSTRIAL AIR PARK, NM US USW00023009**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	36.9	49.4	24.4	870	0	75	19	9	31	0	3	28	0	0.37	0.09	26	1.9	0	31	10	0	0
Feb	43.2	57.7	28.6	612	0	73	21	3	02	0	1	19	0	0.04	0.02	21	0.3	1	02	2	0	0
Mar	54.4	68.8	40.0	329	6	83	10	24	05	0	0	5	0	0.70	0.32	20	0.0	0	31	3	2	0
Apr	63.4	78.4	48.4	88	41	88	15	35	02	0	0	0	0	2.48	1.48	28	0.0	0	30	4	3	1
May	70.1	84.0	56.2	11	169	96	29	43	14	6	0	0	0	2.22	0.92	18	0.0	0	31	6	5	0
Jun	75.8	89.5	62.0	2	325	100	21	52	06	19	0	0	0	2.59	1.25	09	0.0	0	30	5	4	1
Jul	79.4	92.8	66.0	0	447	101	05	61	02	25	0	0	0	2.71	1.65	25	0.0	0	31	6	4	1
Aug	80.4	93.3	67.5	0	477	100	06	62	31	26	0	0	0	0.34	0.14	21	0.0	0	31	7	1	0
Sep	70.7	82.4	59.0	48	218	96	01	43	30	7	0	0	0	1.93	0.79	18	0.0	0	30	12	6	0
Oct	61.1	73.6	48.7	136	16	89	07	42	31	0	0	0	0	0.98	0.43	16	0.0	0	31	6	4	0
Nov	53.2	68.4	38.0	354	0	81	05	23	15	0	0	7	0	0.12	0.12	01	0.0	0	30	1	1	0
Dec	40.2	57.0	23.4	768	0	72	30	9	14	0	2	28	0	0.07	0.07	12	1.1	0	31	1	0	0

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National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3649 ft. Lat: 33.3075° N Lon: -104.5083° W
Station: **ROSWELL INDUSTRIAL AIR PARK, NM US USW00023009**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	44.1	60.8	27.4	648	0	77	28	13	09	0	0	26	0	0.67	0.47	07	5.4	3	08	2	2	0
Feb	46.8	60.6	33.0	510	0	85	26	14	10	0	5	11	0	0.50	0.31	09	4.9	4	12	5	1	0
Mar	56.2	72.5	39.8	279	5	88	31	30	21	0	0	4	0	0.12	0.05	19	0.0	0	31	4	0	0
Apr	64.6	80.7	48.5	81	69	92	07	37	20	2	0	0	0	0.31	0.31	08	0.0	0	30	1	1	0
May	69.5	85.2	53.9	16	158	97	21	38	18	9	0	0	0	1.20	0.51	30	0.0	0	31	7	3	0
Jun	75.8	88.7	63.0	0	324	102	16	53	01	17	0	0	0	5.02	1.44	24	0.0	0	30	9	5	3
Jul	79.2	92.4	65.9	0	439	101	27	62	19	23	0	0	0	1.11	0.66	01	0.0	0	31	8	3	0
Aug	78.6	90.9	66.3	0	421	103	20	61	25	21	0	0	0	3.11	0.85	26	0.0	0	31	13	9	0
Sep	72.1	85.0	59.2	0	213	93	19	48	30	5	0	0	0	3.93	1.71	02	0.0	0	30	8	5	1
Oct	59.3	71.6	47.0	186	9	88	01	36	14	0	0	0	0	5.48	3.46	10	0.0	0	31	8	6	1
Nov	46.0	59.3	32.7	570	0	76	17	22	25	0	1	15	0	1.89	0.79	03	0.5	0	13	6	4	0
Dec	39.9	51.0	28.9	777	0	67	07	20	12	0	1	23	0	1.47	0.44	22	3.4	0	22	7	6	0

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Station: **ROSWELL INDUSTRIAL AIR PARK, NM US USW00023009**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	39.7	54.9	24.5	784	0	74	27	8	21	0	2	27	0	0.45	0.19	20	5.5	4	18	5	2	0
Feb	44.9	58.1	31.7	562	0	78	02	14	22	0	0	12	0	2.02	0.91	20	8.7	6	20	8	5	0
Mar	49.1	64.3	33.8	493	0	77	06	14	30	0	1	9	0	0.20	0.11	26	0.5	0	31	4	1	0
Apr	57.3	73.6	41.0	248	16	93	18	26	03	2	0	3	0	0.26	0.12	04	0.0	0	30	3	2	0
May	67.4	81.7	53.1	25	100	91	17	43	04	1	0	0	0	1.54	0.46	24	0.0	0	31	7	5	0
Jun	75.8	89.9	61.7	0	323	101	23	56	05	17	0	0	0	3.70	1.22	03	0.0	0	30	9	8	1
Jul	80.2	94.6	65.7	0	470	104	03	60	06	26	0	0	0	0.40	0.20	10	0.0	0	31	5	1	0
Aug	78.7	91.5	65.9	0	423	101	08	57	31	19	0	0	0	4.72	2.20	22	0.0	0	31	13	6	2
Sep	70.5	84.5	56.6	4	170	94	13	48	24	4	0	0	0	0.78	0.38	14	0.0	0	30	6	2	0
Oct	63.8	79.3	48.4	75	38	93	08	41	21	1	0	0	0	0.28	0.24	14	0.0	0	31	3	1	0
Nov	49.0	64.3	33.6	481	0	79	04	20	19	0	0	17	0	0.46	0.43	01	0.0	0	30	2	1	0
Dec	39.3	54.1	24.5	797	0	79	11	-3	27	0	5	22	2	1.41	0.61	13	15.3	10	15	6	5	0

Notes

(Blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence.

A Accumulated amount.

X Monthly means or totals based on incomplete time series.

T Trace Amount.

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Environmental Satellite, Data, and Information Service

Global Summary of the Month for 1988

Generated on 09/25/2019

National Centers for Environmental Information
151 Patton Avenue
Asheville, North Carolina 28801

Current Location: Elev: 3649 ft. Lat: 33.3075° N Lon: -104.5083° W
Station: **ROSWELL INDUSTRIAL AIR PARK, NM US USW00023009**

Date	Temperature (F)													Precipitation (Inches)								
Elem ->	TAVG	TMAX	TMIN	HTDD	CLDD	EMXT		EMNT		DX90	DX32	DT32	DT00	PRCP	EMXP		SNOW	EMSD		DP01	DP10	DP1X
										Number of Days					Greatest Observed		Snow, Sleet			Number of Days		
Month	Mean	Mean Max.	Mean Min	Heating Degree Days	Cooling Degree Days	Highest	High Date	Lowest	Low Date	Max >= 90	Max <= 32	Min <= 32	Min <= 0	Total	Amount	Date	Total Fall	Max Depth	Max Date	>=.01	>=.10	>=1.0
Jan	37.5	51.2	23.8	852	0	72	15	14	25	0	1	30	0	0.22	0.11	06	0.4	0	31	4	1	0
Feb	44.4	59.6	29.3	596	0	77	28	12	08	0	1	21	0	1.48	1.05	05	16.9	9	06	3	2	1
Mar	51.3	69.2	33.3	425	0	85	24	16	14	0	0	14	0	0.03	0.03	03	0.0	0	31	1	0	0
Apr	59.7	76.2	43.1	169	9	90	08	27	02	1	0	2	0	0.27	0.15	16	0.0	0	30	4	1	0
May	68.1	83.4	52.9	39	137	98	15	37	03	6	0	0	0	3.42	1.41	28	0.0	0	31	6	4	2
Jun	77.4	92.0	62.9	0	373	99	22	51	01	20	0	0	0	1.27	0.47	27	0.0	0	30	7	3	0
Jul	78.6	91.7	65.5	0	422	102	13	59	22	24	0	0	0	4.45	3.32	19	0.0	0	31	10	5	1
Aug	78.7	90.4	67.0	7	432	99	13	56	28	25	0	0	0	0.51	0.12	09	0.0	0	31	10	2	0
Sep	72.2	87.2	57.1	7	222	99	08	46	30	12	0	0	0	1.56	0.72	20	0.0	0	30	6	2	0
Oct	63.9	79.4	48.5	63	29	93	17	41	29	1	0	0	0	0.01	0.01	07	0.0	0	31	1	0	0
Nov	53.3	70.1	36.5	366	15	87	08	20	28	0	0	13	0	0.03	0.03	08	0.0	0	30	1	0	0
Dec	40.6	54.9	26.4	756	0	68	03	15	28	0	0	28	0	0.51	0.28	08	3.9	4	09	3	2	0

Notes

(Blank) Data element not reported or missing.

\+ Occurred on one or more previous dates during the month. The date in the Date field is the last day of occurrence.

A Accumulated amount.

X Monthly means or totals based on incomplete time series.

T Trace Amount.

GSOM (Global Summary of the Month) documentation

I. Description

The Global Summary of the Month (GSOM) dataset includes climate data for thousands of locations worldwide. Data files contain over 50 climatological variables computed from the summary of the day observations of the Global Historical Climatology Network Daily dataset (GHCN-D). A description of each of these is included below. GSOM data can be accessed at https://www.ncdc.noaa.gov/cdo-web/search?datasetid=GSOM or for bulk delivery at https://www.ncei.noaa.gov/data/gsom.

II. Format/Observation Definitions

Users are given the choice between the following two delivery formats:

1) Portable Document Format (PDF) output. All units are standard.

2) CSV file for use in spreadsheet applications. Users will be able to choose between standard or metric units with this option.

A. Data observations

Each record represents all selected observations (i.e. elements) available for a given station-month. The initial section of each record is ordered as follows with the following definitions:

STATION (11 characters) is the station identification code.

STATION_NAME (max 50 characters) is the name of the station (usually city/airport name). This is an optional output field.

LATITUDE (8 characters) is the latitude (decimated degrees w/Northern Hemisphere values > 0). This is an optional output field.

LONGITUDE (9 characters) is the longitude (decimated degrees w/Western Hemisphere values < 0 and Eastern Hemisphere values > 0). This is an optional output field.

ELEVATION (13 characters) is the elevation above mean sea level in meters (to nearest thousandth of a meter). This is an optional output field.

DATE is the year of the record (4 digits) followed by a month (2 digits).

GHCN-Daily Dataset Measurement Flag (M) These flags that pertain to temperature, precipitation and wind measurement are given in the attribute fields following many of the data variables described below as noted.

Blank = no measurement information applicable

A = value in precipitation or snow is a multi-day total, accumulated since last measurement (used on Daily Form pdf file)
B = precipitation total formed from two twelve-hour totals
D = precipitation total formed from four six-hour totals
H = represents highest or lowest hourly temperature (TMAX or TMIN) or average of hourly values (TAVG)
K = converted from knots
L = temperature appears to be lagged with respect to reported hour of observation
O = converted from oktas
P = identified as "missing presumed zero" in DSI 3200 and 3206
T = trace of precipitation, snowfall, or snow depth
W = converted from 16-point WBAN code (for wind direction)

Table A (variables)

AWND – Monthly Average Wind Speed. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

AWND_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

CDSD – Cooling Degree Days (season-to-date). Running total of monthly cooling degree days through the end of the most recent month. Each month is summed to produce a season-to-date total. Season starts in January in Northern Hemisphere and July in Southern Hemisphere. Given in Fahrenheit degrees in PDF output and Celsius or Fahrenheit degrees depending on user specification in CSV output.

CDSD_ATTRIBUTES – S where:

S = GHCN-Daily Dataset Source Code (values are given below in Table B)

CLDD - Cooling Degree Days. Computed when daily average temperature is more than 65 degrees Fahrenheit/18.3 degrees Celsius. CDD = mean daily temperature - 65 degrees Fahrenheit/18.3 degrees Celsius. Each day is summed to produce a monthly total. Given in Fahrenheit units on PDF output. CSV output is Fahrenheit or Celsius units depending on user specification.

CLDD_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DP01 – Number of days with >= 0.01 inch/0.254 millimeter in the month

DP01_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DP10 – Number of days with >= 0.1 inch/2.54 millimeters in the month.

DP10_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DP1X – Number of days with >= 1 inch/25.4 millimeters in the month.

DP1X_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DSND – Number of days with snow depth >= 1 inch/25 millimeters.

DSND_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DSNW – Number of days with snowfall >= 1 inch/25 millimeters.

DSNW_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DT00 – Number of days with maximum temperature <= 0 degrees Fahrenheit/-17.8 degrees Celsius.

DT00_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DT32 – Number of days with maximum temperature <= 32 degrees Fahrenheit/0 degrees Celsius.

DT32_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DX32 – Number of days with maximum temperature <= 32 degrees Fahrenheit/0 degrees Celsius.
DX32_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DX70 – Number of days with maximum temperature <= 70 degrees Fahrenheit/21.1 degrees Celsius.

DX70_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

DX90 – Number of days with maximum temperature >= 90 degrees Fahrenheit/32.2 degrees Celsius.

DX90_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

EMNT – Extreme minimum temperature for month. Lowest daily minimum temperature for the month. Given in Fahrenheit units on PDF output. CSV output is Fahrenheit or Celsius units depending on user specification.

EMNT_ATTRIBUTES – a,S,cc,d where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
cc = two-digit date during the month when the EMNT value occurred (always latest date if more than one occurrence)
d = + if there is more than one date of occurrence, blank if only one date of occurrence

EMSD – Highest daily snow depth in the month. Given in inches for PDF output. CSV output is in inches or millimeters depending on user specification.

EMSD_ATTRIBUTES – a,M,S,cc,d where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
cc = two-digit date during the month when the EMNT value occurred (always latest date if more than one occurrence)

d = + if there is more than one date of occurrence, blank if only one date of occurrence

EMSN – Highest daily snowfall in the month. Given in inches for PDF output. CSV output is in inches or millimeters depending on user specification.

EMSN_ATTRIBUTES – a,M,S,cc,d where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
cc = two-digit date during the month when the EMNT value occurred (always latest date if more than one occurrence)
d = + if there is more than one date of occurrence, blank if only one date of occurrence

EMXP – Highest daily total of precipitation in the month. Given in inches for PDF output. CSV output is in inches or millimeters depending on user specification.

EMXP_ATTRIBUTES – a,M,S,cc,d where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
cc = two-digit date during the month when the EMNT value occurred (always latest date if more than one occurrence)
d = + if there is more than one date of occurrence, blank if only one date of occurrence

EMXT – Extreme maximum temperature for month. Highest daily maximum temperature for the month. Given in Fahrenheit units on PDF output. CSV output is Fahrenheit or Celsius units depending on user specification.

EMXT_ATTRIBUTES – a,S,cc,d where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
cc = two-digit date during the month when the EMNT value occurred (always latest date if more than one occurrence)
d = + if there is more than one date of occurrence, blank if only one date of occurrence

EVAP – Total Monthly Evaporation. Given in inches for PDF output. CSV output is in inches or millimeters depending on user specification. Measurement Flags: T is used for trace amount, *a* is used for any accumulation within a month that includes missing days. If no days are missing, no flag is used. Source Flag: Source flag from GHCN-Daily (see separate documentation for GHCN-Daily). Days Miss Flag: Number of days missing or flagged.

EVAP_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)

Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

HDSD – Heating Degree Days (season-to-date). Running total of monthly heating degree days through the end of the most recent month. Each month is summed to produce a season-to-date total. Season starts in July in Northern Hemisphere and January in Southern Hemisphere. Given in Fahrenheit degrees in PDF output and Celsius or Fahrenheit degrees depending on user specification in CSV output.

HDSD_ATTRIBUTES – S where:

S = GHCN-Daily Dataset Source Code (values are given below in Table B)

HNyz – Highest minimum soil temperature for the month. Given in Fahrenheit for PDF output and Fahrenheit or Celsius depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged. Note: “yz” portion of variable name correspond with values in Table E below.

HNyz_ATTRIBUTES = a,M,Q,S,y,z where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
y = ground cover code (see table E below)
z = soil depth code (see table E below)

HTDD - Heating Degree Days. Computed when daily average temperature is less than 65 degrees Fahrenheit/18.3 degrees Celsius. HDD = 65(F)/18.3(C) – mean daily temperature. Each day is summed to produce a monthly total. Given in Fahrenheit units on PDF output. CSV output is Fahrenheit or Celsius units depending on user specification.

HTDD_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

HXyz – Highest maximum soil temperature for the month. Given in Fahrenheit for PDF output and Fahrenheit or Celsius depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged. Note: “yz” portion of variable name correspond with values in Table E below.

HXyz_ATTRIBUTES = a,M,Q,S,y,z where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

y = ground cover code (see table E below)
z = soil depth code (see table E below)

LNyz – Lowest minimum soil temperature for the month. Given in Fahrenheit for PDF output and Fahrenheit or Celsius depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged. Note: "yz" portion of variable name correspond with values in Table E below.

LNyz_ATTRIBUTES = a,M,Q,S,y,z where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
y = ground cover code (see table E below)
z = soil depth code (see table E below)

LXyz – Lowest maximum soil temperature for the month. Given in Fahrenheit for PDF output and Fahrenheit or Celsius depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged. Note: "yz" portion of variable name correspond with values in Table E below.

LXyz_ATTRIBUTES = a,M,Q,S,y,z where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
y = ground cover code (see table E below)
z = soil depth code (see table E below)

MNPN – Monthly Mean Minimum Temperature of evaporation pan water. Given in Fahrenheit units for PDF output and Celsius or Fahrenheit units in CSV output depending on user specification. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

MNPN_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

MNyz – Monthly Mean of daily minimum soil temperature. Given in Fahrenheit for PDF output and Fahrenheit or Celsius depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

MNyz_ATTRIBUTES = a,M,Q,S,y,z where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
y = ground cover code (see table E below)
z = soil depth code (see table E below)

MXPN – Monthly Mean Maximum Temperature of evaporation pan water. Given in Fahrenheit units for PDF output and Celsius or Fahrenheit units in CSV output depending on user specification. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

MXPN_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

MXyz – Monthly Mean of daily maximum soil temperature. Given in Fahrenheit for PDF output and Fahrenheit or Celsius depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

MXyz_ATTRIBUTES = a,M,Q,S,y,z where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)
y = ground cover code (see table E below)
z = soil depth code (see table E below)

PRCP – Total Monthly Precipitation. Given in inches for PDF output. CSV output is in inches or millimeters depending on user specification. Measurement Flags: T is used for trace amount, a is used for any accumulation within a month that includes missing days. If no days are missing, no flag is used.

PRCP_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

PSUN – Monthly Average of the daily percents of possible sunshine.

PSUN_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

SNOW – Total Monthly Snowfall. Given in inches for PDF output. CSV output is in inches or millimeters depending on user specification. Measurement Flags: T is used for trace amount, *a* is used for any accumulation within a month that includes missing days. If no days are missing, no flag is used. Source Flag: Source flag from GHCN-Daily (see separate documentation for GHCN-Daily). Days Miss Flag: Number of days missing or flagged.

SNOW_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

TAVG – Average Monthly Temperature. Computed by adding the unrounded monthly/annual maximum and minimum temperatures and dividing by 2. Fahrenheit units on PDF output. CSV output is Fahrenheit or Celsius units depending on user specification. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

TAVG_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

TMAX – Monthly Maximum Temperature. Average of daily maximum temperature given in Fahrenheit on PDF output. CSV output is given in Fahrenheit or Celsius depending on user specification. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

TMAX_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

TMIN – Monthly Minimum Temperature. Average of daily minimum temperature given in Fahrenheit units on PDF output. CSV output is given in Fahrenheit or Celsius units depending on user specification. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

TMIN_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided

M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

TSUN – Monthly total sunshine in minutes.

TSUN_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDF1 – Wind Direction for Maximum Wind Speed/Fastest 1-Minute (WSF1). Given in 360-degree compass point directions (e.g. 360 = north, 180 = south, etc.). Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WDF1_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDF2 – Wind Direction for Maximum Wind Speed/Fastest 2-Minute (WSF2). Given in 360-degree compass point directions (e.g. 360 = north, 180 = south, etc.). Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WDF2_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDF5 – Wind Direction for Peak Wind Gust Speed – Fastest 5-second (WSF5). Given in 360-degree compass point directions (e.g. 360 = north, 180 = south, etc.). Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WDF5_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDFG – Wind Direction for Peak Wind Gust Speed (WSFG). Given in 360-degree compass point directions (e.g. 360 = north, 180 = south, etc.). Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WDFG_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided

S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDFI –Direction of highest instantaneous wind speed (WDFI). Given in 360-degree compass point directions (e.g. 360 = north, 180 = south, etc.). Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WDFI_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDFM – Wind Direction for Maximum Wind Speed/Fastest Mile (WSFM). Given in 360-degree compass point directions (e.g. 360 = north, 180 = south, etc.).

WDFM_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WDMV – Total Monthly Wind Movement over evaporation pan. Given in miles for PDF output and miles or kilometers depending on user specification for CSV output.

WDMV_ATTRIBUTES = a,M,Q,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
M = GHCN-Daily Dataset Measurement Flag (values are given below in Table C)
Q = GHCN-Daily Dataset Quality Flag (values are given below in Table D)
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WSF1 - Maximum Wind Speed/Fastest 1-minute. Maximum wind speed for the month reported as the fastest 1-minute. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WSF1_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WSF2 – Maximum Wind Speed/Fastest 2-minute. Maximum wind speed for the month reported as the fastest 2-minute. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WSF2_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WSF5 – Peak Wind Gust Speed – Fastest 5-second wind. Maximum wind gust for the month. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WSF5_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WSFG – Peak Wind Gust Speed. Maximum wind gust for the month. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WSFG_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WSFI – Highest instantaneous wind speed for the month. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WSFI_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

WSFM – Maximum Wind Speed/Fastest Mile. Maximum wind speed for the month reported as the fastest mile. Given in miles per hour for PDF output and miles per hour or meters per second depending on user specification for CSV output. Missing if more than 5 days within the month are missing or flagged or if more than 3 consecutive values within the month are missing or flagged.

WSFM_ATTRIBUTES – a,S where:

a = DaysMissing (Numeric value): The number of days (from 1 to 5) missing or flagged is provided
S = GHCN-Daily Dataset Source Code (values are given below in Table B)

Table B - GHCN-Daily Dataset Source Codes:

Blank = No source (i.e., data value missing)
0 = U.S. Cooperative Summary of the Day (NCDC DSI-3200)
6 = CDMP Cooperative Summary of the Day (NCDC DSI-3206)
7 = U.S. Cooperative Summary of the Day -- Transmitted via WxCoder3 (NCDC DSI-3207)

A = U.S. Automated Surface Observing System (ASOS) real-time data (since January 1, 2006)
a = Australian data from the Australian Bureau of Meteorology
B = U.S. ASOS data for October 2000-December 2005 (NCDC DSI-3211)
b = Belarus update
C = Environment Canada
E = European Climate Assessment and Dataset (Klein Tank et al., 2002)
F = U.S. Fort data
G = Official Global Climate Observing System (GCOS) or other government-supplied data
H = High Plains Regional Climate Center real-time data
I = International collection (non U.S. data received through personal contacts)
K = U.S. Cooperative Summary of the Day data digitized from paper observer forms (from 2011 to present)
M = Monthly METAR Extract (additional ASOS data)
N = Community Collaborative Rain, Hail,and Snow (CoCoRaHS)
Q = Data from several African countries that had been "quarantined", that is, withheld from public release until permission was granted from the respective meteorological services
R = NCEI Reference Network Database (Climate Reference Network and Regional Climate Reference Network)
r = All-Russian Research Institute of Hydrometeorol Information-World Data Center
S = Global Summary of the Day (NCDC DSI-9618)

NOTE: "S" values are derived from hourly synoptic reports exchanged on the Global Telecommunications System (GTS). Daily values derived in this fashion may differ significantly from "true" daily data, particularly for precipitation (i.e., use with caution).

s = China Meteorological Administration/National Meteorological Information Center/ Climatic Data Center (http://cdc.cma.gov.cn)
T = SNOwpack TELemtry (SNOTEL) data obtained from the U.S. Department of Agriculture's Natural Resources Conservation Service
U = Remote Automatic Weather Station (RAWS) data obtained from the Western Regional Climate Center
u = Ukraine update
W = WBAN/ASOS Summary of the Day from NCDC's Integrated Surface Data (ISD).
X = U.S. First-Order Summary of the Day (NCDC DSI-3210)
Z = Datzilla official additions or replacements
z = Uzbekistan update

Table C - GHCN-Daily Dataset Measurement Flags:

Blank = no measurement information applicable
B = precipitation total formed from two 12-hour totals
D = precipitation total formed from four six-hour totals
H = represents highest or lowest hourly temperature (TMAX or TMIN) or the average of hourly values (TAVG)
K = converted from knots

L = temperature appears to be lagged with respect to reported hour of observation
O = converted from oktas
P = identified as "missing presumed zero" in DSI 3200 and 3206
T = trace of precipitation, snowfall, or snow depth
W = converted from 16-point WBAN code (for wind direction)

Table D - GHCN-Daily Dataset Quality Flags (as of 1/9/2017):

Blank = did not fail any quality assurance check
D = failed duplicate check
G = failed gap check
I = failed internal consistency check
K = failed streak/frequent-value check
L = failed check on length of multiday period
M = failed megaconsistency check
N = failed naught check
O = failed climatological outlier check
R = failed lagged range check
S = failed spatial consistency check
T = failed temporal consistency check
W = temperature too warm for snow
X = failed bounds check
Z = flagged as a result of an official Datzilla investigation

Table E – Ground cover code (y) and soil depth code (z) for HXyz, HNyz, LXyz, LNyz, MNYZ and MXYZ

Y (ground cover):
1 = grass
2 = fallow
3 = bare ground
4 = brome grass
5 = sod
6 = straw mulch
7 = grass muck
8 = bare muck
0 = unknown

Z (soil depth):
1 = 2 inches or 5 centimeters depth
2 = 4 inches or 10 centimeters depth
3 = 8 inches or 20 centimeters depth
4 = 20 inches or 50 centimeters depth
5 = 40 inches or 100 centimeters depth
6 = 60 inches or 150 centimeters depth
7 = 72 inches or 180 centimeters depth
0 = unknown

Attachment E

Liner System Design Calculations

Attachment E1

Settlement and Liner Stress Calculations

CALCULATIONS BY: Deep K. Khatri, P.E. (TX) – Senior Staff Geotechnical Engineer
F. Owen Carpenter, P.E. (AR, CO, OK), P.G. – Senior Solid Waste Engineer
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PURPOSE

This calculation package includes settlement analyses for the proposed North Ranch landfill to be located within Section 9 and 10 of T25S, R34E approximately 16 miles west of the City of Jal in Lea County, New Mexico. The settlement analyses include both foundation and waste settlements. The settlement analyses were performed to determine that the final cover slope, liner, and leachate collection system (after settlement) are consistent with the performance specifications of the project. The following calculations show the anticipated strains on the geosynthetic materials are less the allowable strains and the designed grades for final cover and leachate collection system will allow adequate drainage even after settlement.

METHOD OF ANALYSIS

The methodology for estimating settlements involves calculating settlements at multiple points and evaluating the resultant change in the designed grade and its impact on the landfill elements. Points were conservatively selected from a cross-section based on the thickness of waste material. The location of the cross-section is shown on the liner and final cover grading plans (Figures 1 and 2). The cross-section drawing and settlement location points are shown in Figure 3.

Foundation Soil Settlement

On-site (native) soils predominately consist of granular soils, medium to very dense sandy soils and strongly cemented, calcareous interbedded caliche materials in the upper approximately 2 to 65 feet of existing grades, underlain by sandstone extending to boring termination depths of 165 feet below existing grade. For granular soils, settlement is caused by the compression of the soil skeleton as the particles rearrange due to the applied loads. The immediate (elastic) settlement of the foundation soils was calculated using the following equation:

$$S = \Delta\sigma / M_s * H$$

where:
S = elastic settlement of soil layer
H = thickness of soil layer
$\Delta\sigma$ = Applied Stress
M_s = constrained modulus of soils

Waste Material Settlements

The compression settlement of oil field wastes can be analyzed using the one-dimensional consolidation theory, commonly used for cohesive soils. Based on this theory, waste settlement has two components: settlement due to primary consolidation and settlement due to secondary consolidation. The primary settlement component of waste material is related to the increase in effective vertical stresses resulting from the additional waste material and landfill final cover system. The secondary settlement component is typically related to compression of the waste structure (skeleton) and is time-dependent.

Settlements resulting from primary consolidation of the waste were calculated using the general form of the 1-D consolidation theory settlement equation as given below [Holtz and Kovacs, 1981]:

$$Sp = Cer * H * log(\sigma'p/\sigma'vo) + Cec * H * log(\sigma'f\ /\sigma'p)$$

where: Sp = primary settlement

C_{ec} = primary compression index ratio

C_{er} = recompression index ratio

H = initial thickness of the waste layer before settlement

σ'_{vo} = initial effective pressure in the waste layer

σ'_{p} = effective pressure in the waste layer

σ'_{p} = pre-consolidation stress

σ'_{f} = final overburden pressure applied at the mid-level of the waste layer

The mechanisms for secondary settlement are mechanical creep, chemical reactions, and biodegradation. This type of compression is dependent on time, not applied loads. Settlements resulting from secondary settlement of the waste may be calculated according to the following equation [Qian, Koerner, and Gray, 2002]:

$$\Delta H_\alpha = C'_\alpha * H_o * log\frac{t_2}{t_1}$$

where: ΔH_α = long-term secondary settlement

C'_α = modified secondary compression index

t_2 = ending time of the time period for which long-term settlement of the layer is desired

t_1 = starting time of the time period for which long-term settlement of the layer is desire

t_1 = 1 year

t_2 = 30 years

However, from the best available information and discussions with the project team members, it is considered that waste materials for this landfill will typically be granular soils, contaminated silty sands/sands. Therefore, a secondary settlement of the waste material was neglected in our analyses.

Final Cover Settlement

Since (1) the waste material and foundation soils are permeable and will experience an immediate primary consolidation settlement under applied load, and (2) foundation soil settlement resulting from the final cover will be minimal, the total final cover settlement will be due to the primary compression of the waste material only with the increase in effective vertical stresses resulting from the final cover system. The settlement equation presented above for the waste material settlement calculation was used for the final cover settlement estimates.

Tensile Strains

The effects of waste settlement on the final cover and foundation settlement on the liner system were evaluated as described below.

Tensile strains in the final cover and the liner were estimated by the following general equation:

$$\varepsilon_{tens} = L_o - \frac{L_f}{L_o}$$

where: ε_{tens} = strain in the cover/liner (tension is negative)
L_o = initial length of cover/liner between adjacent points
L_f = length of cover/liner between adjacent points after settlement

MATERIAL PARAMETERS

The waste materials for this landfill are assumed to be granular soils, contaminated silty sands/sands. Based on the available typical compression parameters for sandy soils and our experience for similar waste materials and project, a compression index ratio C_{ec} of 0.014, a recompression index ratio Cer of about one-third of Cec, the total unit weight of 120 pcf, and a pre-consolidation pressure σ'_p of 1,000 psf were selected for the presented analyses. Based on the available typical compression parameters for native silty sands/sands and our experience for similar materials, a constrained modulus Ms of about 850 ksf was used for the foundation settlement estimate.

Table 1. Material Properties

Cover System	γ, pcf	120
Waste	γ, pcf	120
	$C_{c\varepsilon}$	0.014
	$C_{r\varepsilon}$	0.004
	σ'_p, psf	1,000
Foundation Soils-Silty Sands/Sands (Medium to Very Dense)	Ms, ksf	850

RESULTS

The foundation soil, waste, and final cover settlement estimates are presented in Tables 2, 3, and 4 respectively. The spreadsheet output that details settlement estimates for the foundation soil, waste, and final cover settlement are also included in Tables 2, 3, and 4, respectively.

SUMMARY AND CONCLUSIONS

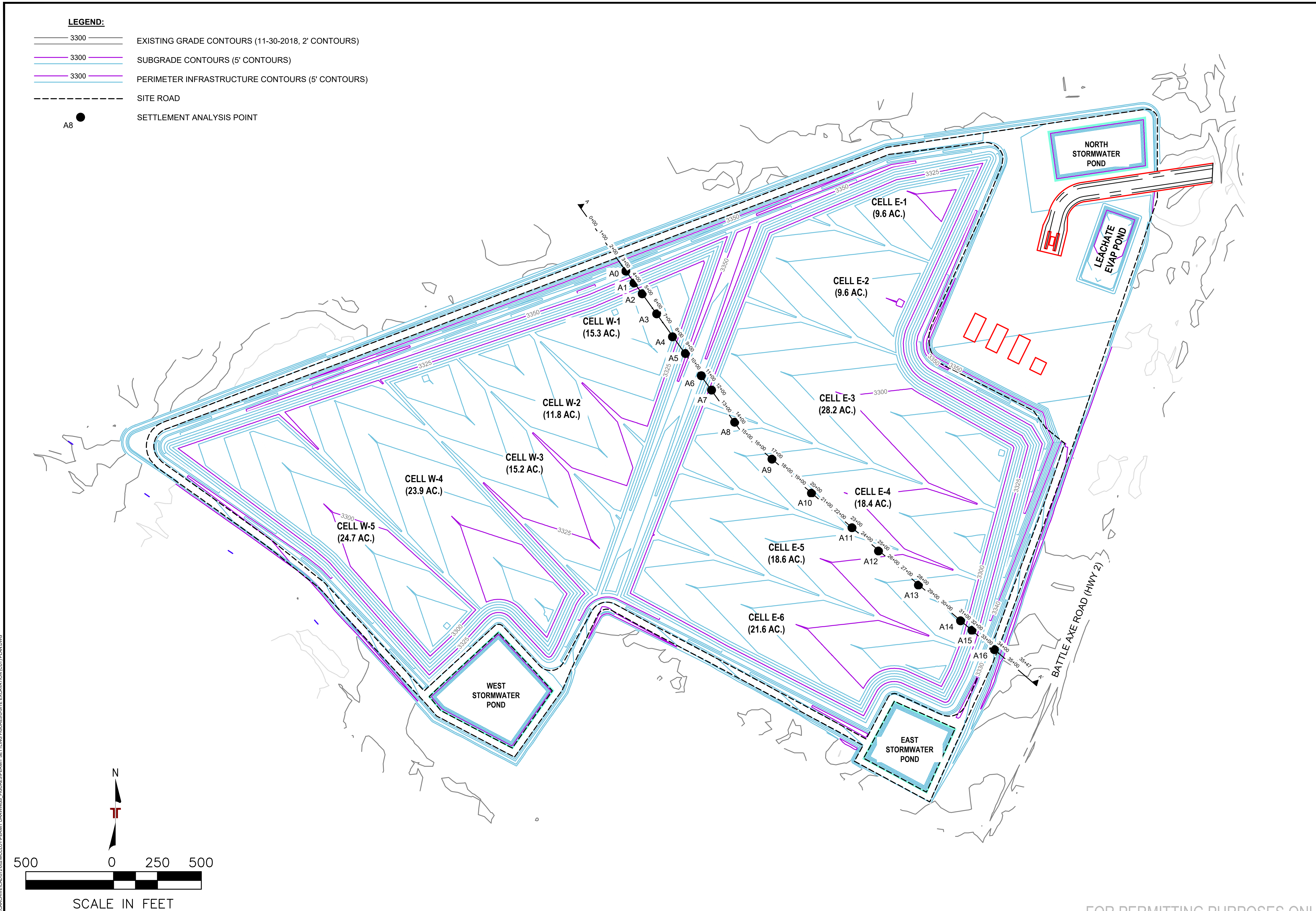
Based on our calculations, the foundation soils will settle about 1.8 feet (max.) near area (Station 10+00) where foundation (native) soil is thick (no excavation was planned near this area) and about 1.2 feet (max.) for the remaining area. The estimated settlements resulted in a maximum grade change of 0.6% near Station 10+00 and minimal grade change for the remaining area. The required 2.0% slope of the leachate collection system will not adversely be affected by the foundation settlements. Additionally, a maximum tensile stress on the liner was estimated to be 0.1%, which was less than the allowable strain on the geosynthetic liner system.

The final cover will settle on the order of 1 inch due to compression of waste material, resulting from the increase in effective stress due to the placement of the final cover system. Grade changes induced by differential waste settlement were estimated to be minimal and the final cover system will maintain positive drainage on the side slopes. Additionally, negligible tensile strains are expected to develop in the final cover system due to waste settlement.

REFERENCES

Holtz, R. D., and Kovacs, W. D. (1981) An Introduction to Geotechnical Engineering, Prentice-Hall Inc., Englewood Cliffs, N.J.

Qian, X., Koerner, R. M., and Gray, D. H. (2002) “Geotechnical Aspects of Landfill Design and Construction” Prentice Hall, Upper Saddle River, NJ



FOR PERMITTING PURPOSES ONLY

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REV	DATE	BY	DESCRIPTION

SITE EXCAVATION (CUT) PLAN

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WATER SOLUTIONS PERMIAN, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIGURE 1

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	APRIL 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	1 OF 3

REV	DATE	BY	DESCRIPTION

TOP OF WASTE FINAL

PERMIT DRAWING

SURFACE WASTE MANAGEMENT FACILITY

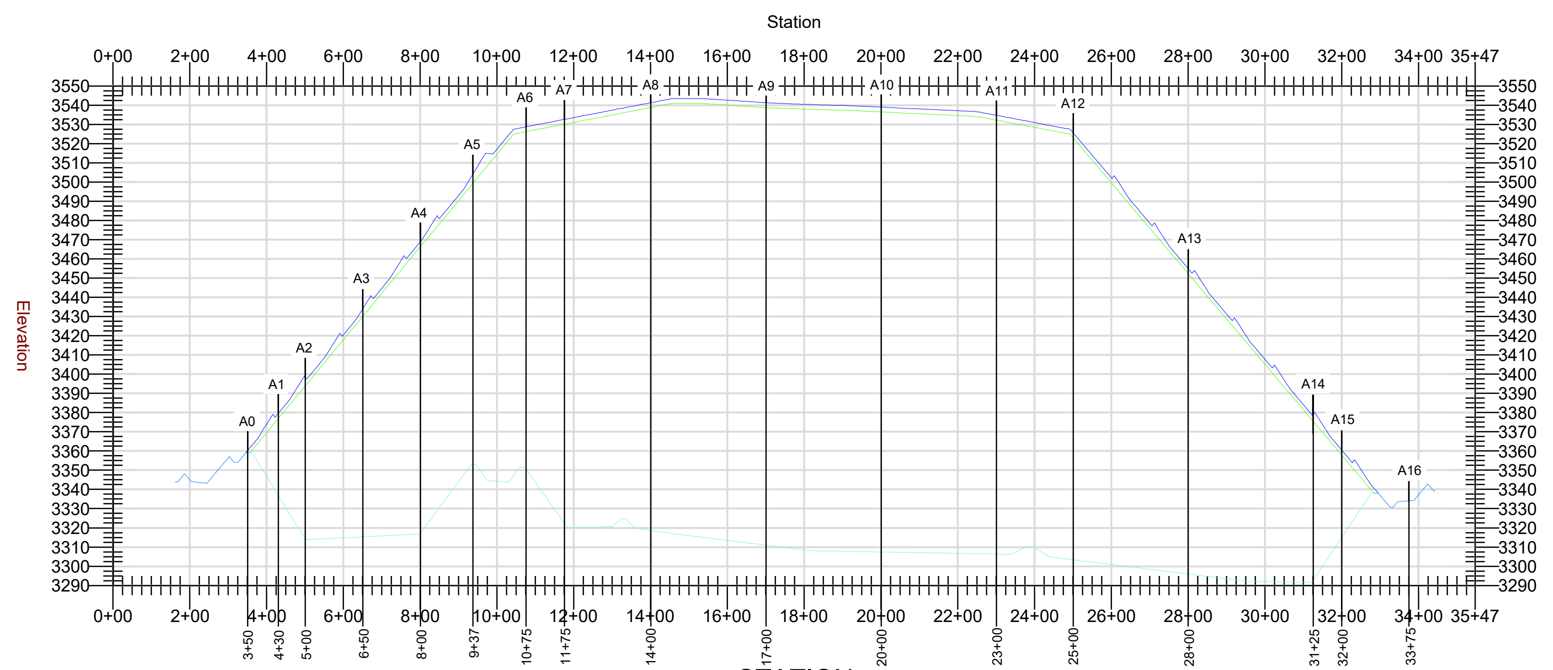
NORTH RANCH

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

FIGURE 2

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	APRIL 2019
JOB NO.	572-002-35187378
ACAD NO.	
SHEET NO.:	2 OF 3



STATION
ALIGN - A-A'

LEGEND:

PROPOSED TOP OF FINAL COVER

PROPOSED TOP OF WASTE

PROPOSED TOP OF PROTECTIVE COVER

PROPOSED TOP OF PERIMETER INFRASTRUCTURE

PROPOSED INTERMEDIATE COVER

A0 3+50 SETTLEMENT ANALYSIS POINTS

NOTES:

1. OPERATIONAL = WASTE PLUS ROUTINE AND INTERIM SOIL COVER.

SCALES:
1" = 500' (HORIZONTAL)
1" = 100' (VERTICAL)
VERTICAL EXAGGERATION = x 5

500 0 250 500
SCALE IN FEET

REV	DATE	BY	DESCRIPTION

FINAL GRADE CROSS-SECTIONS

PERMIT DRAWING
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

Terracon
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25809 I-30 SOUTH BRYANT, AR 72022
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FIGURE 3

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	APRIL 2019
JOB NO.	572-002-35187378
ACAD NO.	
SHEET NO.:	3 OF 3

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TABLE 2 FOUNDATION SOIL SETTLEMENT CALCULATIONS

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+75
Linear Horizontal Distance (ft.)	350	430	500	650	800	937	1075	1175	1400	1700	2000	2300	2500	2800	3125	3200	3375
Final Cover Elevation (ft.)	3360	3380	3395	3430	3465	3500	3530	3530	3540	3540	3540	3533	3530	3450	3380	3360	3340
Final Cover Above Waste (ft.)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Final Waste Elevation (ft.)	3356.5	3376.5	3391.5	3426.5	3461.5	3496.5	3526.5	3526.5	3536.5	3536.5	3536.5	3529.5	3526.5	3446.5	3376.5	3356.5	3336.5
Clay Liner Thickness (ft.)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Top of Clay Liner Elevation (ft.)	3356.5	3334	3312	3312	3314	3350	3350	3320	3318	3308	3305	3302	3300	3295	3290	3315	3336.5
Waste Thickness (ft.)	0.0	42.5	79.5	114.5	147.5	146.5	176.5	206.5	218.5	228.5	231.5	227.5	226.5	151.5	86.5	41.5	0.0
Unit Weight of Final Cover (pcf)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Unit Weight of Waste (pcf)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Applied Pressure (psf)	540	5640	10080	14280	18240	18120	21720	25320	26760	27960	28320	27840	27720	18720	10920	5520	540
Founfation Bedrock Elevation (ft.)	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279	3279
Foundation-Sand Thickness (ft.)	76.5	54.0	32.0	32.0	34.0	70.0	70.0	40.0	38.0	28.0	25.0	22.0	20.0	15.0	10.0	35.0	56.5
Foundation- Sand Constrained Modulus (ksf)	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0	850.0
SETTLEMENT																	
Settlement (ft.)	0.0	0.4	0.4	0.5	0.7	1.5	1.8	1.2	1.2	0.9	0.8	0.7	0.7	0.3	0.1	0.2	0.0
Settlement (in.)	0.6	4.3	4.6	6.5	8.8	17.9	21.5	14.3	14.4	11.1	10.0	8.6	7.8	4.0	1.5	2.7	0.4
Differential Settlement (ft.)		0.3	0.0	0.2	0.2	0.8	0.3	-0.6	0.0	-0.3	-0.1	-0.1	-0.1	-0.3	-0.2	0.1	-0.2
GRADES AND STRAINS																	
Bottom of Clay Liner Elevation Prior to Settlement (ft.)	3355.5	3333.0	3311.0	3311.0	3313.0	3349.0	3349.0	3319.0	3317.0	3307.0	3304.0	3301.0	3299.0	3294.0	3289.0	3314.0	3335.5
Bottom of Clay Liner Elevation After settlement (ft.)	3355.5	3332.6	3310.6	3310.5	3312.3	3347.5	3347.2	3317.8	3315.8	3306.1	3303.2	3300.3	3298.3	3293.7	3288.9	3313.8	3335.5
Initial Liner Cover GeoMembrane Segment Length (ft.)		83.1	73.4	150.0	150.0	141.7	138.0	104.4	225.0	300.2	300.0	300.0	200.0	300.0	325.0	79.1	176.3
PostSettlement Final Cover GeoMemberane Segment Length (ft.)		83.2	73.4	150.0	150.0	141.5	138.0	104.2	225.0	300.2	300.0	300.0	200.0	300.0	325.0	79.0	176.3
Strain (+ Compression/- Tension)		-0.1%	0.0%	0.0%	0.0%	0.1%	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PreSettlement Slope (+ up/- down)		-28.1%	-31.4%	0.0%	1.3%	26.3%	0.0%	-30.0%	-0.9%	-3.3%	-1.0%	-1.0%	-1.0%	-1.7%	-1.5%	33.3%	12.3%
Post Settlement Slope (+ up/- down)		-28.5%	-31.5%	-0.1%	1.2%	25.7%	-0.2%	-29.4%	-0.9%	-3.2%	-1.0%	-1.0%	-1.0%	-1.6%	-1.5%	33.2%	12.4%
Grade Change (+ Steeper/- Milder)		0.4%	0.0%	0.1%	-0.1%	-0.6%	0.2%	-0.6%	0.0%	-0.1%	0.0%	0.0%	0.0%	-0.1%	-0.1%	-0.1%	0.1%

TABLE 3 WASTE SETTLEMENT CALCULATIONS

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+75
Linear Horizontal Distance (ft.)	350	430	500	650	800	937	1075	1175	1400	1700	2000	2300	2500	2800	3125	3200	3375
Final Cover Elevation (ft.)	3360	3380	3395	3430	3465	3500	3530	3530	3540	3540	3540	3533	3530	3450	3380	3360	3340
Final Cover Above Waste (ft.)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Final Waste Elevation (ft.)	3356.5	3376.5	3391.5	3426.5	3461.5	3496.5	3526.5	3526.5	3536.5	3536.5	3536.5	3529.5	3526.5	3446.5	3376.5	3356.5	3336.5
Top of Clay Liner (ft.)	3356.5	3334	3312	3312	3314	3350	3350	3320	3318	3308	3305	3302	3300	3295	3290	3315	3336.5
Waste Thickness (ft.)	0.0	42.5	79.5	114.5	147.5	146.5	176.5	206.5	218.5	228.5	231.5	227.5	226.5	151.5	86.5	41.5	0.0
Number of Layers	0	4	8	11	15	15	18	20	20	20	20	20	20	15	9	4	0
Layer Thickness (ft.)	0	11	10	10	10	10	10	10	11	11	12	11	11	10	10	10	0
Unit Weight of Final Cover (pcf)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Unit Weight of Waste (pcf)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Pre Consolidation Pressure (psf)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Modified Primary Compression Index	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Modified Recompression Index	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Modified Secondary Compression Index	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SUB LAYER	1																
Top of Layer Elevation (ft.)		3376.5	3391.5	3426.5	3461.5	3496.5	3526.5	3526.5	3536.5	3536.5	3536.5	3529.5	3526.5	3446.5	3376.5	3356.5	
Bottom of Layer Elevation (ft.)		3365.9	3381.6	3416.1	3451.7	3486.7	3516.7	3516.2	3525.6	3525.1	3524.9	3518.1	3515.2	3436.4	3366.9	3346.1	
Layer Midpoint Elevation (ft.)		3371.2	3386.5	3421.3	3456.6	3491.6	3521.6	3521.3	3531.0	3530.8	3530.7	3523.8	3520.8	3441.5	3371.7	3351.3	
Initial Effective Stress (psf)		637.5	596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7	622.5	
Final Effective Stress (psf)		1057.5	1016.3	1044.5	1010.0	1006.0	1008.3	1039.5	1075.5	1105.5	1114.5	1102.5	1099.5	1026.0	996.7	1042.5	
Primary Settlement (ft.)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Primary Settlement (in.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1	
SUB LAYER	2																
Top of Layer Elevation (ft.)		3365.9	3381.6	3416.1	3451.7	3486.7	3516.7	3516.2	3525.6	3525.1	3524.9	3518.1	3515.2	3436.4	3366.9	3346.1	
Bottom of Layer Elevation (ft.)		3355.3	3371.6	3405.7	3441.8	3477.0	3506.9	3505.9	3514.7	3513.7	3513.4	3506.8	3503.9	3426.3	3357.3	3335.8	
Layer Midpoint Elevation (ft.)		3360.6	3376.6	3410.9	3446.8	3481.9	3511.8	3511.0	3520.1	3519.4	3519.1	3512.4	3509.5	3431.4	3362.1	3340.9	
Initial Effective Stress (psf)		637.5	596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7	622.5	
Final Effective Stress (psf)		2332.5	2208.8	2293.6	2190.0	2178.0	2185.0	2278.5	2386.5	2476.5	2503.5	2467.5	2458.5	2238.0	2150.0	2287.5	
Primary Settlement (ft.)		0.1	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	
Primary Settlement (in.)		0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.8	0.7	0.7	0.6	0.6	0.6	
SUB LAYER	3																
Top of Layer Elevation (ft.)		3355.3	3371.6	3405.7	3441.8	3477.0	3506.9	3505.9	3514.7	3513.7	3513.4	3506.8	3503.9	3426.3	3357.3	3335.8	
Bottom of Layer Elevation (ft.)		3344.6	3361.7	3395.3	3432.0	3467.2	3497.1	3495.5	3503.7	3502.2	3501.8	3495.4	3492.5	3416.2	3347.7	3325.4	
Layer Midpoint Elevation (ft.)		3349.9	3366.7	3400.5	3436.9	3472.1	3502.0	3500.7	3509.2	3507.9	3507.6	3501.1	3498.2	3421.3	3352.5	3330.6	
Initial Effective Stress (psf)		637.5	596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7	622.5	
Final Effective Stress (psf)		3607.5	3401.3	3542.7	3370.0	3350.0	3361.7	3517.5	3697.5	3847.5	3892.5	3832.5	3817.5	3450.0	3303.3	3532.5	
Primary Settlement (ft.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Primary Settlement (in.)		1.0	0.9	0.9	0.9	0.8	0.9	0.9	1.0	1.1	1.1	1.0	1.0	0.9	0.8	0.9	
SUB LAYER	4																
Top of Layer Elevation (ft.)		3344.6	3361.7	3395.3	3432.0	3467.2	3497.1	3495.5	3503.7	3502.2	3501.8	3495.4	3492.5	3416.2	3347.7	3325.4	
Bottom of Layer Elevation (ft.)		3334.0	3351.8	3384.9	3422.2	3457.4	3487.3	3485.2	3492.8	3490.8	3490.2	3484.0	3481.2	3406.1	3338.1	3315.0	
Layer Midpoint Elevation (ft.)		3339.3	3356.7	3390.1	3427.1	3462.3	3492.2	3490.4	3498.3	3496.5	3496.0	3489.7	3486.9	3411.2	3342.9	3320.2	
Initial Effective Stress (psf)		637.5	596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7	622.5	
Final Effective Stress (psf)		4882.5	4593.8	4791.8	4550.0	4522.0	4538.3	4756.5	5008.5	5218.5	5281.5	5197.5	5176.5	4662.0	4456.7	4777.5	
Primary Settlement (ft.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
Primary Settlement (in.)		1.2	1.1	1.1	1.0	1.0	1.0	1.1	1.2	1.3	1.3	1.3	1.3	1.1	1.0	1.1	

TABLE 3 WASTE SETTLEMENT CALCULATIONS (CONTINUED)

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+75
SUB LAYER	5																
Top of Layer Elevation (ft.)			3351.8	3384.9	3422.2	3457.4	3487.3	3485.2	3492.8	3490.8	3490.2	3484.0	3481.2	3406.1	3338.1		
Bottom of Layer Elevation (ft.)			3341.8	3374.5	3412.3	3447.7	3477.5	3474.9	3481.9	3479.4	3478.6	3472.6	3469.9	3396.0	3328.4		
Layer Midpoint Elevation (ft.)			3346.8	3379.7	3417.3	3452.6	3482.4	3480.0	3487.3	3485.1	3484.4	3478.3	3475.5	3401.1	3333.3		
Initial Effective Stress (psf)			596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7		
Final Effective Stress (psf)			5786.3	6040.9	5730.0	5694.0	5715.0	5995.5	6319.5	6589.5	6670.5	6562.5	6535.5	5874.0	5610.0		
Primary Settlement (ft.)			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Primary Settlement (in.)			1.2	1.3	1.2	1.2	1.2	1.3	1.4	1.4	1.5	1.4	1.4	1.2	1.1		
SUB LAYER	6																
Top of Layer Elevation (ft.)			3341.8	3374.5	3412.3	3447.7	3477.5	3474.9	3481.9	3479.4	3478.6	3472.6	3469.9	3396.0	3328.4		
Bottom of Layer Elevation (ft.)			3331.9	3364.0	3402.5	3437.9	3467.7	3464.6	3471.0	3468.0	3467.1	3461.3	3458.6	3385.9	3318.8		
Layer Midpoint Elevation (ft.)			3336.8	3369.3	3407.4	3442.8	3472.6	3469.7	3476.4	3473.7	3472.8	3466.9	3464.2	3391.0	3323.6		
Initial Effective Stress (psf)			596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7		
Final Effective Stress (psf)			6978.8	7290.0	6910.0	6866.0	6891.7	7234.5	7630.5	7960.5	8059.5	7927.5	7894.5	7086.0	6763.3		
Primary Settlement (ft.)			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Primary Settlement (in.)			1.3	1.4	1.3	1.3	1.3	1.4	1.5	1.6	1.6	1.6	1.6	1.3	1.3		
SUB LAYER	7																
Top of Layer Elevation (ft.)			3331.9	3364.0	3402.5	3437.9	3467.7	3464.6	3471.0	3468.0	3467.1	3461.3	3458.6	3385.9	3318.8		
Bottom of Layer Elevation (ft.)			3321.9	3353.6	3392.7	3428.1	3457.9	3454.2	3460.0	3456.5	3455.5	3449.9	3447.2	3375.8	3309.2		
Layer Midpoint Elevation (ft.)			3326.9	3358.8	3397.6	3433.0	3462.8	3459.4	3465.5	3462.2	3461.3	3455.6	3452.9	3380.9	3314.0		
Initial Effective Stress (psf)			596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7		
Final Effective Stress (psf)			8171.3	8539.1	8090.0	8038.0	8068.3	8473.5	8941.5	9331.5	9448.5	9292.5	9253.5	8298.0	7916.7		
Primary Settlement (ft.)			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1		
Primary Settlement (in.)			1.4	1.5	1.4	1.4	1.4	1.5	1.6	1.7	1.7	1.7	1.7	1.4	1.4		
SUB LAYER	8																
Top of Layer Elevation (ft.)			3321.9	3353.6	3392.7	3428.1	3457.9	3454.2	3460.0	3456.5	3455.5	3449.9	3447.2	3375.8	3309.2		
Bottom of Layer Elevation (ft.)			3312.0	3343.2	3382.8	3418.4	3448.1	3443.9	3449.1	3445.1	3443.9	3438.5	3435.9	3365.7	3299.6		
Layer Midpoint Elevation (ft.)			3317.0	3348.4	3387.8	3423.3	3453.0	3449.1	3454.6	3450.8	3449.7	3444.2	3441.6	3370.8	3304.4		
Initial Effective Stress (psf)			596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7		
Final Effective Stress (psf)			9363.8	9788.2	9270.0	9210.0	9245.0	9712.5	10252.5	10702.5	10837.5	10657.5	10612.5	9510.0	9070.0		
Primary Settlement (ft.)			0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1		
Primary Settlement (in.)			1.5	1.6	1.5	1.5	1.5	1.6	1.7	1.8	1.8	1.8	1.8	1.5	1.4		
SUB LAYER	9																
Top of Layer Elevation (ft.)				3343.2	3382.8	3418.4	3448.1	3443.9	3449.1	3445.1	3443.9	3438.5	3435.9	3365.7	3299.6		
Bottom of Layer Elevation (ft.)				3332.8	3373.0	3408.6	3438.3	3433.6	3438.2	3433.7	3432.3	3427.1	3424.6	3355.6	3290.0		
Layer Midpoint Elevation (ft.)				3338.0	3377.9	3413.5	3443.2	3438.7	3443.6	3439.4	3438.1	3432.8	3430.2	3360.7	3294.8		
Initial Effective Stress (psf)				624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7		
Final Effective Stress (psf)				11037.3	10450.0	10382.0	10421.7	10951.5	11563.5	12073.5	12226.5	12022.5	11971.5	10722.0	10223.3		
Primary Settlement (ft.)				0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1		
Primary Settlement (in.)				1.7	1.6	1.5	1.5	1.6	1.8	1.9	1.9	1.9	1.8	1.6	1.5		
SUB LAYER	10																
Top of Layer Elevation (ft.)				3332.8	3373.0	3408.6	3438.3	3433.6	3438.2	3433.7	3432.3	3427.1	3424.6	3355.6			
Bottom of Layer Elevation (ft.)				3322.4	3363.2	3398.8	3428.4	3423.3	3427.3	3422.3	3420.8	3415.8	3413.3	3345.5			
Layer Midpoint Elevation (ft.)				3327.6	3368.1	3403.7	3433.3	3428.4	3432.7	3428.0	3426.5	3421.4	3418.9	3350.6			
Initial Effective Stress (psf)				624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0			
Final Effective Stress (psf)				12286.4	11630.0	11554.0	11598.3	12190.5	12874.5	13444.5	13615.5	13387.5	13330.5	11934.0			
Primary Settlement (ft.)				0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1			
Primary Settlement (in.)				1.7	1.6	1.6	1.6	1.7	1.8	1.9	2.0	1.9	1.9	1.7			

TABLE 3 WASTE SETTLEMENT CALCULATIONS (CONTINUED)

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+75
SUB LAYER	11																
Top of Layer Elevation (ft.)				3322.4	3363.2	3398.8	3428.4	3423.3	3427.3	3422.3	3420.8	3415.8	3413.3	3345.5			
Bottom of Layer Elevation (ft.)				3312.0	3353.3	3389.1	3418.6	3412.9	3416.3	3410.8	3409.2	3404.4	3401.9	3335.4			
Layer Midpoint Elevation (ft.)				3317.2	3358.3	3394.0	3423.5	3418.1	3421.8	3416.5	3415.0	3410.1	3407.6	3340.5			
Initial Effective Stress (psf)				624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0			
Final Effective Stress (psf)				13535.5	12810.0	12726.0	12775.0	13429.5	14185.5	14815.5	15004.5	14752.5	14689.5	13146.0			
Primary Settlement (ft.)				0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.1			
Primary Settlement (in.)				1.8	1.7	1.7	1.7	1.8	1.9	2.0	2.0	2.0	2.0	1.7			
SUB LAYER	12																
Top of Layer Elevation (ft.)					3353.3	3389.1	3418.6	3412.9	3416.3	3410.8	3409.2	3404.4	3401.9	3335.4			
Bottom of Layer Elevation (ft.)					3343.5	3379.3	3408.8	3402.6	3405.4	3399.4	3397.6	3393.0	3390.6	3325.3			
Layer Midpoint Elevation (ft.)					3348.4	3384.2	3413.7	3407.8	3410.9	3405.1	3403.4	3398.7	3396.3	3330.4			
Initial Effective Stress (psf)					590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0			
Final Effective Stress (psf)					13990.0	13898.0	13951.7	14668.5	15496.5	16186.5	16393.5	16117.5	16048.5	14358.0			
Primary Settlement (ft.)					0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1			
Primary Settlement (in.)					1.7	1.7	1.7	1.8	2.0	2.1	2.1	2.1	2.1	1.8			
SUB LAYER	13																
Top of Layer Elevation (ft.)					3343.5	3379.3	3408.8	3402.6	3405.4	3399.4	3397.6	3393.0	3390.6	3325.3			
Bottom of Layer Elevation (ft.)					3333.7	3369.5	3399.0	3392.3	3394.5	3388.0	3386.0	3381.6	3379.3	3315.2			
Layer Midpoint Elevation (ft.)					3338.6	3374.4	3403.9	3397.4	3399.9	3393.7	3391.8	3387.3	3384.9	3320.3			
Initial Effective Stress (psf)					590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0			
Final Effective Stress (psf)					15170.0	15070.0	15128.3	15907.5	16807.5	17557.5	17782.5	17482.5	17407.5	15570.0			
Primary Settlement (ft.)					0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2			
Primary Settlement (in.)					1.8	1.8	1.8	1.9	2.0	2.1	2.2	2.1	2.1	1.8			
SUB LAYER	14																
Top of Layer Elevation (ft.)					3333.7	3369.5	3399.0	3392.3	3394.5	3388.0	3386.0	3381.6	3379.3	3315.2			
Bottom of Layer Elevation (ft.)					3323.8	3359.8	3389.2	3382.0	3383.6	3376.6	3374.5	3370.3	3368.0	3305.1			
Layer Midpoint Elevation (ft.)					3328.8	3364.7	3394.1	3387.1	3389.0	3382.3	3380.2	3375.9	3373.6	3310.2			
Initial Effective Stress (psf)					590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0			
Final Effective Stress (psf)					16350.0	16242.0	16305.0	17146.5	18118.5	18928.5	19171.5	18847.5	18766.5	16782.0			
Primary Settlement (ft.)					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2			
Primary Settlement (in.)					1.8	1.8	1.8	1.9	2.1	2.2	2.2	2.2	2.2	1.9			
SUB LAYER	15																
Top of Layer Elevation (ft.)					3323.8	3359.8	3389.2	3382.0	3383.6	3376.6	3374.5	3370.3	3368.0	3305.1			
Bottom of Layer Elevation (ft.)					3314.0	3350.0	3379.4	3371.6	3372.6	3365.1	3362.9	3358.9	3356.6	3295.0			
Layer Midpoint Elevation (ft.)					3318.9	3354.9	3384.3	3376.8	3378.1	3370.8	3368.7	3364.6	3362.3	3300.1			
Initial Effective Stress (psf)					590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0			
Final Effective Stress (psf)					17530.0	17414.0	17481.7	18385.5	19429.5	20299.5	20560.5	20212.5	20125.5	17994.0			
Primary Settlement (ft.)					0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2			
Primary Settlement (in.)					1.9	1.9	1.9	2.0	2.1	2.2	2.3	2.2	2.2	1.9			
SUB LAYER	16																
Top of Layer Elevation (ft.)							3379.4	3371.6	3372.6	3365.1	3362.9	3358.9	3356.6				
Bottom of Layer Elevation (ft.)							3369.6	3361.3	3361.7	3353.7	3351.3	3347.5	3345.3				
Layer Midpoint Elevation (ft.)							3374.5	3366.5	3367.2	3359.4	3357.1	3353.2	3351.0				
Initial Effective Stress (psf)							588.3	619.5	655.5	685.5	694.5	682.5	679.5				
Final Effective Stress (psf)							18658.3	19624.5	20740.5	21670.5	21949.5	21577.5	21484.5				
Primary Settlement (ft.)							0.2	0.2	0.2	0.2	0.2	0.2	0.2				
Primary Settlement (in.)							1.9	2.0	2.2	2.3	2.3	2.3	2.3				

TABLE 3 WASTE SETTLEMENT CALCULATIONS (CONTINUED)

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+75
SUB LAYER	17																
Top of Layer Elevation (ft.)							3369.6	3361.3	3361.7	3353.7	3351.3	3347.5	3345.3				
Bottom of Layer Elevation (ft.)							3359.8	3351.0	3350.8	3342.3	3339.7	3336.1	3334.0				
Layer Midpoint Elevation (ft.)							3364.7	3356.1	3356.2	3348.0	3345.5	3341.8	3339.6				
Initial Effective Stress (psf)							588.3	619.5	655.5	685.5	694.5	682.5	679.5				
Final Effective Stress (psf)							19835.0	20863.5	22051.5	23041.5	23338.5	22942.5	22843.5				
Primary Settlement (ft.)							0.2	0.2	0.2	0.2	0.2	0.2	0.2				
Primary Settlement (in.)							1.9	2.1	2.2	2.3	2.4	2.3	2.3				
SUB LAYER	18																
Top of Layer Elevation (ft.)							3359.8	3351.0	3350.8	3342.3	3339.7	3336.1	3334.0				
Bottom of Layer Elevation (ft.)							3350.0	3340.7	3339.9	3330.9	3328.2	3324.8	3322.7				
Layer Midpoint Elevation (ft.)							3354.9	3345.8	3345.3	3336.6	3333.9	3330.4	3328.3				
Initial Effective Stress (psf)							588.3	619.5	655.5	685.5	694.5	682.5	679.5				
Final Effective Stress (psf)							21011.7	22102.5	23362.5	24412.5	24727.5	24307.5	24202.5				
Primary Settlement (ft.)							0.2	0.2	0.2	0.2	0.2	0.2	0.2				
Primary Settlement (in.)							2.0	2.1	2.2	2.4	2.4	2.4	2.3				
SUB LAYER	19																
Top of Layer Elevation (ft.)								3340.7	3339.9	3330.9	3328.2	3324.8	3322.7				
Bottom of Layer Elevation (ft.)								3330.3	3328.9	3319.4	3316.6	3313.4	3311.3				
Layer Midpoint Elevation (ft.)								3335.5	3334.4	3325.1	3322.4	3319.1	3317.0				
Initial Effective Stress (psf)								619.5	655.5	685.5	694.5	682.5	679.5				
Final Effective Stress (psf)								23341.5	24673.5	25783.5	26116.5	25672.5	25561.5				
Primary Settlement (ft.)								0.2	0.2	0.2	0.2	0.2	0.2				
Primary Settlement (in.)								2.1	2.3	2.4	2.4	2.4	2.4				
SUB LAYER	20																
Top of Layer Elevation (ft.)								3330.3	3328.9	3319.4	3316.6	3313.4	3311.3				
Bottom of Layer Elevation (ft.)								3320.0	3318.0	3308.0	3305.0	3302.0	3300.0				
Layer Midpoint Elevation (ft.)								3325.2	3323.5	3313.7	3310.8	3307.7	3305.7				
Initial Effective Stress (psf)								619.5	655.5	685.5	694.5	682.5	679.5				
Final Effective Stress (psf)								24580.5	25984.5	27154.5	27505.5	27037.5	26920.5				
Primary Settlement (ft.)								0.2	0.2	0.2	0.2	0.2	0.2				
Primary Settlement (in.)								2.2	2.3	2.4	2.5	2.4	2.4				
SETTLEMENT																	
Total Primary Settlement (in.)	0.0	2.9	8.1	13.8	20.0	19.8	25.7	31.8	34.1	36.0	36.6	35.8	35.6	20.7	9.2	2.8	0.0
Total Secondary Settlement (in.)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Settlement (in.)	0.0	2.9	8.1	13.8	20.0	19.8	25.7	31.8	34.1	36.0	36.6	35.8	35.6	20.7	9.2	2.8	0.0
Total Settlement (ft.)	0.0	0.2	0.7	1.1	1.7	1.7	2.1	2.6	2.8	3.0	3.1	3.0	3.0	1.7	0.8	0.2	0.0

TABLE 4 FINAL COVER SETTLEMENT CALCULATIONS

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+70
Linear Horizontal Distance (ft.)	350	430	500	650	800	937	1075	1175	1400	1700	2000	2300	2500	2800	3125	3200	3370
Final Cover Elevation (ft.)	3360	3380	3395	3430	3465	3500	3530	3530	3540	3540	3540	3533	3530	3450	3380	3363	3330
Final Cover Above Waste (ft.)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Final Waste Elevation (ft.)	3356.5	3376.5	3391.5	3426.5	3461.5	3496.5	3526.5	3526.5	3536.5	3536.5	3536.5	3529.5	3526.5	3446.5	3376.5	3359.5	3326.5
Top of Clay Liner (ft.)	3356.5	3334	3312	3312	3314	3350	3350	3320	3318	3308	3305	3302	3300	3295	3290	3315	3331.5
Waste Thickness (ft.)	0.0	42.5	79.5	114.5	147.5	146.5	176.5	206.5	218.5	228.5	231.5	227.5	226.5	151.5	86.5	44.5	-5.0
Number of Layers	0	4	8	11	15	15	18	20	20	20	20	20	20	15	9	4	0
Layer Thickness (ft.)	0	11	10	10	10	10	10	10	11	11	12	11	11	10	10	11	0
Unit Weight of Final Cover (pcf)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Unit Weight of Waste (pcf)	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120	120
Pre Consolidation Pressure (psf)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000
Modified Primary Compression Index	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012	0.012
Modified Recompression Index	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
Modified Secondary Compression Index	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
SUB LAYER									1								
Top of Layer Elevation (ft.)		3376.5	3391.5	3426.5	3461.5	3496.5	3526.5	3526.5	3536.5	3536.5	3536.5	3529.5	3526.5	3446.5	3376.5	3359.5	
Bottom of Layer Elevation (ft.)		3365.9	3381.6	3416.1	3451.7	3486.7	3516.7	3516.2	3525.6	3525.1	3524.9	3518.1	3515.2	3436.4	3366.9	3348.4	
Layer Midpoint Elevation (ft.)		3371.2	3386.5	3421.3	3456.6	3491.6	3521.6	3521.3	3531.0	3530.8	3530.7	3523.8	3520.8	3441.5	3371.7	3353.9	
Initial Effective Stress (psf)		637.5	596.3	624.5	590.0	586.0	588.3	619.5	655.5	685.5	694.5	682.5	679.5	606.0	576.7	667.5	
Final Effective Stress (psf)		1057.5	1016.3	1044.5	1010.0	1006.0	1008.3	1039.5	1075.5	1105.5	1114.5	1102.5	1099.5	1026.0	996.7	1087.5	
Primary Settlement (ft.)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Primary Settlement (in.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.2	
SUB LAYER									2								
Top of Layer Elevation (ft.)		3365.9	3381.6	3416.1	3451.7	3486.7	3516.7	3516.2	3525.6	3525.1	3524.9	3518.1	3515.2	3436.4	3366.9	3348.4	
Bottom of Layer Elevation (ft.)		3355.3	3371.6	3405.7	3441.8	3477.0	3506.9	3505.9	3514.7	3513.7	3513.4	3506.8	3503.9	3426.3	3357.3	3337.3	
Layer Midpoint Elevation (ft.)		3360.6	3376.6	3410.9	3446.8	3481.9	3511.8	3511.0	3520.1	3519.4	3519.1	3512.4	3509.5	3431.4	3362.1	3342.8	
Initial Effective Stress (psf)		1912.5	1788.8	1873.6	1770.0	1758.0	1765.0	1858.5	1966.5	2056.5	2083.5	2047.5	2038.5	1818.0	1730.0	2002.5	
Final Effective Stress (psf)		2332.5	2208.8	2293.6	2190.0	2178.0	2185.0	2278.5	2386.5	2476.5	2503.5	2467.5	2458.5	2238.0	2150.0	2422.5	
Primary Settlement (ft.)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Primary Settlement (in.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
SUB LAYER									3								
Top of Layer Elevation (ft.)		3355.3	3371.6	3405.7	3441.8	3477.0	3506.9	3505.9	3514.7	3513.7	3513.4	3506.8	3503.9	3426.3	3357.3	3337.3	
Bottom of Layer Elevation (ft.)		3344.6	3361.7	3395.3	3432.0	3467.2	3497.1	3495.5	3503.7	3502.2	3501.8	3495.4	3492.5	3416.2	3347.7	3326.1	
Layer Midpoint Elevation (ft.)		3349.9	3366.7	3400.5	3436.9	3472.1	3502.0	3500.7	3509.2	3507.9	3507.6	3501.1	3498.2	3421.3	3352.5	3331.7	
Initial Effective Stress (psf)		3187.5	2981.3	3122.7	2950.0	2930.0	2941.7	3097.5	3277.5	3427.5	3472.5	3412.5	3397.5	3030.0	2883.3	3337.5	
Final Effective Stress (psf)		3607.5	3401.3	3542.7	3370.0	3350.0	3361.7	3517.5	3697.5	3847.5	3892.5	3832.5	3817.5	3450.0	3303.3	3757.5	
Primary Settlement (ft.)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Primary Settlement (in.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	

TABLE 4 FINAL COVER SETTLEMENT CALCULATIONS (CONTINUED)																	
Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+70
SUB LAYER									4								
Top of Layer Elevation (ft.)		3344.6	3361.7	3395.3	3432.0	3467.2	3497.1	3495.5	3503.7	3502.2	3501.8	3495.4	3492.5	3416.2	3347.7	3326.1	
Bottom of Layer Elevation (ft.)		3334.0	3351.8	3384.9	3422.2	3457.4	3487.3	3485.2	3492.8	3490.8	3490.2	3484.0	3481.2	3406.1	3338.1	3315.0	
Layer Midpoint Elevation (ft.)		3339.3	3356.7	3390.1	3427.1	3462.3	3492.2	3490.4	3498.3	3496.5	3496.0	3489.7	3486.9	3411.2	3342.9	3320.6	
Initial Effective Stress (psf)		4462.5	4173.8	4371.8	4130.0	4102.0	4118.3	4336.5	4588.5	4798.5	4861.5	4777.5	4756.5	4242.0	4036.7	4672.5	
Final Effective Stress (psf)		4882.5	4593.8	4791.8	4550.0	4522.0	4538.3	4756.5	5008.5	5218.5	5281.5	5197.5	5176.5	4662.0	4456.7	5092.5	
Primary Settlement (ft.)		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Primary Settlement (in.)		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	
SUB LAYER									5								
Top of Layer Elevation (ft.)			3351.8	3384.9	3422.2	3457.4	3487.3	3485.2	3492.8	3490.8	3490.2	3484.0	3481.2	3406.1	3338.1		
Bottom of Layer Elevation (ft.)			3341.8	3374.5	3412.3	3447.7	3477.5	3474.9	3481.9	3479.4	3478.6	3472.6	3469.9	3396.0	3328.4		
Layer Midpoint Elevation (ft.)			3346.8	3379.7	3417.3	3452.6	3482.4	3480.0	3487.3	3485.1	3484.4	3478.3	3475.5	3401.1	3333.3		
Initial Effective Stress (psf)			5366.3	5620.9	5310.0	5274.0	5295.0	5575.5	5899.5	6169.5	6250.5	6142.5	6115.5	5454.0	5190.0		
Final Effective Stress (psf)			5786.3	6040.9	5730.0	5694.0	5715.0	5995.5	6319.5	6589.5	6670.5	6562.5	6535.5	5874.0	5610.0		
Primary Settlement (ft.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Primary Settlement (in.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
SUB LAYER									6								
Top of Layer Elevation (ft.)			3341.8	3374.5	3412.3	3447.7	3477.5	3474.9	3481.9	3479.4	3478.6	3472.6	3469.9	3396.0	3328.4		
Bottom of Layer Elevation (ft.)			3331.9	3364.0	3402.5	3437.9	3467.7	3464.6	3471.0	3468.0	3467.1	3461.3	3458.6	3385.9	3318.8		
Layer Midpoint Elevation (ft.)			3336.8	3369.3	3407.4	3442.8	3472.6	3469.7	3476.4	3473.7	3472.8	3466.9	3464.2	3391.0	3323.6		
Initial Effective Stress (psf)			6558.8	6870.0	6490.0	6446.0	6471.7	6814.5	7210.5	7540.5	7639.5	7507.5	7474.5	6666.0	6343.3		
Final Effective Stress (psf)			6978.8	7290.0	6910.0	6866.0	6891.7	7234.5	7630.5	7960.5	8059.5	7927.5	7894.5	7086.0	6763.3		
Primary Settlement (ft.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Primary Settlement (in.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
SUB LAYER									7								
Top of Layer Elevation (ft.)			3331.9	3364.0	3402.5	3437.9	3467.7	3464.6	3471.0	3468.0	3467.1	3461.3	3458.6	3385.9	3318.8		
Bottom of Layer Elevation (ft.)			3321.9	3353.6	3392.7	3428.1	3457.9	3454.2	3460.0	3456.5	3455.5	3449.9	3447.2	3375.8	3309.2		
Layer Midpoint Elevation (ft.)			3326.9	3358.8	3397.6	3433.0	3462.8	3459.4	3465.5	3462.2	3461.3	3455.6	3452.9	3380.9	3314.0		
Initial Effective Stress (psf)			7751.3	8119.1	7670.0	7618.0	7648.3	8053.5	8521.5	8911.5	9028.5	8872.5	8833.5	7878.0	7496.7		
Final Effective Stress (psf)			8171.3	8539.1	8090.0	8038.0	8068.3	8473.5	8941.5	9331.5	9448.5	9292.5	9253.5	8298.0	7916.7		
Primary Settlement (ft.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Primary Settlement (in.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
SUB LAYER									8								
Top of Layer Elevation (ft.)			3321.9	3353.6	3392.7	3428.1	3457.9	3454.2	3460.0	3456.5	3455.5	3449.9	3447.2	3375.8	3309.2		
Bottom of Layer Elevation (ft.)			3312.0	3343.2	3382.8	3418.4	3448.1	3443.9	3449.1	3445.1	3443.9	3438.5	3435.9	3365.7	3299.6		
Layer Midpoint Elevation (ft.)			3317.0	3348.4	3387.8	3423.3	3453.0	3449.1	3454.6	3450.8	3449.7	3444.2	3441.6	3370.8	3304.4		
Initial Effective Stress (psf)			8943.8	9368.2	8850.0	8790.0	8825.0	9292.5	9832.5	10282.5	10417.5	10237.5	10192.5	9090.0	8650.0		
Final Effective Stress (psf)			9363.8	9788.2	9270.0	9210.0	9245.0	9712.5	10252.5	10702.5	10837.5	10657.5	10612.5	9510.0	9070.0		
Primary Settlement (ft.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Primary Settlement (in.)			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		

TABLE 4 FINAL COVER SETTLEMENT CALCULATIONS (CONTINUED)

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+70
SUB LAYER	9																
Top of Layer Elevation (ft.)				3343.2	3382.8	3418.4	3448.1	3443.9	3449.1	3445.1	3443.9	3438.5	3435.9	3365.7	3299.6		
Bottom of Layer Elevation (ft.)				3332.8	3373.0	3408.6	3438.3	3433.6	3438.2	3433.7	3432.3	3427.1	3424.6	3355.6	3290.0		
Layer Midpoint Elevation (ft.)				3338.0	3377.9	3413.5	3443.2	3438.7	3443.6	3439.4	3438.1	3432.8	3430.2	3360.7	3294.8		
Initial Effective Stress (psf)				10617.3	10030.0	9962.0	10001.7	10531.5	11143.5	11653.5	11806.5	11602.5	11551.5	10302.0	9803.3		
Final Effective Stress (psf)				11037.3	10450.0	10382.0	10421.7	10951.5	11563.5	12073.5	12226.5	12022.5	11971.5	10722.0	10223.3		
Primary Settlement (ft.)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
Primary Settlement (in.)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
SUB LAYER	10																
Top of Layer Elevation (ft.)				3332.8	3373.0	3408.6	3438.3	3433.6	3438.2	3433.7	3432.3	3427.1	3424.6	3355.6			
Bottom of Layer Elevation (ft.)				3322.4	3363.2	3398.8	3428.4	3423.3	3427.3	3422.3	3420.8	3415.8	3413.3	3345.5			
Layer Midpoint Elevation (ft.)				3327.6	3368.1	3403.7	3433.3	3428.4	3432.7	3428.0	3426.5	3421.4	3418.9	3350.6			
Initial Effective Stress (psf)				11866.4	11210.0	11134.0	11178.3	11770.5	12454.5	13024.5	13195.5	12967.5	12910.5	11514.0			
Final Effective Stress (psf)				12286.4	11630.0	11554.0	11598.3	12190.5	12874.5	13444.5	13615.5	13387.5	13330.5	11934.0			
Primary Settlement (ft.)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Primary Settlement (in.)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
SUB LAYER	11																
Top of Layer Elevation (ft.)				3322.4	3363.2	3398.8	3428.4	3423.3	3427.3	3422.3	3420.8	3415.8	3413.3	3345.5			
Bottom of Layer Elevation (ft.)				3312.0	3353.3	3389.1	3418.6	3412.9	3416.3	3410.8	3409.2	3404.4	3401.9	3335.4			
Layer Midpoint Elevation (ft.)				3317.2	3358.3	3394.0	3423.5	3418.1	3421.8	3416.5	3415.0	3410.1	3407.6	3340.5			
Initial Effective Stress (psf)				13115.5	12390.0	12306.0	12355.0	13009.5	13765.5	14395.5	14584.5	14332.5	14269.5	12726.0			
Final Effective Stress (psf)				13535.5	12810.0	12726.0	12775.0	13429.5	14185.5	14815.5	15004.5	14752.5	14689.5	13146.0			
Primary Settlement (ft.)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Primary Settlement (in.)				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
SUB LAYER	12																
Top of Layer Elevation (ft.)					3353.3	3389.1	3418.6	3412.9	3416.3	3410.8	3409.2	3404.4	3401.9	3335.4			
Bottom of Layer Elevation (ft.)					3343.5	3379.3	3408.8	3402.6	3405.4	3399.4	3397.6	3393.0	3390.6	3325.3			
Layer Midpoint Elevation (ft.)					3348.4	3384.2	3413.7	3407.8	3410.9	3405.1	3403.4	3398.7	3396.3	3330.4			
Initial Effective Stress (psf)					13570.0	13478.0	13531.7	14248.5	15076.5	15766.5	15973.5	15697.5	15628.5	13938.0			
Final Effective Stress (psf)					13990.0	13898.0	13951.7	14668.5	15496.5	16186.5	16393.5	16117.5	16048.5	14358.0			
Primary Settlement (ft.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Primary Settlement (in.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
SUB LAYER	13																
Top of Layer Elevation (ft.)					3343.5	3379.3	3408.8	3402.6	3405.4	3399.4	3397.6	3393.0	3390.6	3325.3			
Bottom of Layer Elevation (ft.)					3333.7	3369.5	3399.0	3392.3	3394.5	3388.0	3386.0	3381.6	3379.3	3315.2			
Layer Midpoint Elevation (ft.)					3338.6	3374.4	3403.9	3397.4	3399.9	3393.7	3391.8	3387.3	3384.9	3320.3			
Initial Effective Stress (psf)					14750.0	14650.0	14708.3	15487.5	16387.5	17137.5	17362.5	17062.5	16987.5	15150.0			
Final Effective Stress (psf)					15170.0	15070.0	15128.3	15907.5	16807.5	17557.5	17782.5	17482.5	17407.5	15570.0			
Primary Settlement (ft.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Primary Settlement (in.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
SUB LAYER	14																
Top of Layer Elevation (ft.)					3333.7	3369.5	3399.0	3392.3	3394.5	3388.0	3386.0	3381.6	3379.3	3315.2			
Bottom of Layer Elevation (ft.)					3323.8	3359.8	3389.2	3382.0	3383.6	3376.6	3374.5	3370.3	3368.0	3305.1			
Layer Midpoint Elevation (ft.)					3328.8	3364.7	3394.1	3387.1	3389.0	3382.3	3380.2	3375.9	3373.6	3310.2			
Initial Effective Stress (psf)					15930.0	15822.0	15885.0	16726.5	17698.5	18508.5	18751.5	18427.5	18346.5	16362.0			
Final Effective Stress (psf)					16350.0	16242.0	16305.0	17146.5	18118.5	18928.5	19171.5	18847.5	18766.5	16782.0			
Primary Settlement (ft.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Primary Settlement (in.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			

TABLE 4 FINAL COVER SETTLEMENT CALCULATIONS (CONTINUED)

Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+70
SUB LAYER	**15**																
Top of Layer Elevation (ft.)					3323.8	3359.8	3389.2	3382.0	3383.6	3376.6	3374.5	3370.3	3368.0	3305.1			
Bottom of Layer Elevation (ft.)					3314.0	3350.0	3379.4	3371.6	3372.6	3365.1	3362.9	3358.9	3356.6	3295.0			
Layer Midpoint Elevation (ft.)					3318.9	3354.9	3384.3	3376.8	3378.1	3370.8	3368.7	3364.6	3362.3	3300.1			
Initial Effective Stress (psf)					17110.0	16994.0	17061.7	17965.5	19009.5	19879.5	20140.5	19792.5	19705.5	17574.0			
Final Effective Stress (psf)					17530.0	17414.0	17481.7	18385.5	19429.5	20299.5	20560.5	20212.5	20125.5	17994.0			
Primary Settlement (ft.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
Primary Settlement (in.)					0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0			
SUB LAYER	**16**																
Top of Layer Elevation (ft.)							3379.4	3371.6	3372.6	3365.1	3362.9	3358.9	3356.6				
Bottom of Layer Elevation (ft.)							3369.6	3361.3	3361.7	3353.7	3351.3	3347.5	3345.3				
Layer Midpoint Elevation (ft.)							3374.5	3366.5	3367.2	3359.4	3357.1	3353.2	3351.0				
Initial Effective Stress (psf)							18238.3	19204.5	20320.5	21250.5	21529.5	21157.5	21064.5				
Final Effective Stress (psf)							18658.3	19624.5	20740.5	21670.5	21949.5	21577.5	21484.5				
Primary Settlement (ft.)							0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Primary Settlement (in.)							0.0	0.0	0.0	0.0	0.0	0.0	0.0				
SUB LAYER	**17**																
Top of Layer Elevation (ft.)							3369.6	3361.3	3361.7	3353.7	3351.3	3347.5	3345.3				
Bottom of Layer Elevation (ft.)							3359.8	3351.0	3350.8	3342.3	3339.7	3336.1	3334.0				
Layer Midpoint Elevation (ft.)							3364.7	3356.1	3356.2	3348.0	3345.5	3341.8	3339.6				
Initial Effective Stress (psf)							19415.0	20443.5	21631.5	22621.5	22918.5	22522.5	22423.5				
Final Effective Stress (psf)							19835.0	20863.5	22051.5	23041.5	23338.5	22942.5	22843.5				
Primary Settlement (ft.)							0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Primary Settlement (in.)							0.0	0.0	0.0	0.0	0.0	0.0	0.0				
SUB LAYER	**18**																
Top of Layer Elevation (ft.)							3359.8	3351.0	3350.8	3342.3	3339.7	3336.1	3334.0				
Bottom of Layer Elevation (ft.)							3350.0	3340.7	3339.9	3330.9	3328.2	3324.8	3322.7				
Layer Midpoint Elevation (ft.)							3354.9	3345.8	3345.3	3336.6	3333.9	3330.4	3328.3				
Initial Effective Stress (psf)							20591.7	21682.5	22942.5	23992.5	24307.5	23887.5	23782.5				
Final Effective Stress (psf)							21011.7	22102.5	23362.5	24412.5	24727.5	24307.5	24202.5				
Primary Settlement (ft.)							0.0	0.0	0.0	0.0	0.0	0.0	0.0				
Primary Settlement (in.)							0.0	0.0	0.0	0.0	0.0	0.0	0.0				
SUB LAYER	**19**																
Top of Layer Elevation (ft.)								3340.7	3339.9	3330.9	3328.2	3324.8	3322.7				
Bottom of Layer Elevation (ft.)								3330.3	3328.9	3319.4	3316.6	3313.4	3311.3				
Layer Midpoint Elevation (ft.)								3335.5	3334.4	3325.1	3322.4	3319.1	3317.0				
Initial Effective Stress (psf)								22921.5	24253.5	25363.5	25696.5	25252.5	25141.5				
Final Effective Stress (psf)								23341.5	24673.5	25783.5	26116.5	25672.5	25561.5				
Primary Settlement (ft.)								0.0	0.0	0.0	0.0	0.0	0.0				
Primary Settlement (in.)								0.0	0.0	0.0	0.0	0.0	0.0				

TABLE 4 FINAL COVER SETTLEMENT CALCULATIONS (CONTINUED)																	
Point	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16
Station	3+50	4+30	5+00	6+50	8+00	9+37	10+75	11+75	14+00	17+00	20+00	23+00	25+00	28+00	31+25	32+00	33+70
SUB LAYER	**20**																
Top of Layer Elevation (ft.)								3330.3	3328.9	3319.4	3316.6	3313.4	3311.3				
Bottom of Layer Elevation (ft.)								3320.0	3318.0	3308.0	3305.0	3302.0	3300.0				
Layer Midpoint Elevation (ft.)								3325.2	3323.5	3313.7	3310.8	3307.7	3305.7				
Initial Effective Stress (psf)								24160.5	25564.5	26734.5	27085.5	26617.5	26500.5				
Final Effective Stress (psf)								24580.5	25984.5	27154.5	27505.5	27037.5	26920.5				
Primary Settlement (ft.)								0.0	0.0	0.0	0.0	0.0	0.0				
Primary Settlement (in.)								0.0	0.0	0.0	0.0	0.0	0.0				
SETTLEMENT																	
Total Primary Settlement (in.)	0.0	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.6	0.4	0.0
Total Secondary Settlement (in.)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total Settlement (in.)	0.0	0.4	0.5	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.6	0.4	0.0
Total Settlement (ft.)	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0
Differential Settlement (ft.)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GRADES AND STRAINS																	
Final Waste Elevation Prior to Settlement (ft.)	3356.5	3376.5	3391.5	3426.5	3461.5	3496.5	3526.5	3526.5	3536.5	3536.5	3536.5	3529.5	3526.5	3446.5	3376.5	3359.5	3326.5
Final Waste Elevation After settlement (ft.)	3356.5	3376.5	3391.5	3426.4	3461.4	3496.4	3526.4	3526.4	3536.4	3536.4	3536.4	3529.4	3526.4	3446.4	3376.5	3359.5	3326.5
Initial Final Cover GeoMembrane Segment Length (ft.)	0.0	82.5	71.6	154.0	154.0	141.4	141.2	100.0	225.2	300.0	300.0	300.1	200.0	310.5	332.5	76.9	173.2
PostSettlement Final Cover GeoMemberane Segment	0.0	82.5	71.6	154.0	154.0	141.4	141.2	100.0	225.2	300.0	300.0	300.1	200.0	310.5	332.5	76.9	173.2
Strain (+ Compression/- Tension)		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
PreSettlement Slope (+ up/- down)		25.0%	21.4%	23.3%	23.3%	25.5%	21.7%	0.0%	4.4%	0.0%	0.0%	-2.3%	-1.5%	-26.7%	-21.5%	-22.7%	-19.4%
Post Settlement Slope (+ up/- down)		25.0%	21.4%	23.3%	23.3%	25.5%	21.7%	0.0%	4.4%	0.0%	0.0%	-2.3%	-1.5%	-26.7%	-21.5%	-22.7%	-19.4%
Grade Change (+ Steeper/- Milder)		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Attachment E2

Liner Stress Due to Equipment Loads

North Ranch Surface Waste Management Facility

PROJECT: Tensile Stresses in Geosynthetics due to Equipment Loads

JOB NO.: 35187378 **DATE:** September 2019 **COMP. BY:** MPB

CALCULATIONS BY: Michael Paul Bradford, P.E.
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PURPOSE

In this calculation, tensile stresses exerted onto the base liner system by operational equipment is evaluated. This evaluation considers the worst case tensile stress condition to be exerted onto the uppermost geosynthetic layer, 200-mil geocomposite leachate drainage layer just below the 2-foot protective cover layer. This condition considers the during protective cover placement on the side slope walls. Once waste material begins being filled into a cell the tensile stresses on the geosynthetics becomes less. Stress below the uppermost geosynthetic will be distributed. In this scenario, a Caterpillar 657 scraper or equivalent is used to place protective soil layer up the side slope at a constant speed and a sufficient distance to accommodate an approximate 10-foot lift of waste placed on the landfill floor, or an unsupported slope (3:1) length of ~70-feet. Although it is highly unlikely and not recommended to allow scrapers on a slope for any reason due to its immense size and weight, it is being used to demonstrate a very conservative worst-case condition of liner performance.

METHOD OF ANALYSIS

Assumptions:

- Unit weight of protective soil = 120 lbs/ft^3 dry density
  - h_{lift} = 2 feet
  - Distribution Distance 70-ft
    - Unit Weight Distribution = W_s = 120 lbs/ft^3 x 2ft x 70 ft = 16,800 lb/ft
- Internal friction angle of protective soil = B = 23°
- Slope Angle = A = 18° (3:1)
- Equipment loading assuming a fully loaded Standard Tandem 657 Scraper:
  - Governing Front Axle Weight = 128,246 lbs (published by CAT)
  - Distributed weight per tire = 64,123 lbs

- Tire width = 36 in = 3 feet
  - Unit Weight Distribution = W_b = 64,123 lbs / 3 ft = 23,374 lb/ft

- Tensile forces acting on geomembrane = $F_{soil} + F_{scraper}$:
  - Protective soil layer, F_{soil}
  - 657 scraper, $F_{scraper}$

- Total resisting forces = $F_{geomembrane}$
  - Geomembrane interface friction, $F_{geomembrane}$

<u>Tensile forces acting on geomembrane:</u>

F_{soil} = h_{lift} (2) x (unit weight of protective soil) x (sin(slope angle))

F_{soil} = (2 ft) x (70 ft) x (120 lbs/ft^3) (sin(18°))

F_{soil} = 5,191 lbs/ft

$F_{Scraper}$ = [(scraperweight) / (width acting on geocomposite)] (sin(18°))

$F_{Scraper}$ = [(64,123lbs) / 3 ft] (sin(18°))

$F_{Scraper}$ = 6,605 lbs/ft

Total tensile force acting on geomembrane due to equipment and soil:

$F_{tensile}$= 5,191 lbs/ft + 1390 lbs/ft

$F_{membrane}$= 11,796 lbs/ft

<u>Total resisting forces acting due to friction from geomembrane:</u>

F_{resist} = (weight of protective soil + weight of scraper) (cos(slope angle)) (tan(interface friction angle))

F_{resist} = [(2 ft)(70 ft)(120 lbs/ft3) + (64,123 lbs / 3 ft)] (cos 18°) (tan 23°)

F_{resist} = [(16,800 lb/ft) + (21,374 lbs/ft)] (cos 18°) (tan 21°)

F_{resist} = 13,936 lbs/ft

To summarize,

tensile force acting on the liner = 11,796 lbs/ft
resisting force acting on the liner = 13,936 lbs/ft.

See Diagram 1 below which represents the various forces acting on the liner in this scenario:

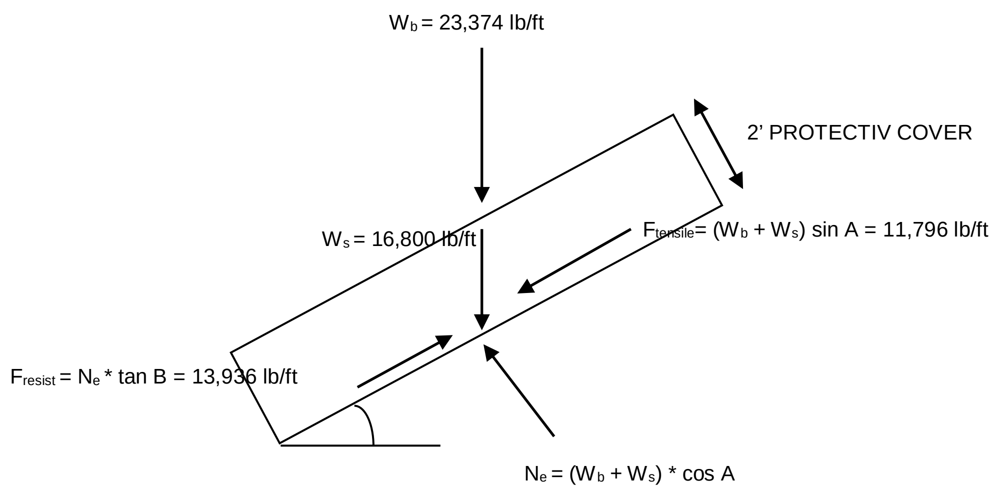


DIAGRAM 1. TENSILE FORCE DIAGRAM

As the resisting forces are greater than the tensile forces this indicates that the friction strength from the geomembrane is sufficient to counter tensile forces from the soil and equipment with a factor of safety of 1.2.

North Ranch Surface Waste Management Facility

PROJECT: Tensile Stresses in Geosynthetics due to Equipment Loads

JOB NO.: 35187378 **DATE:** September 2019 **COMP. BY:** MPB

Reference:

Sangeeta, Lewis P., and Hari D. Sharma, Waste Containment Systems, Waste Stabilization and Landfills: Design and Evaluation. New York: John Wiley and Sons. 1994. Print.

Gray, Donald, Robert M. Koerner, and Xian Quede, Geotechnical Aspects of Landfill Design and Construction. New York: Prentice Hall, 2002. Print.

Attachment E3
Anchor Trench Pullout

Objective:

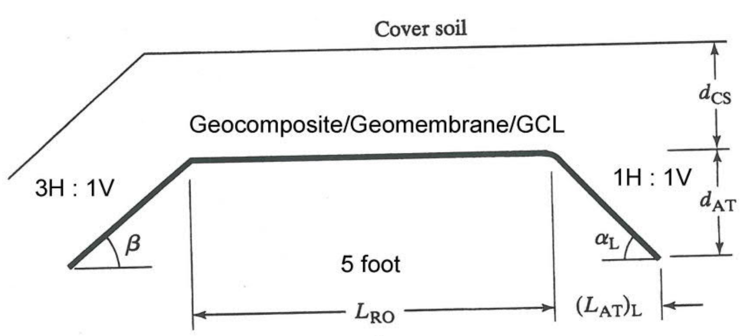
Determine the ability of the anchor trench to resist the weight of the geosynthetic components and to verify that the material will pull out of the anchor trench prior to geomembrane failure.

Assumptions:

- the anchor trench will have a 2 foot runout length
- anchor trench will be 2 foot deep
- the interior slope will be 3H : 1V or flatter
- the exterior slope will be 1H : 1V or flatter
- the deepest slope is approximately 62 foot deep (Phase 1, Cell E3)
- the composite liner system of future cells will consist of in-situ subgrade, a geosynthetic clay liner (GCL), a 60 mil HDPE geomembrane that is textured on both sides, a geocomposite with textile bonded on both sides, 60-mil HDPE geomembrane that is textured on both sides, a geocomposite with textile bonded on both sides, and a 2-foot soil protection layer.

Approach:

Calculations were performed in accordance with the procedures outline in the textbook "Geotechnical Aspects of Landfill Design and Construction" by Xued Qian, Robert Koerner, and Donald Gray, 2002, pp. 104-119.



Equation

$$T = \frac{\gamma_s \cdot d_{CS} \cdot L_{RO} \cdot \tan\delta_C + \gamma_s \cdot (d_{CS} + 0.5 \cdot d_{AT}) \cdot d_{AT} \cdot (\tan\delta_C + \tan\delta_F) \cdot (\cot\alpha_L + \cot\alpha_R)}{\cos\beta - \sin\beta \cdot \tan\delta_C}$$

T = geomembrane tensile force (i.e, anchor trench resistance force)
γ_s = unit weight of the cover and the backfill soil
d_{CS} = depth of cover soil
L_{RO} = runout length
$\tan\delta_C$ = tangent of the friction angle between the geosynthetic layers and the underlying soil
d_{AT} = anchor trench depth
$\tan\delta_F$ = tangent of the friction angle between the geosynthetic layers and the backfill soil
$\cot\alpha_L$ = cotangent of the left bottom angle of V-shaped anchor trench
$\cot\alpha_R$ = cotangent of the right bottom angle of V-shaped anchor trench
$\cos\beta$ = cosine of the sideslope angle
$\sin\beta$ = sine of the sideslope angle
L_t = Liner thickness

γ_s = 120 pcf
d_{CS} = 2 foot
L_{RO} = 2 foot
$\tan\delta_C$ = Tan (18°) = 0.3249
d_{AT} = 2.0 foot
$\tan\delta_F$ = Tan (18°) = 0.3249
$\cot\alpha_L$ = cot (45°) = 1
$\cot\alpha_R$ = Assume 0 to be conservative 0
$\cos\beta$ = cos (18.4°) = 0.9489
$\sin\beta$ = sine (18.4°) = 0.3156
L_t = 0.06 inches

Calculations:

$$T = \frac{\gamma_s \cdot d_{CS} \cdot L_{RO} \cdot \tan\delta_C + \gamma_s \cdot (d_{CS} + 0.5 \cdot d_{AT}) \cdot d_{AT} \cdot (\tan\delta_C + \tan\delta_F) \cdot (\cot\alpha_L + \cot\alpha_R)}{\cos\beta - \sin\beta \cdot \tan\delta_C}$$

T = 737.0 lb./ft.

T = 1023.7 lb./in.^{2}

Ultimate Strength (lb./in.^{2})	>	Anchor Trench Resistance Capacity (lb./in.^{2})	>	Allowable Strength (lb./in.^{2})
2100		1023.7		840

Note:
The ultimate strength is based off of material properties for standard 60 mil HDPE material. The allowable strength was calculated by dividing the ultimate strength by a 2.5 safety factor.

Summary

The results of the calculations indicate that the design anchor resistance capacity between the yield stress and the allowable stress of the geosynthetic layer system. Therefore, the anchor trench dimensions are acceptable. This assumes that the protective cover is being properly placed on the slopes using low groundpressure equipment and the equipment is backfilling up the slope.

Attachment E4

Geocomposite Compression and Hydraulic Performance

PROJECT: North Ranch Surface Waste Management Facility
Geocomposite Performance Under Overburden Compression

JOB NO.: 35187378 DATE: April 2019 COMP. BY: MPB

CALCULATIONS BY: Michael Paul Bradford, P.E.
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(501) 847-9292

PURPOSE

In this calculation, the compression under the waste overburden and the resulting transmissivity of the geocomposite leachate drainage and leak detection layers are evaluated. A 200-mil geonet composite will be used in the base liner system for both leachate collection and leak detection. The site's leachate collection was modeled using the HELP Model in Attachment D of **Appendix J** of the Facility Permit Application. The HELP Model uses a hydraulic conductivity of 10 cm/sec for the estimated geocomposite flow rate. The geocomposite will compress under the immense weight of the overlying waste.

METHOD OF ANALYSIS

Assumptions:

• 200-mil geonet or 0.2 inches thick
• Unit weight of waste y_w = 74 pcf, assuming a nominal operational density of 2000 lb/cubic yard
• Unit weight of soil y_s = 120 pcf
• Maximum height of waste over geocomposite = 230.5 feet, assume 2' protective cover, and 3.5' final cover soils
• 50% compressibility at 20,000 psf

Thickness (t)

$t_o = t_i + (t_c - t_i)((P_o-P_i)/(P_t-P_i))$

Where:

to = thickness after loading
tc = thickness of geonet at 20,000 psf = 0.1 inch
t_i = initial thickness = 0.2 inch
P_O = loading on geocomposite
= (230.5 ft)(74 pcf)+(5.5 ft)(120 pcf) = 17,720 lbs/ft2
P_i = initial loading
P_t = total compressibility

$t_o = t_i + (t_c - t_i)((P_o-P_i)/(P_t-P_i))$

$t_o = 0.2 + (0.1 – 0.2)*((17,720 – 0) / (20,000 – 0))$

t_o = 0.11 inch or 0.28 cm

A factor of safety was assumed to be 1.5 to account for geotextile intrusion, creep deformation, chemical clogging, and biological clogging.

Transmissivity (T)

$T_{FS} = T/FS$

Where:

T_{FS} = transmissivity with factor of safety (m^2/s)

T = transmissivity of geocomposite (m^2/s), *$1x10^{-4}$ m^2/s as published by GSE for 200-mil FabriNet*

FS = 1.5

$T_{FS} = (1x10^{-4}\ m^2/s) / (1.5)$

$T_{FS} = 6.67x10^{-5}\ m^2/s$ or $.667\ cm^{2/}s$

Applying the estimated compressed thickness from above to the geocomposite's transmissivity, a new hydraulic conductivity value is calculated.

$K = T_{FS} / t$

$K = (.667\ cm^{2/}s) / (0.28\ cm)$

K = 2.38 cm/s

Summary

NMAC **19.15.36.14.C(3)** requires that the leak detection layer have a minimum hydraulic conductivity of $1x10^{-5}$ cm/s and NMAC **19.15.36.14.C(3)** requires that the leachate collection and recovery system have a minimum hydraulic conductivity of $1x10^{-2}$ cm/s. Therefore, even under full height waste compression, the proposed 200-mil geocomposite alternative layers will have hydraulic conductivity of 2.38 cm/s, far exceeding the required minimum performance criteria. To be conservative, the HELP modeling provided in **Attachment D** of **Appendix J** of the Facility Permit Application has assumed a hydraulic conductivity of 1 cm/s for the geocomposite components of the base liner system.

PROJECT: North Ranch Surface Waste Management Facility
Geocomposite Performance Under Overburden Compression

JOB NO.: 35187378 DATE: April 2019 COMP. BY: MPB

Reference:

Bachus, Robert, Mengjia Li, Dhani Narejo, Richard Thiel, and Te-Yang Soong, GSE Drainage Design Manual. GSE Environmental, June 2007. Web. 3 May 2016.
<https://www.gseworld.com/content/documents/product-sheets/Drainage_Design_Manual.pdf>

Attachment F

Leachate Pipe Design Calculations

TERRACON CONSULTANTS, INC.			
CALCULATIONS BY:	Michael Bradford, P.E.	**DATE:**	4/1/2019
CHECKED BY:	Owen Carpenter, P.G., P.E.	**DATE:**	4/1/2019
FACILITY: North Ranch Surface Waste Management Facility			
PROJECT: 35187378 - Permit Application			
CLIENT: NGL Water Solutions Permian, LLC			

LEACHATE COLLECTION PIPE DESIGN

INTRODUCTION:

The purpose of these calculations is to evaluate the performance of the leachate collection system proposed design at the North Ranch Surface Waste Management Facility in Lea County, New Mexico. The function of the leachate collection system is to convey leachate that is collected in the drainage layer to the leachate collection sump. In order for the system to be effective, it has to convey this liquids and withstand the loads that will be applied from the overlying waste.

PIPE SIZE:

In the design of a leachate collection pipe, the capacity of the proposed pipe should be greater than the flow rate estimated from the HELP Model. The required flow rate used to determine the pipe size can be calculated using the following equation:

$$Q_{reqd} = q_{max} \times A_{cell}$$

Where:

Qreqd = required leachate leachate flow rate (ft^3/sec)
qmax = maximum unit area leachate production, (in/day (from HELP Model))
Acell = cell area served by a leachate collection, (Acres)

Note: In reviewing the HELP Model data corresponding to this Permit Modification Application, the peak daily rate for a 30 year period was obtained.

Cell E-3 is the largest cell at the Landfill. The following calculations use the geometry of this cell.

qmax =	0.208	**in/acre/day**
Acell =	28.2	**acres**
Qreqd =	**0.246**	**ft^3/sec**

Once the required leachate flow rate, pipe slope, and material of the pipe are known, the size of pipe can be determined by a trial-and-error procedure using Manning's equation. To determine the suitable pipe size, a pipe size is assumed first to calculate the flow rate using Manning's equation The calculated flow rate from Manning's equation must be greater than or equal to the required leachate flow rate. Manning's Equation (in U.S. Units) is as follows:

$$Q = (1.486 * A * rh^{2/3} * S^{1/2})/n$$

Where:

Q = flow rate of pipe (ft^3/sec)
n = Manning's roughness coefficient (+/- 0.011 for HDPE pipe)
A = Area in flow (ft^2)
S = slope of the pipe (%)
rh = hydraulic radius (in)

Header Line Pipe Selected :

6" diameter SDR 17 HDPE Pipe

STEP 1: CALCULATE AREA OF PIPE

$$A = \pi * Di^2 / 4$$

Where:

A = area of flow (in^2)
Di = inside diameter of pipe (in)

$Di = Do - 2t$

Where:

Do = Outside Diameter of Pipe (in)
t = wall thickness (in)

$t = Do/SDR$

Where:

SDR = Outside Diameter of Pipe

Do =	6.625	**inches**
SDR =	17	
t =	**0.390**	**inches**
Di =	**5.85**	**inches**
A =	**0.186**	**ft^2**

STEP 2: CALCULATE HYDRAULIC RADIUS

$rh = Di / 4$

Where:

rh = hydraulic radius of pipe (in)
Di = inside diameter of pipe (in)

Di =	5.85	**inches**
rh =	**1.46**	**inches**

STEP 3: CALCULATE FLOW RATE

$$Q = (1.486*A*rh^{2/3}*S^{1/2})/n$$

A =	0.186	**ft^2**
rh =	1.46	**inches**
S =	0.01	**ft/ft**
n =	0.011	**for Smooth HDPE Pipe**
Q =	**0.62**	**ft^3/sec**
Qreqd =	**0.246**	**ft^3/sec**
FS =	**2.51**	

Because Q is greater than Qreqd,. a 6" diameter SDR 17 HDPE pipe is adequate to convey the expected peak leachate flow conditions.

PIPE PERFORATIONS:

The most important parameter for determining the size and distribution of slots or perforations in the leachate collection pipes is the maximum leachate inflow per unit length of pipe. The maximum leachate inflow per unit length of pipe, which mainly depends on the maximum unit area of leachate production and the maximum servicing unit area per foot of pipe can be calculated from the equation:

Qin = qmax x Aunit

Where:

Qin = maximum leachate inflow per unit length of pipe, (ft^3/sec/ft)

qmax = maximum unit area leachate production, (ft^3/sec/ft^2)

STEP 1: CALCULATE MAXIMUM UNIT AREA

Aunit = Lhmax x dw

Where:

LHmax = Sum of drainage lengths on both sides of pipe for the largest cell

dw = unit width at the area of the maximum horizontal distance of leachate flow

LHmax =	1652.00	**feet**
dw	1	**feet**
Aunit	**1652.00**	**ft^2**

STEP 2: CALCULATE MAXIMUM LEACHATE INFLOW

$$\underline{Qin = qmax \times Aunit}$$

Aunit	1652.00	**ft^2**
qmax	5.036E-07	**$ft^3/sec/ft^2$**
Qin	**8.319E-04**	**ft^3/sec**

STEP 3: CACULATE INFLOW CAPACITY OF EACH ORFICE

The inflow capacity per orifice can be calculated from the Bernoulli equation based on the size of the orifice as follows:

$$\underline{Qb = C \times Ab \times (2 \times g \times dh)^{0.5}}$$

Where:

Qb = inflow capacity per orifice (or slot) (ft^3/sec)
C = discharge coefficient (use 0.62)
Ab = cross-sectional area of a slot or hole on the selected perforated pipe
g = gravitational constant (use 32.2 ft/sec^2)
dh = liquid head (in)

STEP 4: CALCULATE CROSS SECTIONAL AREA OF ORFICE

$$\underline{Ab = \pi \times dhole^2 / 4}$$

A 3/8 inch orifice was chosen for the perforation size

Where:

Ab = cross sectional area of orifice (in^2)
dhole = perforation size (in)

dhole =	**0.375**	**inches**
Ab =	**7.670E-04**	**ft^2**

STEP 5: CALCULATE INFLOW CAPACITY OF EACH ORIFICE

C=	0.62	**ft^2**
Ab=	7.670E-04	**inches**
g =	32.2	**ft/sec^2**
dh =	1	**ft**
Qb =	**3.816E-03**	**ft$^{3/}$sec**

Once the maximum leachate inflow rate per unit length of pipe and the inflow capacity per opening are known, the number of the perforated holes per unit length of pipe can be calculated using the equation:

$$\underline{N = Qin/Qb}$$

Where:

N = number of perforations per foot of pipe

Qin=	8.32E-04	**ft$^{3/}$sec**
Qb=	3.816E-03	**ft$^{3/}$sec**
N =	**0.218**	**holes per foot of pipe**

STEP 5: SPACING OF HOLE PATTERN ALONG PIPE

Assuming 3 holes at each location spaced around the circumference at 120 degrees would result in a hole spacing of:

SP = 3/N

Where:

SP = number of perforations per X feet of pipe

SP =	**14**

A perforation every 14 feet would be sufficient. A spacing of less than 14 feet is acceptable. Although 3 holes spaced on a 120 degree off-set would allow for one line of perforations every 60 feet, the standard perforation pattern is 3 perforations every foot that is offset by 6 inches (See Permit Drawings for the typical leachate collection piping perforations).

Gravel Bedding Materials Around Perforated Piping:

When perforated pipes are bedded in gravel, no unplugged ends should be used. In addition, the gravel bedding should be coarse enough not to enter the holes (or slots). The USEPA (1983) recommends that the 85% particle size for the gravel be greater then the hole size by a factor F. The F factor varies from 1.2 to 2.0. A factor of 1.5 was chosen for the proposed Landfill. When specifying gravel bedding materials for cell construction, the following gradation criteria should be considered:

dhole=	0.375	**inches**
F=	1.5	
d85 =	**0.563**	**inches**

Therefore the d85 for the gravel bedding should be 0.563 inches or greater.

DEFORMATION AND STABILITY OF LEACHATE COLLECTION PIPE:

All components of the leachate collection and removal system must have sufficient strength to support the weight of the overlying waste, cover system, and post-closure loadings, as well as the stresses from operating equipment. The component that is the most vulnerable to compressive strength failure is the drainage layer piping. Leachate collection and removal system piping can fail by excessive deflection, which may lead to buckling or collapsing.

RING DEFLECTION:

Ring deflection occurs when large vertical pressures are applied to the pipe/gravel bedding systems. Ring deflection is a horizontal over-deflection that results in a reversal of the curvature of the pipe wall. The following formula, commonly known as the Modified Iowa formula, can be used to estimate ring deflection (Spangler and Handy, 1973; Moser, 1990).

DX = (DL*K*Wc*r3) / (E*I+0.061*E'*r3)

Where:

DX = horizontal deflection, in
K = bedding constant (assume 0.1) (Qian et al)
DL= deflection lag factor (assume 1) (Qian Et al)
Wc = vertical load per unit length of pipe, lb/in^2
r = mean radius of the pipe (in)
E = elastic modulus of the pipe material (psi)(see attached worksheet)
I = moment of inertia of the pipe wall per unit length in^4/in
t = thickness of pipe, in
E' = soil reaction modulus (psi)

Based on guidance from Chevron (1993), an allowable ring deflection of 7% is acceptable.

STEP 1: STRESS PER UNIT LENGTH OF PIPE

σvl = Σ Dl x γl

σvl =vertical load on pipe (psf)
Dl = depth of layer (ft)
γl = unit weight of layer (pcf)

Layer	γl	Dl	γl x Dl
	(pcf)	(ft)	(psf)
1	120	2	240
2	100	78	7800
3	120	2.5	300
		σvl =	8340

psf

STEP 2: CALCULATE VERTICAL LOAD

Wc = σvl * Do

σvl =	57.92	**psi**
Do=	6.625	**in**
Wc=	**383.70**	**lb/in**

STEP 3: **CALCULATE MEAN RADIUS OF PIPE**

$$Rm = (Do-t)/2$$

Where:

Rm = Mean radius of pipe (in)

Do=	6.625	**inches**
t=	0.390	**inches**
Rm =	**3.118**	**inches**

STEP 4: **CALCULATE MOMENT OF INERTIA OF PIPE**

$$I = t^3/12$$

t=	0.39	**inches**
I =	**0.00493**	**inches**

STEP 5: **CALCULATE RING DEFLECTION**

$$DX = (DL*K*Wc*r3\ ) / (E*I+0.061*E'*r3)$$

DL=	1.00	
K=	0.10	
Wc=	383.70	**psf**
r=	3.12	**inches**
E=	23,000.00	**psi**
I=	0.00	**in^4/in**
E'	3,000.00	**psi**
Dx =	**0.20547**	**inches**
ΔDx =	**3.10**	Ring deflection is acceptable

WALL BUCKLING:

Wall buckling can occur because of insufficient pipe stiffness. Mosher (1990) noted that as the higher the SDR (more flexible) the more unstable the wall structure will be in resisting buckling. Meyerhof and Baike (1963) develop the following formula for estimating the critical buckling pressure in a circular conduit.

$$Pcr = 2 *[(E'/(1-\mu^2))*(E*I/r^3)]^{0.5}$$

Where:

Pcr = critical buckling pressure (lb/in)
μ = poissons ratio of pipe material
E'= soil reaction modulus ($lb/in^{2)}$
E = elastic modulus of the pipe material (lb/in^2)
I = moment of inertia of the pipe wall per unit length (in^4/in)
r = mean radius of the pipe (in)

STEP 1: CALCULATE ACTUAL VERTICAL STRESS

$$Ptp = WC/Do$$

Ptp= actual vertical stress on pipe (psf)

STEP 2: STRESS PER UNIT LENGTH OF PIPE

$$Pcr = 2 *[(E'/(1-\mu^2))*(E*I/r^3)]^{0.5}$$

E'	3,000.00	**psi**
μ=	0.30	
E=	23,000.00	**psi**
r=	3.12	**inches**
I=	0.004932	**inches**
Pcr =	**222.18**	**lb/in^2**
Ptp =	**57.92**	**lb/in^2**
FS =	**4**	Pipe critical buckling has a suitable factor of safety

WALL CRUSHING:

When external pressures exceed the compressive strength of the pipe wall crushing will occur. The factor safety against wall crushing can estimated by the following equation:

$$FSwc = 2 *\sigma y / ((SDR - 1)*\sigma max)$$

Where:

FSwc = Factor of safety against wall crushing
σy = compressive yield strength of pipe (psi)
σmax= maximum stress applied to the pipe (psi)
SDR = standard dimension ratio of the pipe

σy =	230400	**psi**
SDR =	17	
σmax =	8340	

FSwc =	**3.45**	Pipe wall crushing has a suitable factor of safety

EXCESSIVE BENDING STRAIN:

A pipe will deflect under external loading. As a result of this deflection bending strains are induced in the pipe. These strains can be calculated by the following equation (Mosher 1990):

$$\acute{\varepsilon}b = f\,d * t * \Delta y/Do^2$$

Where:

έb = Bending Strain %
***f* d** = deformation shape factor (assume 6)
Δy = vertical deflection (in)
Do = outside diameter of pipe

***f* d =**	6
Do =	6.625
t =	0.39
Δy =	0.21
έb =	**1.09**

Chevron (1994) recommends a maximum allowable bending strain between 1.5 to 2.25% for fd=6 depending on the quality of bedding around the pipe. This pipe has been designed for the worst case scenario, therefore a bending strain of 1.09 %, which is less than the maximum allowable, is acceptable.

TERRACON CONSULTANTS, INC.

CALCULATIONS BY: Kyle Jackson
CHECKED BY: Mike Bradford, P.E
FACILITY: North Ranch SWMF
PROJECT: 35187378
CLIENT: NGL Waste

LEACHATE COLLECTION PIPE DESIGN

INTRODUCTION:

The purpose of these calculations is to evaluate the performance of the leachate collection system proposed design at the North Ranch SWMF. The function of the leachate collection system is to convey leachate that is collected in the drainage layer to the leachate collection sump. In order to for the system to be effective, it has to be convey these liquids and withstand the loads that will be applied from the overlying waste.

PIPE SIZE:

In the design of a leachate collection pipe, the capacity of the proposed pipe should be greater than the flow rate estimated from the HELP Model. The required flow rate used to determine the pipe size can be calculated using the following equation:

$$\underline{Q_{reqd} = q_{max} \times A_{cell}}$$

Where:

Qreqd = required leachate leachate flow rate (ft^3/sec)
qmax = maximum unit area leachate production, (in/day (from HELP Model))
Acell = cell area served by a leachate collection, (Acres)

Note: In reviewing the HELP Model data corresponding to this Permit Modification Application, the peak daily rate for a 30 year period was obtained from Scenario 1 which corresponds to a n open case with 10 feet of waste and 6 inches of daily cover. Scenario 1 uses a reduction factor for the transmissivity of the geocomposite.

Cell 1 is the largest cell at the Landfill. The following calculations use the geometry of this cell.

qmax =	0.479	**in/day**
Acell =	10	**acres**
Qreqd =	**0.201**	**ft^3/sec**

Once the required leachate flow rate, pipe slope, and material of the pipe are known, the size of pipe can be determined by a trial-and-error procedure using Manning's equation. To determine the suitable pipe size, a pipe size is assumed first to calculate the flow rate using Manning's equation The calculated flow rate from Manning's equation must be greater than or equal to the required leachate flow rate. Manning's Equation (in U.S. Units) is as follows:

$$Q = (1.486 * A * rh^{2/3} * S^{1/2})/n$$

Where:

Q = flow rate of pipe (ft^3/sec)
n = Manning's roughness coefficient (+/- 0.011 for HDPE pipe)
A = Area in flow (ft^2)
S = slope of the pipe (%)
rh = hydraulic radius (in)

Header Line Pipe Selected :

6" diameter SDR 17 HDPE Pipe

STEP 1: CALCULATE AREA OF PIPE

$$A = \pi * Di^2 / 4$$

Where:

A = area of flow (in^2)
Di = inside diameter of pipe (in)

Di = Do - 2t

Where:

Do = Outside Diameter of Pipe (in)
t = wall thickness (in)

t = Do/SDR

Where:

SDR = Outside Diameter of Pipe

Do =	6.625	**inches**
SDR =	17	
t =	**0.390**	**inches**
Di =	**5.85**	**inches**
A =	**0.186**	**ft^2**

STEP 2: CALCULATE HYDRAULIC RADIUS

rh = Di / 4

Where:

rh = hydraulic radius of pipe (in)
Di = inside diameter of pipe (in)

Di =	5.85	**inches**
rh =	**1.46**	**inches**

STEP 3: CALCULATE FLOW RATE

$$Q = (1.486 * A * rh^{2/3} * S^{1/2})/n$$

A =	0.186	**ft^2**
rh =	1.46	**inches**
S =	0.02	**ft/ft**
n =	0.011	**for Smooth HDPE Pipe**
Q =	**0.87**	**ft^3/sec**
Qreqd =	**0.201**	**ft^3/sec**
FS =	**4.35**	

Because Q is greater than Qreqd,. a 6" diameter SDR 17 HDPE pipe is adequate to convey the expected peak leachate flow conditions.

PIPE PERFORATIONS:

The most important parameter for determining the size and distribution of slots or perforations in the leachate collection pipes is the maximum leachate inflow per unit length of pipe. The maximum leachate inflow per unit length of pipe, which mainly depends on the maximum unit area of leachate production and the maxmum servicing unit area per foot of pipe can be calculated from the equation:

Qin = qmax x Aunit

Where:

Qin = maximum leachate inflow per unit length of pipe, (ft^3/sec/ft)
qmax = maximum unit area leachate production, ($ft^3/sec/ft^2$)

STEP 1: CALCULATE MAXIMUM UNIT AREA

Aunit = Lhmax x dw

Where:

LHmax = Sum of drainage lengths on both sides of pipe for the largest cell
dw = unit width at the area of the maximum horizontal distance of leachate flow

LHmax =	434.00	**feet**
dw	1	**feet**
Aunit	**434.00**	**ft^2**

STEP 2: **CALCULATE MAXIMUM LEACHATE INFLOW**

$$\underline{\mathbf{Qin = qmax \times Aunit}}$$

Aunit	434.00	**ft^2**
qmax	4.616E-07	**ft/sec**
Qin	**2.003E-04**	**ft^3/sec**

STEP 3: **CACULATE INFLOW CAPACITY OF EACH ORFICE**

The inflow capacity per orifice can be calculated from the Bernouli equation
based on the size of the orfice as follows:

$$\underline{\mathbf{Qb = C \times Ab \times (2 \times g \times dh)^{0.5}}}$$

Where:

Qb = inflow capacity per orifice (or slot) (ft^3/sec)
C = discharge coefficient (use 0.62)
Ab = cross-sectional area of a slot or hole on the selected perforated pipe
g = gravitational constant (use 32.2 ft/sec^2)
dh = liquid head (in)

STEP 4: CALCULATE CROSS SECTIONAL AREA OF ORFICE

$$Ab = \pi \times dhole^2 / 4$$

A 3/8 inch orifice was choosen for the perforation size

Where:

Ab = cross sectional area of orfice (in^2)
dhole = perforation size (in)

dhole =	**0.375**	**inches**
Ab =	**7.670E-04**	**ft^2**

STEP 5: CALCULATE INFLOW CAPACITY OF EACH ORFICE

C=	0.62	**ft^2**
Ab=	7.670E-04	**inches**
g =	32.2	**ft/sec^2**
dh =	1	**ft**
Qb =	**3.816E-03**	**$ft^{3/}sec$**

Once the maximum leachate inflow rate per unit length of pipe and the inflow capacity per opening are known, the number of the perforated holes per unit length of pipe can be calculated using the equation:

$$N = Qin/Qb$$

Where:

N = number of perforations per foot of pipe

Qin=	2.00E-04	**$ft^{3/}sec$**
Qb=	3.816E-03	**$ft^{3/}sec$**
N =	**0.052**	**holes per foot of pipe**

STEP 5: SPACING OF HOLE PATTERN ALONG PIPE

Assuming 3 holes at each location spaced around the circumference at 120 degrees would result in a hole spacing of:

$$SP = 1.3/N$$

Where:

SP = number of perforations per foot of pipe

SP = **24.764** **1 hole per every X feet of pipe**

A perforation every 25 feet would be sufficient. A spacing is less than 25 is acceptable.

Gravel Bedding Materials Around Perforated Piping:

When perforated pipes are bedded in gravel, no unplugged ends should be used. In addition, the gravel bedding should be coarse enough not to enter the holes (or slots). The USEPA (1983) recommends that the 85% particle size for the gravel be greater then the holesize by a factor F. The F factor varies from 1.2 to 2.0 A factor of 1.5 was chosen for the Landfill. When specifying gravel bedding materials for cell construction, the following gradation criteria should be considered:

dhole=	0.375	**inches**
F=	1.5	
d85 =	**0.563**	**inches**

Therefore the d85 for the gravel bedding should be 0.563 inches or greater.

DEFORMATION AND STABILITY OF LEACHATE COLLECTION PIPE:

All components of the leachate collection and removal system must have sufficient strength to support the weight of the overlying waste, cover system, and post-closure loadings, as well as the stresses from operating equipment. The componentthat is the most vulnerable to compressive strength failure is the drainage layer piping. Leachate collection and removal system piping can fail by excessive deflection, which may lead to buckling or collapsing.

RING DEFLECTION:

Ring deflection occurs when large vertical pressures are applied to the pipe/gravel bedding systems. Ring deflection is a horizontal over-deflection that results in a reversal of the curvature of the pipe wall. The following formula, commomly known as the Modified Iowa formula, can be used to estimate ring deflection (Spangler and Handy, 1973; Moser, 1990).

DX = (DL*K*Wc*r3) / (E*I+0.061*E'*r3)

Where:

DX = horizontal deflection, in
K = bedding constant (assume 0.1) (Qian et al)
DL= deflection lag factor (assume 1) (Qian Et al)
Wc = vertical load per unit length of pipe, lb/in^2
r = mean radius of the pipe (in)
E = elastic modulus of the pipe material (psi)(see attached worksheet)
I = moment of inertia of the pipe wall per unit length in^4/in
t = thickness of pipe, in
E' = soil reaction modulus (psi)

Based on guidance from Chevron (1993), an allowable ring deflection of 7% is acceptable.

STEP 1: STRESS PER UNIT LENGTH OF PIPE

$$\sigma vl = \Sigma Dl \times \gamma l$$

σvl =vertical load on pipe (psf)
Dl = depth of layer (ft)
γl = unit weight of layer (pcf)

Layer	γl	Dl	γl x Dl
	(pcf)	(ft)	(psf)
1	120	3	360
2	70	90	6300
3	120	1	120
		σvl =	6780

psf

STEP 2: CALCULATE VERTICAL LOAD

$$Wc = \sigma vl * Do$$

σvl =	47.08	psi
Do=	6.625	in
Wc=	311.93	lb/in

STEP 3: CALCULATE MEAN RADIUS OF PIPE

$$Rm = (Do-t)/2$$

Where:

Rm = Mean radius of pipe (in)

Do=	6.625	inches
t=	0.390	inches
Rm =	3.118	inches

STEP 4: CALCULATE MOMENT OF INERTIA OF PIPE

$$I = t^3/12$$

t=	0.39	inches
I =	0.00493	inches

STEP 5: CALCULATE RING DEFLECTION

$$DX = (DL*K*Wc*r3) / (E*I+0.061*E'*r3)$$

DL=	1.00	
K=	0.10	
Wc=	311.93	**psf**
r=	3.12	**inches**
E=	23,000.00	**psi**
I=	0.00	**in^4/in**
E'	3,000.00	**psi**
Dx =	**0.16704**	**inches**
ΔDx =	**2.52**	Ring deflection is acceptable

WALL BUCKLING:

Wall buckling can occur because of insufficient pipe stiffness. Mosher (1990) noted that as the higher the SDR (more flexible) the more unstable the wall structure will be in resisting buckling. Meyerhof and Baike (1963) develop the following formula for estimating the critical buckling presure in a circular conduit.

$$Pcr = 2 *[(E'/(1-\mu^2))*(E*I/r^3)]^{0.5}$$

Where:

Pcr = critical buckling pressure (lb/in)
μ = poissons ratio of pipe material
E'= soil reaction modulus ($lb/in^{2)}$
E = elastic modulus of the pipe material (lb/in^2)
I = moment of inertia of the pipe wall per unit length (in^4/in)
r = mean radius of the pipe (in)

STEP 1: CACAULATE ACTUAL VERTICAL STRESS

$$Ptp = WC/Do$$

Ptp= actual vertical stress on pipe (psf)

STEP 2: STRESS PER UNIT LENGTH OF PIPE

$$Pcr = 2 *[(E'/(1-\mu^2))*(E*I/r^3)]^{0.5}$$

E'	3,000.00	**psi**
μ=	0.30	
E=	23,000.00	**psi**
r=	3.12	**inches**
I=	0.004932	**inches**
Pcr =	**222.18**	**lb/in^2**
Ptp =	**47.08**	**lb/in^2**
FS =	**5**	Pipe critical buckling has a suitable factor of safety

WALL CRUSHING:

When external pressures exceed the compressive streength of the pipe wall crushing will occur. The factor safety agains wall crushing can estimated by the following equation:

$$FSwc = 2 *\sigma y / ((SDR - 1)*\sigma max)$$

Where:

FSwc = Factor of safety against wall crushing
σy = compressive yied strength of pipe (psi)
σmax= maximum stress applied to the pipe (psi)
SDR = standard dimension ratio of the pipe

σy =	230400	**psi**	
SDR =	17		
σmax =	6780		
FSwc =	**4.25**	Pipe wall crushing has a suitable factor of safety	

EXCESSIVE BENDING STRAIN:

A pipe will deflect under external loading. As a result of this deflection bending strains are induced in the pipe. These strains can be calculated by the following equation (Mosher 199(

$$\acute{\varepsilon}b = f d * t * \Delta y / Do^2$$

Where:

έb =Bending Strain %
***f*d** = deformation shape factor (assume 6)
Δy = vertical deflection (in)
Do = outside diameter of pipe

***f*d =**	6
Do =	6.625
t =	0.39
Δy =	0.17
έb =	**0.89**

Chevron (1994) reccomends an allowable bending strain between 1.5 to 2.25% for *f*d = 6
Therefore bending strain is acceptable.

TERRACON CONSULTANTS, INC.		
CALCULATIONS BY:	Kyle Jackson	
CHECKED BY:	Mike Bradford, P.E.	
FACILITY: NORTH RANCH SWMF		
PROJECT: 35187378		
CLIENT: NGL Waste		

LEACHATE COLLECTION PIPE DESIGN

INTRODUCTION:

The purpose of these calculations is to evaluate the performance of the leachate collection system proposed design at the North Ranch SWMF. The function of the leachate collection system is to convey leachate that is collected in the drainage layer to the leachate collection sump. In order to for the system to be effective, it has to be convey these liquids and withstand the loads that will be applied from the overlying waste.

Attachment G

Slope Stability Analysis

Slope Stability Analysis

North Ranch Surface Waste Management Facility
Lea County, New Mexico

Revised September 2019
Project No. 35187378

Prepared for:

NGL Waste Services, LLC
3773 Cherry Creek Dr., Suite 1000
Denver, CO 80209
303-815-1010

Prepared by:

Terracon Consultants, Inc.
25809 Interstate 30 South
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2.0 PROJECT INFORMATION 1
2.1 Project Description 1
2.2 Site Location and Description 1
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3.1 Typical Profile 1
4.0 CRITICAL SECTIONS & LINER CONFIGURATIONS 1
4.1 Material Properties 2
5.0 ANALYSIS SUMMARY 3
5.1 General Discussion 3
5.2 Results of Static Analysis 3
6.0 GENERAL COMMENTS 5

EXHIBIT A – LOCATION DIAGRAM

EXHIBIT B – CROSS SECTIONS

EXHIBIT C – CRITICAL FAILURE SURFACE FIGURES

EXHIBIT D – SEISMIC MAP

1.0 INTRODUCTION

Terracon has completed Stability analyses for the proposed NGL Waste Services, LLC (NGL) North Ranch Surface Waste Management Facility (Facility) located in Lea County, New Mexico. The main purpose of this report is to present a slope stability analyses for the critical cross-sections located in the landfill for the final cover system, the top of waste, the top of protective cover, and the top of geosynthetic layer of the base liner system.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	See **EXHIBIT A**, **FIGURE A-1**, Site Layout Plan
Critical Cross Sections	See **EXHIBIT B**, **FIGURE B-1**, Cross Section Phase I and Phase II

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The facility is in Lea County, New Mexico
Existing improvements	Greenfield Facility - add Surface Waste Management System
Current ground cover	--

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

The subsurface information and the laboratory test results used in Terracon's analysis were obtained from the documents 'Terracon GeoReport" dated January 25, 2019. The subsurface profile is typically comprised of poorly graded sands, caliche lenses, and sandstone. The borings were terminated at 165 feet below ground surface with no groundwater encountered.

4.0 CRITICAL SECTIONS AND LINER CONFIGURATIONS

Two critical cross sections were analyzed as part of this slope stability analysis. The locations of the cross-sections are shown on **FIGURE B-1** attached in **EXHIBIT B**. The cross-sections were selected because they represented the landfill's maximum height of the waste and the steepest slope of the fill. The top and the bottom liner configurations are summarized below.

Configuration No. 1	
Final Cover System (From top to bottom)	• 12” Thick Vegetation/Erosion Layer • 36” Thick Protective Cover Layer • 12” Thick Interim Cover
Bottom Liner System (From top to bottom)	• 2’ Thick Protective Cover Layer • Double-Sided Geocomposite • 60-mil Double Sided Textured HDPE Liner • Double-Sided Geocomposite • 60-mil Double Sided Textured HDPE Liner • Reinforced Geosynthetic Clay Liner (GCL) • 6” Prepared Subgrade

4.1 Material Properties

Table 4.1 below presents the strength parameters used for the slope stability analyses for all the conditions analyzed (effective stress). These parameters were selected based on review of the subsurface data and laboratory tests were obtained from the document ‘Terracon GeoReport” dated January 25, 2019 and on our experience with similar soils and materials where test results were not available for site-specific materials.

Table 4.1 Material Properties Summary

Soil/Material Type	Unit Weight	Effective Strength Parameters	
	(pcf)	C (psf)	ϕ (degrees)
60 mil textured HDPE	65	25	21
Compacted Subgrade	120	100	23
Double Sided Geocomposite	40	100	17
Poorly Graded Sand	120	25	22
Protective Cover	110	0	23
Sandstone	120	25	23
Vegetated Soil Layer	100	100	15
Waste	70	0	28

5.0 ANALYSIS SUMMARY

5.1 General Discussion

The computer program SLOPE/W® 2018 (R2) developed by Geo-Slope International was used to evaluate stability of the landfill. This program has several methods available that allow the user to model both circular and block-type failure surfaces (modes). The stability analysis is typically characterized by its calculated factor of safety against failure. The factor of safety may be generally defined as the ratio of the resisting forces to the driving forces. A factor of safety of 1.0 indicates the resisting forces are in equilibrium with the driving forces; therefore, the higher the safety factor, the more stable the slope. Further discussion of the trial failure modes that were analyzed is provided below.

In the program SLOPE/W®, the Morgenstern-Price method with half-sine function was selected to calculate the factor of safety. The Morgenstern-Price method is similar to the Spencer method but allows for various user-specified interslice force functions. The block method function was specified to locate the critical slip surface, and then optimization of the failure plane was performed by the software to "probe" the possibility of a lower safety factor. The soil parameters used for this project are in the **Table 4.1**. The safety factor is shown on the respective cross-section and in the adjoining SLOPE/W analysis in **EXHIBIT C**.

5.2 Results of Static Analyses

The stability analyses were performed by inputting shear strength, friction angles, and unit weight parameters into SLOPE/W®. The long-term stability conditions were considered for these analyses. Figures showing the failure plane and the corresponding factor of safety are presented in **EXHIBIT C**. The factor of safety shown on the graphical plot corresponds to the optimized failure surface.

5.2.1 Stability of the North Ranch Facility

Stability analyses were performed for the final cover system, the top of waste, the top of protective cover, and the top of geosynthetic layer for Phase I and Phase II cross sections. The cross-sections for the landfill were taken at the critical sections. A circular failure was used to describe the lowest factors of safety for the waste stability. **Table 5.1** below summarizes the results of the slope stability analysis for the different phases of construction.

Table 5.1 Final Fill Slope Stability Summary
Final Cover Slope

Cross Section	Calculated Factor of Safety	Minimum Factor of Safety
Phase I (circular)	2.4	1.5
Phase II (circular)	2.2	1.5

Top of Waste Slope

Cross Section	Calculated Factor of Safety	Minimum Factor of Safety
Phase I (circular)	2.4	1.5
Phase II (circular)	2.3	1.5

As noted in **Table 5.1,** the calculated factors of safety for the proposed configurations exceeded the minimum allowable factor of safety established.

The North Ranch Facility is not located in a seismic impact zone since the maximum horizontal acceleration in lithified material at the facility is less than 0.1g (See **EXHIBIT D**). Therefore, a seismic analysis is not required.

A stability run was also performed to confirm the factor of safety for the interim conditions when the landfill has the protective cover in place and with the geosynthetic layers prior to placing the protective cover in **EXHIBIT C**. Table 5.2 summarizes the stability of the cut slopes in relation to the base liner system

Table 5.2 Cut Slope and Base Liner Stability Summary
Top of Protective Cover Slope

Cross Section	Calculated Factor of Safety	Minimum Factor of Safety
Phase I (circular)	2.0	1.5
Phase II (circular)	1.6	1.5

Top of Geosynthetic Layer Slope

Cross Section	Calculated Factor of Safety	Minimum Factor of Safety
Phase I (circular)	2.0	1.5
Phase II (circular)	1.6	1.5

6.0 GENERAL COMMENTS

The analyses and any recommendations presented in this report are based upon the subsurface information obtained from the report prepared by Terracon GeoReport" dated January 25, 2019 and from other information discussed in this report. This report does not reflect variations that may occur due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided. Provisions to verify strength of utilized soil and geosynthetic materials and interfaces may be added as part of the construction quality assurance process as applicable.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted engineering practices. No warranties, express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. If changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

EXHIBIT A
LOCATION DIAGRAM

REV. | DATE | BY | DESCRIPTION

SITE LAYOUT PLAN

SLOPE STABILITY ANALYSIS

SURFACE WASTE MANAGEMENT FACILITY

NORTH RANCH

LEA COUNTY ARKANSAS

Terracon
Consulting Engineers and Scientists
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FIGURE A-1

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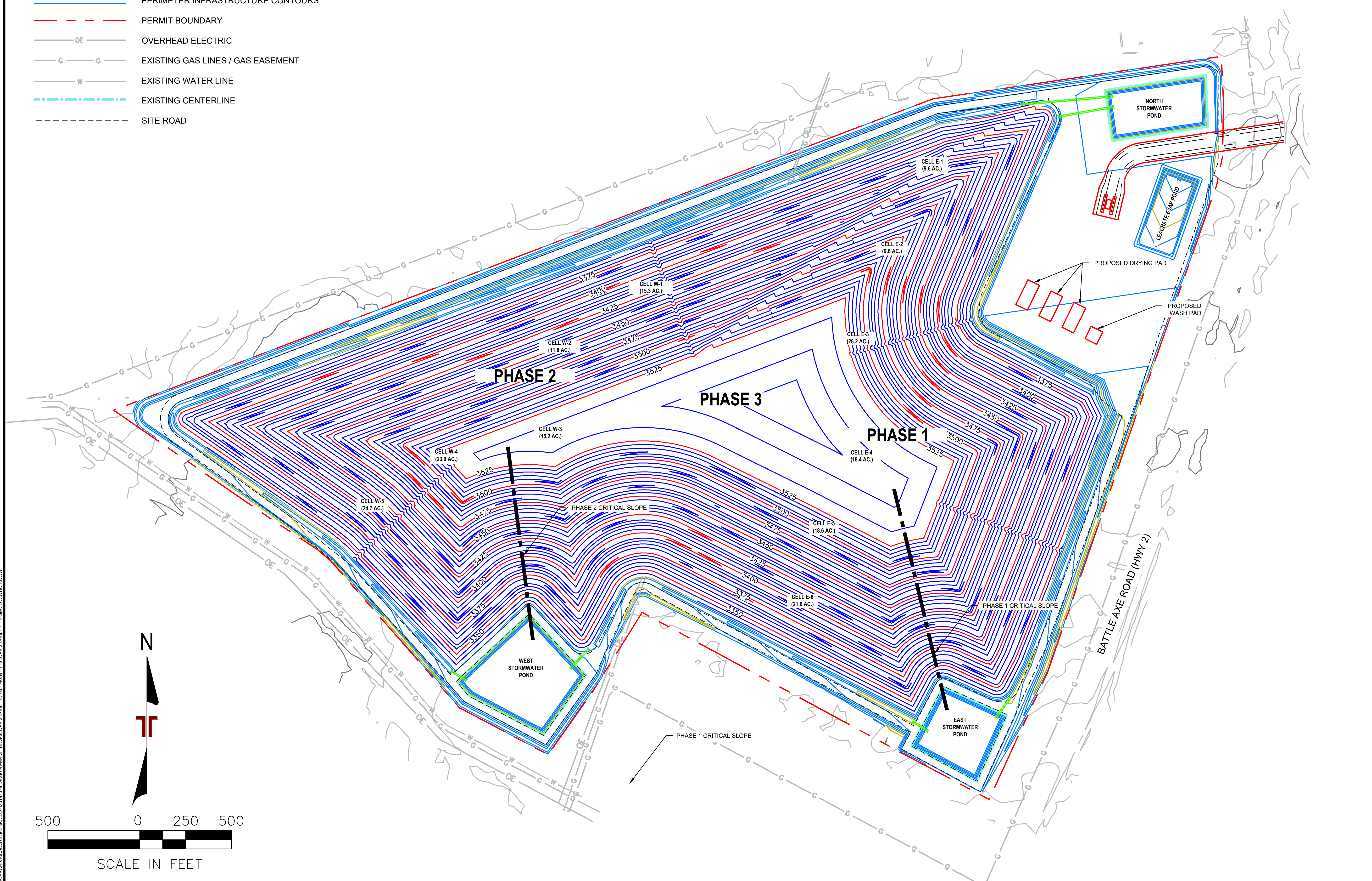
EXHIBIT B
CROSS SECTIONS

LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/18)
3300	FINAL COVER CONTOURS
3300	PERIMETER INFRASTRUCTURE CONTOURS
	PERMIT BOUNDARY
OE	OVERHEAD ELECTRIC
G G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	EXISTING CENTERLINE
	SITE ROAD



CRITICAL SLOPE LOCATIONS
SLOPE STABILITY ANALYSIS
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY
ARKANSAS

REV	DATE	BY	DESCRIPTION

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FIGURE B-1

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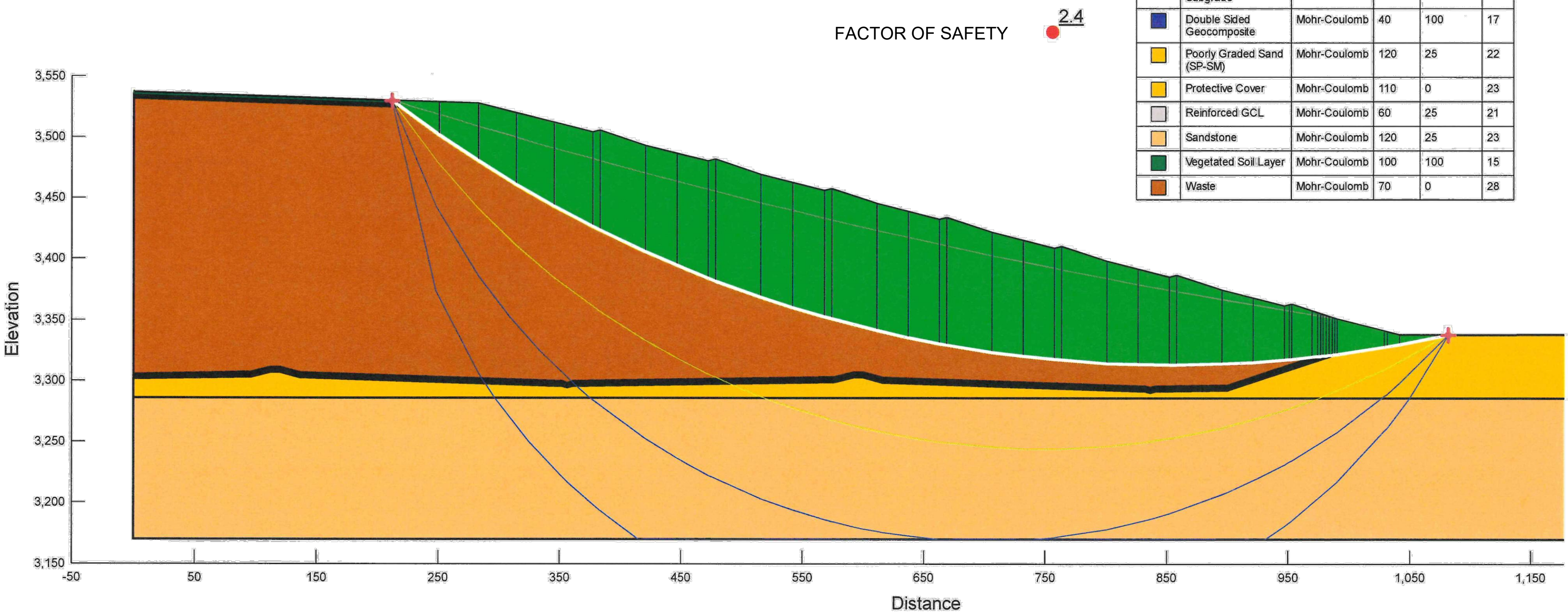
N:\GEARCHIVE\CAD\572\002\MCCLOY\3518737\8 DESIGN PERMITTING\SLOPE STABILITY\103 - FIG B - 1 - SLOPE STABILITY - X-SEC LOCATION.DWG

EXHIBIT C

CRITICAL FAILURE SURFACE FIGURES

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Protective Cover	Mohr-Coulomb	110	0	23
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23
	Vegetated Soil Layer	Mohr-Coulomb	100	100	15
	Waste	Mohr-Coulomb	70	0	28



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PHASE I - FINAL COVER
SLOPE STABILITY ANALYSIS
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

FIGURE C-1

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JOB NO.	572-002-35187378
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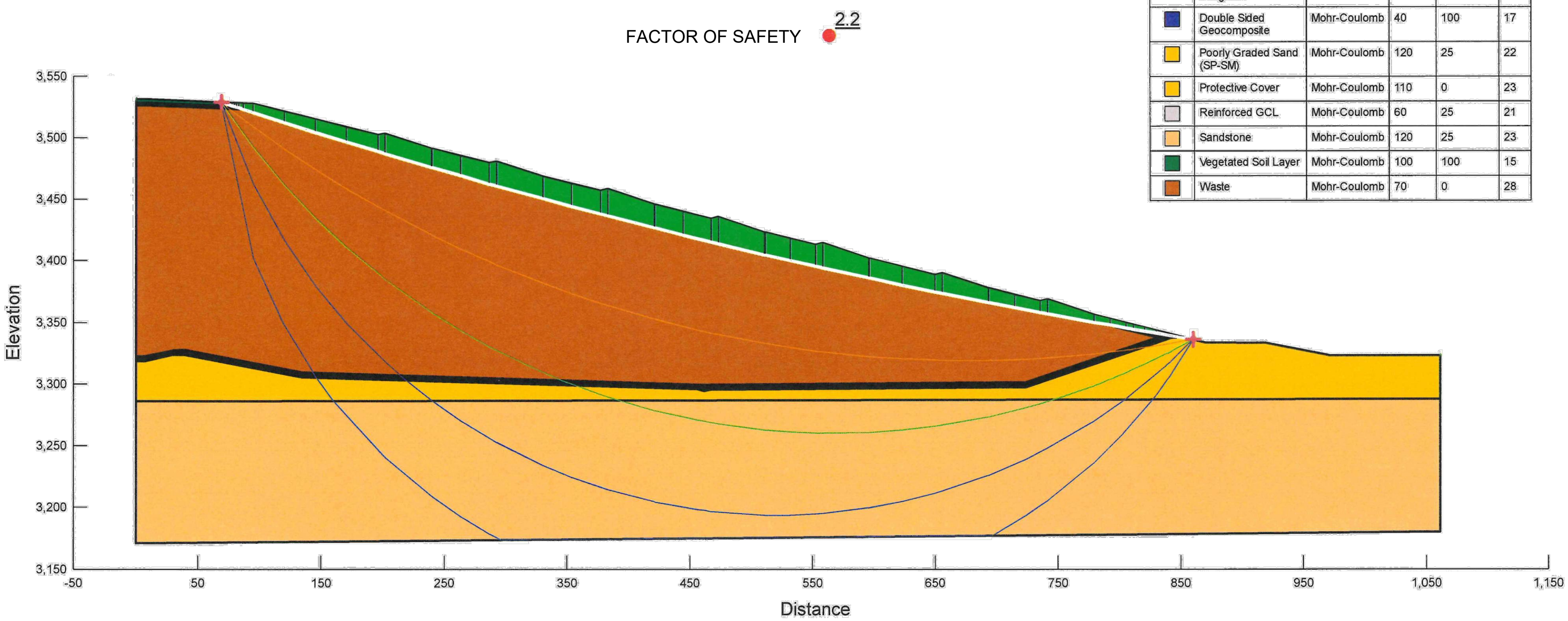
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Protective Cover	Mohr-Coulomb	110	0	23
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23
	Vegetated Soil Layer	Mohr-Coulomb	100	100	15
	Waste	Mohr-Coulomb	70	0	28



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PHASE II - FINAL COVER
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FIGURE C-2

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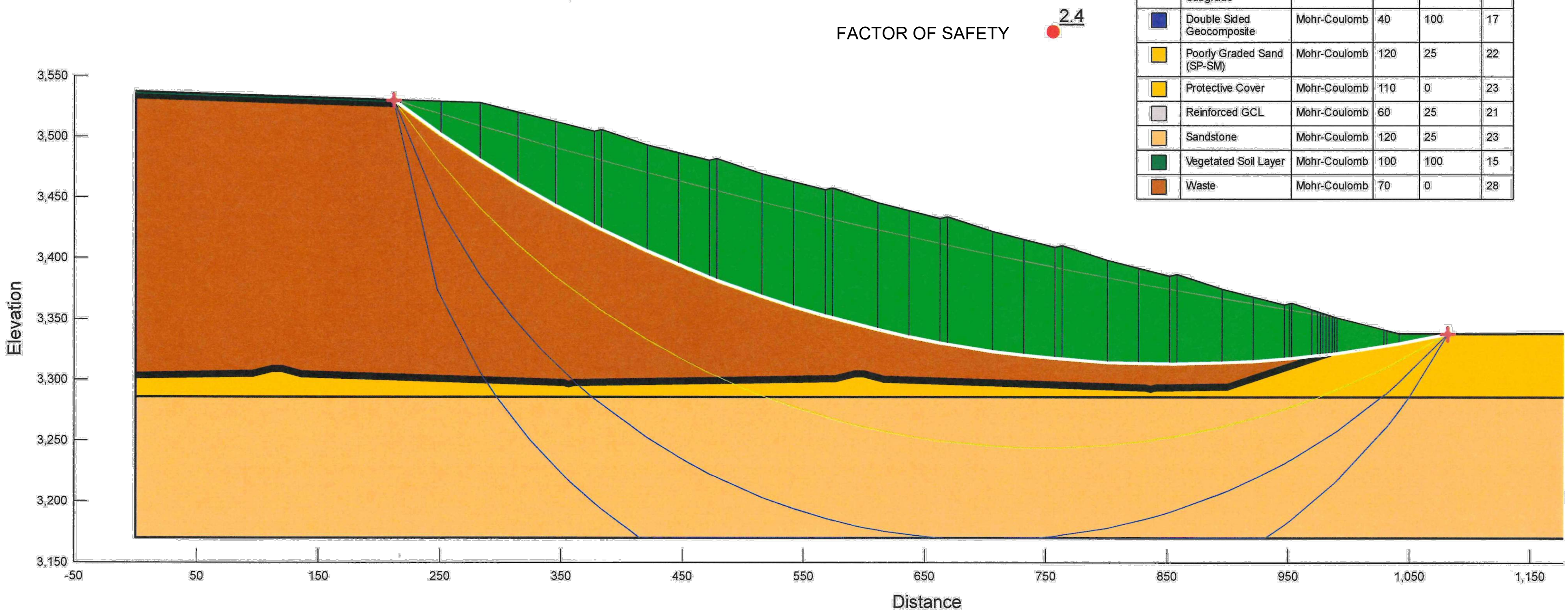
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Protective Cover	Mohr-Coulomb	110	0	23
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23
	Vegetated Soil Layer	Mohr-Coulomb	100	100	15
	Waste	Mohr-Coulomb	70	0	28



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PHASE I - TOP OF WASTE
SLOPE STABILITY ANALYSIS
SURFACE WASTE MANAGEMENT FACILITY
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LEA COUNTY NEW MEXICO

FIGURE C-3

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Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Protective Cover	Mohr-Coulomb	110	0	23
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23
	Waste	Mohr-Coulomb	70	0	28

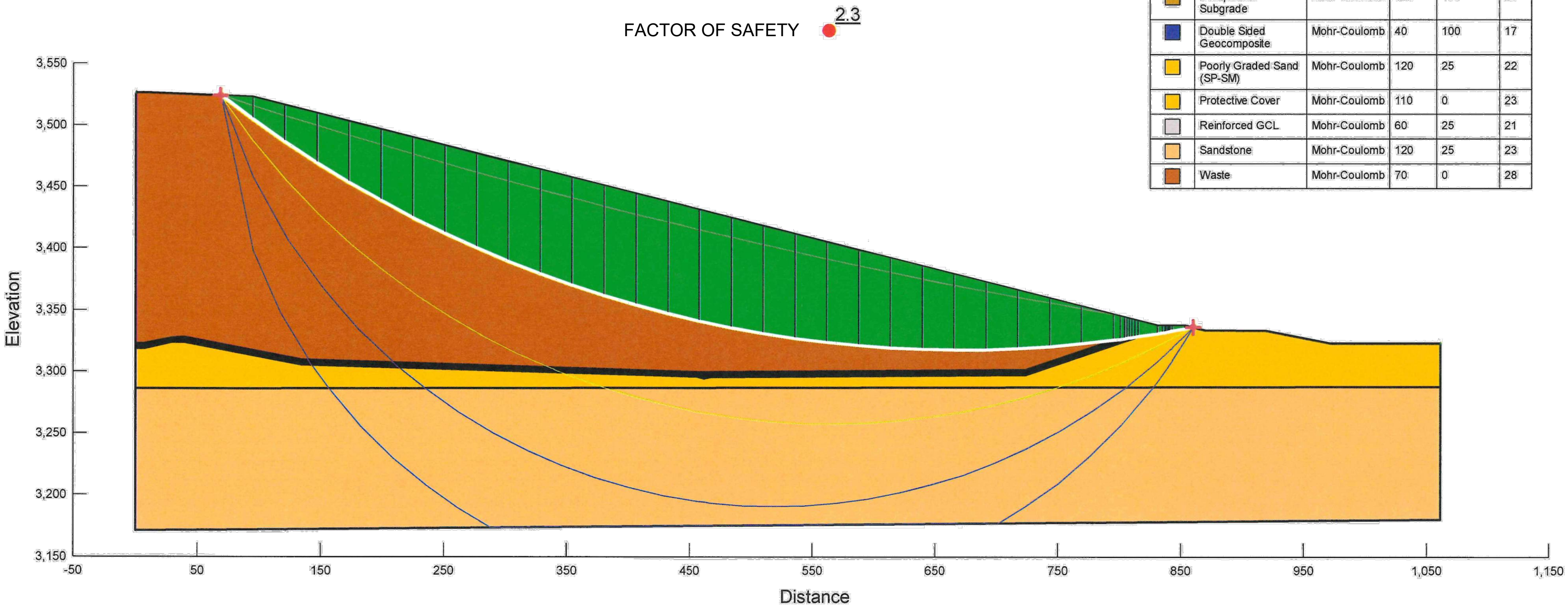

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FIGURE C-4

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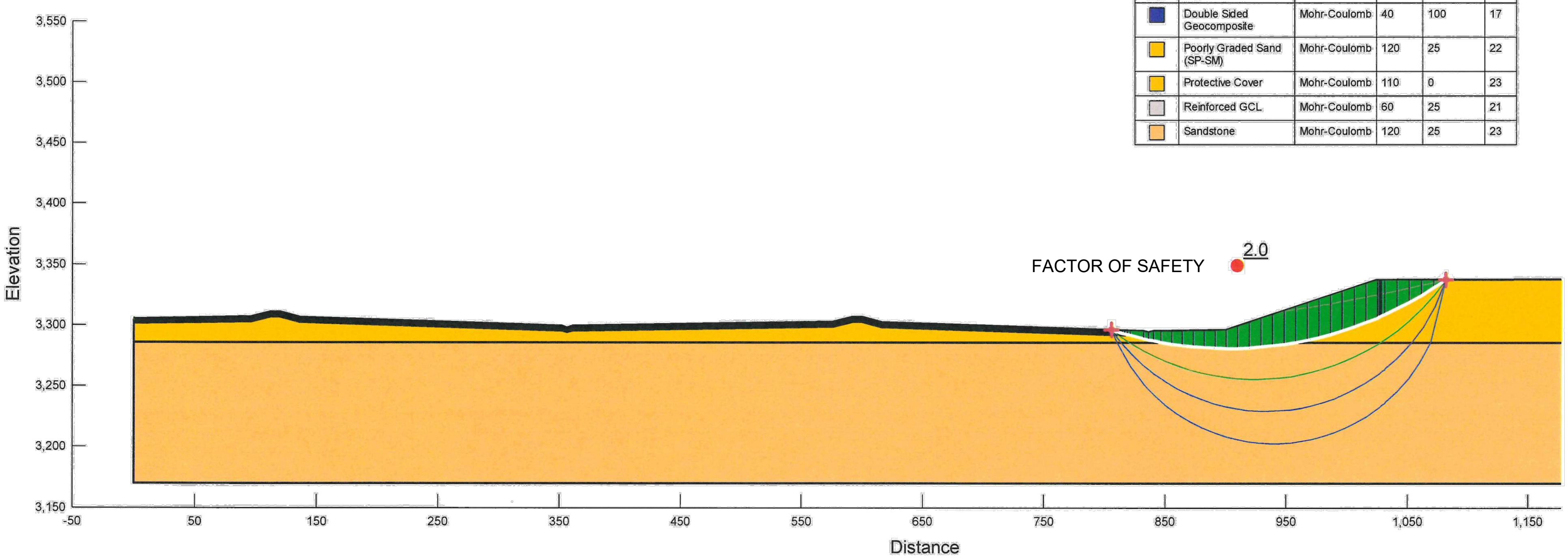
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Protective Cover	Mohr-Coulomb	110	0	23
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23



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PHASE I - TOP OF PROTECTIVE COVER
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SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

FIGURE C-5

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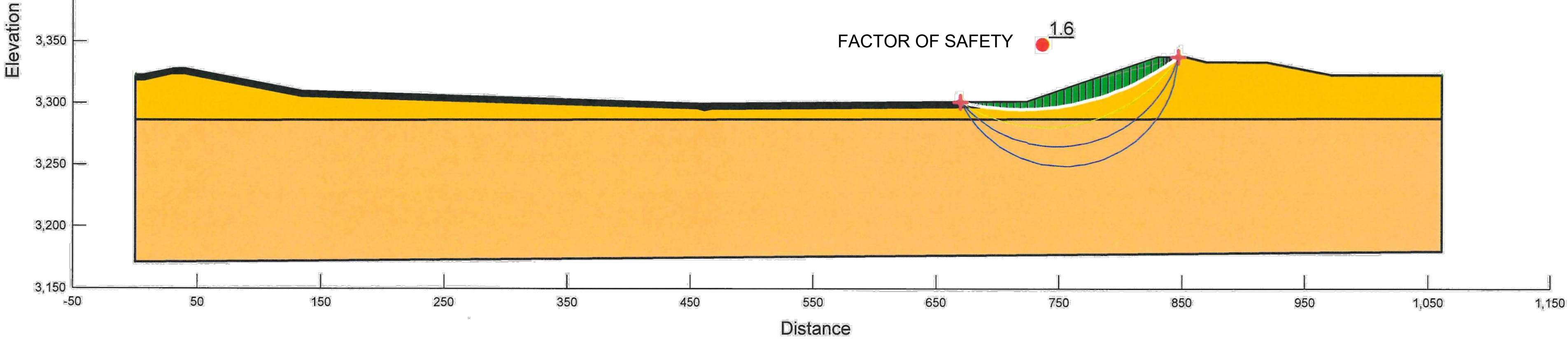
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Protective Cover	Mohr-Coulomb	110	0	23
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23



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PHASE II - TOP OF PROTECTIVE COVER
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SURFACE WASTE MANAGEMENT FACILITY
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LEA COUNTY NEW MEXICO

FIGURE C-6

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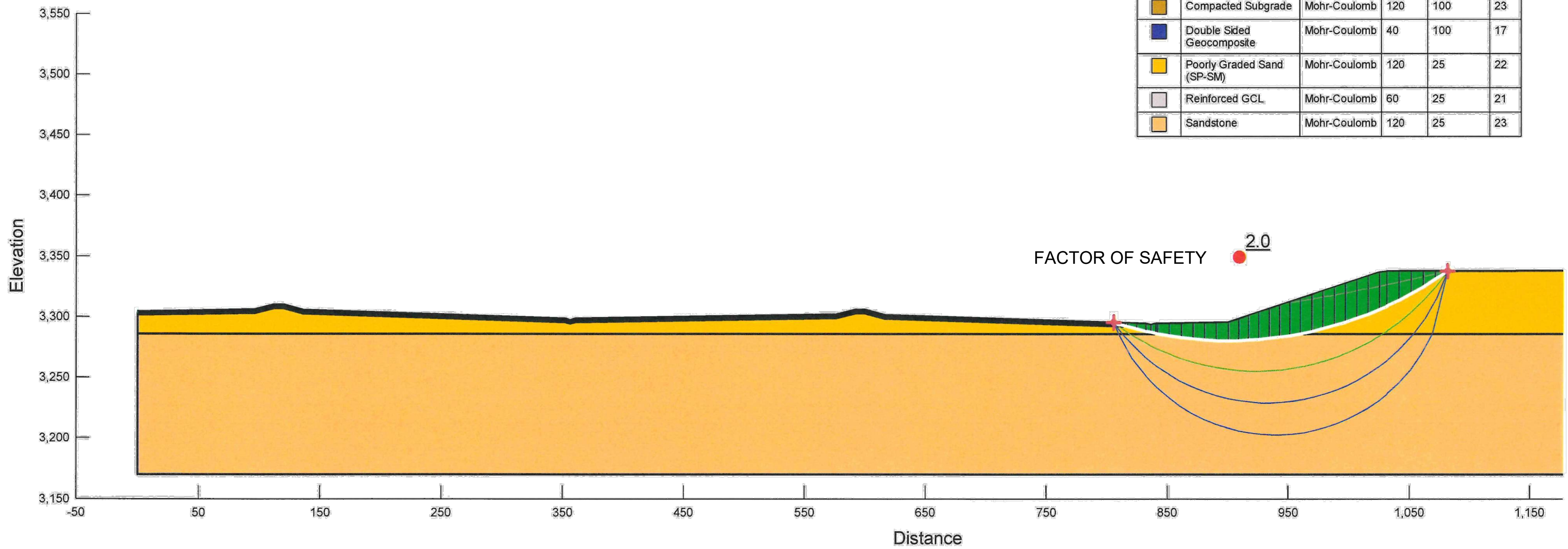
JOB NO.	572-002-35187378
ACAD NO.	101
SHEET NO.:	- OF -

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23



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PHASE I - TOP OF GEOSYNTHETICS
SLOPE STABILITY ANALYSIS
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

FIGURE C-7

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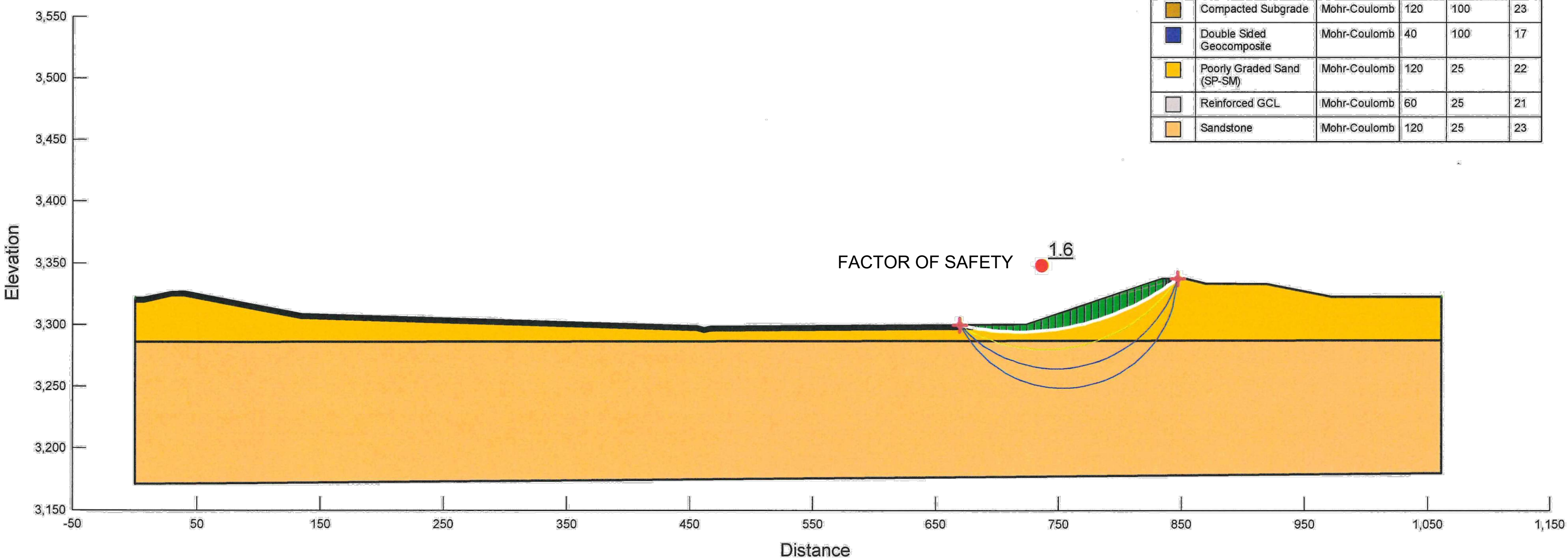
Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
	60-mil Textured HDPE (Both Sides)	Mohr-Coulomb	60	25	21
	Compacted Subgrade	Mohr-Coulomb	120	100	23
	Double Sided Geocomposite	Mohr-Coulomb	40	100	17
	Poorly Graded Sand (SP-SM)	Mohr-Coulomb	120	25	22
	Reinforced GCL	Mohr-Coulomb	60	25	21
	Sandstone	Mohr-Coulomb	120	25	23



N:\GECARCHIVE\CAD\572002\MCCLOY\35187378 DESIGN PERMITTING\SLOPE STABILITY\101 NORTH RANCH SLOPE STABILITY.DWG

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists

25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

PHASE II - TOP OF GEOSYNTHETICS

SLOPE STABILITY ANALYSIS

SURFACE WASTE MANAGEMENT FACILITY

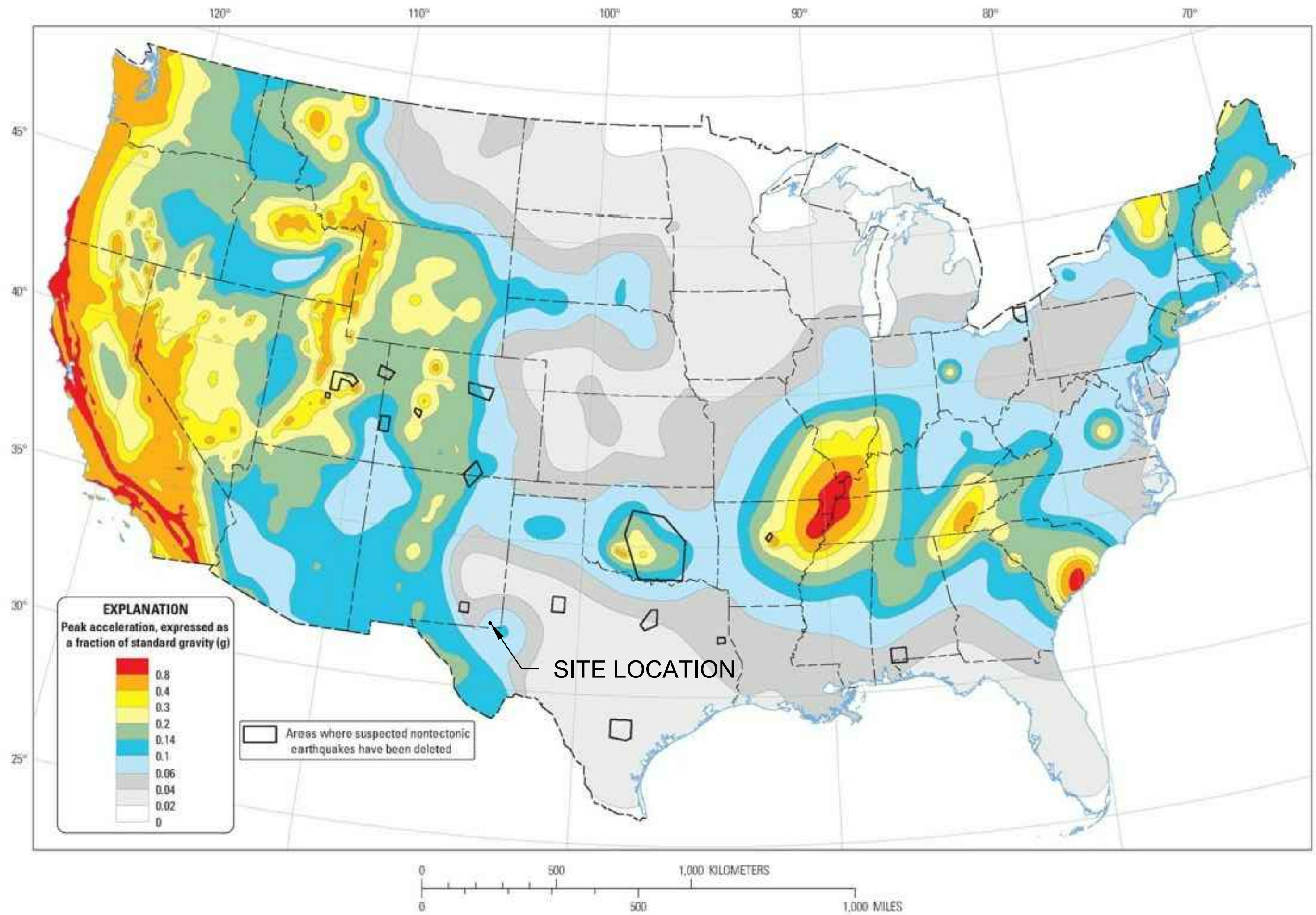
NORTH RANCH

LEA COUNTY NEW MEXICO

FIGURE C-8

DESIGNED BY:	MPB
DRAWN BY:	TLB
APPVD. BY:	DCM
SCALE:	N.T.S.
DATE:	03/28/2019
JOB NO.	572-002-35187378
ACAD NO.	101
SHEET NO.:	- OF -

EXHIBIT D
SEISMIC MAP



Two-percent probability of exceedance in 50 years map of peak ground acceleration

N:\GECARCHIVE\CAD\572002\MCCLOY\35187378 DESIGN PERMITTING\SLOPE STABILITY\104 FIG D - 1- NATIONAL SEISMIC HAZARD MAP.DWG

REV.	DATE	BY	DESCRIPTION

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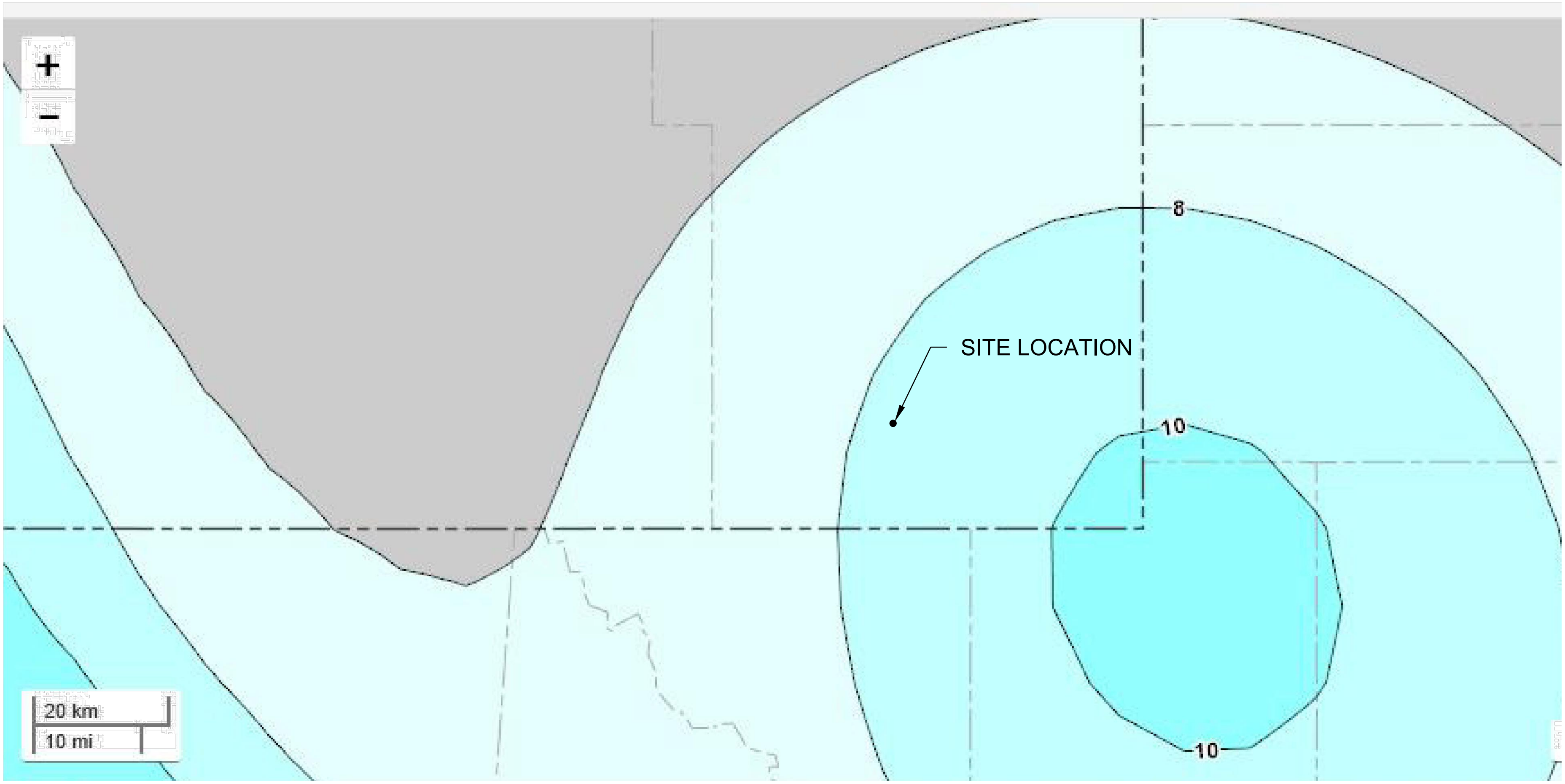
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

NATIONAL SEISMIC HAZARD MAP
SLOPE STABILITY ANALYSIS
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

FIGURE D-1

DESIGNED BY:	TLB
DRAWN BY:	TLB
APPVD. BY:	DCM
SCALE:	N.T.S
DATE:	03/28/2019
JOB NO.	572-002-35187378
ACAD NO.	104
SHEET NO.:	- OF -



TWO-PERCENT PROBABILITY OF EXCEEDANCE IN 50 YEARS MAP OF PEAK GROUND ACCELERATION

REV.	DATE	BY	DESCRIPTION

Terracon
Consulting Engineers and Scientists

25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

NATIONAL SEISMIC HAZARD MAP
SLOPE STABILITY ANALYSIS
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

FIGURE D-2

DESIGNED BY:	TLB
DRAWN BY:	TLB
APPVD. BY:	DCM
SCALE:	N.T.S
DATE:	03/28/2019
JOB NO.	572-002-35187378
ACAD NO.	104
SHEET NO.:	- OF -

N:\GECARCHIVE\CAD\572\002\MCCLOY\35187378 DESIGN PERMITTING\SLOPE STABILITY\104 FIG D - 1- NATIONAL SEISMIC HAZARD MAP.DWG

Unified Hazard Tool

Please do not use this tool to obtain ground motion parameter values for the design code reference documents covered by the U.S. Seismic Design Maps web tools (e.g., the International Building Code and the ASCE 7 or 41 Standard). The values returned by the two applications are not identical.

Input

Edition

Dynamic: Conterminous U.S. 2014

Spectral Period

Peak ground acceleration

Latitude

Decimal degrees

32.145188

Time Horizon

Return period in years

2475

Longitude

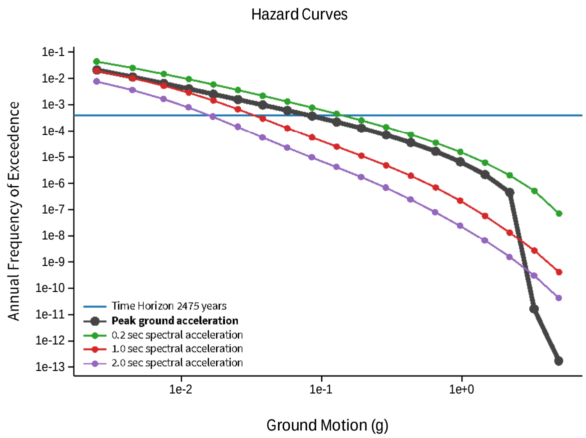
Decimal degrees, negative values for western long…

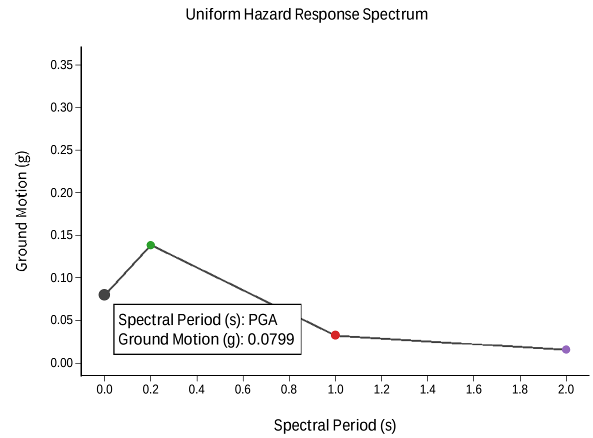
-103.46194

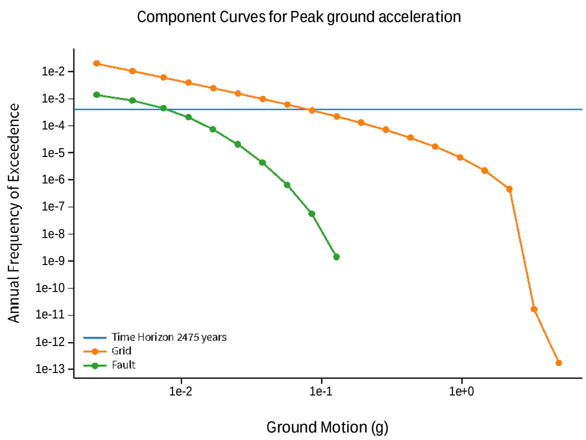
Site Class

760 m/s (B/C boundary)

Hazard Curve





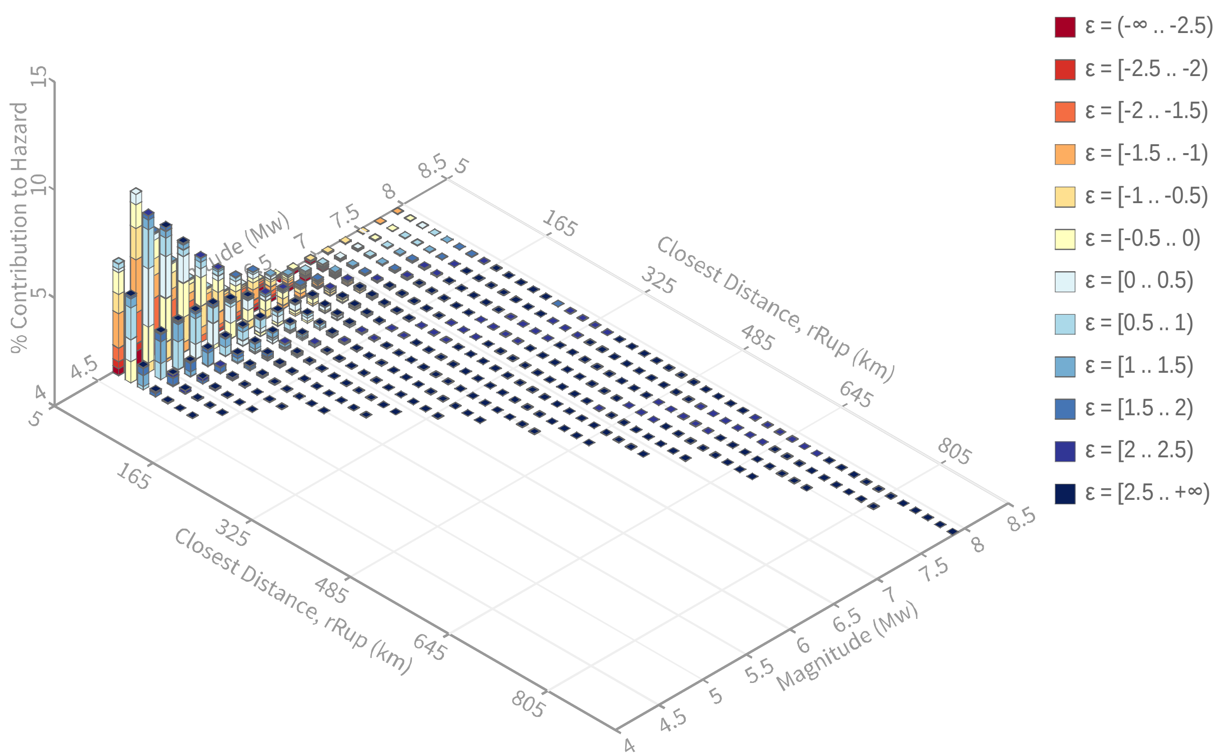


View Raw Data

Deaggregation

Component

Total



Summary statistics for, Deaggregation: Total

Deaggregation targets

Return period: 2475 yrs
Exceedance rate: 0.0004040404 yr^{-1}
PGA ground motion: 0.079945618 g

Recovered targets

Return period: 2478.3733 yrs
Exceedance rate: 0.00040349046 yr^{-1}

Totals

Binned: 100 %
Residual: 0 %
Trace: 1.63 %

Mean (for all sources)

r: 38.68 km
m: 5.45
$\boldsymbol{\varepsilon}_0$: -0.3 σ

Mode (largest r - m bin)

r: 13.68 km
m: 4.9
$\boldsymbol{\varepsilon}_0$: -1.18 σ
Contribution: 7.92 %

Mode (largest ε_0 bin)

Deaggregation Contributors

Source Set ↳ Source	Type	r	m	ε_0	lon	lat	az	%
SSCn Fixed Smoothing Zone 1 (opt)	Grid							29.71
PointSourceFinite: -103.462, 32.303		17.97	5.19	-0.97	103.462°W	32.303°N	0.00	4.33
PointSourceFinite: -103.462, 32.213		8.91	5.13	-2.15	103.462°W	32.213°N	0.00	3.77
PointSourceFinite: -103.462, 32.393		27.56	5.29	-0.31	103.462°W	32.393°N	0.00	3.52
PointSourceFinite: -103.462, 32.348		22.74	5.24	-0.59	103.462°W	32.348°N	0.00	2.70
PointSourceFinite: -103.462, 32.437		32.38	5.34	-0.09	103.462°W	32.437°N	0.00	2.58
PointSourceFinite: -103.462, 32.482		37.20	5.40	0.09	103.462°W	32.482°N	0.00	2.29
PointSourceFinite: -103.462, 32.527		42.02	5.46	0.24	103.462°W	32.527°N	0.00	1.92
PointSourceFinite: -103.462, 32.617		51.62	5.58	0.46	103.462°W	32.617°N	0.00	1.28
PointSourceFinite: -103.462, 32.258		13.30	5.15	-1.48	103.462°W	32.258°N	0.00	1.28
USGS Fixed Smoothing Zone 1 (opt)	Grid							29.71
PointSourceFinite: -103.462, 32.303		17.97	5.19	-0.97	103.462°W	32.303°N	0.00	4.33
PointSourceFinite: -103.462, 32.213		8.91	5.13	-2.15	103.462°W	32.213°N	0.00	3.77
PointSourceFinite: -103.462, 32.393		27.56	5.29	-0.31	103.462°W	32.393°N	0.00	3.52
PointSourceFinite: -103.462, 32.348		22.74	5.24	-0.59	103.462°W	32.348°N	0.00	2.70
PointSourceFinite: -103.462, 32.437		32.38	5.34	-0.09	103.462°W	32.437°N	0.00	2.58
PointSourceFinite: -103.462, 32.482		37.20	5.40	0.09	103.462°W	32.482°N	0.00	2.29
PointSourceFinite: -103.462, 32.527		42.02	5.46	0.24	103.462°W	32.527°N	0.00	1.92
PointSourceFinite: -103.462, 32.617		51.62	5.58	0.46	103.462°W	32.617°N	0.00	1.28
PointSourceFinite: -103.462, 32.258		13.30	5.15	-1.48	103.462°W	32.258°N	0.00	1.28
SSCn Adaptive Smoothing Zone 1 (opt)	Grid							17.97
PointSourceFinite: -103.462, 32.303		17.97	5.19	-0.97	103.462°W	32.303°N	0.00	2.24
PointSourceFinite: -103.462, 32.393		27.56	5.29	-0.31	103.462°W	32.393°N	0.00	1.94
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PointSourceFinite: -103.462, 32.437		32.38	5.34	-0.09	103.462°W	32.437°N	0.00	1.38
PointSourceFinite: -103.462, 32.482		37.20	5.40	0.09	103.462°W	32.482°N	0.00	1.34
PointSourceFinite: -103.462, 32.527		42.02	5.46	0.24	103.462°W	32.527°N	0.00	1.16
USGS Adaptive Smoothing Zone 1 (opt)	Grid							17.97
PointSourceFinite: -103.462, 32.303		17.97	5.19	-0.97	103.462°W	32.303°N	0.00	2.24
PointSourceFinite: -103.462, 32.393		27.56	5.29	-0.31	103.462°W	32.393°N	0.00	1.94
PointSourceFinite: -103.462, 32.213		8.91	5.13	-2.15	103.462°W	32.213°N	0.00	1.93
PointSourceFinite: -103.462, 32.348		22.74	5.24	-0.59	103.462°W	32.348°N	0.00	1.47
PointSourceFinite: -103.462, 32.437		32.38	5.34	-0.09	103.462°W	32.437°N	0.00	1.38
PointSourceFinite: -103.462, 32.482		37.20	5.40	0.09	103.462°W	32.482°N	0.00	1.34
PointSourceFinite: -103.462, 32.527		42.02	5.46	0.24	103.462°W	32.527°N	0.00	1.16
EXTmap_2014_adSm.ch.in (opt)	Grid							2.30
EXTmap_2014_adSm.gr.in (opt)	Grid							1.15

Attachment H
Construction Quality Assurance Plan

Construction Quality Assurance Plan

North Ranch Surface Waste Management Facility
Lea County, New Mexico

September 2019
Project No. 35187378

Prepared for:
NGL Waste Services, LLC
3773 Cherry Creek Dr., Suite 1000
Denver, CO 80209
303-815-1010

Prepared by:
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25809 Interstate 30 South
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EXIBITS

EXHIBIT A DEFINITIONS

SECTION 1
GENERAL

1.0 INTRODUCTION

The purpose of this document is to present a Quality Assurance and Quality Control Plan (QA/QC Plan) for the North Ranch Surface Waste Management Facility an up stream oil and gas exploration and production waste disposal facility. This plan is prepared in general accordance with New Mexico Administrative Code (NMAC) 19.15.36.14.D as it pertains to Landfill liner construction and NMAC 19.15.36.17.B as it pertains to evaporation pond liner construction to ensure excavations and liners used in the facility operations are designed, constructed, installed, and maintained properly. The QA/QC Plan describes procedures for the installation and maintenance of the soil and geosynthetic components used in the composite liners system as specified by the facility design plans.

CQA of the selection, evaluation, treatment, placement, and compaction of soils for earthwork, low-permeability soil liners, granular drainage systems, and final cover layers is included in the scope of this plan. CQA applicable to manufacturing, fabricating, shipping, handling, and installing of all geosynthetics is also included. This CQA Plan does not address design guidelines, installation specifications, or selection of soils, geomembranes, and other geosynthetics (which include chemical compatibility between geosynthetics and contained material). In particular, this document addresses the requirements for CQA monitoring, testing and documentation of activities related to the production, construction, and installation of landfill lining systems, leachate collection systems, and cover systems. When applicable and deemed appropriate by the New Mexico Oil Conservation Division (NMOCD), deviations from this plan must be consistent with changes in applicable State and Federal Regulations, Facility Permit Conditions, and/or accepted practices in the field of Engineering.

The CQA Plan includes references to test procedures and standards of the American Society for Testing and Materials (ASTM), Corps of Engineers (COE), the Federal Test Method Standards (FTMS), the Geosynthetic Research Institute (GRI), and current industry practice.

1. Generic Construction Quality Assurance Plan for the Lining and Cover Systems; Geosyntec Consultants; September 1992;
2. ASTM Standards and Other Specifications and Test Methods on the Quality Assurance of Landfill Liner Systems; ASTM; 1916 Race Street; Philadelphia, PA 19103; 1994;
3. "New Mexico Administrative Code, Title 19 Chapter 15, Part 36, Surface Waste Management Facilities"; Effective February 14, 2007;
4. Waste Containment Facilities-Guidance for Construction, Quality Assurance and Quality Control of Liner and Cover Systems; David E. Daniel and Robert M. Koerner; 1995.
5. Geosynthetic Research Institute Test Methods and Standards; Latest versions as of the date of this CQA Plan.

2.0 DEFINITIONS RELATED TO CQA

This section describes CQA associated with the construction of liner and cover systems and defines terminology used throughout this document. **EXHIBIT A** provides detailed definitions for common quality assurance and landfill terminology used in this document.

2.1 Construction Quality Assurance and Construction Quality Control

This CQA Plan is devoted to Construction Quality Assurance and Construction Quality Control. In the context of this CQA Plan, Construction Quality Assurance and Construction Quality Control are defined as follows:

Construction Quality Assurance (CQA) - A planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements, and will perform satisfactorily in service.

Construction Quality Control (CQC) - Those actions which provide a means to measure and control the characteristics of an item or service to contractual and regulatory requirements.

2.2 Use of the Terms in This Plan

In the context of this plan:

1. CQA refers to means and actions employed by the CQA Consultant to assure conformity of the lining and cover system component production and installation with this CQA Plan, the Project Plans, and the Project Specifications. CQA is provided by a party independent from production and installation.
2. CQC refers to those actions taken by Manufacturers, Fabricators, Installers, or the CQC Firm to insure that the materials and the workmanship meet the requirements of the Project Plans and Specifications.

3.0 CQA AND CQC PARTIES

This section summarizes the CQA parties that will be involved in any liner/cover system installation corresponding to the proposed Landfill and Evaporation Pond.

3.1 Description of CQA Parties

The following section summarizes the CQA Parties who will be either directly or indirectly involved in the construction/installation associated with the bottom liner or final cover system corresponding to the proposed Landfill and Leachate Evaporation Pond. Where applicable, proposed Landfill Operator and/or Owner will be responsible for insuring that each of the Parties selected have the necessary experience and qualifications associated with bottom liner and final cover system installations. In addition, each party shall be aware of its obligations and responsibilities as defined in this plan. Depending on the size and/or scope of the project, a person or firm may act as more than one of the parties listed below, as long as third party and conflict of interest matters are addressed.

3.1.1 Owner

The Owner owns and/or is responsible for the facility, including components constructed and governed by the scope of this document. The Owner is responsible for managing all aspects of the project including planning, cost control, design, permitting, regulatory liaison, contract acquisitions, construction oversight, quality control, and certification. Unless otherwise noted, the proposed Landfill and Leachate Evaporation Pond will be the owner of any liner/final cover system constructed in association with the Landfill. The proposed Landfill Operator and/or Owner will be responsible for negotiating contracts between other CQA Parties, and for insuring that qualified agencies, firms, contractors, etc. are selected who will satisfy the requirements of this CQA Plan and who will be responsible for insuring that the project is completed in accordance with applicable Project Plans, Specifications, Regulations, and within established cost constraints.

3.1.2 Project Manager

The Project Manager is the official representative of the Owner. The Project Manager, along with the Design Engineer, will be the central point of contact for the Owner and CQA Consultant. Depending on the size or scope of the Project, the Project Manager may be a 3rd Party Firm or Agency contracted directly with the Owner to oversee the Project. In some situations, the Project Manager may act jointly as the Project Manager and Design Engineer. The Owner and/or Project Manager shall carefully consider the size and scope of the project when determining whether it is necessary to have separate individuals to fill the role of Design Engineer and Project Manager. Although not specifically required in the NMAC, it is highly recommended and is industry best practice that the Design Engineer and/or CQA Manager be represented as a firm/agency independent of the Owner (i.e., 3rd Party). While considering this, the Design Engineer and/or CQA Manager shall have no corporate ties, which could be construed as a conflict of interest.

3.1.3 Design Engineer

The Design Engineer is responsible for the design of the liner and/or cover systems, and for the preparation of the Project Plans and Specifications. The Design Engineer may be an employee of the Owner/Operator or a 3rd Party firm or agency hired by the Owner/Operator.

3.1.4 CQA Consultant

The CQA Consultant is directly responsible for verifying that construction materials, practices, and procedures, are consistent with the requirements of this plan, the project specifications, plans, and applicable regulations. The CQA Consultant will work directly with the CQC Firm and/or labs in order to efficiently manage all aspects of project quality assurance. The CQA Consultant shall be an independent 3rd Party firm or agency with no direct corporate ties to the Owner, which may be construed as a conflict of interest.

3.1.4.1 CQA Certifying Engineer

The CQA Certifying Engineer is a party, independent from the Owner, Manufacturer, Fabricator, and Installer, that is responsible for the overall observation, testing and documentation activities related to the CQA of the earthwork at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geotextiles and geocomposite on this facility. The CQA Certifying Engineer also is responsible for issuing a certification report, sealed by a Registered Professional Engineer associated with the installation of the liner and collection system. Depending on the size and/or scope of the Project, the CQA Certifying Engineer may also serve as the CQA Consultant, and/or CQA Manager.

3.1.4.2 CQA Manager

The CQA Manager reports to the Certifying Engineer and is responsible for observing, testing and documenting activities related to the CQA of the earthwork at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geomembranes, geotextiles, and geocomposites on this facility.

3.1.4.3 CQA Monitor

The CQA Monitor reports to the CQA Manager and/or the Certifying Engineer and is responsible for observing, testing and documenting activities related to the CQA of the earthwork at the site and the production and installation of the geosynthetic components of the lining and cover systems, i.e., the geomembranes, geotextiles, and geocomposites on this facility.

3.1.4.4 Soils Testing Laboratory

The Soils CQC Firm is responsible for conducting tests in the field and in the laboratory on samples of soils associated with liner and cover system installations. The Owner or the General Contractor may retain the third party CQA Firm.

3.1.4.5 Geosynthetics Laboratory

The Geosynthetics Laboratory is a party, independent from the Owner, Manufacturer, Fabricator, and Installer, that is responsible for conducting tests on samples of geosynthetics taken from the site. The Geosynthetics Laboratory testing services cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. The geosynthetics installer, if deemed acceptable by the CQA consultant, may perform the CQC field-testing. The CQA consultant shall be present during all such testing. In no case shall the geosynthetics installer or subcontractor conduct laboratory testing for conformance or destructive analysis. A firm independent of the geosynthetics installer shall conduct this analysis.

3.1.4.6 CQA Surveyor

The CQA Surveyor is a party that is independent from the Contractor that is responsible for surveying the subgrade and liner during construction.

3.1.5 General Contractor

The General Contractor is responsible for construction of the bottom liner and final cover systems. The General Contractor may perform directly or subcontract out various elements of the construction, including subgrade preparation, geosynthetics, and soil placement. The General Contractor may also be responsible for other construction at the Facility either directly or indirectly related to the waste disposal area.

3.1.6 Soils Contractor

The Soils Contractor excavates and/or delivers soil material to the General Contractor and/or project site. Depending on the size and/or scope of the Project, the General Contractor may also serve as the Soils Contractor.

3.1.7 Geosynthetics Manufacturer

The Geosynthetics (Geomembrane, Geotextile, Geosynthetic Clay, Geonets or Geocomposites) Manufacturer (Manufacturer) is responsible for the production of geomembranes or geonet rolls from resin. The geosynthetics manufacturer may also produce geosynthetic clay liners from bentonite and/or geotextile rolls from resin fibers.

3.1.8 Geosynthetics Installer

The Geosynthetics Installer (Installer) is responsible for field handling, storing, placing, seaming, loading, and other aspects of the geosynthetics installation. The Installer may also be responsible for transportation of these materials to the site and for construction of the anchor trenches if so defined in the project specifications.

3.1.9 Geosynthetics Transporter

The Transporter transports the geosynthetics, including rolls of geotextiles, geocomposites, and geonets between the Manufacturer and the site; or between the Manufacturer and the Fabricator, and/or between the Fabricator and the site.

3.2 Qualifications of the Parties

The following qualifications shall be required of all parties involved with the design, manufacture, fabrication, installation, transportation, and CQA of all lining and cover system materials to be utilized at the Landfill.

3.2.1 Project Manager

The selection of the Project Manager is the responsibility of the Owner. Qualifications for this position are determined by the Owner independently of the CQA Plan and will be based on the objectives and constraints of the Project as determined by the Owner.

3.2.2 Design Engineer

The Design Engineer shall be a qualified professional engineer with registration in the State of New Mexico. The Design Engineer shall have demonstrated experience associated with previous similar solid waste/hazardous waste projects. In particular, the Design Engineer shall have a history which demonstrates familiarity with geosynthetics and/or soils, as appropriate, including detailed design and construction methods commonly used in the field of Civil and/or Sanitary Engineering.

3.2.3 CQA Consultant

The CQA Consultant shall be a designated firm or agency independent of the Owner with demonstrated knowledge and experience with geosynthetics and soil liner/cover systems. The CQA Consultant is responsible for the CQA Manager, CQA Monitors, Soils Testing Laboratory, Geosynthetics Laboratory, and CQA Surveyor.

The CQA Consultant shall be a well-established engineering firm incorporated (or otherwise registered) in the United States. The CQA Consultant shall be experienced in providing CQA services for soils, including low-permeability and high-permeability soils. The CQA Consultant shall be experienced in the preparation of quality assurance documentation including quality assurance forms, reports, certifications, and manuals.

In addition, the CQA Consultant shall provide the following in writing, if required, to the Owner before entering into contractual agreements with the Owner:

1. Corporate background and information; and
2. Quality assurance capabilities:
   - a summary of the firm's experience with soils;
   - a summary of the firm's experience in quality assurance, including installation quality assurance of soils;
   - a summary of the CQA documentation and methods used by the firm, including sample CQA forms, reports, certifications, and manuals prepared by the firm;
   - a summary of the firm's experience with geosynthetics, including geomembranes, geocomposites, geonets, and geotextiles;
   - a summary of the firm's experience in quality assurance, including installation quality assurance of geomembranes, geocomposites, geonets, and geotextiles; and
   - a summary of CQA documentation and methods used by the firm, including sample CQA forms, reports, certifications, and manuals prepared by the firm.

In addition, the CQA Consultant shall provide the following in writing, if required, to the Owner before beginning work on this project:

1. Resumes of personnel to be involved in the project including the CQA Certifying Engineer, CQA Manager, and CQA Monitors;

2. Proof of Professional Engineering registration in the project state of the engineer to be designated the CQA Certifying Engineer; and
3. Proof of quality assurance experience of the CQA personnel with emphasis on geomembranes, geocomposites, geonets, and geotextiles.

3.2.3.1 CQA Certifying Engineer

The CQA Certifying Engineer shall represent a designated firm or agency, independent of the Owner, with demonstrated knowledge and experience with geosynthetics and soil liner/cover systems. The CQA Certifying Engineer shall be a New Mexico Registered Professional Engineer who will be responsible for preparing and sealing a certification report upon the successful completion of the project.

Third Party CQA Firm – An independent third party shall provide Construction quality assurance (CQA). If the certifying firm or individuals have any relationship with the owner or operator of the facility, which could be interpreted as a conflict (such as belonging to a firm under the same corporate umbrella), these shall be disclosed in advance of the construction.

Required Presence – A qualified member of the CQA firm shall be present at the site continuously during liner or final cover barrier construction. The professional certifying the construction shall at a minimum visit the site at least once prior to construction, once during construction and once after construction is substantially completed unless such visits are not practical. Additional visits by the professional certifying the construction shall be required if additional visits are prescribed in the approved Quality Assurance Plan or if site conditions warrant.

3.2.3.2 Soils Testing Laboratory

The Soils Testing Laboratory shall have experience in soils testing, meet all regulatory requirements, and have demonstrated experience utilizing the standards specified in this Plan. The Soils Testing Laboratory shall be capable of providing test results in accordance with the test methods described in the specifications. **The Soils Testing Laboratory shall be capable of providing a minimum of ten flexible wall permeability test results in six (6) days or less**.

3.2.3.3 Geosynthetics Laboratory

The Geosynthetics Laboratory shall have experience in testing geosynthetics and be familiar with American Society for Testing and Materials (ASTM), National Sanitation Foundation (NSF), and Geosynthetic Research Institute (GRI) test methods and standards. The Geosynthetics CQC Firm shall be capable of providing destructive test results within 24 hours of receipt of samples and shall maintain that standard throughout the installation.

3.2.4 Soils Supplier

Qualifications of the soils supplier are specific to the construction contract. The soils supplier shall have a demonstrated history of providing soils with consistent properties (when applicable).

3.2.5 Earthwork Contractor

Qualifications of the Earthwork Contractor are specific to the construction contract. The Earthwork Contractor shall have a demonstrated history of successful earthwork construction. In particular, the Contractor shall have successfully completed liner or cover systems for solid waste, hazardous waste, or surface water containment. Documentation of this experience shall be submitted with the Contractor's Bid to the Owner or Project Manager.

3.2.6 Geosynthetics Installer

The Geosynthetics Installer shall be trained and qualified to install geosynthetics. Prior to confirmation of any contractual agreements, the Geosynthetic Installer shall provide the Project Manager with the following written information:

1. Corporate background and information;
2. Installation capabilities;
3. Equipment and personnel;
4. Daily anticipated production;
5. Quality control manual for installation;

3.2.7 Transporter

All personnel responsible for the loading, transport and unloading of the geosynthetics must be aware of the consequences of damage to the geosynthetics, and be familiar with the handling and transport constraints required by the Manufacturer and/or Fabricator.

3.3 Duties of the CQA Personnel

In this CQA Plan, the roles of the CQA Certifying Engineer, CQA Manager, Soils CQA Monitor, and Geosynthetics CQA Monitor are described separately. Individuals or consultants may be responsible for each particular aspect of the liner/cover system construction.

1. The CQA Manager, who depending on the size and/or scope of the project may direct CQA activities from the offices of the CQA Consultant's firm and visit the site periodically; The CQA Manager may designate CQA Monitors depending on the size and/or scope of the project to oversee certain aspects of the project. The CQA Monitors will report directly to the CQA Manager.
2. The CQA Monitors will be on site during all aspects of construction pertaining to the liner/cover system installation.

As described in earlier sections, the CQA Manager may also serve as the Soils CQA Monitor and the Geosynthetics CQA Monitor depending on the size and/or scope of the project. It is likely that a CQA Manager will be designated for both the Soils and Geosynthetics components of the liner/cover system installation on large projects.

3.3.1 CQA Certifying Engineer

The CQA Certifying Engineer will be responsible for:

1. Review of all project related designs, plans, and specifications;
2. Reviews all other site-specific documentation, including bid documents, proposed layouts, soils and groundwater investigation reports, and for geosynthetics, the manufacturer's and installer's literature;
3. Attends the resolution meetings;
4. Administers the CQA program (i.e., assigns and manages all CQA personnel, reviews all field reports, and provides engineering review of all CQA related issues);
5. Provides quality control of the CQA personnel, including site visits;
6. Reviews all changes to the design, plans, and specifications; and
7. Prepares/approves the final certification report, including a review of the Record Drawing(s).

3.3.2 CQA Manager

The CQA Manager may also be the CQA Monitor depending on the size and/or scope of the project and will be responsible for:

1. Familiarizes self and/or all CQA Monitors with the site and the project requirements;
2. Manages the daily activities of the CQA Monitors;
3. Attending CQA-related meetings (resolution, pre-construction, daily, weekly, etc.);
4. Prepares or oversees the ongoing preparation of the Record Drawings(s);
5. Assigns locations for testing and sampling;
6. Reviews results of laboratory testing and makes appropriate recommendations;
7. Reviews all CQA Monitors' daily reports and logs;
8. Reports to the Project Manager, and logs in his daily field report any relevant observations reported by the CQA Monitors;
9. Prepares daily report;
10. Prepares weekly summary of CQA activities; and

11. Delegate's responsibilities to a senior CQA Monitor whenever absent from the site while operations are ongoing.

In addition, the CQA Manager shall be responsible for insuring:

1. Periodically checks stockpile or borrow pit sources for variability of the soils, and insures that conformance testing is carried out;
2. Establishes additional test requirements beyond those in the specifications, where necessary to confirm permeability or density requirements;
3. May perform site visit and review of manufacturing plant facilities (as deemed necessary), methods, and quality control;
4. Reviews all Supplier, Manufacturer, and Installer certifications and documentation and makes appropriate recommendations;
5. Reviews the Installer's personnel qualifications for conformance with those pre-approved for work on site; and
6. Notes any on-site activities that could result in damage to the geosynthetics.

3.3.3 CQA Monitors

The duties of the CQA Monitors include, as assigned by the CQA Certifying Engineer and/or CQA Manager: monitoring, logging, and/or documenting all appropriate operations. The duties to be performed, and operations to be monitored by the Soils CQA Monitors include:

1. Soils delivery, dumping, and placement;
2. Soils moisture content, and moisture conditioning, if required;
3. Compaction of soils, and in situ testing of compacted density and moisture content;
4. Collection of samples for laboratory testing for moisture/density relationships, permeability; and other testing as outlined in the specifications;
5. Operations to protect completed areas before the covering materials are placed;
6. Measurement of loose and compacted lift thickness;
7. Verification of bonding between lifts;
8. Observation of equipment type, number of passes and equipment contact pressure;
9. Examination of the soil surface for signs of excessive wetting, desiccation, or other disturbance prior to placement of any cover materials; and
10. Scarification, rewetting, recompaction, or proof rolling required to repair deteriorated areas; and
11. Reports any unresolved deviations from the CQA Plan to the CQA Manager.

The operations to be monitored by the Geosynthetics CQA Monitors, for all geosynthetics include:

1. Material delivery and "spotting";
2. Unloading and on-site transport and storage;
3. Marking samples for conformance testing;
4. Sampling for conformance testing by the Geosynthetics CQC Firm;
5. All placement operations;
6. Condition of panels as placed;
7. All joining and/or seaming operations; and
8. Repair operations.

All CQA Monitors shall take note of on-site activities that could result in damage to the soils or geosynthetics components of the lining system. Any observations so noted shall be reported as soon as possible to the CQA Manager.

4.0 SITE AND PROJECT CONTROL

In order to coordinate various aspects of the construction project and develop time frames for completion of the project, various project coordination meetings will be required associated with all liner/cover system installations. The Owner will be responsible for organizing or selecting a representative to organize the various project coordination meetings. A person shall be designated at the beginning of all meetings to document and transmit the minutes to all parties.

4.1 Resolution Meeting

Following the completion of the design, plans, and specifications for the project, a Resolution Meeting shall be held. This meeting shall include all parties then involved, including the Owner, Project Manager, and Design Engineer. This meeting may be combined with the pre-construction meeting depending on the size and scope of the project.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems, which might cause difficulties and delays in construction, and present the CQA Plan to all the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all. The first part of the Resolution Meeting may be devoted to a review of the design drawings and specifications for completeness and clarity. This is different from the peer review of the design, including design calculations, which shall have been carried out previously. This meeting shall include all of the following activities:

1. Communicate to all parties any relevant documents;

2. Review critical design details of the project;
3. Review the seam layout drawing provided by the Designer, the Fabricator, or the Installer;
4. Review the project-specific CQA Plan;
5. Make any appropriate modifications to the CQA Plan to insure that it specifies all CQA activities that are necessary (within the context of the regulatory agency approval if necessary);
6. Make any appropriate modifications to the design criteria, plans, and specifications so that the fulfillment of all design specifications or performance standards can be determined through the implementation of the site-specific CQA Plan;
7. Reach a consensus on the CQA Plan and quality control procedures, especially on methods of determining the acceptability of the soils and geosynthetics comprising the lining system;
8. Assign the responsibilities of each party;
9. Decide the number of soil density testing units to be maintained on site;
10. Establish work area security and safety protocol;
11. Select testing equipment and review protocols for testing and placement of soil materials;
12. Confirm the methods for documenting and reporting, and for distributing documents and reports; and
13. Confirm the lines of authority and communication.

4.2 Pre-Construction Meeting

A Pre-Construction Meeting shall be held at the site. At a minimum, the Owner, Project Manager, Design Engineer, CQA Manager, Earthwork Contractor, and Geosynthetics Installer shall attend the meeting. If deemed appropriate by the Project Manager, the Pre-Construction Meeting may be separated into two separate meetings; one for the Earthwork Contractor and one for the Geosynthetics Installer.

Specific topics considered for this meeting include:

1. Make any appropriate modifications to the CQA Plan (within the context of regulatory agency approval as necessary);
2. Review the responsibilities of each party;
3. Review lines of authority and communication;
4. Review methods for documenting and reporting, and for distributing documents and reports;

5. Establish protocols for testing;
6. Establish protocols for handling deficiencies, repairs, and retesting;
7. Review the time schedule for all operations;
8. Conduct a site walk-around to verify that earthwork construction is proceeding on schedule, and to review material storage locations;
9. Establish soil stockpiling locations; and

4.3 Progress Meetings

Periodic progress meetings shall be held between the Soils and Geosynthetics CQA Monitors, the Installer's superintendent, the Project Manager, and any other concerned parties. These meetings shall discuss current progress, planned activities for the next period, and any new business or revisions to the work. The CQA Monitors shall log any problems, decisions, or questions arising at this meeting in their daily reports. Any matter requiring action, which is raised in this meeting, shall be reported to the appropriate parties. The CQA Monitor's logs shall be submitted to the CQA Manager for inclusion in the Certification Report if deemed pertinent and appropriate.

4.4 Problem or Work Deficiency Meetings

A special meeting shall be held when and if a problem or deficiency is present or likely to occur. At a minimum, the affected contractor, the Project Manager, and the appropriate CQA Manager(s) shall attend the meeting. If the problem requires a design modification, the Design Engineer shall also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

1. Define and discuss the problem or deficiency;
2. Review alternative solutions; and
3. Implement an action plan to resolve the problem or deficiency.

4.5 Project Control Visits

4.5.1 Periodic Visits

Periodically, the CQA Manager, and the Certifying Engineer(s) shall visit the construction site. This visit shall be coordinated with a similar visit by the Design Engineer when appropriate. The professional certifying the construction shall at a minimum visit the site at least once prior to construction, once during construction and once after construction is substantially completed, unless such visits are not practical. Additional visits by the professional certifying the construction shall be required if additional visits are prescribed in the approved Quality Assurance Plan or if site conditions warrant. The Project Manager and/or Owner may also inform state regulatory officials of these designated inspection dates if deemed appropriate.

4.5.2 Manufacturing Plant Visits

A representative of the Owner, Project Manager, Design Engineer, or CQA Manager may carry out a geosynthetic manufacturing plant visit in order to verify manufacturing practices or quality control procedures. These visits be arranged on an "as needed" basis if deemed appropriate by the Project Manager. Project specific plant visits for the manufacture and fabrication of the geosynthetics (geomembranes, geotextiles, geocomposites, and geonets) are optional. These plant visits shall be carried out at the discretion of the Owner, by the Owner, or his designated alternate.

SECTION 2
SURVEYING CONSTRUCTION QUALITY ASSURANCE

1.0 INTRODUCTION

Surveying of lines and reference elevations is conducted on an ongoing basis during the construction of the compacted soil liner materials, synthetic layers, and leachate collection system components. Accurate surveying is essential to insure that the liner/cover and hydraulic transport systems function as designed. The Contractor will be responsible for establishing grade control and the preparation of accurate record drawings (as built). The CQA Consultant will be responsible for reviewing all surveying activity performed by the Contractor to insure that construction adheres to the Project Plans and Specifications.

2.0 SURVEY CONTROL

At least one permanent elevation benchmark and at least two horizontal control benchmarks will be established for the project in a location convenient for reference during construction. The reference control points will be consistent with State Plane Coordinates and the established facility grid/survey coordinate system. The vertical and horizontal control for the benchmarks shall be established within normal land surveying standards. All initial survey controls either are in place as of the date of this writing, or will be established by the Design Engineer prior to execution of the Project.

3.0 LINES AND GRADES

The following surfaces shall be surveyed by the Contractor and verified by the CQA Consultant to document the lines and grades achieved during placement and compaction.

1. For the berms and other earthworks:
   - original grade surface;
   - compacted surface of cut slopes; and
   - finished grade surface.
2. For the compacted soil liners:
   - original contours;
   - prepared subgrade surface; and
   - finished compacted soil liner surface.
3. For the soil cover materials:
   - prepared surface; and
   - finished soil cover surface.

In addition, the lateral and vertical extent of all synthetic components as well as critical leachate collection system components shall be provided on the record drawings for future reference (if necessary).

4.0 FREQUENCY AND SPACING

All surveying shall be carried out immediately upon completion of a given installation to facilitate progress and avoid delaying commencement of the next installation. Any surveying conducted by the CQA team, is to be conducted as a check on the Contractor, but is not intended to alleviate the Contractor from his/her responsibilities for insuring that all construction is within the required grades and lines shown in the project plans and specifications.

The following minimum spacing's and locations shall be provided for survey points:

1. All "flat" surfaces, such as the base of the landfill, with gradients less than 10 percent, shall be surveyed on a square grid not wider spaced than 100 feet;
2. On all slopes greater than 10 percent, a square grid not wider than 100 feet shall be used, but in any case, a line at the crest, midpoint, and toe of the slope shall be taken;
3. A line of survey points no further than 100 feet apart must be taken along any slope break (this will include the inside edge and outside edge of any bench on a slope);
4. A line of survey points no further than 100 feet apart must be taken at the invert of any pipes or other appurtenances to the liner;
5. At the corners and midpoints of the top and bottom of all sumps;
6. At the midpoint of the crest of the outside berms; and
7. At appropriate spacing to define geosynthetics panel layouts.

5.0 DOCUMENTATION

The Surveying CQA Managing Engineer shall retain copies of all field survey notes provided. The findings from the field surveys shall be documented on a set of Survey Record (As Built) Drawings.

The Record Drawings shall include the following information when applicable:

1. Site Layout Drawing showing:
    a. Layout of Prepared Area in Relation to Permitted Boundaries;
    b. Property boundaries and/or corners;
    c. Monitoring wells and piezometers (if scale permits);

d. Leachate risers, manholes and collection piping related to the specific cell and/or construction;

e. Limits of existing/future oil field waste disposal areas and limits of liner or final cover barrier;

f. Labeling and Miscellaneous Information:

- Descriptions of what each line style represents;
- Drawing scale;
- Legend; and
- North Arrow.

g. Existing Contours (prior to construction activity corresponding to this project);

h. A key map showing the location of the construction related to the permitted design, along with an identification of areas previously constructed and areas yet to be constructed;

i. If necessary to document leachate head level compliance, the report shall also indicate the lowest point of the liner constructed not including leachate trenches and sumps;

j. In addition, the certifying professional shall make a statement that the cell was constructed in accordance with the permit drawings and narrative. The report shall also include a list of any deviations from the permitted drawings, if they exist, and any reasons for the deviations; and

k. Any other features deemed significant.

2. Subgrade Drawing showing:

a. Prepared Subgrade Surface (Plan View);

b. The limits of excavation including all slopes;

c. The location of slope breaks, leachate sump and trenches, berms; and

d. Any other features deemed significant.

3. Top of Liner System showing:

a. The top and bottom of liner or final cover elevations referenced to the site grid coordinate system at 100' intervals;

b. The location and elevation of slope breaks, leachate piping, leachate sump and trenches, berms; and any other features which are material to the disposal area construction; and

c. Any other features deemed significant.

4. Top of Drainage Layers or Liner Protection Layers showing:

a. If a granular blanket is utilized in the design, top of blanket elevation shall be identified at 100' intervals;

   b. The location of slope breaks, leachate sump and trenches, berms; and any other features which are material to the disposal area construction; and
   c. Any other features deemed significant.

5. Top of Waste
   a. Verify top of waste elevations are at or below permitted elevations prior to placing final cover. The elevations shall be referenced to the site grid coordinate system at 100' intervals.

6. Top of Final Cover Layers showing:
   a. The top and bottom of the vegetative support/topsoil layers referenced to the site grid coordinate system at 100' intervals;
   b. The location of slope breaks, trenches, berms; and trenches, berms; and any other features which are material to the disposal area construction; and
   c. Any other features deemed significant.
   d. ***NOTE: Depth verification may be required due to possible settlement of waste during construction of the final cover system.***

The Contractor will be responsible for submitting these record drawings (as-builts) if applicable to the CQA Consultant for review. The applicable record drawings are to be included in the Certification Report along with the CQA Consultant's Certifying Engineer's seal. The report shall then be submitted to the Design Engineer and Owner for review prior to being submitted to the NMOCD.

SECTION 3
CONSTRUCTION QUALITY ASSURANCE INVOLVING SOILS

1.0 INTRODUCTION

This CQA document covers five types of soil that are used in the construction of an industrial landfill liner and/or cover system. The following types of soil layers will be used in some form in the construction of liner and cover systems corresponding to the proposed landfill and leachate evaporation pond.

1. Subgrade Surface;
2. Drainage layers or media (free-draining, high-permeability soils, usually clean sand or gravel);
3. Liner Protective Cover Layers; and
4. Topsoil (soil demonstrating the ability to support plant growth).

2.0 SOIL MATERIALS SPECIFICATIONS

Except when otherwise noted in the Project Specifications or Plans, soil materials to be utilized in each component of the liner system shall conform to the following minimum materials specifications.

2.1 Subgrade Surface

The subgrade soils require treatment in the form of compaction or recompaction, prior to the placement of any of the lining system materials. This supporting layer is comprised of natural in-place materials, so this document will only address the compaction criteria. If the subgrade is disturbed, through undercutting of unsuitable material etc.; the subgrade is to be replaced, moisture conditioned, and compacted to the standards established in the Project Specifications. When possible, the subgrade surface shall be relatively smooth and free of non angular rocks, sticks, or other debris in excess of ½-inch in maximum dimension which could compromise the liner system. The subgrade will not require any subgrade compaction testing as the contractor shall excavate down to subgrade. If material is over excavated, testing shall be determined by CQA Firm.

The upper portion of the subgrade can be damaged by excess moisture (causing softening) and insufficient moisture (causing desiccation and shrinkage), or by freezing. These conditions are normally not discovered until after the design phase of the project. At a minimum, the Soils CQA Monitor shall determine the suitability of the subgrade for fill placement by one or more of the following methods:

1. Continuous visual inspection during proof-rolling;
2. Pocket penetrometer or Torvane shear tests in suspect soil areas; and
3. Other tests identified in **TABLE 3**.

The main requirement for the subgrade is it must have sufficient compaction and strength to enable the placement of liner. The subgrade also must be stable to prevent large differential settlements that would be conducive to damage of the liner system or the pooling of leachate.

2.2 Drainage Layers

Materials to be utilized in the construction of lateral drainage layers, particularly in leachate collection systems shall be comprised of clean washed river sand or gravel with a minimum hydraulic conductivity as specified and as determined utilizing the Hydrologic Evaluation of Landfill Performance (HELP, Version 3.0) Model. The hydraulic conductivity value shall be determined by the Design Engineer and made a part of the Project Specifications. These drainage materials shall consist of clean sands and/or gravel or other permeable material classified as SW, SP, GW, or GP that contains less than 10% (by dry weight) passing the US. No. 200 sieve with 100% (by dry weight) passing the 3" sieve. Gravel placed in sumps and around perforated pipes shall be classified as GW, GP, or GW-GM with no more than 10% passing the No.200 sieve. The frequencies and criteria for preconstruction and construction testing of the appropriate drainage materials are shown on **TABLE 3**. Testing shall be performed on off-site borrow sources or on-site stockpiles. Drainage geocomposites may be utilized in place of a soil drainage layer as long as the material and installation requirements of Section 5 are adhered to.

The installer shall insure that all soil materials such as sand and gravel are placed in such a manner as to insure that no damage occurs to the geomembrane liner and that no excess tensile stresses occur in the geomembrane. The following details will be followed during construction of the drainage media system.

1. A geotextile or other cushion approved by the designer will be installed between the drainage media and the geomembrane if any of the following conditions are met:
   - The drainage layer material contains angular aggregate; and/or
   - The drainage layer contains aggregate over 1 inch in nominal size as determined by a gradation test (ASTM D422);
2. A minimum of 12 inches of drainage media will be maintained between the dozer and the geomembrane at all times and thicker layers are required for heavier dozers (Larger than a D6). Typical minimum thicknesses used for the ground pressure exerted by the equipment is described in **TABLE 1**.
3. In areas of heavy traffic such as access ramps, the thickness shall be at least 2 to 3 feet. This material can be common protective cover or the material used for the drainage media.

2.3 Protective Cover Layers

The protective cover materials above the lining system and primary leachate collection system components are to be as follows: The protective cover materials used to protect the leachate collection system, shall consist of fine grained sandy soils, gravels or geosynthetic cushion materials as per the Project Specifications. Protective cover in the cover system (frost protection layer) shall consist of native soils with no particles over 1 inch in nominal size and shall be placed in accordance with standard construction practices.

2.4 Vegetative Soil Layer

Vegetative soil cover material shall be of quality to support vegetative growth and shall be placed in accordance with standard construction practices. No lab or field testing specifications are required for the installation of the vegetative soil layer beyond permeability testing discussed in **Section 2.5**. This layer will be installed at a minimum 6-inch thick layer as the uppermost layer of the final cover system

2.5 Intermediate and Final Cover Materials

Soil materials from borrow areas or stockpiles to be utilized for final cover system, (intermediate cover, infiltration barrier, and erosion/vegetation layers) must be tested for permeability prior to construction. Soils with a permeability of $1x10^{-5}$ cm/s or less shall be constructed as defined in the Closure and Post Closure Care Plan (**Appendix H** of the Permit Narrative). Soils with high permeabilities must be re-evaluated using the HELP model to determine required thickness to achieve 0.0 inches of percolation through the lower most layer.

2.5 Soils Testing

2.5.1 Test Methods

All testing used to evaluate the suitability or conformance of soils materials shall be carried out in accordance with the current versions of the corresponding American Society for Testing and Materials (ASTM) test procedures. The test methods indicated in **TABLES 2** and **3** are to be utilized for evaluating soil materials (when applicable) for adherence to the project specifications and the materials standards specified in this CQA Plan. All pre-construction and construction testing shall be performed at the frequency given in the **TABLES 2** and **3**.

2.5.2 Soils Testing Requirements

All soils testing shall be conducted under the direct supervision of the Soils CQA Consultant and/or qualified Soils CQC Firm. Nuclear densometer methods shall be used for field density testing in all cases. The drive cylinder (ASTM D2937) test or other approved method shall be used in cases of uncertainty, or as a check of the machine calibration. The Soils CQA Consultant and/or CQA Manager shall resolve any conflict over the results.

The test frequencies presented in **TABLES 2** and **3** are specified as minimum test frequencies. The CQA Manager or Soils CQA Consultant can increase the actual frequency of testing required as necessary in order to insure adequate quality control associated with all soil liner/cover systems. For example, the actual test frequencies may be increased in order to consider local soil variability (if applicable).

3.0 GEOSYNTHETIC CLAY LINERS

3.1 Manufacturing

The Geosynthetic Clay Liner (GCL), shall consist of a layer of natural sodium bentonite clay encapsulated between two geotextiles and shall comply with all of the criteria listed in this Section. Reinforced GCL must be used as designated by the Engineer.

Acceptable reinforced GCL products are Bentomat® ST, as manufactured by CETCO, 1350 West Shure Drive, Arlington Heights, Illinois 60004 USA (847-392-5800), or an engineer-approved equal.

The reinforced GCL and its components shall be tested for the properties shown in **TABLE 4**.

The reinforced GCL shall have 10,000 hour test data for large-scale constant-load (creep) shear testing under hydrated conditions. The constant shear load shall be 0.56 kN and the normal load shall be 1.1 kN.

The minimum acceptable dimensions of full-size GCL panels shall be 150 feet (45.7 m) in length. Short rolls [(those manufactured to a length greater than 70 feet (21 m) but less than a full-length roll)] may be supplied at a rate no greater than 3 per truckload or 3 rolls every 36,000 square feet (3,500 square meters) of GCL, whichever is less.

A 6-inch (150 mm) overlap guideline shall be imprinted on both edges of the upper geotextile component of the GCL as a means for providing quality assurance of the overlap dimension. Lines shall be printed in easily visible, non-toxic ink.

The GCL manufacturer shall provide the Project Manager or other designated party with manufacturing QA/QC certifications for each shipment of GCL. The certifications shall be signed by a responsible party employed by the GCL manufacturer and shall include:

A. Certificates of analysis for the bentonite clay used in GCL production stating the parameters swell index and fluid loss.
B. Manufacturer's test data for finished GCL product(s) of bentonite mass/area, GCL tensile strength and GCL peel strength (reinforced only).
C. GCL lot and roll numbers supplied for the project (with corresponding shipping information).

These conformance tests shall be performed in accordance with the test methods specified on **TABLE 4**. Other conformance tests may be required by the project specifications.

Manufacturer's Quality control tests must be performed in accordance with the test methods and frequency's specified in **TABLE 4**.

The CQA Consultant shall examine all manufacturer's certifications to insure that the property values listed on the certifications meet or exceed those specified by the project specifications and the measurements of properties by the manufacturer are properly documented, test methods acceptable and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project Manager.

3.2 Roll Label Requirements

The GCL manufacturer shall identify all rolls with the following:

A. Manufacturer's name
B. Product identification
C. Lot number
D. Roll number
E Roll Dimensions (length, width, and weight)

The CQA Monitor shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

3.3 Shipping, Handling, and Storage

The GCL rolls shall be wrapped in polyethylene sheets or otherwise protected against dust and dirt during shipping and storage. The wrapping shall be removed just prior to the deployment of the rolls.

The manufacturer shall be responsible for initial loading the GCL. Shipping will be the responsibility of the party paying the freight. Unloading, on-site handling and storage of the GCL are the responsibility of the Contractor, Installer or other designated party.

A visual inspection of each roll shall be made during unloading to identify if any packaging has been damaged. Rolls with damaged packaging shall be marked and set aside for further inspection. The packaging shall be repaired prior to being placed in storage.

The party responsible for unloading the GCL shall contact the Manufacturer prior to shipment to ascertain the appropriateness of the proposed unloading methods and equipment.

Storage of the GCL rolls shall be the responsibility of the installer. A dedicated storage area shall be selected at the job site that is away from high traffic areas and is level, dry and well drained. Rolls shall be stored in a manner that prevents sliding or rolling from the stacks and may be accomplished by the use of chock blocks. Rolls shall be stacked at a height no higher than that at which the lifting apparatus can be safely handled (typically no higher than four). All stored GCL materials and the accessory bentonite must be covered with a plastic sheet or tarpaulin until their installation.

3.4 Conformance Testing

3.4.1 Testing Requirements

Upon delivery of the rolls of GCL, the CQA Consultant shall take conformance samples of the GCL, to ensure conformance to both the design specifications and the list of Manufacturer guaranteed properties. **TABLE 4** presents the conformance testing requirements.

3.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first linear meter (three feet). The geosynthetic testing laboratory shall be contacted to determine the sampling size necessary for laboratory testing of the GCL.

3.4.3 Test Results

The CQA Monitor shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager. Any lots not meeting conformance testing specifications will result in the rejection of the lot.

3.5 Installation of the GCL

3.5.1 Earthwork

The Installer shall take whatever steps are necessary to insure that any underling layers are not damaged during the placement of the GCL or that the GCL is damaged in any way, which shall include but is not limited to the following conditions.

Any earthen surface upon which the GCL is installed shall be prepared and compacted in accordance with the project specifications and drawings. The surface shall be smooth, firm, and unyielding, and free of:

A. Vegetation.
B. Construction Debris.
C. Sticks.
D. Sharp rocks (1/2 inch maximum dimension, non-angular)
E. Void spaces.

F. Ice.
G. Abrupt elevation changes.
H. Standing water.
I. Cracks larger than one-quarter inch (6 mm) in width.
J. Any other foreign matter that could contact the GCL.

Subgrade surfaces consisting of granular soils or gravel shall be inspected due to their large void fraction and puncture potential. Immediately prior to GCL deployment, the subgrade shall be final-graded to fill in all voids or cracks and then smooth-rolled to provide the best practicable surface for the GCL. At completion of this activity, no wheel ruts, footprints or other irregularities shall exist in the subgrade. Furthermore, all protrusions extending more than one-half inch (12 mm) from the surface shall either be removed, crushed or pushed into the surface with a smooth-drum compactor. Prior to the placement of all GCL panels, the Installer shall certify in writing that the soil subgrade is acceptable and meets the manufacturer approved installation conditions.

It shall be the Installer's responsibility thereafter to indicate to the Design Engineer changes in the condition of the subgrade that could cause the subgrade to be out of compliance with any of the requirements listed in this Section.

At the top of sloped areas of the job site, an anchor trench for the GCL shall be excavated or an equivalent runout shall be utilized in accordance with the project plans and specifications and as approved by the CQA Inspector. When utilizing an anchor trench design, the trench shall be excavated and approved by the CQA Inspector prior to GCL placement. No loose soil shall be allowed at the bottom of the trench and no sharp corners or protrusions shall exist anywhere within the trench.

The CQA Monitor will note any deficiencies or non-compliance and report it to the Project Manager.

3.5.2 GCL Placement

GCL rolls shall be delivered to the working area of the site in their original packaging. Immediately prior to deployment, the packaging shall be carefully removed without damaging the GCL. The orientation of the GCL (i.e., which side faces up) shall be in accordance with the Design Engineer's recommendations.

Equipment, which could damage the GCL, shall not be allowed to travel directly on it. If the installation equipment causes rutting of the subgrade, the subgrade must be restored to its originally accepted condition before placement continues.

Care must be taken to minimize the extent to which the GCL is dragged across the subgrade in order to avoid damage to the bottom surface of the GCL. A temporary geosynthetic subgrade covering commonly known as a slip sheet or rub sheet may be used to reduce friction damage during placement.

The GCL panels shall be placed parallel to the direction of the slope.

All GCL panels shall lie flat on the underlying surface, with no wrinkles or folds, especially at the exposed edges of the panels.

Only as much GCL shall be deployed as can be covered at the end of the working day with soil, a geomembrane, or a temporary waterproof tarpaulin. The GCL shall not be left uncovered overnight. If the GCL is hydrated when no confining stress is present, it may be necessary to remove and replace the hydrated material. The Design Engineer, CQA inspector, and GCL supplier shall be consulted for specific guidance if premature hydration occurs.

3.5.3 Anchorage

As directed by the project drawings and specifications, the ends of the GCL rolls shall be placed in an anchor trench at the top of the slope or an equivalent run out design shall be utilized. When utilizing an anchor trench design, the front edge of the trench shall be rounded so as to eliminate any sharp corners. Loose soil shall be removed from the floor of the trench. The GCL shall cover the entire trench floor but not extend up the rear trench wall.

3.5.4 Seaming

The GCL seams are constructed by overlapping their adjacent edges. Care shall be taken to ensure that the overlap zone is not contaminated with loose soil or other debris. Supplemental bentonite is required for reinforced GCL. All GCL shall be installed according to the manufacturer's recommendations.

The minimum dimension of the longitudinal overlap shall be 6 inches (150 mm). End-of-roll overlapped seams shall be similarly constructed, but the minimum overlap shall measure 24 inches (600 mm).

Seams at the ends of the panels shall be constructed such that they are shingled downhill in the direction of the grade to prevent the potential for runoff flow to enter the overlap zone.

Bentonite-enhanced seams are constructed between the overlapping adjacent panels described above. The underlying edge of the longitudinal overlap is exposed and then a continuous bead of granular sodium bentonite is applied along a zone defined by the edge of the underlying panel and the 6-inch (150-mm) line. A similar bead of granular sodium bentonite is applied at the end-of-roll overlap. The granular bentonite shall be applied at a minimum application rate of one quarter pound per lineal foot (0.4 kg/m).

3.5.5 Detail Work

The GCL shall be sealed around penetrations and embedded structures embedded in accordance with the design drawings and the GCL Manufacturer.

Cutting the GCL shall be performed using a sharp utility knife. Frequent blade changes are recommended to avoid damage to the geotextile components of the GCL during the cutting process.

3.5.6 Damage Repair

If the GCL is damaged (torn, punctured, perforated, etc.) during installation, it may be possible to repair it by cutting a patch to fit over the damaged area. The patch shall be obtained from a new GCL roll and shall be cut to size such that a minimum overlap of 12 inches (300 mm) is achieved around all of the damaged area. Granular bentonite or bentonite mastic shall be applied around the damaged area prior to placement of the patch. It may be desirable to use an adhesive to affix the patch in place so that it is not displaced during cover placement.

3.5.7 Cover Placement

If soil cover is to be placed in direct contact, cover soils shall be free of angular stones or other foreign matter that could damage the GCL. Cover soils shall be approved the Design Engineer with respect to particle size, uniformity and chemical compatibility. Cover soils with high concentrations of calcium (e.g., limestone, dolomite) are not acceptable.

Soil cover shall be placed over the GCL using construction equipment that minimizes stresses on the GCL. A minimum thickness of 1 foot (300 mm) of cover shall be maintained between the equipment tires/tracks and the GCL at all times during the covering process. This thickness recommendation does not apply to frequently trafficked areas or roadways, for which a minimum thickness of 2 feet (600 mm) is required (see **TABLE 1**).

Soil cover shall be placed in a manner that prevents the soil from entering the GCL overlap zones. Cover soil shall be pushed up slopes, not down slopes, to minimize tensile forces on the GCL.

Although direct vehicular contact with the GCL is to be avoided, lightweight, low ground pressure vehicles (such as 4-wheel all-terrain vehicles) may be used to facilitate the installation of any geosynthetic material placed over the GCL. The GCL supplier or CQA engineer shall be contacted with specific recommendations on the appropriate procedures in this situation.

When a textured geomembrane is installed over the GCL, a temporary smooth geosynthetic covering known as a slip sheet or rub sheet shall be used to minimize friction during placement and to allow the textured geomembrane to be more easily moved into its final position.

4.0 DOCUMENTATION

The CQA Manager shall document that quality assurance requirements have been addressed and satisfied. The CQA Manager shall provide the Project Manager with signed descriptive remarks, data sheets, and logs to verify that all monitoring activities have been carried out. The CQA Manager shall also maintain at the job site a complete file of plans and specifications, a CQA plan, checklists, test procedures, daily logs, and other pertinent documents.

4.1 Daily Recordkeeping

Standard reporting procedures shall include preparation of a daily report, which at a minimum, will consist of: (a) field notes, including memoranda of meetings and/or discussions with the Contractor; (b) observation logs and testing data sheets; and (c) construction problems and solution data sheets. This information will be regularly submitted to and reviewed by the Project Manager.

4.1.1 Memorandum of Discussion with Earthwork Contractor or Subcontractors

A memorandum will be prepared each day, if required, summarizing discussions between the Soils CQA Monitor and Contractor. At a minimum, the memorandum will include the following information:

1. Date, project name, location, and other identification;
2. Name of parties to discussion;
3. Relevant subject matter or issues;
4. Activities planned;
5. Constraints or suggestions;
6. Schedule; and
7. Signature of the CQA Monitor and/or CQA Manager.

4.1.2 Observation Logs and Testing Data Sheets

Observation and testing data sheets shall be prepared daily with a Site Plan diagram prepared at the end of each week. At a minimum, these data sheets shall include the following information:

1. An identifying sheet number for cross referencing and document control;
2. Date, project name, location, and other identification;
3. Data on weather conditions;
4. A scaled Site Plan (weekly) showing all active and proposed work areas and test locations;

5. Descriptions and locations of ongoing construction;
6. Equipment and personnel in each work area, including subcontractors;
7. Descriptions and specific locations of areas of work being tested and/or observed and documented (identified by lift and location);
8. Locations where tests and samples were taken;
9. A summary of test results;
10. Calibration or recalibrations or test equipment, and actions taken as result of recalibration;
11. Off-site materials received, including quality verification documentation;
12. Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and
13. The CQA Monitor signature.

In any case, all logs must be completely filled out with no items left blank.

4.2 Construction Problems and Solution Data Sheets

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, and must include the following information, where available:

1. An identifying sheet number for cross-referencing and document control;
2. A detailed description of the situation or deficiency;
3. The location and probable cause of the situation or deficiency;
4. How and when the situation or deficiency was found or located;
5. Documentation of the response to the situation or deficiency;
6. Final results of any responses;
7. Any measures taken to prevent a similar situation from occurring in the future; and
8. The signature of the CQA Monitor and signature indicating concurrence from the Project Manager.

The Project Manager shall be made aware of any significant recurring non-conformance with specifications. The Project Manager shall then determine the cause of the non-conformance and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results must be documented, and the Owner and the Design Engineer shall approve any revision to procedures or specifications.

A summary of all supporting data sheets, along with final testing results and the CQA Manager's approval of the work, shall be required upon completion of construction.

4.3 Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, shall be cross-referenced with observation and testing data sheet(s), and/or construction problems and solution data sheet(s). These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain digital color prints; the digital photos will also be stored on appropriate media. These records shall be presented to the Project Manager upon completion of the project and all CQA documentation will be stored in the POR.

4.4 Design and/or Specification Changes

Design and/or specification changes may be required during construction. In such cases, the CQA Manager shall notify the Project Manager and the Design Engineer. Design and/or specification changes shall be made only with written agreement from the Project Manager and the Design Engineer, and shall take the form of an addendum to the specifications.

4.5 Progress Reports

The CQA Manager shall prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report shall include the following information:

1. A unique identifying sheet number for cross-referencing and document control;
2. The date, project name, location, and other information;
3. A summary of work activities during progress reporting period;
4. A summary of construction situations, deficiencies, and/or defects occurring during progress reporting period;
5. A summary of test results, failures and retests; and
6. The signature of the CQA Manager.

4.6 Signatures and Final Report

At the completion of the work, the CQA Engineer shall submit to the Project Manager and/or Design Engineer a signed final Report. This report shall certify that the work has been performed in compliance with the plans and specifications except as properly authorized and implemented, and that the summary document provides the necessary supporting information.

At a minimum, this report shall include: (a) summaries of all construction activities; (b) observation logs and testing data sheets including sample location plans; (c) construction problems and solutions data sheets; (d) changes from design and material specifications; (e) Record Drawings; and (f) a summary statement sealed and signed by a registered Professional

Engineer. The Record Drawings shall include scaled drawings depicting the location of the construction details pertaining to the extent of construction (depths, plan dimensions, elevations, soil component thickness, etc.). This document shall be prepared by the CQA Consultant and included as part of the CQA documentation. CQA documentation will be submitted to the NMOCD and retained in the Facility POR.

SECTION 4
GEOSYNTHETICS CONSTRUCTION QUALITY ASSURANCE

1.0 GEOMEMBRANE MANUFACTURING, SHIPPING, & CONFORMANCE TESTING

1.1 Manufacturing

1.1.1 Raw Material

The raw material to be utilized in the manufacturing of the geomembrane shall be first quality polyethylene resin. The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material. The base polyethylene resin shall be mixed with carbon black and a proprietary additive package of heat stabilizers and anti-oxidants. The percent distribution of these components including recycled polymer shall be as per the project specifications.

The raw material shall be first quality polyethylene resin and shall be tested by the Manufacturer for the specifications in **TABLES 5A** and **5B**.

Raw materials (resin, carbon black, and additive package) may be mixed during the production stage using a “masterbatch” carrier resin containing the carbon black and other additives or during a compounding process prior to production.

Conformance testing shall be carried out by the Manufacturer to demonstrate that the product meets this specification. At the Owner's discretion, additional testing may be carried out for purposes of conformance by the Geosynthetics CQC Firm, and paid for by the Owner. If the results of the Manufacturer's and the Geosynthetics CQC Firm's testing differ, the testing shall be repeated by the Geosynthetics CQC Firm, and the Manufacturer shall be allowed to monitor this testing. The results of this latter series of tests will prevail, if the applicable test methods have been followed.

Prior to the installation of any geomembrane material, the Manufacturer shall provide the Project Manager and the Geosynthetics CQA Monitor with the following information:

1. The origin (Resin Supplier's name and resin production plant), identification (brand name, number) and production date of the resin;
2. A copy of the quality control certificates issued by the Resin Supplier to include specific gravity (ASTM D1505) and melt index (ASTM D1238 Condition , 190ºC/2.16 kg); and
3. A statement that no reclaimed polymer is added to the resin (however, the use of polymer recycled during the manufacturing process may be permitted if done with appropriate cleanliness and if recycled polymer does not exceed 2% by weight).

The CQA Monitor shall review these documents and shall report any discrepancies to the Project Manager.

1.1.2 Geomembrane Manufacturing

The Project Manager shall provide to the CQA Monitor the plans, specifications and drawings for the lining system prepared by the Design Engineer. **TABLES 5A** and **5B** provide the frequency of testing for the geomembrane. The CQA Monitor shall verify that the specifications include at least all properties listed in **TABLES 5A** and **5B**, measured with the same methods or equivalent.

If the specifications do not fulfill the above conditions, the Design Engineer shall complete the required alterations of the specifications. The Geomembrane Manufacturer shall provide the Project Manager and the CQA Monitor with the following:

1. A properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications, or equivalent;
2. A list of quantities and descriptions of materials other than the base polymer which comprise the geomembrane;
3. The sampling procedures and results of testing; and
4. A certification that property values given in the properties sheet are guaranteed by the Geomembrane Manufacturer.

The CQA Monitor shall verify that:

1. the property values certified by the Geomembrane Manufacturer meet all of the specifications; and
2. the measurements of properties by the Geomembrane Manufacturer are properly documented and that the test methods used are acceptable.

In addition, the Geosynthetics CQA Monitor may, at the request of the owner, undertake a manufacturing plant visit, preferably during the production of the particular geomembrane for this project, in order to evaluate the Manufacturer's quality control procedures.

1.1.3 Rolls

Prior to shipment, the Geomembrane Manufacturer shall provide the Project Manager and the CQA Consultant with a quality control certificate for every roll of geomembrane to be provided for the particular project. A responsible party employed by the Geomembrane Manufacturer, such as the production manager, shall sign the quality control certificate. The quality control certificate shall include:

1. Roll numbers and identification; and

2. Sampling procedures and results of quality control tests - as a minimum, results shall be given for thickness, tensile strength, and tear resistance, evaluated in accordance with the methods indicated in the specifications or equivalent methods approved by the Designer.

The CQA Monitor shall:

1. Verify that the quality control certificates have been provided at the specified frequency, and that each certificate identifies the rolls related to it; and
2. Review the quality control certificates and verify that the certified roll properties meet the specifications.

1.2 Roll Label Requirements

All rolls delivered to the site must be labeled containing the following information:

1. Roll Number;
2. Material Type;
3. Nominal Thickness; and
4. Batch Number.

The geomembrane rolls are to be packaged with a label placed on the outside of the roll and one within the roll core. If both of these labels are missing or ineligible, the roll will be rejected.

1.3 Shipping, Handling, and Storage Requirements

1.3.1 Shipping

Shipping of the geomembrane is the responsibility of the Geomembrane Manufacturer, Fabricator, Installer, or other party as agreed upon. All handling on site is the responsibility of the Installer.

Upon delivery at the site, the Installer and the Geosynthetics CQA Consultant shall conduct a surface observation of all rolls or factory panels for defects and for damage. This inspection shall be conducted without unrolling rolls or unfolding factory panels unless defects or damages are found or suspected. The Geosynthetics CQA Consultant shall indicate to the Project Manager:

1. Rolls, factory panels, or portions thereof, which shall be rejected and removed from the site because they have severe flaws; and
2. Rolls or factory panels that include minor repairable flaws.

1.3.2 Handling

The geomembrane temporary tagging area on site shall be coordinated with the on-site CQA Manager and the Installer to insure ease of transportation and placement in an area were the geomembrane will not be damaged or in the way of daily operations of the landfill. Two high strength carrying straps must be placed around the outside of the roll to assist in transportation and handling of the material on the construction site.

1.3.3 Storage Requirements

The Installer shall be responsible for the storage of the geomembrane on site. The Project Manager shall provide storage space in a location (or several locations) such that on-site transportation and handling are optimized if possible. Storage space shall be protected from theft, vandalism, passage of vehicles, etc. If the geomembrane is to be exposed to the weather for an extended period of time, it shall be covered until installed. The designated storage area shall be a firm, smooth surface free of large and/or sharp stones or any other sharp objects that could damage the liner. If the area is sloped or the rolls are stacked, precautions shall be taken to insure that the rolls will not shift or move causing possible damage to the rolls are injuring workers.

1.4 Conformance Testing of Geomembrane

1.4.1 Tests and Procedures

Upon or prior to delivery of the rolls of geomembrane, the CQA Monitor shall insure that samples are removed at the specified frequency and forwarded to the Geosynthetics CQC Firm for testing to insure conformance to both the design specifications and the list of guaranteed properties. The test procedures shall be as indicated in **TABLES 5A** and **5B** based on material type or as specified in the project plans. Additionally, the Geomembrane shall meet or exceed the following specifications:

1. Conformance testing (1 test set every lot or every 100,000 ft^2 whichever is greater). Material lots found not in conformance will be rejected.
   a. Density (ASTM D1505);
   b. Carbon Black Content (ASTM D1603);
   c. Carbon Black Dispersion (ASTM D5596);
   d. Thickness (ASTM D5994);
   e. Tensile Properties (ASTM D6693/Type IV); and
   f. Tear Resistance (ASTM D1004, Die C).
2. Seam Testing:
   a. Trial seams tested in field tensiometer or at testing laboratory at the beginning of everyday and every five working hours; and
   b. Air pressure and vacuum testing of all field seam lengths (ASTM D4437).

1.4.2 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three linear feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the machine direction on the samples with an arrow. The required minimum sampling frequencies are provided in **TABLES 5A** and **5B** .

1.4.3 Test Results

The CQA Monitor shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager.

2.0 INSTALLATION OF GEOMEMBRANE

2.1 Earthwork

2.1.1 Subgrade Preparation

The CQA Monitor shall verify that:

1. A qualified land surveyor has verified all lines and grades;
2. A qualified geotechnical engineer, normally the Soils CQA Consultant, has verified that the supporting soil meets the density specification;
3. The surface to be lined has been rolled and compacted to be free of irregularities, protrusions, loose soil, and abrupt changes in grade;
4. The surface of the supporting soil does not contain stones larger than ½” in diameter and non-angular which may be damaging to the geomembrane; and
5. There is no area excessively softened by high water content.

The Installer shall certify in writing that the surface on which the geomembrane will be installed is acceptable. The certificate of acceptance shall be given by the Installer to the Project Manager prior to commencement of geomembrane installation in the area under consideration. The CQA Consultant shall be given a copy of this certificate by the Project Manager.

After the supporting soil has been accepted by the Installer, it shall be the Installer's responsibility to indicate to the Project Manager any change in the supporting soil condition that may require repair work. If the Geosynthetics CQA Monitor concurs with the Installer, then the Project Manager shall insure that the supporting soil is repaired.

At any time before and during the geomembrane installation, the Geosynthetics CQA Monitor shall indicate to the Project Manager locations that may not provide adequate support to the geomembrane.

2.1.2 Anchor Trench System

All anchor trench systems will be excavated in accordance with the lines and widths as shown on the contract drawings, before geosynthetics placements. The CQA Consultant shall verify that the anchor trench has been constructed according to design drawings.

If the anchor trench is excavated in a clay liner susceptible to desiccation, no more than the amount of trench required for the geomembrane to be anchored in one day shall be excavated (unless otherwise specified) to minimize desiccation potential of the anchor trench clay soils. The corners of the anchor trench where geosynthetic enters the trench shall be slightly rounded to avoid sharp bends in the geosynthetics. No loose soil shall be allowed to underlie the geomembrane in the anchor trench. No large rocks or clay lumps will be allowed to underlie the geomembrane in the anchor trench.

Backfilling of the anchor trench shall be conducted utilizing suitable backfill materials as deemed appropriate by the CQA Manager. All anchor trenches shall be backfilled in 12" compacted lifts. If a compaction standard is included in the Project Specifications, the anchor trenches shall be tested at a frequency of one test per 100 feet of trench (each lift).

2.2 Geosynthetic Placement

2.2.1 Installation Schedule

Field panels may be installed using any one of the following schedules:

1. All field panels are placed prior to field seaming (in order to protect the subgrade from erosion by rain);
2. Field panels are placed one at a time and each field panel is seamed immediately after its placement (in order to minimize the number of unseamed field panels exposed to wind), and
3. Any combination of the above.

If a decision is reached to place all field panels prior to field seaming, installation normally shall begin at the low point area and proceed toward the low point with "shingle" overlaps to facilitate drainage in the event of precipitation. It is also usually beneficial to proceed in the direction of prevailing winds. Accordingly, an early decision regarding installation scheduling shall be made if, and only if, weather conditions can be predicated with certainty. Otherwise, scheduling decisions must be made during installation, in accordance with varying conditions. In any event, the Installer is fully responsible for the decision made regarding placement procedures.

The CQA Monitor shall evaluate changes in the schedule proposed by the Installer and advise the Project Manager on the acceptability of that change. The CQA Monitor shall verify that the condition of the supporting soil has not changed detrimentally during installation. The CQA Monitor shall record the identification code, location, and date of installation of each field panel.

2.2.2 Field Panel Location and Identification

Field panels are to be located by the CQA Monitor in a manner consistent with the specifications and in a manner best suited to existing site conditions (i.e., a field panel is a roll or a portion of roll cut in the field).

A field panel is the unit area of geomembrane which is to be seamed in the field. Two cases can be considered:

1. If the geomembrane is fabricated into panels in a factory, a field panel is a factory panel or a portion of factory panel cut in the field.
2. If the geomembrane is not fabricated into factory panels, a field panel is a roll or a portion of roll cut in the field.

It shall be the responsibility of the CQA Monitor to insure that each field panel is given an "identification code" (number or letter-number) consistent with the layout plan. The Project Manager, Installer and CQA Monitor shall agree upon this identification code. This field panel identification code shall be as simple and logical as possible. (Note that roll numbers established in the manufacturing plant must be traceable to the field panel identification code.)

The CQA Consultant shall establish documentation showing correspondence between roll numbers, factory panels, and field panel identification codes. The Field panel identification code shall be used for all quality assurance records. The CQA Consultant shall verify that field panels are installed at the location indicated in the Designer's layout plan, as approved or modified.

2.2.3 Weather Conditions

Geomembrane placement shall not proceed at an ambient temperature below 5°C (40°F) unless otherwise authorized. Geomembrane placement shall not be done during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponding water, or in the presence of excessive winds.

The CQA Monitor shall verify that the above conditions are fulfilled. Additionally, the CQA Consultant shall verify that the supporting soil has not been damaged by weather conditions. The Geosynthetics CQA Monitor shall inform the Project Manager if the above conditions are not fulfilled.

2.2.4 Method of Placement

The Geosynthetics CQA Monitor shall verify the following:

1. Construction equipment used to deploy geomembranes shall not create excessive rutting in the subgrade;
2. If the substratum is a geosynthetic material, deployment may be by hand, by use of small jack lifts on pneumatic tires having low ground contact pressure, or by use of all-terrain vehicles (ATVs) having low ground contact pressure;
3. Any equipment used does not damage the geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means;
4. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance, and is still acceptable immediately prior to geomembrane placement;
5. Any geosynthetic elements immediately underlying the geomembrane are clean and free of debris;
6. All personnel working on the geomembrane do not smoke, wear damaging shoes, or engage in other activities which could damage the geomembrane;
7. The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil;
8. The method used to place the panels minimizes wrinkles (especially differential wrinkles between adjacent panels);
9. Adequate temporary loading and/or anchoring (e.g., sand bags, tires), not likely to damage the geomembrane, has been placed to prevent uplift by wind (in case of high winds, continuous loading, e.g., adjacent sand bags, is recommended along edges of panels to minimize risk of wind flow under the panels);
10. Direct contact with the geomembrane is minimized; i.e., the Geomembrane is protected by geotextiles, extra geomembrane, or other suitable materials, in areas where excessive traffic may be expected;
11. No bridging or stressed conditions in the material; and
12. Pipes or other objects that penetrate the liner are connected to the liner material in a way that prevents leakage and unnecessary stresses.

The Geosynthetics CQA Monitor shall inform the Project Manager if the above conditions are not fulfilled.

2.2.5 Damage

The Geosynthetics CQA Monitor shall inspect each panel, after placement and prior to seaming, for damage. The Geosynthetics CQA Manager shall advise the Project Manager which panels, or portions of panels, shall be rejected, repaired, or accepted. Damaged panels or portions of damaged panels which have been rejected shall be marked and their removal from the work area recorded by the Geosynthetics CQA Consultant. Repairs shall be made according to procedures described in Section 2.4.

2.3 Seaming and Joining

2.3.1 Seam Layout

The Installer shall provide the Project Manager and the Geosynthetics CQA Monitor with a seam layout drawing, i.e., a drawing of the facility to be lined showing all expected seams. The Geosynthetics CQA Monitor shall review the seam layout drawing and verify that it is consistent with accepted industry practice. No panels may be seamed in the field without the Project Manager's approval. In addition, no panels not specifically shown on the seam layout drawing may be used without the Project Manager's prior approval.

Seams will be made by overlapping sheets approximately three inches (3") for extrusion welding and approximately four inches (4") for hot wedge welding. In general, seams shall be oriented parallel to the line of maximum slope, i.e., oriented along, not across, the slope, In corners and odd shaped geometric locations, the number of seams shall be minimized. No horizontal seam shall be less than 5 feet from the toe of the slope, or areas of potential stress concentrations, unless otherwise authorized.

A seam numbering system compatible with the panel numbering system shall be agreed upon at the Resolution and/or Pre-Construction Meeting.

2.3.2 Requirements of Personnel

All personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. At least one seamer shall have experience seaming a minimum of 5,000,000 ft^2 of polyethylene geomembrane using the same type of seaming apparatus to be used to fabricate the site-specific geomembrane. The most experienced seamer, the "master seamer", shall provide direct supervision over less experienced seamers.

The Installer shall provide the Project Manager and the Geosynthetics CQA Consultant with a list of proposed seaming personnel and their experience records. The Project Manager and the Geosynthetic CQA Monitor shall review this document.

2.3.3 Seaming Equipment and Products

The approved processes for field seaming are extrusion welding and hot wedge (fusion) welding. Proposed alternate processes will be documented and submitted to the owner or his representative for approval. The hot wedge welding system is generally the primary system for geomembrane installation and the extrusion welding system is utilized for repairs and detail work. Only apparatus, which have been specifically approved by make and model, shall be used. The Project Manager and the Geosynthetics CQA Monitor shall approve all seaming processes and apparatus.

The Installer will verify the following general conditions during the seaming of the liner:

1. Equipment used for seaming is not likely to damage the geomembrane;
2. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane;
3. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
4. The geomembrane is protected from damage in heavily trafficked areas.

2.3.3.1 Hot Wedge Welding/Fusion System

The hot wedge welding apparatus (typically called a fusion welder) is self-propelled and produces a double seam with an enclosed air channel for testing. The fusion welding consists of placing two heated wedge mounted self-propelled unit, between two overlapped sheets of polyethylene liner. The heated plate heats and fuses the two sheets together. The fusion welder must meet the following requirements:

1. A temperature readout device that continuously monitors the temperature of the wedge;
2. For cross seams, the edge of the cross seam is ground to a smooth incline (top and bottom) prior to welding;
3. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage; and
4. The geomembrane is protected from damage in heavily trafficked areas.

2.3.3.2 Extrusion (Fillet) Welding System

The extrusion-welding apparatus shall be equipped with gauges giving the extrudate temperature in the apparatus and at the nozzle. The Installer shall provide documentation regarding the extrudate to the Project Manager and the Geosynthetics CQA Monitor, and shall certify that the extrudate is compatible with the specifications, and in any event is comprised of the same resin as the geomembrane sheeting.

The Geosynthetics CQA Monitor and the Installer shall log apparatus temperatures, extrudate temperatures, ambient temperatures, and geomembrane surface temperatures at appropriate intervals. The Geosynthetics CQA Monitor shall verify that the extruder is purged prior to beginning a seam until all heat-degraded extrudate has been removed from the barrel. The welder also must be equipped with gauges giving the temperature in the apparatus and the preheat temperature at the nozzle.

2.3.4 Seam Preparation

The Installer shall insure that:

1. Before seaming, the seam area is clean and free of moisture, dust, dirt, debris of any kind, and foreign material;
2. If seam overlap grinding is required, the process is completed according to the Geomembrane Manufacturer's instructions, within one hour of the seaming operation and in a way that does not damage the geomembrane; and
3. Seams are aligned with the fewest possible number of wrinkles and "fish mouths".

2.3.5 Seaming in Various Weather Conditions

The high temperature limit for welding is based on two factors:

1. The well-being of the crew. Black lining material will get very hot when exposed to sunlight. It is possible that the elevated sheet temperature in conjunction with immoderate ambient conditions could place the well-being of the crew at risk. (It is the responsibility of the Installer to determine if their crew can work in the weather conditions at the site).
2. Material capability.

The highest temperature at which the material can be welded is dependent upon ambient temperature, wind, subgrade conditions exposure to light, material type, and material thickness.

Thinner materials and low density products are the most difficult to seam at high liner temperatures. The problem typically is characterized by frequent burnouts (places in the liner weld where the rollers lose traction and the machine stops moving causing the wedge to burn through the liner). The number of burnouts can often be reduced by adjusting the speed or the temperature at which the welder is operating. If the Installer determines the sheet temperature has reached a temperature in which to large a number of burnouts occurs they can stop welding until favorable conditions return.

The lowest allowable temperature at which welding may be permitted is dependent on ambient temperature, wind, subgrade conditions exposure to light, material type, and material thickness.

Typically during cold weather it is necessary to reduce the welders speed and increase the temperature. Pre-heating the liner in advance of the welding apparatus may also be done by using a hot air blower.

At low temperatures, special attention must be made to the pre-weld destructive samples (trial welds). In cold conditions trial welds shall be performed under the same conditions that will be seen during actual seaming conditions. The lowest temperature at which welding may occur is at the temperature which consistent passing trial seams can be performed under actual seaming conditions. In order to obtain passing results, it may be necessary to preheat the sheet in advance and/or shield the sheets from the wind. This is allowable as long as it is done during the actual welding of the liner.

The normally required weather conditions for seaming are as follows:

1. Unless authorized in writing by the Project Manager, no seaming shall be attempted at an ambient temperature below 5°C (40°F) or above 40°C (104°F);
2. In all cases, the geomembrane shall be dry and protected from wind.

If the Installer wishes to use methods which may allow seaming at ambient temperature below 5 °C (40°F) or above 40°C (104°F), the Installer shall demonstrate and certify that such methods produce seams which are entirely equivalent to seams produced at ambient temperatures above 5°C (40°F), and that the overall quality of the geomembrane is not adversely affected. In addition, an addendum to the contract between the Owner and the Installer is required which specifically states that the seaming procedure does not cause any physical or chemical modification to the geomembrane that will generate any short or long term damage to the geomembrane. Then, the temperatures in the above quality assurance procedure shall be modified accordingly.

The Geosynthetics CQA Monitor shall verify that these weather conditions are fulfilled and will advise the Project Manager if they are not. The Project Manager shall then decide if the installation shall be stopped or postponed.

2.3.6 Trial Seams

Trial seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, and at least once each five hours, for each seaming apparatus used that day. In addition, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams.

An extrusion welded trial seam sample shall be at least 3 feet long by 1 foot wide (after seaming) with the seam centered lengthwise. Fusion welded trial seam samples shall be at least 15 feet long by 1 foot wide (after seaming) with the seam centered lengthwise.

Ten adjoining specimens, each 1 inch wide, shall be cut from the trial seam sample by the Installer. Three specimens shall be tested for shear strength and three shall be tested for peel using a gauged tensiometer. If a specimen fails to meet the seam requirement set forth in the Project Specifications, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full trial seams achieved.

The CQA Monitor shall observe all trial seam procedures. The remainder of the successful trial seam sample shall be assigned a number and marked accordingly by the CQA Monitor, who shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description. At the discretion of the CQA Consultant, samples of trial seams may be submitted to the Geosynthetics Laboratory for analysis.

After completion of the above described tests, the remaining portion of the trial seam sample can be discarded. Alternatively, if agreed upon between the parties involved and documented by the CQA Monitor in his daily report, the remaining portion of the trial seam sample can be subjected to destructive testing. If a trial seam sample fails a test conducted by the Geosynthetics Installer, then a destructive test seam sample shall be taken from each of the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the Geosynthetics Laboratory and, if they fail the tests, the procedure indicated in Section 2.3.9.5 shall apply. The conditions of this paragraph shall be considered fulfilled for a given seam if a destructive seam test sample has previously been taken.

2.3.7 Seaming Procedures

Unless otherwise specified, the general seaming procedure used by the Installer shall be as follows:

1. For fusion welding, a movable protective layer of plastic may be required to be placed directly below each overlap of geomembrane that is to be seamed. This is to prevent any moisture build-up between the sheets to be welded;
2. The rolls of the membrane will be overlapped wide enough to weld and test properly; this is usually 3” for extrusion welding and 4” for fusion welding;
3. Fish mouths or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut fish mouths or wrinkles shall be seamed and any position where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 6 inches beyond the cut in all directions;
4. If seaming operations are carried out at night, adequate illumination shall be provided at the Contractor's expense; and

5. Seaming shall extend to the outside edge of panels to be placed in the anchor trench.

The CQA Monitor shall verify that the above seaming procedures are followed, and shall inform the Project Manager if they are not.

2.3.8 Non-Destructive Testing

The Installer shall non-destructively test all field seams over their full length using a vacuum test unit or air pressure test (for double fusion seams only), or other approved method. The purpose of nondestructive tests is to check the continuity of seams. It does not provide any information on seam strength. Continuity testing shall be carried out as the seaming work progresses, not at the completion of all field seaming.

The CQA Monitor shall:

1. Observe all continuity testing;
2. Record location, date, test unit number, name of tester, and outcome of all testing;
3. Inform the Installer and Project Manager of any required repairs;
4. Observe the repair and re-testing of the repair;
5. Mark on the geomembrane that the repair has been made; and
6. Document the results.

The seam number, date of observation, name of tester, and outcome of the test or observation shall be recorded by the CQA Monitor.

2.3.8.1 Vacuum Testing

The equipment shall be comprised of the following:

1. A vacuum pump that is fuel or electric powered and capable of sustaining the required vacuum for the test;
2. A vacuum gauge capable of registering to 10 psi (70 kPa) in increments of ¾ psi (5 kPa);
3. A foaming solution shall be pre-mixed with water at a ratio to form bubbles. It shall be dispensed by spray, brush, or other means. The solution shall be compatible with the geomembrane;
4. A vacuum chamber shall have an open bottom and a clear viewing panel on top. It shall be an appropriate size and shape, made of rigid materials, and equipped with a vacuum gauge, valve, and soft pliable gasket around the periphery of the open bottom.

The following procedures shall be followed:

1. The area to be tested shall be clean and free of soil or foreign objects to promote a good seal;
2. Energize the vacuum pump;
3. Wet the seam and surrounding area approximately twice the width and length of the vacuum chamber with a foamy solution;
4. Place the vacuum chamber over the test area such that the gasket is in complete contact with the geomembrane;
5. Apply a force to the top of the vacuum chamber to obtain a seal and open the vacuum valve;
6. Ensure a leak tight seal is created. A minimum vacuum of 4 to 8 psi (28 to 55 kPa) registered on the gauge shall be appropriate;
7. With the force applied, observe the geomembrane seam through the viewing port for bubbles through any defects in the seam. The vacuum shall hold for a duration not less than 10 seconds;
8. If bubbles appear on the geomembrane seam, open the valve to release the vacuum and remove the chamber from the seam. The defective area shall be marked for repair;
9. If no bubble appears after 10 seconds, open the valve to release the vacuum and remove the vacuum chamber from the seam.
10. Move the vacuum chamber to the adjoining portion of the seam or test area overlapping the previously tested area by no less than 10% of the chamber length or at least 2"(50mm), whichever is greater and repeat the procedure for the entire seam.
11. All areas where soap bubbles appear shall be marked and repaired in accordance with Section 2.4.

2.3.8.2 Air Pressure Testing (Fusion Welded Seams)

The following procedures are applicable to those processes that produce a double seam with an enclosed space. The equipment shall be comprised of the following:

1. An air pump (manual or motor driven) equipped with pressure gauge capable of generating and sustaining a pressure of 50 psi and mounted on a cushion to protect the geomembrane;
2. A rubber hose with fittings and connections;
3. A sharp hollow needle, or other approved pressure feed device;
4. A knife capable of cutting the liner material; and
5. A pressure gauge capable of indicating air pressure in 1 psi within the test range.

The following procedures shall be followed:

1. Seal both ends of the seam to be tested;
2. Insert needle or other approved pressure feed device into the tunnel created by the fusion weld;
3. insert a protective cushion between the air pump and the geomembrane;
4. Energize the air pump to a pressure of 35 psi plus or minus 1%, close valve, and sustain pressure for at least 5 minutes;
5. Cut opposite end of tested seam after completion of the 5-minute pressure hold period to verify complete testing of the seam. If the pressure gauge does not indicate a release of pressure, locate blockage of the air channel and retest until entire seam is tested; and
6. Remove needle or other approved pressure feed device and seal.

2.3.9 Destructive Testing

Destructive testing provides direct evaluation of seam strength and bonding efficiency which indicates seam strength and durability. Destructive seam tests shall be performed at selected locations. Seam strength testing shall be done as the seaming work progresses, not at the completion of all field seaming.

Destructive testing involves two techniques (1) shear testing and (2) peel testing. Shear testing applies a tensile stress from the top of the sheet through the weld and into the bottom sheet. Peel testing, on the other hand, peels the top sheet back against the overlapped edge of the bottom of the sheet in order to observe how separation occurs. The peel test indicates whether the sheets are continuously and homogeneously connected through the seam.

2.3.9.1 Location and Frequency

The Geosynthetics CQA Monitor shall select locations where seam samples will be cut out for laboratory testing. Those locations shall be established as follows:

- A minimum frequency of one test location per 500 feet of seam length as indicated in **TABLES 5A** and **5B**. This minimum frequency is to be determined as an average taken throughout the entire facility;
- A maximum frequency shall be agreed upon by the Installer, Project Manager and Geosynthetics CQA Monitor at the Resolution and/or Pre-Construction Meeting; and
- Test locations shall be determined during seaming at the Geosynthetics CQA Manager's discretion. Selection of such locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or any other potential cause of imperfect welding.

The Installer shall not be informed in advance of the locations where the seam samples will be taken.

Note: For either test, sample failure shall be a Film Tear Bond (FTB) as outlined in NSF 54, Appendix A.

2.3.9.2 Sampling Procedure

Samples shall be cut by the Installer as the seaming progresses in order to have laboratory test results before the geomembrane is covered by another material. The CQA Monitor shall:

1. Observe sample cutting;
2. Assign a number to each sample, and mark it accordingly;
3. Record sample location on layout drawing; and
4. Record reason for taking the sample at this location (e.g., statistical routine, suspicious feature of the geomembrane).

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 2.4. The continuity of the new seams in the repaired area shall be tested according to Section 2.3.8.1. At a given sampling location, two types of samples shall be taken by the Installer.

First, two samples for field testing shall be taken. Each of these samples shall be 1 inch wide by 12 inch long, with the seam centered parallel to the width. The distance between these two samples shall be 42 inches. If both samples pass the field test described in Section 2.3.9.3, a sample for laboratory testing shall be taken. The sample for laboratory testing shall be located between the two samples for field testing. The sample for laboratory testing shall be 12 inches wide by 42 inches long with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Installer for laboratory testing, (12 in. x 12 in.);
2. One portion for Geosynthetics CQC Firm testing, (12 in. x 18 in.); and
3. One portion to the Owner for archive storage, (12 in. x 12 in.).

Final determination of the sample sizes shall be made at the Pre-Construction Meeting.

2.3.9.3 Field Testing

The ten, 1-inch wide strips mentioned in Section 2.3.9.2 shall be tested in the field, by gauged tensiometer, for peel and shear respectively and shall not fail in the seam in addition to meeting the requirements outlined in the specifications. If any field test sample fails to pass, then the procedures outlined in Section 2.3.9.5 shall be followed.

The CQA Monitor shall witness all field tests and mark all samples and portions with their number. The CQA Monitor shall also log the date and time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures, and pass or fail description.

2.3.9.4 Laboratory Testing

Destructive test samples shall be packaged and shipped, if necessary, under the responsibility of the CQA Monitor in a manner which will not damage the test sample. The Project Manager will verify that packing and shipping conditions are acceptable. The Project Manager will be responsible for storing the archive samples. This procedure shall be fully outlined at the Resolution Meeting. Test samples shall be tested by the Geosynthetics CQC Firm. The Geosynthetics CQA Consultant shall select the Geosynthetics CQC Firm, with the concurrence of the Project Manager.

Testing shall include "Bonded Seam Strength and Peel Adhesion". At least 5 specimens shall be tested for each test method. Specimens shall be selected alternately be test from the samples (i.e., peel, shear, peel, shear...). A passing test shall meet the minimum required values in at least 4 out of 5 specimens.

The Geosynthetics CQC Firm shall provide test results no more than 24 hours after they receive the samples. The Geosynthetics CQA Manager shall review laboratory test results as soon as they become available, and make appropriate recommendations to the Project Manager.

The Installer's laboratory test results shall be presented to the Project Manager and the CQA Monitor for comments.

2.3.9.5 Procedures for Destructive Test Failure

The following procedure shall apply whenever a sample fails a destructive test, whether the Geosynthetics CQC Firm, the Installer's laboratory, or the gauged tensiometer conducted that test.

1. The Installer shall trace the welding path to an intermediate location at 10 feet minimum from the point of the failed test in each direction and take a small sample for an additional field test at each location. If these additional samples pass the test, then full laboratory samples are taken. If these laboratory samples pass the tests, then the seam is reconstructed between these locations. If either sample fails, then the process is repeated to establish the zone in which the seam shall be reconstructed.

All acceptable seams must be bonded by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of reconstructed seam, a sample taken from the zone in which the seam has been reconstructed must pass destructive testing. Repairs shall be made in accordance with Section 2.4. The CQA Monitor shall document all actions taken in conjunction with destructive test failures.

2.4 Defects and Repairs

2.4.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the CQA Monitor for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination or foreign matter. Because light reflected by the geomembrane helps to detect defects, the surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be broomed or washed by the Installer if the amount of dust or mud inhibits examination.

2.4.2 Evaluation

Each suspect location both in seam and non-seam areas shall be non-destructively tested using the methods described in Section 2.3.8.1 as appropriate. Each location that fails the non-destructive testing shall be marked by the CQA Monitor and repaired by the Installer. Work shall not proceed with any materials which will cover locations which have been repaired until laboratory test results with passing values are available.

2.4.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be agreed upon between the Project Manager, Installer, and CQA Monitor. The procedures available include:

1. Patching - used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
2. Buffing and re-welding - used to repair small sections of extruded seams;
3. Spot welding or seaming - used to repair small tears, pinholes, or other minor, localized flaws;
4. Capping, used to repair large lengths of failed seams;
5. Removing bad seam and replacing with a strip of new material welded into place (used with large lengths of fusion seams); and
6. Welding of the flap, used to make a new extrusion weld adjacent to an unsatisfactory fusion weld (this procedure may be used only if the flap created by the overlap of the top and bottom panels beyond the fusion weld has not been cut back to the outer edge of the fusion weld).

In addition, the following provisions shall be satisfied:

1. Surfaces of the geomembrane which are to be repaired shall be abraded no more than one hour prior to the repair;
2. All surfaces must be clean and dry at the time of the repair;
3. All seaming equipment used in repairing procedures must be approved;
4. The repair procedures, materials, and techniques shall be approved in advance of the specific repair by the Project Manager, Geosynthetics Construction Quality Assurance Manager, and Installer; and
5. Patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.

2.4.4 Repairs - Non-destructive Testing

Each repair shall be non-destructively tested using the methods described in Section 2.3.8.1 as appropriate. Repairs, which pass the non-destructive test, shall be taken as an indication of an adequate repair. Failed test indicate that the repair must be redone and retested until a passing result is obtained.

2.5 Backfilling of Anchor Trench

The anchor trench, if any, shall be adequately drained, to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted by the Earthwork Contractor of the Installer, as outlined in the specifications and/or bid documents. Care shall be taken when backfilling the trenches to prevent any damage to the geosynthetics. The Geosynthetics and/or Soils CQA Monitor shall observe the backfilling operation and advise the Project Manager of any problems.

Since backfilling the anchor trench can affect material bridging at the toe of the slope, consideration shall be given to backfilling the liner at its most contracted state, preferably during the cool of the morning or extended period of overcast skies.

2.6 Lining System Acceptance

The Installer and the Manufacturers shall retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the Owner. The geosynthetic lining system shall be accepted by the Owner when:

- The installation of all materials are deployed an welded;
- Verification of the adequacy of all seams and repairs, including associated testing, is complete;
- All documentation of installation is completed including the Geosynthetics CQA Consultant's final report; and
- The Project Manager has received certification, including "as built" drawing, sealed by a registered professional engineer.

The Geosynthetics CQA Monitor shall certify that installation has proceeded in accordance with the Geosynthetics CQA Plan for the project except as noted to the Project Manager.

2.7 Materials in Contact with the Geomembrane

The quality assurance procedures indicated in this section are only intended to assure that the installation of these materials does not damage the geomembrane. Additional quality assurance procedures would be necessary to assure that systems built with these materials would be constructed in such a way to enable proper performance.

2.7.1 Soils

The Project Manager shall give a copy of the specifications, prepared by the Designer for placement of soils, to the Geosynthetics CQA Consultant. The Geosynthetics CQA Consultant shall verify that these specifications are consistent with current industry practices.

2.7.2 Concrete

The Project Manager shall give a copy of the specifications, prepared by the Design Engineer for placement of concrete, to the Geosynthetics CQA Monitor. The Geosynthetics CQA Monitor shall verify that these specifications are consistent with the state of the art, including the use of geosynthetic layers between concrete and geomembrane. The Geosynthetics CQA Consultant shall verify the geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. He will also verify that construction methods used are not likely to damage the geomembrane.

2.7.3 Sumps and Appurtenances

The Project Manager shall give a copy of the specifications, prepared by the Design Engineer for sumps and appurtenances, to the Geosynthetics CQA Monitor. The Geosynthetics CQA Monitor shall review these specifications and verify the use of geosynthetic layers between concrete and geomembranes.

The Geosynthetics CQA Monitor shall verify that:

1. Installation of the geomembrane in sump and appurtenance areas, and connection of geomembrane to sumps and appurtenances have been made according to specifications;
2. Care is taken while welding around appurtenances, since neither non-destructive nor destructive testing may be feasible in these areas;
3. The geomembrane has not been damaged while making connections to sumps and appurtenances; and
4. All sumps are tested for primary and secondary geomembrane integrity by filling them with water and making appropriate observations.

3.0 DOCUMENTATION

3.1 Daily Reports

Each of the Geosynthetics CQA Monitors shall complete a daily report and/or logs on prescribed forms, outlining all of his or her monitoring activities for that day. The areas, panel numbers, seams completed and approved, and measures taken to protect unfinished areas overnight shall be identified. Failed seams or other panel areas requiring remedial action shall be identified with regard to nature of action, required repair, and precise location. Repairs completed shall also be identified. Any problems or concerns with regard to operations on site shall be noted. This report must be completed at the end of each monitor's shift, and submitted to the Geosynthetics CQA Manager daily, if possible, but at least by the end of each week.

The Geosynthetics CQA Manager shall review the daily reports submitted by the Geosynthetics CQA Monitors and incorporate a summary of their reports into his own daily report. Any matters requiring action by the Project Manager shall be highlighted. This report shall be completed daily, summarizing the previous day's activities, and a copy submitted to the Project Manager daily, if possible, but at least within his weekly summary each week.

3.2 Destructive Test Reports

The Geosynthetics CQA Monitor shall collate the destructive test reports from all sources. This includes field tests, Installer's laboratory tests, and Geosynthetics CQC Firm tests. A summary list of test samples pass/fail results shall be prepared by the Geosynthetics CQA Manager on an ongoing basis, and submitted with the periodic progress reports.

3.3 Progress Reports

Progress Reports shall be prepared by the Geosynthetics CQA Manager and submitted to the Owner. This report shall include: an overview of progress to date; an outline of any changes made to the plans, drawing, or specifications; any problems or deficiencies in operations at the site, and an outline of any action taken to remedy the situation(s); a summary of weather conditions; and a brief description of activities anticipated for the next reporting period. All Destructive Test Reports for the period shall be appended to each Progress Report.

3.4 Construction Problem and Solution Data Sheets

Sheets describing special construction situations shall be cross-referenced with specific observation logs and testing data sheets, and must include the following information, where available:

1. An identifying sheet number for cross-referencing and document control;
2. A detailed description of the situation or deficiency;
3. The location and probable cause of the situation or deficiency;
4. How and when the situation or deficiency was found or located;
5. Documentation of the response to the situation or deficiency;
6. Final results of any responses;
7. Any measures taken to prevent a similar situation from occurring in the future; and
8. The signature of the CQA Manager/Monitor and signature indicating concurrence from the Project Manager.

The Project Manager shall be made aware of significant recurring non-conformance with specifications. The Project Manager shall then determine the cause and recommend appropriate changes in procedures or specifications. When this type of evaluation is made, the results shall be documented, and the Owner and Design Engineer shall approve any revision to procedures or specifications.

A Summary of all supporting data sheets, along with final testing results and the CQA Engineer's approval of the work, shall be required upon completion of construction.

3.5 Design and/or Specification Changes

Design and/or specifications changes may be required during construction. In such cases, the CQA Engineer shall notify the Project Manager and Design Engineer. Design and/or specifications changes shall be made only with written agreement of the Project Manager and the Design Engineer, and shall take the form of an addendum to the specifications.

3.6 Record Drawings

Record drawings shall be prepared by the Contractor and approved by the CQA Consultant. A third party independent surveyor shall perform the survey. Record drawings shall include, as a minimum, the following information for geomembranes:

1. The limits of the liner or final cover barrier construction;
2. The top and bottom liner or final cover barrier elevation at 50’ intervals referenced to the site grid coordination system;
3. If a granular drainage blanket is utilized in the design, top of blanket elevation shall be identified at 50’ intervals;
4. The location and elevation of slope breaks, leachate piping, leachate sumps and trenches, berms, and any other features which are material to the disposal area construction;
5. A key map showing the location of the construction in relation to the permitted design, along with an identification of areas previously constructed and areas yet to be constructed;
6. Dimensions of all geomembrane field panels;
7. Location, as closely as possible, of each panel relative to the surveyors plan (furnished by the Owner);
8. Identification of all seams and panels with appropriate number or "identification codes" (see Section 2.2.1);
9. Location of all patched and repairs; and
10. Location of all destructive testing samples.

The Record drawing shall address each layer of geomembrane, and if necessary, another drawing shall identify problems or unusual conditions of the geotextile or geonet layers. In addition, applicable cross-sections shall show layouts of geonets, geotextiles or Geogrids which are unusual or differ from the design drawings.

3.7 Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, shall be cross-referenced with observation and testing data sheet(s) and/or construction problem and solution data sheets(s).

These photographs shall serve as a pictorial record of work progress, problems, and mitigation activities. The basic file will contain digital color prints; the digital photos will also be stored on appropriate media. These records shall be presented to the Project Manager upon completion of the project and all CQA documentation will be stored in the POR.

3.8 Final Report

A Final Report shall be submitted upon completion of the work. This report shall include all reports prepared by the CQA Consultant personnel, summarize the activities of the project, and document all aspects of the quality assurance program performed. The Final Report shall include as a minimum the following information:

- Personnel involved with the project;
- Scope of work;
- Outline of project;
- Construction quality assurance methods;
- Test results (destructive and non-destructive, including laboratory tests);
- Sealed and signed by a registered professional engineer; and
- Record drawings, sealed and signed by a registered professional engineer.

3.9 Storage of Records

During construction, the Geosynthetics CQA Monitor shall be responsible for submitting the facility Record drawings. The owner/operator, in a manner that will allow for easy access, shall store the document originals. CQA documentation will be submitted to the NMOCD as required and a copy shall be retained in the Facility POR.

SECTION 5
OTHER

1.0 GEOTEXTILES

1.1 Manufacturing

The geotextile manufacturer shall provide the Project Manager with a list of guaranteed "minimum average roll value" (MARV) properties for the type of geotextile to be delivered. The geotextile manufacturer shall also provide the Project Manager with a written quality control certification signed by a responsible party employed by the manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geotextile. The quality control certificates shall include:

1. Roll identification numbers;
2. Sampling procedures; and
3. Results of quality control testing.

The geotextile manufacturer shall provide, as a minimum, test results for the following in accordance with **TABLE 6**:

1. Mass per unit area;
2. Grab strength;
3. Trapezoidal Tear strength;
4. Puncture strength;
5. Apparent opening size (AOS);
6. Thickness; and
7. Permittivity and apparent opening size.

The geotextile manufacturer shall provide a written certification that the nonwoven, needle-punched geotextiles are continuously inspected and found to be needle-free. Quality assurance tests shall be performed in accordance with the test methods specified in **TABLE 6** for every 100,000 ft^2 of geotextile produced for the project.

The CQA Consultant shall examine all manufacturer certifications to insure the following: property values listed on the certifications meet or exceed those specified for the particular type of geotextile; the measurements of properties by the Manufacturer are properly documented; test methods are acceptable; and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project Manager.

1.2 Roll Label Requirements

The geotextile manufacturer shall identify all rolls of geotextile with the following:

1. Manufacturer's name
2. Product identification;
3. Lot number;
4. Roll number; and
5. Roll dimensions.

Additionally, if any special handling of the geotextile is required, it shall be so marked on the top surface of the geotextile, e.g., "This Side Up" or "This Side Against Geonet". The CQA Monitor shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

1.3 Shipping, Handling & Storage

During shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation or other inundation, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions. To that effect, geotextile rolls shall be shipped and stored in relatively opaque and watertight wrappings.

Geotextiles shall not be exposed to precipitation prior to being installed. Wrappings protecting geotextile rolls shall be removed less than one hour prior to unrolling the geotextile. After the wrapping has been removed, a geotextile shall not be exposed to sunlight for more than 15 days, unless otherwise specified and guaranteed by the geotextile manufacturer.

The CQA Consultant shall observe rolls upon delivery at the site and any deviation from the above requirements shall be reported to the Project Manager. Any damaged rolls shall be rejected and replaced at no cost to the Owner.

1.4 Conformance Testing

Upon delivery of the rolls of geotextiles, the CQA Monitor shall insure that samples are removed and forwarded to the Geosynthetics Laboratory for testing to ensure conformance to both the design specifications and the list of guaranteed properties. The material may also be sampled at the manufacturing facility by a third party and forwarded to the Geosynthetic Laboratory. As a minimum, the following tests shall be performed on geotextiles:

1. Mass per unit area;
2. Grab strength;
3. Grab elongation;

4. Puncture strength; and
5. Apparent opening size.

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the specifications. Testing frequency for the geotextiles is presented in **TABLE 6**.

1.4.1 Sampling Procedures

Samples shall be taken across the entire width of the roll and shall not include the first three linear feet. Unless otherwise specified, samples shall be 3 feet long by the roll width. The CQA Monitor shall mark the machine direction on the samples with an arrow. Unless otherwise specified, samples shall be taken at a rate of one per lot or one per 100,000 ft^2, whichever is least, as indicated in **TABLE 6** for geotextiles.

1.4.2 Test Results

The CQA Consultant shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager.

1.5 Handling and Placement

The Installer shall handle all geotextiles and geocomposites in such a manner to ensure they are not damaged in any way. The following shall be complied with:

1. On slopes, the geotextile and geocomposites shall be securely anchored in the anchor trench and then rolled down the slope in such a manner as to continually keep the geotextile or the geocomposite sheet in tension;
2. In the presence of wind, all geotextiles and geocomposites shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with earth cover material;
3. Geotextiles/Geocomposites shall be cut using an approved geotextile cutter only. If in place, special care must be taken to protect other materials from damage which could be caused by the cutting of the geotextiles/geocomposites; and
4. The Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile or the geocomposite.

In addition, the following applies to geotextiles only:

1. During placement of geotextiles, care shall be taken not to entrap in the geotextile: stones, excessive dust, or moisture that could generate clogging of drains or filters, or hamper subsequent seaming; and

2. A visual examination of the geotextile shall be carried out over the entire surface, after installation, to ensure that no potentially harmful foreign objects, such as needles, are present.

1.6 Seams and Overlaps

On slopes steeper than 10 horizontal/1 vertical, all geotextiles shall be continuously sewn (i.e., spot sewing is not allowed). Geotextiles shall be overlapped 0.15m (6 in.) prior to seaming. No horizontal seams shall be allowed on side slopes (i.e., seams shall be along, not across, the slope), except as part of a patch. The Design Engineer must approve other seaming options.

On bottom and slopes flatter than 10/1 (horizontal/vertical), geotextiles can be either seamed as indicated above, or thermally bonded. The Installer and CQA Monitor shall pay particular attention at seams to insure that no earth cover material could be inadvertently inserted beneath the geotextile. Any sewing shall be done using polymeric thread with chemical and ultraviolet resistance properties equal to or exceeding those of the geotextile.

1.7 Defects and Repairs

Any holes or tears in the geotextile shall be repaired as follows:

1. On slopes: A patch made from the same geotextile shall be double seamed into place [with each seam 5 mm to 20 mm (1/4 in. to 3/4 in.) apart and no closer than 25 mm (1 in.) from any edge]. Shall any tear exceed 10% of the width of the roll, that roll shall be removed from the slope and replaced.
2. Non-slopes: A patch made from the same geotextile shall be spot-seamed in place with a minimum of 0.60m (24 in.) overlap in all directions.

Care shall be taken to remove any soil or other material which may have penetrated the torn geotextile. The CQA Consultant shall observe any repair, note any non-compliance with the above requirements and report them to the Project Manager.

1.8 Placement of Soil Materials

The Installer shall place all soil materials located on top of a geotextile or geocomposite, in such a manner as to insure:

1. No damage of the geotextile or geocomposite;
2. Minimal slippage of the geotextile or geocomposite on underlying layers; and
3. No excess tensile stresses in the geotextile.

Unless otherwise specified by the Designer, all lifts of soil material shall be in conformance with the guidelines in **TABLE 1**.

Any non-compliance shall be noted by the CQA Consultant and reported to the Project Manager. If portions of the geotextile or the geocomposite are exposed, the CQA Consultant shall periodically place two (or more, at his discretion) marks on the geotextile or the geocomposite 3 m (10 ft.) apart along the slope and measure the elongation of the geotextile or the geocomposite during the placement of soil. The Designer shall relate this elongation to the tensile stress in the geotextile or the geocomposite.

2.0 GEONETS AND GEOCOMPOSITES

2.1 Manufacturing

The geonet, unless otherwise specified, shall be made from the same type of resins used to manufacture HDPE geomembranes. The raw material will consist of polyethylene resin, heat stabilizers, and anti-oxidant additives.

The geonet and geocomposite manufacturer shall provide the Project Manager with a list of guaranteed "minimum average roll value" properties for the type of geonet and/or geocomposite to be delivered. The manufacturer shall also provide the Project Manager with a written quality control certification signed by a responsible party employed by the manufacturer that the materials actually delivered have property "minimum average roll values" which meet or exceed all property values guaranteed for that type of geonet. The quality control certificates shall include:

1. Roll identification numbers;
2. Resin batch numbers;
3. Nominal thickness;
4. Sampling procedures; and
5. Results of quality control testing:
    - Polymer specific gravity;
    - Mass per unit area; and
    - Thickness.

These conformance tests shall be performed in accordance with the test methods specified in the project specifications. Other conformance tests may be required by the project specifications.

The manufacturer shall provide the origin, identification, and production date of the resin and quality control certificates for the resin used in the manufacture of the geonets and/or geocomposite. Quality assurance tests shall be performed in accordance with the test methods specified in **TABLE 6** for every 100,000 ft^2 of geonet and/or geocomposite produced for the project.

The CQA Consultant shall examine all manufacturer's certifications to insure the following: property values listed on the certifications meet or exceed those specified; the measurements of properties by the manufacturer are properly documented; test methods are acceptable; and the certificates have been provided at the specified frequency properly identifying the rolls related to testing. Any deviations shall be reported to the Project Manager.

2.2 Roll Label Requirements

The manufacturer shall identify all rolls of geonets and/or geocomposite with the following:

1. Manufacturer's name;
2. Product identification;
3. Lot number;
4. Roll number; and
5. Roll dimensions.

The CQA Monitor shall examine rolls upon delivery and any deviation from the above requirements shall be reported to the Project Manager.

2.3 Shipping, Handling, and Storage

Protecting the geonet and/or geocomposite for cleanliness is important to ensure proper drainage characteristics are maintained. The CQA Consultant shall verify that geocomposite and/or geonet rolls are wrapped in polyethylene sheets or otherwise protected against dust and dirt during shipping and storage. The wrapping shall be removed just prior to the deployment of the rolls. The CQA Consultant shall verify that geonets and/or geocomposite are free of dirt and dust just before installation. The CQA Consultant shall report the outcome of this verification to the Project Manager. If the geonets and/or geocomposite are judged dirty, they shall be cleaned by the Installer prior to installation.

2.4 Conformance Testing

2.4.1 Testing Requirements

Upon delivery of the rolls of geonets, the CQA Consultant shall take conformance samples of the geonet and/or geocomposite, to ensure conformance to both the design specifications and the list of guaranteed properties. The material may also be sampled at the manufacturing facility by a third party and forwarded to the Geosynthetic Laboratory. The tests presented in **TABLE 6** shall be performed on the geonet and/or geocomposite.

2.4.2 Sampling Procedures
Samples shall be taken across the entire width of the roll and shall not include the first three linear feet. Unless otherwise specified, samples shall be 3 ft wide by the roll width.

2.4.3 Test Results
The CQA Monitor shall examine all results from laboratory conformance testing and shall report any non-conformance to the Project Manager. Any lots not meeting conformance testing specifications will result in the rejection of the lot.

2.5 Installation of the Geonet
2.5.1 Handling and Placement
The Installer shall take steps necessary to insure that any underlying layers are not damaged during the placement of the geonet and/or geocomposite. These steps shall include but are not limited to the following conditions:

1. During placement of geonets and/or geocomposite, care shall be taken not to entrap in the geonet, dirt or excessive dust that could cause clogging of the drainage system. If dirt or excessive dust is entrapped in the geonet, it shall be hosed clean prior the placement of the next material on top of it. In this regard, care shall be taken with the handling of sandbags, to prevent rupture or damage of the sandbag;
2. Geonets and/or geocomposite shall only be cut using scissors or curved blade (hook blade) utility knife that will not damage underlying geosynthetics;
3. On slopes, the geonets and/or geocomposite shall be secured in the anchor trench and then rolled down the slope in such a manner as to continually keep the geonet sheet in tension. If necessary, the geonet and/or geocomposite shall be positioned by hand after being unrolled to minimize wrinkles. Geonets and geocomposites can be placed in the horizontal direction (i.e., across the slope) in some special locations (e.g., at the toe of a slope, if an extra layer is required, this extra layer can be placed in the horizontal direction). The Designer shall identify such locations in the design drawings. Designers shall note that placement of layers at 90 degree angles to each other will result in a partial loss of effective thickness and transmissivity; and
4. In the presence of wind, all geonets and/or geocomposite shall be weighted with sandbags or the equivalent. Such sandbags shall be installed during placement and shall remain until replaced with cover material.

The CQA Monitor will note any deficiencies or non-compliance and report it to the Project Manager.

2.5.2 Stacking Geonets/Geocomposites

When several layers of geonets and/or geocomposite are stacked, care shall be taken to prevent strands from one layer from penetrating the channels of the next layer, thereby significantly reducing the transmissivity. This cannot happen if stacked in the same direction. A stacked geonet shall never be laid in perpendicular directions to the underlying geonet (unless otherwise specified by the Designer). In the corners of side slopes of rectangular landfills, adjacent overlapping geonets are usually perpendicular and special precautions shall be taken as discussed below. The CQA Monitor shall note any non-compliance and report it to the Project Manager.

2.5.3 Joining and Splicing

Adjacent geonets and/or geocomposite shall be joined according to construction drawings and specifications. As a minimum, the following requirements shall be met:

1. Geonets may be butt-joined or lapped if specified;
2. Nylon/plastic cable ties will be applied to the net edge at five feet intervals along the edge; and
3. End splices will be made as follows:
   - On slopes, the ends will overlap two feet with the uphill panel on top with two rows of cable ties applied; and
   - In flat areas, the end will be overlapped a minimum of two inches and one row of cable ties applied.

The CQA Monitor shall note any non-compliance and report it to the Project Manager.

2.5.4 Defects and Repairs

If the geonet and/or geocomposite are damaged, it can be repaired by the following methods at the discretion of the CQA Monitor. Holes and tears in the geonet shall be repaired by placing a patch extending 2 feet beyond edges of the hole or tear. The patch shall be secured to the original geonet by spot welding or tying every 6 inches. Tying devices shall be as indicated in Section 2.5.3. If the hole or tear width across the roll is more the 50% the width of the roll, the damaged area shall be cut out and the two portions of the geonet shall be joined as indicated in Section 2.5.3.

The CQA Monitor shall observe any repair, note any non-compliance with the above requirements and report them to the Project Manager.

3.0 OTHER PROJECT CONSTRUCTION

The CQA Consultant shall be responsible for reviewing, verifying and testing all aspects of the Construction Project. The Scope of the CQA Consultant's responsibilities shall include the review and quality control testing of all road installations, concrete structure installations, and other construction addressed in the Contractor's Project Specifications, but not discussed in this CQA Plan. Performance Criteria, and Quality Control Testing frequencies for construction not associated with the landfill footprint is addressed in applicable sections of the Project Specifications.

Quality Assurance for incidental Items – Quality assurance procedures for other materials deployed in the construction, such as geotextiles, geonets, granular drainage blankets, etc., shall also be included in the QA plans. There above requirements are only intended to act as minimum values and will not relieve the facility of the burden to prepare a project specific quality assurance plan.

TABLES

Terracon

Table 1
Minimum Protective Soil Thickness

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in.)
<= 5	12
5 - 8	18
8 - 16	24
>16	36

Table 1 is based off of EPA technical guidance document from "Quality Assurance and Quality Control for Waste Containment Facilities", EPA/600/R-93/182, dated September 1993, page 167, Table 3.7. Although this Facility is also incorporating a geocomposite to protect the geomembrane, this guidance should be followed during construction and operation.

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TABLE 2
Pre-construction & Construction Intermediate and Final Cover Materials

Pre-Construction Testing			
Test	**Method(1)**	**Testing Frequency**	**Min. Requirements**
Cover Material			
Standard Proctor	ASTM D698	1 test per source	Not Applicable
Atterberg Limits	ASTM D4318	1 test per source	P.I. >10
Moisture	ASTM D2216	1 test per source	0 to 10% above optimum moisture
Permeability	ASTM D5084	1 test per 6,500 CY of material to be placed	Not Applicable
Construction Testing			
Cover Material			
In-Place Field Density/Moisture	ASTM D6938	3 test per acre per cover placed	95% and 0% to 10% of OMC[(2)]
Standard Proctor	ASTM D698	1 test per 5,000 yd^3 or change of material or borrow area.	Not Applicable
Moisture	ASTM D2216	1 test per 1,000 yd^3 or change of material or borrow area.	0 to 10% above optimum moisture
Atterberg Limits	ASTM D4318	1 test per 1,000 yd^3 or change of material or borrow area.	P.I. >10
Permeability	ASTM D5084	1 test per lift per acre	To maintain average permeability determined duing preconstruction testing.

1. Test to be performed according to the latest test method as approved by the certifying engineer.

2. Optimum Moisture Content as determined by ASTM D 698 in Pre-Construction testing

TABLE 3
Pre-constrution and Construction Testing of Subgrade, Protective Cover Material, & Gravel

Pre-Construction Testing			
Test	**Method(1)**	**Testing Frequency**	**Min. Requirements**
Subgrade Material			
USCS Classification	ASTM D 2487	Once Per Source	Report
Atterberg Limits	ASTM D 4318	Once per 20,000 yd^3 or Source Change	Report
Gradation (3" thru # 200 sieve)	ASTM D 422	Same as above	Report
Standard Proctor	ASTM D 698	Same as above	Not Applicable
Protective Cover Material			
Gradation	ASTM D 422	Once per Source	Report
Permeability (3)	ASTM D 2434	Once Per Source	1.0×10^{-2} cm/sec or greater
USCS Classification	ASTM D 2487	Once Per Source	GW, GP, SW, SP, SM
Calcium Carbonate	ASTM D 4373	Once Per Source	15% (max)
Collection System Gravel			
Gradation	ASTM D 422	Once per Source	Minimum 90% larger than pipe perforations (typically 3/4 inch sieve)
Calcium Carbonate	ASTM D 4373	Once Per Source	15% (max)
USCS Classification	ASTM D 2487	Once Per Source	GW or GP
Permeability (3)	ASTM D 2434	Once Per Source	1.0×10^{-2} cm/sec or greater
Construction Testing			
Subgrade and Clay Berm Material			
Recompacted (5)	ASTM D 6938/3017	12 tests per acre per lift	90% compaction (2)
Protective Cover Material			
Gradation (4)	ASTM D 422	1 test per 3,000 yd^3	Report
Permeability (3)	ASTM D 2434	Once Per Source	1.0×10^{-2} cm/sec or greater
USCS Classification	ASTM D 2487	1 test per 3,000 yd^3	GW, GP, SW, SP, SM
Collection System Gravel			
Gradation	ASTM D 422	1 test per 1,500 yd^3	Minimum 90% larger than pipe perforations (typically 3/4 inch sieve)
Calcium Carbonate	ASTM D 4373	Once Per Source	15% (max)
USCS Classification	ASTM D 2487	1 test per 1,500 yd^3	GW, GP
Permeability (3)	ASTM D 2434	Once Per Source	1.0×10^{-2} cm/sec or greater

1. Test to be performed according to the latest test method as approved by the certifying engineer.
2. Optimum Moisture Content as determined by ASTM D 698 in Pre-Construction testing
3. Permeability testing not required on final cover protective soil.
4. Minimum 90% larger than the pipe perforations (Normally 3/4 inch).
5. No subgrade testing required unless material is over-excavated.

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TABLE 4
Geosynthetic Clay Liner Specifications

Test	Method(1)	Testing Frequency	Units	Min. Requirements
Manufacturer's Quality Control				
Reinforced				
Bentonite Swell Index[2]	ASTM D 5890	1 per 100,000 lbs	mL/g	≥ 24 / 2 (min)
Bentonite Fluid Loss[2]	ASTM D 5891	1 per 100,000 lbs	mL	≤ 18 (max)
Bentonite Mass per Area[3]	ASTM D 5993	40,000 ft^2	lb/ft^2	≥ 0.75 (min)
GCL Grab Strength[4]	ASTM D 4632 ASTM D 6768	200,000 ft^2	lbs/in	≥ 30 MARV
GCL Peel Strength[4]	ASTM D 6496	40,000 ft^2	lbs/in	≥ 3.5 MARV
GCL Index Flux[5]	ASTM D 5887	30,000 $yd.^2$	$m^3/m^2/s$	≤ 1×10^{-8} (max)
GCL Permeability[5]	ASTM D 5887	30,000 yd.2	cm/sec	≤ 5×10^{-9} (max)
GCL Hydrated Internal Shear Strength[6]	ASTM D 5321 ASTM D 6243	Periodic (6)	psf	≥ 500 typical @ 200 psf (min)
Conformance Testing by CQA Engineer				
Bentonite Mass per Area[3]	ASTM D 5993	100,000 ft^2	lb/ft^2	0.75 (min)
GCL Grab Strength[4]	ASTM D 4632 ASTM D 6768	100,000 ft^2	lbs/in	≥ 30 MARV
GCL Peel Strength[4]	ASTM D 4632/6496	100,000 ft^2	lbs/in	≥ 3.5/NA MARV
GCL Permeability[5]	ASTM D 5887	100,000 ft^2	cm/sec	5×10^{-9} (max)

1. Test to be performed according to the latest test method as approved by the certifying engineer. Test methods that have been superceded by updated or different methods that are then accepted as industry standard will be replaced by the updated standards.

2. These parameters are for the bentonite incorporated into the GCL and do not necessarily reflect the properties of the bentonite in the finished product.

3. Bentonite mass per area is exclusive of the average weight of the geotextiles and is normalized to 0 percent moisture content per ASTM D 5993.

4. All tensile testing is performed in the machine direction, with results as minimum average roll values unless otherwise indicated.

5. Index flux and permeability testing with deaired distilled/deionized water at 80 psi cell pressure, 77 psi headwater pressure and 75 psi tail water pressure. Reported value is equivalent to 925 gal/acre/day. This flux value is equivalent to a permeability of 5 x 10-9 cm/sec for typical GCL thickness. This flux value should not be used for equivalency calculations unless gradient used represent field conditions. A flux test using gradients that represent field conditions must be performed to determine equivalency. The last 20 weekly values prior to end of the production date of the supplied GCL may be provided.

6. ASTM D5321-08 (geosynthetics) or D 6243 (GCLs) internal direct shear performed on GCL sample hydrated under 200 psf normal load and then sheared at 0.2 in./min. max for Procedure A and 0.04 in/min for Procedure B. Use wet conditions as per ASTM D5321. The testing is required prior to construction of the first E&PW Cell.

TABLE 5A
60 mil HDPE Textured MQC Specifications

Resin Manufacturer (1)			
Test	**Method(2)**	**Testing Frequency**	**Min. Requirements (5)**
Density	ASTM D 1505 ASTM 792, Meth B	200,000 lb and per batch	≥ 0.932 g/cm^3
Melt Flow Index	ASTM D 1238 (190°C/2.16 kg)	200,000 lb and per batch	≤ 1.0 g / 10 min.
Manufacturer's Quality Control			
Thickness, nominal	ASTM D 5994	Each Roll	60 mil
Thickness, Min. ave	ASTM D 5994	Each Roll	57 mil
Thickness, lowest indiv. For 8 of 10 spec.	ASTM D 5994	Each Roll	54 mil
Thickness, lowest indiv. For 1 of 10 spec.	ASTM D 5994	Each Roll	51 mil
Asperity Height (Min. ave.) [3]	GRI GM13 ASTM D 7466	Each Roll	16 mil
Density	ASTM D 1505	Per 200,000 lb.	0.94 g/cm^3
Carbon Black Dispersion [4]	ASTM D 5596	Per 45,000 lb	Category 1 or 2
Carbon Black Content [6]	ASTM D 1603 ASTM D 4218	Per 20,000 lb	2 to 3 %
Tensile Properties:			
Break Strength Elongation Yield Strength Elongation	ASTM D 6693 Type IV Dumbbell, 2 ipm G.L. = 2.0 inches	Per 20,000 lb	 90 lb/in 100% 126 lb/in 12%
Tear Resistance	ASTM D 1004	Per 45,000 lb	42 lb
Puncture Resistance	ASTM D 4833	Per 45,000 lb	90 lb
Oxidation Induction Time (OIT)			
Standard OIT	ASTM D 3895	200,000 lb and per batch	100 min
High Pressure OIT	ASTM D 5885		400 min
Oven Aging @ 85^{0}C			
Standard OIT	ASTM D 3895	Per each formulation	55%
High Pressure OIT	ASTM D 5885		80%
UV Resistance			
High Pressure OIT	ASTM D 5885	Per each formulation	50%

1. The resin shall be virgin material with no more than 10% rework. If rework is used, it must be a similar HDPE as the parent material. No post consumer resin (PCR) of any type shall be added to the formulation.

2. Test to be performed according to the latest test method as approved by the certifying engineer. Test methods that have been superceded by updated or different methods that are then accepted as industry standard will be replaced by the updated standards.

3. Textured geomembrane shall generally have uniform texturing appearance. It shall be free from agglomerated texturing material and such defects that would affect the specified properties of the geomembrane.

4. Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.

5. If 60-mil HDPE smooth is used, it must meet GRI-GM13 standards. Use of smooth geomembrane instead of textured geomembrane must be approved by the certifying engineer.

6. Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

TABLE 5B
60 mil HDPE Textured Conformance & Field Testing Specifications

Test	Method(1)	Testing Frequency	Min. Requirements
Conformance Testing by CQA Engineer			
Thickness, nominal	ASTM D 5994	1 per 100,000 sf	60 mil
Thickness, Min. ave	ASTM D 5994		57 mil
Thickness, lowest indiv. For 8 of 10 spec.	ASTM D 5994		54 mil
Thickness, lowest indiv. For 1 of 10 spec.	ASTM D 5994		51 mil
Asperity Height (Min. ave.)	GRI GM13 ASTM D 7466	1 per 100,000 sf	16 mil
Density	ASTM D 1505	1 per 100,000 sf	0.94 g/cm^3
Carbon Black Dispersion [2]	ASTM D 5596	1 per 100,000 sf	A-1, A-2 or B-1 rating
Carbon Black Content [3]	ASTM D 1603	1 per 100,000 sf	2 to 3 %
Tensile Properties:			
Break Strength Elongation Yield Strength Elongation	ASTM D 6693 Type IV Dumbbell, 2 ipm G.L. = 2.0 inches	1 per 100,000 sf	 90 lb/in 100% 126 lb/in 12%
Tear Resistance	ASTM D 1004	1 per 100,000 sf	42 lb
Trial Seams			
Shear	ASTM D 6392 GRI GM 19	Every 5 (five) hours of seaming.	Shear 120 ppi
Peel Fusion[4]			Peel 91 ppi
Peel Extrusion[4]			Peel 78 ppi
Destructive Seam Testing			
Shear	ASTM D 6392 GRI GM 19	1 per 500 linear feet (LF) of seam	Shear 120 ppi
Peel Fusion[4]			Peel 91 ppi
Peel Extrusion[4]			Peel 78 ppi
Shear Elongation at break	GRI GM19	1 per 500 linear feet (LF) of seam	
Fusion [4]			50%
Extrusion [4]			50%
Peel Separation	GRI GM19	1 per 500 linear feet (LF) of seam	
Fusion			25%
Extrusion			25%
Non-destructive Seam Field Testing			
Air Pressure	GRI GM6	Dual track fusion weld seams	Min 30 psi, held for 5 minutes; losing < 4 psi; puncture opposite end after test to check for continuity
Vacuum	ASTM D 4437	Extrusion Seams	4 to 8 psi held for ≥ 10 sec.

1. Test to be performed according to the latest test method as approved by the certifying engineer. Test methods that have been superceded by updated or different methods that are then accepted as industry standard will be replaced by the updated standards.

2. Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.

3. Other methods such as D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D 1603 (tube furnace) can be established.

4. Four (4) out of five (5) specimens must meet the requirements. The 5th specimen can be as low as 80% of the listed values. For peel adhesion, seam separation shall not extend more than 25 percent in the same interface. Testing shall be discontinued when the sample has visually yielded a sample. Elongation measurements should be omitted for field testing.

Terracon

TABLE 6
Geonet, Geotextile, & Geocomposite MQC & Conformance Testing Specifications

Manufacturer's Quality Control			
Geonet			
Test	**Method (1)**	**Testing Frequency**	**Min. Requirements**
Thickness	ASTM D5199	1/50,000 sf	200±20 mil
Density	ASTM D1505	1/50,000 sf	0.94 g/cm^3
Tensile Strength (2)	ASTM D5035	1/50,000 sf	45 lb/in
Transmissivity (3)	ASTM D4716	1/540,000 sf	2.0×10^{-3} m^2/s
Carbon Black Content	ASTM D1603[3]/4218	1/50,000 sf	2%
Geotextile			
Mass per Unit Area	ASTM D 5261	1/90,000 sf	≥8 oz/sq. yd.
Grab Tensile	ASTM D 4632	1/90,000 sf	220 lbs.
Grab Elongation	ASTM D 4632	1/90,000 sf	50%
Trapezoid Tear Strength	ASTM D 4533	1/90,000 sf	90 lbs.
Puncture Strength	ASTM D 4833/6241	1/90,000 sf	120/575 lbs.
Permittivity, T	ASTM D 4491	1/540,000 sf	1.26 Sec^{-1}
AOS (largest opening size)	ASTM D 4751	1/540,000 sf	80 Sieve Size
Geocomposite			
Ply Adhesion	ASTM D 7005	1/50,000 sf	1.0 lb./in (MARV)
Transmissivity (3)	ASTM D 4716	1/540,000 sf	1.0×10^{-4} m^2/s
Conformance Testing by CQA Engineer			
Geonet			
Test	**Method**	**Testing Frequency**	**Min. Requirements**
Thickness	ASTM D5199	1/100,000 sf	200±20 mil
Density	ASTM D1505	1/100,000 sf	0.94 g/cm^3
Tensile Strength (1)	ASTM D5035	1/100,000 sf	45 lb/in
Transmissivity (4)	ASTM D4716	1/100,000 sf	2.0×10^{-3} m^2/s
Carbon Black Content	ASTM D1603/4218	1/100,000 sf	2%
Geotextile			
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AOS (largest opening size)	ASTM D 4751	1/100,000 sf	80 Sieve Size
Geocomposite			
Ply Adhesion	ASTM D 7005	1/100,000 sf	1.0 lb./in (MARV)
Transmissivity (4)	ASTM D 4716	1/100,000 sf	1.0×10^{-4} m^2/s

1. Test to be performed according to the latest test method as approved by the certifying engineer. Test methods that have been superceded by updated or different methods that are then accepted as industry standard will be replaced by the updated standards.

2. Machine Direction

3. Measured using water @ 20^{o} C with a gradient of one, between two steel plates, after 15 minutes. Confining pressure 10,000 psf.

4. Transmissivity conformance testing only required on the geonet when the geonet and geotextile are installed separately. If a geocomposite is used, then the transmissivity testing will be performed on the geocomposite material.

EXHIBIT A
DEFINITIONS

SOIL RELATED TERMS

Aggregate - any combination of sand, gravel and crushed stone in their natural or processed state.

Atterberg limits - The liquid limit, plastic limit, and shrinkage limit for soil. The water content where the soil behavior changes from liquid to the plastic state is the liquid limit; from plastic to semisolid state is plastic limit; and from the semisolid to the solid state is the shrinkage limit.

Backfill - Soil material placed back into an area that has been excavated, such as against structures, in anchor trenches and in pipe trenches

Borrow - Soil material obtained from an off-site source for the clay liner, leachate collection layer, daily cover, or other construction projects.

Clays - Very small soil particles having a crystalline (layer structure, created as the result of the chemical alteration of primary rock minerals. Since the clay particles are very small, the air voids are very small and the flow of water through the soil material is very slow.

Coarse Aggregate - is generally considered to be a crushed stone or gravel almost all of which is retained on a No. 4 sieve.

Compaction - The process of increasing the density or unit weight of a soil by rolling, tamping, vibrating, or other mechanical means.

Density - The mass per unit volume.

Fine Aggregate - is considered to be any aggregate material that will pass a 3/8 in. sieve and essentially all of which will pass a No. 4 sieve and is predominately retained on a No. 4 sieve.

Liquid Limit - The water content where the soil behavior changes from liquid to the plastic state.

Hydraulic Conductivity - the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles.

In situ - Refers to soil when it is at its natural location in the earth and in its natural condition

Permeability - A generic term for the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles. Properly called *hydraulic conductivity*.

Plastic Limit - The water content where the soil behavior changes from plastic to semisolid state.

Plasticity - Term applied to fine-grained soils (particularly clays) to indicate the soils' (plus included waster's) ability to flow or be remolded without raveling or breaking apart.

Sand - The category of coarse-grained soil whose particles size range between about 0.07 mm and 5 mm in diameter.

Silt - The category of fine-grained soil particles whose mineralogical composition remains similar to the rock they were derived from.

Shrinkage Limit - The water content where the soil behavior changes from the semisolid to the solid state.

Sump - Small excavation or pit provided in the floor of a structure, or in the earth, to serve as a collection basin for surface water and leachate.

Water content - The ratio of the quantity of water in a soil (by weight) to the weight of the soil solid (dry soil), typically expressed as a percentage.

GEOTEXTILE AND GEOTEXTILE-RELATED* TERMS

Actinic degradation - The strength of fibers and fabrics due to exposure to sunlight or an accelerated weathering light source.

Arching - The formation of soil particles upstream of a geotextile where the particles arch (or bridge) over the fabrics' voids.

Basis weight* - A deprecated term for *mass per unit area*.

Blinding - The condition in which soil particles block the voids at the surface of a geotextile, thereby reducing the hydraulic conductivity of the geotextile.

Blocking - A synonym for *blinding.*

Bonding - The process of combining fibers, filaments, or films into sheets, webs, or bats by means of mechanical, thermal, or chemical binding.

Clogging - The movement by mechanical action or hydraulic flow of soil particles into the voids of a fabric and retention therein, thereby reducing the hydraulic conductivity of a geotextile.

Composite - *See* Fabric, composite.

Cross-plane - The direction of a geosynthetic which is perpendicular to the plane of its manufactured direction. Referred to in hydraulic situations.

Deformation - The change in length of a geosynthetic under load from its original manufactured dimensions.

Denier - The weight in grams of 9000 m of yarn.

Density* - The mass per unit volume.

Direction, cross-machine - The direction perpendicular to the long, machine, or manufactured direction (synonyms: *woven geotextiles, weft direction*).

Direction, machine - In textiles, the direction in a machine-made fabric parallel to the direction of movement the fabric followed in the manufacturing process (synonym: *lengthwise,* or *long direction*, and for woven geotextiles, *wrap direction*).

Downstream - The direction of the opposite side of a geotextile from which liquid is moving.

Elongation - The increase in length produced in the gage length of the test specimen by a tensile load.

Elongation at break - The elongation corresponding to the maximum load.

Elongation, percent - For geosynthetics, the increase in length of a specimen expressed as a percentage of the original gage length (i.e., engineering strain).

Fabric - Term used interchangeably with geotextile, particularly after placement in the manner described in this book.

Fabric, composite - A textile structure produced by combining nonwoven, woven, or knit manufacturing methods.

Fabric, knit - A textile structure produced by interlooping one or more ends of yarn or comparable material.

Fabric, nonwoven - For geotextiles, a planar and essentially random textile structure produced by bonding, interlocking of fibers or both, accomplished by mechanical, chemical, thermal, or solvent means and combinations thereof.

Fabric, woven - A planar textile structure produced by interlacing two or more sets of elements, such as yarns, fibers, rovings, or filaments, where the elements pass each other, usually at right angles, and one set of elements are parallel to the fabric axis.

Filament yarn - The yarn made from continuous filament fibers.

Fill - A deprecated term for *filling*.

Filing - The yarn running from selvedge to selvedge at right angles to the wrap in a woven fabric.

Filling Direction - *See* Direction, cross-machine. *Note*: For use with woven fabrics only.

Filter cake - The soil structure developed upstream of a geotextile by separating the suspended soil from liquid as the mixture attempts to pass through a soil fabric system.

Filter cloth - A deprecated term for *geotextile*.

Geocell - A three-dimensional structure filled with soil, thereby forming a mattress for increased stability when used with loose or compressible subsoils.

Geocomposite - A manufactured material using geotextiles, geogrids, geonets, and/or geomembranes in laminated or composite form.

Geogrid - A deformed or nondeformed gridlike polymeric material formed by intersecting ribs joined at the junctions used for reinforcement with foundations, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project structure or system.

Geomembrane - An essentially impermeable membrane used a s liquid or vapor barrier with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

Geonet - A netlike polymeric material formed form intersecting ribs integrally joined at the junctions used for drainage with foundation, soil, rock, earth, or any other geotechnical-related material as an integral part of a human-made project, structure, or system.

Geopipe - Any plastic pipe used with foundation, soil, rock, earth, or any other subsurface related material as an integral part of a human-made project, structure, or system.

Geosynthetic clay liner (GCL) - Factory-manufactured hydraulic barriers consisting of a layer of bentonite clay or other very low permeability material supported by geotextiles and/or geomembranes, and mechanically held together by needling, stitching, or chemical adhesives.

Geosynthetics - The generic term for all synthetic materials used in geotechnical engineering applications; it includes geotextiles, geogrids, geonets, geomembranes, and geocomposites.

Geotechnical engineering* - The engineering application of geotechnics.

Geotechnics* The application of scientific methods and engineering principles to the acquisition, interpretation, and use of knowledge of materials of the earth's crust to the solution of engineering problems, it embraces the filed of soil mechanics, rock mechanics, and many of the engineering aspects of geology, geophysics, hydrology, and related sciences.

Geotextile* - Any permeable textile used with foundation, soil, rock, earth, or any other geotechnical engineering-related material as an integral part of a human-made project, structure, or system.

Gradient - The degree of slope or a rate of change of a parameter measured over distance.
Heat bonded Thermally bonded by melting the fibers to form weld points.

Hydrophilic - A material's attraction to water.

Hydrophobic - A material's repulsion of water.

In-plane - The direction of a geosynthetic that is parallel to its long, manufactured, or machine direction. Referred to in hydraulic situations.

Knit - *See* Fabric, knit.

Mass per unit area - The proper term to represent and compare to the amount of material per unit area (units are oz./yd^2 or g/m^2). Often incorrectly called "weight" or "basis weight."

Melt bounded - *See* Heat bonded.

Modulus of elasticity - The initial linear portion of the stress-versus-strain test of a geosynthetic during its evaluation in a tensile strength test (units are lb./in.^{2}, kPa, lb./in., or kN/m).

Needle-punched - Mechanically bonded by needling with barbed needles.

Nonwoven - *See* Fabric, nonwoven.

Normal direction* - For geotextiles, the direction perpendicular to the plane of a geotextile.

Permeability - A generic term for the property that reflects the ability of a material to conduct a fluid or vapor through a porous media such as soil or geotextiles. Properly called *hydraulic conductivity*.

Permittivity - For a geotextile, the volumetric flow rate of water per unit cross-section area, per unit head, under laminar flow conditions, in the normal direction through the fabric.

pH - A measure of the acidity or alkalinity of a material, liquid, or solid. pH is represented on a scale of 0 to 14; 7 represents a neutral state; 0 represents the most acid, and 14 the most alkaline.

Resin bonded - The joining of fibers at their intersection points by resin in the formation of a nonwoven geotextile or geocomposites.

Siphoning - The transferring of a liquid to a lower level over an intermediate higher elevation than both of the endpoints, which can be achieved by saturated geotextiles in planar flow.

Staple - Short fibers in the range 0.5 to 3.0 in. (1 cm to 8 cm) long.

Staple yarn - Yarn made from staple fibers.

Tenacity - The fiber strength on a grams per denier basis.

Tex - Denier multiplied by 9 and is the weight in grams of 1000 m of yarn.

Transmissivity - For a geotextile, the volumetric flow rate per unit thickness under laminar flow conditions, within the in-plane direction of the fabric.

Transverse direction - A deprecated term for *cross-machine direction*.

Ultraviolet degradation - The breakdown of polymeric structure when exposed to natural light.

Upstream - The direction from which flowing liquid approaches a filter or drain.

Voids - The open spaces in a geosynthetic material through which flow can occur.

Wrap - The yarn running the length of the fabric in the machine direction when manufacturing woven fabrics.

Wrap direction - *See* Direction, machine. *Note*: For use with woven fabrics only.

Water table - (1) The upper limit of the part of the soil or underlying rock material that is wholly saturated with water. (2) The upper surface of the zone of saturation in ground water in which the hydrostatic pressure is equal to atmospheric pressure.

Weft - The cross-machine direction when manufacturing woven geotextiles.

Width - For a geotextile, the cross-direction edge-to-edge measurement of a fabric in a relaxed condition on a flat surface.

Woof - A deprecated term for *cross-machine direction*.

Woven - *See* Fabric, woven.

Woven, monofilament - The woven fabric produced with monofilament yarns.

Woven, multifilament - The woven fabric produced with multifilament yarns.

Woven, slit-film - The woven fabric produced with yarns produced from slit film.

Yarn* - A generic term for continuous strands of textile fibers or filaments in a form suitable for knitting, weaving, or otherwise intertwining to form a textile fabric. *Yarn* may refer to (1) a number of fibers twisted together, (2) a number of filaments laid together without twist (a zero-twist yarn), (3) a number of filaments laid together with more or less twist, or (4) a single filament with or without twist (a monofilament).

** Those items marked by an asterisk (*) are from ASTM's Committee D35 on Geotextiles Tentative Terminology Standard.*

GEOMEMBRANE AND GEOMEMBRANE-RELATED* TERMS

Adhesion - The state in which two surfaces are held together by interfacial forces which may consist of molecular forces or interlocking action or both. Measured in shear and peel modes.

Air lance - A device used to test, in the field, the integrity of field seams in plastic sheeting, It consists of a wand or tube through which compressed air is blown.

Alloys, polymeric - A blend of two or more polymers (e.g., a rubber and plastic) to improve a given property (e.g., impact strength).

Antioxidants - Primary types include phenols and amines that scavenge extraneous free radicals. Secondary types decompose peroxides as a source of free radicals.

Berm - The upper edge of an excavation on which the ends of a geomembrane are buried to hold it in place or to anchor the material.

Blocking - Unintentional adhesion usually occurring during storage or shopping between plastic films or between a film and another surface.

Bodied solvent adhesive - An adhesive consisting of a solution of the geomembrane compound used in the seaming of geomembranes.

Boot - A bellows-type covering to exclude dust, dirt, moisture, etc., from a geomembrane protrusion.

Breaking factor - Tensile strength at break in force per unit of width. Expressed in Newtons per meter or pounds per inch.

Calender - A machine equipped with three or more heavy internally heated or cooled rolls, revolving in opposite directions. Used for preparation of continuous sheeting or plying up of polymer compounds and frictioning or coating of fabric with rubber or plastic compounds.

Catalysts - Used in the polymerization process to make plastics. Generally they do not become part of the polymers. Typical examples are metal oxides (to make polyolefins) and the Ziegler-Natta systems containing aluminum allklys and transition metal salts.

Chlorosulfonated polyethylene (CSPE) - Family of polymers that is produced y polyethylene reacting with chlorine and sulfur dioxide. Present CSPEs contain 25 to 43% chlorine and 1.0 to 1.4% sulfur. They are used in both vulcanized and nonvulcanized forms. Most membranes based on CSPE are nonvulcanized. (ASTM designation for this polymer is CSM.)

Coated fabric - Fabric that has been impregnated and/or coated with a rubbery or plastic material in the form of a solution, dispersion, hot melt, or powder. The term also applies to materials resulting from the application of a performed film to a fabric by means of calendering.

Creep - The slow change in length or thickness of a material under prolonged stress.

Cross-linking - A general term referring to the formation of chemical bonds between polymeric chains to yield an insoluble, three-dimensional polymeric structure. Cross-linking of rubbers is vulcanization. *See also* Vulcanization.

Curing - *See* Vulcanization.

Denier - A unit used in the textile industry to indicate the fineness of continuous filaments. Fineness in deniers equals the mass in grams of 9000-m length of the filament.

Dielectric seaming - *See* Heat seaming.

Elasticity - The property of matter by virtue of which it tends to return to its original size and shape after removal of the stress that caused the deformation.

Elastomer - *See* Rubber.

EPDM - A synthetic elastomer based on ethylene, propylene, and a small amount of a nonconjugated diene to provide sites for vulcanization.

EVA - A family of copolymers of ethylene and vinyl acetate used for adhesives and thermoplastic modifiers. They posses a wide range of melt indexes.

Extruder - A machine with a driver screw for continuous forming of polymeric compounds by forcing through a die; regularly used to manufacture geomembranes.

Fabric reinforcement - A fabric, scrim, and so on, used to add structural strength to a two-ply (or more) polymeric sheet. Such sheeting is referred to as *supported*.

Fill - As used in textile technology refers to the threads or yarns in a fabric running at right angles to the wrap. Also called *filler threads*.

Film - Sheeting having norminal thickness not greater than 10 mils.

Heat seaming - The process of joining two or more thermoplastic geomembranes by heating areas in contact with each other to the temperature at which fusion occurs. The process is usually aided by a controlled pressure (synonym: *heat fusion*).

Hot wedge - Common method of heat seaming of thermoplastic geomembranes by a fusing process wherein heat is delivered by a hot wedge passing between the opposing surfaces to be bonded.

Lapped seam - A seam made by placing one surface to be joined partly over another surface and bonding the overlapping portions.

Leachate - Liquid that has percolated through or drained from solid waste or other human-emplaced materials and contains soluble, partially soluble, or miscible components removed from such waste.

Leno fabric - An open fabric in which two warp yarns wrap around each fill yarn to prevent the warp or fill yarns from sliding over each other.

Liner - A layer of emplaced materials beneath a surface impoundment or landfill which serves to restrict the escape of waste or its constituents from the impoundment or landfill [*Fed. Regist.*].

Membrane - A continuous sheet of material, whether prefabricated as a flexible polymeric sheeting or sprayed or coated in the field, such as a sprayed-on asphalt (synonym: *geomembrane*).

Modulus - The stress on deforming a material to a given strain value (e.g., E_{50} and E_{100}).

Modulus of elasticity - The ratio of stress to strain within the elastic range, also known as Young's modulus [ASTM].

Nylon - Generic name for a family of polyamide polymers characterized by the presence of the amide group, $CONH_2$. Used as a scrim in fabric-reinforced geomembranes.

Plastic - A material that contains as an essential ingredient one or more organic polymeric substances of large molecular weight, is solid in its finished state, and at some stage in its manufacture or processing into finished articles can be shaped by flow.

Plasticizer - A plasticizer is a material, frequently solvent-like, incorporated in a plastic or a rubber to increase its ease of workability, its flexibility, or distensibility. Adding the plasticizer may lower the melt viscosity, the temperature of the second-order transition, or the elastic modules of the polymer. Plasticizer may be monomer liquids (phthalate esters), low-molecular-weight liquid polymers (polyesters), or rubbery high polymers (EVA). The most important use of plasticizers is with PVC geomembranes, where the choice of plasticizer will dictate under what conditions the liner may be used.

Polyester fiber - Generic name for a manufactured fiber in which the fiber-forming substance is any long-chain synthetic polymer composed of an ester of a dihydric alcohol and terephthalic acid. Scrims made of polyester fibers are used for fabric reinforcement.

Polyethylene - A polyolefins formed by bulk polymerization (for low density) or solution polymerization (for high density) where the ethylene monomer is placed in a reactor under high pressure and temperature. The oxygen produces free radicals which initiate the chain polymerization. For solution polymerization the monomer is first dissolved in an inert solvent. Catalysts are sometime required to initiate the reaction.

Polymer - A macromolecular material formed by the chemical combination of monomers having either the same or different chemical composition. Plastics, rubbers, and textile fibers are all high-molecular-weight polymers.

Polymeric liner - Plastic or rubber sheeting used to line disposal sites, pits, pounds, lagoons, canals, and so on.

Polyolefin - A family of polymeric materials that includes polypropylene and polyethylene, the former being very common in geotextiles, the latter in geomembranes. Many variations of each exist.

Polyvinyl chloride (PVC) - A synthetic thermoplastic polymer prepared from vinylchloride, PVC can be compounded into flexible and rigid forms through the use of plasticizers, stabilizers, fillers, and other modifiers; rigid forms used in pipes and well screens; flexible forms used in manufacture of geomembranes.

Puncture resistance - Extent to which a material is able to withstand the action of a sharp object without perforation.

Quality assurance (QA) - A planned system of activities whose purpose it to provide a continuing evaluation of the quality control program, initiating corrective action were necessary. It is applicable to both the manufactured product and its field installation.

Quality control (QC) - Actions that provide a means of controlling and measuring the characteristics of (both) the manufactured and the field installed product.

Roll goods - A general term applied[lied to rubber and plastic sheeting, whether fabric reinforced or not. It is usually furnished in rolls.

Rubber - A polymeric material which, at room temperature, is capable of recovering substantially in shape and size after removal of a deforming force. Refers to both synthetic and natural rubber. Also called an *elastomer*.

Scrim - A woven, open-mesh reinforcing fabric made from continuous-filament yarn, that is, a high-percent--open-area geotextile. Used in the reinforcement of some geomembranes.

Seam strength - Strength of a seam of geomembrane material measured either in shear or peel modes. Strength of the seam is reported either in absolute units (e.g., pounds per inch of width) or as percent of the strength of the sheet.

Sheeting - A form of plastic or rubber in which the thickness is very small in proportion to length and width and in which the polymer compound is present as a continuous phase throughout, with or without fabric (synonym: *geomembrane*).

Slope - Deviation of a surface from the horizontal expressed as a percentage, by a ration, or in degrees, In engineering, usually expressed as a percentage of vertical to horizontal change [EPA].

Spread coating - A manufacturing process whereby a polymeric material is spread in a continuous fashion on a fabric substrate thereby forming a reinforced geomembrane composite.

Strikethrough - A term used in the manufacture of fabric-reinforced polymeric sheeting to indicate that two layers of polymer have made bonding contact through the scrim.

Support sheeting - *See* Fabric reinforcement.

Surface cure - Curing or vulcanization that occurs in a thin layer on the surface of a manufactured polymeric sheet or other items.

Tear strength - The maximum force required to tear a specified specimen, the force acting substantially parallel to the major axis of the test specimen. Measured in both initiated and uninitiated modes. Obtained value is dependent on specimen geometry, rate of extension, and type of fabric reinforcement. Values are reported in force (e.g., pounds) of force per unit of thickness (e.g., pounds per inch).

Tensile strength - The maximum force required to cause tension failure in a given test specimen. The obtained value is dependent on specimen geometry, rate of extrusion and property of material.. Values are reported in maximum stress (e.g., pounds per square inch) or force per unit thickness (e.g., pound per inch width).

Thermoplastic elastomers - New materials that are being developed and that are probably related to elasticized polyolefins. Polymers of this type behave similarly to cross-linked rubber. They have a limited upper-temperature service range which, however, is substantially above the temperature encountered in waste disposal sites (200°F may be too high for some TPEs).

Thread count - The number of threads per inch in each direction with the warp mentioned first and the fill second. A thread count of 20 X 10 means 20 threads per inch in the warp and 10 threads per inch in the fill direction.

Ultimate elongation - The elongation of a stretched specimen at the time of break. Usually reported as percent of the original length. Also called *elongation at break* (synonym: *engineering strain at failure*).

Unsupported sheeting - A polymeric sheeting consisting of one or more plies without a reinforcing-fabric layer or scrim.

Vacuum box - A device used to asses the integrity of field seams in geomembrane installations.

Vulcanize - Used to denote the product of the vulcanization of a rubber compound without reference to shape or form.

Vulcanization - An irreversible process during which a rubber compound, through a change in its chemical structure (cross-linking), becomes less plastic and more resistant to swelling by organic liquids, and during which elastic properties are conferred, improved, or extended over a greater range of temperature.

Warp - In textiles, the lengthwise yarns in a woven fabric.

Water vapor transmission (WVT) - Water vapor flow normal to two parallel surfaces of a material, through a unit area, under the conditions of a specified test such as ASTM E96.

** Many of these terms are from Lining of Waste Impoundment and Disposal Facilities, by Matrecon, Inc., for U.S. EPA Municipal Environmental Research Laboratory, Cincinnati, OH, R. Landreth, Project Officer, 1984, EPA/SW870, March 1983, G.P.O. No. 055-000-00231-2.*

Appendix K
Permit Design Drawings

K-1 North Ranch Surface Waste Management Facility Design Drawings
K-2 North Ranch Striker 4 Facility Design Drawings

Appendix K-1

North Ranch Surface Waste Management Facility Design Drawings

PERMIT APPLICATION DRAWINGS FOR

NGL WASTE SERVICES, LLC
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
LEA COUNTY, NEW MEXICO

PROFESSIONAL ENGINEER'S CERTIFICATION

"I CERTIFY TO THE BEST OF MY PROFESSIONAL JUDGMENT THAT THIS DRAWING SET PROPERLY ADHERE TO ESTABLISHED, SOUND ENGINEERING PRACTICES. THIS CERTIFICATION IS CONTINGENT ON THE FACT THAT ALL INFORMATION SUPPLIED TO THE SIGNATORY AUTHORITY, UP TO THE DATE OF THIS CERTIFICATION, IS UNQUESTIONABLY ACCURATE AND WAS PROVIDED IN GOOD FAITH."

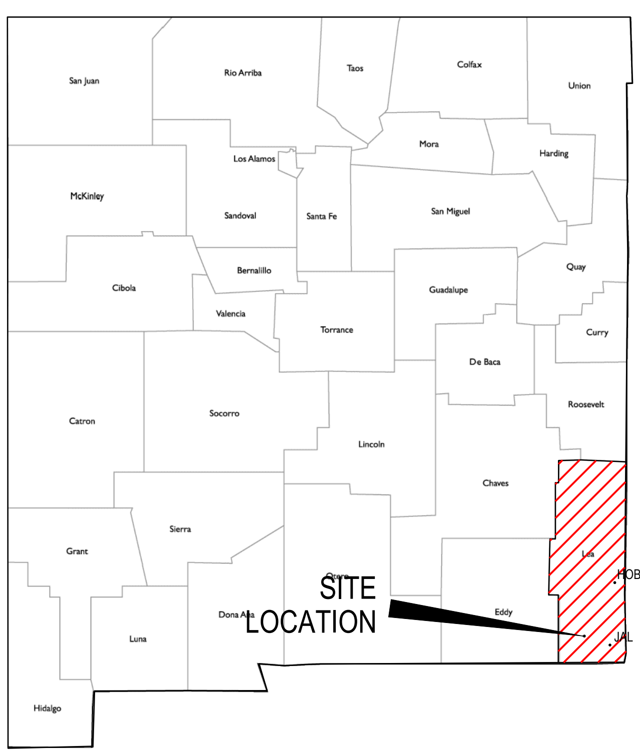
MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER

9/20/19

SEPTEMBER 2019
PROJECT NO. 35187378

PREPARED FOR:

NGL WASTE SERVICES, LLC
3773 CHERRY CREEK DR # 1000
DENVER, COLORADO 80209
(303) 815-1010



VICINITY MAP
N.T.S.

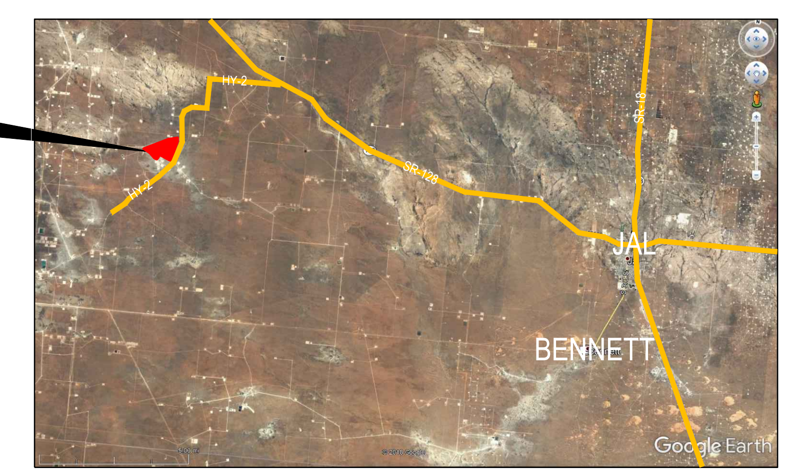
811
Know what's below.
Call before you dig.

PREPARED BY:

Terracon
Consulting Engineers and Scientists

25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

SITE
LOCATION



SITE: 2018 GOOGLE EARTH IMAGERY

SITE LOCATION MAP
SCALE: N.T.S.

INDEX OF DRAWINGS

DRAWING NO.	TITLE
--	COVER SHEET
--	INDEX SHEET
1.	EXISTING CONDITIONS
2.	SITE DEVELOPMENT
3.	EXISTING DRAINAGE
4.	FINAL DRAINAGE
5.	SITE EXCAVATION (CUT) PLAN
6.	CELL E-1 & E-2 PLAN VIEW
7.	CELL E-1 & E-2 SECTION VIEW
8.	CELL E-3 & E-4 PLAN VIEW
9.	CELL E-3 & E-4 SECTION VIEW
10.	CELL E-5 & E-6 PLAN VIEW
11.	CELL E-5 & E-6 SECTION VIEW
12.	CELL W-1 & W-2 PLAN VIEW
13.	CELL W-1 & W-2 SECTION VIEW
14.	CELL W-3 & W-4 PLAN VIEW
15.	CELL W-3 & W-4 SECTION VIEW
16.	CELL W-5 CELL PLAN VIEW
17.	CELL W-5 SECTION VIEW
18.	PIGGY BACK PLAN VIEW
19.	PIGGY BACK SECTION VIEW
20.	TOP OF PROTECTIVE COVER
21.	INTERMEDIATE TOP OF WASTE
22.	FINAL TOP OF WASTE
23.	FINAL COVER SYSTEM GRADE
24.	FINAL COVER SYSTEM GRADE SECTION VIEW
25.	LINER AND FINAL COVER DETAILS
26.	ANCHOR TRENCH DETAILS
27.	FINAL COVER STORMWATER STRUCTURE DETAILS
28.	BASE LINER TIE IN AND TECHNICAL DETAILS
29.	LEACHATE COLLECTION AND SUMP DETAILS
30.	MISCELLANEOUS LINER DETAILS
31.	MISCELLANEOUS INFRASTRUCTURE DETAILS
32.	MISCELLANEOUS INFRASTRUCTURE DETAILS
33.	DRYING PAD PLAN VIEW
34.	DRYING PAD DETAIL AND CROSS-SECTION
35.	TRUCK WASH PLAN VIEW
36.	TRUCK WASH CROSS-SECTION (1 OF 2)
37.	TRUCK WASH CROSS-SECTION (2 OF 2)
38.	LEACHATE POND CROSS-SECTIONS
39.	LEACHATE POND DETAILS

TYPICAL ABBREVIATIONS

DIA	DIAMETER
ELEV	ELEVATION
FT	FEET
HDPE	HIGH DENSITY POLYETHYLENE
HORZ	HORIZONTAL
ID	INSIDE DIAMETER
IN	INCHES
INV	INVERT
MAX	MAXIMUM
MIN	MINIMUM
MSL	MEAN SEA LEVEL
NTS	NOT TO SCALE
OD	OUTSIDE DIAMETER
PL	PROPERTY LINE
SDR	STANDARD DIMENSION RATIO
TYP	TYPICAL
VERT	VERTICAL

CONTACT INFORMATION

OWNER:
NGL WASTE SERVICES, LLC
ATTENTION: DOUG WHITE, EXECUTIVE VICE PRESIDENT.
3773 CHERRY CREEK DR STE # 1000
DENVER, COLORADO 80209
PHONE: (303) 815-1010

ENGINEER:
TERRACON CONSULTANTS, INC.
ATTENTION: MICHAEL BRADFORD P.E. - SR. PROJECT ENGINEER
25809 I-30 SOUTH
BRYANT, ARKANSAS 72022
PHONE: (501) 943-1011
FAX: (501) 847-9210

REGULATORY AUTHORITY:
NEW MEXICO OIL CONSERVATION DIVISION
1220 SOUTH ST. FRANCIS DR
SANTA FE, NM 87505
PHONE: (505) 476-3440
FAX: (505) 476-3462

GENERAL NOTES

1. EXISTING FACILITIES AND FEATURES ARE SHOWN LIGHT-LINED AND/OR SCREENED. NEW FACILITIES AND FEATURES ARE SHOWN SOLID AND HEAVY-LINED.
2. SLOPES AND GRADES ARE IN UNITS OF FT(H):FT(V), UNLESS OTHERWISE NOTED.
3. THESE DRAWINGS WERE PREPARED IN ACCORDANCE WITH APPLICABLE STATE NEW MEXICO OIL CONVERSATION DIVISION REGULATIONS AND NEW MEXICO ADMINISTRATIVE CODE, TITLE 19, CHAPTER 15, PART 36.
4. THESE DRAWINGS ARE ONLY PART OF AND SUPPLEMENTAL TO THE PERMIT MODIFICATION APPLICATION.

SECTION/DETAIL KEY

TITLE
DETAIL
SCALE: 1" = 1'-0"
A
1
DETAIL DESIGNATION
SHEET NUMBER ON WHICH DETAIL IS SHOWN
DETAIL KEY

A
#
PROFILE DIRECTION OF PERSPECTIVE
SECTION KEY

A
#
IMPLIES DETAIL APPLIES TO THE AREA

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

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REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

INDEX
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
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PERMIT APPLICATION DRAWING
LEA COUNTY
NEW MEXICO

Terracon
Consulting Engineers and Scientists
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BRYANT, AR 72022
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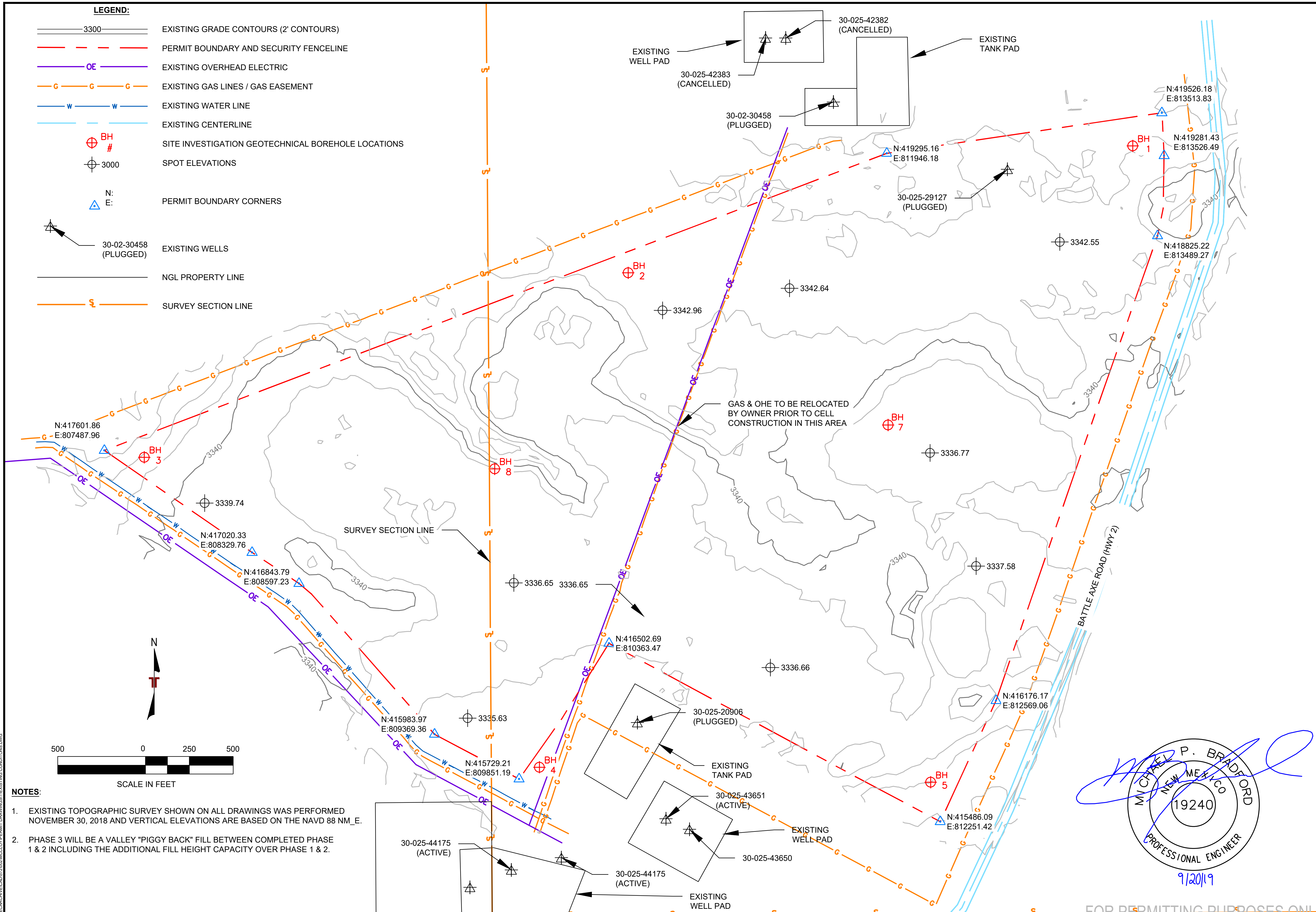
-

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	OF



NOTES:

1. EXISTING TOPOGRAPHIC SURVEY SHOWN ON ALL DRAWINGS WAS PERFORMED NOVEMBER 30, 2018 AND VERTICAL ELEVATIONS ARE BASED ON THE NAVD 88 NM_E.
2. PHASE 3 WILL BE A VALLEY "PIGGY BACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY OVER PHASE 1 & 2.

REV	DATE	BY	DESCRIPTION
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EXISTING CONDITIONS

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

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LEA COUNTY NEW MEXICO

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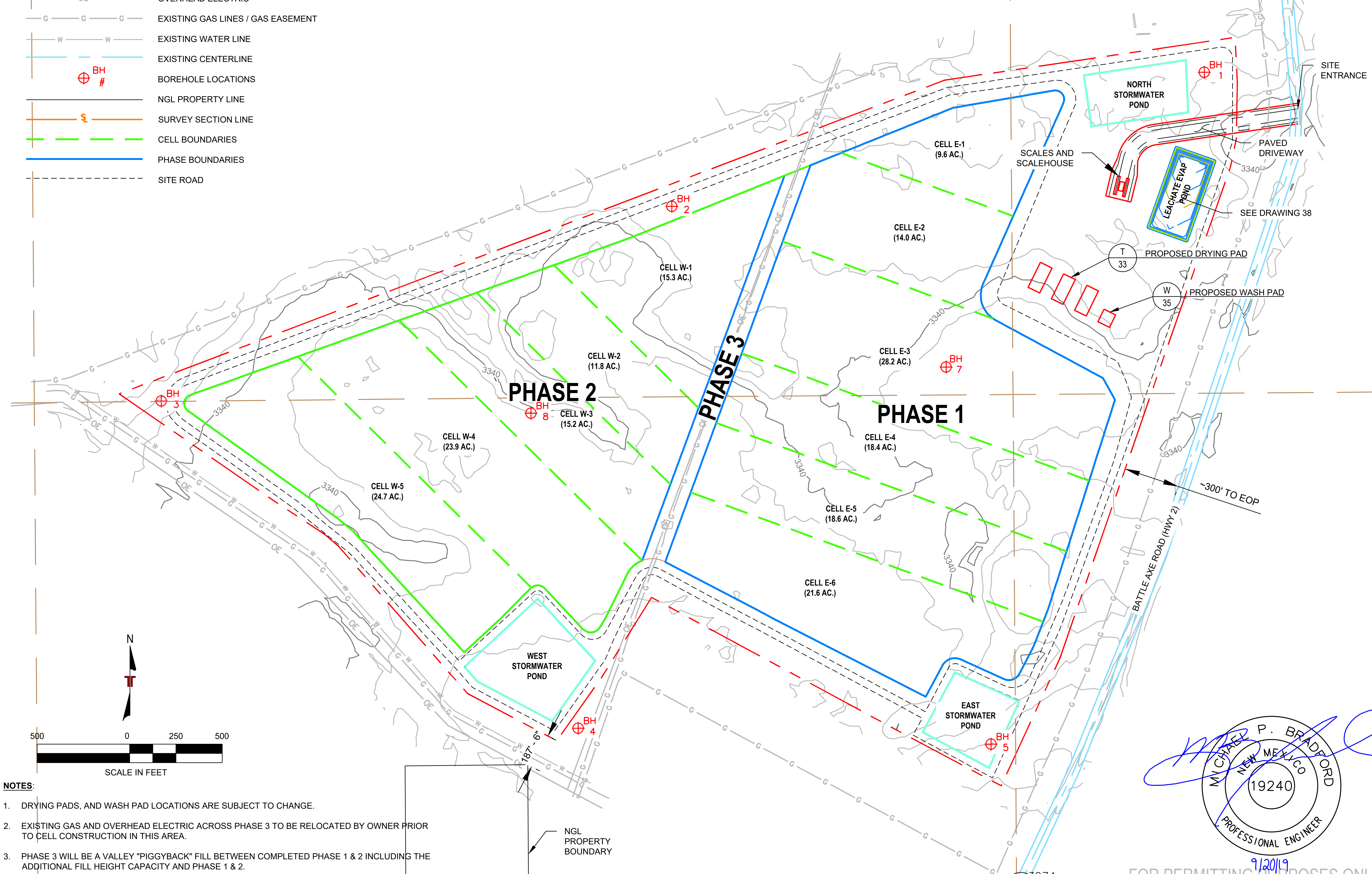
DRAWING 1

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	1 OF 39

LEGEND:

3300	EXISTING GRADE CONTOURS (11-30-2018, 2' CONTOURS)
	PERMIT BOUNDARY AND SECURITY FENCELINE
OE	OVERHEAD ELECTRIC
G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	EXISTING CENTERLINE
BH #	BOREHOLE LOCATIONS
	NGL PROPERTY LINE
℄	SURVEY SECTION LINE
	CELL BOUNDARIES
	PHASE BOUNDARIES
	SITE ROAD



NOTES:

1. DRYING PADS, AND WASH PAD LOCATIONS ARE SUBJECT TO CHANGE.
2. EXISTING GAS AND OVERHEAD ELECTRIC ACROSS PHASE 3 TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA.
3. PHASE 3 WILL BE A VALLEY "PIGGYBACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY AND PHASE 1 & 2.

MICHAEL P. BRADFORD
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PROFESSIONAL ENGINEER
9/20/19

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SITE DEVELOPMENT

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
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DRAWING 2

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	2 OF 39

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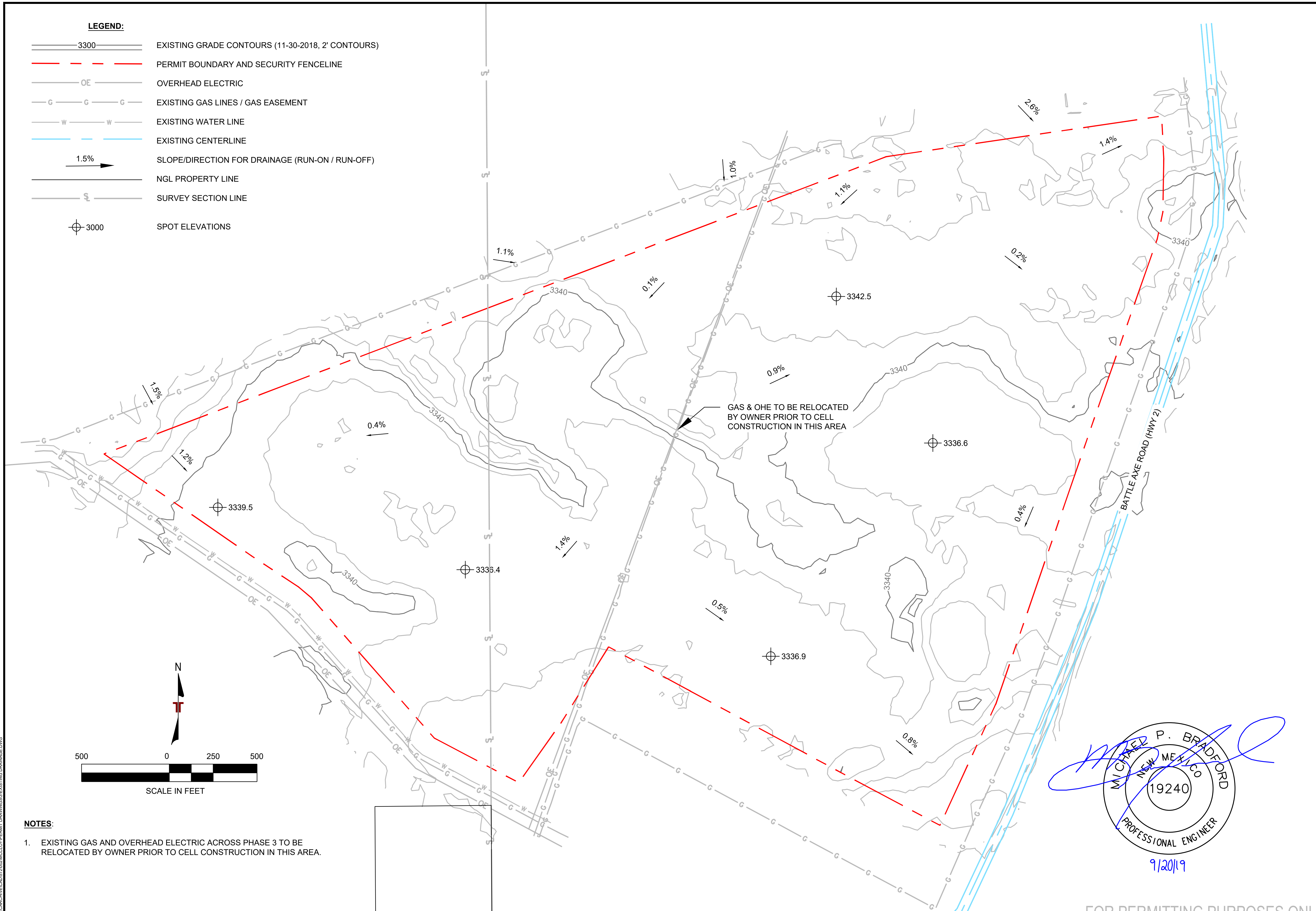
LEGEND:

3300	EXISTING GRADE CONTOURS (11-30-2018, 2' CONTOURS)
	PERMIT BOUNDARY AND SECURITY FENCELINE
OE	OVERHEAD ELECTRIC
G G G	EXISTING GAS LINES / GAS EASEMENT
W W	EXISTING WATER LINE
	EXISTING CENTERLINE
1.5%	SLOPE/DIRECTION FOR DRAINAGE (RUN-ON / RUN-OFF)
	NGL PROPERTY LINE
S	SURVEY SECTION LINE
3000	SPOT ELEVATIONS



NOTES:

1. EXISTING GAS AND OVERHEAD ELECTRIC ACROSS PHASE 3 TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA.

MICHAEL P. BRADFORD
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9/20/19

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N:\GEC\ARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\3-EXISTING DRAINAGE.DWG

REV	DATE	BY	DESCRIPTION
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EXISTING DRAINAGE

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

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DRAWING 3

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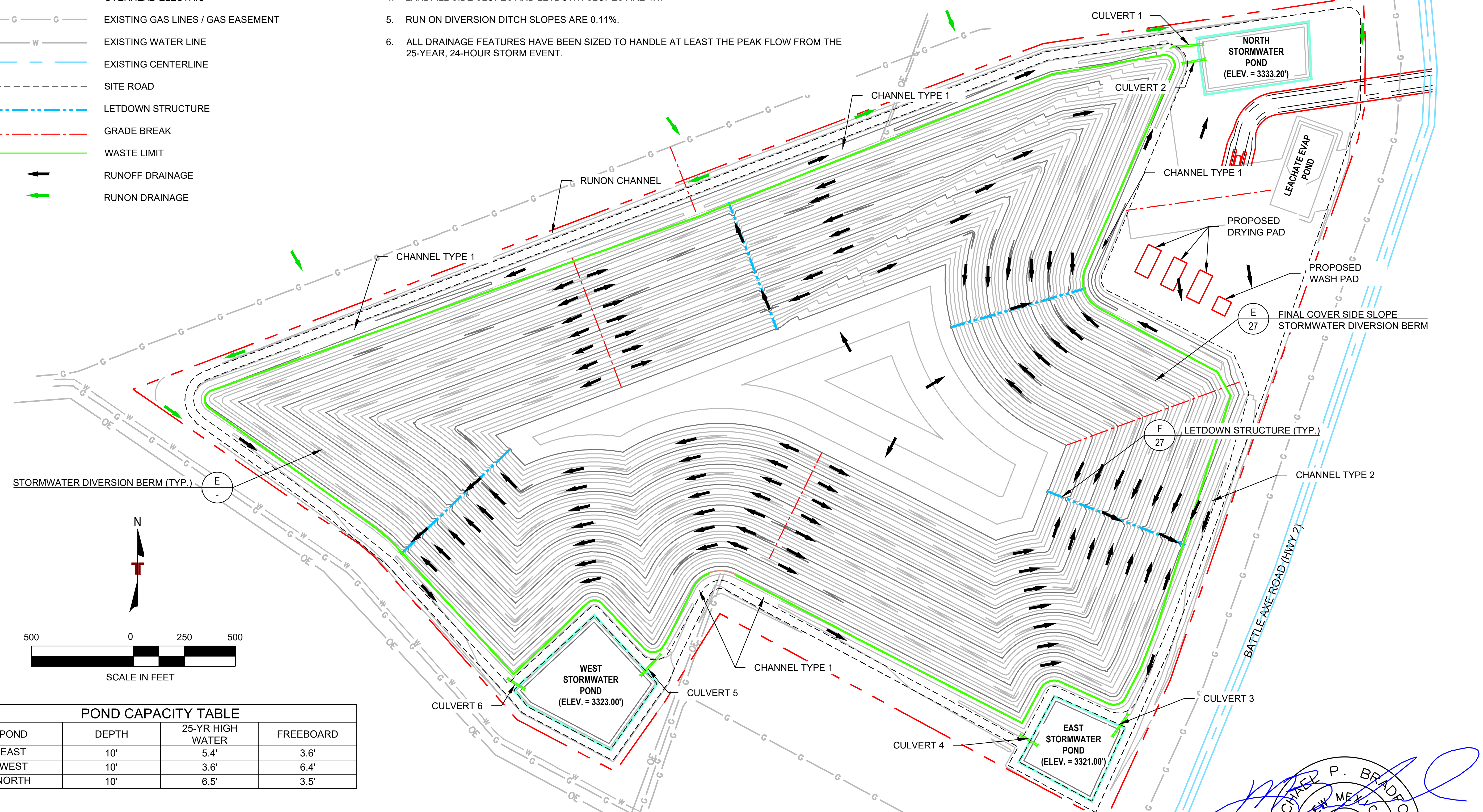
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	3 OF 39

LEGEND:

3300	FINAL COVER CONTOURS (5' INTERVALS)
3300	PERIMETER INFRASTRUCTURE CONTOURS (5' INTERVALS)
	PERMIT BOUNDARY
OE	OVERHEAD ELECTRIC
G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	EXISTING CENTERLINE
	SITE ROAD
	LETDOWN STRUCTURE
	GRADE BREAK
	WASTE LIMIT
	RUNOFF DRAINAGE
	RUNON DRAINAGE

NOTES:

1. ALL PERIMETER CHANNEL FLOWLINE SLOPES ARE 0.5%.
2. ALL SIDE SLOPE CHANNEL FLOWLINE SLOPES ARE 1.0%.
3. LANDFILL TOP DECK SLOPES ARE 4.0%.
4. LANDFILL SIDE SLOPES AND LETDOWN SLOPES ARE 4:1.
5. RUN ON DIVERSION DITCH SLOPES ARE 0.11%.
6. ALL DRAINAGE FEATURES HAVE BEEN SIZED TO HANDLE AT LEAST THE PEAK FLOW FROM THE 25-YEAR, 24-HOUR STORM EVENT.



POND CAPACITY TABLE			
POND	DEPTH	25-YR HIGH WATER	FREEBOARD
EAST	10'	5.4'	3.6'
WEST	10'	3.6'	6.4'
NORTH	10'	6.5'	3.5'

CULVERT SIZE AND CAPACITY TABLE				
CULVERT #	DIAMETER (IN)	# BARRELS	CAPACITY (CFS)	PEAK FLOW 25-YR (CFS)
1	36	3	222	164
2	36	3	222	195
3	48	2	375	297
4	36	2	204	34
5	24	2	55	13
6	48	2	350	304

CHANNEL GEOMETRY TABLE				
CHANNEL TYPE	SHAPE	DEPTH (FT)	BOTTOM WIDTH (FT)	SIDE SLOPE (H:V)
1	TRAPEZOIDAL	3	10	4:1
2	TRAPEZOIDAL	3	6	4:1
SIDE SLOPE BERM	V-DITCH	1.5	-	4:1
ALL LET DOWN CHANNEL	TRAPEZOIDAL	2	10	3:1
RUN-ON CHANNEL	TRAPEZOIDAL	4	7	4:1

MICHAEL P. BRADFORD NEW MEXICO 19240 PROFESSIONAL ENGINEER

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NGL

FINAL DRAINAGE

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

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DRAWING 4

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APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	4 OF 39

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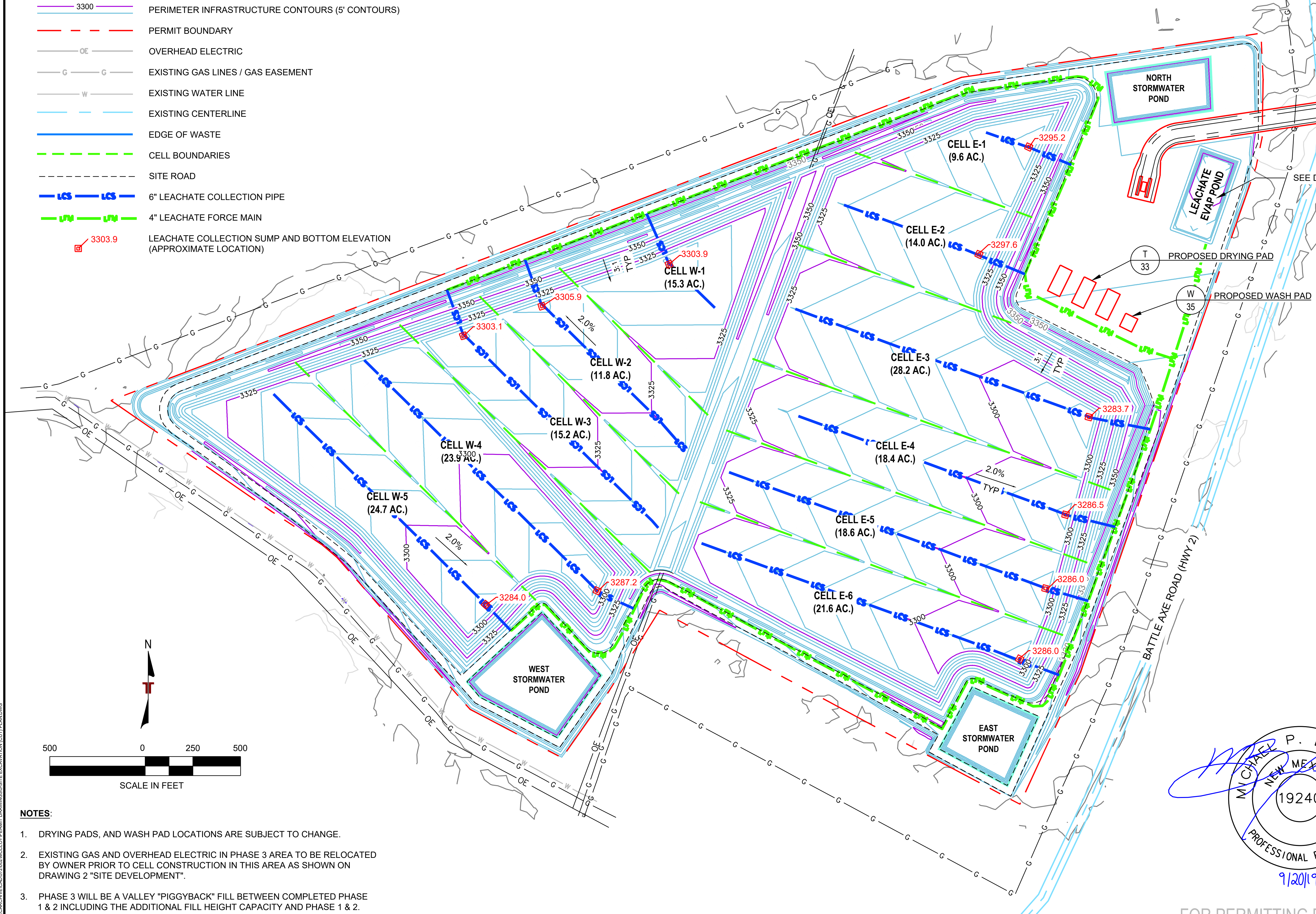
LEGEND:

3300	EXISTING GRADE CONTOURS (11-30-2018, 2' CONTOURS)
3300	SUBGRADE CONTOURS (5' CONTOURS)
3300	PERIMETER INFRASTRUCTURE CONTOURS (5' CONTOURS)
	PERMIT BOUNDARY
OE	OVERHEAD ELECTRIC
G G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	EXISTING CENTERLINE
	EDGE OF WASTE
	CELL BOUNDARIES
	SITE ROAD
LCS LCS	6" LEACHATE COLLECTION PIPE
LFM LFM	4" LEACHATE FORCE MAIN
3303.9	LEACHATE COLLECTION SUMP AND BOTTOM ELEVATION (APPROXIMATE LOCATION)



NOTES:

1. DRYING PADS, AND WASH PAD LOCATIONS ARE SUBJECT TO CHANGE.
2. EXISTING GAS AND OVERHEAD ELECTRIC IN PHASE 3 AREA TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA AS SHOWN ON DRAWING 2 "SITE DEVELOPMENT".
3. PHASE 3 WILL BE A VALLEY "PIGGYBACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY AND PHASE 1 & 2.

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NEW MEXICO
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9/20/19

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NGL

SITE EXCAVATION (CUT) PLAN

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

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DRAWING 5

DESIGNED BY:	MPB
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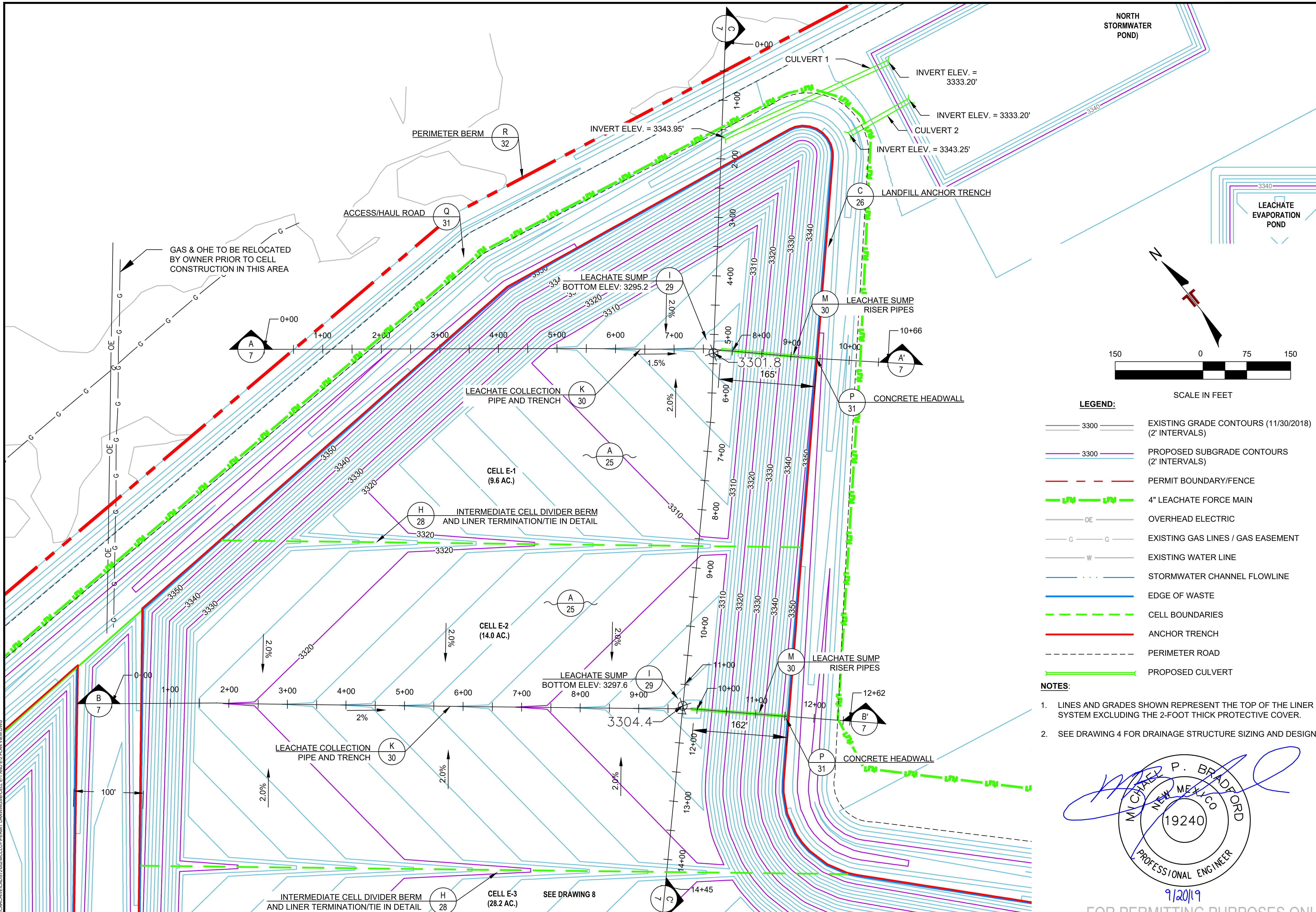
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	5 OF 39



NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.

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REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL E1 & E2 PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

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PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 6

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
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ACAD NO.	572-002
SHEET NO.:	6 OF 39

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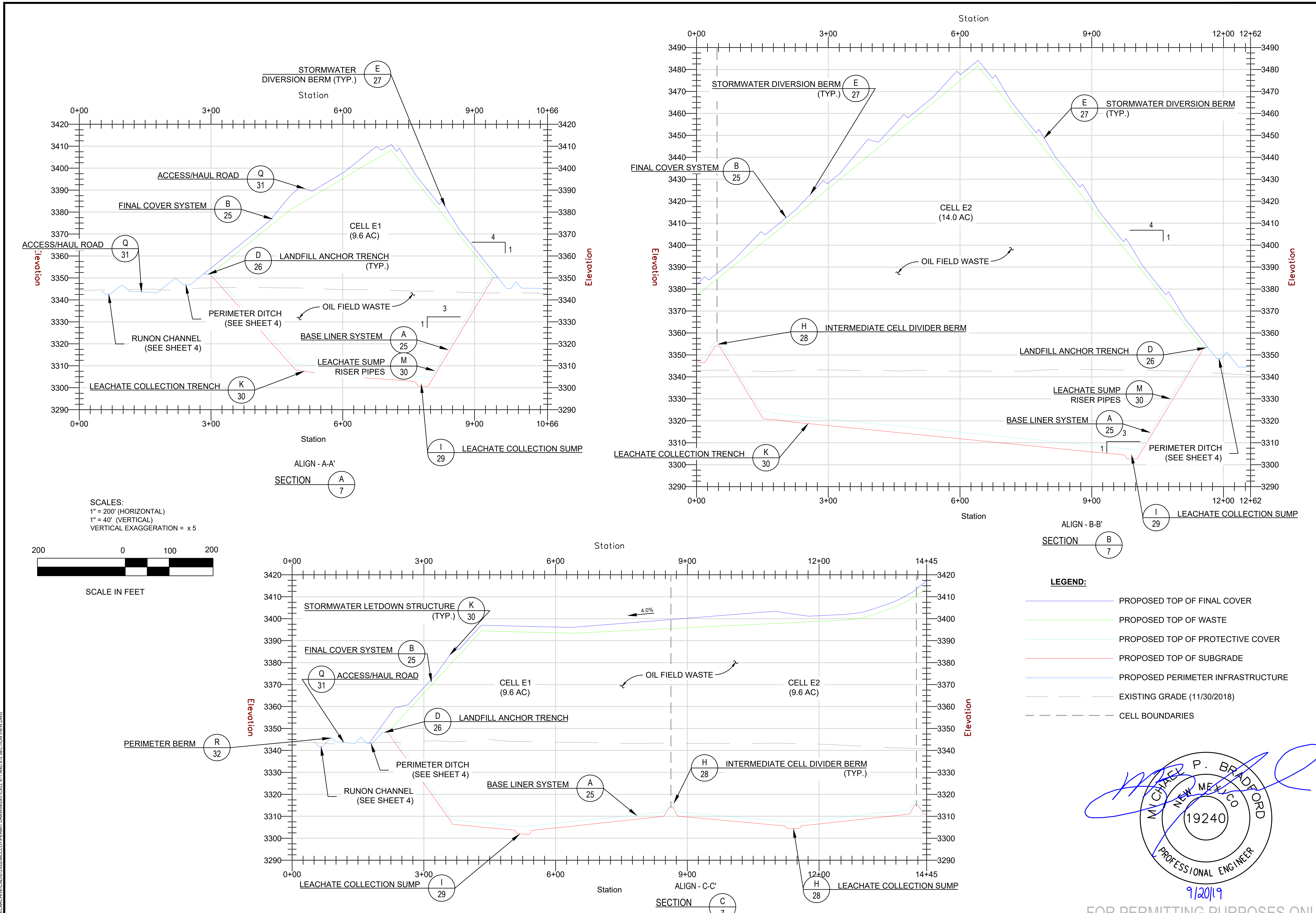

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1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL E1 & E2 SECTION VIEW

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

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DRAWING 7

DESIGNED BY:	MPB
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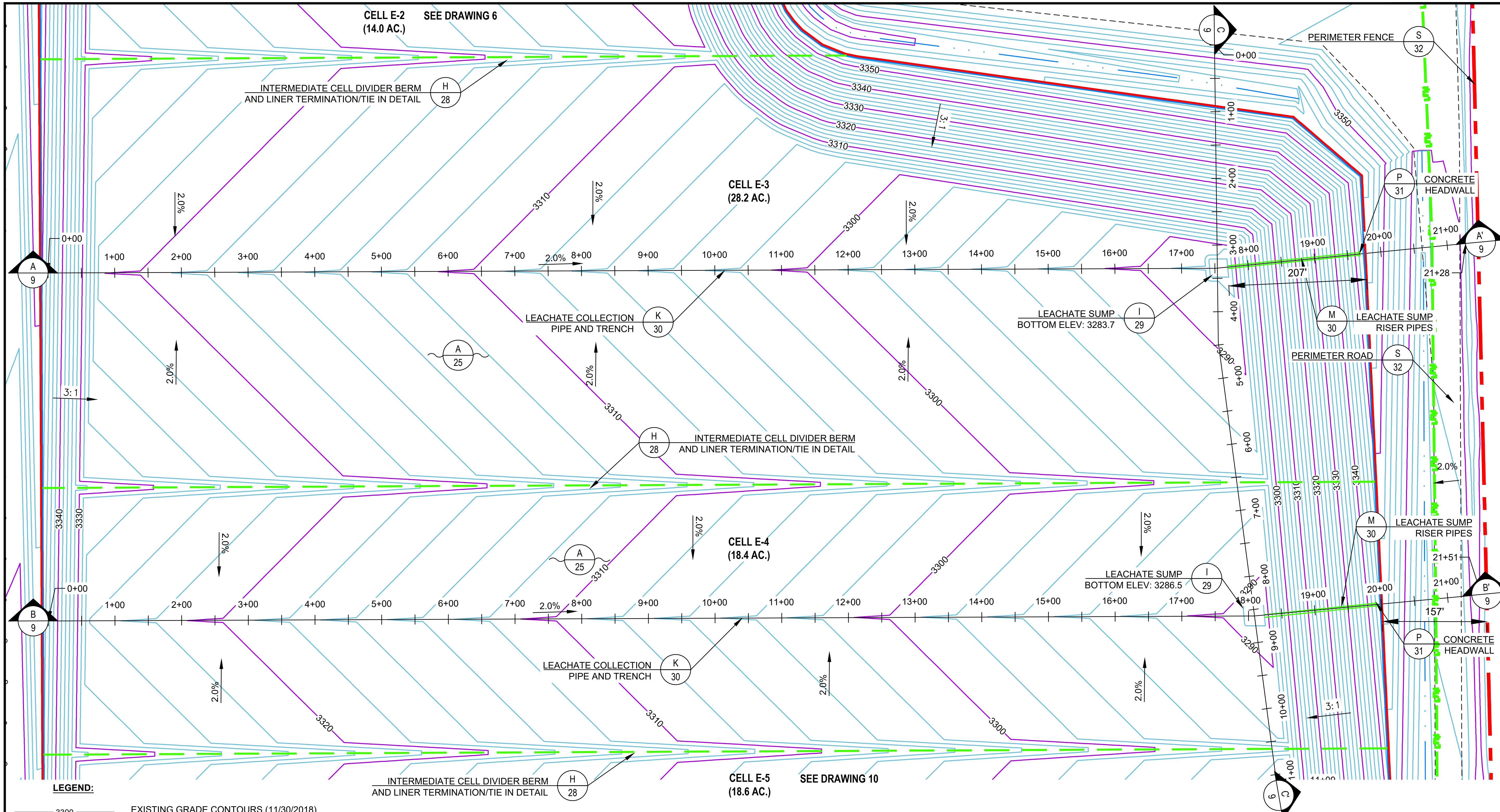
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	7 OF 39



LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
3300	PROPOSED SUBGRADE CONTOURS (2' INTERVALS)
	PERMIT BOUNDARY/FENCE
	4" LEACHATE FORCE MAIN
	STORMWATER CHANNEL FLOWLINE
	EDGE OF WASTE
	CELL BOUNDARIES
	ANCHOR TRENCH
	PERIMETER ROAD
	PROPOSED CULVERT

162'

N

150 0 75 150

SCALE IN FEET

NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

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CELL E3 & E4 PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY
NEW MEXICO

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FAX. (501) 847-9210

DRAWING 8

DESIGNED BY:	MPB
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JOB NO.	35187378
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SHEET NO.:	8 OF 39

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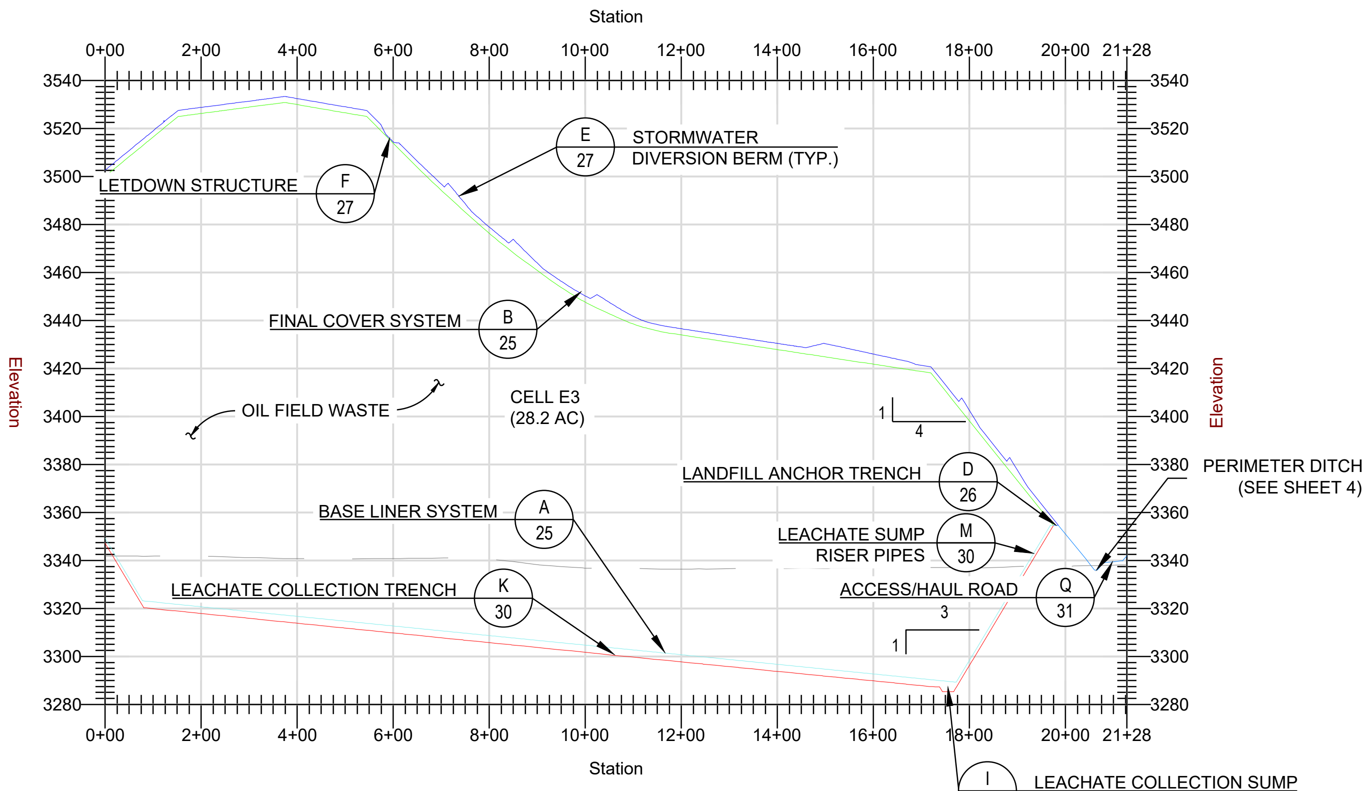
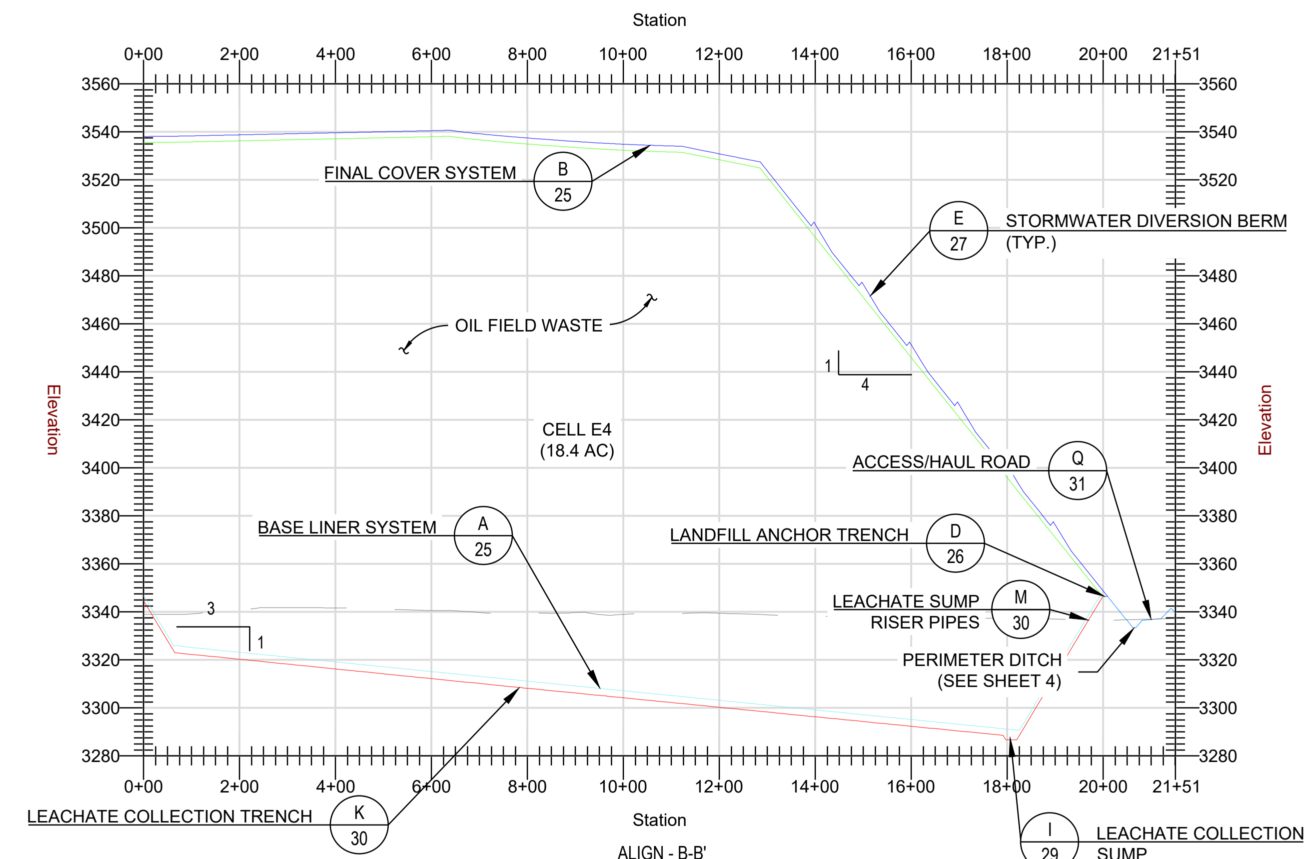
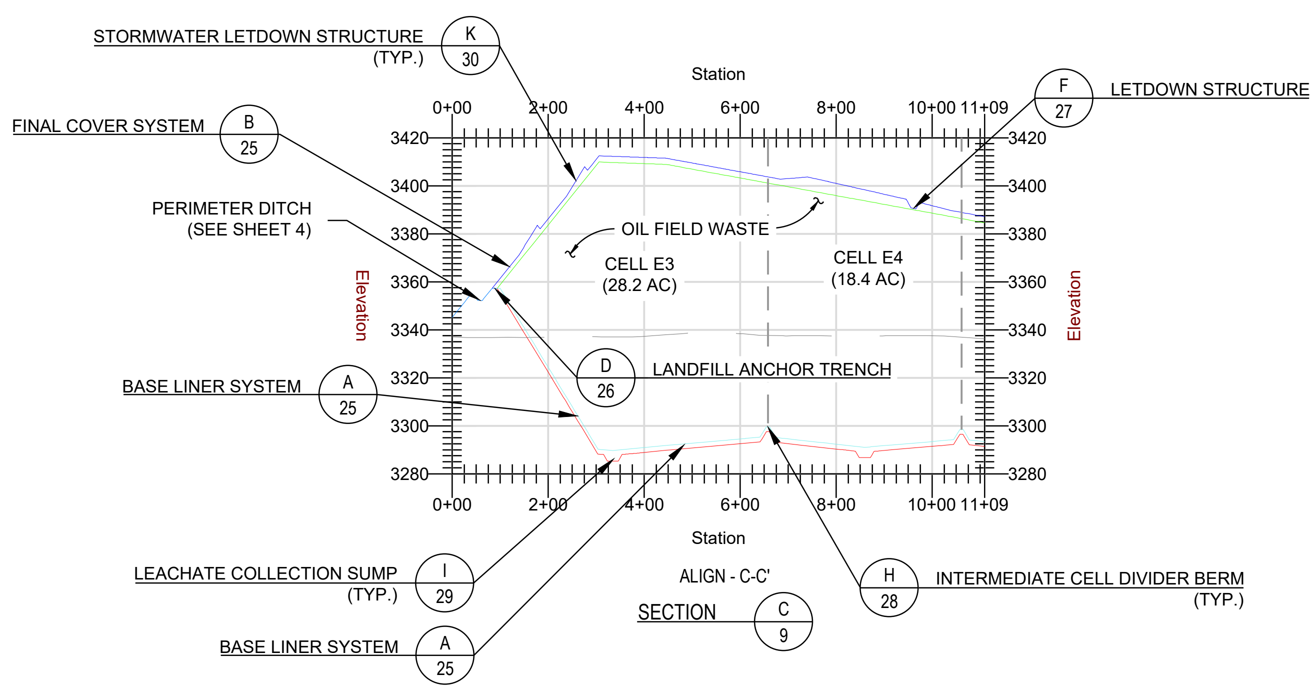


SECTION A / 9



SECTION B / 9



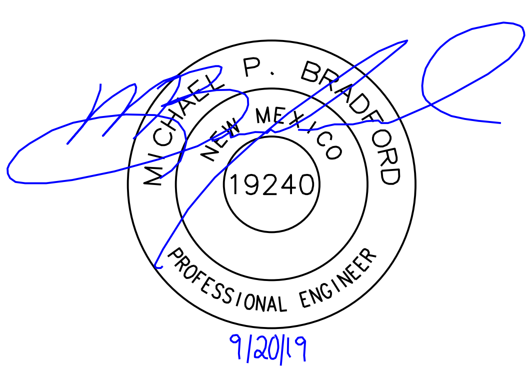
SECTION C / 9

LEGEND:

- PROPOSED TOP OF FINAL COVER
- PROPOSED TOP OF WASTE
- PROPOSED TOP OF PROTECTIVE COVER
- PROPOSED TOP OF SUBGRADE
- PROPOSED PERIMETER INFRASTRUCTURE
- EXISTING GRADE (11/30/2018)
- CELL BOUNDARIES

SCALES:
1" = 400' (HORIZONTAL)
1" = 80' (VERTICAL)
VERTICAL EXAGGERATION = x 5

400 0 200 400
SCALE IN FEET



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REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL E3 & E4 SECTION VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

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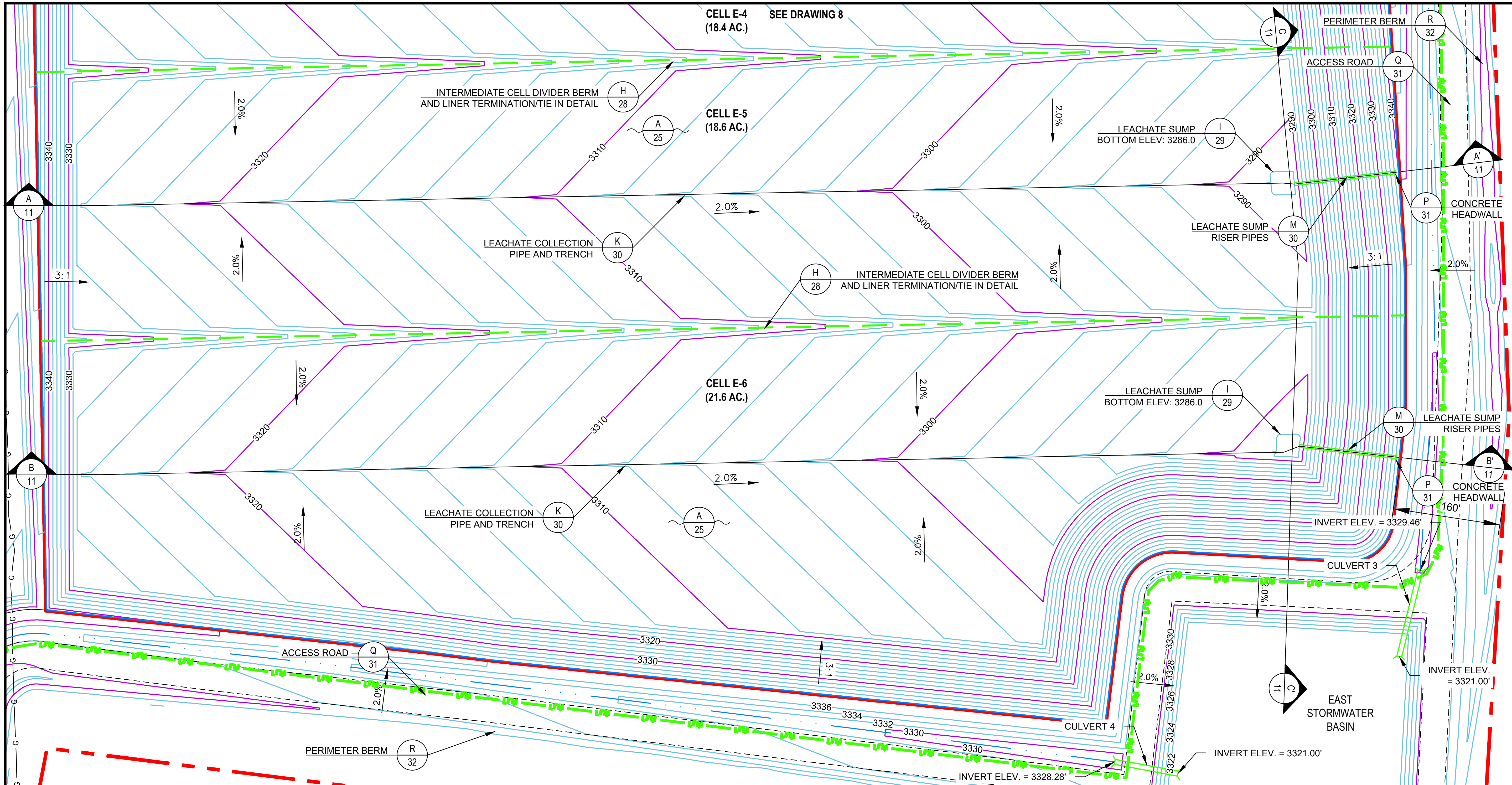
DRAWING 9

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	9 OF 39



LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
3300	PROPOSED SUBGRADE CONTOURS (2' INTERVALS)
	PERMIT BOUNDARY/FENCE
LW	4" LEACHATE FORCE MAIN
	STORMWATER CHANNEL FLOWLINE
	EDGE OF WASTE
	CELL BOUNDARIES
	ANCHOR TRENCH
	PERIMETER ROAD
	PROPOSED CULVERT

N

150 0 75 150

SCALE IN FEET

NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER

9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

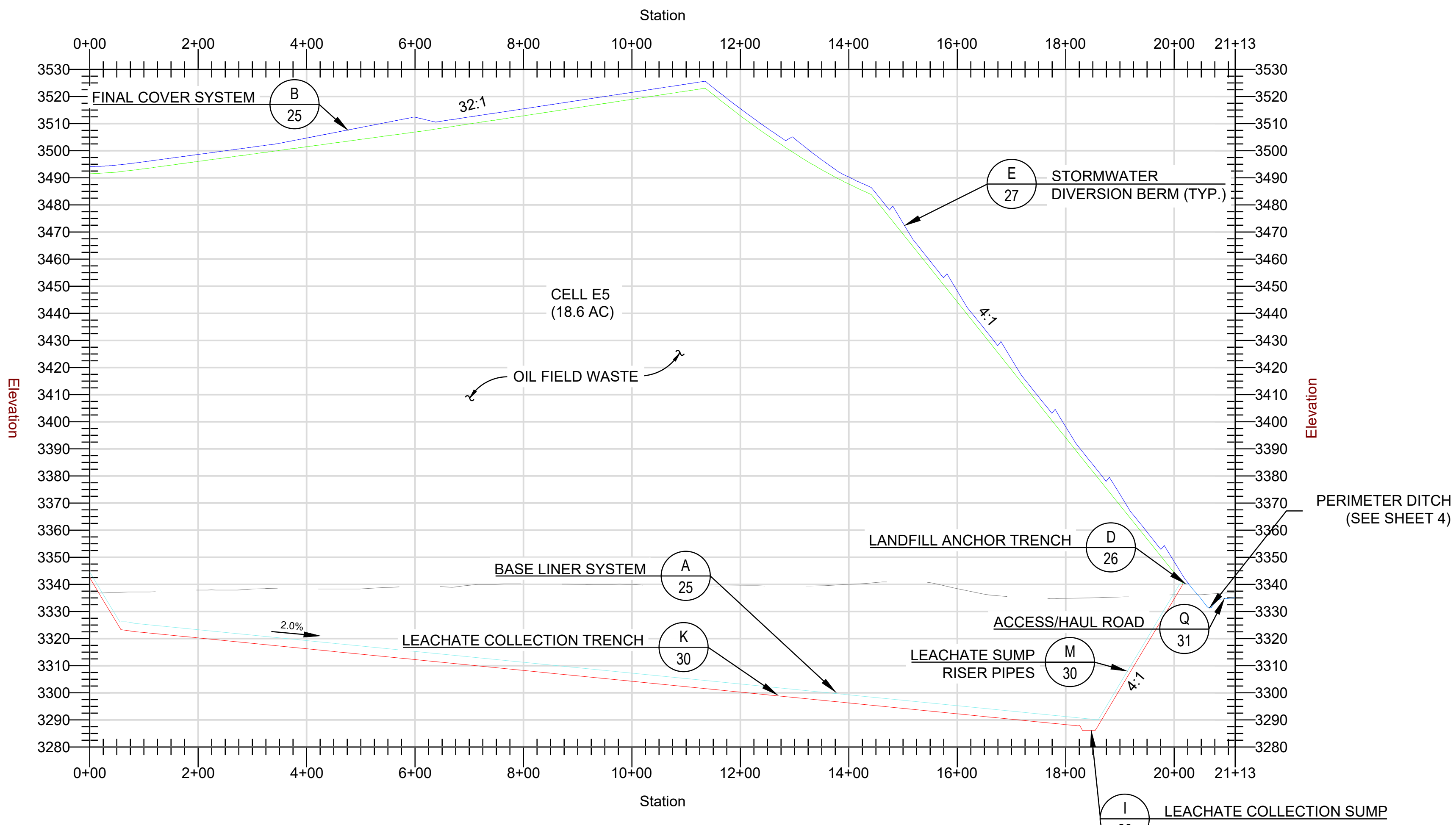
CELL E5 & E6 PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 10

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	10 OF 39

N:\GEOARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\10-CELL E-5 AND E-6 PLAN VIEW.DWG



ALIGN - A-A'

SECTION A 11

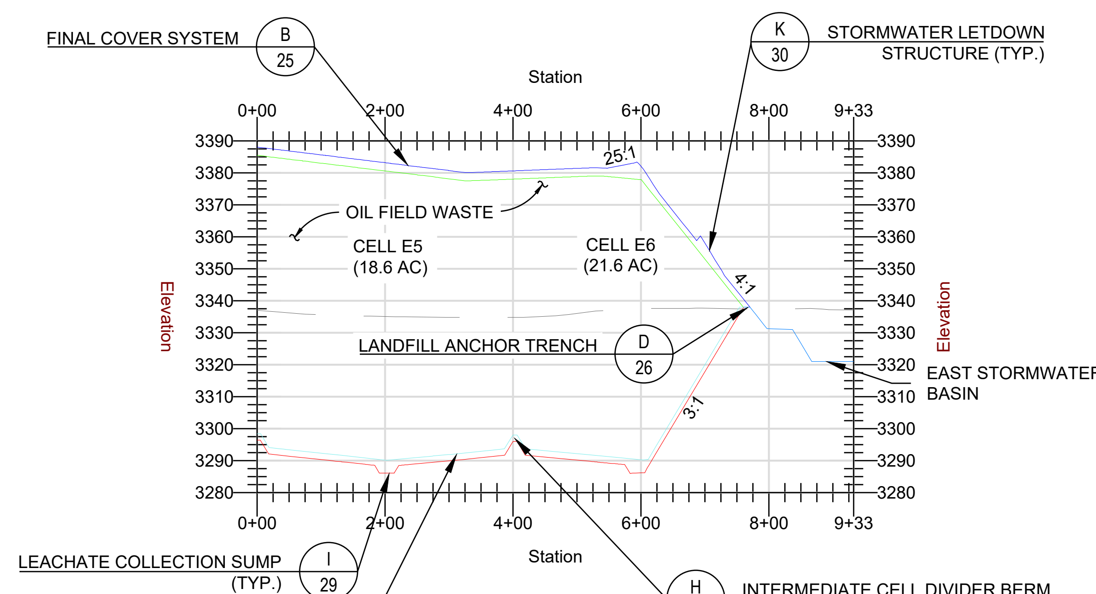
LEGEND:

- PROPOSED TOP OF FINAL COVER
- PROPOSED TOP OF WASTE
- PROPOSED TOP OF PROTECTIVE COVER
- PROPOSED TOP OF SUBGRADE
- PROPOSED PERIMETER INFRASTRUCTURE
- EXISTING GRADE (11/30/2018)
- CELL BOUNDARIES

SCALES:
1" = 300' (HORIZONTAL)
1" = 60' (VERTICAL)
VERTICAL EXAGGERATION = x 5

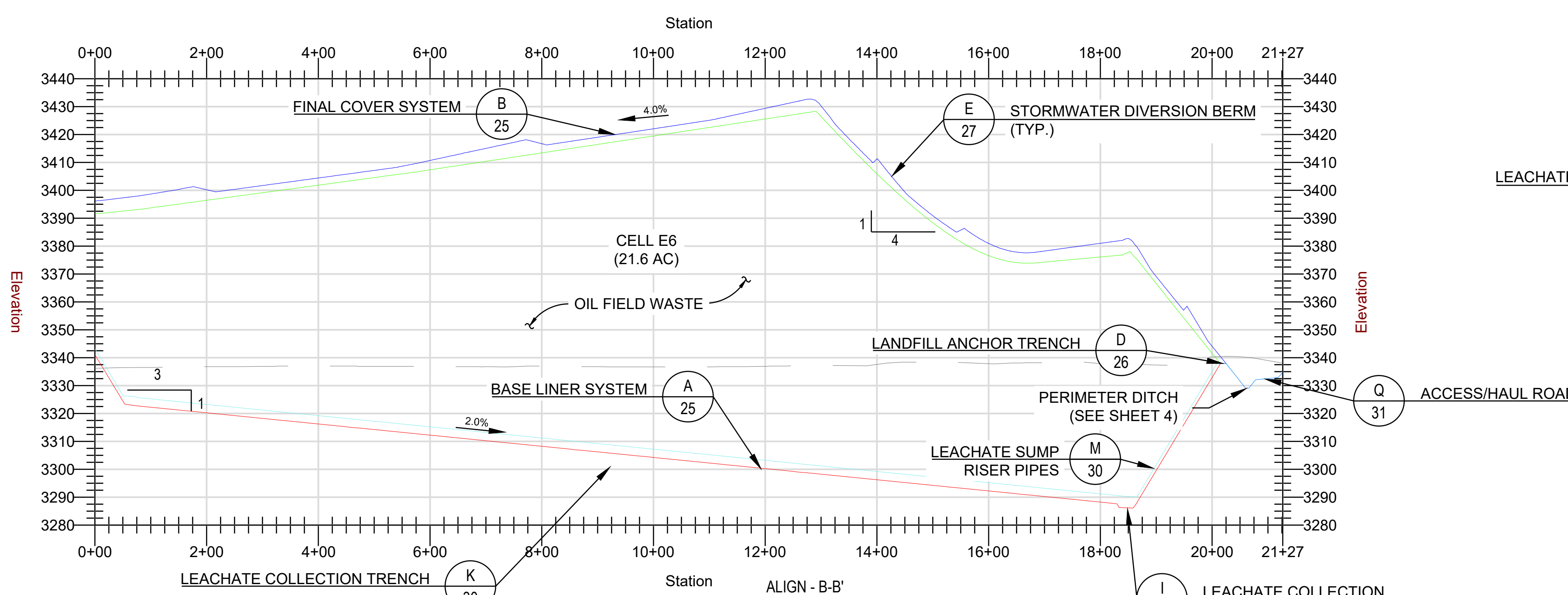
300 0 150 300

SCALE IN FEET



ALIGN - C-C'

SECTION C 11



ALIGN - B-B'

SECTION B 11

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL E5 & E6 SECTION VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

DRAWING 11

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	11 OF 39

FOR PERMITTING PURPOSES ONLY

150 0 75 150

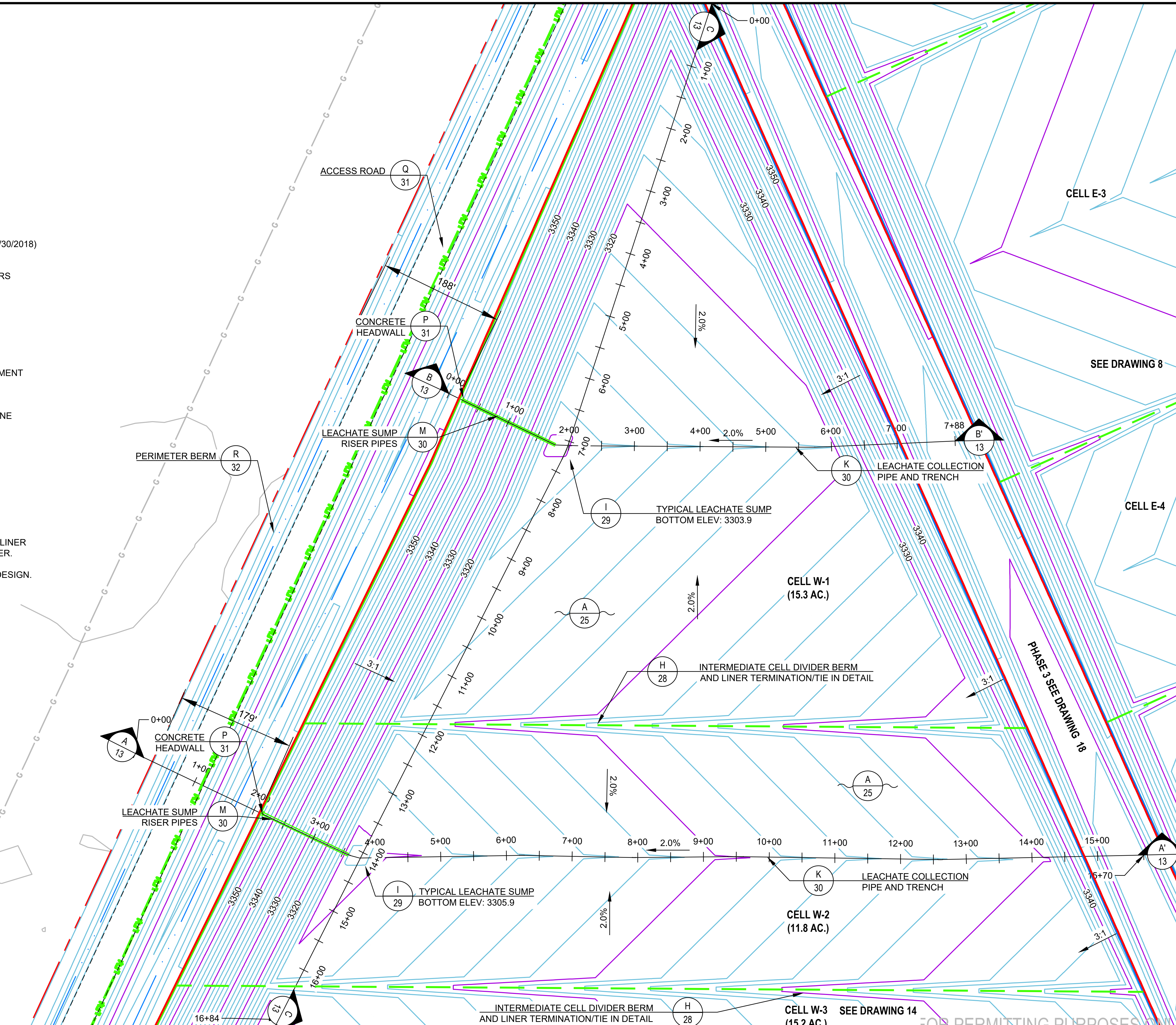
SCALE IN FEET

LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
3300	PROPOSED SUBGRADE CONTOURS (2' INTERVALS)
	PERMIT BOUNDARY/FENCE
LFM	4" LEACHATE FORCE MAIN
OE	OVERHEAD ELECTRIC
G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	STORMWATER CHANNEL FLOWLINE
	EDGE OF WASTE
	CELL BOUNDARIES
	ANCHOR TRENCH
	PROPOSED CULVERT

NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.



MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER

9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL W-1 & W-2 PLAN VIEW

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 12

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	12 OF 39

N:\GECARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\12-CELL W-1 AND W-2 PLAN VIEW.DWG

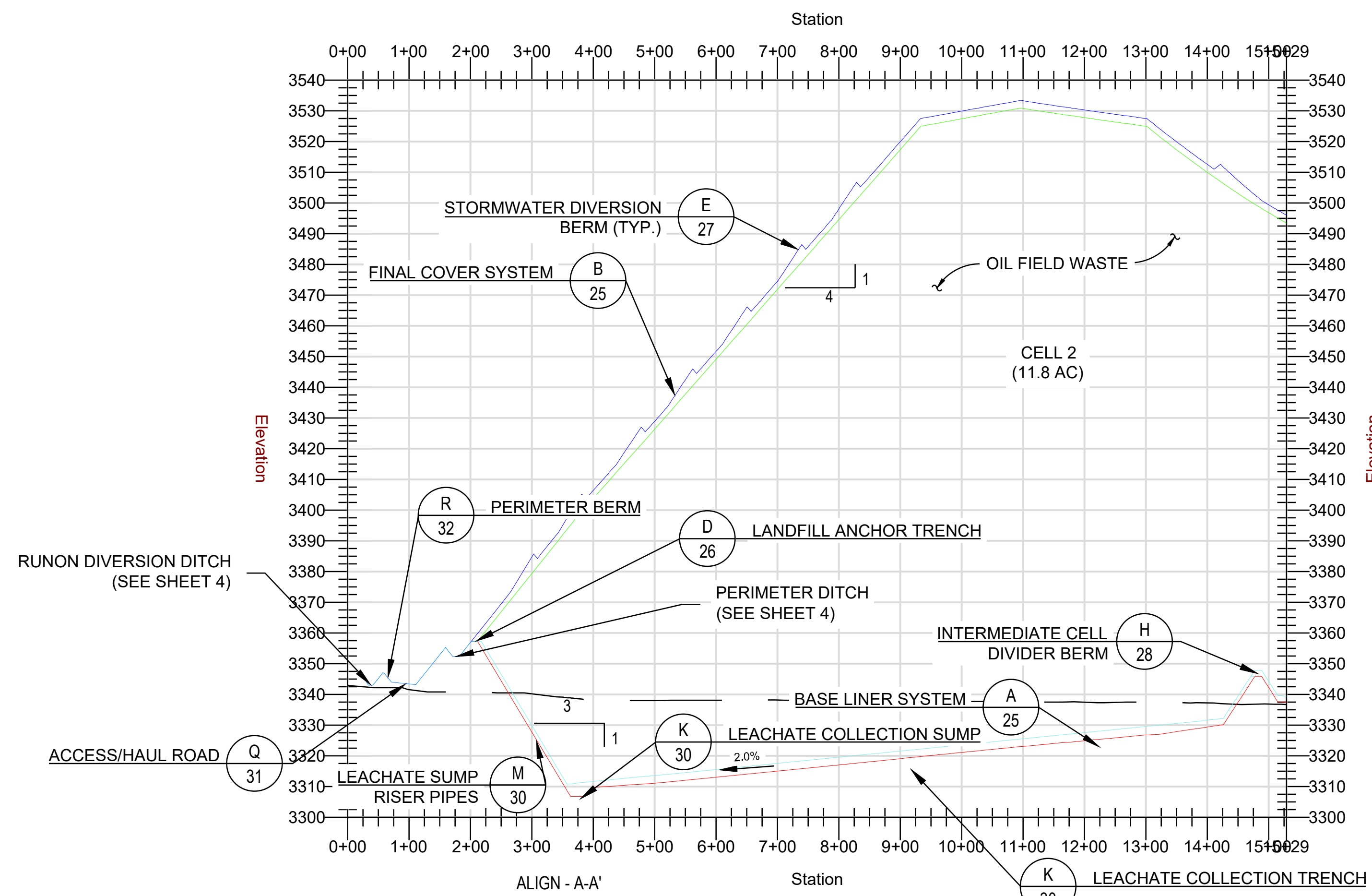
LEGEND:

- PROPOSED TOP OF FINAL COVER
- PROPOSED TOP OF WASTE
- PROPOSED TOP OF PROTECTIVE COVER
- PROPOSED TOP OF SUBGRADE
- PROPOSED PERIMETER INFRASTRUCTURE
- EXISTING GRADE (11/30/2018)
- CELL BOUNDARIES

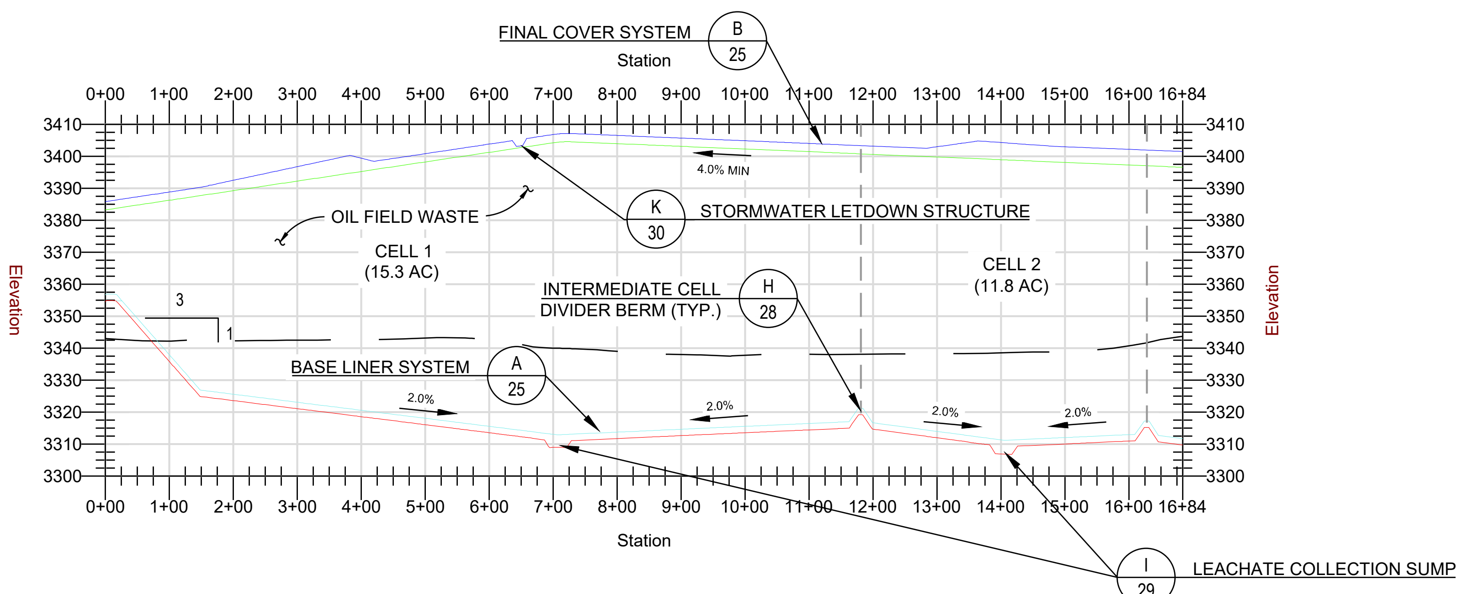
SCALES:
1" = 300' (HORIZONTAL)
1" = 60' (VERTICAL)
VERTICAL EXAGGERATION = x 5

300 0 150 300

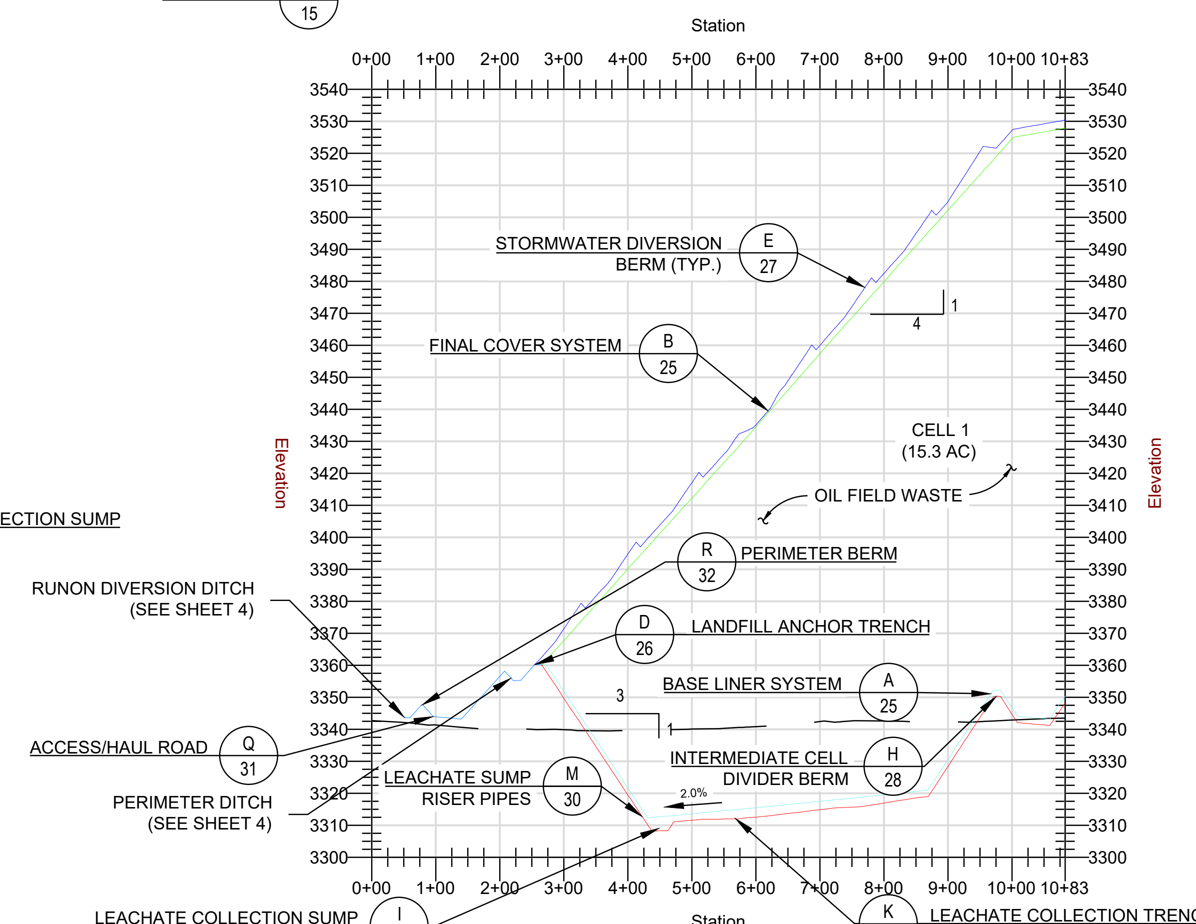
SCALE IN FEET



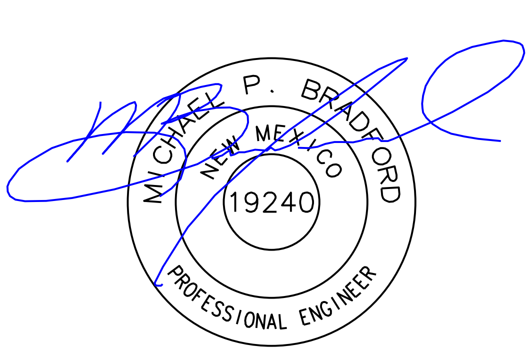
SECTION A 15



SECTION C 15



SECTION B 15



9/20/19

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N:\GEOARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\13-CELL W-1 AND W-2 SECTION VIEW.DWG

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL W-1 & W-2 SECTION VIEW

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

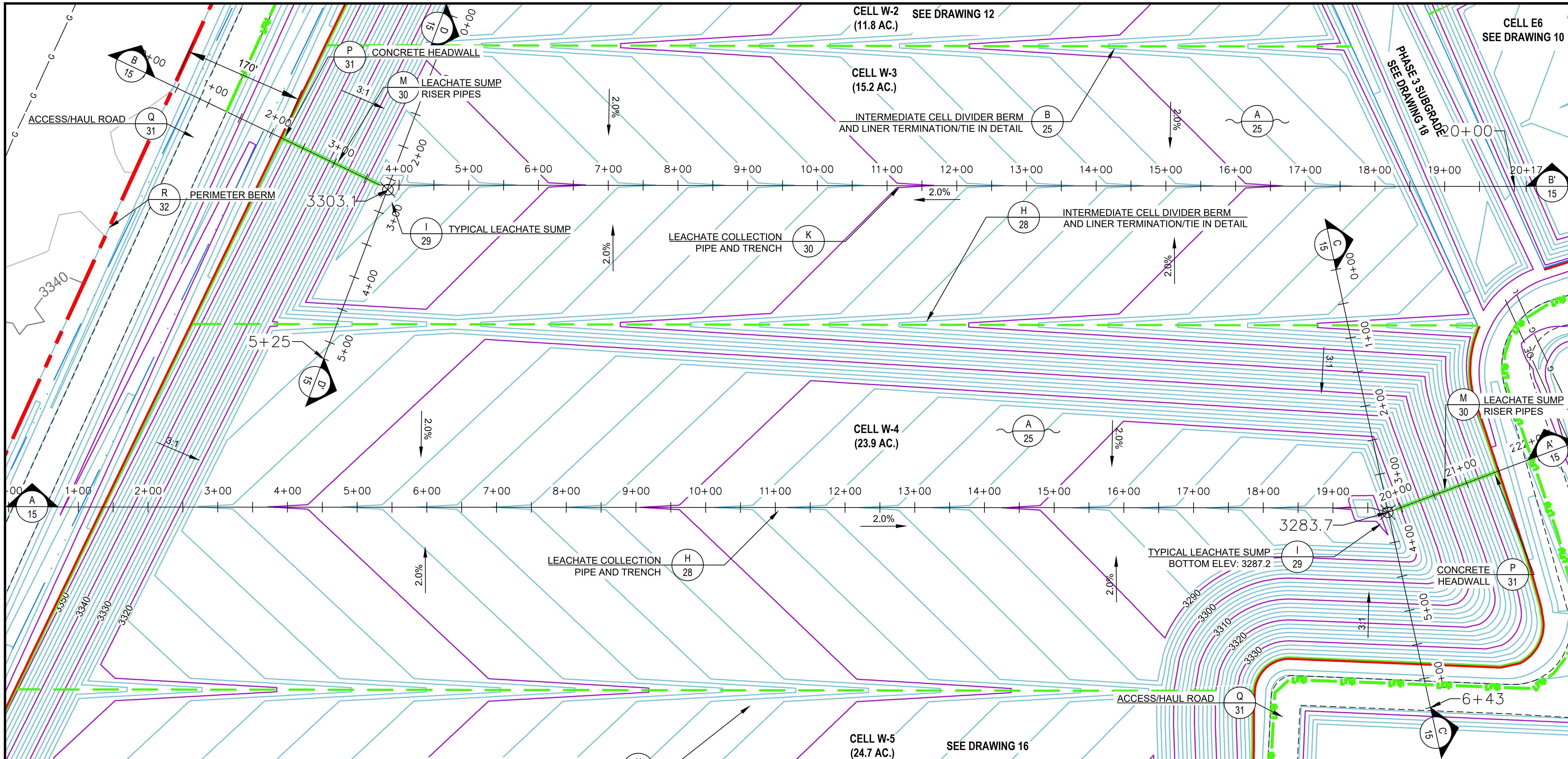
PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 13

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	13 OF 39



LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
3300	PROPOSED SUBGRADE CONTOURS (2' INTERVALS)
	PERMIT BOUNDARY/FENCE
LFM	4" LEACHATE FORCE MAIN
OE	OVERHEAD ELECTRIC
G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	STORMWATER CHANNEL FLOWLINE
	EDGE OF WASTE
	CELL BOUNDARIES
	ANCHOR TRENCH
	PROPOSED CULVERT

N

150 0 75 150

SCALE IN FEET

NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

FOR PERMITTING PURPOSES ONLY

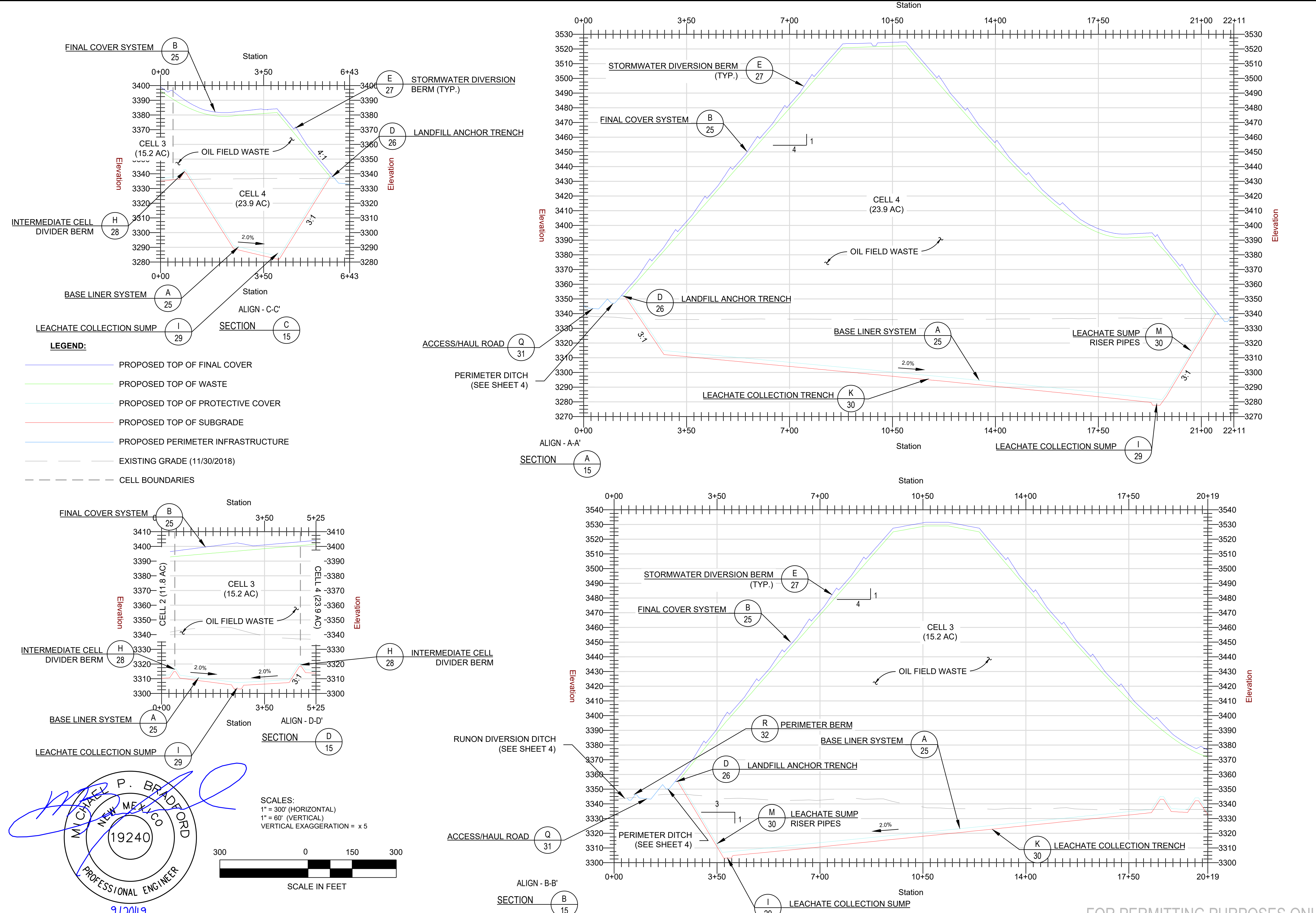
REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL W-3 & W-4 PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 14

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	14 OF 39



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REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL W-3 & W-4 SECTION VIEW

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

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Consulting Engineers and Scientists
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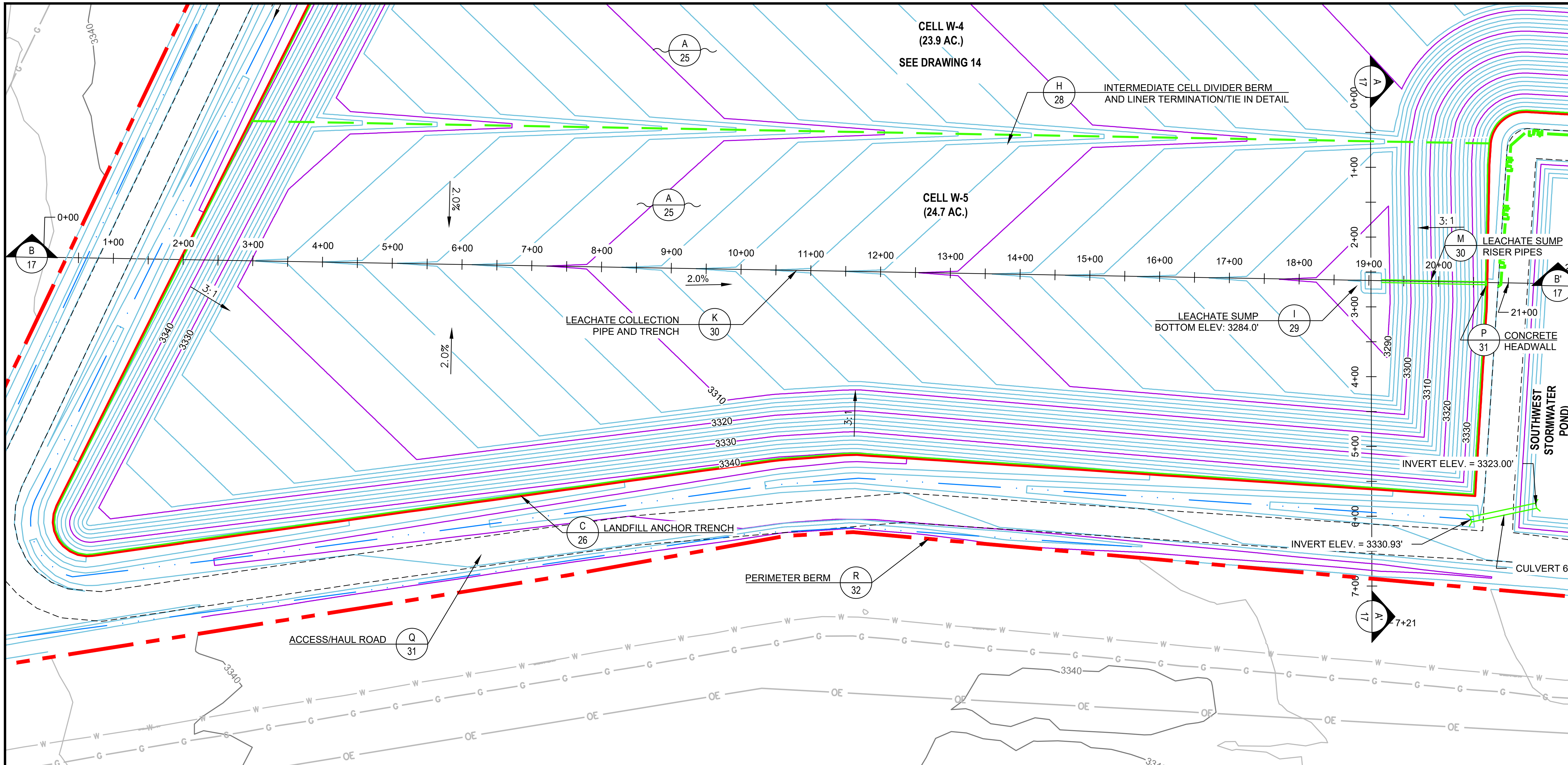
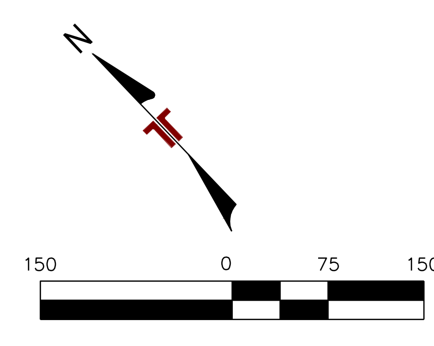
DRAWING 15

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	15 OF 39





LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
3300	PROPOSED SUBGRADE CONTOURS (2' INTERVALS)
	PERMIT BOUNDARY/FENCE
	4" LEACHATE FORCE MAIN
OE	OVERHEAD ELECTRIC
G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	STORMWATER CHANNEL FLOWLINE
	EDGE OF WASTE
	CELL BOUNDARIES
	ANCHOR TRENCH
	PROPOSED CULVERT

NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

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REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

NGL

CELL W-5 PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

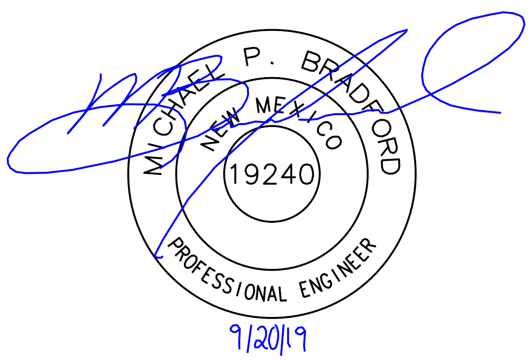
DRAWING 16

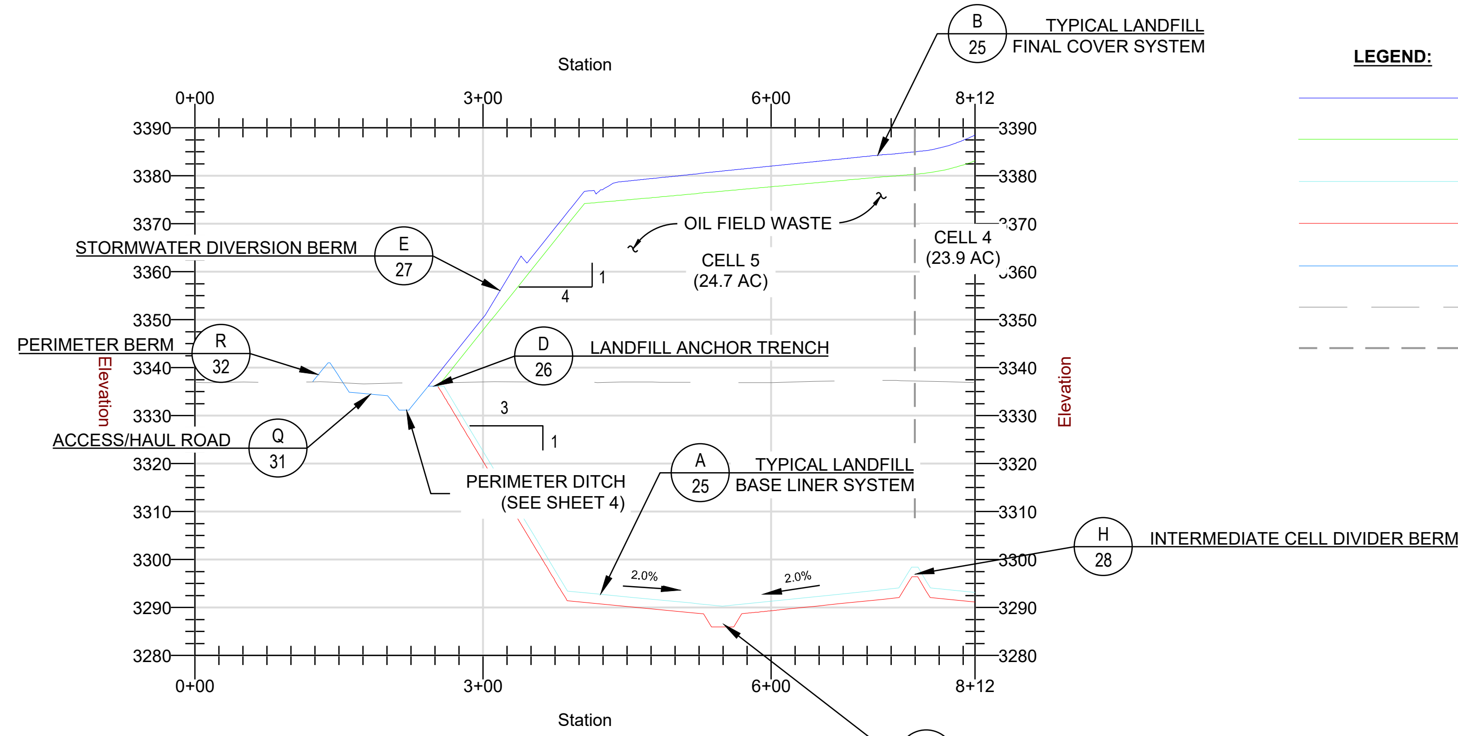
DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	16 OF 39

SCALES:
1" = 200' (HORIZONTAL)
1" = 40' (VERTICAL)
VERTICAL EXAGGERATION = x 5

200 0 100 200

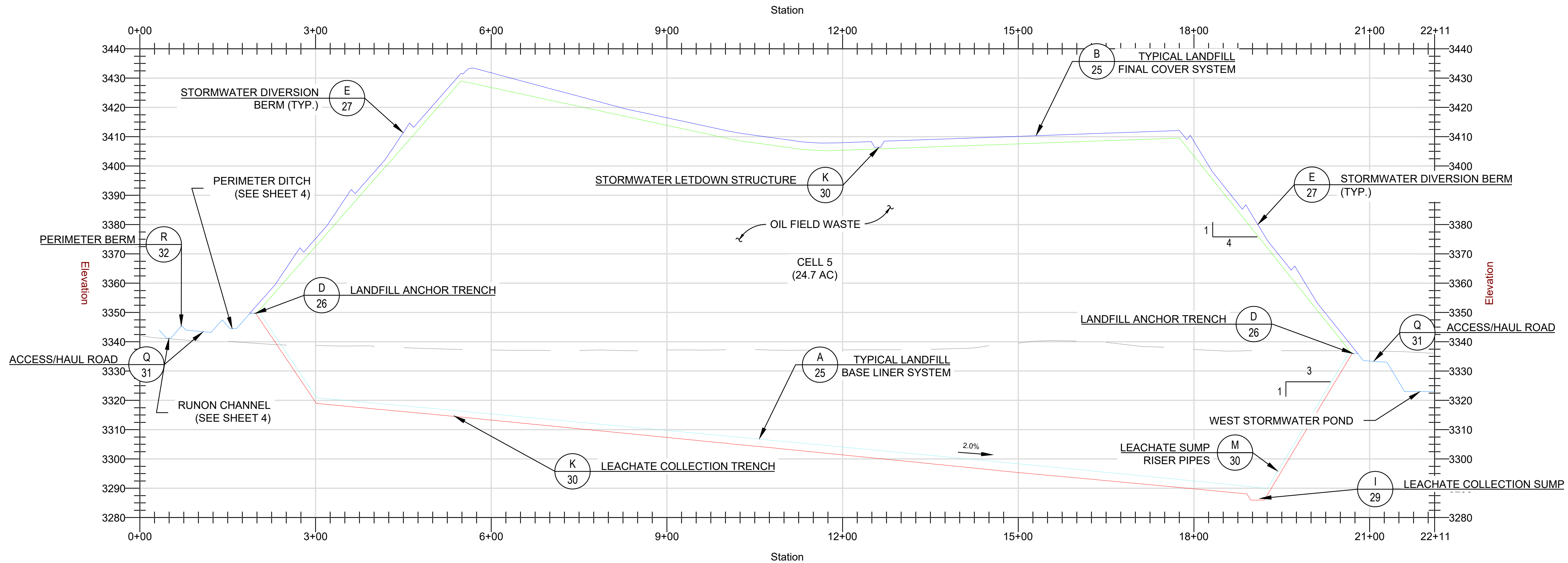
SCALE IN FEET





ALIGN - A-A'

SECTION A 17



ALIGN - B-B'

SECTION B 17

LEGEND:

- PROPOSED TOP OF FINAL COVER
- PROPOSED TOP OF WASTE
- PROPOSED TOP OF PROTECTIVE COVER
- PROPOSED TOP OF SUBGRADE
- PROPOSED PERIMETER INFRASTRUCTURE
- EXISTING GRADE (11/30/2018)
- CELL BOUNDARIES

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

CELL W- 5 SECTION VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY
NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 17

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	17 OF 39

FOR PERMITTING PURPOSES ONLY

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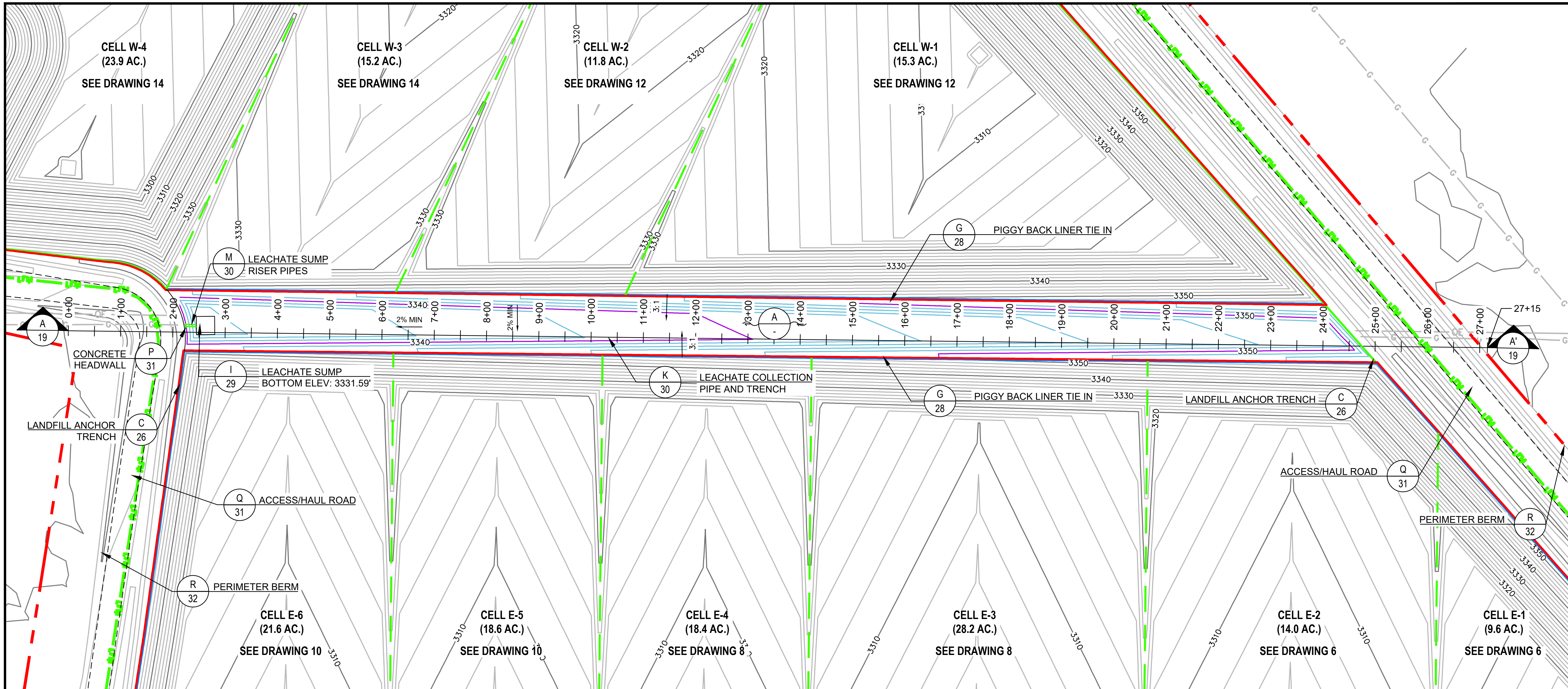
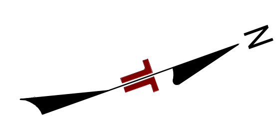


LEGEND:

- 3300 — EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
- 3300 — PROPOSED SUBGRADE CONTOURS (5' INTERVALS)
- PERMIT BOUNDARY/FENCE
- LFM — 4" LEACHATE FORCE MAIN
- OE — OVERHEAD ELECTRIC
- G — EXISTING GAS LINES / GAS EASEMENT
- W — EXISTING WATER LINE
- STORMWATER CHANNEL FLOWLINE
- EDGE OF WASTE
- CELL BOUNDARIES
- ANCHOR TRENCH



200 0 100 200

SCALE IN FEET

NOTES:

1. LINES AND GRADES SHOWN REPRESENT THE TOP OF THE LINER SYSTEM EXCLUDING THE 2-FOOT THICK PROTECTIVE COVER.
2. SEE DRAWING 4 FOR DRAINAGE STRUCTURE SIZING AND DESIGN.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

NGL

PIGGY BACK PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY
NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 18

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	18 OF 39

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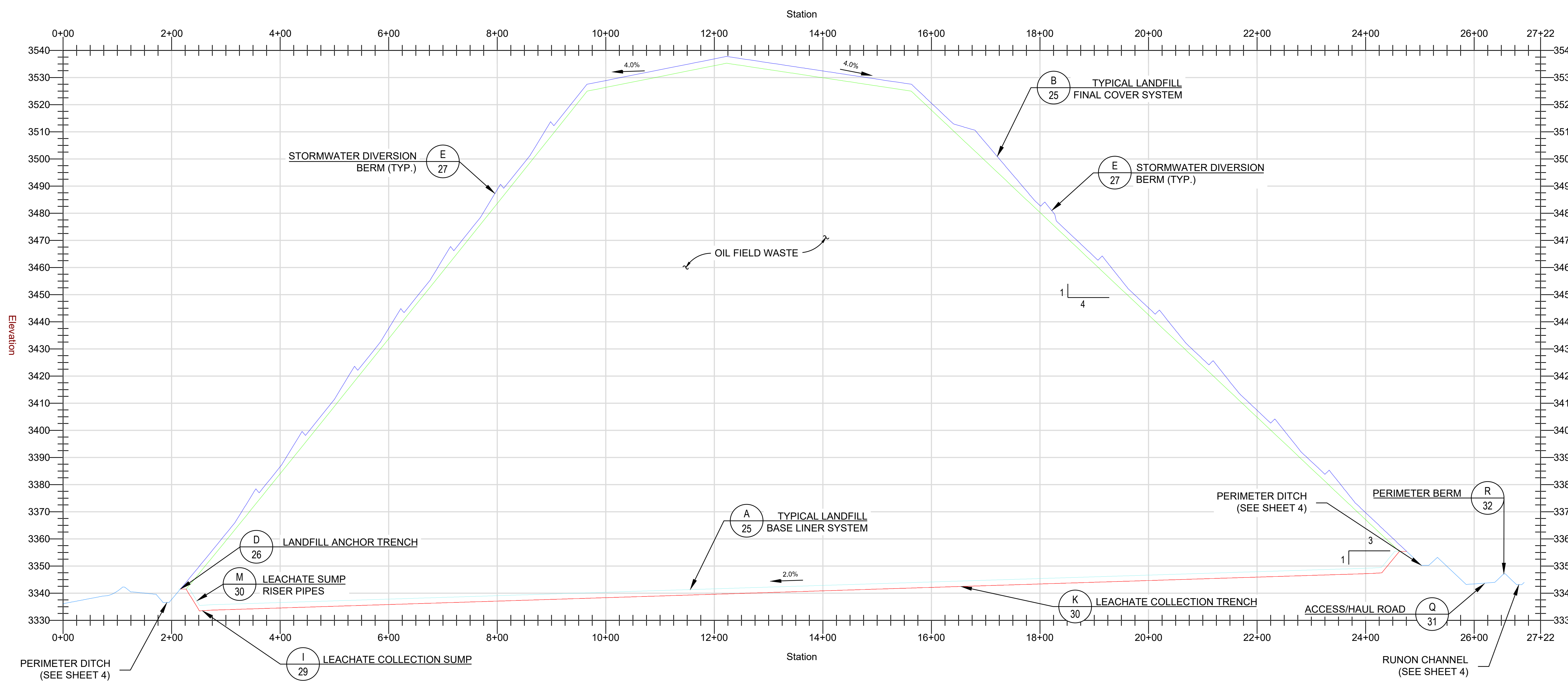


ALIGN - A-A'

SECTION A 19

LEGEND:

- PROPOSED TOP OF FINAL COVER
- PROPOSED TOP OF WASTE
- PROPOSED TOP OF PROTECTIVE COVER
- PROPOSED TOP OF SUBGRADE
- PROPOSED PERIMETER INFRASTRUCTURE
- EXISTING GRADE (11/30/2018)
- CELL BOUNDARIES

SCALES:
1" = 200' (HORIZONTAL)
1" = 40' (VERTICAL)
VERTICAL EXAGGERATION = x 5

200 0 100 200

SCALE IN FEET

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

PIGGY BACK SECTION VIEW

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

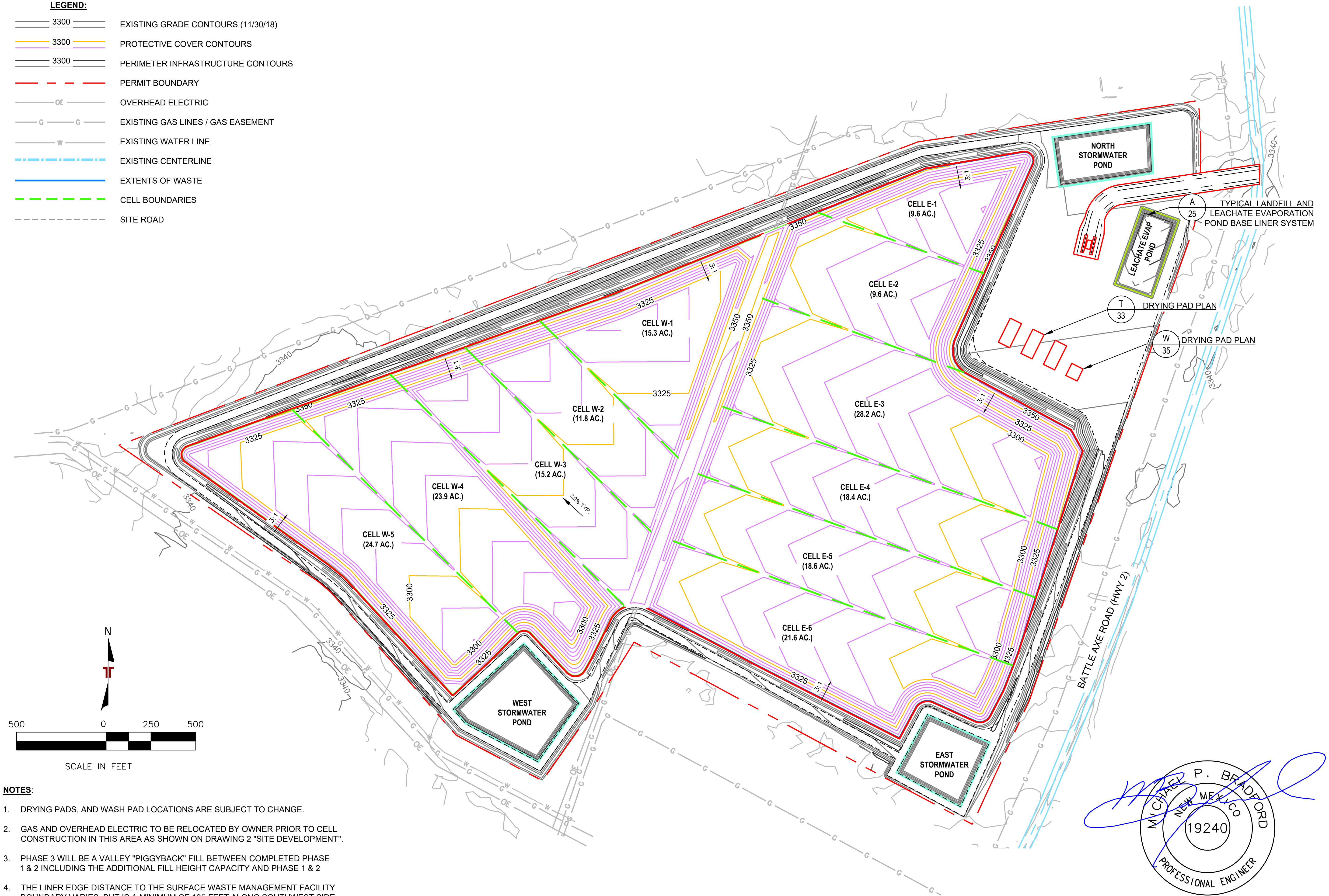
Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 19

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	19 OF 39

LEGEND:

3300 (grey)	EXISTING GRADE CONTOURS (11/30/18)
3300 (orange/pink)	PROTECTIVE COVER CONTOURS
3300 (dark)	PERIMETER INFRASTRUCTURE CONTOURS
red dashed	PERMIT BOUNDARY
— OE —	OVERHEAD ELECTRIC
— G — G —	EXISTING GAS LINES / GAS EASEMENT
— W —	EXISTING WATER LINE
blue dash-dot	EXISTING CENTERLINE
blue solid	EXTENTS OF WASTE
green dashed	CELL BOUNDARIES
black dashed	SITE ROAD



NOTES:

1. DRYING PADS, AND WASH PAD LOCATIONS ARE SUBJECT TO CHANGE.
2. GAS AND OVERHEAD ELECTRIC TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA AS SHOWN ON DRAWING 2 "SITE DEVELOPMENT".
3. PHASE 3 WILL BE A VALLEY "PIGGYBACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY AND PHASE 1 & 2.
4. THE LINER EDGE DISTANCE TO THE SURFACE WASTE MANAGEMENT FACILITY BOUNDARY VARIES, BUT IS A MINIMUM OF 125-FEET ALONG SOUTHWEST SIDE OF PHASE 2.

N:\GEARCHIVE\CAD\3572\0602\MCCLOY\PERMIT DRAWINGS\20-TOP OF PROTECTIVE.DWG

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

NGL

TOP OF PROTECTIVE COVER

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists

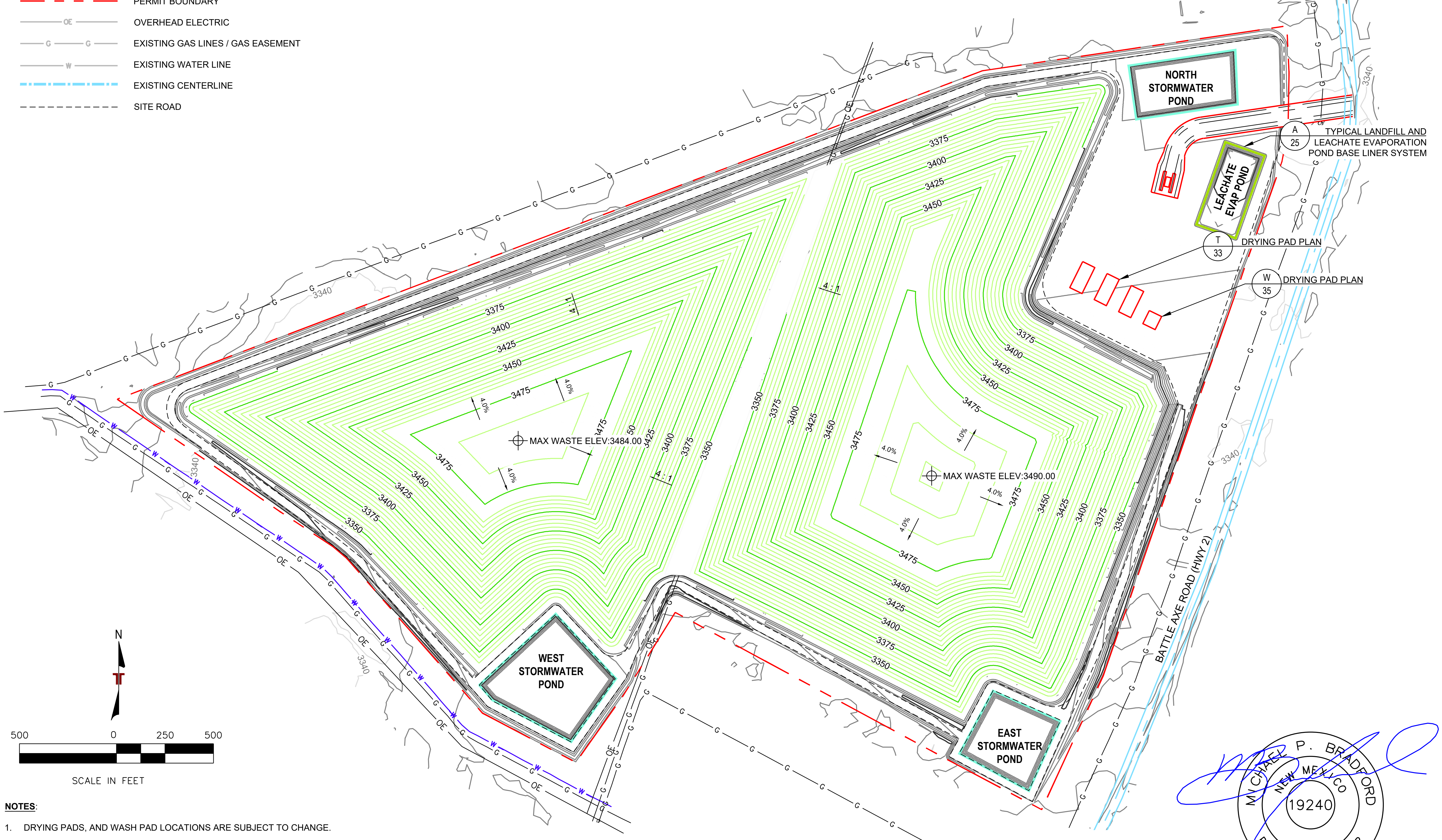
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 20

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	20 OF 39

LEGEND:

3300 (gray line)	EXISTING GRADE CONTOURS (11/30/18)
3300 (green line)	PROTECTIVE COVER CONTOURS
3300 (dark line)	PERIMETER INFRASTRUCTURE CONTOURS
(red dashed line)	PERMIT BOUNDARY
OE	OVERHEAD ELECTRIC
G — G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
(cyan dash-dot line)	EXISTING CENTERLINE
(dashed line)	SITE ROAD



NOTES:

1. DRYING PADS, AND WASH PAD LOCATIONS ARE SUBJECT TO CHANGE.
2. EXISTING GAS AND OVERHEAD ELECTRIC OVER PHASE 3 AREA TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA AS SHOWN ON DRAWING 2 "SITE DEVELOPMENT".
3. PHASE 3 WILL BE A VALLEY "PIGGYBACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY AND PHASE 1 & 2.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

NGL

INTERMEDIATE TOP OF WASTE
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY
NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

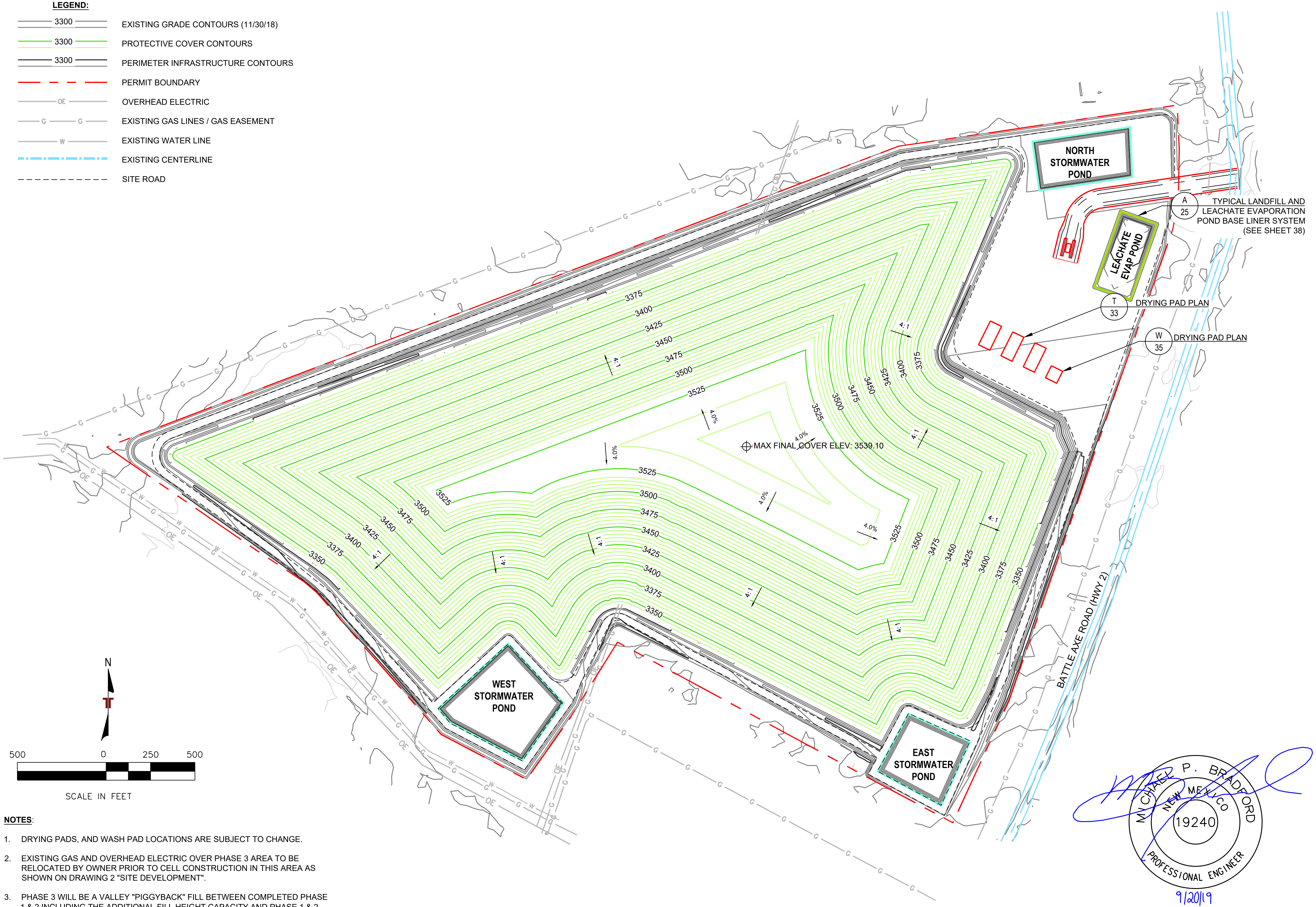
DRAWING 21

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	21 OF 39

N:\GEOARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\21-TOP OF WASTE.DWG

LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/18)
3300	PROTECTIVE COVER CONTOURS
3300	PERIMETER INFRASTRUCTURE CONTOURS
	PERMIT BOUNDARY
OE	OVERHEAD ELECTRIC
G G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	EXISTING CENTERLINE
	SITE ROAD



NOTES:

1. DRYING PADS, AND WASH PAD LOCATIONS ARE SUBJECT TO CHANGE.
2. EXISTING GAS AND OVERHEAD ELECTRIC OVER PHASE 3 AREA TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA AS SHOWN ON DRAWING 2 "SITE DEVELOPMENT".
3. PHASE 3 WILL BE A VALLEY "PIGGYBACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY AND PHASE 1 & 2.

N:\GEOARCHIVE\CAD\35187378\MCCLOY\PERMIT DRAWINGS\22-TOP OF WASTE FINAL.DWG

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

FOR PERMITTING PURPOSES ONLY

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

FINAL TOP OF WASTE

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

NGL WASTE SERVICES, LLC

PERMIT APPLICATION DRAWING

LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
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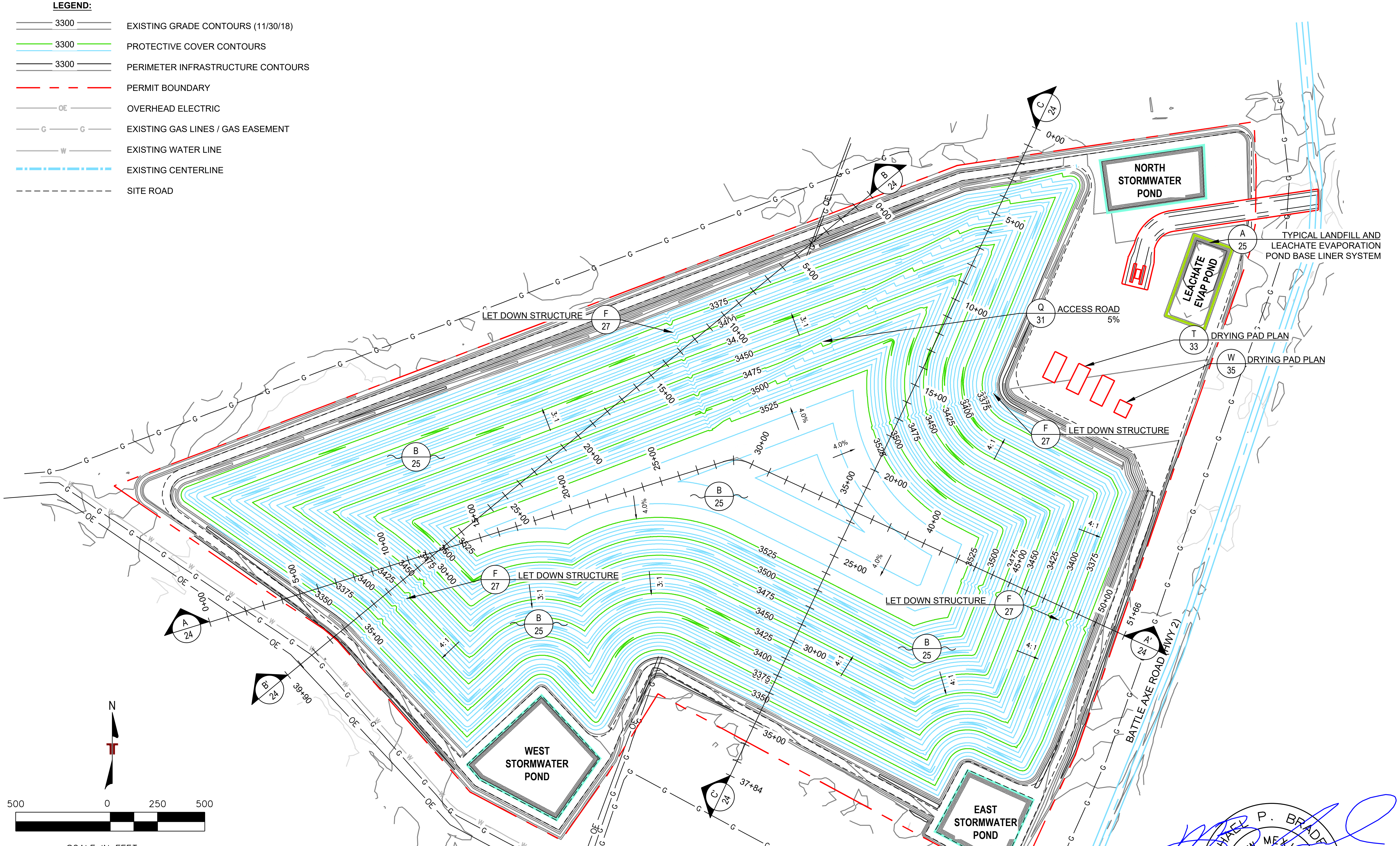
DRAWING 22

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	22 OF 39

LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/18)
3300	PROTECTIVE COVER CONTOURS
3300	PERIMETER INFRASTRUCTURE CONTOURS
	PERMIT BOUNDARY
OE	OVERHEAD ELECTRIC
G G	EXISTING GAS LINES / GAS EASEMENT
W	EXISTING WATER LINE
	EXISTING CENTERLINE
	SITE ROAD



NOTES:

1. DRYING PADS, AND WASH PAD LOCATIONS ARE SUBJECT TO CHANGE.
2. EXISTING GAS AND OVERHEAD ELECTRIC OVER PHASE 3 AREA TO BE RELOCATED BY OWNER PRIOR TO CELL CONSTRUCTION IN THIS AREA AS SHOWN ON DRAWING 2 "SITE DEVELOPMENT".
3. PHASE 3 WILL BE A VALLEY "PIGGYBACK" FILL BETWEEN COMPLETED PHASE 1 & 2 INCLUDING THE ADDITIONAL FILL HEIGHT CAPACITY AND PHASE 1 & 2.
4. SEE DRAWING 4 FOR DRAINAGE DESIGN UNDER FINAL CONDITION.

MICHAEL P. BRADFORD
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PROFESSIONAL ENGINEER
9/20/19

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REV	DATE	BY	DESCRIPTION
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FINAL COVER SYSTEM GRADE
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
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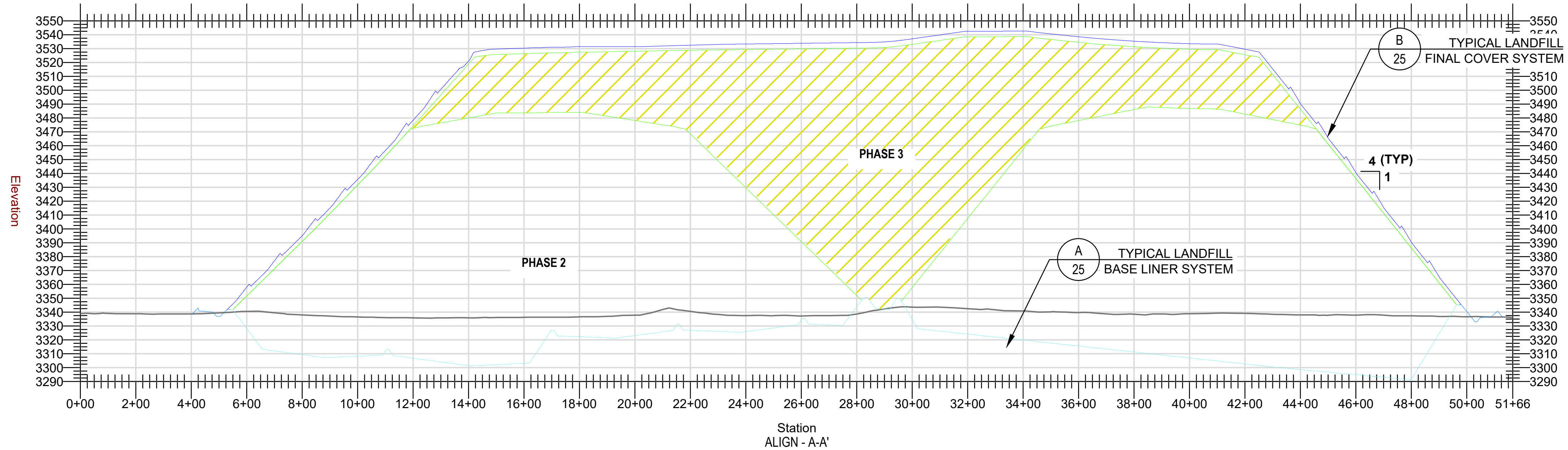
DRAWING 23

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	23 OF 39

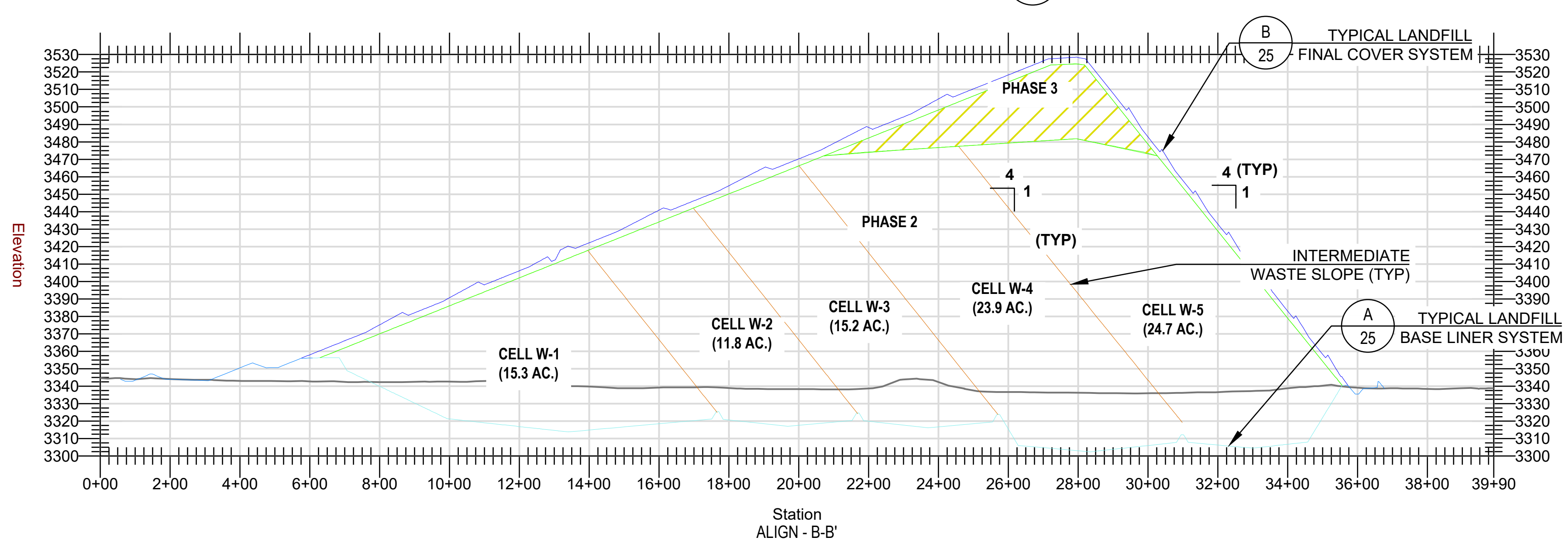
N:\GECARCHIVE\CAD\572002\MCLOY\PERMIT DRAWINGS\23-24-FINAL GRADE (FILL).DWG



SECTION A / 24

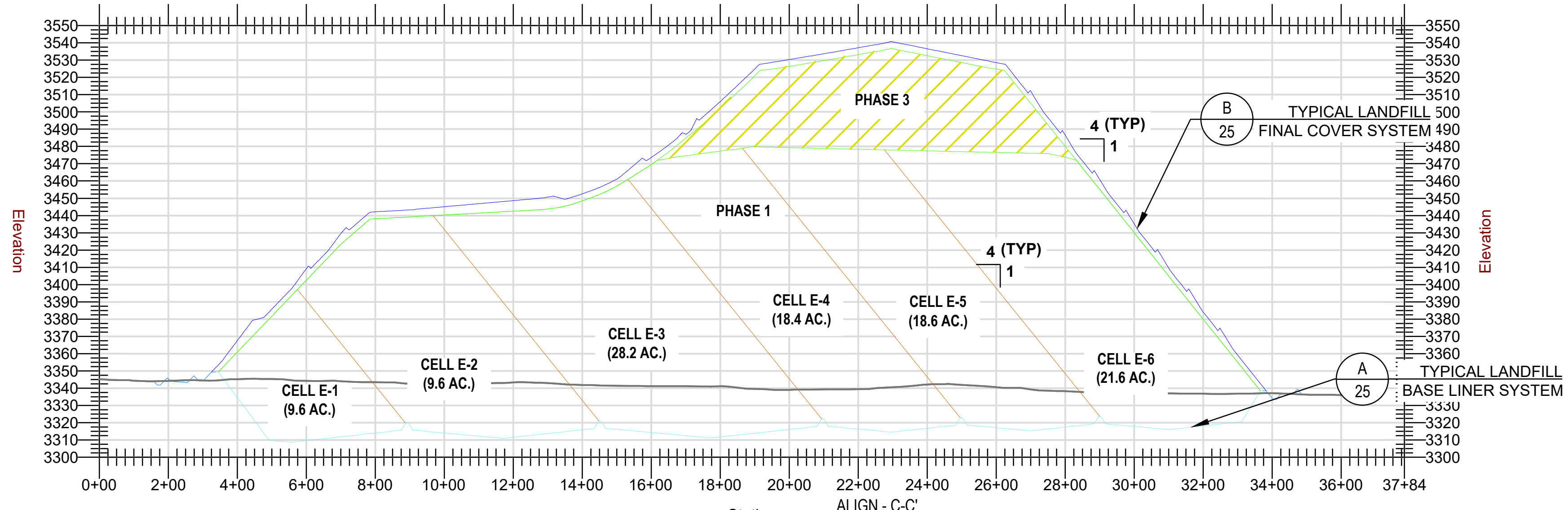
LEGEND:

- PROPOSED TOP OF FINAL COVER
- PROPOSED TOP OF WASTE
- PROPOSED TOP OF PROTECTIVE COVER
- PROPOSED TOP OF PERIMETER INFRASTRUCTURE
- PROPOSED INTERMEDIATE COVER
- EXISTING GROUND
- PHASE 3 WASTE FILL



SECTION B / 24

Cell	Operational Capacity (CY)	Routine and Intermediate Soil Cover [10% of Operational Waste Capacity] (CY)	Waste Capacity [90% of Operational Capacity] (CY)
		PHASE 1	
E-1	933,202	93,320	839,882
E-2	2,111,021	211,102	1,899,919
E-3	5,116,491	511,649	4,604,842
E-4	3,939,124	393,912	3,545,212
E-5	3,840,751	384,075	3,456,676
E-6	2,564,850	256,485	2,308,365
PHASE 1	**18,505,439**	**1,850,543**	**16,654,896**
		PHASE 2	
W-1	1,108,726	110,873	997,853
W-2	1,322,275	132,228	1,190,048
W-3	2,075,688	207,569	1,868,119
W-4	4,148,670	414,867	3,733,803
W-5	4,679,514	467,951	4,211,563
PHASE 2	**13,334,873**	**1,333,493**	**12,001,391**
PHASE 3	**8,424,012**	**842,401**	**7,581,611**
TOTAL	**40,264,324**	**4,026,432**	**36,237,892**



SECTION C / 24

NOTES:

1. OPERATIONAL = WASTE PLUS ROUTINE AND INTERIM SOIL COVER.

SCALES:
1" = 500' (HORIZONTAL)
1" = 100' (VERTICAL)
VERTICAL EXAGGERATION = x 5

500 0 250 500

SCALE IN FEET

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PROFESSIONAL ENGINEER

9/20/19

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FINAL COVER SYSTEM GRADE SECTION VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
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LEA COUNTY, NEW MEXICO

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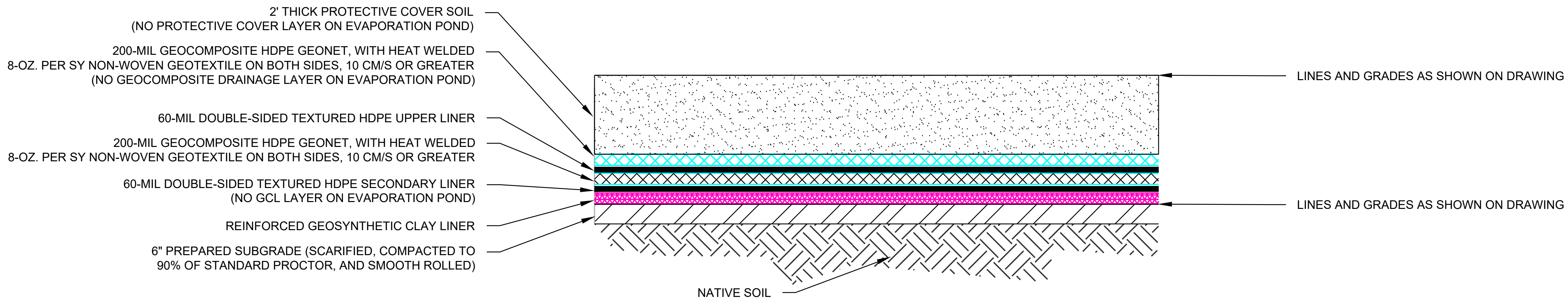
DRAWING 24

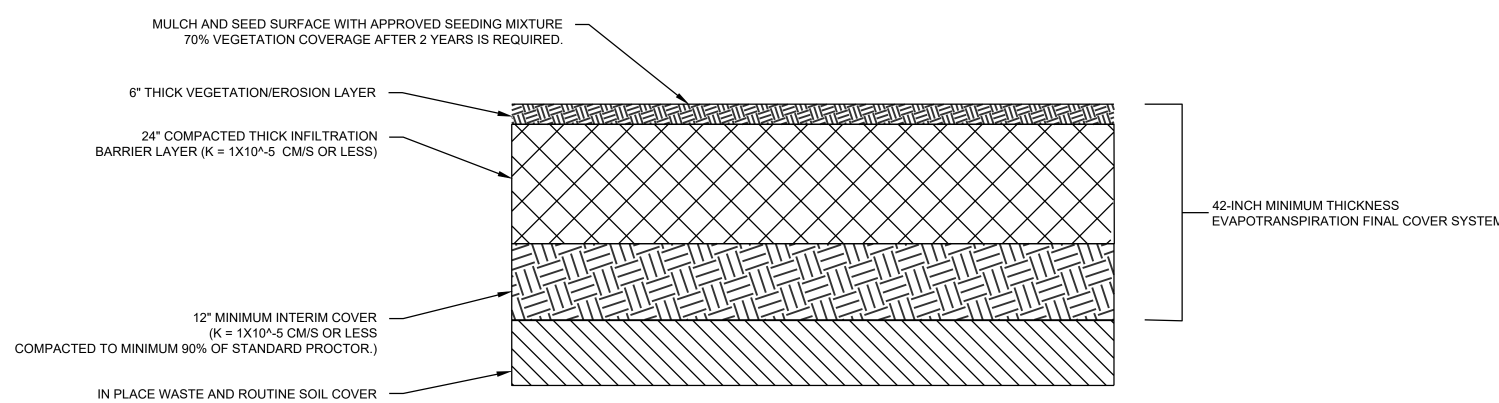
DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	24 OF 39

N:\GEOARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\23-24-FINAL GRADE (FILL).DWG



TYPICAL LANDFILL AND LEACHATE EVAPORATION POND BASE LINER SYSTEM

DETAIL A / 25
N.T.S.



TYPICAL LANDFILL FINAL COVER SYSTEM

DETAIL B / 25
N.T.S.

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19240
PROFESSIONAL ENGINEER

9/20/19

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

LINER AND FINAL COVER DETAILS

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

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DRAWING 25

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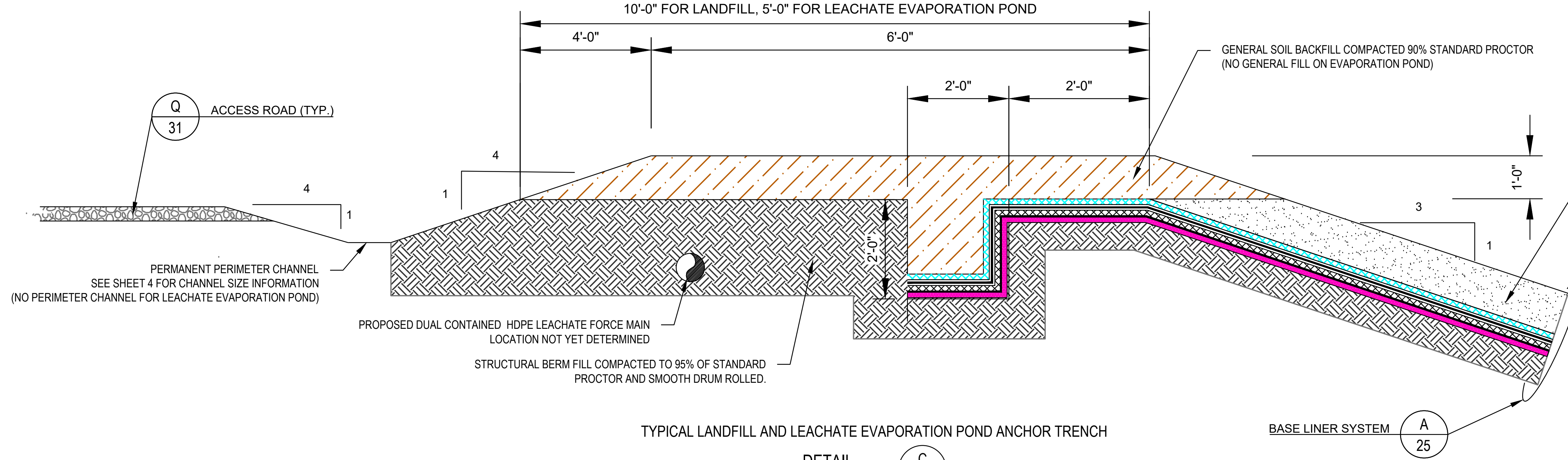
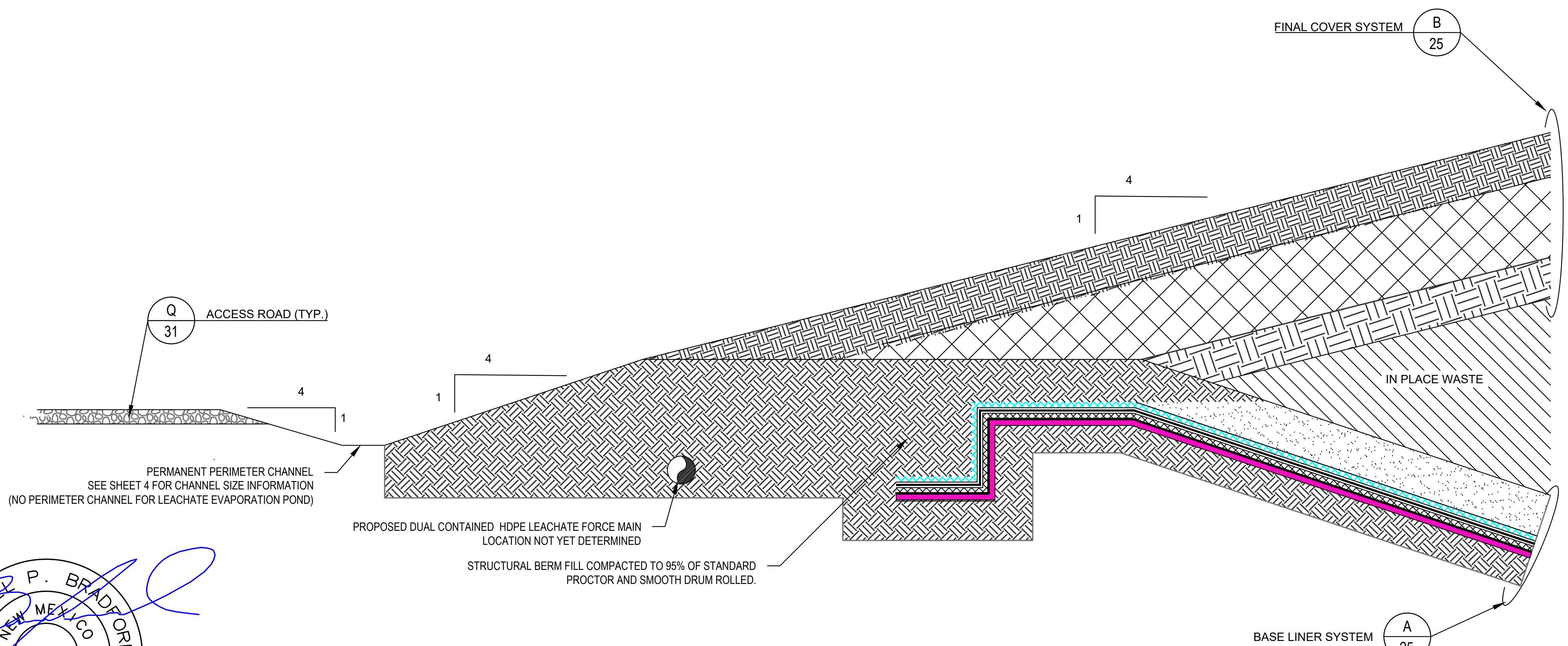
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	25 OF 39

N:\GECARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\25-A-B LINER AND FINAL COVER DETAILS.DWG



TYPICAL LANDFILL AND LEACHATE EVAPORATION POND ANCHOR TRENCH

DETAIL C / 26
N.T.S.



TYPICAL LANDFILL FINAL COVER SYSTEM ANCHOR TRENCH

DETAIL D / 26
N.T.S.

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ANCHOR TRENCH DETAILS
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DRAWING 26

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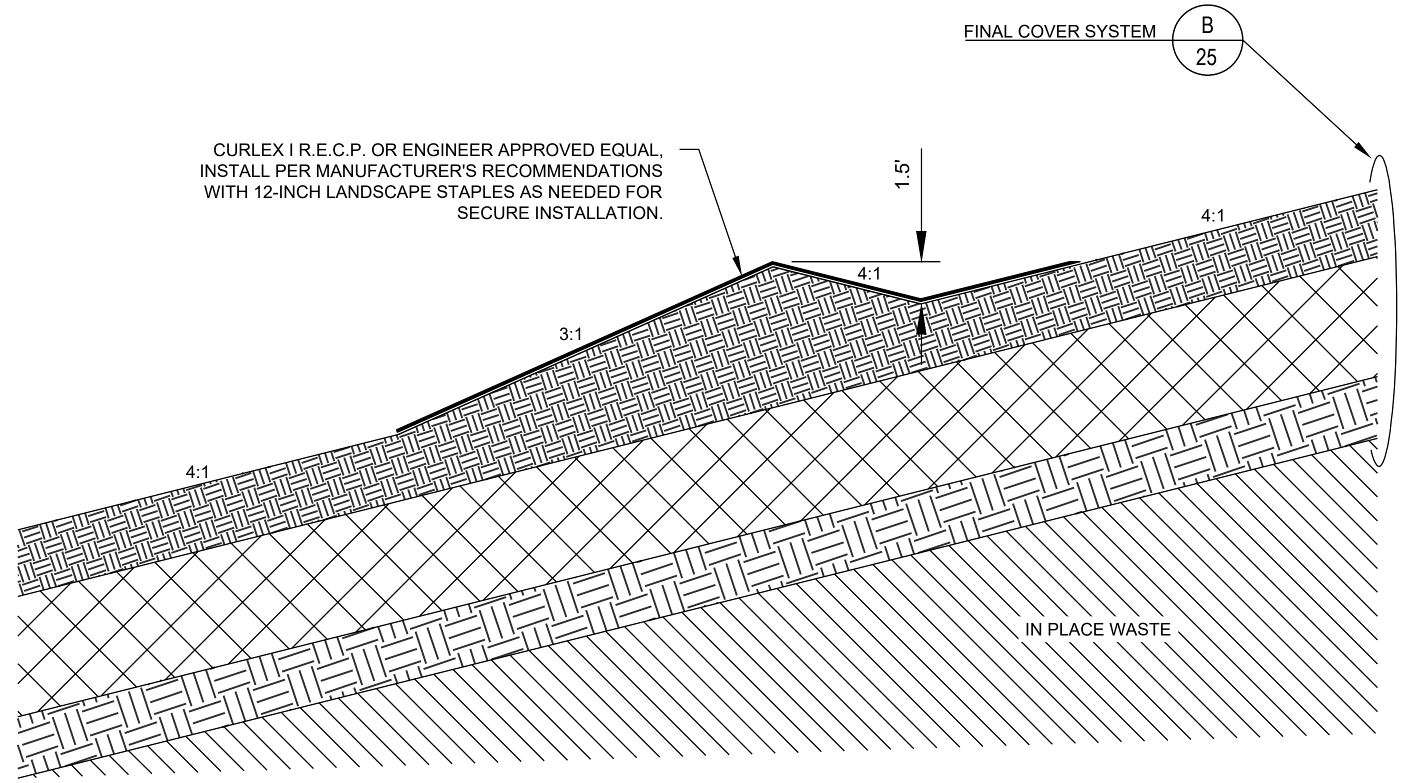
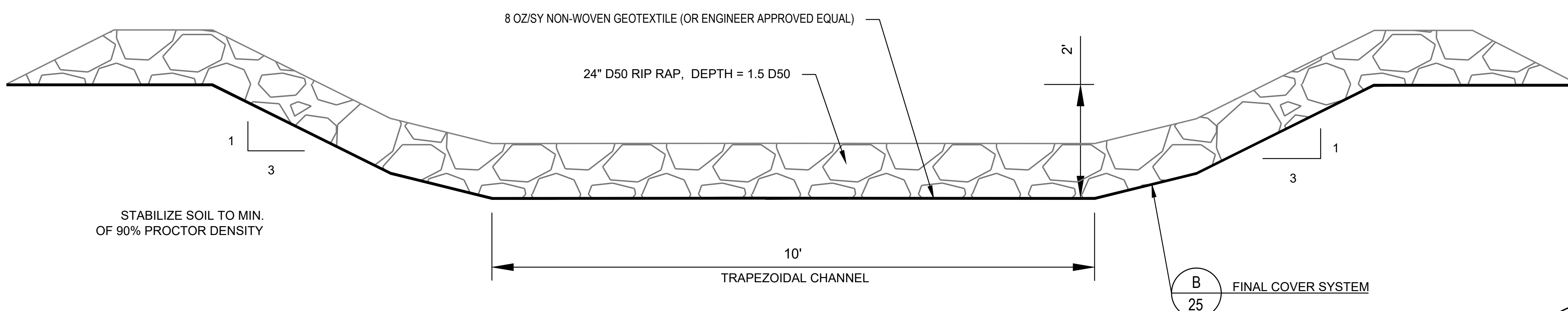
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	26 OF 39



FINAL COVER SIDE SLOPE STORMWATER DIVERSION BERM

DETAIL E/27
N.T.S.



FINAL COVER SIDE SLOPE LET DOWN STRUCTURE

DETAIL F/27
N.T.S.

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19240
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9/20/19

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FINAL COVER STORMWATER STRUCTURE DETAILS
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DRAWING 27

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SHEET NO.:	27 OF 39

N:\GECARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\27-E-F SIDE SLOPE SW DIVERSION.DWG

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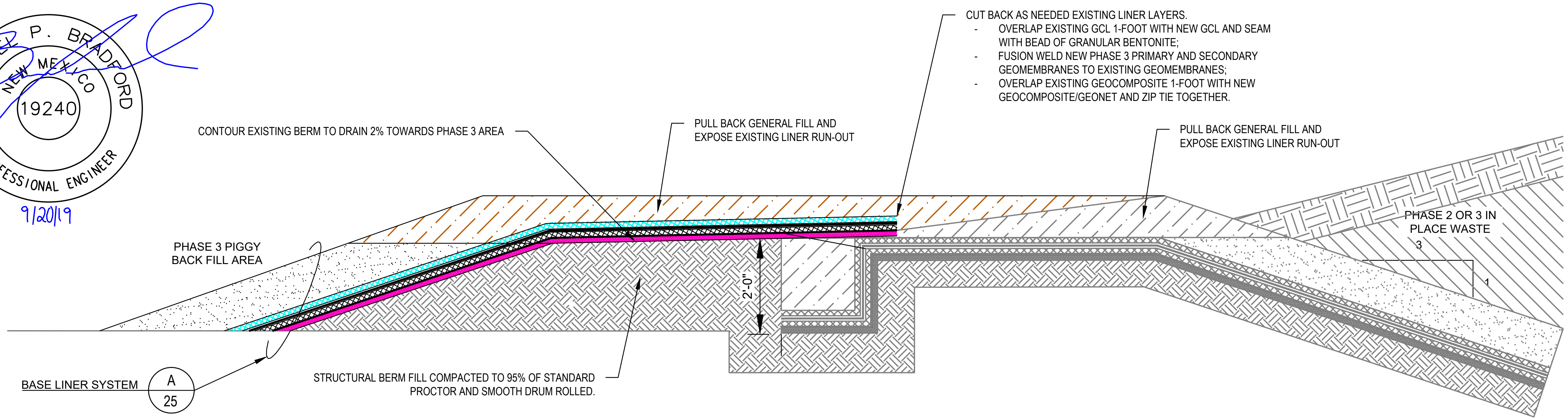
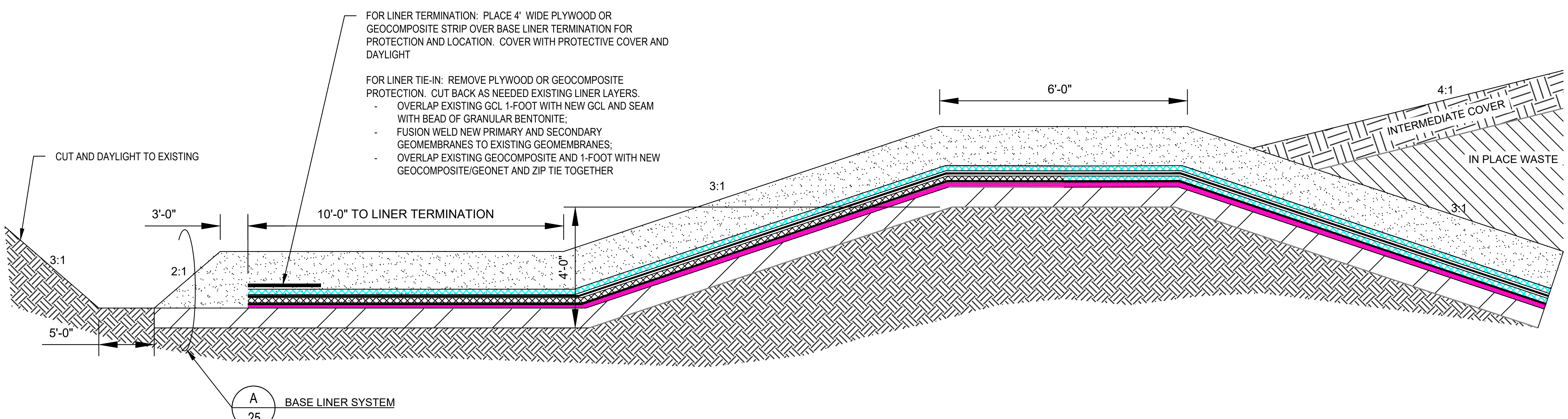
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19



TYPICAL PIGGYBACK LINER TIE IN

DETAIL G / 28
N.T.S.



INTERMEDIATE CELL DIVIDER BERM AND LINER TERMINATION/TIE IN DETAIL

DETAIL H / 28
N.T.S.

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

BASE LINER TIE IN AND TERMINATION DETAILS
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
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LEA COUNTY NEW MEXICO

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DRAWING 28

DESIGNED BY:	MPB
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APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	28 OF 39

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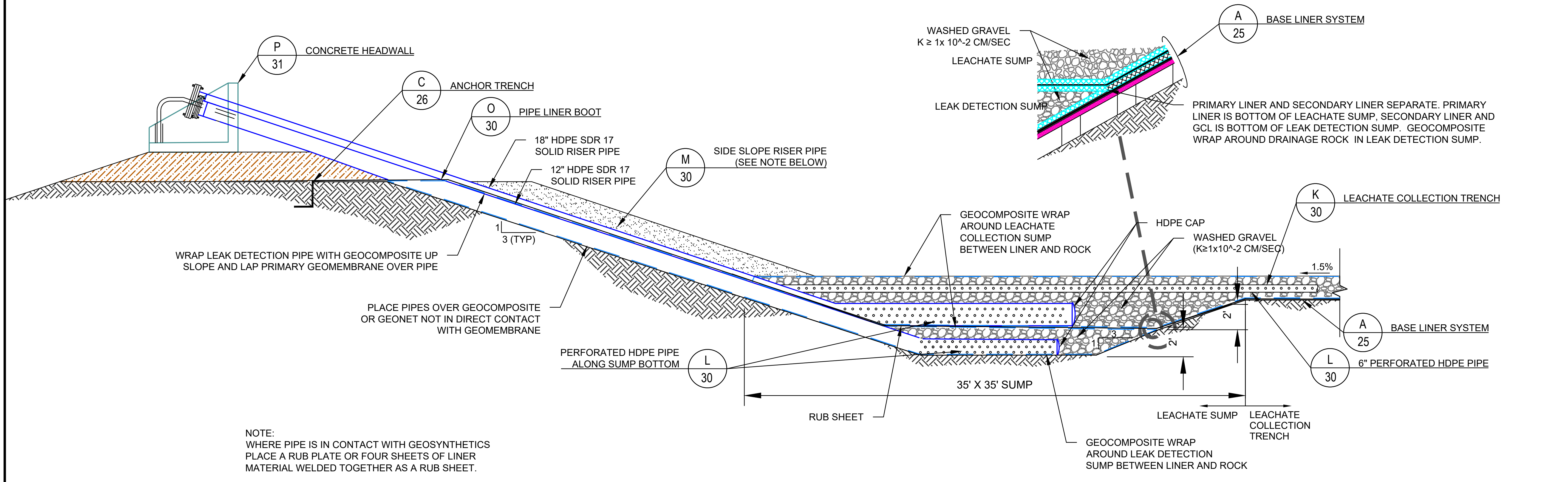
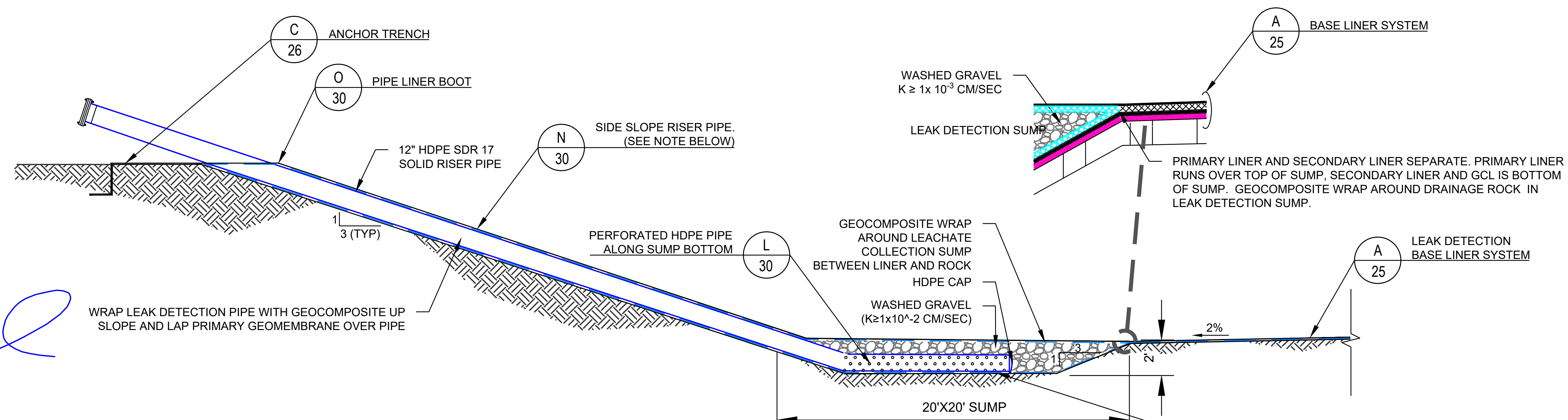
N:\GECARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\28-G-H LINER TIE IN DETAIL.DWG



NOTE:
WHERE PIPE IS IN CONTACT WITH GEOSYNTHETICS PLACE A RUB PLATE OR FOUR SHEETS OF LINER MATERIAL WELDED TOGETHER AS A RUB SHEET.

LEACHATE COLLECTION AND RECOVERY SUMP WITH LEAK DETECTION SUMP

DETAIL I/29
N.T.S.



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NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

NOTE:
WHERE PIPE IS IN CONTACT WITH GEOSYNTHETICS PLACE A RUB PLATE OR FOUR SHEETS OF LINER MATERIAL WELDED TOGETHER AS A RUB SHEET.

EVAPORATION POND LEAK DETECTION SUMP

DETAIL J/29
N.T.S.

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

LEACHATE AND LEAK DETECTION SUMP DETAILS
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
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LEA COUNTY NEW MEXICO

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DRAWING 29

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	29 OF 39

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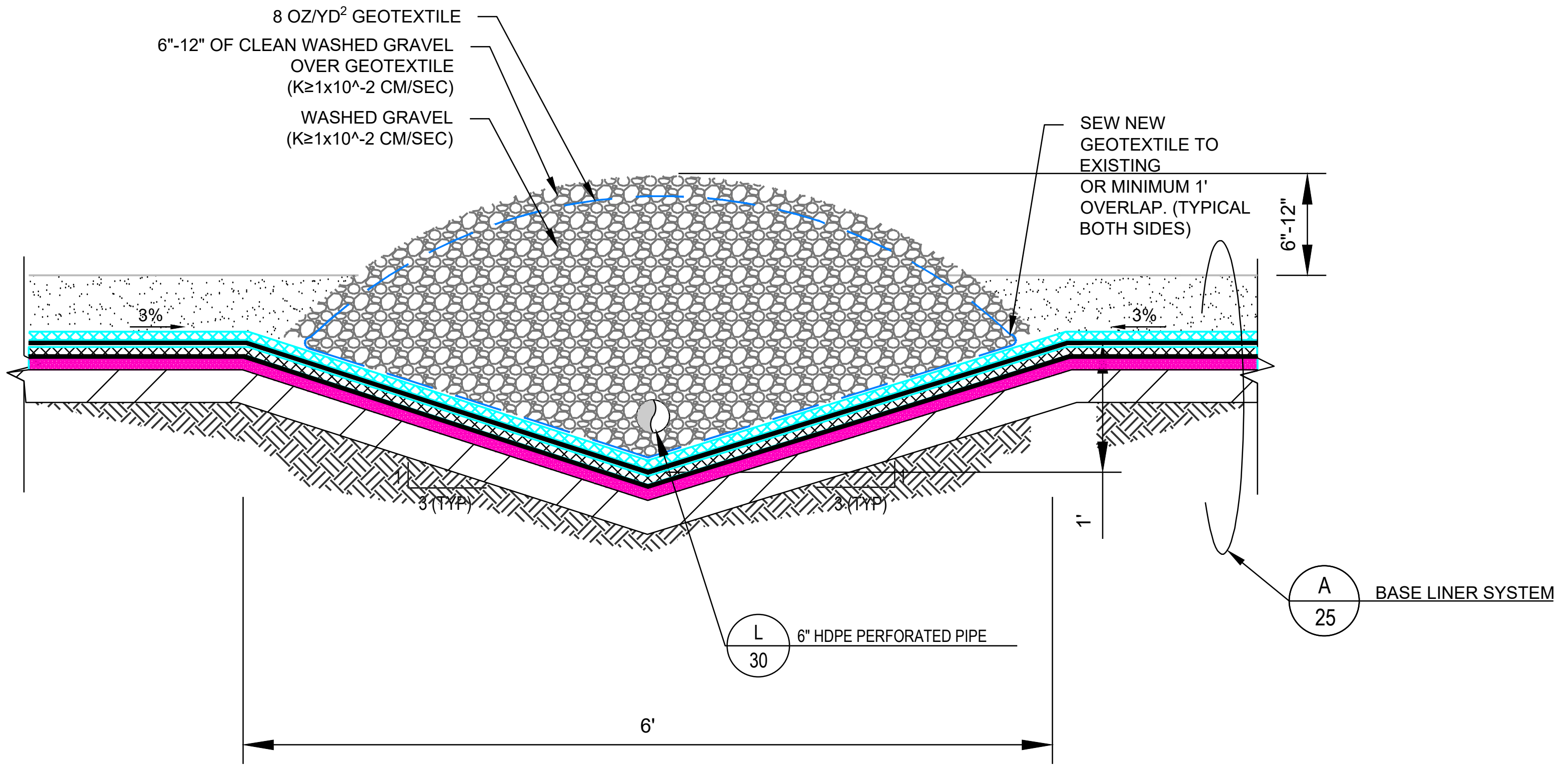
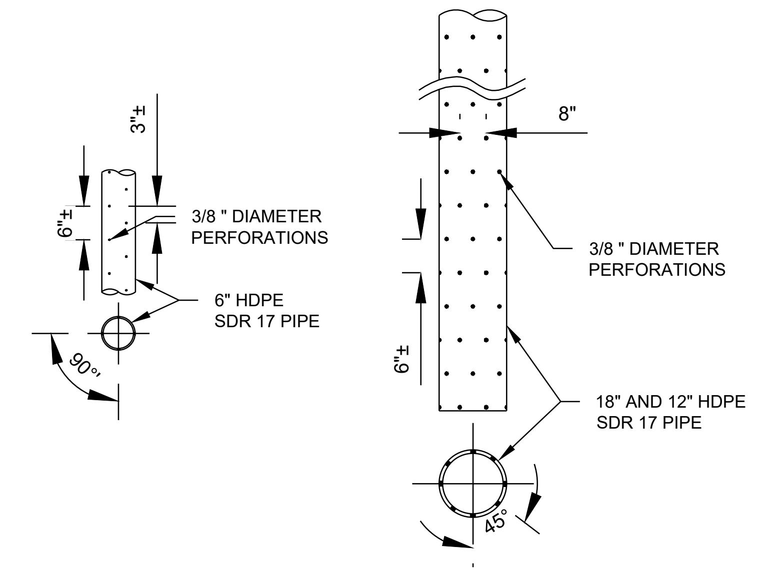
N:\GEOARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\29-I-J LEACHATE COLLECTION AND LEAK DETECTION DETAILS.DWG



LEACHATE COLLECTION PIPE AND TRENCH

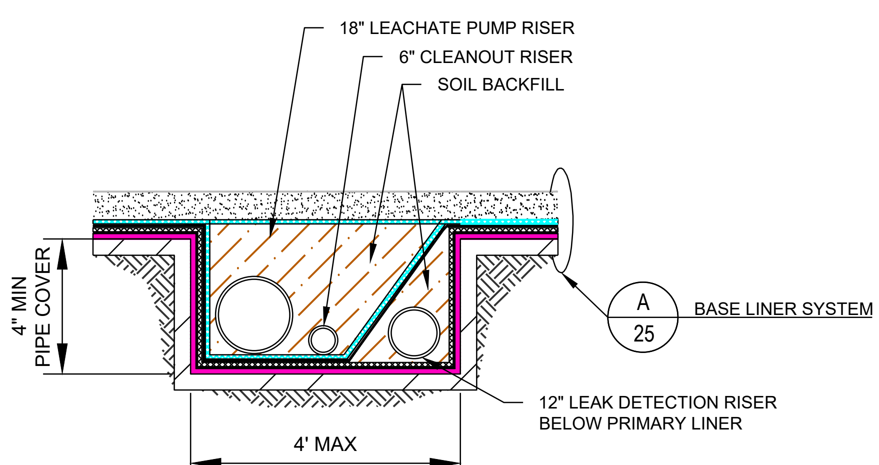
DETAIL K / 30
N.T.S.



NOTE:
PERFORATIONS BUILT TO MANUFACTURER STANDARD.

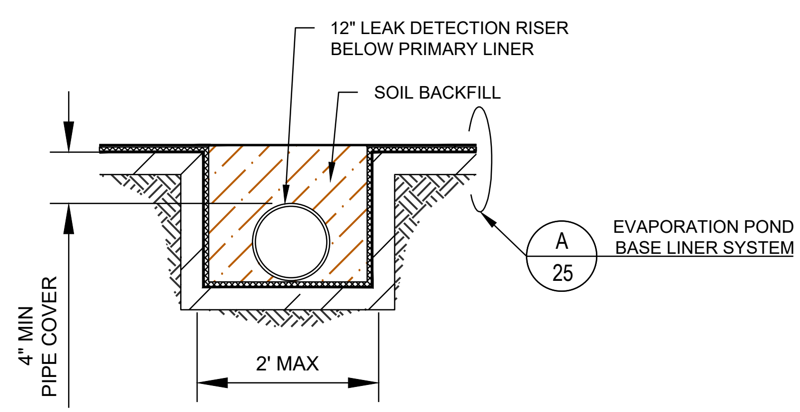
PIPE PERFORATION DETAIL

DETAIL L / 30
N.T.S.



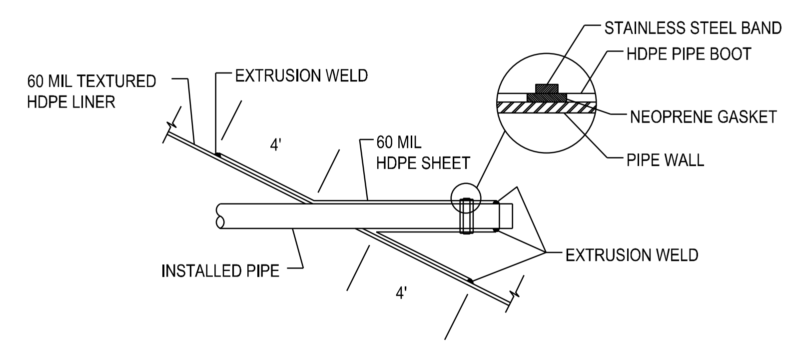
LANDFILL LEACHATE AND LEAK DETECTION SUMP RISER PIPE TRENCH

DETAIL M / 30
N.T.S.



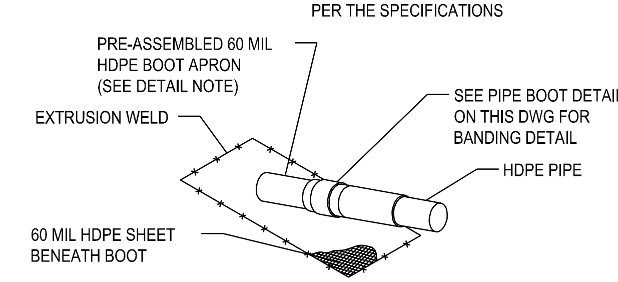
EVAPORATION POND LEAK DETECTION SUMP RISER PIPE TRENCH

DETAIL N / 30
N.T.S.



HDPE LINER PIPE BOOT DETAIL – PROFILE VIEW

NOTE:
CONTRACTOR SHALL PROVIDE PRE-ASSEMBLED AND TESTED/ CERTIFIED PIPE BOOTS FOR EACH PIPE PENETRATION AS PER THE SPECIFICATIONS



PIPE BOOT DETAIL – ISOMETRIC VIEW

GEOMEMBRANE PIPE BOOT

DETAIL O / 30
N.T.S.

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19240
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9/20/19

N:\GEARCHIVE\CAD\572002\MCCLOY\PERMIT DRAWINGS\30-K-O MISC LINER DETAILS.DWG

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REV	DATE	BY	DESCRIPTION
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MISCELLANEOUS LINER DETAILS
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
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LEA COUNTY
NEW MEXICO

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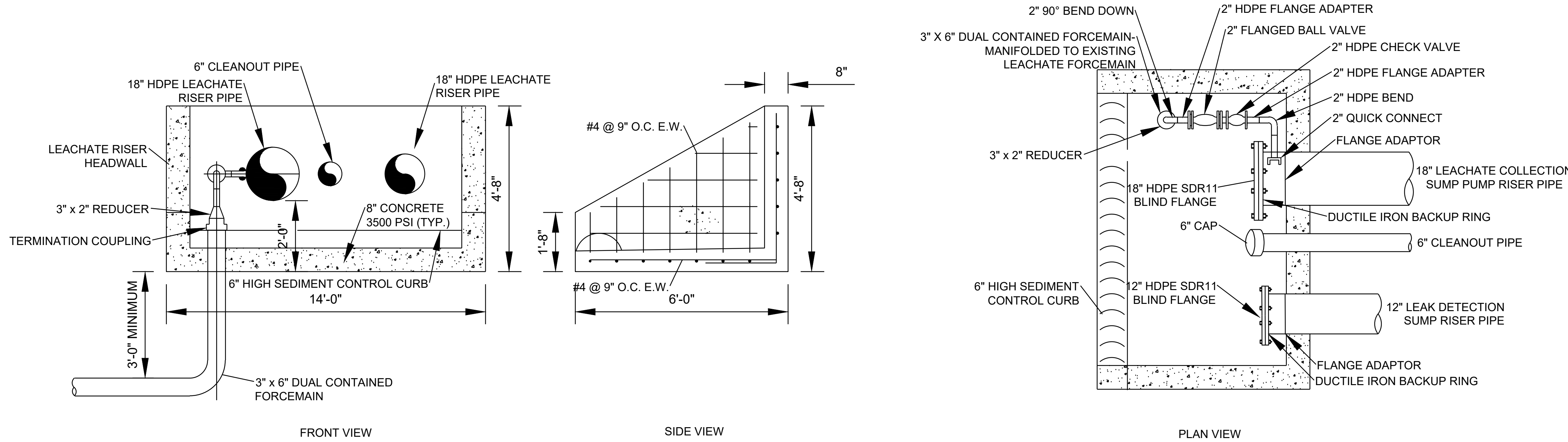
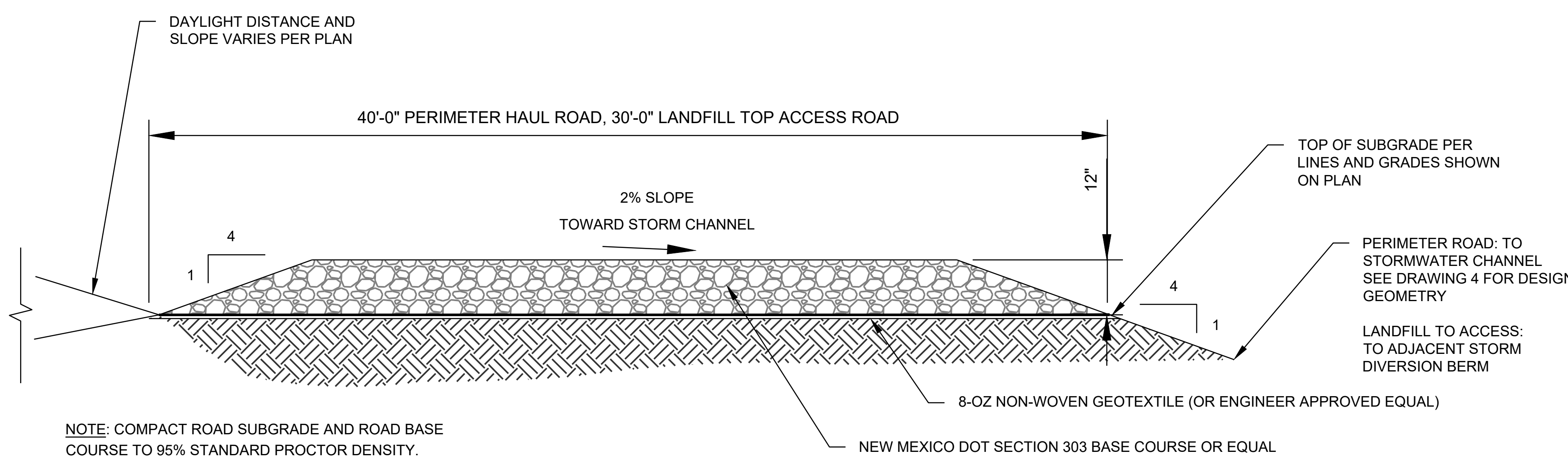
DRAWING 30

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	30 OF 39



CONCRETE LANDFILL LEACHATE AND LEAK DETECTION RISER PIPE HEADWALL

DETAIL P/31
N.T.S.



NOTE: COMPACT ROAD SUBGRADE AND ROAD BASE COURSE TO 95% STANDARD PROCTOR DENSITY.

TYPICAL ACCESS AND HAUL ROAD

DETAIL Q/31
N.T.S.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

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MISCELLANEOUS INFRASTRUCTURE DETAILS
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

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DRAWING 31

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
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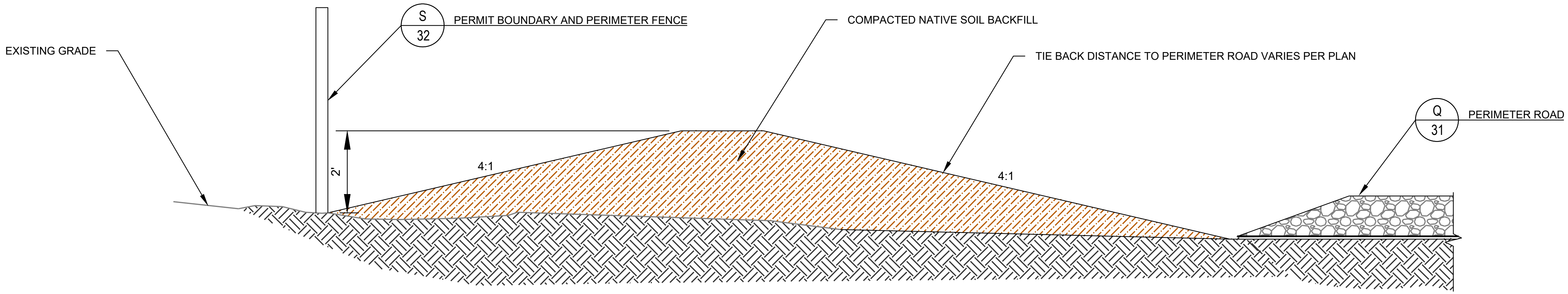
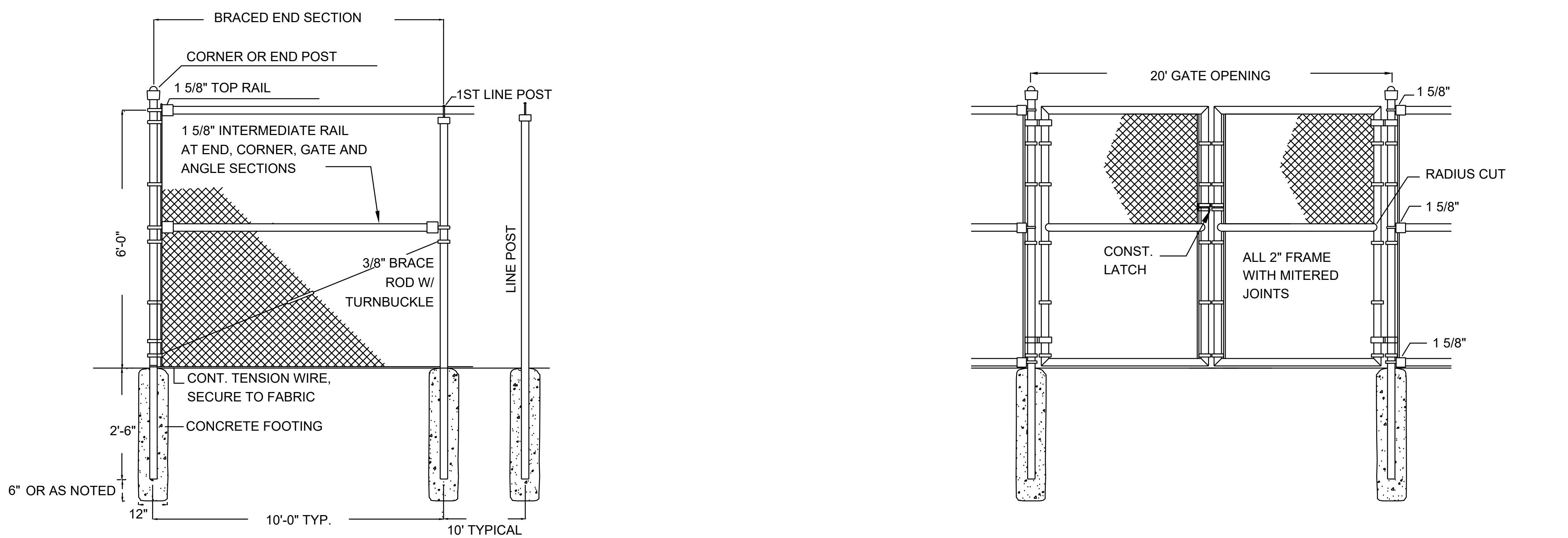
ACAD NO.	572-002
SHEET NO.:	31 OF 39

N:\GEARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\31-P-Q MISC INFRASTRUCTURE DETAILS.DWG



PERIMETER BERM

DETAIL R/32
N.T.S.



NOTES: USE 11 GUAGE FABRIC TYP. USE 9 GUAGE AT ALL BACKSTOPS, 10' FENCES (EXCEPT TENNIS COURTS) AND DUGOUTS.

1. USE 3" GATE, CORNER AND END POSTS WITH 2 1/2" LINE POSTS.
2. ALL JOINTS WITH CONTINUOUS FILLET WELD AND GROUND SMOOTH AND RE-GALVANIZED.
3. CONSTRUCT BRACED END SECTION AT BOTH SIDES OF GATES, CORNERS, ANGLES AND AT ALL FENCE ENDS.
4. ALL PIPE SCH. 40. ALL FENCE FABRIC AND FENCE MEMBERS HOT DIPPED GALVANIZED
5. SET ALL SECTIONS PLUMB & IN LINE, 1" MAX.
6. DEVIATION ON TENNIS COURTS USE 11 GA W/ COLD FUSION BLACK VINYL COATING

PERIMETER CHAIN LINK FENCE

DETAIL S/32
N.T.S.

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NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

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MISCELLANEOUS INFRASTRUCTURE DETAILS
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
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DRAWING 32

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	SEPT. 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	32 OF 39

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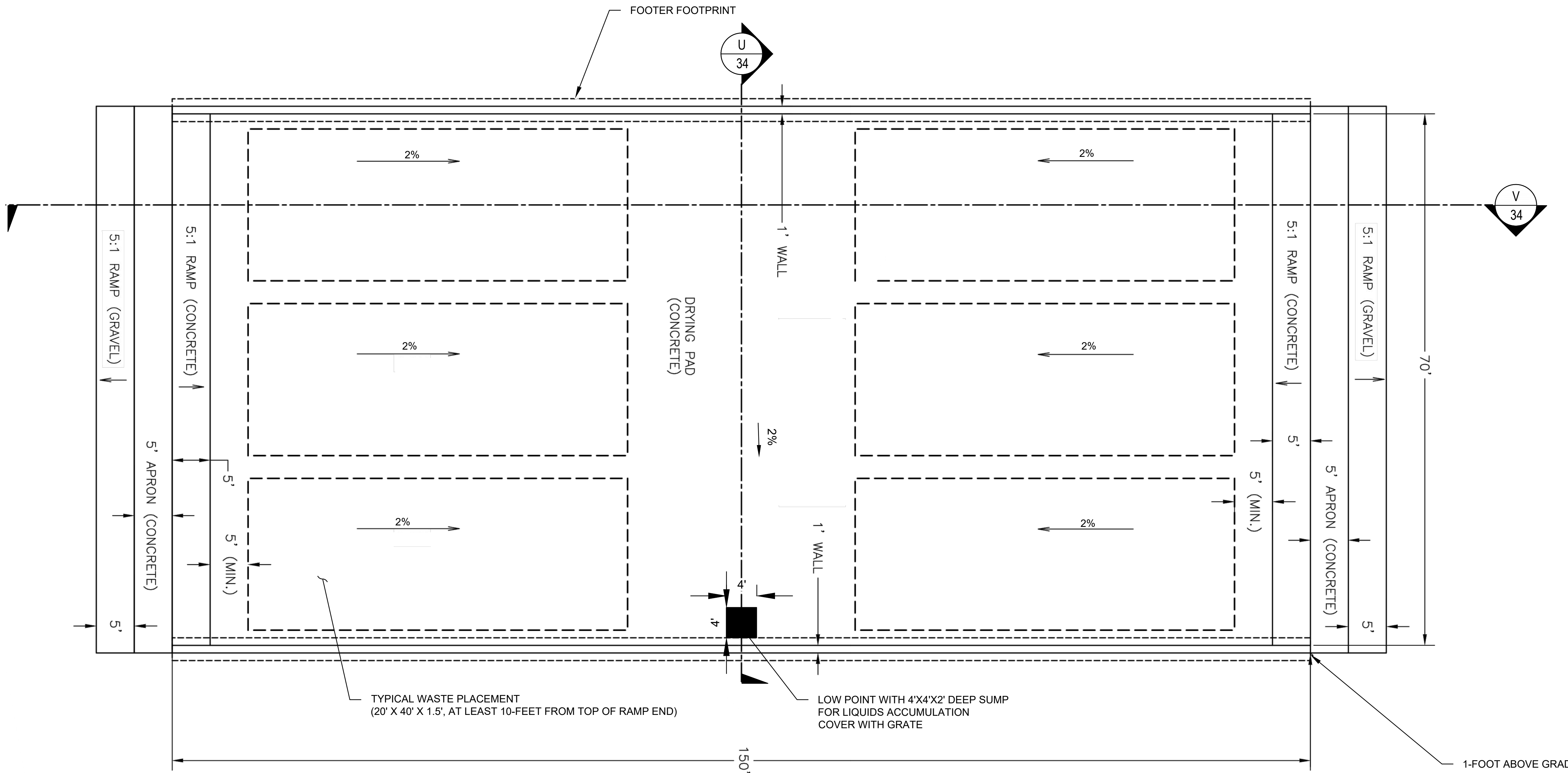

DRYING PAD PLAN

DETAIL T/33
N.T.S.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

REV	DATE	BY	DESCRIPTION
1	9/19	KHJ	UPDATED PER JIM JORDAN COMMENTS

DRYING PAD PLAN VIEW
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 33

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APPVD. BY:	MPB
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JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	33 OF 39

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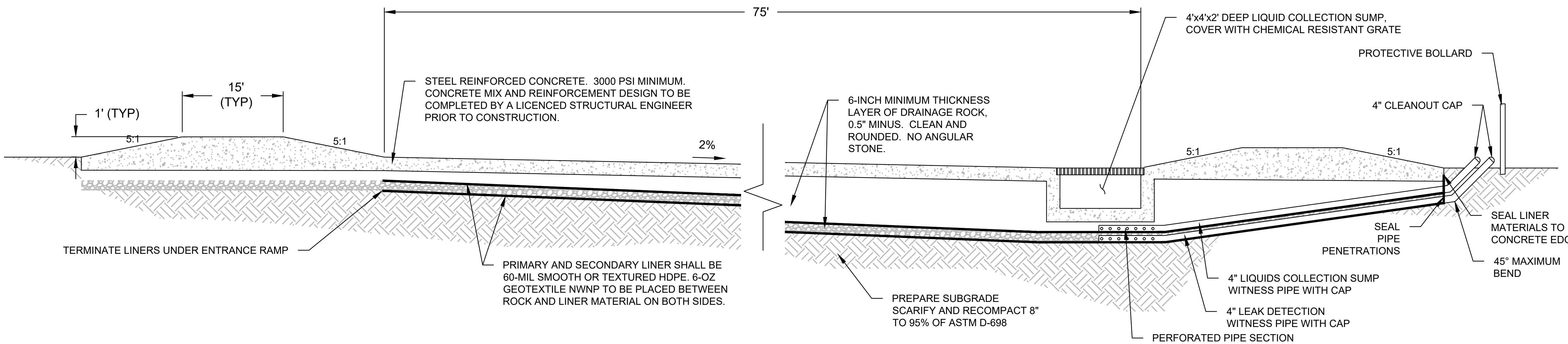
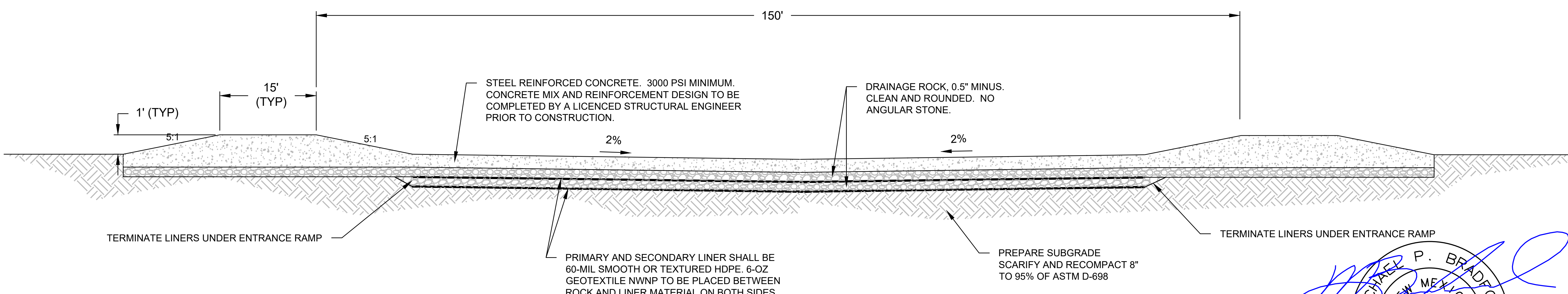


DRYING PAD CROSS SECTION AND STEEL REINFORCEMENT

DETAIL U/34
N.T.S.



DRYING PAD CROSS SECTION AND STEEL REINFORCEMENT

DETAIL V/34
N.T.S.

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NEW MEXICO
19240
PROFESSIONAL ENGINEER

9/20/19

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DRYING PAD DETAIL AND CROSS-SECTION
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NGL WASTE SERVICES, LLC
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LEA COUNTY NEW MEXICO

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ACAD NO.	572-002
SHEET NO.:	34 OF 39

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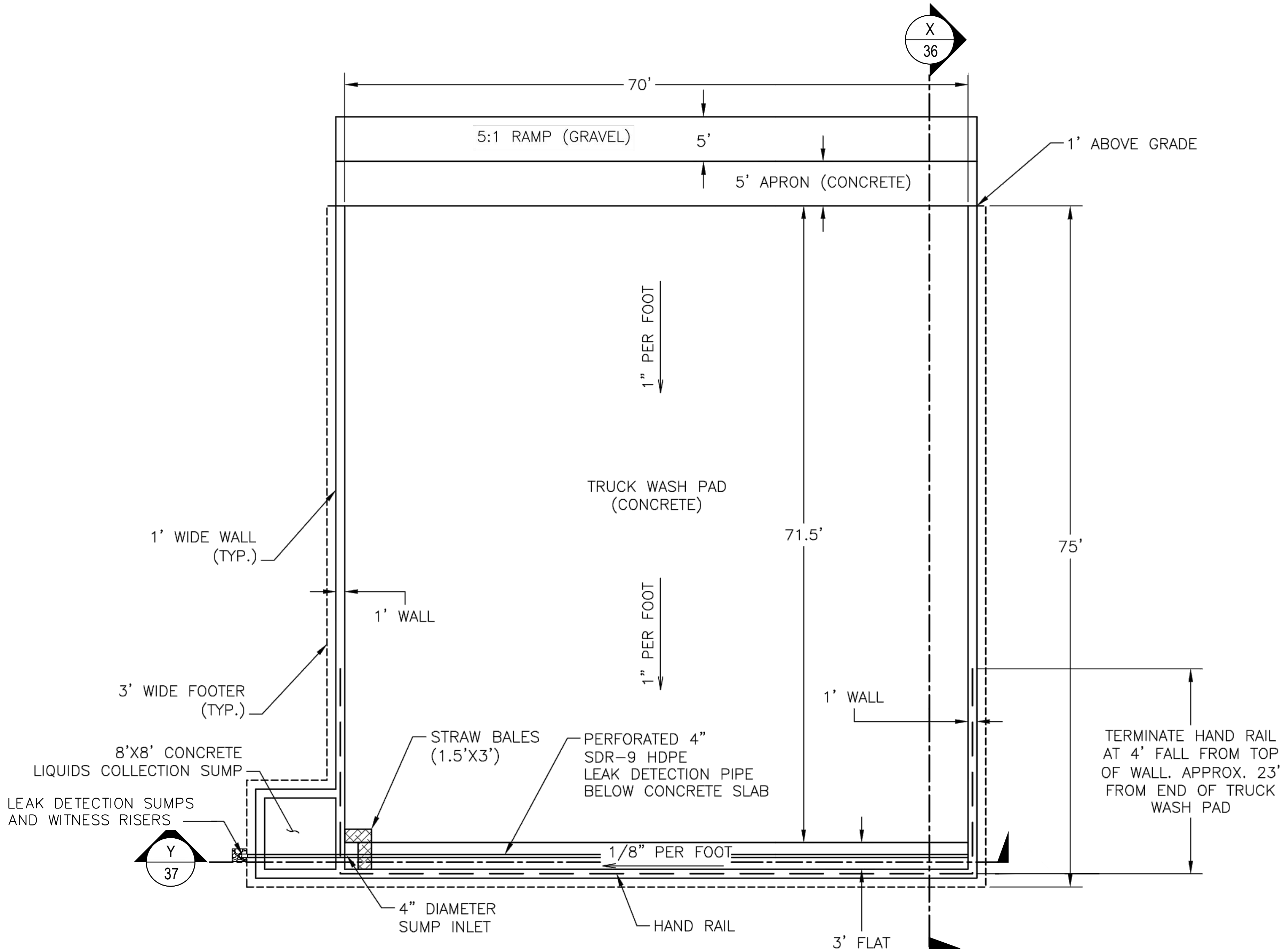

TRUCK WASH PAD PLAN

DETAIL W/35
N.T.S.

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19240
PROFESSIONAL ENGINEER
9/20/19

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TRUCK WASH PAD PLAN VIEW
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PERMIT APPLICATION DRAWING
LEA COUNTY
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SHEET NO.:	35 OF 39

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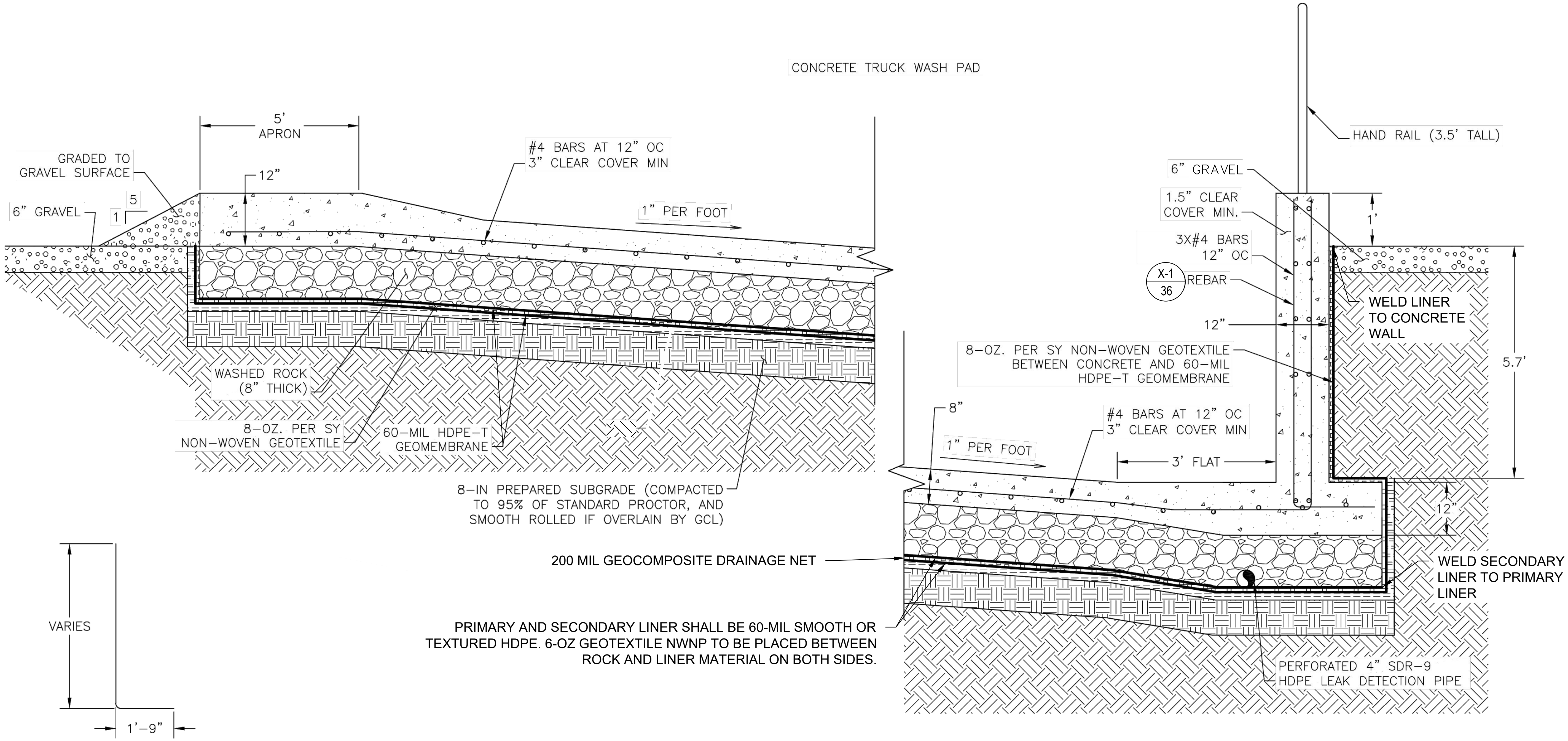

X-1 / 36 **REBAR DETAIL**
SCALE: NONE

TRUCK WASH PAD CROSS SECTION AND STEEL REINFORCEMENT

DETAIL X / 36
N.T.S.

NOTES:

1. REBAR NOT TO BE FIELD-BENT
2. CONCRETE SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 4,500 POUND PER SQUARE INCH (PSI), A 28-DAY FLEXURAL STRENGTH OF 650 PSI, AND CONTAIN 5% TO 7% ENTRAINED AIR.
3. GCL SUBGRADE AREA SHALL BE SMOOTH DRUM ROLLED AND CLEAR OF DEBRIS IN EXCESS OF 0.5" IN MAXIMUM DIAMETER.

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9/20/19

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REV	DATE	BY	DESCRIPTION
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TRUCK WASH PAD CROSS SECTION (1 OF 2)
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
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APPVD. BY:	MPB
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JOB NO.	35187378
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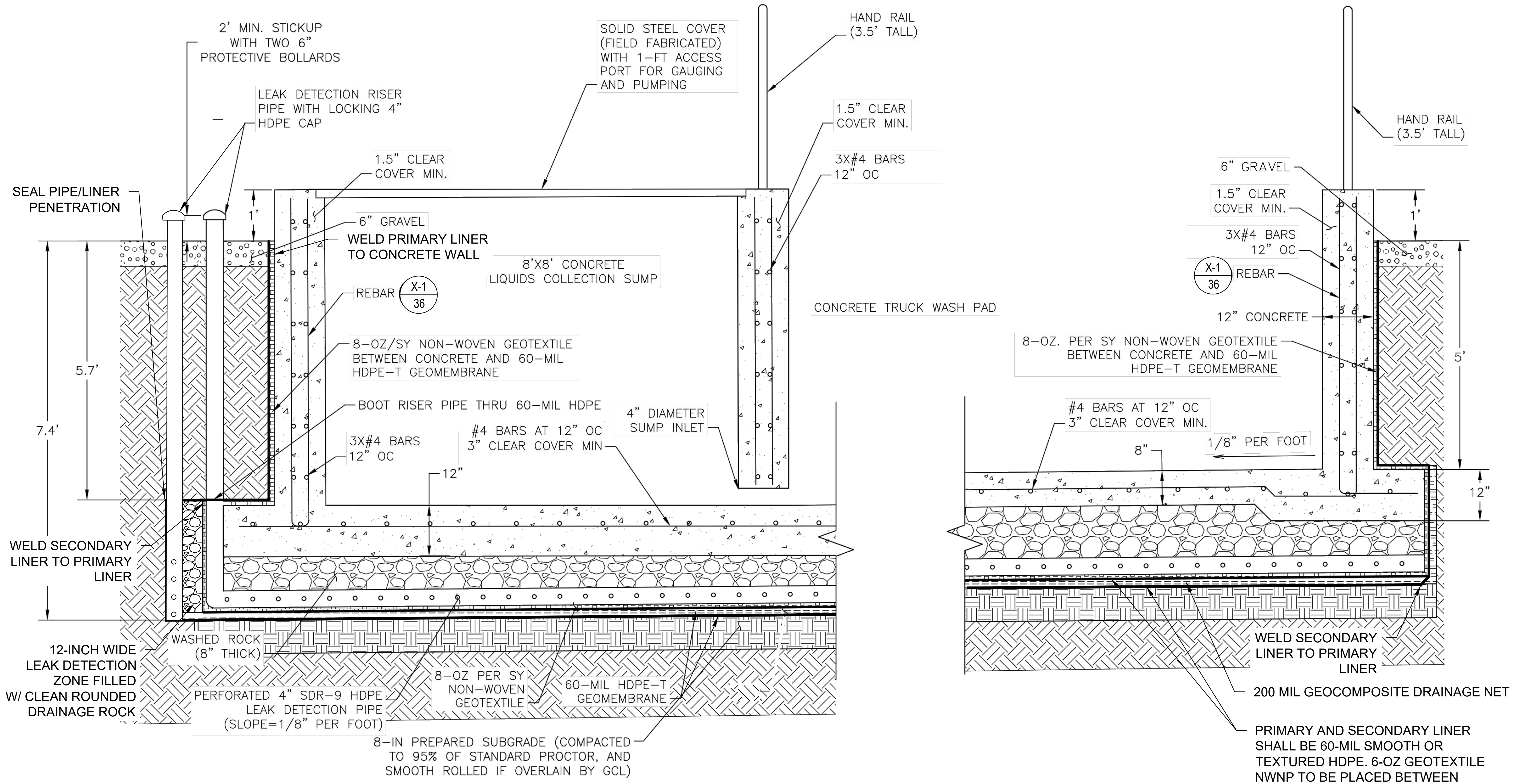
SHEET NO.:	36 OF 39



TRUCK WASH PAD CROSS SECTION AND STEEL REINFORCEMENT

DETAIL Y/37
N.T.S.

NOTES:

1. REBAR NOT TO BE FIELD-BENT
2. CONCRETE SHALL HAVE A MINIMUM 28-DAY COMPRESSIVE STRENGTH OF 4,500 POUND PER SQUARE INCH (PSI), A 28-DAY FLEXURAL STRENGTH OF 650 PSI, AND CONTAIN 5% TO 7% ENTRAINED AIR.
3. GCL SUBGRADE AREA SHALL BE SMOOTH DRUM ROLLED AND CLEAR OF DEBRIS IN EXCESS OF 0.5" IN MAXIMUM DIAMETER.

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19240
PROFESSIONAL ENGINEER
9/20/19

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TRUCK WASH PAD CROSS SECTION (2 OF 2)
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NGL WASTE SERVICES, LLC
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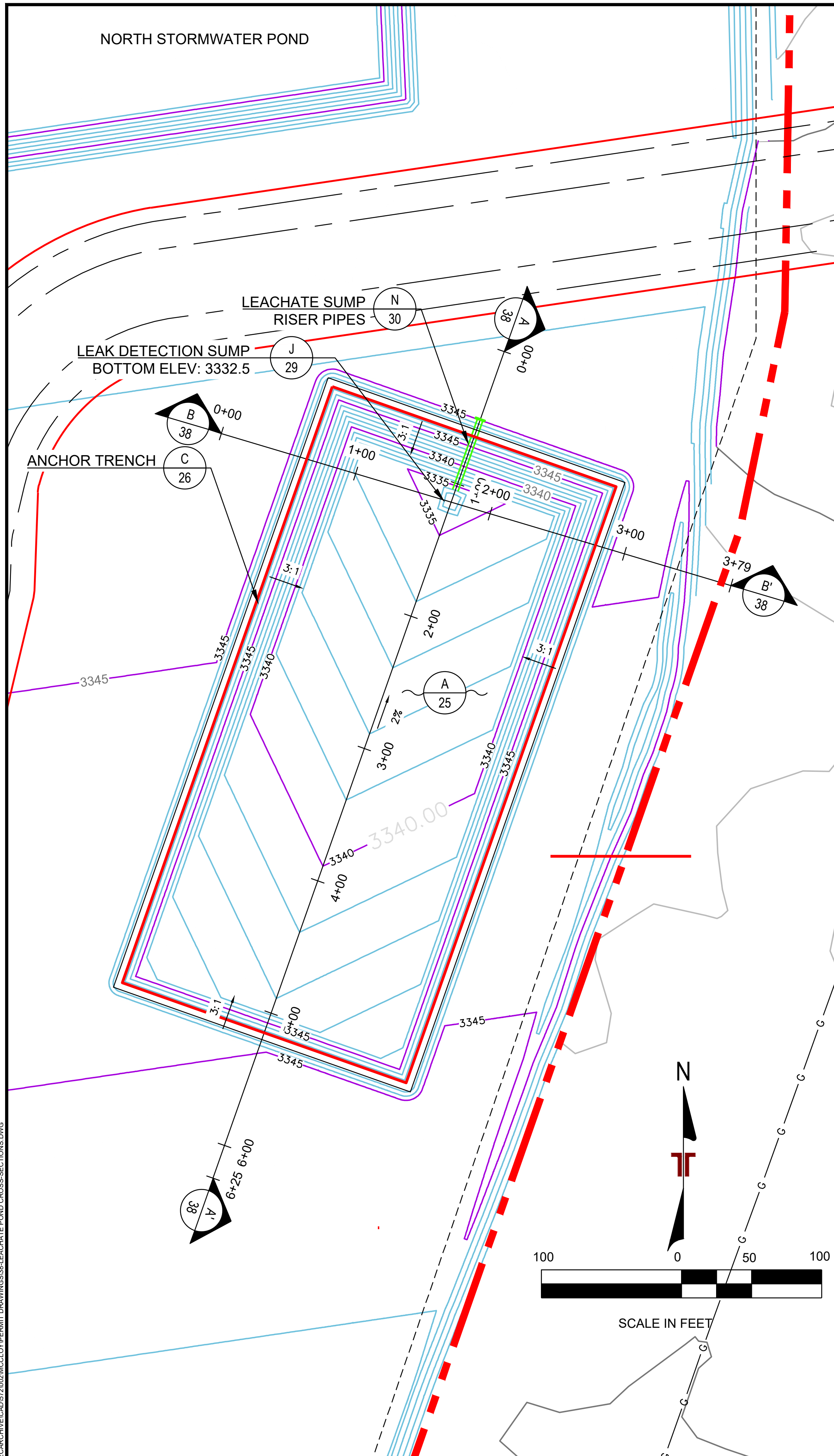
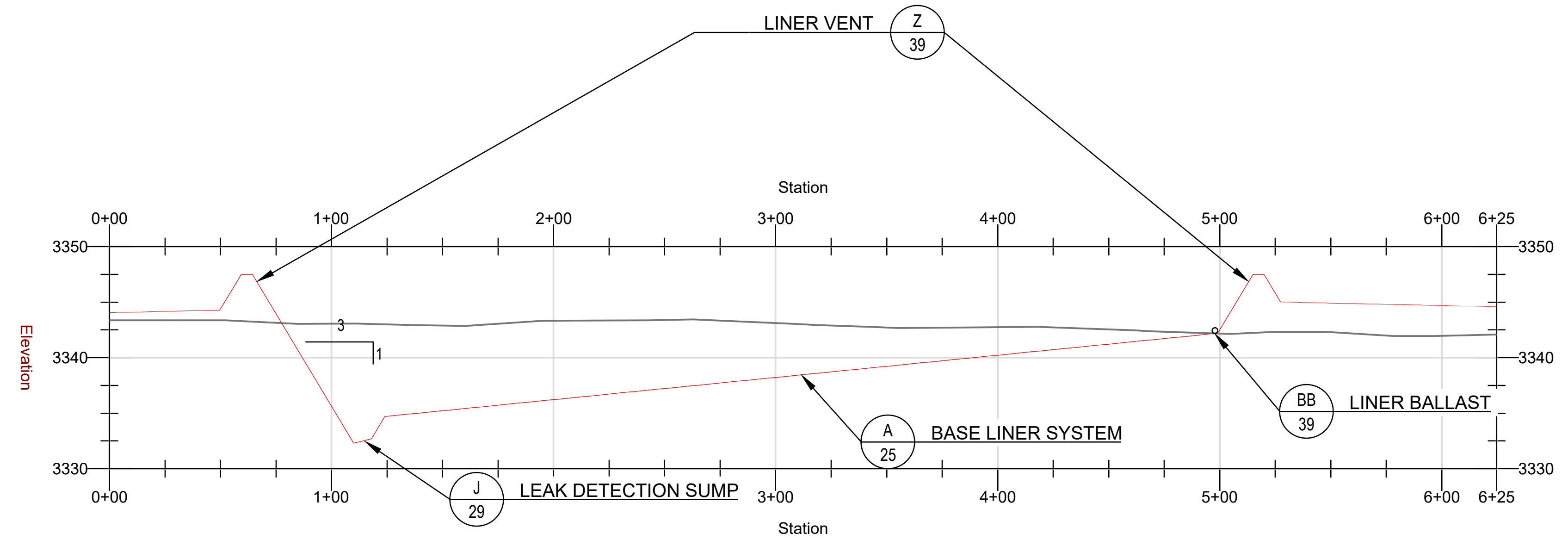
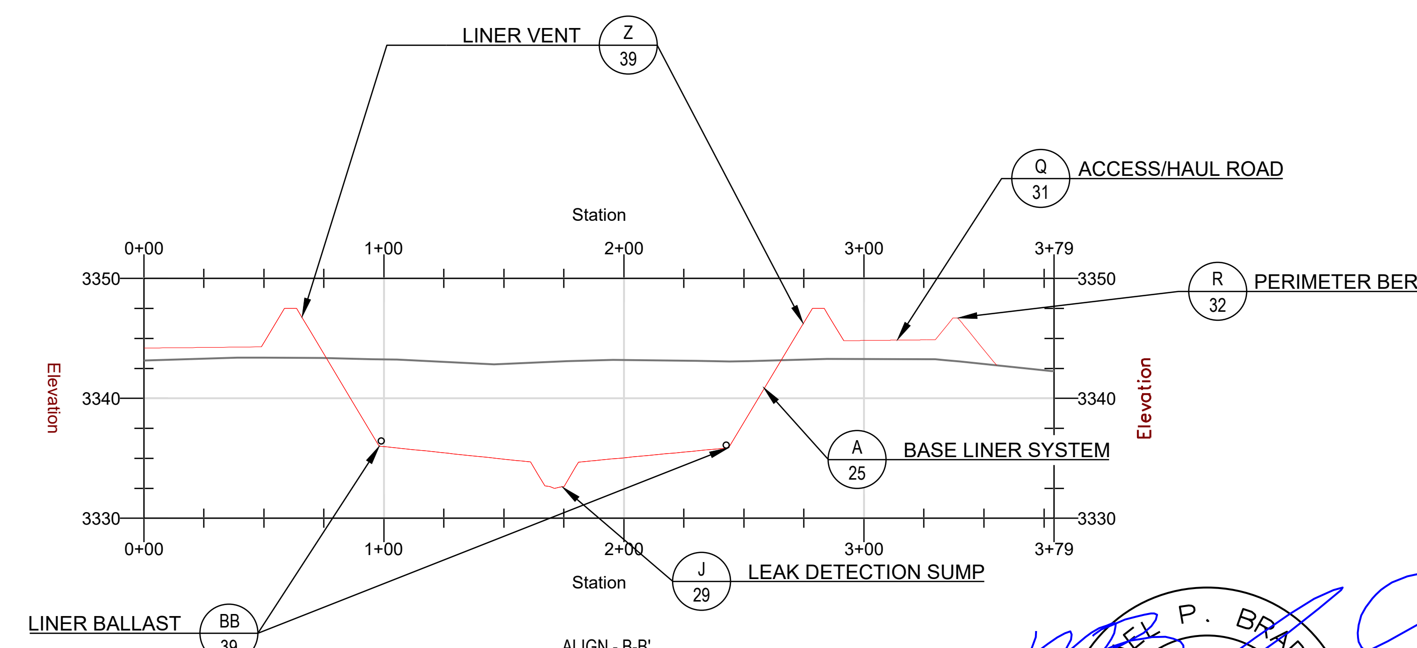




ALIGN - A-A'

SECTION A 38



ALIGN - B-B'

SECTION B 38

LEGEND:

3300	EXISTING GRADE CONTOURS (11/30/2018) (2' INTERVALS)
3300	PROPOSED SUBGRADE CONTOURS (1' INTERVALS)
	PERMIT BOUNDARY/FENCE
	STORMWATER CHANNEL FLOWLINE
	ANCHOR TRENCH
	PERIMETER ROAD
	TOP OF PROFILE SUBGRADE
	EXISTING PROFILE PERIMETER

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NEW MEXICO
19240
PROFESSIONAL ENGINEER

9/20/19

SCALES:
1" = 80' (HORIZONTAL)
1" = 16' (VERTICAL)
VERTICAL EXAGGERATION = x 5

80 0 40 80
SCALE IN FEET

REV	DATE	BY	DESCRIPTION

LEACHATE POND CROSS-SECTION

PERMIT DRAWING

NGL WASTE SERVICES, LLC

NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY

LEA COUNTY NEW MEXICO

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DRAWING 38

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APPVD. BY:	MPB
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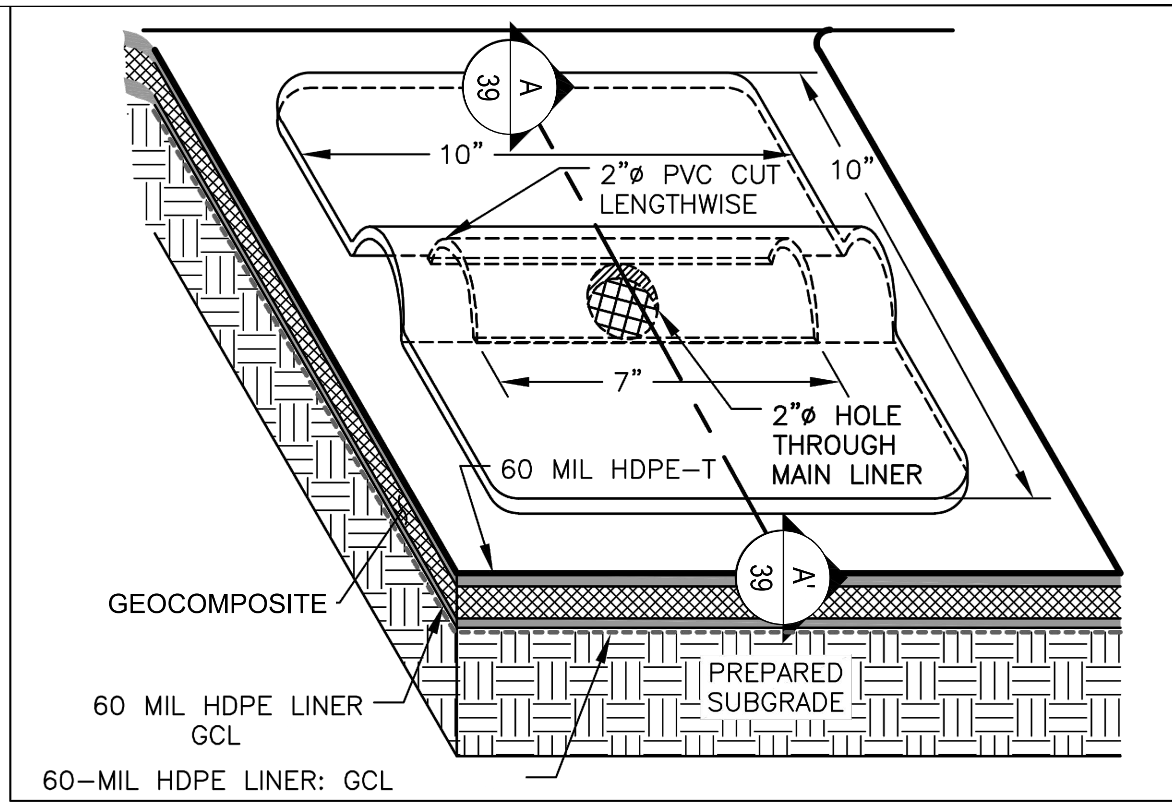
DATE:	APRIL 2019
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	38 OF 39

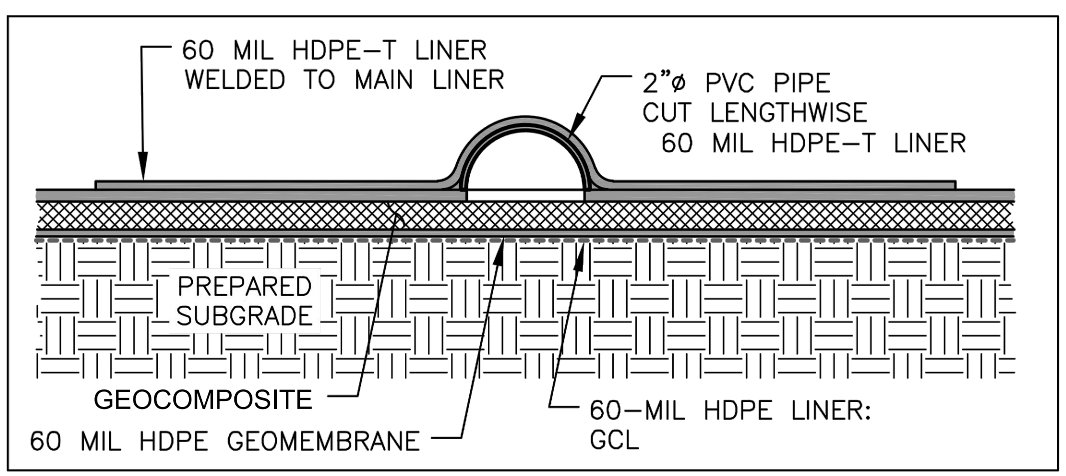


AIR VENT SCHEMATIC

DETAIL Z/39
N.T.S.

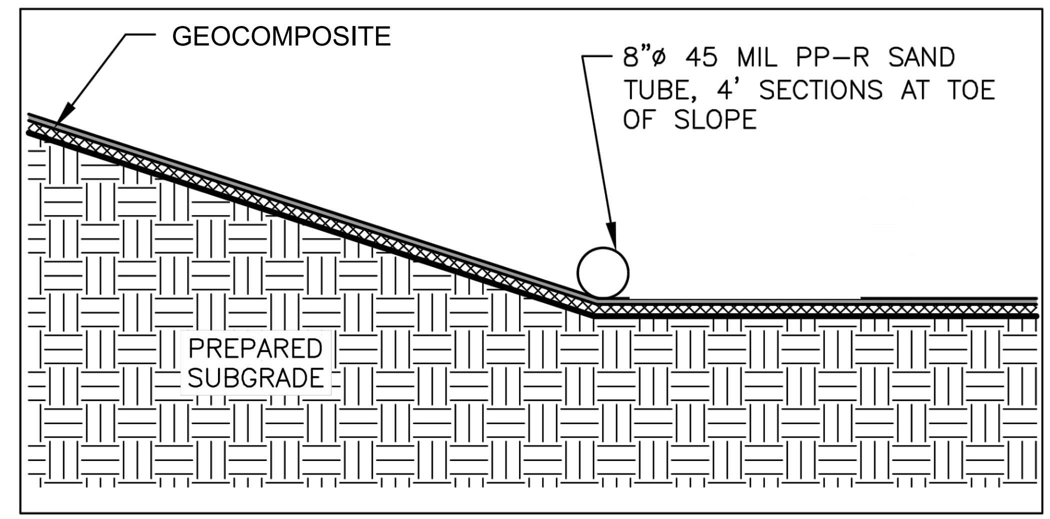
NOTE:

VENTS TO BE SPACED 25' ALONG ENTIRE TOP OF SLOPE.



AIR VENT PROFILE

DETAIL AA/39
N.T.S.



LINER BALLAST

DETAIL BB/39
N.T.S.

MICHAEL P. BRADFORD
NEW MEXICO
19240
PROFESSIONAL ENGINEER
9/20/19

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REV	DATE	BY	DESCRIPTION
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LEACHATE POND DETAILS
NORTH RANCH SURFACE WASTE MANAGEMENT FACILITY
NGL WASTE SERVICES, LLC
PERMIT APPLICATION DRAWING
LEA COUNTY NEW MEXICO

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SCALE:	SEE SCALEBAR
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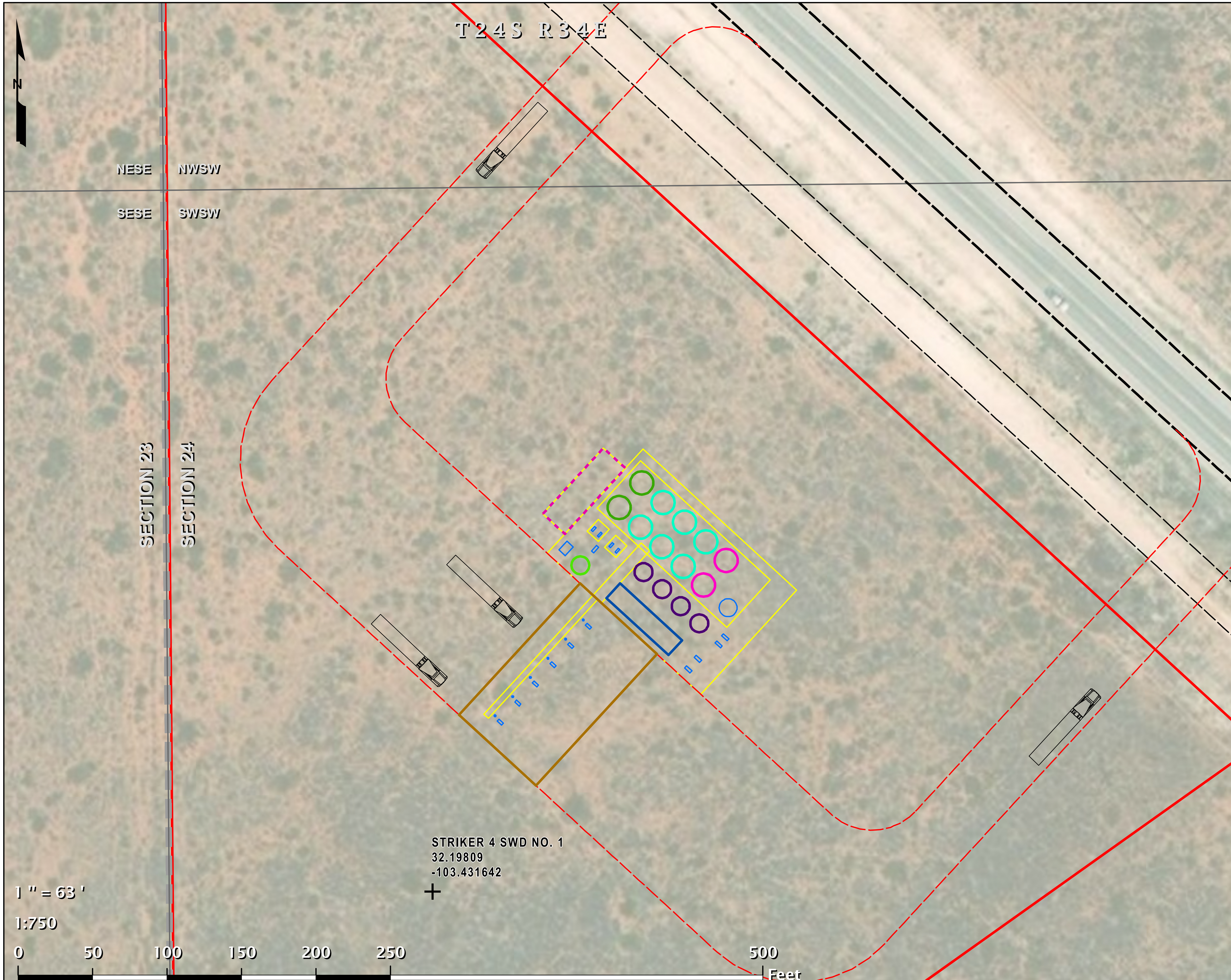
JOB NO.	35187378
ACAD NO.	572-002
SHEET NO.:	39 OF 39

N:\GEARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\39-Z-BB LEACHATE POND VENT DETAILS.DWG

Appendix K-2

North Ranch Striker 4 Facility Design Drawings



Striker 4 SWD No. 1
Mud Facility Layout

NGL Water Solutions Permian, LLC

Lea County, NM

PCS: NAD 1983 SPCS NM-E FIPS 3001 (US Ft.)		
Drawn by: ELR	Date: 5/6/2020	Approved by: CBW

LONQUIST & CO. LLC

PETROLEUM ENGINEERS | ENERGY ADVISORS

AUSTIN · HOUSTON · CALGARY · WICHITA
DENVER · COLLEGE STATION · BATON ROUGE · EDMONTON

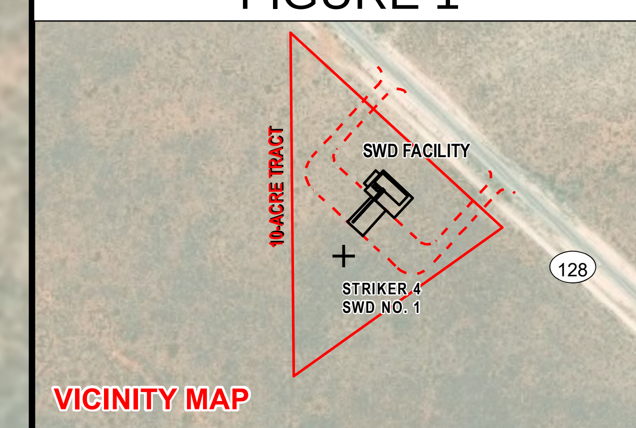
- Striker 4 SWD No. 1
- 10-Acre Tract Boundary
- QQ-Section (NM-PLSS 2nd Div.)
- Section (NM-PLSS 1st Div.)
- Township/Range (NM-PLSS)

SWD Facility Features

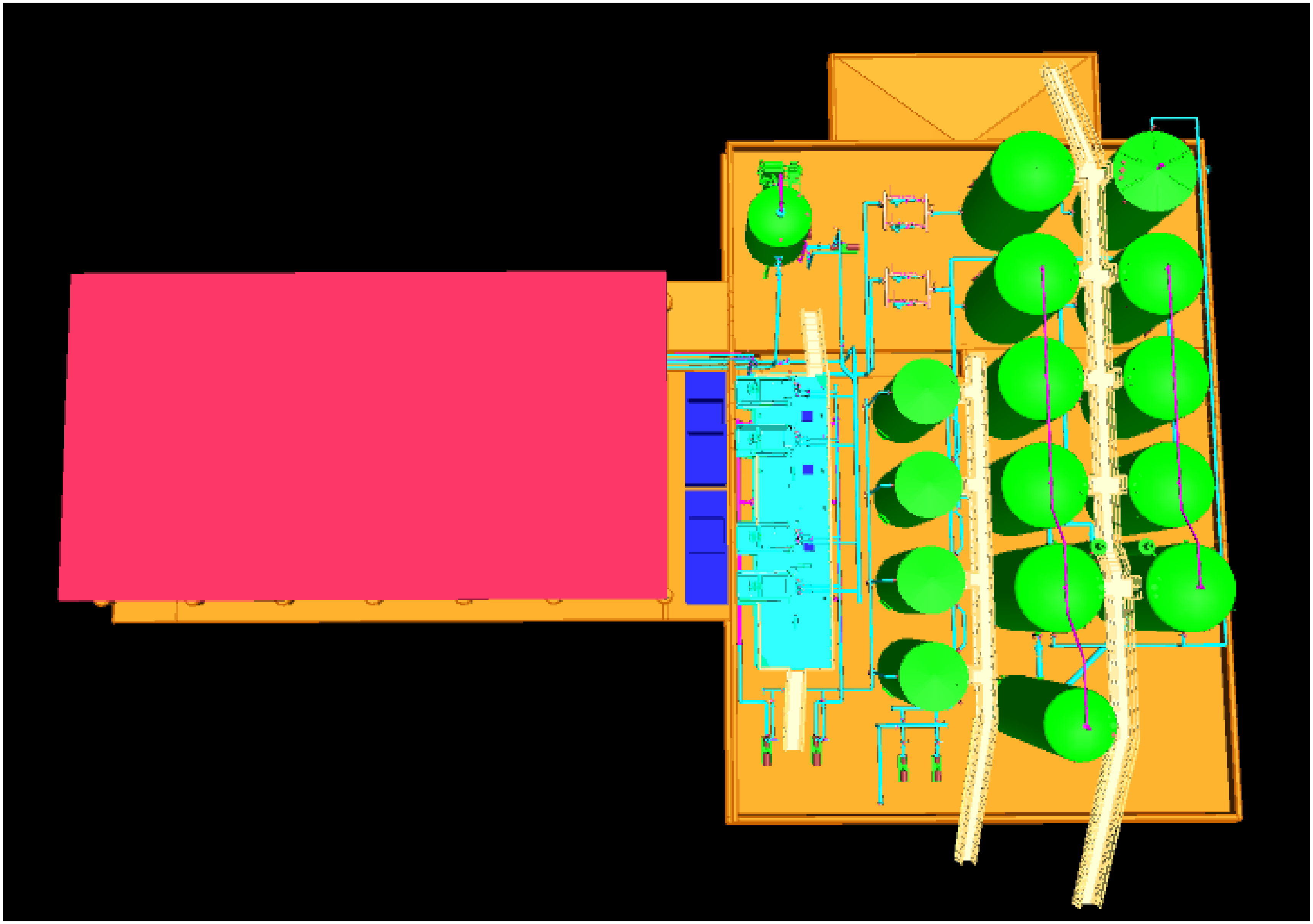
- Highway Shoulder Boundary
- Highway Access Road
- Facility Truck Path
- Facility Pad/Containment Boundaries
- Offload Pad
- Electrical Gear/Control Building
- Desander; Vacuum Blower Skid; Pumps; Rock Catchers
- Freshwater Tank
- Brine Tanks
- Gunbarrel Tanks
- Oil Tanks
- Vacuum Tank
- Slurry Tanks

Note: All coordinates shown are in NAD 83 (GCS).

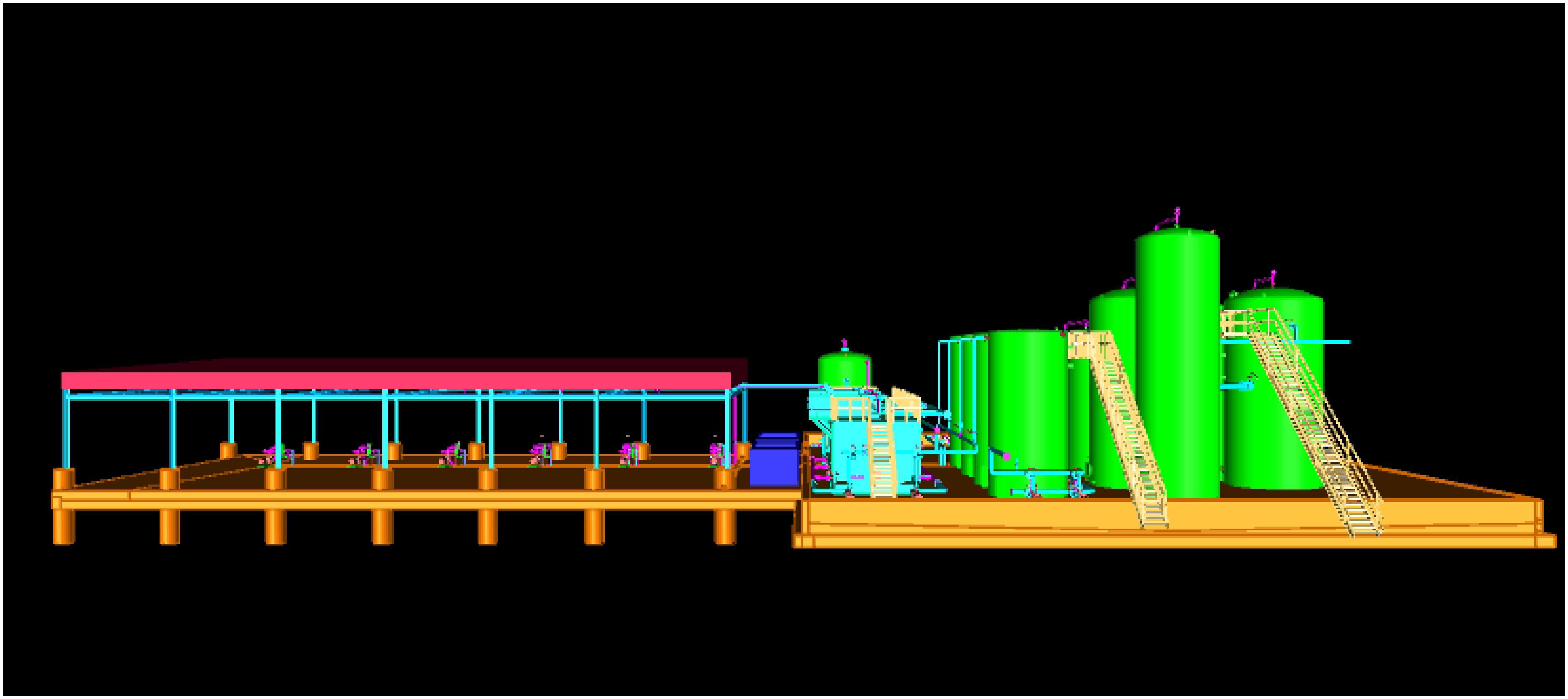
FIGURE 1



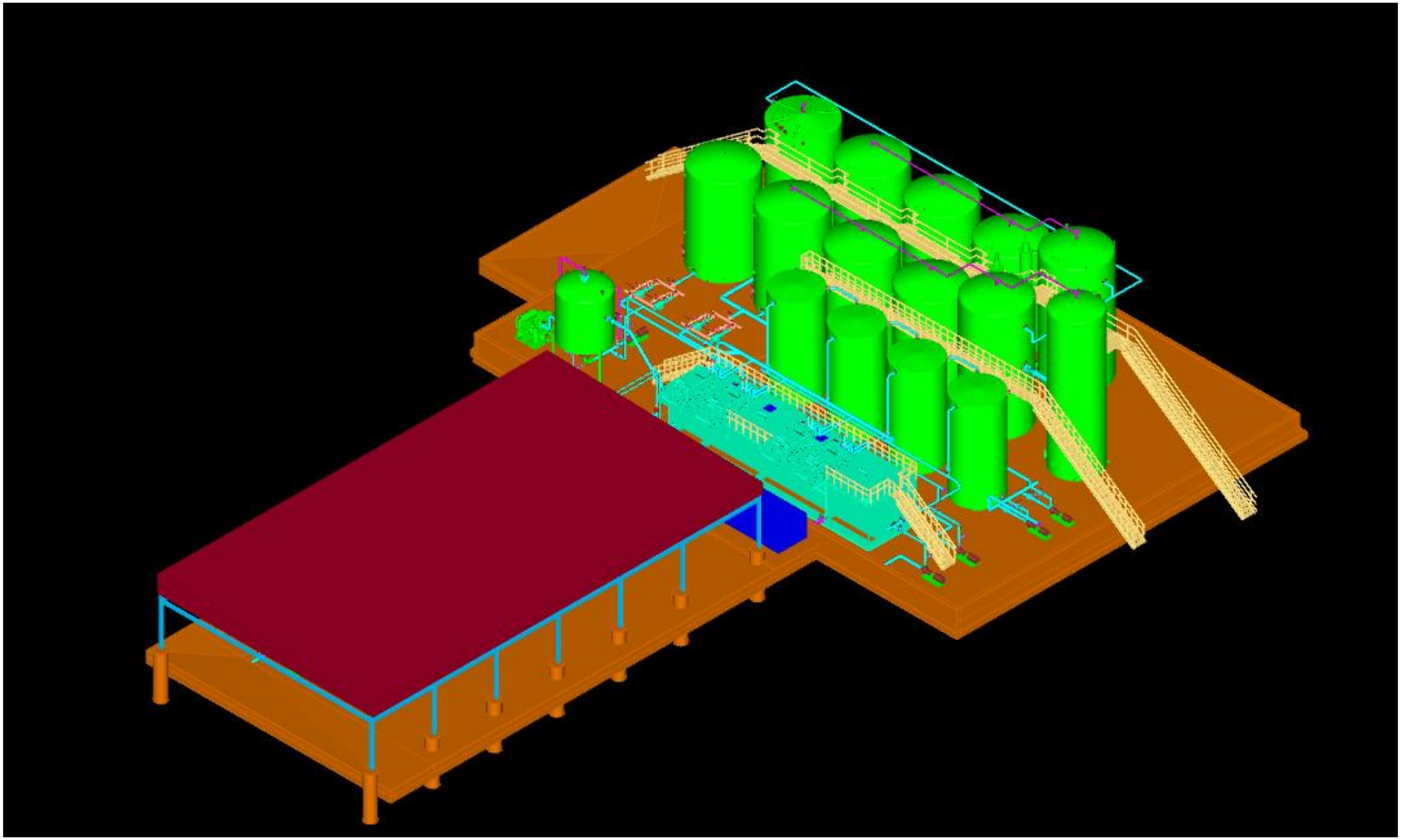
NGL Striker 4 Slurry Injection - Figure 2



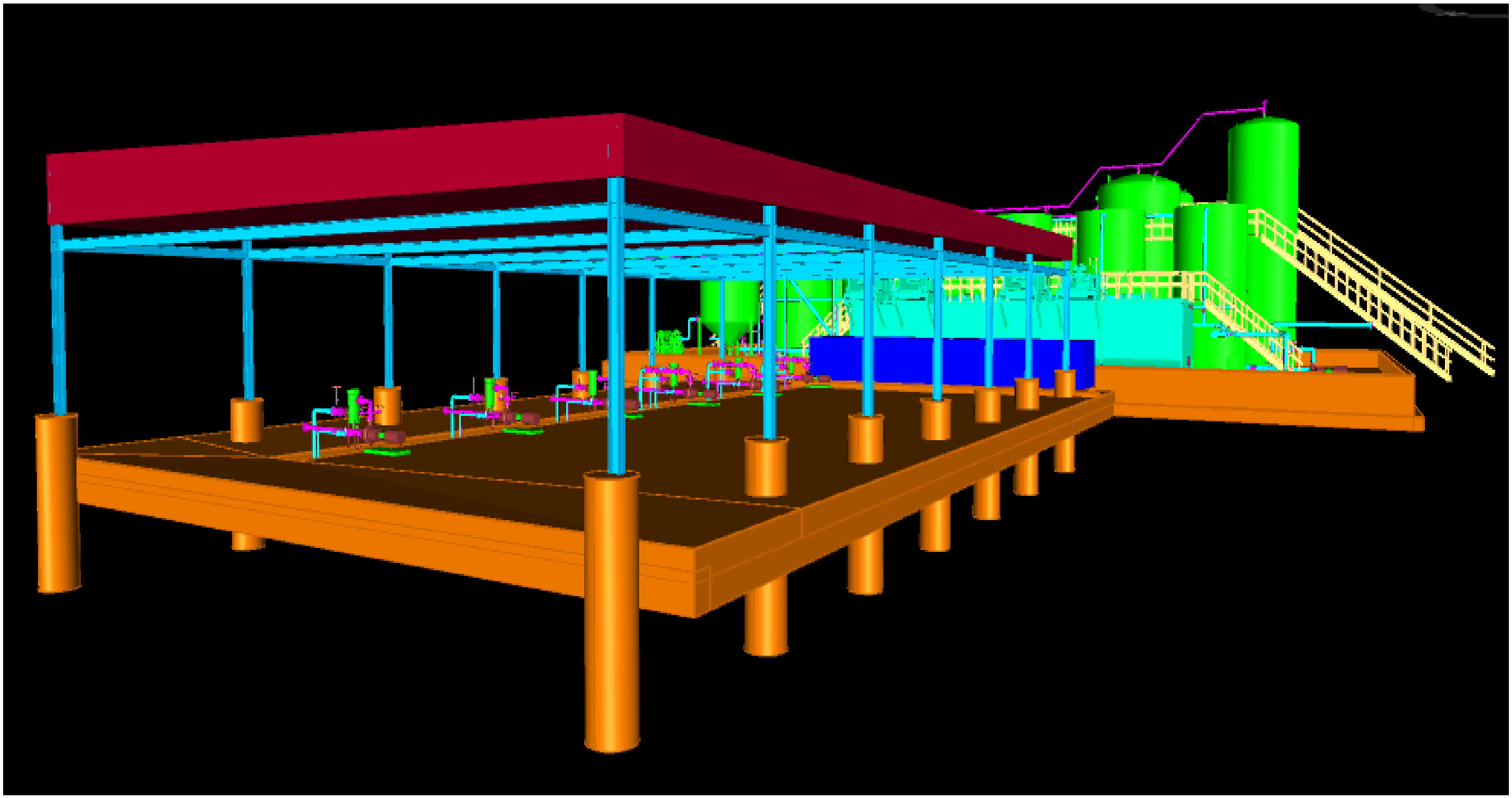
NGL Striker 4 Slurry Injection - Figure 3



NGL Striker 4 Slurry Injection - Figure 4



NGL Striker 4 Slurry Injection - Figure 5



Appendix L

North Ranch Surface Waste Management Facility

Stormwater Pollution Prevention Plan

Stormwater Pollution Prevention Plan (SWP3)

for:

North Ranch Surface Waste Management Facility
Battle Axe Road,
Jal, NM 88252

NGL Waste Services, LLC
3773 Cherry Creek North Drive, Suite 1000
Denver, CO 80209
(303) 370-7100

SWP3 Contact(s):

NGL Waste Services, LLC
Craig Rutland
14100 San Pedro STE: 501
San Antonio, Texas 78232
Office: 210-495-0452 Ext. 3
Craig.Rutland@nglep.com

SWP3 Prepared By:

Bear Creek Consultants
1320 E. 9th Street, Suite 2
Edmond, OK 73034
(405) 531-0600
vchoquette@bearcreekconsultants.com

SWP3 Preparation Date:

April 17, 2019

Project Start Date: 05/15/2019
Project Completion Date: 07/15/2029

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Appendix A – Site Maps

Appendix B – Construction General Permit

Appendix C – Notice of Intent (NOI)

Appendix D – Forms

Appendix E – Delegation of Authority

Section 1: Site Evaluation, Assessment, and Planning

1.1 Project/Site Information

Facility Location:

Near Jal, New Mexico in Lea County, Zip: 88252
32.144875° N, 103.4624139° W (Facility Centroid, using GPS)

Is the project located in Indian country? No
Is this project considered a federal facility? No
NPDES ID: NMR10022R

Facility Information (If the facility lacks a street address, indicate the general location of the facility)		
Name of Facility: North Ranch Surface Waste Management Facility		
Street: From Jal, NM take NM-128 W for about 13.8 miles, turn South, staying on Battle Axe Road for about 5 miles. Turn Right.		
City: Jal	State: NM	ZIP Code: 88252
County: Lea		
Latitude/Longitude (Facility Centroid)		
Latitude: 32.144875° N	Longitude: 103.4624139° W	
Method for determining latitude/longitude (check one):		
___ ✓ GPS	☐ EPA My WATERS Mapper	☐ USGS National Map
Is this project considered a federal facility? No		

1.2 Contact Information/Responsible Parties

See Appendix A – Site Map for geographic area of control.

OPERATOR	
Contact Information	**Geographic Area of Control**
NGL Waste Services, LLC Garrett Clemons, VP, EHS 3773 Cherry Creek N. Dr. Ste. 1000 Denver, CO 80209 Office Phone: (303) 370-7106 Email: garrett.clemons@nglep.com	

Project Manager:
PM Contact Name (Primary): TBD
Telephone number:
Email address:
Address: NA

SWP3 Contact:
SWP3 Contact Name (Primary): Craig Rutland
Telephone number: 210-495-0452 Ext. 3
Email address: Craig.Rutland@nglep.com
Address: 14100 San Pedro STE: 501, San Antonio, Texas 78232

SWP3 Prepared by:
SWP3 Contact Name (Primary): Vern Choquette
Telephone number: (405) 531-0600
Email address: vchoquette@bearkcreekconsultants.com
Address: 1320 E. 9th St. Ste.2 Edmond, OK 73034

Emergency 24-Hour Contact:
SWP3 Contact Name (Primary): TBD
Site Phone:
Cellular Phone:

SUBCONTRACTOR(S)	
Contact Information	**Subcontracted Responsibilities**
TBD	TBD
See Appendix D – Subcontractor Certifications/Agreements	

1.3 Nature and Sequence of Construction Activity

NGL Waste Services, LLC is planning to build a surface waste management facility on Battle Axe Rd. near Jal, Lea County, New Mexico. During construction, approximately 270.25 acres of soil will be disturbed. Soil disturbing activities will include: clearing and grubbing; installing stabilized construction exits; installing erosion and sediment controls; grading; excavation.

What is the function of the construction activity?

[ ] Residential [ ] Commercial [**X**] Industrial [ ] Road [ ] Construction [ ] Linear [ ] Utility

[ ] Other (please specify):

Estimated Project Start Date: 2019-05-15

Estimated Project Completion Date: 2029-06-15

As NGL Waste Services, LLC has not yet awarded the development work to a contractor, a general timeline cannot be provided at this time. When a Timeline of Activity is determined, the SWP3 will be updated and the change will be noted in Section 6.2.

Table 1. Timeline of Activity: NGL Waste Services, LLC will follow the sequence described below for major construction activities and BMP installation

Estimated Timeline of Activity	Construction Activity and BMP Descriptions
5/15/19 to 6/1/19	Site Mobilization -Contractor equipment (heavy equipment, job trailers, etc.) and any off-site construction materials (geosynthetics, off-site soils, etc.) are brought to the site and set up and stored in a designated area.
6/1/19 to 7/1/19	Stormwater Controls - Stormwater and erosion controls are set up prior to earthwork. Driveways are constructed and covered in crushed rock, sediment ponds are constructed.
7/1/19 to 7/15/29	In the cell construction area, soil is excavated or filled to meet design grades as required. The excavated soil is placed in a designated stockpile area. If fill soil is required and is unable to be obtained from the construction area soils, a borrow area will be used. Once the design subgrade elevations are met, the surface of the subgrade soils is conditioned and re-compacted to design specifications. Following completion of subgrade, geosynthetic materials (Geosythetic Clay Liner, HDPE Geomembrane, Geotextile, and Geocomposite) are installed. Lastly, a protective soil layer is placed over the geosynthetic materials. Outside of the cell area, additional construction may take place to install HDPE leachate force main, construct concrete headwalls, perimeter ditches, roads, etc. Following all earthwork, disturbed areas are seeded.
See Appendix D – Subcontractor Certifications/Agreements	

1.4 Soil, Slopes, Vegetation, and Current Drainage Patterns

Soil Types

The current soil type of the site consists of Ratliff-Wink fine sandy loams, pyote and maljamar fine sands, and Wink loamy fine sand.

Slopes

The site slopes very slightly to the south. Site is lower than surrounding property on all sides.

Drainage Patterns

Within the site, drainage flows south. The site is lower than surrounding property on all sides.

Vegetation

The site is populated by dry desert brush and grasses.

1.5 Construction Site Estimates

Total Project area:	275 ac.
Construction site area to be disturbed:	270.25 ac.
Percentage impervious area before construction:	< 1%
Runoff coefficient before construction:	0.15
Percentage impervious area after construction:	< 5%
Runoff coefficient after construction:	0.20

1.6 Receiving Waters

There are no nearby creeks, bodies of water, or storm sewer systems. The site is lower than surrounding property on all sides.

1.7 Site Features and Sensitive Areas to be Protected

The site has no unique natural features that warrant preservation.

1.8 Potential Sources of Pollution

Potential sources of sediment to stormwater runoff:

- Clearing and grubbing operations
- Grading and excavation operations
- Vehicle tracking
- Vehicle wash pad

Other potential pollutants to stormwater:

- Combined Staging Area—Small fueling activities, minor equipment maintenance, sanitary facilities.

Material	Physical Description	Stormwater pollutants	Location
Hydraulic oil/fluids	Brown, oily petroleum hydrocarbon	Mineral oil	Equipment leaks
Gasoline	Colorless, pale brown or pink petroleum hydrocarbon	Benzene, ethyl benzene, toluene, xylene, MTBE	Secondary containment/ staging area
Diesel Fuel	Clear, blue-green to yellow liquid	Petroleum distillate, oil & grease, naphthalene, xylenes	Secondary containment/ staging area

1.9 Endangered Species Certification

According to the USFWS Information for Planning and Conservation (IPaC) Environmental Conservation Online System, only one federally protected species is located in the area—the Northern Aplomado Falcon (Falco femoralis septentrionalis). There is no critical habitat located in the project area.

1.10 Historic Preservation

There are no historic sites on or near the construction site. A search was performed on http://nmhistoricsites.org/index/maps-and-directions, New Mexico's online index of historic sites.

1.11 Applicable Federal, Tribal, State or Local Programs

No federal, tribal, state, or county programs were found to pertain to the site.

1.12 Maps

See Appendix A

Section 2: Erosion and Sediment Control BMPs

2.1 Minimize Disturbed Area and Protect Natural Features and Soil

The disturbed area on the site is necessary for the site's industrial application. No unique natural features have been identified for protection. As needed, topsoil will be stockpiled in areas that do not interfere with construction phases and at least 15 feet away from areas of concentrated flow and pavement. Stockpile slopes will be roughened by equipment tracking and will not exceed 2:1 to prevent erosion.

2.2 Phase Construction Activity

Contractor equipment (heavy equipment, job trailers, etc.) and any off-site construction materials (geosynthetics, off-site soils, etc.) are brought to the site and set up and stored in a designated area. Temporary stormwater and erosion controls are set up prior to earthwork. In the cell construction area, soil is excavated or filled to meet design grades as required. The excavated soil is placed in a designated stockpile area (no steeper than 2:1). If fill soil is required and is unable to be obtained from the construction area soils, a borrow area will be used. Once the design subgrade elevations are met, the surface of the subgrade soils is conditioned and re-compacted to design specifications. Following completion of subgrade, geosynthetic materials (Geosynthetic Clay Liner, HDPE Geomembrane, Geotextile, and Geocomposite) are installed. Lastly, a protective soil layer is placed over the geosynthetic materials. Outside of the cell area, additional construction may take place to install HDPE leachate force main, construct concrete headwalls, perimeter ditches, roads, etc. Following all earthwork, disturbed areas are seeded.

2.3 Control Stormwater Flowing onto and through the Project

Where required, ditches (i.e., trapezoidal channels) of depth 3 feet and base width of 10 feet (for channel Type 1) and 6 feet (for channel Type 2) will be constructed along the perimeter of the site, directing run on and run off the stormwater ponds (see Maps Appendix A).

2.4 Stabilize Soils

As needed, temporary stormwater and erosion controls are set up prior to earthwork. Following all earthwork, disturbed areas are seeded.

2.5 Protect Slopes

As needed, geosynthetic materials (Geosynthetic Clay Liner, HDPE Geomembrane, Geotextile, and Geocomposite) are installed to protect slopes. A protective soil layer is placed over the geosynthetic materials. Geosynthetic materials will be installed according to the manufacturer's instructions. Landfill side slopes and let down slopes are 4:1 (See Map in 1.12).

2.6 Protect Storm Drain Inlets

There are no storm drains near the site.

2.7 Establish Perimeter Controls and Sediment Barriers

As needed, run off and run on diversion channels surround the site. Sediment will be diverted to stormwater ponds. Temporary stormwater and erosion controls are set up prior to earth work. Silt fences will be installed as deemed necessary by regular inspections. Given the scale of the site and the permanent stormwater controls on the perimeter of the site, silt fencing is neither feasible nor effective for the perimeter of the entire property.

2.8 Retain Sediment On-Site

As needed, sediment will be retained in the three stormwater ponds, which can contain a minimum of 3.5' freeboard over 25-yr, 24 hour event high water mark.

2.9 Establish Stabilized Construction Exits

As needed, stone anti-tracking pads will be installed at the construction exit (NE corner) to mitigate off-site tracking. A proposed wash pad and drying pads will be installed in the Northeast corner of the site to remove sediment before equipment leaves the site.

2.10 Additional BMPs

Based on regular erosion and sediment inspections, appropriate BMPs will be implemented with consideration for the site's surroundings on an as needed basis.

Section 3: Good Housekeeping BMPs

This section describes all areas at my facility where industrial materials or activities are exposed to stormwater or from which allowable non-stormwater discharges originate.

3.1 Material Handling and Waste Management

All waste materials, trash, and construction debris will be collected and disposed of appropriately on site. Waste materials, trash, and construction debris will be stored away from stormwater conveyances and meet all local and state solid-waste management regulations. Special attention will be given to hazardous waste materials, which will be stored in sealed containers with sufficient secondary containment. All personnel will be instructed, during tailgate training sessions, regarding the correct procedure for disposal of trash and construction debris. The individual who manages day-to-day site operations will be responsible for seeing that these practices are followed.

3.2 Establish Proper Building Material Staging Areas

Equipment and construction materials will be temporarily stored in the designated staging and material storage area. Hazardous materials such as oil filters, petroleum products, and equipment maintenance fluids will be stored in sealed, structurally sound containers.

3.3 Designated Washout Areas

The site will not have any designated concrete washout areas. Vehicle washing will occur on a proposed wash pad.

3.4 Establish Proper Equipment/Vehicle Fueling and Maintenance Practices

Several types of vehicles and equipment will be used on-site throughout the project, including graders, scrapers, excavators, loaders, paving, rollers, trucks and trailers, backhoes. Major equipment will be performed off-site. A small fuel tank will be kept on-site in the combined staging area. When vehicle fueling must occur on-site, the fueling activity will occur in the staging area. Only minor equipment maintenance will occur on-site. Equipment fluids generated from maintenance activities will be disposed of into sealable containers accordance with Section 3, Part 3.1. Absorbent, spill-cleanup materials and spill kits will be available at the combined staging and materials storage area.

3.5 Control Equipment/Vehicle Washing

A wash pad and drying pads are proposed for the Northeast corner of the site (see Map found in Appendix A). Run off from the pads will be collected in a channel of Type 1 (as described above) and diverted to a stormwater pond.

3.6 Spill Prevention and Control

Employee Training: employees will be trained. Vehicles and equipment will be maintained off-site. Hazardous materials will be stored in accordance with section 3 part 1. Spill kits will be available on-site. Spills will be cleaned up immediately upon discovery. Safety data sheets, inventory, and emergency contact information will be accessible electronically.

3.7 Any Additional BMPs

No additional BMPs were identified.

3.8 Allowable Non-Stormwater Discharge Management

Water Used to Control Dust

Dust control will be implemented as needed by spraying water onto dirt surfaces during high winds.

Uncontaminated Excavation Dewatering

Because sub-grade construction activities will occur in the dry season, dewatering is not expected.

All Other Discharges

All other non-stormwater discharges will be diverted to the perimeter channels and subsequently to the stormwater ponds.

Section 4: Selecting Post-Construction BMPs

As described above, 3 permanent stormwater ponds will be built on the site to accommodate the 25 year, 24-hour event with sufficient freeboard. Permanent diversion channels will direct run off and run on water to the stormwater ponds. An earthen berm to divert stormwater will be added in later phases as cells are added to the facility. Letdown structures will direct stormwater down the slopes to the channels.

Slopes will be maintained at 4:1 to prevent erosion. When required, geosynthetic materials will be installed as described in section 2.5.

All devices mentioned in this section will be inspected regularly and after storm events. Adjustments to permanent stormwater controls will be implemented as necessary based on observed erosion.

Section 5: Inspections

5.1 Inspections

Inspection Personnel

Mr. Craig Rutland is responsible for site compliance with this SWP3 and EPA's Construction General Permit. Mr. Rutland will oversee the inspection program for all areas of the site disturbed by construction activity, areas used for storage of materials that are exposed to precipitation, discharge points, and construction exits.

Qualifications

Mr. Rutland is an experienced compliance professional. He is overseeing the development and implementation of the SWP3.

Inspection Schedule and Procedures

Inspections will be performed at least once every 14 days and within 24 hours of the end of a storm event of one-half inch or greater. The inspections will verify that all BMPs required in Sections 2 and 3 are implemented, maintained, and effectively minimizing pollutants in stormwater runoff from the project site.

If corrective actions are identified during an inspection, staff will notify and submit a copy of the inspection report to the Project Manager. The Project Manager will be responsible for initiating the corrective action within 72 hours of the report and completing maintenance as soon as possible or before the next storm event.

For a copy of the inspection report, see Appendix D.

5.2 Delegation of Authority

Duly Authorized Representative or Position:

NGL Waste Services, LLC
Craig Rutland
14100 San Pedro STE: 501
San Antonio, Texas 78232
Office: 210-495-0452 Ext. 3
Craig.Rutland@nglep.com

5.3 Corrective Action Log

See Appendix D – Corrective Action Log

Section 6: Recordkeeping and Training

6.1 Recordkeeping

Records will be kept for a minimum of 3 years after the permit is terminated.

Date(s) when major grading, construction activities, and stabilization activities occur:

See Appendix D – Grading and Stabilization Activities Log

6.2 Log of Changes to the SWP3

See Appendix D – SWP3 Amendment Log

6.3 Training

Individual(s) Responsible for Training:

Mr. Craig Rutland

Describe Training Conducted:

- General stormwater and BMP awareness training for staff and subcontractors:

Mr. Rutland will implement informal training for staff, including subcontractors, on the site. The training will focus on avoiding damage to stormwater BMPs and preventing illicit discharges. Training will address the following topics:

- Erosion Control BMPs;
- Sediment Control BMPs;
- Non-Stormwater BMPs;
- Waste Management and Materials Storage BMPs; and
- Emergency Procedures specific to the construction site.

(See Appendix D – Training Log)

Section 7: Final Stabilization

Once the design subgrade elevations are met, the surface of the subgrade soils is conditioned and re-compacted to design specifications. Following completion of subgrade, geosynthetic materials (Geosynthetic Clay Liner, HDPE Geomembrane, Geotextile, and Geocomposite) are installed. Lastly, a protective soil layer is placed over the geosynthetic materials. Outside of the cell area, additional construction may take place to install HDPE leachate force main, construct concrete headwalls, perimeter ditches, roads, etc. Following earthwork, disturbed areas will be seeded as needed.

Section 8: Certification and Notification

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 gathered and evaluated 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.

Name: Garrett Clemons Title: VP, EHS

Signature: Garrett Clemons Date: 4-17-19

SWP3 Appendices

The following documentations are attached to the SWP3:

Appendix A – Site Maps

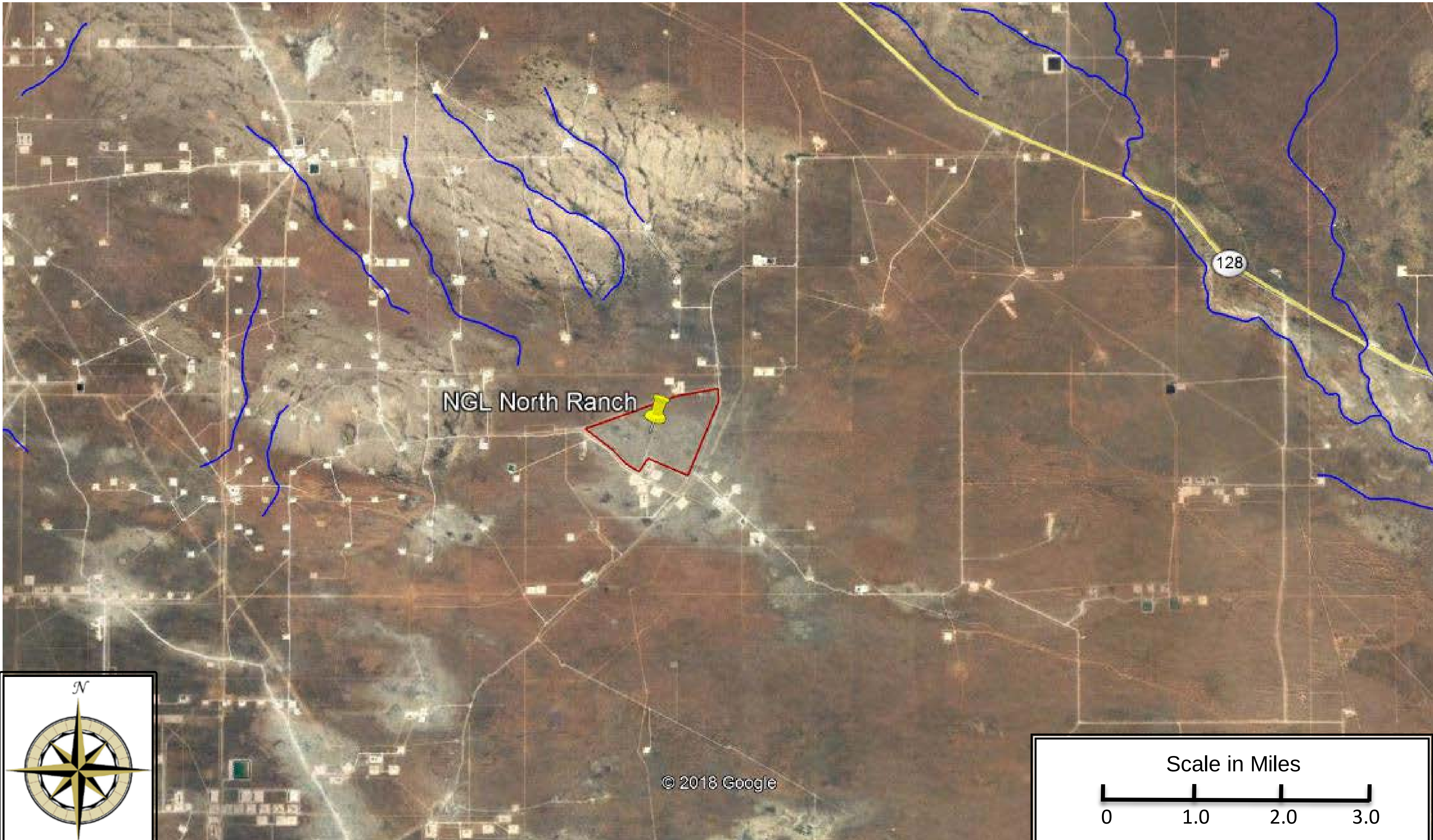
Appendix B – Construction General Permit

Appendix C – Notice of Intent (NOI)

Appendix D – Forms

Appendix E – Delegation of Authority.

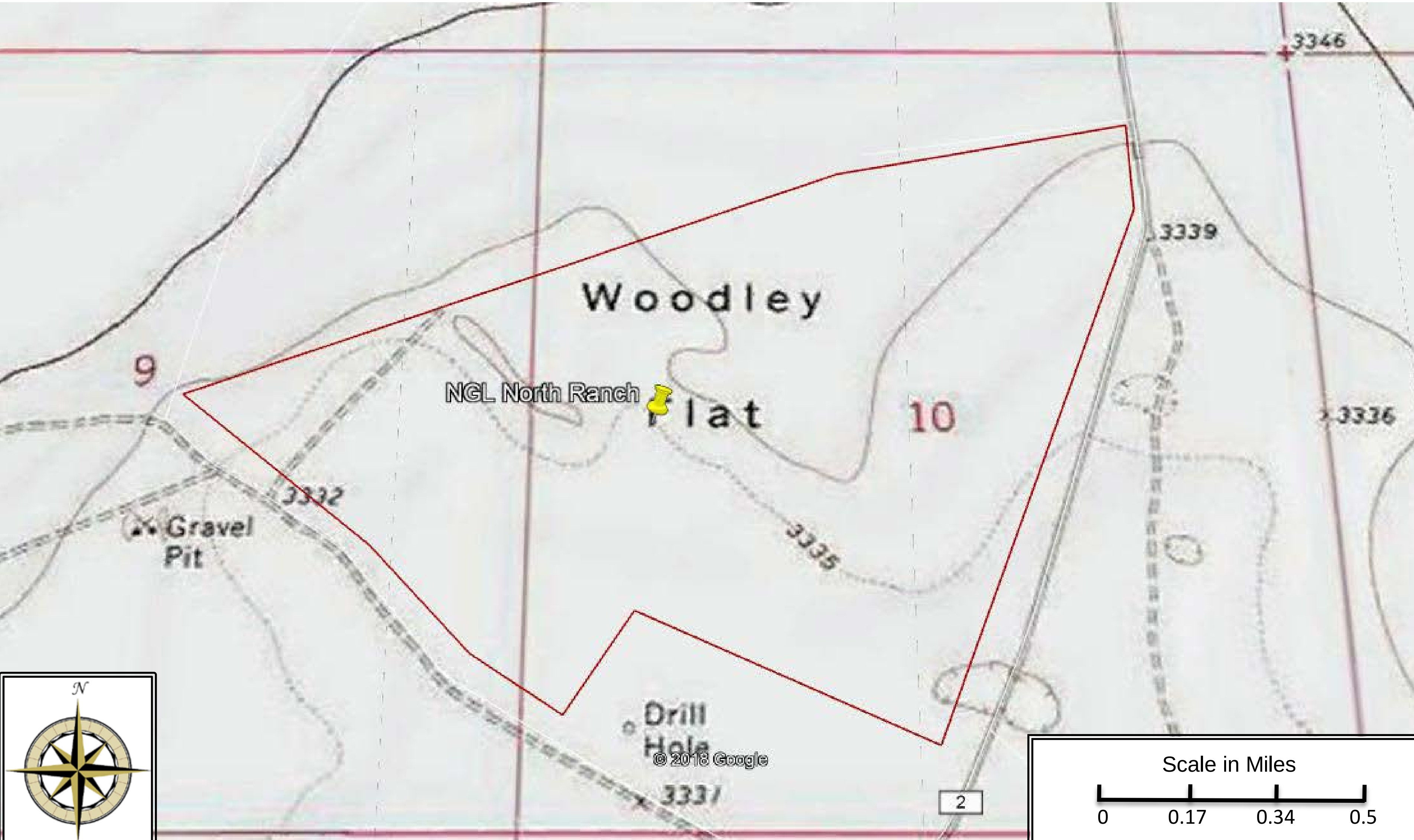
Appendix A
Site Maps



Site Location
NGL Waste Services, LLC
North Ranch SWMF
32.144875º / -103.462413º
Jal, New Mexico

BEAR CREEK CONSULTANTS
1320 E. 9th Street, Suite 2
Edmond, OK 73034

FIGURE 1
Google Earth Image
February 21, 2019



Topographic Map
NGL Waste Services, LLC
North Ranch SWMF
32.144875º / -103.462413º
Jal, New Mexico

BEAR CREEK CONSULTANTS
2524 N Broadway, Suite 317
Edmond, OK 73034

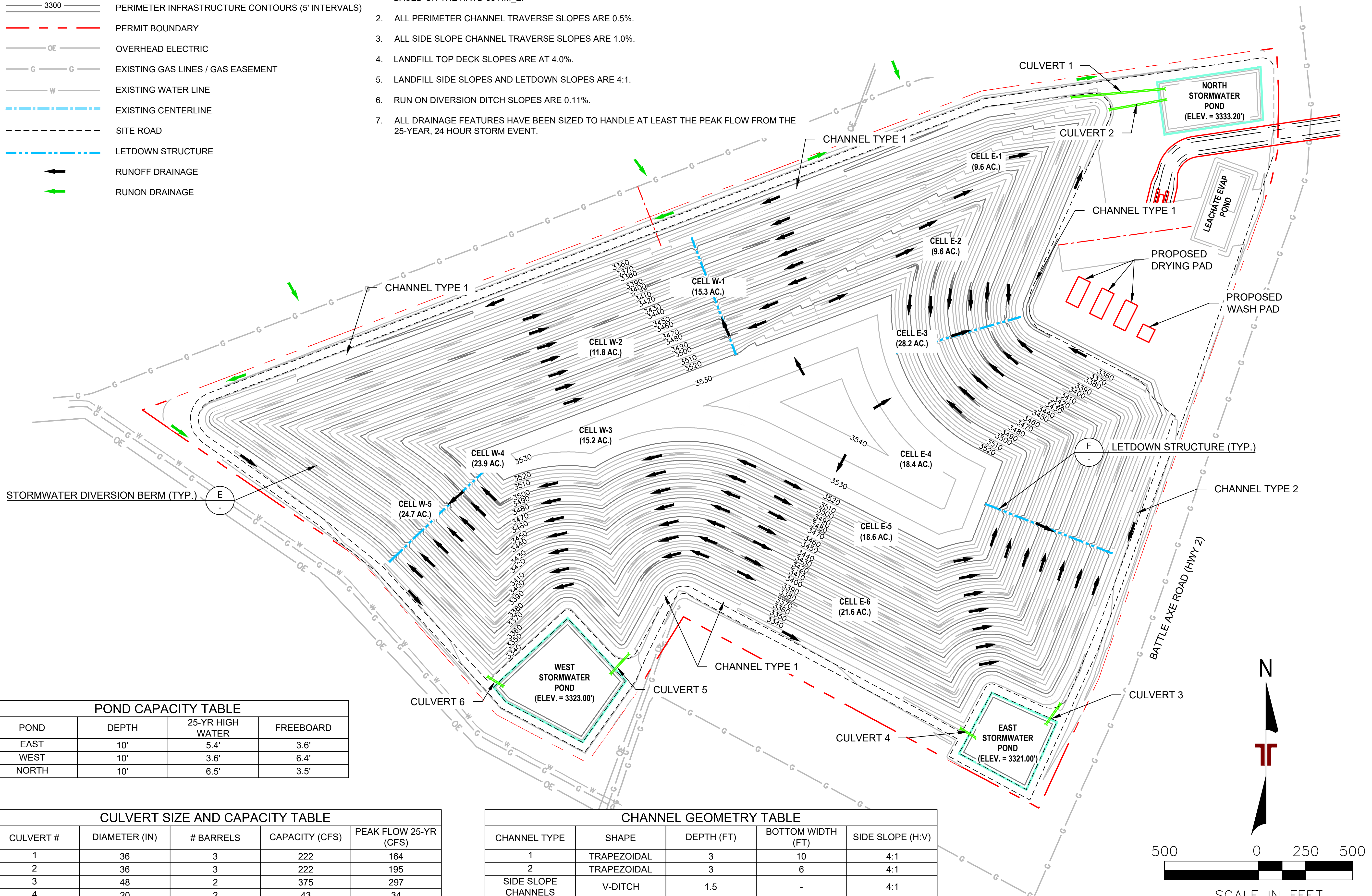
FIGURE 2
Topographic Map
April 15, 2019

LEGEND:

- 3300 — FINAL COVER CONTOURS (5' INTERVALS)
- 3300 — PERIMETER INFRASTRUCTURE CONTOURS (5' INTERVALS)
- PERMIT BOUNDARY
- OE — OVERHEAD ELECTRIC
- G — EXISTING GAS LINES / GAS EASEMENT
- W — EXISTING WATER LINE
- EXISTING CENTERLINE
- SITE ROAD
- LETDOWN STRUCTURE
- RUNOFF DRAINAGE
- RUNON DRAINAGE

NOTES:

1. EXISTING TOPOGRAPHY WAS PERFORMED NOVEMBER 30, 2018 AND VERTICAL ELEVATIONS ARE BASED ON THE NAVD 88 NM_E.
2. ALL PERIMETER CHANNEL TRAVERSE SLOPES ARE 0.5%.
3. ALL SIDE SLOPE CHANNEL TRAVERSE SLOPES ARE 1.0%.
4. LANDFILL TOP DECK SLOPES ARE AT 4.0%.
5. LANDFILL SIDE SLOPES AND LETDOWN SLOPES ARE 4:1.
6. RUN ON DIVERSION DITCH SLOPES ARE 0.11%.
7. ALL DRAINAGE FEATURES HAVE BEEN SIZED TO HANDLE AT LEAST THE PEAK FLOW FROM THE 25-YEAR, 24 HOUR STORM EVENT.



POND CAPACITY TABLE

POND	DEPTH	25-YR HIGH WATER	FREEBOARD
EAST	10'	5.4'	3.6'
WEST	10'	3.6'	6.4'
NORTH	10'	6.5'	3.5'

CULVERT SIZE AND CAPACITY TABLE

CULVERT #	DIAMETER (IN)	# BARRELS	CAPACITY (CFS)	PEAK FLOW 25-YR (CFS)
1	36	3	222	164
2	36	3	222	195
3	48	2	375	297
4	20	2	43	34
5	20	2	34	13
6	48	2	350	304

CHANNEL GEOMETRY TABLE

CHANNEL TYPE	SHAPE	DEPTH (FT)	BOTTOM WIDTH (FT)	SIDE SLOPE (H:V)
1	TRAPEZOIDAL	3	10	4:1
2	TRAPEZOIDAL	3	6	4:1
SIDE SLOPE CHANNELS	V-DITCH	1.5	-	4:1
ALL LET DOWN CHANNEL	TRAPEZOIDAL	2	10	3:1
RUNON CHANNEL	TRAPEZOIDAL	4	7	4:1

N:\GEC\ARCHIVE\CAD\572\002\MCCLOY\PERMIT DRAWINGS\5-FINAL DRAINAGE.DWG

REV	DATE	BY	DESCRIPTION

FINAL DRAINAGE
PERMIT DRAWING
SURFACE WASTE MANAGEMENT FACILITY
NORTH RANCH
LEA COUNTY NEW MEXICO

Terracon
Consulting Engineers and Scientists
25809 I-30 SOUTH BRYANT, AR 72022
PH. (501) 847-9292 FAX. (501) 847-9210

DRAWING 4

DESIGNED BY:	MPB
DRAWN BY:	DEW
APPVD. BY:	MPB
SCALE:	SEE SCALEBAR
DATE:	APRIL 2019
JOB NO.	572-002-35187378
ACAD NO.	005
SHEET NO.:	4 OF XX

Appendix B
Construction General Permit

National Pollutant Discharge Elimination System
General Permit for Discharges from
Construction Activities

In compliance with the provisions of the Clean Water Act, 33 U.S.C. §1251 et. seq., (hereafter CWA), as amended by the Water Quality Act of 1987, P.L. 100-4, "operators" of construction activities (defined in Appendix A) that meet the requirements of Part 1.1 of this National Pollutant Discharge Elimination System (NPDES) general permit, are authorized to discharge pollutants in accordance with the effluent limitations and conditions set forth herein. Permit coverage is required from the "commencement of construction activities" (see Appendix A) until one of the conditions for terminating CGP coverage has been met (see Part 8.2).

This permit becomes effective on **February 16, 2017**.

This permit and the authorization to discharge expire at 11:59pm, **February 16, 2022.**

Signed and issued this 11th day of January 2017

Deborah Szaro,
Acting Regional Administrator, EPA Region 1

Signed and issued this 11th day of January 2017

Javier Laureano, Ph.D.,
Director, Clean Water Division, EPA Region 2

Signed and issued this 11th day of January 2017

Jose C. Font,
Acting Director, Caribbean Environmental Protection Division, EPA Region 2.

Signed and issued this 11th day of January 2017

Dominique Lueckenhoff,
Acting Director, Water Protection Division, EPA Region 3

Signed and issued this 11th day of January 2017

César A. Zapata,
Deputy Director, Water Protection Division, EPA Region 4

Signed and issued this 11th day of January 2017

Christopher Korleski,
Director, Water Division, EPA Region 5

Signed and issued this 11th day of January 2017

William K. Honker, P.E.,
Director, Water Division, EPA Region 6

Signed and issued this 11th day of January 2017

Karen Flournoy,
Director, Water, Wetlands, and Pesticides Division, EPA Region 7

Signed and issued this 11th day of January 2017

Darcy O'Connor,
Assistant Regional Administrator, Office of Water Protection, EPA Region 8

Signed and issued this 11th day of January 2017

Kristin Gullatt
Deputy Director, Water Division, EPA Region 9

Signed and issued this 11th day of January 2017

Daniel D. Opalski,
Director, Office of Water and Watersheds, EPA Region 10

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1 HOW TO OBTAIN COVERAGE UNDER THE CONSTRUCTION GENERAL PERMIT (CGP)

To be covered under this permit, you must meet the eligibility conditions and follow the requirements for obtaining permit coverage in this Part.

1.1 ELIGIBILITY CONDITIONS

1.1.1 You are an "operator" of a construction site for which discharges will be covered under this permit. For the purposes of this permit and in the context of stormwater discharges associated with construction activity, an "operator" is any party associated with a construction project that meets either of the following two criteria:

a. The party has operational control over construction plans and specifications, including the ability to make modifications to those plans and specifications *(e.g., in most cases this is the owner of the site);* or

b. The party has day-to-day operational control of those activities at a project that are necessary to ensure compliance with the permit conditions *(e.g., they are authorized to direct workers at a site to carry out activities required by the permit; in most cases this is the general contractor (as defined in Appendix A) of the project)*.

Where there are multiple operators associated with the same project, all operators must obtain permit coverage.[1] Subcontractors generally are not considered operators for the purposes of this permit.

1.1.2 Your site's construction activities:

a. Will disturb one or more acres of land, or will disturb less than one acre of land but are part of a common plan of development or sale that will ultimately disturb one or more acres of land; or

b. Have been designated by EPA as needing permit coverage under 40 CFR 122.26(a)(1)(v) or 40 CFR 122.26(b)(15)(ii);

1.1.3 Your site is located in an area where EPA is the permitting authority (see Appendix B);

1.1.4 Discharges from your site are not:

a. Already covered by a different NPDES permit for the same discharge; or

b. In the process of having coverage under a different NPDES permit for the same discharge denied, terminated, or revoked.[2,3]

1.1.5 You are able to demonstrate that you meet one of the criteria listed in Appendix D with respect to the protection of species that are federally listed as endangered or threatened under the Endangered Species Act (ESA) and federally designated critical habitat;

[1] If the operator of a "construction support activity" (see Part 1.2.1c) is different than the operator of the main site, that operator must also obtain permit coverage. See Part 7.1 for clarification on the sharing of liability between and among operators on the same site and for conditions that apply to developing a SWPPP for multiple operators associated with the same site.

[2] Parts 1.1.4a and 1.1.4b do not include sites currently covered under the 2012 CGP that are in the process of obtaining coverage under this permit, nor sites covered under this permit that are transferring coverage to a different operator.

[3] Notwithstanding a site being made ineligible for coverage under this permit because it falls under the description of Parts 1.1.4a or 1.1.4b, above, EPA may waive the applicable eligibility requirement after specific review if it determines that coverage under this permit is appropriate.

1.1.6 You have completed the screening process in Appendix E relating to the protection of historic properties; and

1.1.7 You have complied with all requirements in Part 9 imposed by the applicable state, Indian tribe, or territory in which your construction activities and/or discharge will occur.

1.1.8 For "new sources" (as defined in Appendix A) only:

a. EPA has not, prior to authorization under this permit, determined that discharges from your site will cause, have the reasonable potential to cause, or contribute to an excursion above any applicable water quality standard. Where such a determination is made prior to authorization, EPA may notify you that an individual permit application is necessary. However, EPA may authorize your coverage under this permit after you have included appropriate controls and implementation procedures designed to bring your discharge into compliance with this permit, specifically the requirement to meet water quality standards. In the absence of information demonstrating otherwise, EPA expects that compliance with the requirements of this permit, including the requirements applicable to such discharges in Part 3, will result in discharges that will not cause, have the reasonable potential to cause, or contribute to an excursion above any applicable water quality standard.

b. Discharges from your site to a Tier 2, Tier 2.5, or Tier 3 water[4] will not lower the water quality of the applicable water. In the absence of information demonstrating otherwise, EPA expects that compliance with the requirements of this permit, including the requirements applicable to such discharges in Part 3.2, will result in discharges that will not lower the water quality of such waters.

1.1.9 If you plan to add "cationic treatment chemicals" (as defined in Appendix A) to stormwater and/or authorized non-stormwater prior to discharge, you may not submit your Notice of Intent (NOI) unless and until you notify your applicable EPA Regional Office (see Appendix L) in advance and the EPA Regional Office authorizes coverage under this permit after you have included appropriate controls and implementation procedures designed to ensure that your use of cationic treatment chemicals will not lead to discharges that cause an exceedance of water quality standards.

1.2 TYPES OF DISCHARGES AUTHORIZED[5]

1.2.1 The following stormwater discharges are authorized under this permit provided that appropriate stormwater controls are designed, installed, and maintained (see Parts 2 and 3):

a. Stormwater discharges, including stormwater runoff, snowmelt runoff, and surface runoff and drainage, associated with construction activity under 40 CFR 122.26(b)(14) or 122.26(b)(15)(i);

---

[4] Note: Your site will be considered to discharge to a Tier 2, Tier 2.5, or Tier 3 water if the first water to which you discharge is identified by a state, tribe, or EPA as a Tier 2, Tier 2.5, or Tier 3 water. For discharges that enter a storm sewer system prior to discharge, the first water of the U.S. to which you discharge is the waterbody that receives the stormwater discharge from the storm sewer system. See list of Tier 2, Tier 2.5, and Tier 3 waters in Appendix F.

[5] See "Discharge" as defined in Appendix A. Note: Any discharges not expressly authorized in this permit cannot become authorized or shielded from liability under CWA section 402(k) by disclosure to EPA, state, or local authorities after issuance of this permit via any means, including the Notice of Intent (NOI) to be covered by the permit, the SWPPP, or during an inspection.

b. Stormwater discharges designated by EPA as needing a permit under 40 CFR 122.26(a)(1)(v) or 122.26(b)(15)(ii);

c. Stormwater discharges from construction support activities *(e.g., concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, borrow areas)* provided that:

i. The support activity is directly related to the construction site required to have permit coverage for stormwater discharges;

ii. The support activity is not a commercial operation, nor does it serve multiple unrelated construction sites;

iii. The support activity does not continue to operate beyond the completion of the construction activity at the site it supports; and

iv. Stormwater controls are implemented in accordance with Part 2 and Part 3 for discharges from the support activity areas.

d. Stormwater discharges from earth-disturbing activities associated with the construction of staging areas and the construction of access roads conducted prior to active mining.

1.2.2 The following non-stormwater discharges associated with your construction activity are authorized under this permit provided that, with the exception of water used to control dust and to irrigate vegetation in stabilized areas, these discharges are not routed to areas of exposed soil on your site and you comply with any applicable requirements for these discharges in Parts 2 and 3:

a. Discharges from emergency fire-fighting activities;

b. Fire hydrant flushings;

c. Landscape irrigation;

d. Water used to wash vehicles and equipment, provided that there is no discharge of soaps, solvents, or detergents used for such purposes;

e. Water used to control dust;

f. Potable water including uncontaminated water line flushings;

g. External building washdown, provided soaps, solvents, and detergents are not used, and external surfaces do not contain hazardous substances (as defined in Appendix A) *(e.g., paint or caulk containing polychlorinated biphenyls (PCBs));*

h. Pavement wash waters, provided spills or leaks of toxic or hazardous substances have not occurred (unless all spill material has been removed) and where soaps, solvents, and detergents are not used. You are prohibited from directing pavement wash waters directly into any water of the U.S., storm drain inlet, or stormwater conveyance, unless the conveyance is connected to a sediment basin, sediment trap, or similarly effective control;

i. Uncontaminated air conditioning or compressor condensate;

j. Uncontaminated, non-turbid discharges of ground water or spring water;

k. Foundation or footing drains where flows are not contaminated with process materials such as solvents or contaminated ground water; and

l. Construction dewatering water discharged in accordance with Part 2.4.

1.2.3 Also authorized under this permit are discharges of stormwater listed above in Part 1.2.1, or authorized non-stormwater discharges listed above in Part 1.2.2, commingled with a discharge authorized by a different NPDES permit and/or a discharge that does not require NPDES permit authorization.

1.3 PROHIBITED DISCHARGES[6]

1.3.1 Wastewater from washout of concrete, unless managed by an appropriate control as described in Part 2.3.4;

1.3.2 Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds, and other construction materials;

1.3.3 Fuels, oils, or other pollutants used in vehicle and equipment operation and maintenance;

1.3.4 Soaps, solvents, or detergents used in vehicle and equipment washing or external building washdown; and

1.3.5 Toxic or hazardous substances from a spill or other release.

To prevent the above-listed prohibited non-stormwater discharges, operators must comply with the applicable pollution prevention requirements in Part 2.3.

1.4 SUBMITTING YOUR NOTICE OF INTENT (NOI)

All "operators" (as defined in Appendix A) associated with your construction site, who meet the Part 1.1 eligibility requirements, and who seek coverage under this permit, must submit to EPA a complete and accurate NOI in accordance with the deadlines in **Table 1** prior to commencing construction activities.

Exception: If you are conducting construction activities in response to a public emergency *(e.g., mud slides, earthquake, extreme flooding conditions, widespread disruption in essential public services)*, and the related work requires immediate authorization to avoid imminent endangerment to human health, public safety, or the environment, or to reestablish essential public services, you may discharge on the condition that a complete and accurate NOI is submitted within 30 calendar days after commencing construction activities (see Table 1) establishing that you are eligible for coverage under this permit. You must also provide documentation in your Stormwater Pollution Prevention Plan (SWPPP) to substantiate the occurrence of the public emergency.

1.4.1 Prerequisite for Submitting Your NOI

You must develop a SWPPP consistent with Part 7 before submitting your NOI for coverage under this permit.

1.4.2 How to Submit Your NOI

You must use EPA's NPDES eReporting Tool (NeT) to electronically prepare and submit your NOI for coverage under the 2017 CGP, unless you received a waiver from your EPA Regional Office.

To access NeT, go to https://www.epa.gov/npdes/stormwater-discharges-construction-activities#ereporting.

[6] EPA includes these prohibited non-stormwater discharges here as a reminder to the operator that the only non-stormwater discharges authorized by this permit are at Part 1.2.2. Any unauthorized non-stormwater discharges must be covered under an individual permit or alternative general permit.

Waivers from electronic reporting may be granted based on one of the following conditions:

a. If your operational headquarters is physically located in a geographic area (*i.e., ZIP code or census tract*) that is identified as under-served for broadband Internet access in the most recent report from the Federal Communications Commission; or

b. If you have limitations regarding available computer access or computer capability.

If the EPA Regional Office grants you approval to use a paper NOI, and you elect to use it, you must complete the form in Appendix J.

1.4.3 Deadlines for Submitting Your NOI and Your Official Date of Permit Coverage

Table 1 provides the deadlines for submitting your NOI and the official start date of your permit coverage, which differ depending on when you commence construction activities.

Table 1 NOI Submittal Deadlines and Official Start Date for Permit Coverage.

Type of Operator	**NOI Submittal Deadline**[7]	**Permit Authorization Date**[8]
Operator of a new site (*i.e., a site where construction activities commence on or after February 16, 2017*)	At least 14 calendar days before commencing construction activities.	14 calendar days after EPA notifies you that it has received a complete NOI, unless EPA notifies you that your authorization is delayed or denied.
Operator of an existing site (*i.e., a site with 2012 CGP coverage where construction activities commenced prior to February 16, 2017*)	No later than **May 17, 2017**.	
New operator of a permitted site (*i.e., an operator that through transfer of ownership and/or operation replaces the operator of an already permitted construction site that is either a "new site" or an "existing site"*)	At least 14 calendar days before the date the transfer to the new operator will take place.	
Operator of an "emergency-related project" (*i.e., a project initiated in response to a public emergency (e.g., mud slides, earthquake, extreme flooding conditions, disruption in essential public services), for which the related work requires immediate authorization to avoid imminent endangerment to human health or the environment, or to reestablish essential public services*)	No later than 30 calendar days after commencing construction activities.	You are considered provisionally covered under the terms and conditions of this permit immediately, and fully covered 14 calendar days after EPA notifies you that it has received a complete NOI, unless EPA notifies you that your authorization is delayed or denied.

[7] If you miss the deadline to submit your NOI, any and all discharges from your construction activities will continue to be unauthorized under the CWA until they are covered by this or a different NPDES permit. EPA may take enforcement action for any unpermitted discharges that occur between the commencement of construction activities and discharge authorization.

[8] Discharges are not authorized if your NOI is incomplete or inaccurate or if you are not eligible for permit coverage.

1.4.4 Modifying your NOI

If after submitting your NOI you need to correct or update any fields, you may do so by submitting a "Change NOI" form using NeT. Waivers from electronic reporting may be granted as specified in Part 1.4.1. If the EPA Regional Office has granted you approval to submit a paper NOI modification, you may indicate any NOI changes on the same NOI form in Appendix J.

When there is a change to the site's operator, the new operator must submit a new NOI, and the previous operator must submit a Notice of Termination (NOT) form as specified in Part 8.3.

1.4.5 Your Official End Date of Permit Coverage

Once covered under this permit, your coverage will last until the date that:

a. You terminate permit coverage consistent with Part 8; or

b. You receive permit coverage under a different NPDES permit or a reissued or replacement version of this permit after expiring on February 16, 2022; or

c. You fail to submit an NOI for coverage under a revised or replacement version of this permit before the deadline for existing construction sites where construction activities continue after this permit has expired.

1.5 REQUIREMENT TO POST A NOTICE OF YOUR PERMIT COVERAGE

You must post a sign or other notice of your permit coverage at a safe, publicly accessible location in close proximity to the construction site. The notice must be located so that it is visible from the public road that is nearest to the active part of the construction site, and it must use a font large enough to be readily viewed from a public right-of-way.[9] At a minimum, the notice must include:

a. The NPDES ID (*i.e., permit tracking number assigned to your NOI*);

b. A contact name and phone number for obtaining additional construction site information;

c. The Uniform Resource Locator (URL) for the SWPPP (if available), or the following statement: "If you would like to obtain a copy of the Stormwater Pollution Prevention Plan (SWPPP) for this site, contact the EPA Regional Office at [*include the appropriate CGP Regional Office contact information found at https://www.epa.gov/npdes/contact-us-stormwater#regional*];" and

d. The following statement "If you observe indicators of stormwater pollutants in the discharge or in the receiving waterbody, contact the EPA through the following website: https://www.epa.gov/enforcement/report-environmental-violations."

[9] If the active part of the construction site is not visible from a public road, then place the notice of permit coverage in a position that is visible from the nearest public road and as close as possible to the construction site.

2 TECHNOLOGY-BASED EFFLUENT LIMITATIONS

You must comply with the following technology-based effluent limitations in this Part for all authorized discharges.[10]

2.1 GENERAL STORMWATER CONTROL DESIGN, INSTALLATION, AND MAINTENANCE REQUIREMENTS

You must design, install, and maintain stormwater controls required in Parts 2.2 and 2.3 to minimize the discharge of pollutants in stormwater from construction activities. To meet this requirement, you must:

2.1.1 Account for the following factors in designing your stormwater controls:

a. The expected amount, frequency, intensity, and duration of precipitation;

b. The nature of stormwater runoff and run-on at the site, including factors such as expected flow from impervious surfaces, slopes, and site drainage features. You must design stormwater controls to control stormwater volume, velocity, and peak flow rates to minimize discharges of pollutants in stormwater and to minimize channel and streambank erosion and scour in the immediate vicinity of discharge points; and

c. The soil type and range of soil particle sizes expected to be present on the site.

2.1.2 Design and install all stormwater controls in accordance with good engineering practices, including applicable design specifications.[11]

2.1.3 Complete installation of stormwater controls by the time each phase of construction activities has begun.

a. By the time construction activity in any given portion of the site begins, install and make operational any downgradient sediment controls (*e.g., buffers, perimeter controls, exit point controls, storm drain inlet protection*) that control discharges from the initial site clearing, grading, excavating, and other earth-disturbing activities.[12]

b. Following the installation of these initial controls, install and make operational all stormwater controls needed to control discharges prior to subsequent earth-disturbing activities.

[10] For each of the effluent limits in Part 2, as applicable to your site, you must include in your SWPPP (1) a description of the specific control(s) to be implemented to meet the effluent limit; (2) any applicable design specifications; (3) routine maintenance specifications; and (4) the projected schedule for its (their) installation/implementation. See Part 7.2.6.

[11] Design specifications may be found in manufacturer specifications and/or in applicable erosion and sediment control manuals or ordinances. Any departures from such specifications must reflect good engineering practices and must be explained in your SWPPP. You must also comply with any additional design and installation requirements specified for the effluent limits in Parts 2.2 and 2.3.

[12] Note that the requirement to install stormwater controls prior to each phase of construction activities for the site does not apply to the earth disturbance associated with the actual installation of these controls. Operators should take all reasonable actions to minimize the discharges of pollutants during the installation of stormwater controls.

2.1.4 Ensure that all stormwater controls are maintained and remain in effective operating condition during permit coverage and are protected from activities that would reduce their effectiveness.

a. Comply with any specific maintenance requirements for the stormwater controls listed in this permit, as well as any recommended by the manufacturer.[13]

b. If at any time you find that a stormwater control needs routine maintenance, you must immediately initiate the needed maintenance work, and complete such work by the close of the next business day.

c. If at any time you find that a stormwater control needs repair or replacement, you must comply with the corrective action requirements in Part 5.

2.2 EROSION AND SEDIMENT CONTROL REQUIREMENTS

You must implement erosion and sediment controls in accordance with the following requirements to minimize the discharge of pollutants in stormwater from construction activities.

2.2.1 Provide and maintain natural buffers and/or equivalent erosion and sediment controls when a water of the U.S. is located within 50 feet of the site's earth disturbances.

a. **Compliance Alternatives.** For any discharges to waters of the U.S. located within 50 feet of your site's earth disturbances, you must comply with one of the following alternatives:

   i. Provide and maintain a 50-foot undisturbed natural buffer; or

   ii. Provide and maintain an undisturbed natural buffer that is less than 50 feet and is supplemented by erosion and sediment controls that achieve, in combination, the sediment load reduction equivalent to a 50-foot undisturbed natural buffer; or

   iii. If infeasible to provide and maintain an undisturbed natural buffer of any size, implement erosion and sediment controls to achieve the sediment load reduction equivalent to a 50-foot undisturbed natural buffer.

   See Appendix G, Part G.2 for additional conditions applicable to each compliance alternative.

b. **Exceptions.** See Appendix G, Part G.2 for exceptions to the compliance alternatives.

2.2.2 Direct stormwater to vegetated areas and maximize stormwater infiltration and filtering to reduce pollutant discharges, unless infeasible.

2.2.3 Install sediment controls along any perimeter areas of the site that will receive pollutant discharges.[14]

a. Remove sediment before it has accumulated to one-half of the above-ground height of any perimeter control.

b. **Exception**. For areas at "linear construction sites" (as defined in Appendix A) where perimeter controls are infeasible *(e.g., due to a limited or restricted right-of-way),*

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[13] Any departures from such maintenance recommendations made by the manufacturer must reflect good engineering practices and must be explained in your SWPPP.

[14] Examples of perimeter controls include filter berms, silt fences, vegetative strips, and temporary diversion dikes.

implement other practices as necessary to minimize pollutant discharges to perimeter areas of the site.

2.2.4 Minimize sediment track-out.

a. **Restrict vehicle use to properly designated exit points;**

b. Use appropriate stabilization techniques[15] at all points that exit onto paved roads.

   i. **Exception**: Stabilization is not required for exit points at linear utility construction sites that are used only episodically and for very short durations over the life of the project, provided other exit point controls[16] are implemented to minimize sediment track-out;

c. Implement additional track-out controls[17] as necessary to ensure that sediment removal occurs prior to vehicle exit; and

d. Where sediment has been tracked-out from your site onto paved roads, sidewalks, or other paved areas outside of your site, remove the deposited sediment by the end of the same business day in which the track-out occurs or by the end of the next business day if track-out occurs on a non-business day. Remove the track-out by sweeping, shoveling, or vacuuming these surfaces, or by using other similarly effective means of sediment removal. You are prohibited from hosing or sweeping tracked-out sediment into any stormwater conveyance, storm drain inlet, or water of the U.S.[18]

2.2.5 Manage stockpiles or land clearing debris piles composed, in whole or in part, of sediment and/or soil:

a. Locate the piles outside of any natural buffers established under Part 2.2.1 and away from any stormwater conveyances, drain inlets, and areas where stormwater flow is concentrated;

b. Install a sediment barrier along all downgradient perimeter areas;[19]

c. For piles that will be unused for 14 or more days, provide cover[20] or appropriate temporary stabilization (consistent with Part 2.2.14);

d. You are prohibited from hosing down or sweeping soil or sediment accumulated on pavement or other impervious surfaces into any stormwater conveyance, storm drain inlet, or water of the U.S.

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[15] Examples of appropriate stabilization techniques include the use of aggregate stone with an underlying geotextile or non-woven filter fabric, and turf mats.

[16] Examples of other exit point controls include preventing the use of exit points during wet periods; minimizing exit point use by keeping vehicles on site to the extent possible; limiting exit point size to the width needed for vehicle and equipment usage; using scarifying and compaction techniques on the soil; and avoiding establishing exit points in environmentally sensitive areas (*e.g., karst areas; steep slopes)*.

[17] Examples of additional track-out controls include the use of wheel washing, rumble strips, and rattle plates.

[18] Fine grains that remain visible *(i.e., staining)* on the surfaces of off-site streets, other paved areas, and sidewalks after you have implemented sediment removal practices are not a violation of Part 2.2.4.

[19] Examples of sediment barriers include berms, dikes, fiber rolls, silt fences, sandbags, gravel bags, or straw bale.

[20] Examples of cover include tarps, blown straw and hydroseeding.

2.2.6 Minimize dust. On areas of exposed soil, minimize the generation of dust through the appropriate application of water or other dust suppression techniques.

2.2.7 Minimize steep slope disturbances. Minimize the disturbance of "steep slopes" (as defined in Appendix A).

2.2.8 Preserve native topsoil, unless infeasible.[21]

2.2.9 Minimize soil compaction.[22] In areas of your site where final vegetative stabilization will occur or where infiltration practices will be installed:

a. Restrict vehicle and equipment use in these locations to avoid soil compaction; and

b. Before seeding or planting areas of exposed soil that have been compacted, use techniques that rehabilitate and condition the soils as necessary to support vegetative growth.

2.2.10 Protect storm drain inlets.

a. Install inlet protection measures that remove sediment from discharges prior to entry into any storm drain inlet that carries stormwater flow from your site to a water of the U.S., provided you have authority to access the storm drain inlet;[23] and

b. Clean, or remove and replace, the protection measures as sediment accumulates, the filter becomes clogged, and/or performance is compromised. Where there is evidence of sediment accumulation adjacent to the inlet protection measure, remove the deposited sediment by the end of the same business day in which it is found or by the end of the following business day if removal by the same business day is not feasible.

2.2.11 Minimize erosion of stormwater conveyance channels and their embankments, outlets, adjacent streambanks, slopes, and downstream waters. Use erosion controls and velocity dissipation devices[24] within and along the length of any stormwater conveyance channel and at any outlet to slow down runoff to minimize erosion.

2.2.12 If you install a sediment basin or similar impoundment:

a. Situate the basin or impoundment outside of any water of the U.S. and any natural buffers established under Part 2.2.1;

b. Design the basin or impoundment to avoid collecting water from wetlands;

c. Design the basin or impoundment to provide storage for either:

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[21] Stockpiling topsoil at off-site locations, or transferring topsoil to other locations, is an example of a practice that is consistent with the requirements in Part 2.2.8. Preserving native topsoil is not required where the intended function of a specific area of the site dictates that the topsoil be disturbed or removed. For example, some sites may be designed to be highly impervious after construction, and therefore little or no vegetation is intended to remain, or may not have space to stockpile native topsoil on site for later use, in which case, it may not be feasible to preserve topsoil.

[22] Minimizing soil compaction is not required where the intended function of a specific area of the site dictates that it be compacted.

[23] Inlet protection measures can be removed in the event of flood conditions or to prevent erosion.

[24] Examples of velocity dissipation devices include check dams, sediment traps, riprap, and grouted riprap at outlets.

ii. The calculated volume of runoff from a 2-year, 24-hour storm (see Appendix H); or

iii. 3,600 cubic feet per acre drained.

d. Utilize outlet structures that withdraw water from the surface of the sediment basin or similar impoundment, unless infeasible;[25]

e. Use erosion controls and velocity dissipation devices to prevent erosion at inlets and outlets; and

f. Remove accumulated sediment to maintain at least one-half of the design capacity and conduct all other appropriate maintenance to ensure the basin or impoundment remains in effective operating condition.

2.2.13 If using treatment chemicals (*e.g., polymers, flocculants, coagulants*):

a. **Use conventional erosion and sediment controls before and after the application of treatment chemicals.** Chemicals may only be applied where treated stormwater is directed to a sediment control *(e.g., sediment basin, perimeter control)* before discharge.

b. **Select appropriate treatment chemicals**. Chemicals must be appropriately suited to the types of soils likely to be exposed during construction and present in the discharges being treated *(i.e., the expected turbidity, pH, and flow rate of stormwater flowing into the chemical treatment system or area)*.

c. **Minimize discharge risk from stored chemicals.** Store all treatment chemicals in leak-proof containers that are kept under storm-resistant cover and surrounded by secondary containment structures *(e.g., spill berms, decks, spill containment pallets)*, or provide equivalent measures designed and maintained to minimize the potential discharge of treatment chemicals in stormwater or by any other means *(e.g., storing chemicals in a covered area, having a spill kit available on site and ensuring personnel are available to respond expeditiously in the event of a leak or spill)*.

d. **Comply with state/local requirements.** Comply with applicable state and local requirements regarding the use of treatment chemicals.

e. **Use chemicals in accordance with good engineering practices and specifications of the chemical provider/supplier.** Use treatment chemicals and chemical treatment systems in accordance with good engineering practices, and with dosing specifications and sediment removal design specifications provided by the provider/supplier of the applicable chemicals, or document in your SWPPP specific departures from these specifications and how they reflect good engineering practice.

f. **Ensure proper training.** Ensure that all persons who handle and use treatment chemicals at the construction site are provided with appropriate, product-specific training. Among other things, the training must cover proper dosing requirements.

g. **Perform additional measures specified by the EPA Regional Office for the authorized use of cationic chemicals.** If you have been authorized to use cationic chemicals at your site pursuant to Part 1.1.9, you must perform all additional measures as

[25] The circumstances in which it is infeasible to design outlet structures in this manner are rare. Exceptions may include areas with extended cold weather, where using surface outlets may not be feasible during certain time periods (although they must be used during other periods). If you determine that it is infeasible to meet this requirement, you must provide documentation in your SWPPP to support your determination, including the specific conditions or time periods when this exception will apply.

conditioned by your authorization to ensure that the use of such chemicals will not cause an exceedance of water quality standards.

2.2.14 Stabilize exposed portions of the site. Implement and maintain stabilization measures (e.g., seeding protected by erosion controls until vegetation is established, sodding, mulching, erosion control blankets, hydromulch, gravel) that minimize erosion from exposed portions of the site in accordance with Parts 2.2.14a and 2.2.14b.

a. **Stabilization Deadlines:**[26]

Total Amount of Land Disturbance Occurring At Any One Time[27]	**Deadline**
i. **Five acres or less (≤5.0)** **Note: this includes sites disturbing more than five acres (>5.0) total over the course of a project, but that limit disturbance at any one time *(i.e., phase the disturbance)* to five acres or less (≤5.0)**	• Initiate the installation of stabilization measures immediately[28] in any areas of exposed soil where construction activities have permanently ceased or will be temporarily inactive for 14 or more calendar days;[29] and • Complete the installation of stabilization measures as soon as practicable, but no later than 14 calendar days after stabilization has been initiated.[30]

[26] EPA may determine, based on an inspection carried out under Part 4.8 and corrective actions required under Part 5.3, that the level of sediment discharge on the site makes it necessary to require a faster schedule for completing stabilization. For instance, if sediment discharges from an area of exposed soil that is required to be stabilized are compromising the performance of existing stormwater controls, EPA may require stabilization to correct this problem.

[27] Limiting disturbances to five (5) acres or less at any one time means that at no time during the project do the cumulative earth disturbances exceed five (5) acres. The following examples would qualify as limiting disturbances at any one time to five (5) acres or less:

1. The total area of disturbance for a project is five (5) acres or less.
2. The total area of disturbance for a project will exceed five (5) acres, but the operator ensures that no more than five (5) acres will be disturbed at any one time through implementation of stabilization measures. In this way, site stabilization can be used to "free up" land that can be disturbed without exceeding the five (5)-acre cap to qualify for the 14-day stabilization deadline. For instance, if an operator completes stabilization of two (2) acres of land on a five (5)-acre disturbance, then two (2) additional acres could be disturbed while still qualifying for the longer 14-day stabilization deadline.

[28] The following are examples of activities that would constitute the immediate initiation of stabilization:

1. Prepping the soil for vegetative or non-vegetative stabilization as long as seeding, planting, and/or installation of non-vegetative stabilization products takes place as soon as practicable, but no later than one (1) calendar day of completing soil preparation;
2. Applying mulch or other non-vegetative product to the exposed area;
3. Seeding or planting the exposed area;
4. Starting any of the activities in # 1 – 3 on a portion of the entire area that will be stabilized; and
5. Finalizing arrangements to have stabilization product fully installed in compliance with the deadlines for completing stabilization.

[29] The requirement to initiate stabilization immediately is triggered as soon as you know that construction work on a portion of the site is temporarily ceased and will not resume for 14 or more days, or as soon as you know that construction work is permanently ceased. In the context of this provision, "immediately" means as soon as practicable, but no later than the end of the next business day, following the day when the construction activities have temporarily or permanently ceased.

[30] If vegetative stabilization measures are being implemented, stabilization is considered "installed" when all activities necessary to seed or plant the area are completed. If non-vegetative stabilization measures are being implemented, stabilization is considered "installed" when all such measures are implemented or applied.

Total Amount of Land Disturbance Occurring At Any One Time[27]	Deadline
ii. **More than five acres (>5.0)**	• Initiate the installation of stabilization measures immediately[31] in any areas of exposed soil where construction activities have permanently ceased or will be temporarily inactive for 14 or more calendar days;[32] and • Complete the installation of stabilization measures as soon as practicable, but no later than seven (7) calendar days after stabilization has been initiated.[33]

iii. **Exceptions:**

(a) Arid, semi-arid, and drought-stricken areas (as defined in Appendix A)**.** If it is the seasonally dry period or a period in which drought is occurring, and vegetative stabilization measures are being used:

(i) Immediately initiate and, within 14 calendar days of a temporary or permanent cessation of work in any portion of your site, complete the installation of temporary non-vegetative stabilization measures to the extent necessary to prevent erosion;

(ii) As soon as practicable, given conditions or circumstances on the site, complete all activities necessary to seed or plant the area to be stabilized; and

(iii) If construction is occurring during the seasonally dry period, indicate in your SWPPP the beginning and ending dates of the seasonally dry period and your site conditions. Also include the schedule you will follow for initiating and completing vegetative stabilization.

(b) Operators that are affected by unforeseen circumstances[34] that delay the initiation and/or completion of vegetative stabilization:

(i) Immediately initiate and, within 14 calendar days, complete the installation of temporary non-vegetative stabilization measures to prevent erosion;

(ii) Complete all soil conditioning, seeding, watering or irrigation installation, mulching, and other required activities related to the planting and initial establishment of vegetation as soon as conditions or circumstances allow it on your site; and

(iii) Document in the SWPPP the circumstances that prevent you from meeting the deadlines in Part 2.2.14a and the schedule you will follow for initiating and completing stabilization.

(c) Discharges to a sediment- or nutrient-impaired water or to a water that is identified by your state, tribe, or EPA as Tier 2, Tier 2.5, or Tier 3 for antidegradation purposes. Complete stabilization as soon as practicable, but no later than seven (7) calendar days after stabilization has been initiated.

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[31] See footnote 27

[32] See footnote 28

[33] See footnote 29

[34] Examples include problems with the supply of seed stock or with the availability of specialized equipment and unsuitability of soil conditions due to excessive precipitation and/or flooding.

b. **Final Stabilization Criteria** (for any areas not covered by permanent structures)**:**

i. Establish uniform, perennial vegetation *(i.e., evenly distributed, without large bare areas)* that provides 70 percent or more of the cover that is provided by vegetation native to local undisturbed areas; and/or

ii. Implement permanent non-vegetative stabilization measures[35] to provide effective cover.

iii. **Exceptions:**

(a) Arid, semi-arid, and drought-stricken areas (as defined in Appendix A). Final stabilization is met if the area has been seeded or planted to establish vegetation that provides 70 percent or more of the cover that is provided by vegetation native to local undisturbed areas within three (3) years and, to the extent necessary to prevent erosion on the seeded or planted area, non-vegetative erosion controls have been applied that provide cover for at least three years without active maintenance.

(b) Disturbed areas on agricultural land that are restored to their preconstruction agricultural use. The Part 2.2.14b final stabilization criteria does not apply.

(c) Areas that need to remain disturbed. In limited circumstances, stabilization may not be required if the intended function of a specific area of the site necessitates that it remain disturbed, and only the minimum area needed remains disturbed *(e.g., dirt access roads, utility pole pads, areas being used for storage of vehicles, equipment, materials)*.

2.3 POLLUTION PREVENTION REQUIREMENTS[36]

You must implement pollution prevention controls in accordance with the following requirements to minimize the discharge of pollutants in stormwater and to prevent the discharge of pollutants from spilled or leaked materials from construction activities.

2.3.1 For equipment and vehicle fueling and maintenance:

a. Provide an effective means of eliminating the discharge of spilled or leaked chemicals, including fuels and oils, from these activities;[37]

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[35] Examples of permanent non-vegetative stabilization measures include riprap, gravel, gabions, and geotextiles.

[36] Under this permit, you are not required to minimize exposure for any products or materials where the exposure to precipitation and to stormwater will not result in a discharge of pollutants, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use).

[37] Examples of effective means include:

- Locating activities away from waters of the U.S. and stormwater inlets or conveyances so that stormwater coming into contact with these activities cannot reach waters of the U.S.;
- Providing secondary containment (*e.g., spill berms, decks, spill containment pallets*) and cover where appropriate; and
- Having a spill kit available on site and ensuring personnel are available to respond expeditiously in the event of a leak or spill.

b. If applicable, comply with the Spill Prevention Control and Countermeasures (SPCC) requirements in 40 CFR part 112 and Section 311 of the CWA;

c. Ensure adequate supplies are available at all times to handle spills, leaks, and disposal of used liquids;

d. Use drip pans and absorbents under or around leaky vehicles;

e. Dispose of or recycle oil and oily wastes in accordance with other federal, state, tribal, or local requirements; and

f. Clean up spills or contaminated surfaces immediately, using dry clean up measures (do not clean contaminated surfaces by hosing the area down), and eliminate the source of the spill to prevent a discharge or a continuation of an ongoing discharge.

2.3.2 For equipment and vehicle washing:

a. Provide an effective means of minimizing the discharge of pollutants from equipment and vehicle washing, wheel wash water, and other types of wash waters;[38]

b. Ensure there is no discharge of soaps, solvents, or detergents in equipment and vehicle wash water; and

c. For storage of soaps, detergents, or solvents, provide either (1) cover *(e.g., plastic sheeting, temporary roofs)* to minimize the exposure of these detergents to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas.

2.3.3 For storage, handling, and disposal of building products, materials, and wastes:

a. *For building materials and building products*[39], provide either (1) cover (*e.g., plastic sheeting, temporary roofs*) to minimize the exposure of these products to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas.

b. *For pesticides, herbicides, insecticides, fertilizers, and landscape materials:*

   i. In storage areas, provide either (1) cover (*e.g., plastic sheeting, temporary roofs*) to minimize the exposure of these chemicals to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas; and

   ii. Comply with all application and disposal requirements included on the registered pesticide, herbicide, insecticide, and fertilizer label (see also Part 2.3.5).

c. *For diesel fuel, oil, hydraulic fluids, other petroleum products, and other chemicals*:

   i. Store chemicals in water-tight containers, and provide either (1) cover *(e.g., plastic sheeting, temporary roofs)* to minimize the exposure of these containers to precipitation and to stormwater, or (2) a similarly effective means designed to minimize the discharge of pollutants from these areas *(e.g., having a spill kit available on site and ensuring personnel are available to respond expeditiously in*

[38] Examples of effective means include locating activities away from waters of the U.S. and stormwater inlets or conveyances and directing wash waters to a sediment basin or sediment trap, using filtration devices, such as filter bags or sand filters, or using other similarly effective controls.

[39] Examples of building materials and building products typically present at construction sites include asphalt sealants, copper flashing, roofing materials, adhesives, concrete admixtures, and gravel and mulch stockpiles.

the event of a leak or spill), or provide secondary containment *(e.g., spill berms, decks, spill containment pallets)*; and

ii. Clean up spills immediately, using dry clean-up methods where possible, and dispose of used materials properly. You are prohibited from hosing the area down to clean surfaces or spills. Eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge.

d. *For hazardous or toxic wastes*:[40]

i. Separate hazardous or toxic waste from construction and domestic waste;

ii. Store waste in sealed containers, which are constructed of suitable materials to prevent leakage and corrosion, and which are labeled in accordance with applicable Resource Conservation and Recovery Act (RCRA) requirements and all other applicable federal, state, tribal, or local requirements;

iii. Store all outside containers within appropriately-sized secondary containment (*e.g., spill berms, decks, spill containment pallets*) to prevent spills from being discharged, or provide a similarly effective means designed to prevent the discharge of pollutants from these areas *(e.g., storing chemicals in a covered area, having a spill kit available on site);*

iv. Dispose of hazardous or toxic waste in accordance with the manufacturer's recommended method of disposal and in compliance with federal, state, tribal, and local requirements;

v. Clean up spills immediately, using dry clean-up methods, and dispose of used materials properly. You are prohibited from hosing the area down to clean surfaces or spills. Eliminate the source of the spill to prevent a discharge or a furtherance of an ongoing discharge; and

vi. Follow all other federal, state, tribal, and local requirements regarding hazardous or toxic waste.

e. *For construction and domestic wastes*:[41]

i. Provide waste containers *(e.g., dumpster, trash receptacle)* of sufficient size and number to contain construction and domestic wastes;

ii. Keep waste container lids closed when not in use and close lids at the end of the business day for those containers that are actively used throughout the day. For waste containers that do not have lids, provide either (1) cover *(e.g., a tarp, plastic sheeting, temporary roof)* to minimize exposure of wastes to precipitation, or (2) a similarly effective means designed to minimize the discharge of pollutants *(e.g., secondary containment)*;

iii. On business days, clean up and dispose of waste in designated waste containers; and

iv. Clean up immediately if containers overflow.

[40] Examples of hazardous or toxic waste that may be present at construction sites include paints, caulks, sealants, fluorescent light ballasts, solvents, petroleum-based products, wood preservatives, additives, curing compounds, and acids.

[41] Examples of construction and domestic waste include packaging materials, scrap construction materials, masonry products, timber, pipe and electrical cuttings, plastics, styrofoam, concrete, demolition debris; and other trash or building materials.

f. *For sanitary waste*, position portable toilets so that they are secure and will not be tipped or knocked over, and located away from waters of the U.S. and stormwater inlets or conveyances.

2.3.4 For washing applicators and containers used for stucco, paint, concrete, form release oils, curing compounds, or other materials:

a. Direct wash water into a leak-proof container or leak-proof and lined pit designed so that no overflows can occur due to inadequate sizing or precipitation;

b. Handle washout or cleanout wastes as follows:

   i. Do not dump liquid wastes in storm sewers or waters of the U.S.;

   ii. Dispose of liquid wastes in accordance with applicable requirements in Part 2.3.3; and

   iii. Remove and dispose of hardened concrete waste consistent with your handling of other construction wastes in Part 2.3.3; and

c. Locate any washout or cleanout activities as far away as possible from waters of the U.S. and stormwater inlets or conveyances, and, to the extent feasible, designate areas to be used for these activities and conduct such activities only in these areas.

2.3.5 For the application of fertilizers:

a. Apply at a rate and in amounts consistent with manufacturer's specifications, or document in the SWPPP departures from the manufacturer specifications where appropriate in accordance with Part 7.2.6.b.ix;

b. Apply at the appropriate time of year for your location, and preferably timed to coincide as closely as possible to the period of maximum vegetation uptake and growth;

c. Avoid applying before heavy rains that could cause excess nutrients to be discharged;

d. Never apply to frozen ground;

e. Never apply to stormwater conveyance channels; and

f. Follow all other federal, state, tribal, and local requirements regarding fertilizer application.

2.3.6 Emergency Spill Notification Requirements

Discharges of toxic or hazardous substances from a spill or other release are prohibited, consistent with Part 1.3.5. Where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity established under either 40 CFR 110, 40 CFR 117, or 40 CFR 302 occurs during a 24-hour period, you must notify the National Response Center (NRC) at (800) 424-8802 or, in the Washington, DC metropolitan area, call (202) 267-2675 in accordance with the requirements of 40 CFR 110, 40 CFR 117, and 40 CFR 302 as soon as you have knowledge of the release. You must also, within seven (7) calendar days of knowledge of the release, provide a description of the release, the circumstances leading to the release, and the date of the release. State, tribal, or local requirements may necessitate additional reporting of spills or discharges to local emergency response, public health, or drinking water supply agencies.

2.4 CONSTRUCTION DEWATERING REQUIREMENTS

Comply with the following requirements to minimize the discharge of pollutants in ground water or accumulated stormwater that is removed from excavations, trenches, foundations, vaults, or other similar points of accumulation, in accordance with Part 1.2.2.[42]

2.4.1 Treat dewatering discharges with controls to minimize discharges of pollutants;[43]

2.4.2 Do not discharge visible floating solids or foam;

2.4.3 Use an oil-water separator or suitable filtration device (such as a cartridge filter) that is designed to remove oil, grease, or other products if dewatering water is found to contain these materials;

2.4.4 To the extent feasible, use vegetated, upland areas of the site to infiltrate dewatering water before discharge. You are prohibited from using waters of the U.S. as part of the treatment area;

2.4.5 At all points where dewatering water is discharged, comply with the velocity dissipation requirements of Part 2.2.11;

2.4.6 With backwash water, either haul it away for disposal or return it to the beginning of the treatment process; and

2.4.7 Replace and clean the filter media used in dewatering devices when the pressure differential equals or exceeds the manufacturer's specifications.

3 WATER QUALITY-BASED EFFLUENT LIMITATIONS

3.1 GENERAL EFFLUENT LIMITATION TO MEET APPLICABLE WATER QUALITY STANDARDS

Discharges must be controlled as necessary to meet applicable water quality standards. Discharges must also comply with any additional state or tribal requirements that are in Part 9.

In the absence of information demonstrating otherwise, EPA expects that compliance with the conditions in this permit will result in stormwater discharges being controlled as necessary to meet applicable water quality standards. If at any time you become aware, or EPA determines, that discharges are not being controlled as necessary to meet applicable water quality standards, you must take corrective action as required in Parts 5.1 and 5.2, and document the corrective actions as required in Part 5.4.

EPA may insist that you install additional controls (to meet the narrative water quality-based effluent limit above) on a site-specific basis, or require you to obtain coverage under an individual permit, if information in your NOI or from other sources indicates that your discharges are not controlled as necessary to meet applicable water quality

[42] Uncontaminated, clear (non-turbid) dewatering water can be discharged without being routed to a control.

[43] Appropriate controls include sediment basins or sediment traps, sediment socks, dewatering tanks, tube settlers, weir tanks, filtration systems (*e.g., bag or sand filters*), and passive treatment systems that are designed to remove sediment. Appropriate controls to use downstream of dewatering controls to minimize erosion include vegetated buffers, check dams, riprap, and grouted riprap at outlets.

standards. This includes situations where additional controls are necessary to comply with a wasteload allocation in an EPA-established or approved TMDL.

If during your coverage under a previous permit, you were required to install and maintain stormwater controls specifically to meet the assumptions and requirements of an EPA-approved or established TMDL (for any parameter) or to otherwise control your discharge to meet water quality standards, you must continue to implement such controls as part of your coverage under this permit.

3.2 DISCHARGE LIMITATIONS FOR SITES DISCHARGING TO SENSITIVE WATERS[44]

For any portion of the site that discharges to a sediment or nutrient-impaired water or to a water that is identified by your state, tribe, or EPA as Tier 2, Tier 2.5, or Tier 3 for antidegradation purposes, you must comply with the inspection frequency specified in 4.3 and you must comply with the stabilization deadline specified in Part 2.2.14.a.iii.(c).[45]

If you discharge to a water that is impaired for a parameter other than a sediment-related parameter or nutrients, EPA will inform you if any additional controls are necessary for your discharge to be controlled as necessary to meet water quality standards, including for it to be consistent with the assumptions of any available wasteload allocation in any applicable TMDL, or if coverage under an individual permit is necessary.

In addition, on a case-by-case basis, EPA may notify operators of new sites or operators of existing sites with increased discharges that additional analyses, stormwater controls, or other measures are necessary to comply with the applicable antidegradation requirements, or notify you that an individual permit application is necessary.

If you discharge to a water that is impaired for polychlorinated biphenyls (PCBs) and are engaging in demolition of any structure with at least 10,000 square feet of floor space built or renovated before January 1, 1980, you must:

[44] Sensitive waters include waters that are impaired and Tier 2, Tier 2.5, and Tier 3 waters.

"Impaired waters" are those waters identified by the state, tribe, or EPA as not meeting an applicable water quality standard and (1) requires development of a TMDL (pursuant to section 303(d) of the CWA; or (2) is addressed by an EPA-approved or established TMDL; or (3) is not in either of the above categories but the waterbody is covered by a pollution control program that meets the requirements of 40 CFR 130.7(b)(1). Your construction site will be considered to discharge to an impaired water if the first water of the U.S. to which you discharge is an impaired water for the pollutants contained in the discharge from your site. For discharges that enter a storm sewer system prior to discharge, the first water of the U.S. to which you discharge is the waterbody that receives the stormwater discharge from the storm sewer system. For assistance in determining whether your site discharges to impaired waters, EPA has developed a tool that is available both within the electronic NOI form in NeT, and at https://www.epa.gov/npdes/epas-stormwater-discharge-mapping-tools.

Tiers 2, 2.5 and 3 refer to waters either identified by the state as high quality waters or Outstanding National Resource Waters under 40 CFR 131.12(a)(2) and (3). For the purposes of this permit, you are considered to discharge to a Tier 2, Tier 2.5, or Tier 3 water if the first water of the U.S. to which you discharge is identified by a state, tribe, or EPA as Tier 2, Tier 2.5, or Tier 3. For discharges that enter a storm sewer system prior to discharge, the water of the U.S. to which you discharge is the first water of the U.S. that receives the stormwater discharge from the storm sewer system. See list of Tier 2, Tier 2.5, and Tier 3 waters in Appendix F.

EPA may determine on a case-by-case basis that a site discharges to a sensitive water.

[45] If you qualify for any of the reduced inspection frequencies in Part 4.4, you may conduct inspections in accordance with Part 4.4 for any portion of your site that discharges to a sensitive water.

a. Implement controls[46] to minimize the exposure of PCB-containing building materials, including paint, caulk, and pre-1980 fluorescent lighting fixtures, to precipitation and to stormwater; and

b. Ensure that disposal of such materials is performed in compliance with applicable state, federal, and local laws.

4 SITE INSPECTION REQUIREMENTS

4.1 PERSON(S) RESPONSIBLE FOR INSPECTING SITE

The person(s) inspecting your site may be a person on your staff or a third party you hire to conduct such inspections. You are responsible for ensuring that the person who conducts inspections is a "qualified person."[47]

4.2 FREQUENCY OF INSPECTIONS.[48]

At a minimum, you must conduct a site inspection in accordance with one of the two schedules listed below, unless you are subject to the Part 4.3 site inspection frequency for discharges to sensitive waters or qualify for a Part 4.4 reduction in the inspection frequency:

4.2.1 At least once every seven (7) calendar days; *or*

4.2.2 Once every 14 calendar days *and* within 24 hours of the occurrence of a storm event of 0.25 inches or greater, or the occurrence of runoff from snowmelt sufficient to cause a discharge.[49] To determine if a storm event of 0.25 inches or greater has occurred on your site, you must either keep a properly maintained rain gauge on your site, or obtain the storm event information from a weather station that is representative of your location. For any day of rainfall during normal business hours that measures 0.25 inches or greater, you must record the total rainfall measured for that day in accordance with Part 4.7.1d.

4.3 INCREASE IN INSPECTION FREQUENCY FOR SITES DISCHARGING TO SENSITIVE WATERS.

For any portion of the site that discharges to a sediment or nutrient-impaired water or to a water that is identified by your state, tribe, or EPA as Tier 2, Tier 2.5, or Tier 3 for antidegradation purposes (see Part 3.2), instead of the inspection frequency specified in

[46] Examples of controls to minimize exposure of PCBs to precipitation and stormwater include separating work areas from non-work areas and selecting appropriate personal protective equipment and tools, constructing a containment area so that all dust or debris generated by the work remains within the protected area, using tools that minimize dust and heat (<212°F). For additional information, refer to Part 2.3.3 of the CGP Fact Sheet.

[47] A "qualified person" is a person knowledgeable in the principles and practice of erosion and sediment controls and pollution prevention, who possesses the appropriate skills and training to assess conditions at the construction site that could impact stormwater quality, and the appropriate skills and training to assess the effectiveness of any stormwater controls selected and installed to meet the requirements of this permit.

[48] Inspections are only required during the site's normal working hours.

[49] "Within 24 hours of the occurrence of a storm event" means that you must conduct an inspection within 24 hours once a storm event has produced 0.25 inches within a 24-hour period, even if the storm event is still continuing. Thus, if you have elected to inspect bi-weekly in accordance with Part 4.2.2 and there is a storm event at your site that continues for multiple days, and each day of the storm produces 0.25 inches or more of rain, you must conduct an inspection within 24 hours of the first day of the storm and within 24 hours after the end of the storm.

Part 4.2, you must conduct inspections in accordance with the following inspection frequencies:

Once every seven (7) calendar days *and* within 24 hours of the occurrence of a storm event of 0.25 inches or greater, or the occurrence of runoff from snowmelt sufficient to cause a discharge. To determine if a storm event of 0.25 inches or greater has occurred on your site, you must either keep a properly maintained rain gauge on your site, or obtain the storm event information from a weather station that is representative of your location. For any day of rainfall during normal business hours that measures 0.25 inches or greater, you must record the total rainfall measured for that day in accordance with Part 4.7.1d.

4.4 REDUCTIONS IN INSPECTION FREQUENCY

4.4.1 Stabilized areas.

a. You may reduce the frequency of inspections to twice per month for the first month, no more than 14 calendar days apart, then once per month in any area of your site where the stabilization steps in 2.2.14a have been completed. If construction activity resumes in this portion of the site at a later date, the inspection frequency immediately increases to that required in Parts 4.2 and 4.3, as applicable. You must document the beginning and ending dates of this period in your SWPPP.

b. **Exception.** For "linear construction sites" (as defined in Appendix A) where disturbed portions have undergone final stabilization at the same time active construction continues on others, you may reduce the frequency of inspections to twice per month for the first month, no more than 14 calendar days apart, in any area of your site where the stabilization steps in 2.2.14a have been completed. After the first month, inspect once more within 24 hours of the occurrence of a storm event of 0.25 inches or greater. If there are no issues or evidence of stabilization problems, you may suspend further inspections. If "wash-out" of stabilization materials and/or sediment is observed, following re-stabilization, inspections must resume at the inspection frequency required in Part 4.4.1a Inspections must continue until final stabilization is visually confirmed following a storm event of 0.25 inches or greater.

4.4.2 Arid, semi-arid, or drought-stricken areas (as defined in Appendix A). If it is the seasonally dry period or a period in which drought is occurring, you may reduce the frequency of inspections to once per month and within 24 hours of the occurrence of a storm event of 0.25 inches or greater. You must document that you are using this reduced schedule and the beginning and ending dates of the seasonally dry period in your SWPPP. To determine if a storm event of 0.25 inches or greater has occurred on your site, you must either keep a properly maintained rain gauge on your site, or obtain the storm event information from a weather station that is representative of your location. For any day of rainfall during normal business hours that measures 0.25 inches or greater, you must record the total rainfall measured for that day in accordance with Part 4.7.1d.

4.4.3 Frozen conditions:

a. If you are suspending construction activities due to frozen conditions, you may temporarily suspend inspections on your site until thawing conditions (as defined in Appendix A) begin to occur if:

i. Runoff is unlikely due to continuous frozen conditions that are likely to continue at your site for at least three (3) months based on historic seasonal averages. If unexpected weather conditions (such as above freezing temperatures or rain events) make discharges likely, you must immediately resume your regular inspection frequency as described in Parts 4.2 and 4.3, as applicable;

ii. Land disturbances have been suspended; and

iii. All disturbed areas of the site have been stabilized in accordance with Part 2.2.14a.

b. If you are still conducting construction activities during frozen conditions, you may reduce your inspection frequency to once per month if:

i. Runoff is unlikely due to continuous frozen conditions that are likely to continue at your site for at least three (3) months based on historic seasonal averages. If unexpected weather conditions (such as above freezing temperatures or rain events) make discharges likely, you must immediately resume your regular inspection frequency as described in Parts 4.2 and 4.3, as applicable; and

ii. Except for areas in which you are actively conducting construction activities, disturbed areas of the site have been stabilized in accordance with Part 2.2.14a.

You must document the beginning and ending dates of this period in your SWPPP.

4.5 AREAS THAT MUST BE INSPECTED

During your site inspection, you must at a minimum inspect the following areas of your site:

4.5.1 All areas that have been cleared, graded, or excavated and that have not yet completed stabilization consistent with Part 2.2.14a;

4.5.2 All stormwater controls (including pollution prevention controls) installed at the site to comply with this permit;[50]

4.5.3 Material, waste, borrow, and equipment storage and maintenance areas that are covered by this permit;

4.5.4 All areas where stormwater typically flows within the site, including drainageways designed to divert, convey, and/or treat stormwater;

4.5.5 All points of discharge from the site; and

4.5.6 All locations where stabilization measures have been implemented.

You are not required to inspect areas that, at the time of the inspection, are considered unsafe to your inspection personnel.

4.6 REQUIREMENTS FOR INSPECTIONS

During your site inspection, you must at a minimum:

4.6.1 Check whether all stormwater controls *(i.e., erosion and sediment controls and pollution prevention controls)* are properly installed, appear to be operational, and are working as intended to minimize pollutant discharges;

[50] This includes the requirement to inspect for sediment that has been tracked out from the site onto paved roads, sidewalks, or other paved areas consistent with Part 2.2.4.

4.6.2 Check for the presence of conditions that could lead to spills, leaks, or other accumulations of pollutants on the site;

4.6.3 Identify any locations where new or modified stormwater controls are necessary to meet the requirements of Parts 2 and/or 3;

4.6.4 Check for signs of visible erosion and sedimentation *(i.e., sediment deposits)* that have occurred and are attributable to your discharge at points of discharge and, if applicable, the banks of any waters of the U.S. flowing within or immediately adjacent to the site;

4.6.5 Identify any incidents of noncompliance observed;

4.6.6 If a discharge is occurring during your inspection:

a. Identify all discharge points at the site; and

b. Observe and document the visual quality of the discharge, and take note of the characteristics of the stormwater discharge, including color; odor; floating, settled, or suspended solids; foam; oil sheen; and other indicators of stormwater pollutants.

4.6.7 Based on the results of your inspection, complete any necessary maintenance under Part 2.1.4 and corrective action under Part 5.

4.7 INSPECTION REPORT

4.7.1 You must complete an inspection report within 24 hours of completing any site inspection. Each inspection report must include the following:

a. The inspection date;

b. Names and titles of personnel making the inspection;

c. A summary of your inspection findings, covering at a minimum the observations you made in accordance with Part 4.6, including any necessary maintenance or corrective actions;

d. If you are inspecting your site at the frequency specified in Part 4.2.2, Part 4.3, or Part 4.4.1b, and you conducted an inspection because of rainfall measuring 0.25 inches or greater, you must include the applicable rain gauge or weather station readings that triggered the inspection; and

e. If you determined that it is unsafe to inspect a portion of your site, you must describe the reason you found it to be unsafe and specify the locations to which this condition applies.

4.7.2 Each inspection report must be signed in accordance with Appendix I, Part I.11 of this permit.

4.7.3 You must keep a copy of all inspection reports at the site or at an easily accessible location, so that it can be made available at the time of an on-site inspection or upon request by EPA.

4.7.4 You must retain all inspection reports completed for this Part for at least three (3) years from the date that your permit coverage expires or is terminated.

4.8 INSPECTIONS BY EPA

You must allow EPA, or an authorized representative of EPA, to conduct the following activities at reasonable times. To the extent that you are utilizing shared controls that are not on site to comply with this permit, you must make arrangements for EPA to have access at all reasonable times to those areas where the shared controls are located.

4.8.1 Enter onto all areas of the site, including any construction support activity areas covered by this permit, any off-site areas where shared controls are utilized to comply with this permit, discharge locations, adjoining waterbodies, and locations where records are kept under the conditions of this permit;

4.8.2 Access and copy any records that must be kept under the conditions of this permit;

4.8.3 Inspect your construction site, including any construction support activity areas covered by this permit (see Part 1.2.1c), any stormwater controls installed and maintained at the site, and any off-site shared controls utilized to comply with this permit; and

4.8.4 Sample or monitor for the purpose of ensuring compliance.

5 CORRECTIVE ACTIONS

5.1 CONDITIONS TRIGGERING CORRECTIVE ACTION.

You must take corrective action to address any of the following conditions identified at your site:

5.1.1 A stormwater control needs repair or replacement (beyond routine maintenance required under Part 2.1.4); or

5.1.2 A stormwater control necessary to comply with the requirements of this permit was never installed, or was installed incorrectly; or

5.1.3 Your discharges are causing an exceedance of applicable water quality standards; or

5.1.4 A prohibited discharge has occurred (see Part 1.3).

5.2 CORRECTIVE ACTION DEADLINES

For any corrective action triggering conditions in Part 5.1, you must:

5.2.1 Immediately take all reasonable steps to address the condition, including cleaning up any contaminated surfaces so the material will not discharge in subsequent storm events;

5.2.2 When the problem does not require a new or replacement control or significant repair, the corrective action must be completed by the close of the next business day;

5.2.3 When the problem requires a new or replacement control or significant repair, install the new or modified control and make it operational, or complete the repair, by no later than seven (7) calendar days from the time of discovery. If it is infeasible to complete the installation or repair within seven (7) calendar days, you must document in your records why it is infeasible to complete the installation or repair within the 7-day timeframe and document your schedule for installing the stormwater control(s) and making it operational as soon as feasible after the 7-day timeframe. Where these actions result in changes to any of the stormwater controls or procedures documented in your SWPPP, you must modify your SWPPP accordingly within seven (7) calendar days of completing this work.

5.3 CORRECTIVE ACTION REQUIRED BY EPA

You must comply with any corrective actions required by EPA as a result of permit violations found during an inspection carried out under Part 4.8.

5.4 CORRECTIVE ACTION REPORT

For each corrective action taken in accordance with this Part, you must complete a report in accordance with the following:

5.4.1 Within 24 hours of identifying the corrective action condition, document the specific condition and the date and time it was identified.

5.4.2 Within 24 hours of completing the corrective action (in accordance with the deadlines in Part 5.2), document the actions taken to address the condition, including whether any SWPPP modifications are required.

5.4.3 Each corrective action report must be signed in accordance with Appendix I, Part I.11 of this permit.

5.4.4 You must keep a copy of all corrective action reports at the site or at an easily accessible location, so that it can be made available at the time of an on-site inspection or upon request by EPA.

5.4.5 You must retain all corrective action reports completed for this Part for at least three (3) years from the date that your permit coverage expires or is terminated.

6 STAFF TRAINING REQUIREMENTS

Each operator, or group of multiple operators, must assemble a "stormwater team" to carry out compliance activities associated with the requirements in this permit.

6.1 Prior to the commencement of construction activities, you must ensure that the following personnel[51] on the stormwater team understand the requirements of this permit and their specific responsibilities with respect to those requirements:

a. Personnel who are responsible for the design, installation, maintenance, and/or repair of stormwater controls (including pollution prevention controls);

b. Personnel responsible for the application and storage of treatment chemicals (if applicable);

c. Personnel who are responsible for conducting inspections as required in Part 4.1; and

d. Personnel who are responsible for taking corrective actions as required in Part 5.

[51] If the person requiring training is a new employee who starts after you commence construction activities, you must ensure that this person has the proper understanding as required above prior to assuming particular responsibilities related to compliance with this permit.

For emergency-related projects, the requirement to train personnel prior to commencement of construction activities does not apply, however, such personnel must have the required training prior to NOI submission.

6.2 You are responsible for ensuring that all activities on the site comply with the requirements of this permit. You are not required to provide or document formal training for subcontractors or other outside service providers, but you must ensure that such personnel understand any requirements of this permit that may be affected by the work they are subcontracted to perform.

6.3 At a minimum, members of the stormwater team must be trained to understand the following if related to the scope of their job duties *(e.g., only personnel responsible for conducting inspections need to understand how to conduct inspections*):

a. The permit deadlines associated with installation, maintenance, and removal of stormwater controls and with stabilization**;**

b. The location of all stormwater controls on the site required by this permit and how they are to be maintained;

c. The proper procedures to follow with respect to the permit's pollution prevention requirements; and

d. When and how to conduct inspections, record applicable findings, and take corrective actions.

6.4 Each member of the stormwater team must have easy access to an electronic or paper copy of applicable portions of this permit, the most updated copy of your SWPPP, and other relevant documents or information that must be kept with the SWPPP.

7 STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

7.1 GENERAL REQUIREMENTS

All operators associated with a construction site under this permit must develop a SWPPP consistent with the requirements in Part 7 prior to their submittal of the NOI.[52, 53] The SWPPP must be kept up-to-date throughout coverage under this permit.

[52] The SWPPP does not establish the effluent limits that apply to your site's discharges; these limits are established in this permit in Parts 2 and 3.

[53] You have the option of developing a group SWPPP where you are one of several operators at your site. For instance, if both the owner and the general contractor of the construction site are operators and thus are both required to obtain a permit, the owner may be the party undertaking SWPPP development, and the general contractor (or any other operator at the site) can choose to use this same SWPPP, as long as the SWPPP addresses the general contractor's (or other operator's) scope of construction work and functions to be performed under the SWPPP. Regardless of whether there is a group SWPPP or several individual SWPPPs, all operators would be jointly and severally liable for compliance with the permit.

Where there are multiple operators associated with the same site through a common plan of development or sale, operators may assign to themselves various permit-related functions under the SWPPP provided that each SWPPP, or a group SWPPP, documents which operator will perform each function under the SWPPP. However, dividing the functions to be performed under each SWPPP, or a single group SWPPP, does not relieve an individual operator from liability for complying with the permit should another operator fail to implement any measures that are necessary for that individual operator to comply with the permit, e.g., the installation and maintenance of any shared controls. In addition, all operators must ensure, either directly or through coordination with other operators, that their activities do not cause a violation and/or render any other operators' controls and/or any shared controls ineffective. All operators who rely on a shared control to comply with the permit are jointly and severally liable for violations of the permit resulting from the failure to properly install, operate and/or maintain the shared control.

If a SWPPP was prepared under a previous version of this permit, the operator must review and update the SWPPP to ensure that this permit's requirements are addressed prior to submitting an NOI for coverage under this permit.

7.2 SWPPP CONTENTS

At a minimum, the SWPPP must include the information specified in this Part and as specified in other parts of this permit.

7.2.1 All Site Operators. Include a list of all other operators who will be engaged in construction activities at the site, and the areas of the site over which each operator has control.

7.2.2 Stormwater Team. Identify the personnel (by name or position) that are part of the stormwater team, as well as their individual responsibilities, including which members are responsible for conducting inspections.

7.2.3 Nature of Construction Activities.[54] Include the following:

a. A description of the nature of your construction activities, including the age or dates of past renovations for structures that are undergoing demolition;

b. The size of the property (in acres or length in miles if a linear construction site);

c. The total area expected to be disturbed by the construction activities (to the nearest quarter acre or nearest quarter mile if a linear construction site);

d. A description of any on-site and off-site construction support activity areas covered by this permit (see Part 1.2.1c);

e. The maximum area expected to be disturbed at any one time, including on-site and off-site construction support activity areas;

f. A description and projected schedule for the following:

   i. Commencement of construction activities in each portion of the site, including clearing and grubbing, mass grading, demolition activities, site preparation (*i.e., excavating, cutting and filling*), final grading, and creation of soil and vegetation stockpiles requiring stabilization;

   ii. Temporary or permanent cessation of construction activities in each portion of the site;

   iii. Temporary or final stabilization of exposed areas for each portion of the site; and

   iv. Removal of temporary stormwater controls and construction equipment or vehicles, and the cessation of construction-related pollutant-generating activities.

g. A list and description of all pollutant-generating activities[55] on the site. For each pollutant-generating activity, include an inventory of pollutants or pollutant constituents (*e.g., sediment, fertilizers, pesticides, paints, caulks, sealants, fluorescent light ballasts, contaminated substrates, solvents, fuels*) associated with that activity, which could be discharged in stormwater from your construction site. You must take

[54] If plans change due to unforeseen circumstances or for other reasons, the requirement to describe the sequence and estimated dates of construction activities is not meant to "lock in" the operator to meeting these dates. When departures from initial projections are necessary, this should be documented in the SWPPP itself, or in associated records, as appropriate.

[55] Examples of pollutant-generating activities include paving operations; concrete, paint, and stucco washout and waste disposal; solid waste storage and disposal; and dewatering operations.

into account where potential spills and leaks could occur that contribute pollutants to stormwater discharges, and any known hazardous or toxic substances, such as PCBs and asbestos, that will be disturbed or removed during construction;

h. Business days and hours for the project;

i. If you are conducting construction activities in response to a public emergency (see Part 1.4), a description of the cause of the public emergency *(e.g., mud slides, earthquake, extreme flooding conditions, widespread disruption in essential public services)*, information substantiating its occurrence *(e.g., state disaster declaration or similar state or local declaration)*, and a description of the construction necessary to reestablish affected public services.

7.2.4 **Site Map.** Include a legible map, or series of maps, showing the following features of the site:

a. Boundaries of the property;

b. Locations where construction activities will occur, including:

   i. Locations where earth-disturbing activities will occur (note any phasing), including any demolition activities;

   ii. Approximate slopes before and after major grading activities (note any steep slopes (as defined in Appendix A));

   iii. Locations where sediment, soil, or other construction materials will be stockpiled;

   iv. Any water of the U.S. crossings;

   v. Designated points where vehicles will exit onto paved roads;

   vi. Locations of structures and other impervious surfaces upon completion of construction; and

   vii. Locations of on-site and off-site construction support activity areas covered by this permit (see Part 1.2.1c).

c. Locations of all waters of the U.S. within and one mile downstream of the site's discharge point. Also identify if any are listed as impaired, or are identified as a Tier 2, Tier 2.5, or Tier 3 water;

d. Areas of federally listed critical habitat within the site and/or at discharge locations;

e. Type and extent of pre-construction cover on the site (*e.g., vegetative cover, forest, pasture, pavement, structures*);

f. Drainage patterns of stormwater and authorized non-stormwater before and after major grading activities;

g. Stormwater and authorized non-stormwater discharge locations, including:

   i. Locations where stormwater and/or authorized non-stormwater will be discharged to storm drain inlets;[56] and

   ii. Locations where stormwater or authorized non-stormwater will be discharged directly to waters of the U.S.

h. Locations of all potential pollutant-generating activities identified in Part 7.2.3g;

[56] The requirement to show storm drain inlets in the immediate vicinity of the site on your site map only applies to those inlets that are easily identifiable from your site or from a publicly accessible area immediately adjacent to your site.

i. Locations of stormwater controls, including natural buffer areas and any shared controls utilized to comply with this permit; and

j. Locations where polymers, flocculants, or other treatment chemicals will be used and stored.

7.2.5 Non-Stormwater Discharges. Identify all authorized non-stormwater discharges in Part 1.2.2 that will or may occur.

7.2.6 Description of Stormwater Controls.

a. For each of the Part 2.2 erosion and sediment control effluent limits, Part 2.3 pollution prevention effluent limits, and Part 2.4 construction dewatering effluent limits, as applicable to your site, you must include the following:

   i. A description of the specific control(s) to be implemented to meet the effluent limit;

   ii. Any applicable stormwater control design specifications (including references to any manufacturer specifications and/or erosion and sediment control manuals/ordinances relied upon);[57]

   iii. Routine stormwater control maintenance specifications; and

   iv. The projected schedule for stormwater control installation/implementation.

b. You must also include any of the following additional information as applicable.

   i. **Natural buffers and/or equivalent sediment controls** (see Part 2.2.1 and Appendix G). You must include the following:

      (a) The compliance alternative to be implemented;

      (b) If complying with alternative 2, the width of natural buffer retained;

      (c) If complying with alternative 2 or 3, the erosion and sediment control(s) you will use to achieve an equivalent sediment reduction, and any information you relied upon to demonstrate the equivalency;

      (d) If complying with alternative 3, a description of why it is infeasible for you to provide and maintain an undisturbed natural buffer of any size;

      (e) For "linear construction sites" where it is infeasible to implement compliance alternative 1, 2, or 3, a rationale for this determination, and a description of any buffer width retained and/or supplemental erosion and sediment controls installed; and

      (f) A description of any disturbances that are exempt under Part 2.2.1 that occur within 50 feet of a water of the U.S.

   ii. **Perimeter controls for a "linear construction site"** (see Part 2.2.3). For areas where perimeter controls are not feasible, include documentation to support this determination and a description of the other practices that will be implemented to minimize discharges of pollutants in stormwater associated with construction activities.

   Note: Routine maintenance specifications for perimeter controls documented in the SWPPP must include the Part 2.2.3a requirement that sediment be removed

[57] Design specifications may be found in manufacturer specifications and/or in applicable erosion and sediment control manuals or ordinances. Any departures from such specifications must reflect good engineering practice and must be explained in the SWPPP.

before it has accumulated to one-half of the above-ground height of any perimeter control.

iii. **Sediment track-out controls** (see Parts 2.2.4b and 2.2.4c). Document the specific stabilization techniques and/or controls that will be implemented to remove sediment prior to vehicle exit.

iv. **Sediment basins** (see Part 2.2.12). In circumstances where it is infeasible to utilize outlet structures that withdraw water from the surface, include documentation to support this determination, including the specific conditions or time periods when this exception will apply.

v. **Treatment chemicals** (see Part 2.2.13), you must include the following:

(a) A listing of the soil types that are expected to be exposed during construction in areas of the project that will drain to chemical treatment systems. Also include a listing of soil types expected to be found in fill material to be used in these same areas, to the extent you have this information prior to construction;

(b) A listing of all treatment chemicals to be used at the site and why the selection of these chemicals is suited to the soil characteristics of your site;

(c) If the applicable EPA Regional Office authorized you to use cationic treatment chemicals for sediment control, include the specific controls and implementation procedures designed to ensure that your use of cationic treatment chemicals will not lead to an exceedance of water quality standards;

(d) The dosage of all treatment chemicals to be used at the site or the methodology to be used to determine dosage;

(e) Information from any applicable Safety Data Sheet (SDS);

(f) Schematic drawings of any chemically enhanced stormwater controls or chemical treatment systems to be used for application of the treatment chemicals;

(g) A description of how chemicals will be stored consistent with Part 2.2.13c;

(h) References to applicable state or local requirements affecting the use of treatment chemicals, and copies of applicable manufacturer's specifications regarding the use of your specific treatment chemicals and/or chemical treatment systems; and

(i) A description of the training that personnel who handle and apply chemicals have received prior to permit coverage, or will receive prior to use of the treatment chemicals at your site.

vi. **Stabilization measures** (see Part 2.2.14). You must include the following:

(a) The specific vegetative and/or non-vegetative practices that will be used;

(b) The stabilization deadline that will be met in accordance with Part 2.2.14.a.i-ii;

(c) If complying with the deadlines for sites in arid, semi-arid, or drought-stricken areas, the beginning and ending dates of the seasonally dry period and the schedule you will follow for initiating and completing vegetative stabilization; and

(d) If complying with deadlines for sites affected by unforeseen circumstances that delay the initiation and/or completion of vegetative stabilization, document the circumstances and the schedule for initiating and completing stabilization.

vii. **Spill prevention and response procedures** (see Part 1.3.5 and Part 2.3). You must include the following:

(a) Procedures for expeditiously stopping, containing, and cleaning up spills, leaks, and other releases. Identify the name or position of the employee(s) responsible for detection and response of spills or leaks; and

(b) Procedures for notification of appropriate facility personnel, emergency response agencies, and regulatory agencies where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity consistent with Part 2.3.6 and established under either 40 CFR 110, 40 CFR 117, or 40 CFR 302, occurs during a 24-hour period. Contact information must be in locations that are readily accessible and available to all employees.

You may also reference the existence of Spill Prevention Control and Countermeasure (SPCC) plans developed for the construction activity under Part 311 of the CWA, or spill control programs otherwise required by an NPDES permit for the construction activity, provided that you keep a copy of that other plan on site.[58]

viii. **Waste management procedures** (see Part 2.3.3). Describe the procedures you will follow for handling, storing and disposing of all wastes generated at your site consistent with all applicable federal, state, tribal, and local requirements, including clearing and demolition debris, sediment removed from the site, construction and domestic waste, hazardous or toxic waste, and sanitary waste.

ix. **Application of fertilizers** (see Part 2.3.5). Document any departures from the manufacturer specifications where appropriate.

7.2.7 Procedures for Inspection, Maintenance, and Corrective Action. Describe the procedures you will follow for maintaining your stormwater controls, conducting site inspections, and, where necessary, taking corrective actions, in accordance with Part 2.1.4, Part 4, and Part 5 of this permit. Also include:

a. The inspection schedule you will follow, which is based on whether your site is subject to Part 4.2 or Part 4.3, or whether your site qualifies for any of the reduced inspection frequencies in Part 4.4;

b. If you will be conducting inspections in accordance with the inspection schedule in Part 4.2.2, Part 4.3, or Part 4.4.1b, the location of the rain gauge or the address of the weather station you will be using to obtain rainfall data;

c. If you will be reducing your inspection frequency in accordance with Part 4.4.1b, the beginning and ending dates of the seasonally defined arid period for your area or the valid period of drought;

d. If you will be reducing your inspection frequency in accordance with Part 4.4.3, the beginning and ending dates of frozen conditions on your site; and

e. Any maintenance or inspection checklists or other forms that will be used.

[58] Even if you already have an SPCC or other spill prevention plan in existence, your plans will only be considered adequate if they meet all of the requirements of this Part, either as part of your existing plan or supplemented as part of the SWPPP.

7.2.8 Staff Training. Include documentation that the required personnel were, or will be, trained in accordance with Part 6.

7.2.9 Compliance with Other Requirements.

a. **Threatened and Endangered Species Protection.** Include documentation required in Appendix D supporting your eligibility with regard to the protection of threatened and endangered species and designated critical habitat.

b. **Historic Properties.** Include documentation required in Appendix E supporting your eligibility with regard to the protection of historic properties.

c. **Safe Drinking Water Act Underground Injection Control (UIC) Requirements for Certain Subsurface Stormwater Controls.** If you are using any of the following stormwater controls at your site, document any contact you have had with the applicable state agency[59] or EPA Regional Office responsible for implementing the requirements for underground injection wells in the Safe Drinking Water Act and EPA's implementing regulations at 40 CFR 144 -147. Such controls would generally be considered Class V UIC wells:

   i. Infiltration trenches (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system);

   ii. Commercially manufactured pre-cast or pre-built proprietary subsurface detention vaults, chambers, or other devices designed to capture and infiltrate stormwater flow; and

   iii. Drywells, seepage pits, or improved sinkholes (if stormwater is directed to any bored, drilled, driven shaft or dug hole that is deeper than its widest surface dimension, or has a subsurface fluid distribution system).

7.2.10 SWPPP Certification. You must sign and date your SWPPP in accordance with Appendix I, Part I.11.

7.2.11 Post-Authorization Additions to the SWPPP. Once you are authorized for coverage under this permit, you must include the following documents as part of your SWPPP:

a. A copy of your NOI submitted to EPA along with any correspondence exchanged between you and EPA related to coverage under this permit;

b. A copy of the acknowledgment letter you receive from NeT assigning your NPDES ID (*i.e., permit tracking number*);

c. A copy of this permit (an electronic copy easily available to the stormwater team is also acceptable).

7.3 ON-SITE AVAILABILITY OF YOUR SWPPP

You must keep a current copy of your SWPPP at the site or at an easily accessible location so that it can be made available at the time of an on-site inspection or upon request by EPA; a state, tribal, or local agency approving stormwater management plans; the operator of a storm sewer system receiving discharges from the site; or representatives of the U.S. Fish and Wildlife Service (USFWS) or the National Marine Fisheries Service (NMFS).

[59] For state UIC program contacts, refer to the following EPA website: https://www.epa.gov/uic.

EPA may provide access to portions of your SWPPP to a member of the public upon request. Confidential Business Information (CBI) will be withheld from the public, but may not be withheld from EPA, USFWS, or NMFS.[60]

If an on-site location is unavailable to keep the SWPPP when no personnel are present, notice of the plan's location must be posted near the main entrance of your construction site.

7.4 SWPPP MODIFICATIONS

7.4.1 You must modify your SWPPP, including the site map(s), within seven (7) days of any of the following conditions:

a. Whenever new operators become active in construction activities on your site, or you make changes to your construction plans, stormwater controls, or other activities at your site that are no longer accurately reflected in your SWPPP. This includes changes made in response to corrective actions triggered under Part 5. You do not need to modify your SWPPP if the estimated dates in Part 7.2.3f change during the course of construction;

b. To reflect areas on your site map where operational control has been transferred (and the date of transfer) since initiating permit coverage;

c. If inspections or investigations by EPA or its authorized representatives determine that SWPPP modifications are necessary for compliance with this permit;

d. Where EPA determines it is necessary to install and/or implement additional controls at your site in order to meet the requirements of this permit, the following must be included in your SWPPP:

   i. A copy of any correspondence describing such measures and requirements; and

   ii. A description of the controls that will be used to meet such requirements.

e. To reflect any revisions to applicable federal, state, tribal, or local requirements that affect the stormwater controls implemented at the site; and

f. If applicable, if a change in chemical treatment systems or chemically enhanced stormwater control is made, including use of a different treatment chemical, different dosage rate, or different area of application.

7.4.2 You must maintain records showing the dates of all SWPPP modifications. The records must include the name of the person authorizing each change (see Part 7.2.10 above) and a brief summary of all changes.

7.4.3 All modifications made to the SWPPP consistent with Part 7.4 must be authorized by a person identified in Appendix I, Part I.11.b.

7.4.4 Upon determining that a modification to your SWPPP is required, if there are multiple operators covered under this permit, you must immediately notify any operators who may be impacted by the change to the SWPPP.

[60] Information covered by a claim of confidentiality will be disclosed by EPA only to the extent of, and by means of, the procedures set forth in 40 CFR Part 2, Subpart B. In general, submitted information protected by a business confidentiality claim may be disclosed to other employees, officers, or authorized representatives of the United States concerned with implementing the CWA. The authorized representatives, including employees of other executive branch agencies, may review CBI during the course of reviewing draft regulations.

8 HOW TO TERMINATE COVERAGE

Until you terminate coverage under this permit, you must comply with all conditions and effluent limitations in the permit. To terminate permit coverage, you must submit to EPA a complete and accurate Notice of Termination (NOT), which certifies that you have met the requirements for terminating in Part 8.

8.1 MINIMUM INFORMATION REQUIRED IN NOT

8.1.1 NPDES ID (*i.e., permit tracking number)* provided by EPA when you received coverage under this permit;

8.1.2 Basis for submission of the NOT (see Part 8.2);

8.1.3 Operator contact information;

8.1.4 Name of site and address (or a description of location if no street address is available); and

8.1.5 NOT certification.

8.2 CONDITIONS FOR TERMINATING CGP COVERAGE

You must terminate CGP coverage only if one or more of the following conditions has occurred:

8.2.1 You have completed all construction activities at your site and, if applicable, construction support activities covered by this permit (see Part 1.2.1c), and you have met the following requirements:

a. For any areas that (1) were disturbed during construction, (2) are not covered over by permanent structures, and (3) over which you had control during the construction activities, you have met the requirements for final vegetative or non-vegetative stabilization in Part 2.2.14b;

b. You have removed and properly disposed of all construction materials, waste and waste handling devices, and have removed all equipment and vehicles that were used during construction, unless intended for long-term use following your termination of permit coverage;

c. You have removed all stormwater controls that were installed and maintained during construction, except those that are intended for long-term use following your termination of permit coverage or those that are biodegradable; and

d. You have removed all potential pollutants and pollutant-generating activities associated with construction, unless needed for long-term use following your termination of permit coverage; or

8.2.2 You have transferred control of all areas of the site for which you are responsible under this permit to another operator, and that operator has submitted an NOI and obtained coverage under this permit; or

8.2.3 Coverage under an individual or alternative general NPDES permit has been obtained.

8.3 HOW TO SUBMIT YOUR NOT

You must use EPA's NPDES eReporting Tool (NeT) to electronically prepare and submit your NOT for the 2017 CGP.

To access NeT, go to https://www.epa.gov/npdes/stormwater-discharges-construction-activities#ereporting.

Waivers from electronic reporting may be granted as specified in Part 1.4.1. If the EPA Regional Office grants you approval to use a paper NOT, and you elect to use it, you must complete the form in Appendix K.

8.4 DEADLINE FOR SUBMITTING THE NOT

You must submit your NOT within 30 calendar days after any one of the conditions in Part 8.2 occurs.

8.5 EFFECTIVE DATE OF TERMINATION OF COVERAGE

Your authorization to discharge under this permit terminates at midnight of the calendar day that a complete NOT is submitted to EPA.

9 PERMIT CONDITIONS APPLICABLE TO SPECIFIC STATES, INDIAN COUNTRY LANDS, OR TERRITORIES

The provisions in this Part provide modifications or additions to the applicable conditions of this permit to reflect specific additional conditions required as part of the state or tribal CWA Section 401 certification process, or the Coastal Zone Management Act (CZMA) certification process, or as otherwise established by the permitting authority. The specific additional revisions and requirements only apply to activities in those specific states, Indian country, and areas in certain states subject to construction projects by Federal Operators. States, Indian country, and areas subject to construction by Federal Operators not included in this Part do not have any modifications or additions to the applicable conditions of this permit.

9.1 EPA REGION 1

9.1.1 NHR100000 State of New Hampshire

a. If you disturb 100,000 square feet or more of contiguous area, you must also apply for an Alteration of Terrain (AoT) permit from DES pursuant to RSA 485- A:17 and Env-Wq 1500. This requirement also applies to a lower disturbance threshold of 50,000 square feet or more when construction occurs within the protected shoreline under the Shoreland Water Quality Protection Act (see RSA 483-B and Env-Wq 1400). A permit application must also be filed if your project disturbs an area of greater than 2,500 square feet, is within 50 feet of any surface water, and has a flow path of 50 feet or longer disturbing a grade of 25 percent or greater. Project sites with disturbances smaller than those discussed above, that have the potential to adversely affect state surface waters, are subject to the conditions of an AoT General Permit by Rule.

b. You must determine that any excavation dewatering discharges are not contaminated before they will be authorized as an allowable non-stormwater discharge under this permit (see Part 1.2.2). The water is considered uncontaminated if there is no groundwater contamination within 1,000 feet of the groundwater dewatering location. Information on groundwater contamination can be generated over the Internet via the NHDES web site http://des.nh.gov/ by using the One Stop Data Mapper at http://des.nh.gov/onestop/gis.htm. If it is determined that the groundwater to be dewatered is near a remediation or other waste site you must apply for the Remediation General Permit (see https://www3.epa.gov/region1/npdes/rgp.html.)

c. You must treat any uncontaminated excavation dewatering discharges as necessary to remove suspended solids and turbidity. The discharges must be sampled at least once per week during weeks when discharges occur. Samples must be analyzed for total suspended solids (TSS) or turbidity and must meet monthly average and daily maximum limits of 50 milligrams per liter (mg/L) and 100 mg/L, respectively for TSS or 33 mg/l and 67 mg/l, respectively for turbidity. TSS (a.k.a. Residue, Nonfilterable) or turbidity sampling and analysis must be performed in accordance with Tables IB and II in 40 CFR 136.3 (http://www.ecfr.gov/cgi-bin/text-idx?SID=0243e3c4283cbd7d8257eb6afc7ce9a2&mc=true&node=se40.25.136_13&rgn=div8). Records of any sampling and analysis must be maintained and kept with the SWPPP for at least three years after final site stabilization.

d. Construction site owners and operators must consider opportunities for post-construction groundwater recharge using infiltration best management practices (BMPs) during site design and preparation of the SWPPP. If your construction site is in a town that is required to obtain coverage under the NPDES General Permit for discharges from Municipal Separate Storm Sewer Systems (MS4) you may be required to use such practices. The SWPPP must include a description of any on-site infiltration that will be installed as a post-construction stormwater management measure or reasons for not employing such measures such as 1) The facility is located in a wellhead protection area as defined in RSA 485- C:2; or 2) The facility is located in an area where groundwater has been reclassified to GAA, GAI or GA2 pursuant to RSA 485-C and Env-DW 901; or 3) Any areas that would be exempt from the groundwater recharge requirements contained in Env-Wq 1507.04(e), including all land uses or activities considered to be a "High-load Area" (see Env-Wq 1502.26). For design considerations for infiltration measures see Volume II of the NH Stormwater Manual.

e. Appendix F contains a list of Tier 2, or high quality waters. Although there is no official list of tier 2 waters, it can be assumed that all NH surface waters are tier 2 for turbidity unless 1) the surface water that you are proposing to discharge into is listed as impaired for turbidity in the states listing of impaired waters (see Surface Water Quality - Watershed Report Cards at http://des.nh.gov/organization/divisions/water/wmb/swqa/report_cards.htm) or 2) sampling upstream of the proposed discharge location shows turbidity values greater than 10 NTU. A single grab sample collected during dry weather (no precipitation within 48 hours) is acceptable.

f. To ensure compliance with RSA 485-C, RSA 485-A, RSA 485-A:13, I(a), Env-Wq 1700 and Env-Wq 302, the following information may be requested by NHDES. This information must be kept on site unless you receive a written request from NHDES that it be sent to the address shown in Part 9.1.4 (g).

    i. A site map required in Part 7.2.4, showing the type and location of all post-construction infiltration BMPs utilized at the facility or the reason(s) why none were installed;

    ii. A list of all non-stormwater discharges that occur at the facility, including their source locations and the control measures being used (see Part 1.2.2).

iii. Records of sampling and analysis of TSS required for construction dewatering discharges (see Part 9.1.4 (c)).

g. All required or requested documents must be sent to:

NH Department of Environmental Services, Wastewater Engineering Bureau,
Permits & Compliance Section
P.O. Box 95
Concord, NH 03302-0095

9.2 EPA REGION 3

9.2.1 DCR100000 District of Columbia

a. The permittee must comply with the District of Columbia Water Pollution Control Act of 1984, as amended, (D.C. Official Code §8-103.01 *et seq.*) and its implementing regulations in Title 21, Chapters 11 and 19 of the District of Columbia Municipal Regulations. Nothing in this permit will be construed to preclude the institution of any legal action or relieve the permitee from any responsibilities, liabilities, or penalties established pursuant to District of Columbia laws and regulations.

b. The permittee must comply with the District of Columbia Stormwater Management, and Soil Erosion and Sediment Control in Chapter 5 of Title 21 of the District of Columbia Municipal Regulations.

c. The permittee must comply with the District of Columbia Flood Management control in Chapter 31 of Title 20 of the District of Columbia Municipal Regulations.

d. The Department may request a copy of the Stormwater Pollution Prevention Plan (SWPPP) and the permittee is required to submit the SWPPP to the Department with 14 days of such request. The Department may conduct an inspection of any facility covered by this permit to ensure compliance with District's law requirements including water quality.

9.2.2 DER10F000 Areas in the State of Delaware subject to construction by a Federal Operator

a. Federal agencies engaging in construction activities must submit, to DNREC, a sediment and stormwater management (S&S) plan and obtain approval from DNREC in accordance with 7 Del. C. §4010, 7 DE Admin. Code 5101, and 7 DE Admin. Code 7201.

b. Federal agencies engaging in construction activities must provide for construction review by a certified construction reviewer in accordance with 7 Del. C. §§4010 & 4013 and 7 DE Admin. Code 5101, subsection 6.1.6.

c. Federal agencies engaging in construction activities must certify that all responsible personnel involved in the construction project will have attended the blue card training prior to initiation of any land disturbing activity – *see* 7 Del. C. §§ 4002 & 4014 and 7 DE Admin. Code 5101.

9.3 EPA REGION 5

9.3.1 MNR10I000 Indian country within the State of Minnesota

9.3.1.1 Fond du Lac Band of Lake Superior Chippewa. The following conditions apply only to discharges on the Fond du Lac Band of Lake Superior Chippewa Reservation:

a. A copy of the Stormwater Pollution Prevention Plan (SWPPP) must be submitted to the Office of Water Protection at least fifteen (15) days in advance of sending the Notice of Intent (NOI) to EPA. The SWPPP can be submitted electronically to richardgitar@FDLREZ.com or by hardcopy sent to:

Fond du Lac Reservation
Office of Water Protection
1720 Big Lake Road
Cloquet, MN 55720

CGP applicants are encouraged to work with the FDL Office of Water Protection in the identification of all proposed receiving.

b. Copies of the Notice of Intent (NOI) and the Notice of Termination (NOT) must be sent to the Fond du Lac Office of Water Protection at the same time they are submitted to EPA.

c. The turbidity limit shall NOT exceed 10% of natural background within the receiving water(s) as determined by Office of Water Protection staff.

d. Turbidity sampling must take place within 24 hours of a ½-inch or greater rainfall event. The results of the sampling must be reported to the Office of Water Protection within 7 days of the sample collection. All sample reporting must include the date and time, location (GPS: UTM/Zone 15), and NTU. CGP applicants are encouraged to work with the Office of Water Protection in determining the most appropriate location(s) for sampling.

e. Receiving waters with open water must be sampled for turbidity prior to any authorized discharge as determined by Office of Water Protection staff. This requirement only applies to receiving waters in which no ambient turbidity data exists.

f. This Certification does not pertain to any new discharge to Outstanding Reservation Resource Waters (ORRW) as described in §105 b.3. of the Fond du Lac Water Quality Standards (Ordinance #12/98, as amended). Although additional waters may be designated in the future, currently Perch Lake, Rice Portage Lake, Miller Lake, Deadfish Lake, and Jaskari Lake are designated as ORRWs. New dischargers wishing to discharge to an ORRW must obtain an individual permit from EPA for stormwater discharges from large and small construction activities.

g. All work shall be carried out in such a manner as will prevent violations of water quality criteria as stated in the Water Quality Standards of the Fond du Lac Reservation, Ordinance 12/98, as amended. This includes, but is not limited to, the prevention of any discharge that causes a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of water of the Fond du Lac Reservation for any of the uses designated in the Water Quality Standards of the Fond du Lac Reservation. These uses include wildlife, aquatic life, warm water fisheries, cold water fisheries, subsistence fishing (netting), primary contact recreation, secondary contact recreation, cultural, wild rice areas, aesthetic waters, agriculture, navigation, and commercial.

h. Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the Fond du Lac Reservation. All spills must be reported to the appropriate emergency management agency (National Response Center AND the State Duty Officer), and measures shall be taken immediately to prevent the pollution of waters of the Fond du Lac Reservation, including groundwater. The Fond du Lac Office of Water Protection must also be notified immediately of any spill regardless of size.

i. This certification does not authorize impacts to cultural, historical, or archeological features or sites, or properties that may be eligible for such listing.

9.3.1.2 Grand Portage Band of Lake Superior Chippewa. The following conditions apply only to discharges on the Grand Portage Band of Lake Superior Chippewa Reservation:

a. The CGP authorization is for construction activities that may occur within the exterior boundaries of the Grand Portage Reservation in accordance to the Grand Portage Land Use Ordinance. The CGP regulates stormwater discharges associated with construction sites of one acre or more in size. Only those activities specifically authorized by the CGP are authorized by this certification (the "Certification"). This Certification does not authorize impacts to cultural, historical, or archeological features or sites, or properties that may be eligible for listing as such.

b. All construction stormwater discharges authorized by the CGP must comply with the Water Quality Standards and Water Resources Ordinance, as well as Applicable Federal Standards (as defined in the Water Resources Ordinance). As such, appropriate steps must be taken to ensure that petroleum products or other chemical pollutants are prevented from entering the Waters of the Reservation (as defined in the Water Resources Ordinance). All spills must be reported to the appropriate emergency-management agency, and measures must be taken to prevent the pollution of the Waters of the Reservation, including groundwater.

c. The 2017 CGP requires inspections and monitoring reports of the construction site stormwater discharges by a qualified person. Monitoring and inspection reports must comply with the minimum requirements contained in the 2017 CGP. The monitoring plan must be prepared and incorporated into the Stormwater Pollution Prevention Plan (the "SWPPP"). A copy of the SWPPP must be submitted to the Board at least 30 days in advance of sending the requisite Notice of Intent to EPA. The SWPPP should be sent to:

   Grand Portage Environmental Resources Board
   P.O. Box 428
   Grand Portage, MN 55605

   Copies of the Notice of Intent and Notice of Termination required under the CGP must be submitted to the Board at the address above at the same time they are submitted to the EPA.

d. If requested by the Grand Portage Environmental Department, the permittee must provide additional information necessary for a case-by-case eligibility determination to assure compliance with the Water Quality Standards and any Applicable Federal Standards.

e. Discharges that the Board has determined to be or that may reasonably be expected to be contributing to a violation of Water Quality Standards or Applicable Federal Standards are not authorized by this Certification.

f. The Board retains full authority provided by the Water Resources Ordinance to ensure compliance with and to enforce the provisions of the Water Resource Ordinance and Water Quality Standards, Applicable Federal Standards, and these Certification conditions.

g. Appeals related to Board actions taken in accordance with any of the preceding conditions may be heard by the Grand Portage Tribal Court.

9.3.2 WIR10I000 Indian country within the State of Wisconsin, except the Sokaogon Chippewa (Mole Lake) Community

9.3.2.1 Bad River Band of Lake Superior Tribe of Chippewa Indians: The following conditions apply only to discharges on the Bad River Band of the Lake Superior Tribe of Chippewa Indians Reservation:

a. Only those activities specifically authorized by the CGP are authorized by this Certification. This Certification does not authorize impacts to cultural properties, or historical sites, or properties that may be eligible for listing as such.[61, 62]

b. Operators are not eligible to obtain authorization under the CGP for all new discharges to an Outstanding Tribal Resource Water (or Tier 3 water).[63] Outstanding Tribal Resource Waters, or Tier 3 waters, include the following: Kakagon Slough and the lower wetland reaches of its tributaries that support wild rice, Kakagon River, Bad River Slough, Honest John Lake, Bog Lake, a portion of Bad River, from where it enters the Reservation through the confluence with the White River, and Potato River.[64]

c. Projects utilizing cationic treatment chemicals[65] within the Bad River Reservation boundaries are not eligible for coverage under the CGP.[66]

d. All projects which are eligible for coverage under the CGP and are located within the exterior boundaries of the Bad River Reservation shall be implemented in such a manner that is consistent with the Tribe's Water Quality Standards (WQS).[67]

e. An operator proposing to discharge to an Outstanding Resource Water (or Tier 2.5 water) under the CGP must comply with the antidegradation provisions of the Tribe's WQS. Outstanding Resource Waters, or Tier 2.5 waters, include the following: a portion of Bad River, from downstream the confluence with the White River to Lake Superior, White River, Marengo River, Graveyard Creek, Bear Trap Creek, Wood Creek, Brunsweiler River, Tyler Forks, Bell Creek, and Vaughn Creek.[68] The antidegradation

[61] Bad River Band of Lake Superior Tribe of Chippewa Indians Water Quality Standards adopted by Resolution No. 7-6-11-441 (hereafter, Tribe's WQS).

[62] 36 C.F.R. § 800.16(l)(2).

[63] Tribe's WQS: See provisions E.3.ii. and E.4.iv.

[64] Tribe's WQS: See provision E.2.iii.

[65] See definition of cationic treatment chemicals in Appendix A of the CGP.

[66] Tribe's WQS: See provisions E.6.ii.a. and E.6.ii.c.

[67] See footnote 61.

[68] Tribe's WQS: See provision E.2.ii.

demonstration materials described in provision E.4.iii. must be submitted to the following address:

Bad River Tribe's Natural Resources Department
Attn: Water Resources Specialist
P.O. Box 39
Odanah, WI 54861

f. An operator proposing to discharge to an Exceptional Resource Water (or Tier 2 water) under the CGP must comply with the antidegradation provisions of the Tribe's WQS. Exceptional Resource Waters, or Tier 2 waters, include the following: any surface water within the exterior boundaries of the Reservation that is not specifically classified as an Outstanding Resource Water (Tier 2.5 water) or an Outstanding Tribal Resource Water (Tier 3 water).[69] The antidegradation demonstration materials described in provision E.4.ii. must be submitted to the following address:

Bad River Tribe's Natural Resources Department
Attn: Water Resources Specialist
P.O. Box 39
Odanah, WI 54861

g. A discharge to a surface water within the Bad River Reservation boundaries shall not cause or contribute to an exceedance of the turbidity criterion included in the Tribe's WQS, which states: Turbidity shall not exceed 5 NTU over natural background turbidity when the background turbidity is 50 NTU or less, or turbidity shall not increase more than 10% when the background turbidity is more than 50 NTU.[70]

h. All projects which are eligible for coverage under the CGP within the exterior boundaries of the Bad River Reservation must comply with the Bad River Reservation Wetland and Watercourse Protection Ordinance, or Chapter 323 of the Bad River Tribal Ordinances, including the erosion and sedimentation control, natural buffer, and stabilization requirements. Questions regarding Chapter 323 and requests for permit applications can be directed to the Wetlands Specialist in the Tribe's Natural Resources Department at (715) 682-7123 or wetlands@badriver-nsn.gov.

i. An operator of a project, which is eligible for coverage under the CGP, that would result in an allowable discharge under the CGP occurring within the exterior boundaries of the Bad River Reservation must notify the Tribe prior to the commencing earth-disturbing activities.[71, 72] The operator must submit a copy of the Notice of Intent (NOI) to the following addresses at the same time it is submitted to the U.S. EPA:

Bad River Tribe's Natural Resources Department
Attn: Water Resources Specialist
P.O. Box 39
Odanah, WI 54861

[69] Tribe's WQS: See provision E.2.i.

[70] Tribe's WQS: See provision E.7.iii.

[71] See footnote 61.

[72] See footnote 62.

Bad River Tribe's Natural Resources Department
Attn: Tribal Historic Preservation Officer (THPO)
P.O. Box 39
Odanah, WI 54861

The operator must also submit a copy of the Notice of Termination (NOT) to the above addresses at the same time it is submitted to the U.S. EPA.

j. The THPO must be provided 30 days to comment on the project.[73]

k. The operator must obtain THPO concurrence in writing. This written concurrence will outline measures to be taken to prevent or mitigate effects to historic properties. For more information regarding the specifics of the cultural resources process, see 36 CFR Part 800. A best practice for an operator is to consult with the THPO during the planning stages of an undertaking.[74]

l. An operator of a project, which is eligible for coverage under the CGP, that would result in an allowable discharge under the CGP occurring within the exterior boundaries of the Bad River Reservation must submit a copy of the Stormwater Pollution Prevention Plan (SWPPP) to the following address at the same time as submitting the NOI: [75]

Bad River Tribe's Natural Resources Department
Attn: Water Resources Specialist
P.O. Box 39
Odanah, WI 54861

m. Any corrective action reports that are required under the CGP must be submitted to the following address within one (1) working day of the report completion: [76]

Bad River Tribe's Natural Resources Department
P.O. Box 39
Odanah, WI 54861

n. An operator shall be responsible for meeting any additional permit requirements imposed by the U.S. EPA necessary to comply with the Tribe's antidegradation policies if the discharge point is located upstream of waters designated by the Tribe.[77]

9.3.2.2 Lac du Flambeau Band of Lake Superior Tribe of Chippewa Indians: The following conditions apply only to discharges on the Lac du Flambeau Band of the Lake Superior Tribe of Chippewa Indians Reservation:

a. A copy of the Stormwater Pollution Prevention Plan must be submitted to the following office, for the Traival environmental review process, at least thirty (30) days in advance of sending the Notice of Intent (NOI) to EPA:

Lac du Flambeau
Tribal Land Management

[73] 36 C.F.R. § 800.3(c)(4).

[74] 36 C.F.R. § 800.3(b).

[75] See footnote 61.

[76] See footnote 61.

[77] See footnote 61.

P.O. Box 279
Lac du Flambeau, WI 54538

CGP applicants are encouraged to work with the LdF Water Resources Program in the identification of all proposed receiving waters.

b. Copies of the NOI and the Notice of Termination (NOT) must be sent to the LdF Water Resources Program at the same time they are submitted to EPA.

c. All work shall be carried out in such a manner as will prevent violations of water quality criteria as stated in the Water Quality Standards of the Lac du Flambeau Reservation. This includes, but is not limited to, the prevention of any discharge that cause a condition in which visible solids, bottom deposits, or turbidity impairs the usefulness of water of the Lac du Flambeau Reservation for any of the uses designated in the Water Quality Standards of the Lac du Flambeau Reservation.

d. Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the Lac du Flambeau Reservation. All spills must be reported to the appropriate emergency management agency, and measures shall be taken immediately to prevent the pollution of waters of the Lac du Flambeau reservation, including groundwater.

e. This certification does not authorize impacts to cultural, historical, or archeological features or sties, or properties that may be eligible for such listing.

f. Due to the significant ecological and cultural importance of the Lac du Flambeau Reservation, any operator requesting a permit for a point source discharge of pollutants (i.e., discharge) associated with the Stormwater Discharge will need a stormwater pollution prevention plan in place that does not violate Lac du Flambeau Water Quality Standards to protect Reservation Waters.

9.4 EPA REGION 6

9.4.1 NMR100000 State of New Mexico, except Indian country

a. If construction dewatering activities are anticipated at a site, permittees must complete the following steps:

   i. Investigative information must be documented in the facility SWPPP.

   ii. Refer to the GWQB Mapper at https://gis.web.env.nm.gov/GWQB/ AND the PSTB Mapper (Go Mapper) at https://gis.web.env.nm.gov/GoNM/ and check if the following sources are located within the noted distance from your anticipated construct site groundwater dewatering activity:

Project Location Relative to a Source of Potential Groundwater Contamination	***Constituents likely to be required for testing***
Within 0.5 mile of an open Leaking Underground Storage Tank (LUST) site	*BTEX (Benzene, Toluene, Ethylbenzene, and Xylene) plus additional parameters depending on site conditions.**

Project Location Relative to a Source of Potential Groundwater Contamination	***Constituents likely to be required for testing***
Within 0.5 mile of an open Voluntary Remediation site	*All parameters listed in Appendix A (or an alternate list approved by the NMED SWQB)***
Within 0.5 mile of an open RCRA Corrective Action Site	
Within 0.5 mile of an open Abatement Site	
Within 0.5 mile of an open Brownfield Site	
Within 1.0 mile or more of a Superfund site or National Priorities List (NPL) site with associated groundwater contamination.	

**For further assistance determining whether dewatering may encounter impacted groundwater, the permittee may contact the NMED Ground Water Quality Bureau at: 505-827-2965.*

***EPA approved-sufficiently sensitive methods must be used - approved methods are listed in 40 CFR Part 136.3.*

iii. If dewatering activities are anticipated, information on flow and potential to encounter impacted groundwater must be provided directly to NMED at the following address:

Program Manager, Point Source Regulation Section
NMED Surface Water Quality Bureau
PO Box 5469, Santa Fe, NM 87502

Information may also be emailed - the contact information for the program manager is located on the website at: www.env.nm.gov/swqb/PSR.

iv. Permittee must test the quality of the water being considered for discharge. Permittees must contact the Point Source Regulation Section Program Manager for information on constituents that must be monitored.

v. Permittee must send test result data to EPA Region 6 and the NMED Surface Water Quality Bureau. If the test data exceed standards, it cannot be discharged from the construction site into surface waters under this permit. Discharge to surface waters must be conducted under a separate NPDES individual permit to ensure proper treatment and disposal.

vi. If disposal will be to the ground surface or in an unlined pond, the permittee must submit an NOI/ to the NMED Ground Water Quality Bureau.

b. Operators are not eligible to obtain authorization under this permit for all new and existing storm water discharges to outstanding national resource waters (ONRWs) (also referred to as "Tier 3" waters.)

i. Although state WQS provide for temporary and short-term degradation of water quality in an ONRW under very limited circumstances if approved by the Water Quality Control Commission as specified at 20.6.4.8.A NMAC, the approval process required for these activities does not lend itself for use for projects covered under this general permit. This condition is necessary to ensure that no degradation is allowed in ONRWs by requiring proposed storm water discharges to be reviewed under the individual permit process. Tier 3 waters are defined in Appendix F of the proposed permit.

c. Operators who intend to obtain authorization under this permit for new and existing storm water discharges from construction sites must satisfy the following condition: The SWPPP must include site-specific interim and permanent stabilization, managerial, and structural solids, erosion and sediment control best management practices (BMPs) and/or other controls that are designed to prevent to the maximum extent practicable an increase in the sediment yield and flow velocity from pre-construction, pre-development conditions to assure that applicable standards in 20.6.4.NMAC, including the antidegradation policy, or TMDL waste load allocations (WLAs) are met. This requirement applies to discharges both during construction and after construction operations have been completed. The SWPPP must identify and document the rationale for selecting these BMPs and/or other controls. The SWPPP must also describe design specifications, construction specifications, maintenance schedules (including a long term maintenance plan), criteria for inspections, and expected performance and longevity of these BMPs. For sites greater than 5 acres in size, BMP selection must be made based on the use of appropriate soil loss prediction models (i.e. SEDCAD, RUSLE, SEDIMOT, MULTISED, etc.) OR equivalent generally accepted (by professional erosion control specialists) soil loss prediction tools.

   i. For all sites, the operator(s) must demonstrate, and include documentation in the SWPPP, that implementation of the site-specific practices will assure that the applicable standards or TMDL WLAs are met, and will result in sediment yields and flow velocities that, to the maximum extent practicable, will not be greater than the sediment yield levels and flow velocities from preconstruction, pre-development conditions.

   ii. All SWPPPs must be prepared in accordance with good engineering practices by qualified (e.g. CPESC certified, engineers with appropriate training) erosion control specialists familiar with the use of soil loss prediction models and design of erosion and sediment control systems based on these models (or equivalent soil loss prediction tools). Qualifications of the preparer (e.g., professional certifications, description of appropriate training) must be documented in the SWPPP. The operator(s) must design, implement, and maintain BMPs in the manner specified in the SWPPP.

d. State regulations at 20.6.2.1203 NMAC state: *With respect to any discharge from any facility of oil or other water contaminant, in such quantity as may with reasonable probability injure or be detrimental to human health, animal or plant life, or property, or unreasonably interfere with the public welfare or the use of property, the following notifications and corrective actions are required*:

   i. As soon as possible after learning of such a discharge, but in no event more than twenty-four (24) hours thereafter, any person in charge of the facility shall orally notify the Chief of the Ground Water Quality Bureau of the department, or his counterpart in any constituent agency delegated responsibility for enforcement of these rules as ta any facility subject to such delegation.

   Permittees can call 505-827-9329 for emergencies at any time and 505-476-6000 for non-emergencies during business hours from 5am-5pm, Monday through Friday.

e. NMED does not allow permittees to use the Equivalent Analysis Waiver.

9.4.2 NMR10I000 Indian country within the State of New Mexico, except Navajo Reservation Lands that are covered under Arizona permit AZR10000I and Ute Mountain Reservation Lands that are covered under Colorado permit COR10000I.

9.4.2.1 Pueblo of Isleta. The following conditions apply only to discharges on the Pueblo of Isleta Reservation:

a. CGP at 1.3 Prohibited discharges: Stormwater discharges associated with construction activity that EPA or the Pueblo of Isleta, prior to authorization under this perm it, determines will cause, have the reasonable potential to cause, or may reasonably be expected to contribute to a violation or excursion of any applicable water quality standard, including the antidegradation policy, or the impairment of a designated use of receiving waters are not authorized by this permit.

b. CGP at 1.4.1 How to Submit Your NOI: The operator shall provide a copy of the Notice of Intent ("NOI") to the Pueblo of Isleta at the same time it is submitted to the U.S. Environmental Protection Agency, for projects occurring within the exterior boundaries of the Pueblo of Isleta. The operator shall also notify the Pueblo of Isleta when it has submitted the Notice of Termination ("NOT"). The NOI and NOT shall be sent to the Pueblo of Isleta at the following address:

Water Quality Control Officer
Pueblo of Isleta
Environment Division
PO Box 1270
Isleta, NM 87022
(505) 869-7565
E-mail: POI36871@isletapueblo.com

Overnight/Express Mail Delivery
Pueblo of Isleta
Environment Division
6 Sagebrush St.
Albuquerque, NM 87105

c. CGP at 1.5 Requirement to post a notice of your permit coverage: Amend to read: "You must post a sign or other notice of your permit coverage at a safe, publicly accessible location in close proximity to the construction site. The notice must be located so that it is visible from the public road or tribal road that is nearest to the active part of the construction site…"

d. CGP at 7.2.6 Description of stormwater controls: The SWPPP will be considered to be incomplete if the operator has not coordinated requirements under this Part with the Pueblo of Isleta Public Services Department.

e. CGP I.12.6.1 at pg.I-6 of 8. The Pueblo of Isleta requests notification within 10 hours (rather than 24 hrs.) if health or the environment become endangered.

f. CGP at I.12.2 Anticipated noncompliance: Amend to read: "You must give advance notice to EPA and the Pueblo of Isleta at the address indicated in 1.4.1(a) of any planned changes in the permitted facility or activity which may results in noncompliance with permit requirements."

g. CGP at I.12.6.1: Any noncompliance for projects within the exterior boundaries of the Pueblo of Isleta which may endanger health or the environment shall be reported directly to the EPA Regional Office [(see contacts at https://www.epa.gov/npdes/contact-us-stormwater#regional) I and to the Pueblo of Isleta Water Quality Control Officer. Any information must be provided orally with n 12 hours of the time you become aware of the circumstances. Other requirements of this Part for a written submission apply. Electronic communication (E-mail) shall be provided as soon as practical. Verbal notice shall be provided to:

Water Quality Control Officer
Pueblo of Isleta
E-mail: POI36871@isletapueblo.com
(505) 869-7565
(505) 263-5425 cellular
(505) 869-3030 Police Dispatch

h. CGP at 2.2 Erosion and sediment control requirements: Erosion and sediment controls shall be designed to retain sediment on-site.

i. CGP at 2.2 Under Sediment control requirements, Standard Permit Condition Duty to Mitigate Volumes of sediment at or over (five) 5 cubic yards must be removed and placed for disposal within a tribally approved sediment Disposal Site, located on Pueblo of Isleta lands. CGP 2.2 at pg. 8.

j. Under Minimize erosion, a permittee must secure permission from the Pueblo or affected Pueblo of Isleta land assignment owner if a dissipation device needs to be placed up- or down- elevation of a given construction site. CGP 2.2.11 at pg. 11.

k. CGP at 2.3.6 Emergency spill notification requirements: You must notify the Pueblo of Isleta Water Quality Control Officer and National Response Center (NRC) [at (800) 424-8802 or, in the Washington, DC metropolitan area, call (202) 267-2675 in accordance with the requirements of 40 CFR 110, 40 CFR 117, and 40 CFR 302] as soon as you have knowledge of the release. Verbal and electronic notice shall be provided as specified in I.12.6.1

l. CGP at C.3 Equivalent analysis waiver: Parties wishing to apply for an Equivalent Analysis Waiver (see Appendix D, Section C) must provide a copy of the waiver analysis to the Pueblo of Isleta Water Quality Control Officer at the address indicated in 1.4.1 (a).

9.4.2.2 Pueblo of Sandia. The following conditions apply only to discharges on the Pueblo of Sandia Reservation:

a. Only those activities specifically authorized by the CGP are authorized by the Pueblo of Sandia's Water Quality certification. The Pueblo of Sandia's Water Quality Certification does not authorize impact to cultural properties, historical sites or properties that may be eligible as such.

b. Copies of all Notices of Intent (NOI) submitted to the EPA must also be sent concurrently to the Pueblo of Sandia at the following address. Discharges are not authorized by this permit unless an accurate and complete NOI has been submitted to the Pueblo of Sandia, either by mail or electronically.

Regular U.S. Delivery Mail:
Pueblo of Sandia Environment Department
Attention: Scott Bulgrin, Water Quality Manager
481 Sandia Loop
Bernalillo, New Mexico 87004

Electronically:
sbulgrin@sandiapueblo.nsn.us

c. Any correspondences between the applicant and EPA related to analytical data, written reports, corrective action, enforcement, monitoring, or an adverse incident written reports should likewise be routed to the Pueblo of Sandia at the above address.

d. The Stormwater Pollution Prevention Plan (SWPPP) must be available to the Pueblo of Sandia Environment Department either electronically or hard copy upon request for review. The SWPPP must be made available at least fourteen (14) days before construction begins. The fourteen (14) day period will give Pueblo staff time to become familiar with the project site, prepare for construction site inspections, and determine compliance with the Pueblo of Sandia Water Quality Standards. Failure to provide a SWPPP to the Pueblo of Sandia may result in the delay or denial of the construction project.

e. If requested by the Pueblo of Sandia Environment Department, the permittee must provide additional information necessary for a case-by-case eligibility determination to assure compliance with the Pueblo of Sandia Water Quality Standards and/or applicable Federal Standards not authorized by this certification.

f. An "Authorization to Proceed Letter" with site specific mitigation requirements may be sent out to the permittee when a review of the NOI and SWPPP, on a case- by-case basis is completed by the Pueblo of Sandia Environment Department. This approval will allow the application to proceed if all mitigation requirements are met.

g. The Pueblo of Sandia will not allow Small construction Waivers (Appendix C) or the Rainfall Erosivity Waiver (Appendix C.1) to be granted for any small construction activities.

h. Before submitting a Notice of Termination (NOT) to the EPA, permittees must clearly demonstrate to the Pueblo of Sandia Environment Department through a site visit or documentation that requirements for site stabilization have been met and any temporary erosion control structures have been removed. A short letter stating the NOT is acceptable and all requirements have been met will be sent to the permittee to add to the permittee's NOT submission to EPA.

i. Copies of all NOT submitted to the EPA must also be sent concurrently to the Pueblo of Sandia through the mail or electronically.

Regular U.S. Delivery Mail:
Pueblo of Sandia Environment Department
Attention: Scott Bulgrin, Water Quality Manager 481 Sandia Loop
Bernalillo, New Mexico 87004

Electronically:
sbulgrin@sandiapueblo.nsn.us

j. The Pueblo of Sandia may require the permittee to perform water quality monitoring for pH, turbidity, and total suspended solids (TSS) during the permit term if the discharge is to a surface water leading to the Rio Grande for the protection of public health and the environment.

9.4.2.3 Pueblo of Santa Ana. The following conditions apply only to discharges on the Pueblo of Santa Ana Reservation:

a. The operator shall provide a copy of the Notice of Intent (NOI) to the Pueblo of Santa Ana (the Pueblo), at the same time it is submitted to the U.S. Environmental Protection Agency (EPA), for projects with discharges onto the lands of the Pueblo as defined in the Pueblo of Santa Ana Water Quality Standards.

b. The operator shall provide a copy of the Stormwater Pollution Prevention Plan (SWPPP), at the same time that an NOI is submitted to the EPA, to the Pueblo for projects with discharges onto the lands of the Pueblo as defined in the Pueblo of Santa Ana Water Quality Standards.

c. The operator shall provide a copy of the SWPPP, copies of inspections reports, and copies of corrective action reports to the Pueblo at the address below for review, upon request.

d. The NOI, SWPPP and Notice of Termination (NOT) shall be sent to the Pueblo at the following address:

Pueblo of Santa Ana Department of Natural Resources,
Attention: Water Quality Program Specialist
2 Dove Road
Santa Ana Pueblo, NM, 87004

e. Discharges are not authorized by this permit unless an accurate and complete NOI and SWPPP have been submitted to the Pueblo. Failure to provide an accurate and complete NOI and SWPPP may result in a denial of the discharge permit or groundbreaking or construction delay.

f. The operator will not proceed with site work until authorized by the Pueblo. The Pueblo requires review of the complete and final SWPPP by the Pueblo before authorization to proceed. The Pueblo will provide an "authorization to proceed" notice after review and approval of the SWPPP.

g. Before submitting a NOT, permittees must certify to the Pueblo's Department of Natural Resources in writing that requirements for site stabilization have been met, and any temporary erosion control structures have been removed. Documentation of the Pueblo's review that such requirements have been reviewed and met will be provided for the permittee to add to the permittee's NOT submission to EPA. Copies of all NOT submitted to the EPA must also be sent to the Pueblo at the address provided above.

9.4.2.4 Pueblo of Santa Clara. The following conditions apply only to discharges on the Pueblo of Santa Clara Reservation:

a. The operator must provide a copy of the Notice of Intent (NOI) and Notice of Termination (NOT) to the Santa Clara Pueblo Governor's Office at the same time it is provided to the US Environmental Protection Agency.

b. A copy of the Storm water Pollution Prevention Plan shall be made available to the Pueblo of Santa Clara staff upon request.

9.4.2.5 Pueblo of Tesuque. The following conditions apply only to discharges on the Pueblo of Tesuque Reservation:

a. The operator shall provide a copy of the Notice of Intent (NOI) to the Pueblo of Tesuque Governor's Office and Environment Department at same time it is submitted to the Environmental Protection Agency, for projects occurring within the exterior boundaries of our tribal lands. The operator shall also notify the Pueblo of Tesuque Governor's Office and Environment Department when it submitted the Notice of Termination. The NOI and NOT shall be sent to the Pueblo of Tesuque Governor's Office and Environment Department at the following address:

Pueblo of Tesuque
Office of the Governor
Route 42 Box 360-T
Santa Fe, NM 87506 or
email: governor@pueblooftesuque.org

b. The operator shall also provide a copy of the Stormwater Pollution Prevention Plan, copies of inspections reports, and copies of corrective action reports to staff in the Pueblo of Tesuque Environment Department.

9.4.2.6 Taos Pueblo. The following conditions apply only to discharges on the Taos Pueblo Reservation:

a. The operator shall provide a copy of the Notice of Intent (NOI) to the Taos Pueblo Governor's Office, War Chief's Office and Environmental Office, at the same time it is submitted to the U.S. Environmental Protection Agency, for projects occurring within the exterior boundaries of Taos Pueblo. The operator shall also notify Taos Pueblo when it has submitted the Notice of Termination (NOT). The NOI and NOT shall be sent to the Taos Pueblo at the following addresses:

   i. Taos Pueblo Governor's Office
   P.O. Box 1846
   Taos NM 87571

   ii. Taos Pueblo War Chief's Office
   P.O. Box 2596
   Taos NM 87571

   iii. Environmental Office
   Attn: Program Manger
   P.O. Box 1846
   Taos NM 87571

b. Taos Pueblo requests that in the event Indian artifacts or human remains are inadvertently discovered on projects occurring near or on Taos Pueblo lands that consultation with the tribal Governor's Office occur at the earliest possible time.

c. The operator shall provide a copy of the Stormwater Pollution Prevention Plan, copies of inspections reports, and copies of corrective action reports to staff in the Taos Pueblo Environmental Office for review and copy, upon request.

9.4.2.7 Ohkay Owingeh. The following conditions apply only to discharges on the Ohkay Owingeh Reservation:

a. Prior to commencement of any construction activity on Ohkay Owingeh Lands requiring permit coverage under EPA's Construction General Permit, the operator(s) shall submit to Ohkay Owingeh Office of Environmental Affairs, a copy of the electronic "Notice of Intent," submitted to the Environmental Protection Agency, immediately following EPA's electronic notification that the NOI has been received. A copy of the Stormwater Pollution Prevention Plan(s) must be made available to the Ohkay Owingeh Office of Environmental Affairs upon the tribe's request either electronically or hard copy. Operator(s) shall also submit to Ohkay Owingeh Office of Environmental Affairs a copy of the electronic Notice of Termination (NOT) submitted to the Environmental Protection Agency. Documents shall be submitted to Ohkay Owingeh at the following address:

Ohkay Owingeh Office of Environment Affairs
Attention: Environmental Programs Manager
P.O. Box 717
Ohkay Owingeh, New Mexico 87566
Office # 505.852.4212
Fax # 505.852.1432
Electronic mail: naomi.archuleta@ohkay.org

b. Ohkay Owingeh will not allow the Rainfall Erosivity Waivers (see Appendix C) to be granted for any small construction activities.

c. All vegetation used to prevent soil loss, seeding or planting of the disturbed area(s) to meet the vegetative stabilization requirements must utilize native seeds/vegetation commonly known to the area. All temporary erosion control structures, such as silt fences must be removed as soon as stabilization requirements are met.

9.4.3 OKR10I000 Indian country within the State of Oklahoma

9.4.3.1 Pawnee Nation. The following conditions apply only to discharges within Pawnee Indian country:

a. Copies of the Notice of Intent (NOI) and Notice of Termination (NOT) must be provided to the Pawnee Nation at the same time it is submitted to the Environmental Protection Agency to the following address:

Pawnee Nation Department of Environmental Conservation and Safety
P.O. Box 470
Pawnee, OK 74058
Or email to mmatlock@pawneenation.org

b. The Storm Water Pollution Prevention Plan must be available to Departmental inspectors upon request.

c. The Department must be notified at 918.762.3655 immediately upon discovery of any noncompliance with any provision of the permit conditions.

9.4.4 OKR10F000 Discharges in the State of Oklahoma that are not under the authority of the Oklahoma Department of Environmental Quality, including activities associated with oil and gas exploration, drilling, operations, and pipelines (includes SIC Groups 13 and 46, and SIC codes 492 and 5171), and point source discharges associated with agricultural production, services, and silviculture (includes SIC Groups 01, 02, 07, 08, 09).

a. For activities located within the watershed of any Oklahoma Scenic River, including the Illinois River, Flint Creek, Barren Fork Creek, Upper Mountain Fork, Little Lee Creek, and Lee Creek or any water or watershed designated "ORW" in Oklahoma's Water Quality Standards, this permit may only be used to authorize discharges from temporary construction activities. Certification is denied for any on-going activities such as sand and gravel mining or any other mineral mining.

b. For activities located within the watershed of any Oklahoma Scenic River, including the Illinois River, Flint Creek, Barren Fork Creek, Upper Mountain Fork, Little Lee Creek, and Lee Creek or any water or watershed designated "ORW" in Oklahoma's Water Quality Standards, certification is denied for any discharges originating from support activities, including concrete or asphalt batch plants, equipment staging yards, material storage areas, excavated material disposal areas, or borrow areas.

c. In order to company with Oklahoma's Water Quality Standards, these conditions and restrictions also apply to any construction projects located wholly or partially on Indian Country lands within the State of Oklahoma.

9.5 EPA REGION 8

9.5.1 MTR10I000 Indian country within the State of Montana

9.5.1.1 The Confederated Salish and Kootenai Tribes of the Flathead Nation. The following conditions apply only to discharges on the Confederated Salish and Kootenai Tribes of the Flathead Nation Reservation:

a. Permittees must submit the Stormwater Pollution Prevention Plan (SWPPP) to the Confederated Salish and Kootenai Tribes at least 30 days before construction starts.

b. Before submitting the Notice of Termination (NOT), permittees must clearly demonstrate to an appointed Tribal staff person during an onsite inspection that requirements for site stabilization have been met.

c. The permittee must send a copy of the Notice of Intent (NOI) and the NOT to CSKT.

d. Permittees may submit their SWPPPs, NOIs and NOTs electronically to: clintf@cskt.org.

e. Written SWPPPs, NOIs and NOTs may be mailed to:

Clint Folden, Water Quality Regulatory Specialist
Confederated Salish and Kootenai Tribes
Natural Resources Department
P.O. Box 278
Pablo, MT 59855

9.6 EPA REGION 9

9.6.1 CAR10I000 Indian country within the State of California

9.6.1.1 Twenty-Nine Palms Band of Mission Indians. The following conditions apply only to discharges on the Twenty-Nine Palms Band of Mission Indians Reservation:

a. At the time the applicant submits its Notice of Intent (NOI) to the EPA, the applicant must concurrently submit written notification of the NOI and a copy of the Stormwater Pollution Prevention Plan (SWPPP) to the Twenty-Nine Palms Band of Mission Indians at the address below:

Tribal Environmental Coordinator
Twenty-Nine Palms Band of Mission Indians
46-200 Harrison Place
Coachella, CA 92236

b. The applicant must also concurrently submit to the Tribal Environmental Coordinator written notification of any other forms or information submitted to the EPA, including waivers, reporting, and Notice of Termination (NOT).

c. Permitted entities under the CGP must keep the Tribal EPA informed of authorized discharges under the CGP by submitting written information about the type, quantity, frequency and location, intended purpose, and potential human health and/or environmental effects of their activities. These requirements are pursuant to Section 4 of the Twenty-Nine Palms Band of Mission Indians Water Pollution Control Ordinance (022405A). This information may be submitted to Tribal EPA in the form of Stormwater Pollution Prevention Plans (SWPPPs), monitoring reports, or other reports as required under the CGP. Spills, leaks, or unpermitted discharges must be reported in writing to Tribal EPA within 24 hours of the incident.

9.6.2 GUR100000 Island of Guam. The following conditions apply only to discharges on the Island of Guam:

a. Any earth-moving operations which require a permit must be obtained from the Department of Public Works (DPW) with clearance approval from various Government of Guam Agencies including Guam EPA prior to the start of any earth-moving activity.

b. In the event that the construction sites are within the Guam Sole Source Aquifer, the construction site owner and operator must consider opportunities to facilitate groundwater recharge for construction and post-construction implementing infiltration Best Management Practices. Stormwater disposal systems shall be designed and operated within the boundaries of the project. Stormwater systems shall not be permitted within any Wellhead Protection Zone unless the discharge meets the Guam Water Quality Standards within the zone. Waters discharged within the identified category G-2 recharge zone shall receive treatment to the degree required to protect the drinking water quality prior to it entering the category G-1 resource zone.

c. All conditions and requirements set forth in the 22 Guam Administrative Rules and Regulations (GARR), Division II, Water Control, Chapter 10, Guam Soil Erosion and Sediment Control Regulations (GSESCR) that are more protective than the CGP regarding construction activities must be complied with.

d. All standards and requirements set forth in the 22 GARR, Division II, Water Control, Chapter 5, *Guam Water Quality Standards (GWQS) 2001 Revisions*, must be complied with to include reporting GWQS exceedance to Guam EPA.

e. All operators/owners of any property development or earth moving activities shall comply with the erosion control pre-construction and post-construction BMP design performance standards and criteria set forth in the 2006 CNMI and Guam Stormwater Management Manual.

f. All conditions and requirements regarding dewatering activities set forth in 22 Guam Administrative Rules and Regulations Chapter 7, Water Resources Development and Operating Regulations must be complied with to include securing permits with Guam EPA prior to the start of any dewatering activities.

g. If a project to be developed is covered under the Federal Stormwater Regulations (40 CFR Parts 122 & 123), a Notice of Intent (NOI) to discharge stormwater to the surface and marine waters of Guam must be submitted to the U.S. EPA and a copy furnished to Guam EPA, pursuant to Section 10, 104(B)(5)(d) 22GAR, Division II, Chapter 10.

h. Guam EPA shall apply the Buffer Requirements listed in Appendix G of the CGP NPDES Permit for construction activities as it pertains to Waters of the U.S. in Guam. Guam EPA shall also apply the same buffer requirements for sinkholes in Guam.

i. When Guam EPA, through its permit review process, identifies that the proposed construction activity is close proximity to marine waters, contractors and owners will be informed that any activity that may impair water quality are required to stop during peak coral spawning periods as per the Guam Coral Spawning Construction Moratoriums.

j. The Proposed Construction General Permit must set appropriate measures and conditions to protect Guam's Threatened and Endangered Species and Outstanding Resource Waters of exceptional recreational or ecological significance as determined by the Guam EPA Administrator as per *Guam Water Quality Standards 2001 Revisions,* §5102, Categories of Waters, D. Outstanding Resource Waters.

k. When Guam EPA through its permit review process identifies that proposed construction activity is in close proximity to any Section 303d impaired waters, which includes marine waters and surface waters, shall ensure that construction activity does not increase the impaired water's ambient parameters.

l. When Rainfall Erosivity and TMDL Waivers reflected in the CGP, Appendix C, are submitted to the U.S. EPA, Guam EPA will review waivers on a project by project basis.

m. Prior to submission of the Notice of Termination (NOT) to the U.S. EPA, permittees must clearly demonstration to Guam EPA that the project site has met all soil stabilization requirements and removal of any temporary erosion control as outlined in the GSESCR.

9.7 EPA REGION 10

9.7.1 IDR100000 State of Idaho, except Indian country

a. *Idaho's Antidegradation Policy*. The WQS contain an antidegradation policy providing three levels of protection to water bodies in Idaho (IDAPA 58.01.02.051).

   1. Tier I Protection. The first level of protection applies to all water bodies subject to Clean Water Act jurisdiction and ensures that existing uses of a water body and the level of water quality necessary to protect those existing uses will be maintained and protected (IDAPA 58.01.02.051.01; 58.01.02.052.01). Additionally, a Tier 1 review is performed for all new or reissued permits or licenses (IDAPA 58.01.02.052.05).
   2. Tier II Protection. The second level of protection applies to those water bodies considered high quality and ensures that no lowering of water quality will be allowed unless deemed necessary to accommodate important economic or social development (IDAPA 58.01.02.051.02; 58.01.02.052.08).
   3. Tier III Protection. The third level of protection applies to water bodies that have been designated outstanding resource waters and requires that activities not cause a lowering of water quality (IDAPA 58.01.02.051.03; 58.01.02.052.09).

   DEQ is employing a water body by water body approach to implementing Idaho's antidegradation policy. This approach means that any water body fully supporting its beneficial uses will be considered high quality (IDAPA 58.01.02.052.05.a). Any water body not fully supporting its beneficial uses will be provided Tier I protection for that use, unless specific circumstances warranting Tier II protection are met (IDAPA 58.01.02.052.05.c). The most recent federally approved Integrated Report and supporting data are used to determine support status and the tier of protection (IDAPA 58.01.02.052.05).

b. *Pollutants of Concern.* The primary pollutants of concern associated with stormwater discharges from construction activities are sediment, typically measured as total suspended solids and turbidity. Other potential pollutants include the following:

phosphorus, nitrogen, pesticides, organics, metals, PCBs, petroleum products, construction chemicals, and solid wastes.

c. *Receiving Water Body Level of Protection.* The CGP provides coverage to construction activities throughout the entire State of Idaho. Because of the statewide applicability, all of the jurisdictional waters within Idaho could potentially receive discharges either directly or indirectly from activities covered under the CGP. DEQ applies a water body by water body approach to determine the level of antidegradation a water body will receive.

All waters in Idaho that receive discharges from activities authorized under the CGP will receive, at minimum Tier I antidegradation protection because Idaho's antidegradation policy applies to all waters of the state. Water bodies that fully support their aquatic life or recreational uses are considered to be *high quality waters* and will receive Tier II antidegradation protection.

Although Idaho does not currently have any Tier III designated outstanding resource waters (ORWs) designated, it is possible for a water body to be designated as an ORW during the life of the CGP. Because of this potential, the antidegradation review also assesses whether the permit complies with the outstanding resource water requirements of Idaho's antidegradation policy.

To determine the support status of the receiving water body, persons filing a Notice of Intent (NOI) for coverage under this general permit must use the most recent EPA-approved Integrated Report, available on Idaho DEQ's website: http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report/.

High quality waters are identified in Categories 1 and 2 of the Integrated Report. If a water body is in either Category 1 or 2, it is a Tier II water body.

Unassessed waters are identified as Category 3 of DEQ's Integrated Report. These waters require a case-by-case determination to be made by DEQ based on available information at the time of the application for permit coverage. If a water body is unassessed, the applicant is directed to contact DEQ for assistance in filing the NOI.

Impaired waters are identified in Categories 4 and 5 of the Integrated Report. Category 4(a) contains impaired waters for which a TMDL has been approved by EPA. Category 4(b) contains impaired waters for which controls other than a TMDL have been approved by EPA. Category 5 contains waters which have been identified as "impaired," for which a TMDL is needed. These waters are Tier I waters, for the use which is impaired. With the exception, if the aquatic life uses are impaired for any of these three pollutants—dissolved oxygen, pH, or temperature—and the biological or aquatic habitat parameters show a health, balanced biological community, then the water body shall receive Tier II protection, in addition to Tier I protection, for aquatic life uses (IDAPA 58.01.02.052.05.c.i.).

DEQ's webpage also has a link to the state's map-based Integrated Report which presents information from the Integrated Report in a searchable, map-based format: http://www.deq.idaho.gov/assistance-resources/maps-data/.

Water bodies can be in multiple categories for different causes. If assistance is needed in using these tools, or if additional information/clarification regarding the support status of the receiving water body is desired, the operator is directed to make contact with the appropriate DEQ regional office of the State office in the table below:

Regional and State Office	**Address**	**Phone Number**	**Email**
Boise	1445 N. Orchard Rd., Boise 83706	208-373-0550	Kati.carberry@deq.idaho.gov
Coeur d'Alene	2110 Ironwood Parkway, Coeur D'Alene 83814	208-769-1422	June.bergquist@deq.idaho.gov
Idaho Falls	900 N. Skyline, Suite B., Idaho Falls 83402	208-528-2650	Troy.saffle@deq.idaho.gov
Lewiston	1118 "F" St., Lewiston 83501	208-799-4370	Mark.sellet@deq.idaho.gov
Pocatello	444 Hospital way, #300 Pocatello 83201	208-236-6160	Lynn.vanevery@deq.idaho.gov
Twin Falls	650 Addison Ave., W., Suite 110, Twin Falls 83301	208-736-2190	Balthasar.buhidar@deq.idaho.gov
State Office	1410 N. Hilton Rd., Boise 83706	208-373-0502	Nicole.deinarowicz@deq.idaho.gov

d. *Turbidity Monitoring.* The permittee must conduct turbidity monitoring during construction activities and thereafter on days where there is a direct discharge of pollutants from an unstabilized portion of the site which is causing a visible plume to a water of the U.S.

A properly and regularly calibrated turbidimeter is required for measurements analyzed in the field (preferred method), but grab samples may be collected and taken to a laboratory for analysis. If the permittee can demonstrate that there will be no direct discharge from the construction site, then turbidity monitoring is not required. When monitoring is required, a sample must be taken at an undisturbed area immediately upstream of the project area to establish background turbidity levels for the monitoring event. Background turbidity, location, date and time must be recorded prior to monitoring downstream of the project area. A sample must also be taken immediately downstream from any point of discharge and *within* any visible plume. The turbidity, location, date and time must be recorded. The downstream sample must be taken immediately following the upstream sample in order to obtain meaningful and representative results.

Results from the compliance point sampling or observation[78] must be compared to the background levels to determine whether project activities are causing an exceedance of state WQS. If the downstream turbidity is 50 NTUs or more than the upstream turbidity, then the project is causing an exceedance of WQS. *Any exceedance of the turbidity standard must be reporting to the appropriate DEQ regional office within 24 hours. The following six (6) steps should be followed to ensure compliance with the turbidity standard:*

1. If a visible plume is observed, quantify the plume by collecting turbidity measurements from within the plume and compare the results to Idaho's instantaneous numeric turbidity criterion (50 NTU over the background).
2. If turbidity is less than 50 NTU instantaneously over the background turbidity; continue monitoring as long as the plume is visible. If turbidity exceeds background turbidity by more than 50 NTU instantaneously then stop all earth disturbing construction activities and proceed to step 3.
3. Take immediate action to address the cause of the exceedance. That may include inspection the condition of project BMPs. If the BMPs are functioning to their fullest capability, then the permittee must modify project activities and/or BMPs to correct the exceedance.
4. Notify the appropriate DEQ regional office within 24 hours.
5. Possibly increase monitoring frequency until state water quality standards are met.
6. Continue earth disturbing construction activities once turbidity readings return to within 50 NTU instantaneously <u>and</u> 25 NTU for more than ten consecutive days over the background turbidity.

Copies of daily logs for turbidity monitoring must be available to DEQ upon request. The report must describe all exceedances and subsequent actions taken, including the effectiveness of the action.

e. *<u>Reporting of Discharges Containing Hazardous Materials or Petroleum Products.</u>* All spills of hazardous material, deleterious material or petroleum products which may impact waters (ground and surface) of the state shall be immediately reported. Call 911 if immediate assistance is required to control, contain or clean up the spill. If no assistance is needed in cleaning up the spill, contact the appropriate DEQ regional office in the table below during normal working hours or Idaho State Communications Center after normal working hours. If the spilled volume is above federal reportable quantities, contact the National Repose Center.

<u>For immediate assistance</u>: Call 911

<u>National Response Center</u>: (800) 424-8802

<u>Idaho State Communications Center</u>: (800) 632-8000

[78] A visual observation is only acceptable to determine whether BMPs are functioning properly. If a plume is observed, the project may be causing an exceedance of WQS and the permittee must collect turbidity data and inspect the condition of the projects BMPs. If the BMPs appear to be functioning to their fullest capability and the turbidity is 50 NTUs or more than the upstream turbidity, then the permittee must modify the activity or implement additional BMPs (this may also include modifying existing BMPs).

Regional office	Toll Free Phone Number	Phone Number
Boise	888-800-3480	208-373-0550
Coeur d'Alene	877-370-0017	208-769-1422
Idaho Falls	800-232-4635	208-528-2650
Lewiston	977-547-3304	208-799-4370
Pocatello	888-655-6160	208-236-6160
Twin Falls	800-270-1663	208-736-2190

9.7.2 IDR10I000 Indian country within the State of Idaho, except Duck Valley Reservation lands (see Region 9)

9.7.2.1 Shoshone-Bannock Tribes. The following conditions apply only to discharges on the Shoshone-Bannock Reservation:

f. Each operator shall submit a signed hard copy of the Notice of Intent (NOI) to the Shoshone-Bannock Tribes Water Resources Department at the same time it is submitted electronically to the Environmental Protection Agency (EPA) and shall provide the Shoshone-Bannock Tribes Water Resources Department the acknowledgement of receipt of the NOI from the EPA within 7 calendar days of receipt from the EPA.

9.7.3 WAR10F000 Areas in the State of Washington, except those located on Indian country, subject to construction activity by a Federal Operator. The following conditions apply only to discharges on federal facilities in the State of Washington:

a. Discharges shall not cause or contribute to a violation of surface water quality standards (Chapter 173-201A WAC), groundwater quality standards (Chapter 173-200 WAC), sediment management standards (Chapter 173-204 WAC), and human health-based criteria in the National Toxics Rule (40 CFR Part 131.36). Discharges that are not in compliance with these standards are not authorized.

b. Prior to the discharge of stormwater and non-storm water to waters of the State, the Permittee must apply all known, available, and reasonable methods of prevention, control, and treatment (AKART). This includes the preparation and implementation of an adequate SWPPP, with all appropriate BMPs installed and maintained in accordance with the SWPPP and the terms and conditions of this permit.

c. Permittees who discharge to segments of waterbodies listed as impaired by the State of Washington under Section 303(d) of the Clean Water Act for turbidity, fine sediment, phosphorus, or pH must comply with the following numeric effluent limits:

Parameter Identified in 303{d) Listing	Parameter Sampled	Unit	Analytical Method	Numeric Effluent Limit
• Turbidity • Fine Sediment • Phosphorus	Turbidity	NTU	SM2130 or EPA 180.1	25 NTUs at the point where the stormwater is discharged from the site.
High pH	pH	Su	pH meter	In the range of 6.5 – 8.5

d. All references and requirements associated with Section 303(d) of the Clean Water Act mean the most current EPA approved listing of impaired waters that exists on February 16, 2017, or the date when the operator's complete permit application is received by EPA, whichever is later.

e. Discharges to waterbodies subject to an applicable Total Maximum Daily Load (TMDL) for turbidity, fine sediment, high pH, or phosphorus, shall be consistent with the assumptions and requirements of the TMDL.

   i. Where an applicable TMDL sets specific waste load allocations or requirements for discharges covered by this permit, discharges shall be consistent with any specific waste load allocations or requirements establish by the applicable TMDL.

   ii. Where an applicable TMDL has established a general waste load allocation for construction stormwater discharges, but no specific requirements have been identified, compliance with this permit will be assumed to be consistent with the approved TMDL.

   iii. Where an applicable TMDL has not specified a waste load allocation for construction stormwater discharges, but has not excluded these discharges, compliance with this permit will be assumed to be consistent with the approved TMDL.

   iv. Where an applicable TMDL specifically precludes or prohibits discharges from construction activity, the operator is not eligible for coverage under this permit.

   v. Applicable TMDL means a TMDL for turbidity, fine sediment, high pH, or phosphorus, which has been completed and approved by EPA prior to February 16, 2017, or prior to the date the operator's complete NOI is received by EPA, whichever is later.

9.7.4 WAR10I000 Indian country within the State of Washington

9.7.4.1 Confederated Tribes of the Colville Reservation. The following conditions apply only to discharges on the Colville Indian Reservation (CIR) and on other Tribal trust lands or allotments of the Confederated Tribes of the Colville Reservation:

a. A copy of the Stormwater Pollution Prevention Plan must be submitted to the following office at least thirty (30) days in advance of sending the Notice of Intent (NOI) to EPA:

   Environmental Trust Department
   Confederated Tribes of the Colville Reservation
   PO Box 150
   Nesepelem, WA 99155

b. Copies of the Notice of Intent (NOI) and Notice of Termination (NOT) must be sent to the ETD at the same time they are submitted to EPA.

c. Discharges to Omak Creek, the Okanogan River, and Columbia River downstream of Chief Joseph Dam may affect threatened or endangered species, and shall only be permitted in adherence with Appendix D of the CGP.

d. All work shall be carried out in such a manner as will prevent violations of water quality criteria as stated in Chapter 4-8 Water Quality Standards of the Colville Law and Order Code, as amended.

e. Appropriate steps shall be taken to ensure that petroleum products or other chemical pollutants are prevented from entering waters of the CIR. All spills must be reported to the appropriate emergency management agency and the ETD, and measures shall be taken immediately to prevent the pollution of waters of the CIR, including groundwater.

f. Stormwater site inspections shall be conducted at least once every 7 calendar days, within 24-hours of the occurrence of a rain event of 0.25 inches or greater in a 24-hour period, and daily during periods of saturated ground surface or snowmelt with accompanying surface runoff.

g. Results of discharge sampling must be reported to the ETD within 7 days of sample collection. All sample reporting must include the date and time, location, and individual performing the sampling.

h. Any corrective action reports that are required under the CGP must be submitted to the ETD at the above address within one (1) working day of the report completion.

i. This certification does not authorize impacts to cultural, historical, or archeological features or sites, or proprieties that may be eligible for such listing.

9.7.4.2 Lummi Nation. The following conditions apply only to discharges on the Lummi Reservation:

a. The Lummi Nation reserves the right to modify this 401 certification if the final version of the NPDES General Permit for Storm Water Discharges Associated with Construction Activity (CGP) on tribal lands in the State of Washington (Permit No. WAR10I000) is substantively different than the draft version of the proposed permit that was made available for public comments during April 2016. The Lummi Nation will determine if the final version of the NPDES CGP is substantively different than the draft version following review of the final version once the EPA makes it available.

b. This certification does not exempt and is provisional upon compliance with other applicable statutes and codes administered by federal and Lummi tribal agencies. Pursuant to Lummi Code of Laws (LCL) 17.05.020(a), the operator must also obtain a land use permit from the Lummi Planning Department as provided in Title 15 of the Lummi Code of Laws and regulations adopted thereunder.

c. Pursuant to LCL 17.05.020(a), each operator shall develop and submit a Storm Water Pollution Prevention Plan to the Lummi Water Resources Division for review and approval by the Water Resources Manager prior to beginning any discharge activities.

d. Pursuant to LCL Title 17, each operator shall be responsible for achieving compliance with the Water Quality Standards for Surface Waters of the Lummi Indian Reservation (Lummi Administrative Regulations [LAR] 17 LAR 07.010 through 17 LAR 07.210 together with supplements and amendments thereto).

e. Each operator shall submit a signed hard copy of the Notice of Intent (NOI) to the Lummi Water Resources Division at the same time it is submitted electronically to the Environmental Protection Agency (EPA) and shall provide the Lummi Water Resources Division the acknowledgement of receipt of the NOI from the EPA and the associated NPDES tracking number provided by the EPA within 7 calendar days of receipt from the EPA.

f. Each operator shall submit a signed hard copy of the Notice of Termination (NOT) to the Lummi Water Resources Division at the same time it is submitted electronically to the EPA and shall provide the Lummi Water Resources Division the EPA acknowledgement of receipt of the NOT.

g. Storm Water Pollution Prevention Plans, Notice of Intent, Notice of Termination and associated correspondence with the EPA shall be submitted to:

Lummi Natural Resources Department
ATTN: Water Resources Manager
2665 Kwina Road
Bellingham, WA 98226-9298

9.7.4.3 Makah Tribe. The following conditions apply only to discharges on the Makah Reservation:

a. The operator shall be responsible for achieving compliance with the Makah Tribe's Water Quality Standards.

b. The operator shall submit a Storm Water Pollution Prevention Plan to the Makah Tribe Water Quality Program and Makah Fisheries Habitat Division for review and approval at least thirty (30) days prior to beginning any discharge activities.

c. The operator shall submit a copy of the Notice of Intent to the Makah Tribe Water Quality Program and Makah Fisheries Habitat Division at the same time it is submitted to EPA.

d. Storm Water Pollution Prevention Plans and Notices of Intent shall be submitted to:

Aaron Parker
Makah Fisheries Management Water Quality Specialist
(360) 645-3162
Cell 206-356-0319
Aaron.parker@makah.com
PO Box 115
Neah Bay WA 98357

9.7.4.4 Puyallup Tribe of Indians. The following conditions apply only to discharges on the Puyallup Tribe of Indians Reservation:

a. Each permittee shall be responsible for achieving compliance with the Puyallup Tribe's Water Quality Standards, including antidegradation provisions. The Puyallup Natural Resources Department will conduct an antidegradation review for permitted activities that have the potential to lower water quality. The antidegradation review will be consistent with the Tribe's Antidegradation Implementation Procedures. The Tribe may also impose additional controls on a site-specific basis, or request EPA to require the operator obtain coverage under an individual permit, if information in the NOI or from other sources indicates that the operator's discharges are not controlled as necessary to meet applicable water quality standards.

b. The permittee shall be responsible for meeting any additional permit requirements imposed by EPA necessary to comply with the Puyallup Tribe's antidegradation policies if the discharge point is located within 1 linear mile upstream of waters designated by the Tribe.

c. Each permittee shall submit a copy of the Notice of Intent (NOI) to be covered by the general permit to Char Naylor (char.naylor@puyalluptribe.com) and Russ Ladley (russ.ladley@puyalluptribe.com) by email or at the address listed below at the same time it is submitted to EPA.

   Puyallup Tribe of Indians
   3009 E. Portland Avenue
   Tacoma, WA 98404
   ATTN: Russ Ladley and Char Naylor

d. All supporting documentation and certifications in the NOI related to coverage under the general permit for Endangered Species Act purposes shall be submitted to the Tribe's Resource Protection Manager (russ.ladley@puyalluptribe.com) and Char Naylor (char.naylor@puyalluptribe.com) for review.

e. If EPA requires coverage under an individual or alternative permit, the permittee shall submit a copy of the permit to Russ Ladley and Char Naylor at the address listed above.

f. The permittee shall submit all stormwater pollution prevention plans to Char Naylor for review and approval prior to beginning any activities resulting in a discharge to tribal waters.

g. The permittee shall conduct benchmark monitoring for turbidity (or transparency) and, in the event of significant concrete work or engineered soils, pH monitoring as well. Monitoring, benchmarks, and reporting requirements contained in Condition S.4. (pp.13-20) of the Washington State Construction Stormwater General Permit, effective January 1, 2016, shall apply, as applicable.

h. The permittee shall notify Char Naylor (253-680-5520) and Russ Ladley (253-680-5560) prior to conducting inspections at construction sites generating storm water discharged to tribal waters.

i. Treat dewatering discharges with controls necessary to minimize discharges of pollutants in order to minimize the discharge of pollutants to groundwater or surface waters from stormwater that is removed from excavations, trenches, foundations, vaults, or other storage areas. Examples of appropriate controls include sediment basins or sediment traps, sediment socks, dewatering tanks, tube settlers, weir tanks, and filtration systems (e.g., bag or sand filters) that are designed to remove sediment.

   To the extent feasible, utilize vegetated, upland areas of the site to infiltrate dewatering water before discharge. At all points where dewatering water is discharged, comply with the velocity dissipation requirements of Part 2.2.11 of EPA's 2016 General Construction Stormwater Permit. Examples of velocity dissipation devices include check dams, sediment traps, riprap, and grouted riprap at outlets.

j. The permittee shall provide and maintain natural buffers to the maximum extent possible (and/or equivalent erosion and sediment controls) when tribal waters are located within 100 feet of the site's earth disturbances. If infeasible to provide and maintain an undisturbed 100 foot natural buffer, erosion and sediment controls to achieve the sediment load reduction equivalent to a 100-foot undisturbed natural buffer shall be required.

9.7.4.5 Spokane Tribe of Indians. The following conditions apply only to discharges on the Spokane Tribe Reservation:

a. Pursuant to Tribal Law and Order Code (TLOC) Chapter 30 each operator shall be responsible for achieving compliance with the Surface Water Quality Standards of the Spokane Tribe. The operator shall notify the Spokane Tribe, Water Control Board (WCB) of any spills of hazardous material and;
b. Each operator shall submit a signed hard copy of the Notice of Intent (NOI) to the WCB at the same time it is submitted to EPA.
c. The permittee shall allow the Tribal Water Control Board or its designee to inspect and sample at the construction site as needed.
d. Each operator shall submit a signed copy of the Notice of Termination (NOT) to the WCB at the same time it is submitted to EPA.

The correspondence address for the Spokane Tribe Water Control Board is:

Water Control Board
c/o. Brian Crossley
P0 Box 480
Wellpinit WA 99040
(509)626-4409
crossley@spokanetribe.com

9.7.4.6 Swinomish Indian Tribal Community. The following conditions apply only to discharges on the Swinomish Reservation:

a. Owners and operators seeking coverage under this permit who intend to discharge to Regulated Surface Waters must submit a copy of the Notice of Intent (NOI) to the DEP at the same time the NOI is submitted to EPA.
b. Owners and operators seeking coverage under this permit must also submit a Stormwater Pollution Prevention Plan to the DEP for review and approval by DEP prior to beginning any discharge activities.
c. Owners and operators must also submit to the DEP Changes in NOI and/or Notices of Termination at the same time they are submitted to EPA.

9.7.4.7 Tulalip Tribes. The following conditions apply only to discharges on the Tulalip Reservation:

a. This certification does not exempt and is provisional upon compliance with other applicable statues and codes administered by federal and Tulalip tribal agencies. Pursuant to Tulalip Tribes code of law, the operator must also obtain a land use permit from the Tulalip Tribes Planning Department as provided in Title 7 of the Tulalip Tribal Code (http://www.codepublishing.com/WA/Tulalip/?Tulalip02/Tulalip0205.html).
b. Each CGP operator shall be responsible for achieving compliance with Tulalip Tribes Water Quality Standards.
c. Each CGP operator shall submit their Stormwater Pollution Prevention Plan (SWPPP) to the:

Tulalip Natural & Cultural Resources Department
Tulalip Tribes
6406 Marine Drive
Tulalip, WA 98271

Appendix C
Notice of Intent (NOI)

NPDES FORM 3510-9	EPA	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY WASHINGTON, DC 20460 NOTICE OF INTENT (NOI) FOR THE 2017 NPDES CONSTRUCTION PERMIT	FORM Approved OMB No. 2040-0004

Submission of this Notice of Intent (NOI) constitutes notice that the operator identified in Section III of this form requests authorization to discharge pursuant to the NPDES Construction General Permit (CGP) permit number identified in Section II of this form. Submission of this NOI also constitutes notice that the operator identified in Section III of this form meets the eligibility requirements of Part 1.1 CGP for the project identified in Section IV of this form. Permit coverage is required prior to commencement of construction activity until you are eligible to terminate coverage as detailed in Part 8 of the CGP. To obtain authorization, you must submit a complete and accurate NOI form. Discharges are not authorized if your NOI is incomplete or inaccurate or if you were never eligible for permit coverage. Refer to the instructions at the end of this form.

Permit Information

NPDES ID: NMR10022R

State where your construction site is located: NM

Is your construction site located on Indian Country Lands? ☐ YES ☑ NO

Are you requesting coverage under this NOI as a *"Federal Operator"* as defined in Appendix A (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_a_-_definitions_508.pdf)?

☐ YES ☑ NO

Have stormwater discharges from your current construction site been covered previously under an NPDES permit? ☐ YES ☑ NO

Will you use polymers, flocculants, or other treatment chemicals at your construction site? ☐ YES ☑ NO

Has a Stormwater Pollution Prevention Plan (SWPPP) been prepared in advance of filling this NOI, as required? ☑ YES ☐ NO

Are you able to demonstrate that you meet one of the criteria listed in Appendix D (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_d_-_endangered_species_reqs_508.pdf) with respect to protection of threatened or endangered species listed under the Endangered Species Act (ESA) and federally designated critical habitat?

☑ YES ☐ NO

Have you completed the screening process in Appendix E (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_e_-_historic_properties_reqs_508.pdf) relating to the protection of historic properties?

☑ YES ☐ NO

Indicating "Yes" below, I confirm that I understand that CGP only authorized the allowable stormwater discharges in Part 1.2.1 and the allowable non-stormwater discharges listed in Part 1.2.2. Any discharges not expressly authorized in this permit cannot become authorized or shielded from liability under CWA section 402(k) by disclosure to EPA, state or local authorities after issuance of this permit via any means, Including the Notice of Intent (NOI) to be covered by the permit, the Stormwater Pollution Prevention Plan (SWPPP), during an Inspection, etc. If any discharges requiring NPDES permit coverage other than the allowable stormwater and non-stormwater discharges listed in Parts 1.2.1 and 1.2.2 will be discharged, they must be covered under another NPDES permit.

☑ YES ☐ NO

Operator Information

Operator Information

Operator Name: NGL Waste Services, LLC

Mailing Address:

Street/Location: 3773 Cherry Creek North Drive, Suite 1000

City: Denver **State:** CO **Zip Code:** 80209

County or Similar Government Subdivision: DENVER

Operator Point of Contact Information

First Name, Middle Initial, LastName: Garrett Clemons

Title: Vice President, EHS

Phone: 303-370-7106 **Ext.**

Email: garrett.clemons@nglep.com

Project/Site Information

Project/Site Name: North Ranch Surface Waste Management Facility

Project/Site Address

Street/Location: Battle Axe Road

City: Jal **State:** NM **Zip Code:** 88252

County or Similar Government Subdivision: LEA

Latitude/Longitude: 32.1449°N, 103.4624°W

Latitude/Longitude Data Source: Map

Horizontal Reference Datum: NAD 83

Project Start Date: 2019-05-15

Project End Date: 2029-06-15

Estimated Area to be Disturbed: 270.25

Types of Construction Sites:

- Industrial

Will there be demolition of any structure built or renovated before January 1, 1980? ☐ YES ☑ NO

Was the pre-development land use used for agriculture? ☑ YES ☐ NO

Have earth-disturbing activities commenced on your project/site? ☐ YES ☑ NO

Is your project located on a property of religious or cultural significance to an Indian tribe? ☐ YES ☑ NO

Discharge Information

Does your project/site discharge stormwater into a Municipal Separate Storm Sewer System (MS4)? ☐ YES ☑ NO

Are there any waters of the U.S. within 50 feet of your project's earth disturbances? ☐ YES ☑ NO

Are any of the waters of the U.S. to which you discharge designated by the state or tribal authority under its antidegradation policy as a Tier 2 (or Tier 2.5) water (water quality exceeds levels necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water) or as a Tier 3 water (Outstanding National Resource Water)? See Appendix F (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_f_-_tier_3_tier_2_and_tier_2.5_waters_508.pdf)

☐ YES ☑ NO

001: Unnamed Surrounding property is at a higher elevation (on all sides) than the subject property

Latitude/Longitude: 32.1396°N, 103.4654°W

Tier Designation: N/A

Is this receiving water impaired (on the CWA 303(d) list)? ☐ YES ☑ NO

Has a TMDL been completed for this receiving waterbody? ☐ YES ☑ NO

002: Unnamed Surrounding property is at a higher elevation (on all sides) than the subject property

Latitude/Longitude: 32.1367°N, 103.4592°W

Tier Designation: N/A

Is this receiving water impaired (on the CWA 303(d) list)? ☐ YES ☑ NO

Has a TMDL been completed for this receiving waterbody? ☐ YES ☑ NO

Stormwater Pollution Prevention Plan (SWPPP)

First Name, Middle Initial, LastName: LaVern D Choquette

Title: Principal Consultant

Phone: 405-531-0600 **Ext.**

Email: vchoquette@bearcreekconsultants.com

Endangered Species Protection

Using the Instructions in Appendix D of the CGP, under which criterion listed in Appendix D are you eligible for coverage under this permit? Criterion A

Provide a brief summary of the basis for criterion selection listed above (the necessary content for a supportive basis statement is provided under the criterion you selected.):

According to the USFWS Information for Planning and Conservation (IPaC) Environmental Conservation Online System, only one federally protected species is located in the area: Northern Aplomado Falcon (Falco femoralis septentrionalis). There is no critical habitat located in the project area.

Historic Preservation

Are you installing any stormwater controls as described in Appendix E (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_e_-_historic_properties_reqs_508.pdf) that require subsurface earth disturbances? (Appendix E (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_e_-_historic_properties_reqs_508.pdf), Step 1)

☑ YES ☐ NO

Have prior surveys or evaluations conducted on the site already determined historic properties do not exist, or that prior disturbances have precluded the existence of historic properties? (Appendix (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_e_-_historic_properties_reqs_508.pdf), Step 2):

☐ YES ☑ NO

Have you determined that your installation of subsurface earth-disturbing stormwater controls will have no effect on historic properties? (Appendix E (https://www.epa.gov/sites/production/files/2017-02/documents/2017_cgp_final_appendix_e_-_historic_properties_reqs_508.pdf), Step 3)

☑ YES ☐ NO

Certification Information

Certified By: Garrett Clemons (GCLEMONS)

Certified On: 04/15/2019 4:33 PM

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 gathered and evaluated 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 have no personal knowledge that the information submitted is other than 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. Signing an electronic document on behalf of another person is subject to criminal, civil, administrative, or other lawful action.

Appendix D
SWP3 Forms

General Information (see reverse for instructions)					
Name of Project		**NPDES ID No.**		**Inspection Date**	
Weather conditions during inspection		**Inspection start time**		**Inspection end time**	
Inspector Name, Title & Contact Information					
Present Phase of Construction					
Inspection Location (if multiple inspections are required, specify location where this inspection is being conducted)					

Inspection Frequency *(Note: you may be subject to different inspection frequencies in different areas of the site. Check all that apply)*

Standard Frequency:

☐ Every 7 days

☐ Every 14 days and within 24 hours of a 0.25" rain or the occurrence of runoff from snowmelt sufficient to cause a discharge

Increased Frequency:

☐ Every 7 days and within 24 hours of a 0.25" rain (for areas of sites discharging to sediment or nutrient-impaired waters or to waters designated as Tier 2, Tier 2.5, or Tier 3)

Reduced Frequency:

☐ Twice during first month, no more than 14 calendar days apart; then once per month after first month; (for stabilized areas)

☐ Twice during first month, no more than 14 calendar days apart; then once more within 24 hours of a 0.25" rain (for stabilized areas on "linear construction sites")

☐ Once per month and within 24 hours of a 0.25" rain (for arid, semi-arid, or drought-stricken areas during seasonally dry periods or during drought)

☐ Once per month (for frozen conditions where earth-disturbing activities are being conducted)

Was this inspection triggered by a 0.25" storm event? ☐ Yes ☐ No

If yes, how did you determined whether a 0.25" storm event has occurred?

☐ Rain gauge on site ☐ Weather station representative of site. Specify weather station source:

Total rainfall amount that triggered the inspection (in inches)**:**

Was this inspection triggered by the occurrence of runoff from snowmelt sufficient to cause a discharge? ☐ Yes ☐ No

Unsafe Conditions for Inspection

Did you determine that any portion of your site was unsafe for inspection per CGP Part 4.5? ☐ Yes ☐ No

If "yes", complete the following:

- Describe the conditions that prevented you from conducting the inspection in this location:

- Location(s) where conditions were found:

Instructions for Filling Out "General Information" Section

Name of Project
Enter the name for the project.

NPDES ID No.
Enter the NPDES ID number that was assigned to your NOI for permit coverage.

Inspection Date
Enter the date you conducted the inspection.

Weather Conditions During Inspection
Enter the weather conditions occurring during the inspection, e.g., sunny, overcast, light rain, heavy rain, snowing, icy, windy.

Inspection start and end times
Enter the time you started and ended the inspection.

Inspector Name, Title & Contact Information
Provide the name of the person(s) (either a member of your company's staff or a contractor or subcontractor) that conducted this inspection. Provide the inspector's name, title, and contact information as directed in the form.

Present Phase of Construction
If this project is being completed in more than one phase, indicate which phase it is currently in.

Inspection Location
If your project has multiple locations where you conduct separate inspections, specify the location where this inspection is being conducted. If only one inspection is conducted for your entire project, enter "Entire Site." If necessary, complete additional inspection report forms for each separate inspection location.

Inspection Frequency
Check the box that describes the inspection frequency that applies to you. Note that you may be subject to different inspection frequencies in different areas of your site. If your project does not discharge to a "sensitive water" (i.e., a water impaired for sediment or nutrients, or listed as Tier 2, 2.5, or 3 by your state or tribe) and you are not affected by any of the circumstances described in CGP Part 4.4, then you can choose your frequency based on CGP Part 4.2 – either every 7 calendar days, or every 14 calendar days and within 24 hours of a 0.25-inch storm event. For any portion of your site that discharges to a sensitive water, your inspection frequency for that area is fixed under CGP Part 4.3 at every 7calendar days and within 24 hours of a 0.25-inch storm event. If portions of your site are stabilized, are located in arid, semi-arid, or drought-stricken areas, or are subject to frozen conditions, consult CGP Part 4.4 for the applicable inspection frequency. Check all the inspection frequencies that apply to your project.

Was This Inspection Triggered by a 0.25 Inch Storm Event or the occurrence of runoff from snowmelt sufficient to cause a discharge?
If you were required to conduct this inspection because of a 0.25-inch (or greater) rain event, indicate whether you relied on an on-site rain gauge or a nearby weather station (and where the weather station is located). Also, specify the total amount of rainfall for this specific storm event. If you were required to conduct this inspection because of the occurrence of runoff from snowmelt, then check the appropriate box.

Unsafe Conditions for Inspection
Inspections are not required where a portion of the site or the entire site is subject to unsafe conditions. See CGP Part 4.5. These conditions should not regularly occur, and should not be consistently present on a site. Generally, unsafe conditions are those that render the site (or a portion of it) inaccessible or that would pose a significant probability of injury to applicable personnel. Examples could include severe storm or flood conditions, high winds, and downed electrical wires.

If your site, or a portion of it, is affected by unsafe conditions during the time of your inspection, provide a description of the conditions that prevented you from conducting the inspection and what parts of the site were affected. If the entire site was considered unsafe, specify the location as "Entire site"

Condition and Effectiveness of Erosion and Sediment (E&S) Controls (CGP Part 2.2) (see reverse for instructions)				
Type/Location of E&S Control **[Add an additional sheet if necessary]**	**Maintenance Needed?***	**Corrective Action Required?***	**Date on Which Maintenance or Corrective Action First Identified?**	**Notes**
1.	☐Yes ☐No	☐Yes ☐No		
2.	☐Yes ☐No	☐Yes ☐No		
3.	☐Yes ☐No	☐Yes ☐No		
4.	☐Yes ☐No	☐Yes ☐No		
5.	☐Yes ☐No	☐Yes ☐No		
6.	☐Yes ☐No	☐Yes ☐No		
7.	☐Yes ☐No	☐Yes ☐No		
8.	☐Yes ☐No	☐Yes ☐No		
9.	☐Yes ☐No	☐Yes ☐No		
10.	☐Yes ☐No	☐Yes ☐No		

*** Note:** The permit differentiates between conditions requiring routine maintenance, and those requiring corrective action. The permit requires maintenance in order to keep controls in effective operating condition. Corrective actions are triggered only for specific conditions, which include: 1) A stormwater control needs repair or replacement (beyond routine maintenance) if it is not operating as intended; 2) A stormwater control necessary to comply with the permit was never installed or was installed incorrectly; 3) You become aware that the stormwater controls you have installed and are maintaining are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1; 4) One of the prohibited discharges in Part 1.3 is occurring or has occurred; or 5) EPA requires corrective actions as a result of a permit violation found during an inspection carried out under Part 4.8. If a condition on your site requires a corrective action, you must also fill out a corrective action form found at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources. See Part 5 of the permit for more information.

Instructions for Filling Out the "Erosion and Sediment Control" Table

Type and Location of E&S Controls
Provide a list of all erosion and sediment (E&S) controls that your SWPPP indicates will be installed and implemented at your site. This list must include at a minimum all E&S controls required by CGP Part 2.2. Include also any natural buffers established under CGP Part 2.2.1. Buffer requirements apply if your project's earth-disturbing activities will occur within 50 feet of a water of the U.S. You may group your E&S controls on your form if you have several of the same type of controls (e.g., you may group "Inlet Protection Measures", "Perimeter Controls", and "Stockpile Controls" together on one line), but if there are any problems with a specific control, you must separately identify the location of the control, whether maintenance or corrective action is necessary, and in the notes section you must describe the specifics about the problem you observed.

Maintenance Needed?
Answer "yes" if the E&S control requires maintenance due to normal wear and tear in order for the control to continue operating effectively. At a minimum, maintenance is required in the following specific instances: (1) for perimeter controls, whenever sediment has accumulated to half or more the above-ground height of the control (CGP Part 2.2.3.a); (2) where sediment has been tracked-out onto the surface of off-site streets or other paved areas (CGP Part 2.2.4); (3) for inlet protection measures, when sediment accumulates, the filter becomes clogged, and/or performance is compromised (CGP Part 2.2.10); and (4) for sediment basins, as necessary to maintain at least half of the design capacity of the basin (CGP Part 2.2.12.f). Note: In many cases, "yes" answers are expected and indicate a project with an active operation and maintenance program. You should also answer "yes" if work to fix the problem is still ongoing from the previous inspection.

Corrective Action Needed?
Answer "yes" if during your inspection you found any of the following conditions to be present (CGP, Part 5.1): (1) a required E&S control needs repair or replacement (beyond routine maintenance required under Part 2.1.4); (2) a require E&S control was never installed or was installed incorrectly; (3) you become aware that the inadequacy of the E&S control has led to an exceedance of an applicable water quality standard; (4) one of the prohibited discharges in Part 1.3 is occurring or has occurred; or (5) EPA requires corrective action for an E&S control as a result of a permit violation found during an inspection carried out under Part 4.8. If you answer "yes", you must take corrective action and complete a corrective action report, found at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources.. Note: You should answer "yes" if work to fix the problem from a previous inspection is still ongoing.

Date on Which Maintenance or Corrective Action First Identified?
Provide the date on which the condition that triggered the need for maintenance or corrective action was first identified. If the condition was just discovered during this inspection, enter the inspection date. If the condition is a carryover from a previous inspection, enter the original date of the condition's discovery.

Notes
For each E&S control and the area immediately surrounding it, note whether the control is properly installed and whether it appears to be working to minimize sediment discharge. Describe any problem conditions you observed such as the following, and why you think they occurred as well as actions (e.g., maintenance or corrective action) you will take or have taken to fix the problem:

1. Failure to install or to properly install a required E&S control
2. Damage or destruction to an E&S control caused by vehicles, equipment, or personnel, a storm event, or other event
3. Mud or sediment deposits found downslope from E&S controls
4. Sediment tracked out onto paved areas by vehicles leaving construction site
5. Noticeable erosion at discharge outlets or at adjacent streambanks or channels
6. Erosion of the site's sloped areas (e.g., formation of rills or gullies)
7. E&S control is no longer working due to lack of maintenance

For buffer areas, make note of whether they are marked off as required, whether there are signs of construction disturbance within the buffer, which is prohibited under the CGP, and whether there are visible signs of erosion resulting from discharges through the area.

If maintenance or corrective action is required, briefly note the reason. If maintenance or corrective action have been completed, make a note of the date it was completed and what was done. *If corrective action is required, note that you will need to complete a separate corrective action report describing the condition and your work to fix the problem.*

Condition and Effectiveness of Pollution Prevention (P2) Practices (CGP Part 2.3) (see reverse for instructions)				
Type/Location of P2 Practices [Add an additional sheet if necessary]	**Maintenance Needed?***	**Corrective Action Required?***	**Date on Which Maintenance or Corrective Action First Identified?**	**Notes**
1.	☐Yes ☐No	☐Yes ☐No		
2.	☐Yes ☐No	☐Yes ☐No		
3.	☐Yes ☐No	☐Yes ☐No		
4.	☐Yes ☐No	☐Yes ☐No		
5.	☐Yes ☐No	☐Yes ☐No		
6.	☐Yes ☐No	☐Yes ☐No		
7.	☐Yes ☐No	☐Yes ☐No		
8.	☐Yes ☐No	☐Yes ☐No		
9.	☐Yes ☐No	☐Yes ☐No		
10.	☐Yes ☐No	☐Yes ☐No		

*** Note:** The permit differentiates between conditions requiring routine maintenance, and those requiring corrective action. The permit requires maintenance in order to keep controls in effective operating condition. Corrective actions are triggered only for specific conditions, which include: 1) A stormwater control needs repair or replacement (beyond routine maintenance) if it is not operating as intended; 2) A stormwater control necessary to comply with the permit was never installed or was installed incorrectly; 3) You become aware that the stormwater controls you have installed and are maintaining are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1; 4) One of the prohibited discharges in Part 1.3 is occurring or has occurred; or 5) EPA requires corrective actions as a result of a permit violation found during an inspection carried out under Part 4.8. If a condition on your site requires a corrective action, you must also fill out a corrective action form found at https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources. See Part 5 of the permit for more information.

Instructions for Filling Out the "Pollution Prevention (P2) Practice" Table

Type and Location of P2 Controls
Provide a list of all pollution prevention (P2) practices that are implemented at your site. This list must include all P2 practices required by Part 2.3, and those that are described in your SWPPP.

Maintenance Needed?
Answer "yes" if the P2 practice requires maintenance due to normal wear and tear in order for the control to continue operating effectively. Note: In many cases, "yes" answers are expected and indicate a project with an active operation and maintenance program.

Corrective Action Needed?
Answer "yes" if during your inspection you found any of the following conditions to be present (CGP, Part 5.1): (1) a required P2 practice needs repair or replacement (beyond routine maintenance required under Part 2.1.4); (2) a require P2 practice was never installed or was installed incorrectly; (3) you become aware that the inadequacy of the P2 practice has led to an exceedance of an applicable water quality standard; (4) one of the "prohibited discharges" listed in CGP Part 1.3 is occurring or has occurred, or (5) EPA requires corrective action for a P2 practice as a result of a permit violation found during an inspection carried out under Part 4.8. If you answer "yes", you must take corrective action and complete a corrective action report (see https://www.epa.gov/npdes/stormwater-discharges-construction-activities#resources). Note: You should answer "yes" if work to fix the problem from a previous inspection is still ongoing.

Date on Which Maintenance or Corrective Action First Identified?
Provide the date on which the condition that triggered the need for maintenance or corrective action was first identified. If the condition was just discovered during this inspection, enter the inspection date. If the condition is a carryover from a previous inspection, enter the original date of the condition's discovery.

Notes
For each P2 control and the area immediately surrounding it, note whether the control is properly installed, whether it appears to be working to minimize or eliminate pollutant discharges, and whether maintenance or corrective action is required. Describe problem conditions you observed such as the following, and why you think they occurred, as well as actions you will take or have taken to fix the problem:

1. Failure to install or to properly install a required P2 control
2. Damage or destruction to a P2 control caused by vehicles, equipment, or personnel, or a storm event
3. Evidence of a spill, leak, or other type of pollutant discharge, or failure to have properly cleaned up a previous spill, leak, or other type of pollutant discharge
4. Spill response supplies are absent, insufficient, or not where they are supposed to be located
5. Improper storage, handling, or disposal of chemicals, building materials or products, fuels, or wastes
6. P2 practice is no longer working due to lack of maintenance

If maintenance or corrective action is required, briefly note the reason. If maintenance or corrective action have been completed, make a note of the date it was completed and what was done. *If corrective action is required, note that you will need to complete a separate corrective action report describing the condition and your work to fix the problem.*

Stabilization of Exposed Soil (CGP Part 2.2.14) (see reverse for instructions)			
Stabilization Area **[Add an additional sheet if necessary]**	**Stabilization Method**	**Have You Initiated Stabilization?**	**Notes**
1.		☐ YES ☐ NO If yes, provide date:	
2.		☐ YES ☐ NO If yes, provide date:	
3.		☐ YES ☐ NO If yes, provide date:	
4.		☐ YES ☐ NO If yes, provide date:	
5.		☐ YES ☐ NO If yes, provide date:	

Description of Discharges (CGP Part 4.6.6) (see reverse for instructions)	
Was a stormwater discharge or other discharge occurring from any part of your site at the time of the inspection? ☐ Yes ☐ No **If "yes", provide the following information for each point of discharge:**	
Discharge Location **[Add an additional sheet if necessary]**	**Observations**
1.	Describe the discharge: At points of discharge and the channels and banks of waters of the U.S. in the immediate vicinity, are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? ☐ Yes ☐ No If yes, describe what you see, specify the location(s) where these conditions were found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue:
2.	Describe the discharge: At points of discharge and the channels and banks of waters of the U.S. in the immediate vicinity, are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? ☐ Yes ☐ No If yes, describe what you see, specify the location(s) where these conditions were found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue:

Instructions for Filling Out the "Stabilization of Exposed Soil" Table

Stabilization Area
List all areas where soil stabilization is required to begin because construction work in that area has permanently stopped or temporarily stopped (i.e., work will stop for 14 or more days), and all areas where stabilization has been implemented.

Stabilization Method
For each area, specify the method of stabilization (e.g., hydroseed, sod, planted vegetation, erosion control blanket, mulch, rock).

Have You Initiated Stabilization
For each area, indicate whether stabilization has been initiated.

Notes
For each area where stabilization has been initiated, describe the progress that has been made, and what additional actions are necessary to complete stabilization. Note the effectiveness of stabilization in preventing erosion. If stabilization has been initiated but not completed, make a note of the date it is to be completed. If stabilization has been completed, make a note of the date it was completed. If stabilization has not yet been initiated, make a note of the date it is to be initiated, and the date it is to be completed.

Instructions for Filling Out the "Description of Discharges" Table

You are only required to complete this section if a discharge is occurring at the time of the inspection.

Was a Stormwater Discharge Occurring From Any Part of Your Site At The Time of the Inspection?
During your inspection, examine all points of discharge from your site, and determine whether a discharge is occurring. If there is a discharge, answer "yes" and complete the questions below regarding the specific discharge. If there is not a discharge, answer "no" and skip to the next page.

Discharge Location (repeat as necessary if there are multiple points of discharge)
Location of discharge. Specify the location on your site where the discharge is occurring. The location may be an outlet from a stormwater control or constructed stormwater channel, a discharge into a storm sewer inlet, or a specific point on the site. Be as specific as possible; it is recommended that you refer to a precise point on your site map.

Describe the discharge. Include a specific description of any noteworthy characteristics of the discharge such as color; odor; floating, settled, or suspended solids; foam; oil sheen; and other obvious pollution indicators.

Are there visible signs of erosion or sediment accumulation? At each point of discharge and the channel and streambank in the immediate vicinity, visually assess whether there are any obvious signs of erosion and/or sediment accumulation that can be attributed to your discharge. If you answer "yes", include a description in the space provided of the erosion and sediment deposition that you have found, specify where on the site or in the water of the U.S. it is found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue.

Contractor or Subcontractor Signature and Certification
(see reverse for instructions)

"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 gathered and evaluated 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 have no personal knowledge that the information submitted is other than 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."

Signature of Contractor or Subcontractor: ______________________________ **Date:**

Printed Name and Affiliation: ______________________________

Operator Signature and Certification
(see reverse for instructions)

"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 gathered and evaluated 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 have no personal knowledge that the information submitted is other than 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."

Signature of Operator or "Duly Authorized Representative": ______________________________ **Date:**

Printed Name and Affiliation: ______________________________

Instructions for Signature/Certification

Each inspection report must be signed and certified to be considered complete.

Contractor or Subcontractor Signature and Certification

Where you rely on a contractor or subcontractor to carry out the inspection and complete the inspection report, you should require the inspector to sign and certify each report. Note that this does not relieve you, the permitted operator, of the requirement to sign and certify the inspection report as well.

Operator Signature and Certification

At a minimum, the inspection report must be signed by either (1) the person who signed the NOI, or (2) a duly authorized representative of that person. The following requirements apply to scenarios (1) and (2):

If the signatory will be the person who signed the NOI for permit coverage, as a reminder, that person must be one of the following types of individuals:

- *For a corporation*: A responsible corporate officer. For the purpose of this subsection, a responsible corporate officer means: (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
- *For a partnership or sole proprietorship*: A general partner or the proprietor, respectively.
- *For a municipality, state, federal, or other public agency*: Either a principal executive officer or ranking elected official. For purposes of this subsection, a principal executive officer of a federal agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrator of EPA).

If the signatory will be a duly authorized representative, the following requirements must be met:

- The authorization is made in writing by the person who signed the NOI (see above);
- The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position); and
- The signed and dated written authorization is included in the SWPPP. A copy must be submitted to EPA, if requested.

Section A – Initial Report (CGP Part 5.4.1) (Complete this section within 24 hours of identifying the condition that triggered corrective action)					
Name of Project		**NPDES ID No.**		**Today's Date**	
Date Problem First Discovered		**Time Problem First Discovered**			
Name and Contact Information of Individual Completing this Form					

What site conditions triggered the requirement to conduct corrective action *(check the box that applies)*:

- ☐ A stormwater control needs repair or replacement (beyond routine maintenance required under Part 2.1.4)
- ☐ A stormwater control necessary to comply with the requirements of this permit was never installed, or was installed incorrectly
- ☐ A discharge is causing an exceedance of applicable water quality standards
- ☐ A Part 1.3 prohibited discharge has occurred
- ☐ EPA requires corrective action as a result of permit violations found during an EPA inspection carried out under Part 4.8

Provide a description of the problem:

Deadline for completing corrective action *(check the box that applies)*:

- ☐ Immediately take all reasonable steps to address the condition, including cleaning up any contaminated surfaces so the material will not discharge in subsequent storm events
- ☐ Complete by close of the next business day when problem does not require a new or replacement control or significant repair
- ☐ No later than 7 calendar days from the time of discovery for problems that require a new or replacement control or significant repair
- ☐ Infeasible to complete the installation or repair within 7 calendar days. Explain why it is infeasible and document schedule for installing control:

Enter date of corrective action completion: ____________________

Section B – Corrective Action Completion (CGP Part 5.4.2)
(Complete this section no later than 24 hours after completing the corrective action)

Section B.1 – Why the Problem Occurred

Cause(s) of Problem (Add an additional sheet if necessary)	**How You Determined the Cause and the Date You Determined the Cause**
1.	**1.**
2.	**2.**

Section B.2 – Stormwater Control Modifications Implemented to Correct the Problem

List of Stormwater Control Modification(s) Needed to Correct Problem (Add an additional sheet if necessary)	**Date of Completion**	**SWPPP Update Necessary?**	**Notes**
1.		☐Yes ☐No If yes, provide date SWPPP modified:	
2.		☐Yes ☐No If yes, provide date SWPPP modified:	

Instructions for Filling Out the Initial Report (Section A)

You must complete Section A of the report form within 24 hours of discovering the condition that triggered corrective action

Name of Project
Enter the name for the project.

NPDES ID No.
Enter the NPDES ID number that was assigned to your NOI for permit coverage.

Today's Date
Enter the date you completed this form.

Date/Time Problem First Discovered
Specify the date on which the triggering condition was first discovered. Also specify the time of the discovery.

Name/Contact Information
Provide the individual's name, title, and contact information as directed in the form.

Site Condition That Triggered Corrective Action
Under the CGP, corrective action is required when one of 4 triggering conditions occurs at your site or when EPA requires a corrective action as a result of a permit violation found during an EPA inspection. See CGP Parts 5.1 and 5.3. Check the box that corresponds to the condition that triggered this corrective action.

Description of the Site Condition
Provide a summary description of the condition you found that triggered corrective action under CGP Part 5.1 and the specific location where it was found. Be as specific as possible about the location; it is recommended that you refer to a precise point on your site map. If you have already provided this explanation in an inspection report, you can refer to that report.

Deadline for Completing Corrective Action
This deadline is fixed in CGP Part 5.2. For all projects, the deadlines are: (1) immediately take all reasonable steps; (2) by the close of the next business day when the problem does not require significant repair or replacement; (3) no more than 7 calendar days after the date you discovered the problem when the problem does require significant repair or replacement, or (4) if it is infeasible to complete work within the first 7 days, as soon as practicable following the 7th day. If your estimated date of completion falls after the 7-day deadline consistent with (3), above, explain (a) why you believe it is infeasible to complete work within 7 days, and (b) why the date you have established for making the new or modified stormwater control operational is the soonest practicable timeframe.

Instructions for Filling Out the Corrective Action Completion Table (Section B)

You must complete Section B of the report form no later than 24 hours after completing the correction action.

Section B.1 – Why the Problem Occurred
After you have had the opportunity to examine the problem more closely, provide details as to what you believe to be the cause of the problem, and specify the follow-up actions you took (along with the dates of such actions) to diagnose the problem. This is consistent with CGP Part 5.4.2.

Section B.2 – Stormwater Control Modifications Implemented
Provide a list of modifications you made to your stormwater controls to correct the problem and the date you completed such work. Keep in mind that your work must be completed within the timeline specified in Section A for the completion of corrective action work.

Also, if a SWPPP modification is necessary consistent with Part 7.4.1.a in order to reflect changes implemented at your site, indicate the date you modified your SWPPP. Keep in mind that SWPPP changes must be made within 7 days of discovering the problem that triggered this corrective action.

Space is provided for you to include additional notes or observations regarding the change that you implemented at your site to correct the problem.

Section C –Signature and Certification (CGP Part 5.4.3)

Section C.1 – Contractor or Subcontractor Signature and 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 gathered and evaluated 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 have no personal knowledge that the information submitted is other than 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."

Signature of Contractor or Subcontractor: ____

Date:

Printed Name and Affiliation: ____

Section C.2 – Operator Signature and 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 gathered and evaluated 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 have no personal knowledge that the information submitted is other than 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."

Signature of Operator or "Duly Authorized Representative": ____

Date:

Printed Name and Affiliation: ____

Instructions for Signature and Certification (Section C)

Each corrective action report must be signed and certified to be considered complete.

Section C.1 – Contractor or Subcontractor Signature and Certification
Where you rely on a contractor or subcontractor to complete this report and the associated corrective action, you should require the individual(s) to sign and certify each report. Note that this does not relieve you, the permitted operator, of the requirement to sign and certify the report as well.

Section C.2 – Operator Signature and Certification
At a minimum, the corrective action report form must be signed by either (1) the person who signed the NOI, or (2) a duly authorized representative of that person. The following requirements apply to scenarios (1) and (2):

If the signatory will be the person who signed the NOI for permit coverage, as a reminder, that person must be one of the following types of individuals:

- *For a corporation*: A responsible corporate officer. For the purpose of this subsection, a responsible corporate officer means: (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy- or decision-making functions for the corporation, or (ii) the manager of one or more manufacturing, production, or operating facilities, provided, the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
- *For a partnership or sole proprietorship*: A general partner or the proprietor, respectively.
- *For a municipality, state, federal, or other public agency*: Either a principal executive officer or ranking elected official. For purposes of this subsection, a principal executive officer of a federal agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrator of EPA).

If the signatory will be a duly authorized representative, the following requirements must be met:

- The authorization is made in writing by the person who signed the NOI (see above);
- The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position); and
- The signed and dated written authorization is included in the SWPPP. A copy must be submitted to EPA, if requested.

SWPPP Amendment Log

Instructions (see CGP Part 7.4):

- Create a log here of changes and updates to the SWPPP. You may use the table below to track these modifications.
- SWPPP modifications are required pursuant to CGP Part 7.4.1 in the following circumstances:
  - ✓ Whenever new operators become active in construction activities on your site, or you make changes to your construction plans, stormwater controls, or other activities at your site that are no longer accurately reflected in your SWPPP;
  - ✓ To reflect areas on your site map where operational control has been transferred (and the date of transfer) since initiating permit coverage;
  - ✓ If inspections or investigations determine that SWPPP modifications are necessary for compliance with this permit;
  - ✓ Where EPA determines it is necessary to install and/or implement additional controls at your site in order to meet requirements of the permit; and
- To reflect any revisions to applicable federal, state, tribal, or local requirements that affect the stormwater control measures implemented at the site.
- If applicable, if a change in chemical treatment systems or chemically-enhanced stormwater control is made, including use of a different treatment chemical, different dosage rate, or different area of application.

No.	Description of the Amendment	Date of Amendment	Amendment Prepared by [Name(s) and Title]

SUBCONTRACTOR CERTIFICATION
STORMWATER POLLUTION PREVENTION PLAN

Project Number: ____

Project Title: ____

Operator(s): ____

As a subcontractor, you are required to comply with the Stormwater Pollution Prevention Plan (SWPPP) for any work that you perform on-site. Any person or group who violates any condition of the SWPPP may be subject to substantial penalties or loss of contract. You are encouraged to advise each of your employees working on this project of the requirements of the SWPPP. A copy of the SWPPP is available for your review at the office trailer.

Each subcontractor engaged in activities at the construction site that could impact stormwater must be identified and sign the following certification statement:

I certify under the penalty of law that I have read and understand the terms and conditions of the SWPPP for the above designated project and agree to follow the practices described in the SWPPP.

This certification is hereby signed in reference to the above named project:

Company: ____

Address: ____

Telephone Number: ______________________________

Type of construction service to be provided: ____

____

____

Signature: ______________________________

Title: ______________________________

Date: ______________________________

Grading and Stabilization Activities Log

Date Grading Activity Initiated	**Description of Grading Activity**	**Description of Stabilization Measure and Location**	**Date Grading Activity Ceased** (Indicate Temporary or Permanent)	**Date When Stabilization Measures Initiated**
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	
			☐ Temporary ☐ Permanent	

Stormwater Pollution Prevention Training Log

Project Name:

Project Location:

Instructor's Name(s):

Instructor's Title(s):

Course Location: ____ Date: _____________________

Course Length (hours): ___________________________________

Stormwater Training Topic: *(check as appropriate)*

- ☐ **Sediment and Erosion Controls**
- ☐ **Stabilization Controls**
- ☐ **Pollution Prevention Measures**
- ☐ **Emergency Procedures**
- ☐ **Inspections/Corrective Actions**

Specific Training Objective:____

____

Attendee Roster: *(attach additional pages as necessary)*

No.	Name of Attendee	Company
1		
2		
3		
4		
5		
6		
7		
8		

Appendix E
Delegation of Authority

Delegation of Authority

I, ________________________ (name), hereby designate the person or specifically described position below to be a duly authorized representative for the purpose of overseeing compliance with environmental requirements, including the Construction General Permit (CGP), at the _____________________________________ construction site. The designee is authorized to sign any reports, stormwater pollution prevention plans and all other documents required by the permit.

____ (name of person or position)
____ (company)
____ (address)
____ (city, state, zip)
____ (phone)

By signing this authorization, I confirm that I meet the requirements to make such a designation as set forth in Appendix I of EPA's CGP, and that the designee above meets the definition of a "duly authorized representative" as set forth in Appendix I.

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 gathered and evaluated 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 have no personal knowledge that the information submitted is other than 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.

Name: ____

Company: ____

Title: ____

Signature: ____

Date: ____

Appendix M

Proof of Notice and Proof of Legal Notice Newspaper Publication

Karlene Schuman
Modrall Sperling Roehl Harris & Sisk P.A.
500 Fourth Street, Suite 1000
Albuquerque NM 87102

PS Form 3877

Type of Mailing: CERTIFIED MAIL
12/18/2019

Firm Mailing Book ID: 181167

Line	USPS Article Number	Name, Street, City, State, Zip	Postage	Service Fee	RR Fee	Rest.Del.Fee	Reference Contents
1	9314 8699 0430 0066 8445 43	Oil Conservation Division District IV 1220 South St. Francis Drive Santa Fe NM 87505	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
2	9314 8699 0430 0066 8445 50	Oil Conservation Division District I - Hobbs 1625 N. French Drive Hobbs NM 88240	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
3	9314 8699 0430 0066 8445 67	NGL WATER SOLUTIONS PERMIAN, LLC 1509 W Wall St., Ste. 306 Midland TX 79701	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
4	9314 8699 0430 0066 8445 74	BUREAU OF LAND MGMT 301 Dinosaur Trail Santa Fe NM 87508	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
5	9314 8699 0430 0066 8445 81	EOG RESOURCES INC P.O. Box 2267 Midland TX 79705	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
6	9314 8699 0430 0066 8445 98	VLADIN, LLC P.O. Box 100 Artesia NM 88211	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
7	9314 8699 0430 0066 8446 04	COG Operating LLC 600 W Illinois Ave Midland TX 79701	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
8	9314 8699 0430 0066 8446 11	Marathon Oil Permian LLC 5555 San Felipe St. Houston TX 77056	$1.45	$3.50	$1.60	$0.00	87806.0014. Notice
		Totals:	**$11.60**	**$28.00**	**$12.80**	**$0.00**	
				Grand Total:		**$52.40**	

List Number of Pieces Listed by Sender	Total Number of Pieces Received at Post Office	Postmaster: Name of receiving employee	Dated:
8			

DEC 18 2019

104

Transaction Report Details - CertifiedPro.net
Firm Mail Book ID= 181167
Generated: 1/7/2020 12:51:27 PM

USPS Article Number	Date Created	Reference Number	Name 1	City	State	Zip	Mailing Status	Service Options	Mail Delivery Date
9314869904300066844611	2019-12-18 12:12 PM	87806.0014.	Marathon Oil Permian LLC	Houston	TX	77056	Undelivered	Return Receipt - Electronic, Certified Mail	
9314869904300066844604	2019-12-18 12:12 PM	87806.0014.	COG Operating LLC	Midland	TX	79701	Delivered	Return Receipt - Electronic, Certified Mail	12-23-2019
9314869904300066844598	2019-12-18 12:12 PM	87806.0014.	VLADIN, LLC	Artesia	NM	88211	Delivered	Return Receipt - Electronic, Certified Mail	12-23-2019
9314869904300066844581	2019-12-18 12:12 PM	87806.0014.	EOG RESOURCES INC	Midland	TX	79705	Delivered	Return Receipt - Electronic, Certified Mail	12-23-2019
9314869904300066844574	2019-12-18 12:12 PM	87806.0014.	BUREAU OF LAND MGMT	Santa Fe	NM	87508	Delivered	Return Receipt - Electronic, Certified Mail	12-20-2019
9314869904300066844567	2019-12-18 12:12 PM	87806.0014.	NGL WATER SOLUTIONS PERMIAN, LLC	Midland	TX	79701	Lost	Return Receipt - Electronic, Certified Mail	
9314869904300066844550	2019-12-18 12:12 PM	87806.0014.	Oil Conservation Division District I - Hobbs	Hobbs	NM	88240	Delivered	Return Receipt - Electronic, Certified Mail	12-21-2019
9314869904300066844543	2019-12-18 12:12 PM	87806.0014.	Oil Conservation Division District IV	Santa Fe	NM	87505	Delivered	Return Receipt - Electronic, Certified Mail	12-20-2019

Affidavit of Publication

STATE OF NEW MEXICO
COUNTY OF LEA

I, Daniel Russell, Publisher of the Hobbs News-Sun, a newspaper published at Hobbs, New Mexico, solemnly swear that the clipping attached hereto was published in the regular and entire issue of said newspaper, and not a supplement thereof for a period of 1 issue(s).

Beginning with the issue dated
December 21, 2019
and ending with the issue dated
December 21, 2019.

Daniel Russell
Publisher

Sworn and subscribed to before me this 21st day of December 2019.

Gussie Black
Business Manager

My commission expires
January 29, 2023
(Seal)

OFFICIAL SEAL
GUSSIE BLACK
Notary Public
State of New Mexico
My Commission Expires 1-29-23

This newspaper is duly qualified to publish legal notices or advertisements within the meaning of Section 3, Chapter 167, Laws of 1937 and payment of fees for said

LEGALS

LEGAL NOTICE
DECEMBER 21, 2019

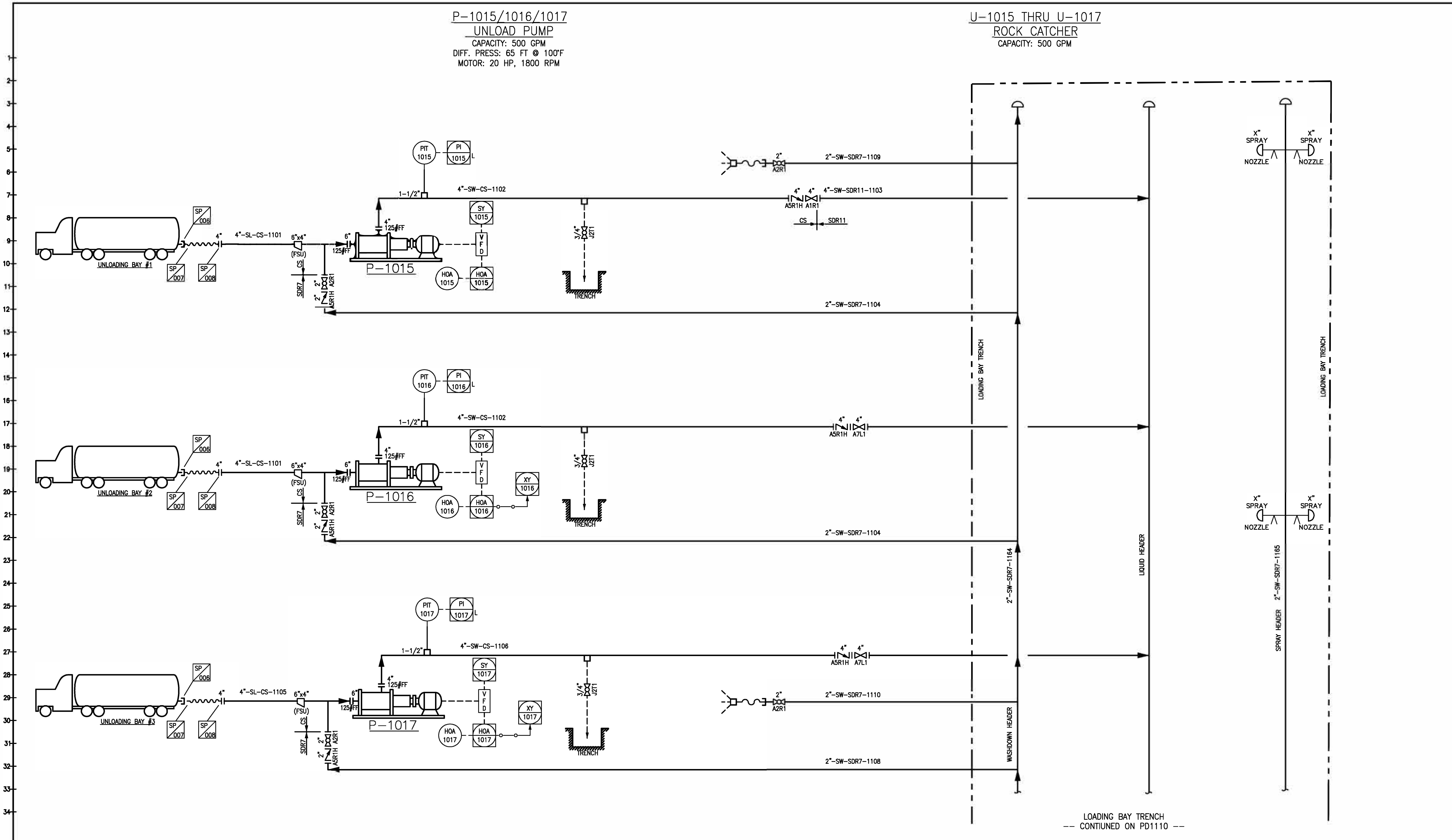
CASE NO. 20985: Notice to all affected parties, as well as the heirs and devisees of Oil Conservation Division District IV, Oil Conservation Division District 1 – Hobbs, Bureau of Land Management, EOG Resources Inc., Vladin, LLC, COG Operating LLC, Marathon Oil Permian LLC of NGL Water Solutions Permian, LLC's application for approval of salt water disposal well in Lea County, New Mexico. The State of New Mexico, through its Oil Conservation Division, hereby gives notice that the Division will conduct a public hearing at 8:15 a.m. on January 9, 2020, to consider this application. Applicant seeks an order approving the Striker 4 SWD #1 well, with a surface location 850 feet from the South line and 174 feet from the West line of Section 24, Township 24 South, Range 34 East, NMPM, Lea County, New Mexico. Applicant requests authorization to inject salt water into the Bell and Cherry Canyon formations at a depth of 5,437 to 7,200'. Applicant requests that the Division approve a maximum daily injection rate for the well of 20,000 bbls per day. Said location is approximately 15 miles west of Jal, New Mexico.
#35013

01104570 00237465

DOLORES SERNA
MODRALL, SPERLING, ROEHL, HARRIS &
P. O. BOX 2168
ALBUQUERQUE, NM 87103-2168

Appendix N

Typical Injection Well Facility Process Flow Diagram



NOTES:

REFERENCE DRAWINGS

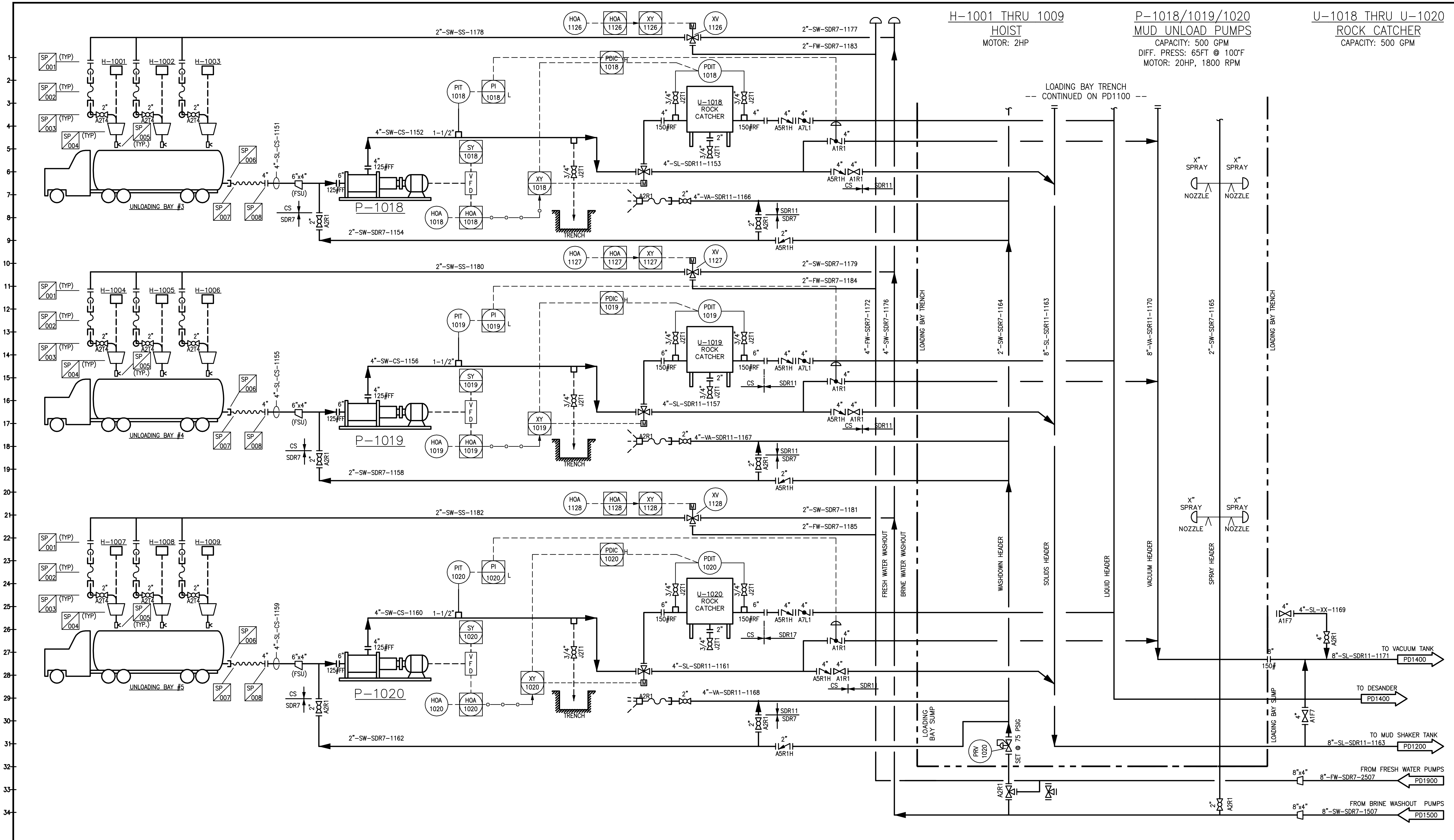
DWG. #	DESCRIPTION

REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENT DIAGRAM FOR TRUCK OFF-LOADING
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1100 — REV. 01



NOTES:

REFERENCE DRAWINGS

DWG. #	DESCRIPTION

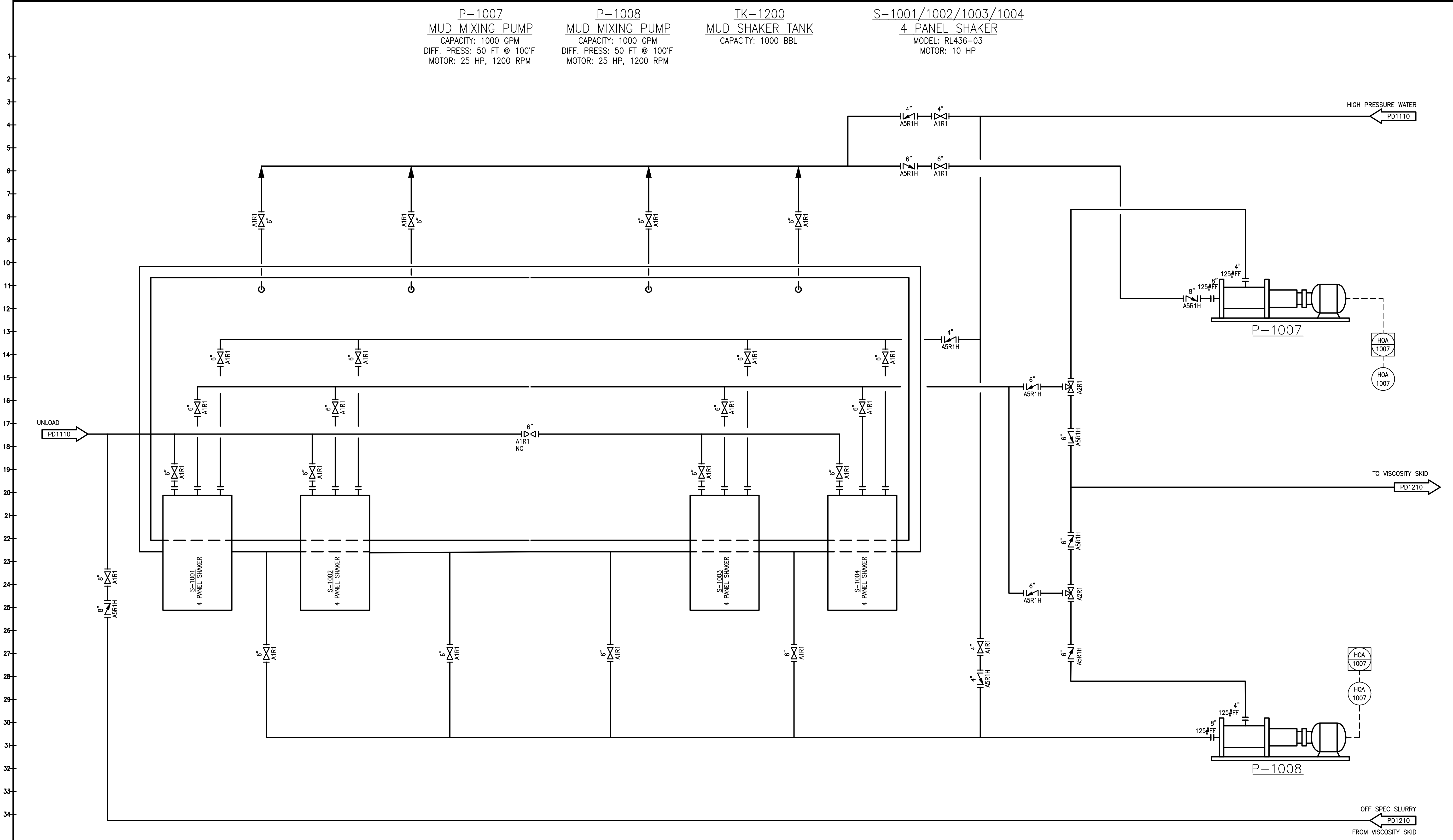
REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLON RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENT DIAGRAM TRUCK OFF-LOADING & WASHOUT
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1110 — REV. 01

Plotted by: RAMV on 2/7/2020



NOTES:

REFERENCE DRAWINGS	
DWG. #	DESCRIPTION

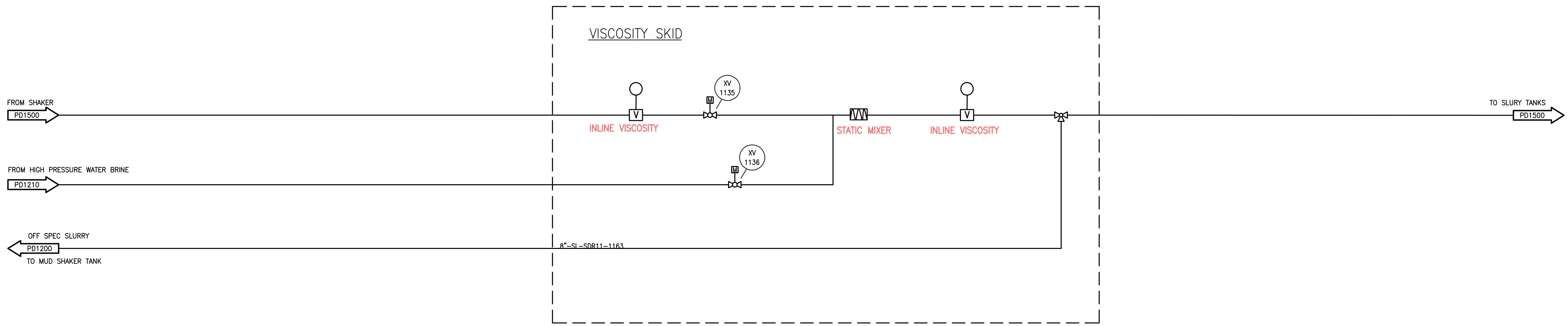
REVISIONS					
REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENT DIAGRAM MUD SHAKER TANK
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1200 — REV. 01

Plotted by: RAWV on 2/7/2020

VISCOSITY SKID



NOTES:

REFERENCE DRAWINGS

DWG. #	DESCRIPTION

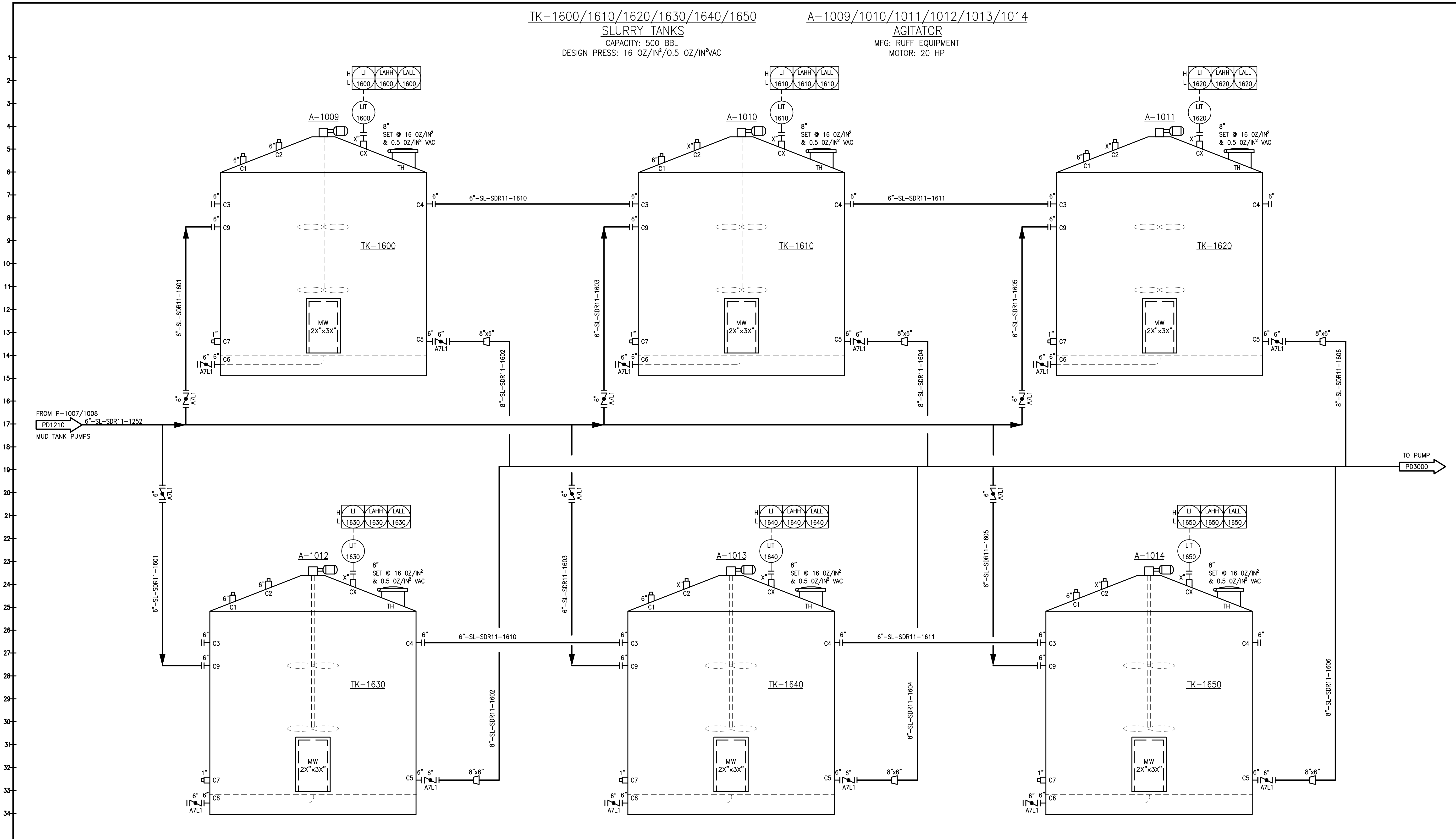
REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENT DIAGRAM FOR VISCOSITY SKID
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1210 — REV. 01

Plotted by: RAVIV on 2/7/2020



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REFERENCE DRAWINGS

DWG. #	DESCRIPTION

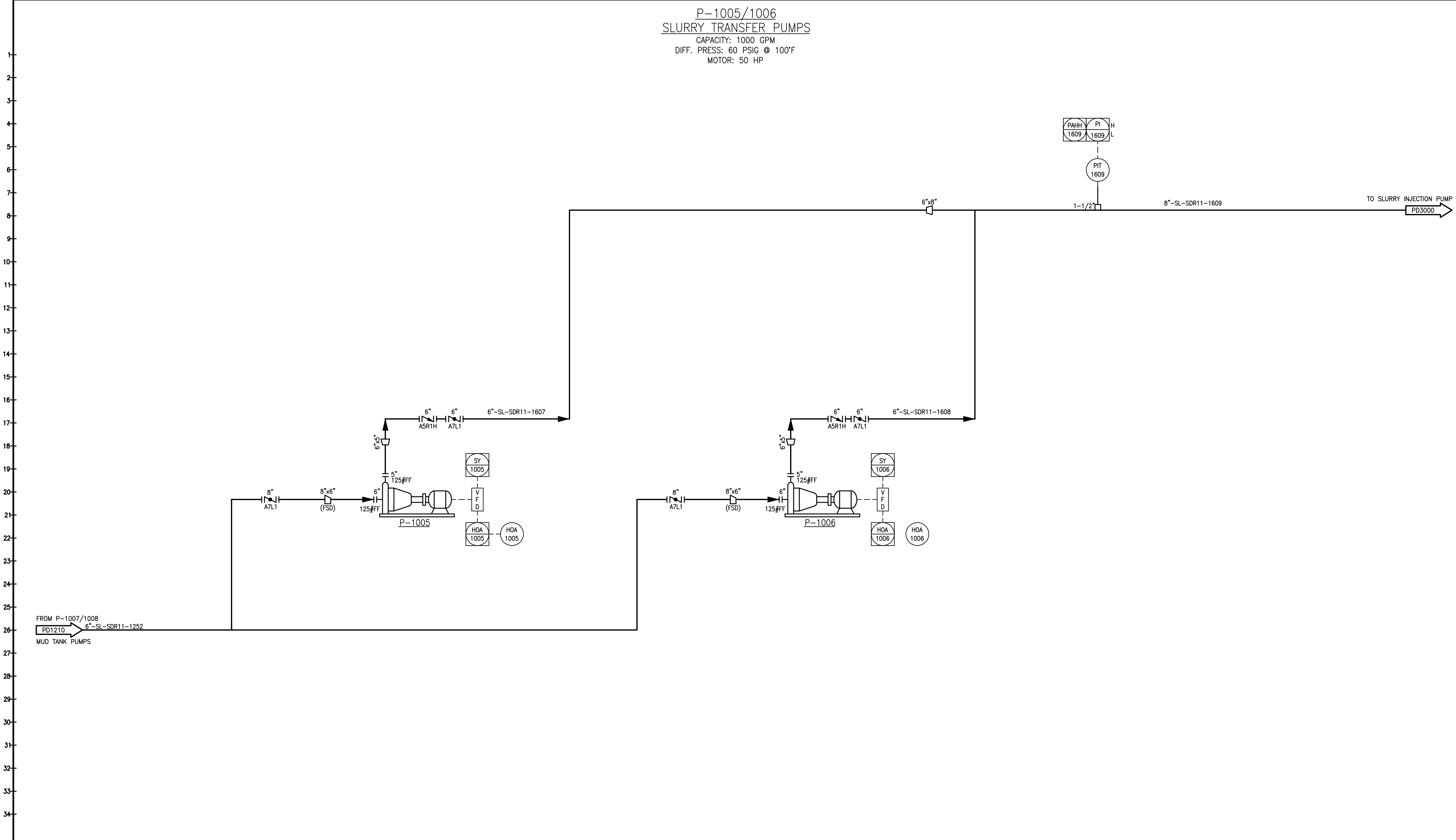
REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENT DIAGRAM SLURRY TANKS
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1300 — REV. 01

Plotted by: RAVV on 2/7/2020



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REFERENCE DRAWINGS

DWG. #	DESCRIPTION

REVISIONS

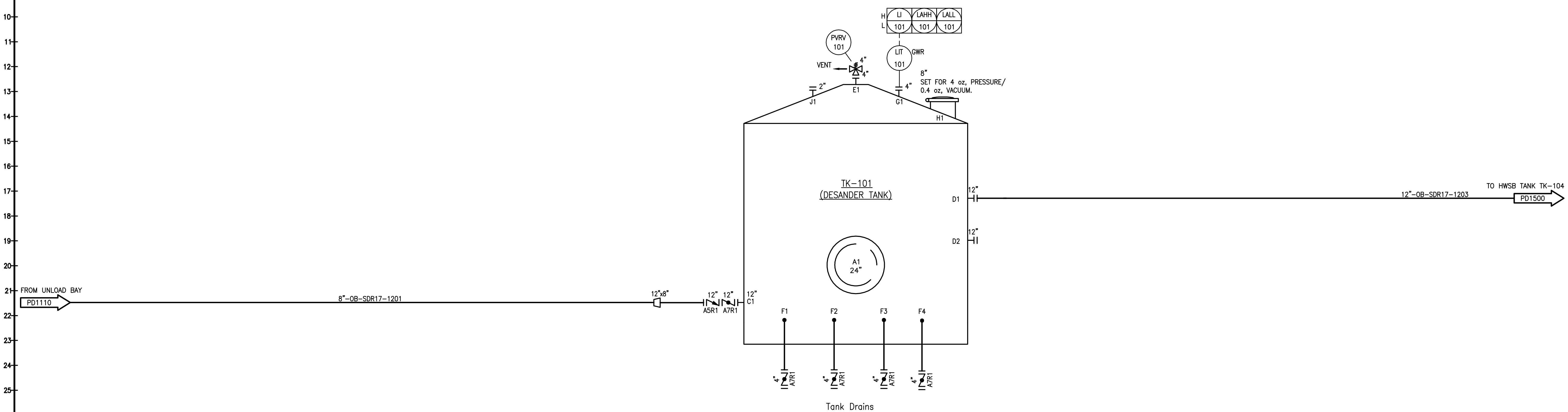
REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENT DIAGRAM SLURRY TRANSFER PUMPS
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1310 — REV. 01

Plotted by: RAWV on 2/7/2020

TK-101
DESANDER TANK
CAPACITY: XXX GAL
DESIGN PRESS: XXX PSIG @ -XX/XXX°F



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REFERENCE DRAWINGS

DWG. #	DESCRIPTION

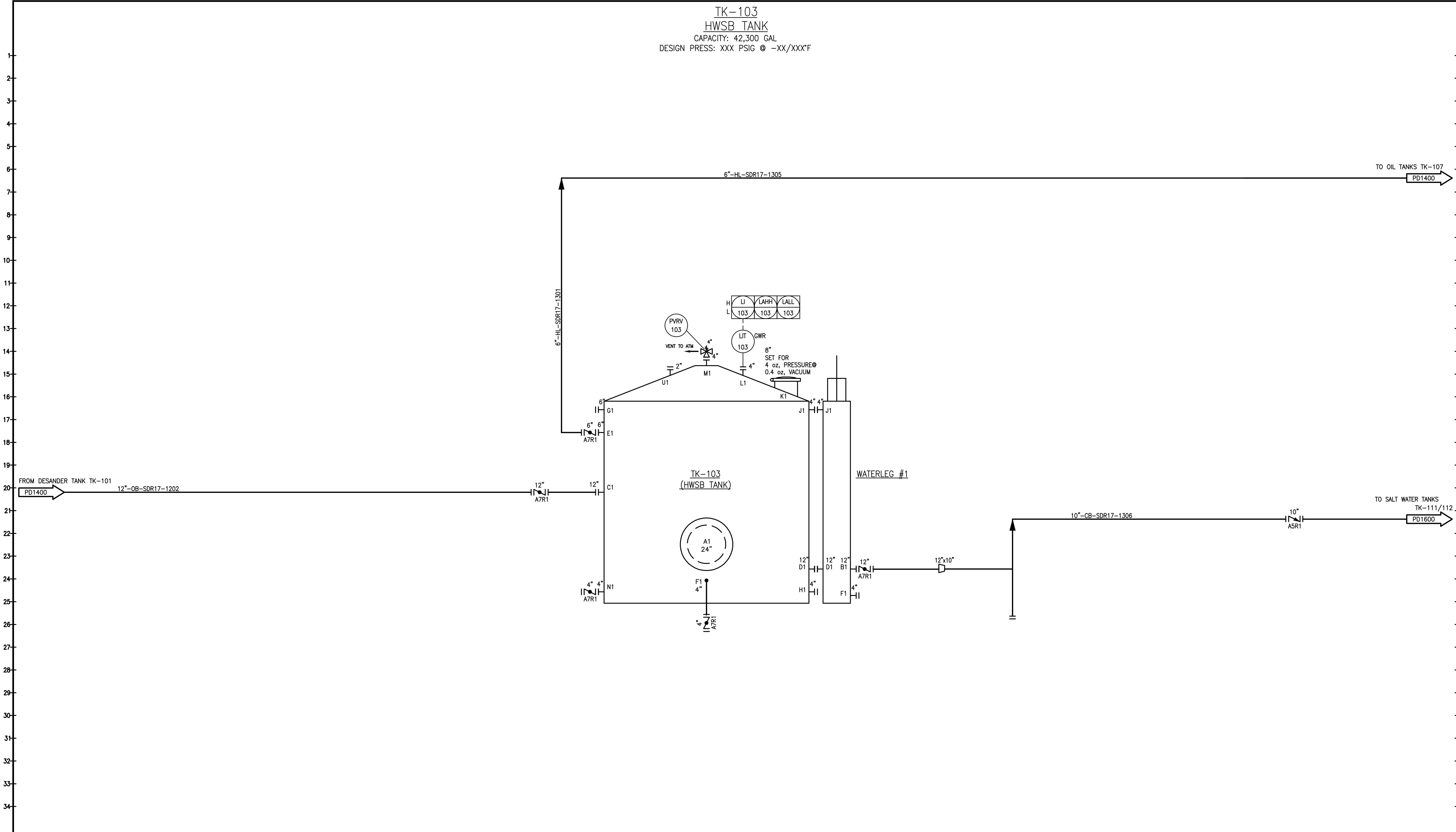
REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENTATION DIAGRAM FOR DESANDER TANKS
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1400 — REV. 01

Plotted by: RAMV on 2/7/2020



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REFERENCE DRAWINGS

DWG. #	DESCRIPTION

REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

DRAWN BY: RP	DATE: 02-07-2020
AFE / P.O. NO.	----
T.H. JOB NO.	----
CLIENT FL. NO.	----
SCALE.	AS NOTED

CYCLONE RPF

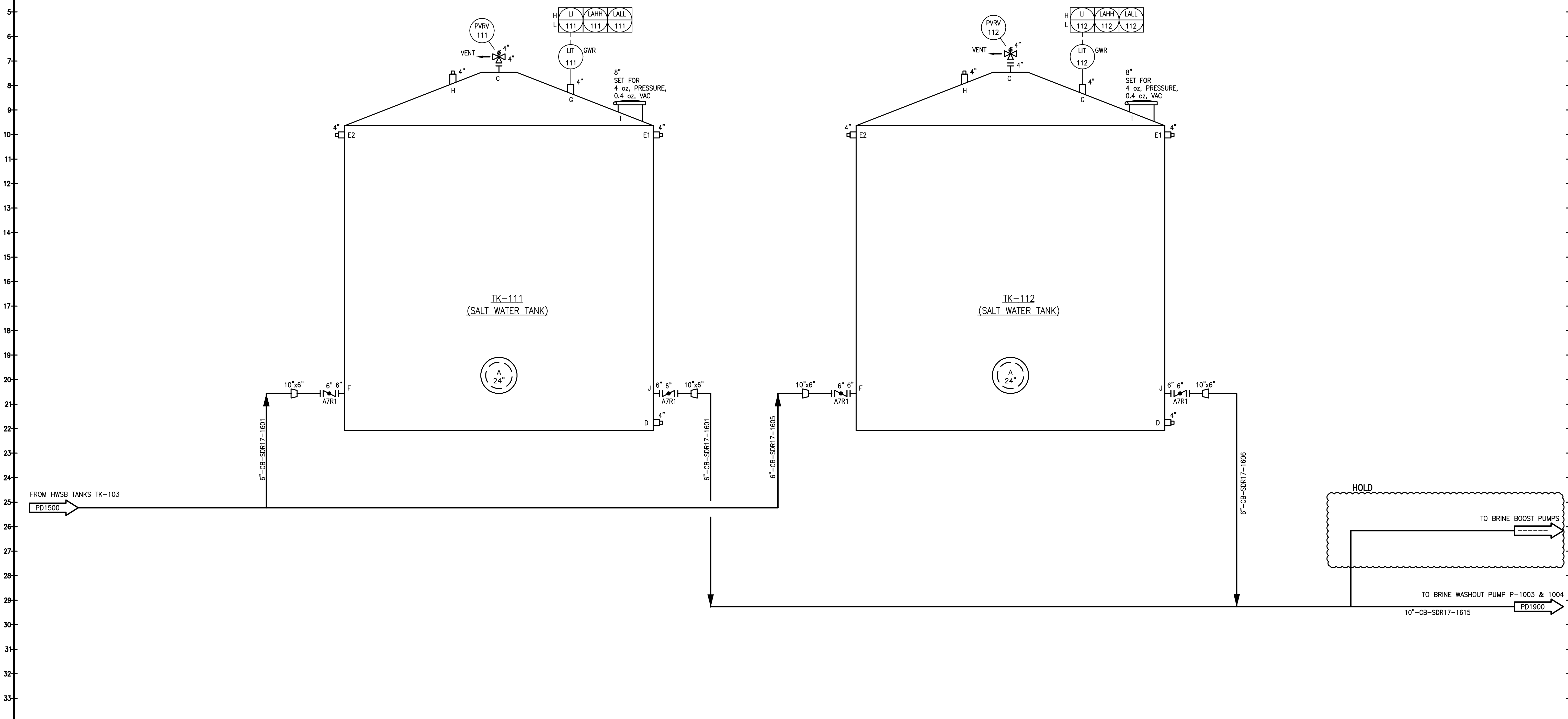
PIPING AND INSTRUMENTATION DIAGRAM FOR HWSB TANKS

SHEET NO.		REV.
1 OF 1	HREPC-MUD-DW-PD1500	01

Plotted by: RAVV on 2/7/2020

TK-111/112
BRINE TANKS

CAPACITY: 750 BBL
DESIGN PRESS: 8 OZ/IN2/ & 0.4 OZ/IN2/ VAC



NOTES:

REFERENCE DRAWINGS

DWG. #	DESCRIPTION

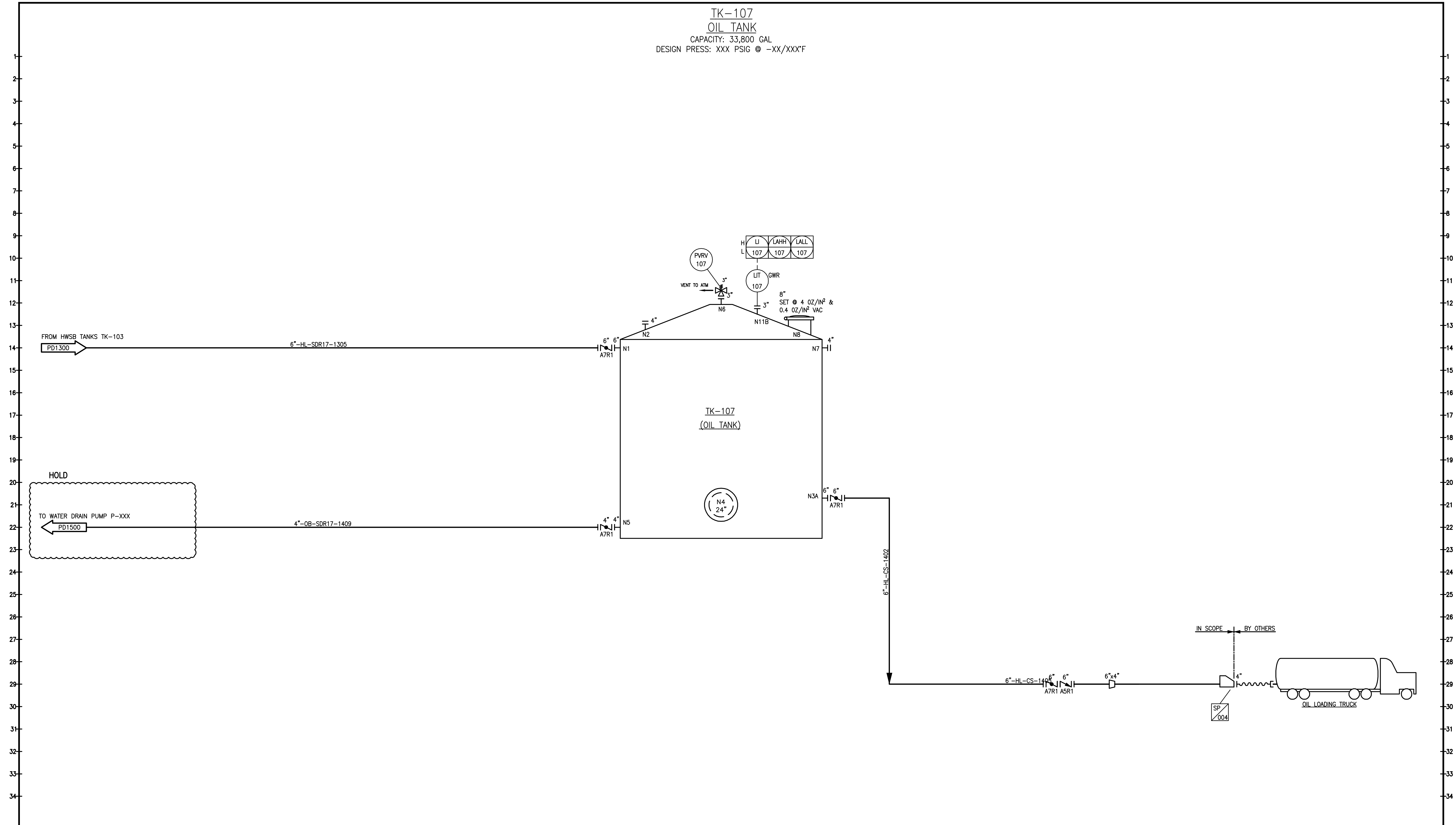
REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENTATION DIAGRAM FOR SALT WATER TANKS
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1600 — REV. 01

Plotted by: RAWV on 2/7/2020



NOTES:

REFERENCE DRAWINGS

DWG. #	DESCRIPTION

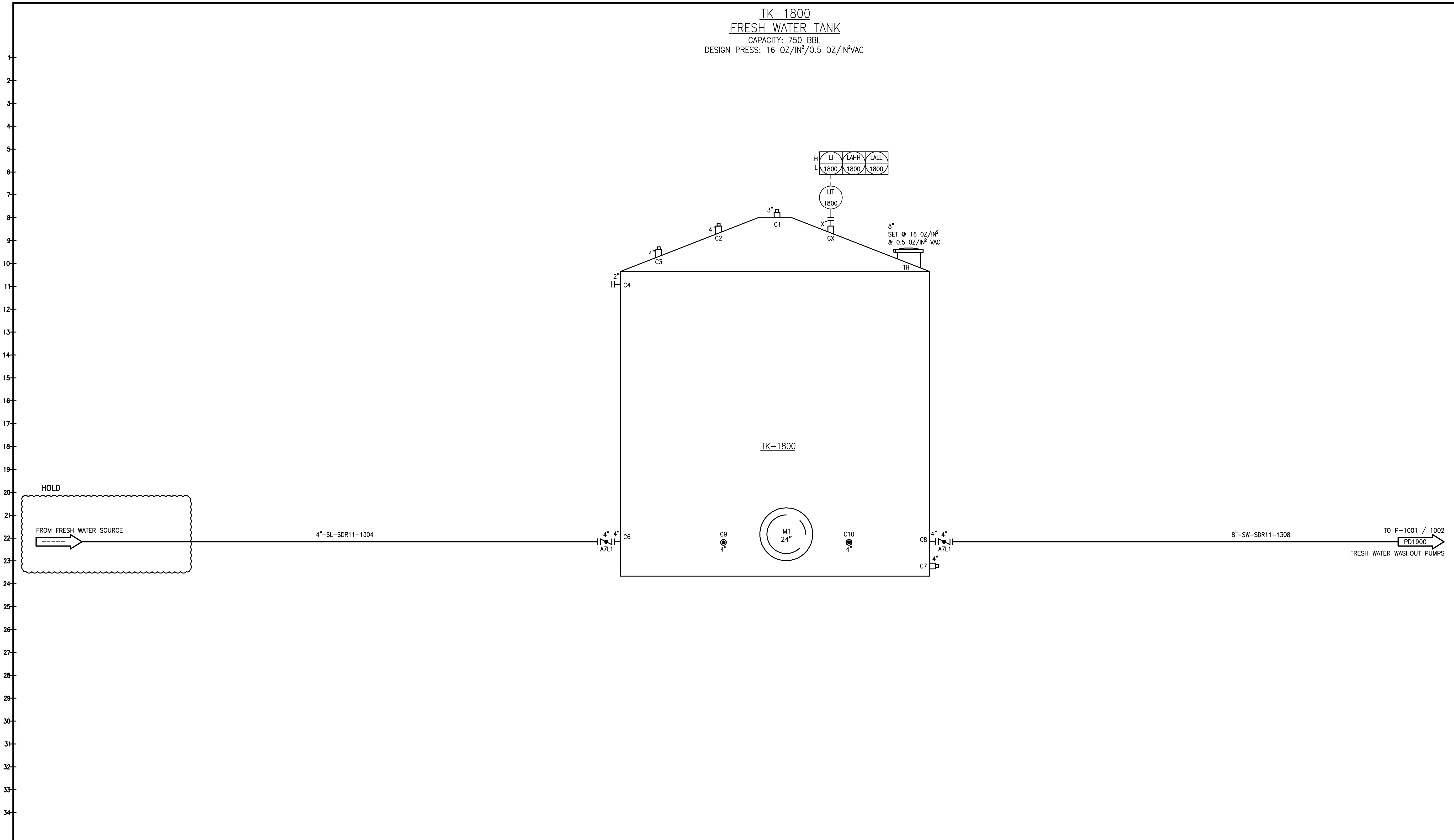
REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

Water Solutions

DRAWN BY: RP	DATE: 02-07-2020	CYCLONE RPF
AFE / P.O. NO.	----	
T.H. JOB NO.	----	PIPING AND INSTRUMENTATION DIAGRAM FOR OIL TANKS
CLIENT FL. NO.	----	
SCALE.	AS NOTED	SHEET NO. 1 OF 1 — HREPC-MUD-DW-PD1700 — REV. 01

Plotted by: RAVIV on 2/7/2020



NOTES:

REFERENCE DRAWINGS	
DWG. #	DESCRIPTION

REVISIONS					
REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

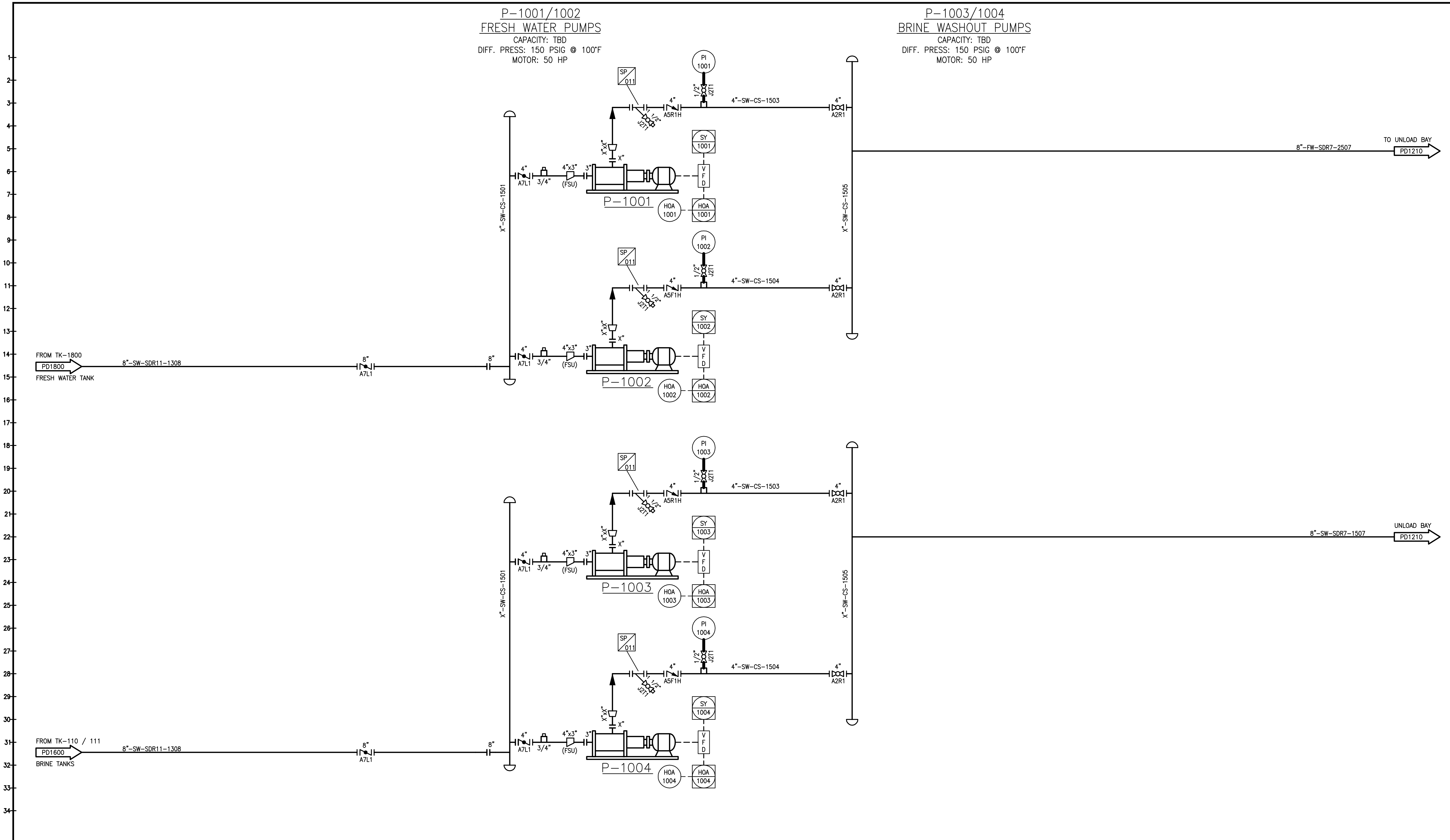
DRAWN BY: RP	DATE: 02-07-2020
AFE / P.O. NO.	----
T.H. JOB NO.	----
CLIENT FL. NO.	----
SCALE.	AS NOTED

CYCLONE RPF

PIPING AND INSTRUMENT DIAGRAM FOR BRINE TANKS

SHEET NO.		REV.
1 OF 1	HREPC-MUD-DW-PD1800	01

Plotted by: RAVIV on 2/7/2020



NOTES:

REFERENCE DRAWINGS

DWG. #	DESCRIPTION

REVISIONS

REV.	DESCRIPTION	DRAWN	CHKD.	APPD.	DATE
01	ISSUED FOR INFORMATION	RP	SS	RV	02-07-20

NGL Water Solutions

DRAWN BY: RP	DATE: 02-07-2020
AFE / P.O. NO.	----
T.H. JOB NO.	----
CLIENT FL. NO.	----
SCALE.	AS NOTED

CYCLONE RPF

PIPING AND INSTRUMENT DIAGRAM
BRINE PUMP SKID

SHEET NO. 1 OF 1 | HREPC-MUD-DW-PD1900 | REV. 01

Plotted by: RAVIV on 2/7/2020