Sandy Creek Energy Station Coal Combustion Residual Waste Management Facility Registration Application

TCEQ Registration No. _____

McLennan County, Texas

Volume 1 of 2

Prepared for

Sandy Creek Services, LLC
2161 Rattlesnake Road
Riesel, Texas 76682

SCS ENGINEERS

SCS Project No. 162210590.00 | Revision 0 – January 2022

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January 19, 2022

Ms. Gulay Aki
Industrial and Hazardous Waste Permits Section, MC-130
Coal Combustion Residuals Program
Waste Permits Division
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, Texas 78711-3087

Re: Registration Application for Coal Combustion Residual (CCR) Waste Management
Sandy Creek Energy Station CCR Waste Management Landfill
McLennan County, Texas
CN604335455/RN105905657

Dear Ms. Aki:

On the behalf of Sandy Creek Services, LLC (Owner and Operator), please see attached two (2) volumes that comprise the Registration Application for the Sandy Creek Energy Station (Plant) Coal CCR Waste Management Facility (Landfill), located in McLennan County. Included are four copies (one original and three copies) of the Registration Application.

This Registration Application has been prepared consistent with Title 30 of the Texas Administrative Code (30 TAC), Chapter 352 and such provisions of Title 40 of the Code of Federal Regulations (40 CFR), Part 257 as incorporated by reference in the Chapter 352 rules. In accordance with 30 TAC §352.231(f), the design, construction, and operation of the Landfill, as outlined in the attached Registration Application, meets the requirements of 30 TAC §352.2.

The outline of this Registration Application generally follows the structure of TCEQ Form 20870. Part I, Section 2, General Information, presents an overview of the Registration Application, a detailed Landfill description, and the types of waste that will be accepted at the Landfill. The remaining portions of the Part I narrative presents information on specific existing and future conditions on and around the Landfill, provides a description of the entities involved in the application process, and summarizes the Registration Application content and compliance with TCEQ regulations that is provided in Parts II through VIII of the Registration Application.

We appreciate your review of this Registration Application. If you or your staff have any questions please do not hesitate to contact us.

Sincerely,

Bryon Kohls
Project Director
Sandy Creek Services, LLC

Attachments: Registration Application (original and three copies)
Pre-printed Mail labels for Landowner's within 1/4-mile of registration boundary

cc: Dana Perry – Sandy Creek Services, LLC
Ryan Kuntz, P.E. – SCS Engineers
Brett DeVries, Ph.D., P.E. – SCS Engineers
TCEQ Region 9 Office

Sandy Creek Energy Station

Coal Combustion Residual Waste Management Facility

Registration Application

TCEQ Registration No. _____

McLennan County, Texas

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SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
REGISTRATION APPLICATION
TCEQ REGISTRATION NO. ----

PART I
GENERAL REGISTRATION APPLICATION REQUIREMENTS

Prepared for:

SANDY CREEK SERVICES, LLC
2161 Rattlesnake Road
P.O. Box 370
Riesel, TX 76682

BRETT J. DeVRIES
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Brett DeVries 1/13/22

Prepared by:

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Revision 0 – January 2022
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LIST OF ACRONYMS

AASHTO - American Association of State Highway and Transportation Officials
ANSI - American National Standards Institute
ASTM - American Society for Testing and Materials
CCR - Coal Combustion Residuals
CDR - Chemical Data Reporting
CFR - Code of Federal Regulations
DOT - Department of Transportation
EPA - U.S. Environmental Protection Agency
FWS - U.S. Fish and Wildlife Service
GWSAP - Ground Sampling and Analysis Plan
HAP - Hazardous Air Pollutant
LCRS - leachate Collection and Removal System
Landfill – CCR Waste Management Facility
MSDS - Material Safety Data Sheets
MSL - mean sea level
NIOSH - National Institute for Occupational Safety and Health
NOR - Notice of Registration
NRR - Noise Reduction Rating
Operator – Sandy Creek Services, LLC
Owner – Sandy Creek Services, LLC
OSHA - Occupational Safety and Health Administration
PAC - Powdered Activated Carbon
Plant – Sandy Creek Energy Station
PRB - Powder River Basin
PSD - Prevention of Significant Deterioration
RCRA - Resource Conservation and Recovery Act
SCR - Selective Catalytic Reduction
SDA - Spray Dry Absorber
SDS - Safety Data Sheet
SHSP - Site Health and Safety Plan
SPCC - Spill Prevention, Control, and Countermeasure Plan
SOP - Site Operating Plan
SWPPP - Storm Water Pollution Prevention Plan
TAC - Texas Administrative Code
TCEQ - Texas Commission on Environmental Quality
TPDES - Texas Pollution Discharge Elimination System
TRI - Toxic Release Inventory
TSCA - Toxic Substances Control Act
TxDOT - Texas Department of Transportation
WWTP - Wastewater treatment plant

1 INTRODUCTION

Sandy Creek Services, LLC (Owner and Operator) propose to continue development and operation of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill) located in McLennan County, Texas. The Plant is a nominal 1,000 MW coal-fired generation unit. The Landfill comprises a waste footprint of 40.7 acres located on 149.3 acres of land (Landfill Registration Boundary) within the overall 697.8-acre property boundary on which the Plant and Landfill are co-located. The Landfill Registration Boundary, including Landfill and associated support facilities, is located on the southwest corner of the Plant's overall property boundary. The Plant and Landfill are both accessed from Farm-to-Market [FM] 1860 via Rattlesnake Road, through a gated entrance located west of the Plant, as shown on Drawing I.B-1 – Site Location Map.

The primary wastes disposed of in the Landfill are fly ash and bottom ash generated during the coal combustion process at the Plant. Additionally, other Class 2 and Class 3 waste generated at the Plant are disposed of at the Landfill. At the time of preparing this Landfill Registration Application (Application), Cells 1 and 2 are existing active cells constructed in 2010 and 2014, respectively. A portion of Cell 3 (inclusive of Subcells 3A through 3D) was constructed in 2021 prior to and during the time of preparing for this Application. Future subcells within Cell 3 will be constructed and operated consistent with this Application. The Landfill was issued Solid Waste Registration Number 88448 and EPA ID TXR000079082 with the initial Registration on December 12, 2007.

This Application has been prepared consistent with Title 30 of the Texas Administrative Code (30 TAC), Chapter 352 and such provisions of Title 40 of the Code of Federal Regulations (40 CFR), Part 257 as incorporated by reference in the Chapter 352 rules. In accordance with 30 TAC §352.231(f), the design, construction, and operation of the Landfill, as outlined in this Application, meets the requirements of 30 TAC §352.2.

The outline of this Application generally follows the structure of TCEQ Form 20870. Part I, Section 2, General Information, presents an overview of the Application, a detailed Landfill description, and the types of waste that will be accepted at the Landfill. The remaining portions of the Part I narrative presents information on specific existing and future conditions on and around the Landfill, provides a description of the entities involved in the application process, and summarizes the application content and compliance with TCEQ regulations that is provided in Parts II through VIII of the Application. As such, this Application is comprised of the following:

- Part I – General Registration Application Requirements, including Appendix I.A – Application Forms

- Part II – Location Restriction Demonstration

- Part III – Fugitive Dust Control Plan

- Part IV – Landfill Criteria, including Landfill Design Drawings, Appendix IV.A – Leachate Collection and Removal System Plan, Appendix IV.B – Liner Construction Quality Assurance Plan, and Appendix IV.C – Run-on and Run-off Control System Plan

- Part V – Site Operating Plan
- Part VI – Groundwater Monitoring and Corrective Action Plan, including Groundwater Sampling and Analysis Plan
- Part VII – Closure and Post-Closure Care Plan
- Part VIII – Post-Closure Care Cost Estimate and Financial Assurance

Since the CCR Waste Management Facility at the Plant is not a surface impoundment, the title of Part V of TCEQ Form 20870, which was entitled “Surface Impoundment Criteria”, has been revised and will be used for the “Site Operating Plan”.

2 GENERAL INFORMATION

2.1 PROJECT OVERVIEW

The Landfill comprises a waste footprint of 40.7 acres within the Landfill Registration Boundary of 149.3 acres as shown on Drawing I.B-4 – Facility Layout Map. Cells 1 and 2 are existing active cells that were constructed in 2010 and 2014, respectively, with ongoing waste placement operations. A portion of Cell 3 (inclusive of Subcells 3A through 3D encompassing approximately 10.3 acres) was constructed in 2021 prior to and during the time of preparing this Application. The approximate areas of Cells 1, 2, and 3 are 8.1, 15.6, and 17.0 acres, respectively. The Landfill will be utilized to dispose of waste generated during the coal combustion process at the Plant as defined in Section 2.2, including CCR and other Class 2 and Class 3 waste.

2.2 WASTE ACCEPTANCE PLAN

The primary wastes streams disposed in the Landfill will be fly ash and bottom ash generated during the coal combustion process at the Plant. Other Class 2 and Class 3 nonhazardous industrial waste generated at the Plant will be disposed of at the Landfill. Details on the waste streams, expected maximum annual waste acceptance rate, waste code, means of conveyance to the Landfill, and ultimate disposition for waste accepted at the Landfill are provided in Table 2-1 and outlined in Drawing I.B-5 – Process Flow Diagram.

Ancillary wastes may also be accepted at the Landfill, including coal mill rejects, waste coal, cooling tower sediments, cooling water screenings, sump pit sediments, nonhazardous sand-blast media, fire brick and refractory materials, sediments from the dredging of Plant's facility stormwater ditches and Plant's TPDES units, and construction debris, as described in a January 29, 2004 notification letter from the Owner to the TCEQ.

Under Toxic Substances Control Act (TSCA), fly ash and bottom ash generated at the Plant are considered chemical byproducts of the coal combustion process. Fly ash and bottom ash may be beneficially used for commercial purposes and are subject to the Chemical Data Reporting (CDR) requirements of TSCA (40 CFR §711). The fly ash and bottom ash are not subject to the CDR requirements if it is used by public or private organizations for enriching soil (40 CFR §720.30 (g)).

The Landfill Owner/Operator will obtain waste classification (including description, character, waste code, and analytical testing) prior to disposal of any waste within the Landfill and following a process change that results in the generation of waste that changes the waste classification.

Table 2-1 Waste Streams and Acceptance Rates

TEXAS WASTE CODE	WASTE TYPE	SOURCE	EXPECTED MAXIMUM ANNUAL WASTE ACCEPTANCE RATE (TONS/YEAR)	Conveyance Method	Disposition Location
00713032	Fly ash	Generated during the coal combustion process at the Plant and collected in the SDA and Fabric Filter	284,000	Hauling Equipment	Landfill or Offsite
00703032	Bottom ash	Generated during the coal combustion process at the Plant	48,000	Hauling Equipment	Landfill
00093192	Filter cake from the water treatment building	Generated from the filtering water at the treatment building	500	Hauling Equipment	Landfill
00523932	Spent SCR catalyst	Generated from the select catalytic reduction (SCR) system used at the Plant to reduce nitrogen oxide emissions	400	Hauling Equipment	Landfill
00564032	Class 2 spent demineralizer resin	Generated from the Plant’s process water treatment system	15	Hauling Equipment	Landfill

Table 2-1 (Continued)

TEXAS WASTE CODE	WASTE TYPE	SOURCE	EXPECTED MAXIMUM ANNUAL WASTE ACCEPTANCE RATE (TONS/YEAR)	Conveyance Method	Disposition Location
00731142	Cooling tower sediments and cooling water screenings	Generated from the condenser and cooling tower as a result of the heat developed during the process of boiling water at the Plant	1	Hauling Equipment	Landfill
00574032	Spent resin	Generated from the Plant's process water treatment system	15	Hauling Equipment	Landfill

2.3 EXISTING CONDITIONS SUMMARY

The existing site conditions within the Landfill Registration Boundary are generally depicted on Drawing I.B-2 – General Topographic and Surrounding Features Map and Drawing I.V-1 – Existing Conditions Map. The Landfill and associated support facilities are located on the southwest corner of the Plant Property. The Plant/Landfill entrance is located approximately 0.7 miles north of the intersection of FM 1860 and Rattlesnake Road. Cells 1 and 2 are existing active cells with ongoing waste placement operations. A portion of Cell 3 (inclusive of Subcells 3A through 3D encompassing approximately 10.3 acres) was constructed in 2021 prior to and during the time of preparing this Application. The site is generally flat, sloping at approximately 1 to 5 percent towards the west, with the exceptions of stormwater features, soil stockpiles, and waste fill areas (i.e., Cells 1, 2, and a portion of 3).

Surface water within the Landfill Registration Boundary generally drains west to an existing channel where it flows to the southwestern Landfill Registration Boundary and flows west into an unnamed tributary that empties into Lake Creek Lake (an impoundment of Manos Creek). Manos Creek provides flow into Brazos River. Surface water runoff (uncontaminated) from the Landfill is conveyed to the perimeter stormwater management system, comprised of perimeter channels and is directed to an existing stormwater pond south of the existing Landfill.

Other existing features at the time of preparing this Application within the Landfill Registration Boundary include: an equipment maintenance building; perimeter and internal roads utilized by the Plant/Landfill; leachate collection and removal system utilized by the Landfill, including leachate forcemain and leachate evaporation pond; groundwater underdrain system for Cell 2 and leachate evaporation pond; and groundwater monitoring wells. These features are depicted on Drawings I.B-2 and I.B-4.

There are two (2) known easements within the Landfill Registration Boundary, including a drainage and electrical easement, as shown on the property and legal description of the Landfill Registration Boundary (Appendix I.B). The drainage easement is under the jurisdiction of McLennan County and the electrical easement is under the jurisdiction of Navasota Valley Electric Cooperative, Inc.

As described in Section 4.6, a portion of the Landfill Registration Boundary is within the 100-year floodplain. However, the existing and future waste disposal footprints are located entirely outside the limits of the 100-year floodplain. The 100-year floodplain is shown on Drawings I.B-4.

No waste storage, processing, or disposal is proposed within the drainage easement, electrical easement, or the 100-year floodplain.

2.4 OTHER PERMITS/AUTHORIZATIONS

Table 2-2 lists existing permits or construction approvals at the time of this Application development that are related to the Landfill.

Table 2-2 Permits and Construction Approvals

PERMIT PROGRAM	LANDFILL APPLICABILITY
Hazardous Waste Management Program under the Texas Solid Waste Disposal Act	TCEQ Solid Waste Registration No.: 88448 EPA ID No.:TXR000079082
Underground Injection Control Program under the Texas Injection Well Act	N.A.
National Pollutant Discharge Elimination System Program under the Clean Water Act and Waste Discharge Program under Texas Water Code, Chapter 26	Texas Permit No.: WQ0004755000 EPA ID No.: TX0127256
Prevention of Significant Deterioration Program under the Federal Clean Air Act (FCAA). Nonattainment Program under the FCAA	TCEQ Permit No. 70861
National Emission Standards for Hazardous Air Pollutants Preconstruction Approval under the FCAA	TCEQ Permit No. 70861

Notes:

1. N.A.: not applicable

2.5 LEGAL AUTHORITY

Verification of legal status for the two entities having over 20 percent ownership in the Landfill (Brazos Sandy Creek Electric Cooperative, Inc. and Sandy Creek Energy Associates, L.P) is provided in Appendix I.C – Legal Authority.

2.6 GENERAL MAPS (30 TAC §352.231(E))

In accordance with 30 TAC §352.231(e), general layout drawings are provided in Appendix I.B, including the following:

- Site Location Map,
- General Topographic and Surrounding Features Map,
- Aerial Photograph,
- Facility Layout Map, and
- Land Ownership Map.

3 LANDOWNERS' MAP AND LIST (30 TAC §352.231(g))

In accordance with 30 TAC §352.231(g) and §330.59(d), the landowners' list presents the names and mailing addresses of the landowners of property within one-quarter (1/4) mile of the Landfill Registration Boundary, as provided in Table 3-1. The numbering in the landowners list corresponds to the numbers on Drawing I.B-6, which depicts the locations of the corresponding properties. The landowners' list and map are based on an online review of the McLennan County Appraisal Districts' property records (http://www.mclennancad.org/), as of January 2022. McLennan County did not identify mineral interests in its online real property appraisal records.

Table 3-1 List of Landowners

1.	Sandy Creek Energy Assoc LP ETAL C/O Duff And Phelps PO Box 2629 Addison, TX 75001-2629	2.	BASF Corporation Attn: Tax Department Florham Park, NJ 07932-1049	3.	Jackson Donald C PO Box 39 Riesel, TX 76682-0039
4.	Jackson Donald C PO Box 39 Riesel, TX 76682-0039	5.	Gillum Donald R PO Box 430 Riesel, TX 76682-0430	6.	Guenat Darcy R ETAL PO Box 430 Riesel, TX 76682-0430
7.	Jackson Don & Brenda PO Box 39 Riesel, TX 76682-0039	8.	Wegwerth Donna Jones 675 W Frederick St Riesel, TX 76682-3439		

4 GENERAL GEOLOGY SUMMARY (30 TAC §352.241)

4.1 REGIONAL AND SITE GEOLOGY

The Landfill Registration Boundary is located in the Blackland Prairies province of the Texas Gulf Coastal plains. The Blackland Prairies consist of chalks and marls that weather to deep, black clay soils (Physiographic Map of Texas 1996). The Landfill is underlain by two integrated formations, the Lower Taylor Marl Formation (Ozan Formation) and the Wolfe City Formation. In general, the subsurface stratigraphy consists predominantly of high plasticity yellow-brown clays, weathered clayshale, and marl units of fluvial and shallow marine origin (Geotechnical Design Report Revision 0. Sandy Creek Power Partners, Apr. 2009). The Ozan Formation consists of a calcareous claystone with increasing upward contents of silt and sand. The Ozan Formation is generally medium gray and contains some glauconite, phosphate pellets, hematite, and pyrite nodules. The Ozan Formation is up to 500 feet in thickness and grades upward to the Wolfe City Formation (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970). The Wolfe City formation is up to 300 feet in thickness. Based on the geologic map (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970), the approximate thickness of the Wolfe City formation at the Landfill is estimated to be 150 feet. The Wolfe City Formation consists of marl, sand, sandstone, and clay interbedded with thin sandstone and un-cemented sand lenses, and containing glauconite, phosphate and hematite nodules. It is generally dark gray to light gray and brown. (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970).

The formations directly underlying the Landfill are considered to be a confining unit to the state-defined aquifer. The shallowest state-defined aquifer beneath the Landfill is the Trinity Aquifer, which would likely be encountered approximately 1,000 feet below the ground surface (Groundwater Atlas of the United States, USGS, Reston, VA, 1996). This aquifer is isolated from the Landfill by thick Cretaceous confining units.

4.2 SITE STRATIGRAPHY

Site soil conditions within the vicinity of the Landfill Registration Boundary were investigated by the Landfill Owner/Operator prior to Landfill Construction, using borings within and adjacent to the Landfill footprint (B&V, 2009, 2010; Geosyntec, 2010, 2015 as provided in Appendix VI.B). Consistent with the above referenced reports, the soils in the vicinity of the Landfill Registration Boundary are comprised of three soil layers, identified in soil borings conducted to depths of up to 100 feet at the Landfill. From top to bottom, these strata generally consist of:

- Stratum I: 1 to 12-ft thick (typical), dry to moist, soft to firm, high plasticity, brown clay with trace amounts of rounded sand and gravel;

- Stratum II: within 10 to 45-ft below ground surface (typical), dry to moist, firm to stiff, high plasticity yellow-brown clay grading to gray with depth, with trace amounts of subrounded sand and gravel, occasional horizontal seams of fine sand in the upper portions of the stratum, and horizontal and vertical deposits of gypsum throughout the layer; and

- Stratum III: dry to moist, hard, high plasticity, fissile, gray clayshale with infrequent fine sand layers and very infrequent fissures and joints, typically found below depths of 50 ft in uplands and 25 ft in bottom valleys.

The locations and logs of the borings drilled in since 2010 in the vicinity of the Landfill Registration Boundary are found in the various reports provided in Appendix II.B. The results of geotechnical laboratory tests conducted on soil samples collected by Black and Veatch and Geosyntec Consultants during subsurface investigation activities are also included in Appendix II.B.

Based on available information, including field investigation of the Landfill Registration Boundary, the geology of the Landfill is considered suitable for Landfill development.

5 LOCATION RESTRICTIONS (30 TAC §352.251)

An "[e]xisting CCR landfill means a CCR landfill…for which construction commenced prior to October 14, 2015..." and a "[n]ew CCR landfill means a CCR landfill or lateral expansion of a CCR landfill that first receives CCR or commences construction after October 14, 2015." 40 CFR §257.53. Because Cells 1 and 2 were constructed in 2010 and 2014, respectively, they are considered existing Landfills. Cell 3, including a portion of that which was constructed in 2021, and any future subcells are considered lateral expansions. As such, location restrictions related to placement above the uppermost aquifer, wetlands, fault areas, and seismic impact zones are only applicable to Cell 3; and location restrictions related to unstable areas, floodplains, and endangered species are applicable to Cells 1 through 3.

5.1 PLACEMENT ABOVE THE UPPERMOST AQUIFER (30 TAC §352.601 [40 CFR §257.60])

The location restriction criteria in 30 TAC §352.601 (40 CFR §257.60) requires that the base of the Landfill lateral expansion (i.e., Cell 3) must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer.

Based on the study provided in Part II –Location Restrictions Demonstration, Section 4, the uppermost aquifer (Trinity Aquifer) is estimated to be located more than 1,000 feet below the existing ground surface. Therefore, Cell 3 will be located no less than five feet from the uppermost aquifer, and the requirement in 40 CFR §257.60(a) have been met. Part II, Section 4 also demonstrates that Cell 3 will meet the requirements of §257.60(b), (c), and (d).

5.2 WETLANDS (30 TAC §352.611 [40 CFR §257.61])

The location restriction criteria in 30 TAC 352.611 (40 CFR §257.61) requires that Landfill lateral expansions (i.e., Cell 3) not be located in wetlands as defined in 40 CFR §232.2 unless a demonstration is made that the lateral expansion meeting requirements 40 CFR §257.61(a)(1) though (5).

As demonstrated in Part II, Section 5, an onsite Jurisdictional Assessment Survey of existing aquatic features, located in the vicinity of Cell 3 was performed by Integrated Environmental Solutions, LLC (IES). Based on this Assessment; one pond, four ditches, and one erosion feature were identified; however, none of these features were identified as Waters of the United States (WOTUS), nor were wetlands identified within the area to be disturbed by development of Cell 3. Following the onsite Jurisdictional Assessment Survey, IES prepared and submitted an Approved Jurisdiction Determination (AJD) request to U.S. Army Corps of Engineers (USACOE), Fort Worth Regulatory Branch. This AJD and USACOE approval is included in Part II, Appendix II.A, Attachment 1. As a result of the Jurisdictional Assessment Survey conducted by IES and the approval by USACOE, the requirements in 30 TAC §352.611 [40 CFR §257.61(a)] have been met for Cell 3, and a demonstration meeting requirements in §257.61(a)(1) though (5) is not required. Part II, Section 5 also demonstrates that Cell 3 meets the requirements of §257.61(b), (c), and (d).

5.3 FAULT AREAS (30 TAC §352.621 [40 CFR §257.62])

The location restriction criteria in 30 TAC 352.621 (40 CFR §257.62) requires that Landfill lateral expansions (i.e., Cell 3) not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless a demonstration is made that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the lateral expansion.

As stated in Part II, Section 5, Cell 3 was reviewed for the presence of faults that has had displacement in Holocene time within 60 meters (200 feet) of Cell 3. Based on the review of the available geologic maps, Cell 3 will not be located within 60 meters (200 feet) of a fault that has had displacement in Holocene time; therefore, the requirements in 40 CFR §257.62(a) have been met and a demonstration for an alternative setback distance is not required. Part II, Section 6 also demonstrates that Cell 3 meets requirements in §257.62(b), (c), and (d).

5.4 SEISMIC IMPACT ZONES (30 TAC §352.631 [40 CFR §257.63])

The location restriction criteria in 30 TAC 352.631 (40 CFR §257.63) requires that lateral expansions (i.e., Cell 3) not be located in seismic impact zones unless the owner or operator can demonstrate that all structural components, including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the Landfill. 40 CFR §257.53 defines a Seismic Impact Zone as an area having a 2 percent or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of earth's gravitational pull (g) will exceed 0.10 g in 50 years. Therefore, if the maximum horizontal acceleration is less than or equal to 0.10 g, then the design of Cell 3 will not need to incorporate an evaluation of seismic effects.

As described in Part II, Section 6, areas within the United States where seismic effects need to be evaluated, as determined by the United States Geological Survey (USGS), are shown on the Figure Appendix B – Liquefaction and Settlement Potential Evaluation of Appendix II.A. As indicated on this Figure, the Landfill (inclusive of Cell 3) is not located within a seismic impact zone as defined by 40 CFR §257.53. Therefore, an evaluation of the seismic effects on the Landfill design is not required for this Landfill and the requirements in 40 CFR §257.63 have been met for Cell 3. Part II, Section 7 also demonstrates that Cell 3 meets requirements in §257.63(b), (c), and (d).

5.5 UNSTABLE AREAS (30 TAC §352.641 [40 CFR §257.64])

The location restriction criteria in 30 TAC 352.641 (40 CFR §257.64) requires that existing Landfills and lateral expansions must not be located in an unstable area unless recognized and generally accepted good engineering practices have been incorporated into the design of the Landfill to ensure that the integrity of the structural components (i.e., liners, leachate collection systems, final covers, etc.) of the Landfill will not be disrupted. Unstable areas, by definition, are areas susceptible to natural or human-induced events or forces that are capable of impairing the integrity of some or all structural components of a disposal unit.

As described in Part II, Section 7, and verified in the Unstable Areas Compliance Demonstration for Cells 1 and 2 (see Part II, Appendix II.B1) and Cell 3 (see Part II, Appendix II.A), the Landfill is not located in an unstable area. The design of the Landfill has been developed in accordance with accepted good engineered practices related to unstable areas so the integrity of the structural components of the Landfill will not be disrupted. Appendices II.A and II.B1 also demonstrate that the Landfill meets requirements in §257.64(b), (c), (d), and (e).

5.6 FLOODPLAIN (40 CFR §257.3-1)

The location restriction criteria in 40 CFR §257.3-1 requires that facilities or practices in floodplains shall not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.

As described in Part II, Section 8, a small portion of the Landfill Registration Boundary is located within a 100-year floodplain. However, the Landfill footprint is located entirely outside the limits of the 100-year floodplain, and no development, levee, or other flood protection improvement are proposed within the floodplain. Landfill operations and development will not restrict the flow or reduce the temporary storage capacity of the 100-year floodplain; nor will Landfill operations result in washout of solid waste associated with the 100-year floodplain. Furthermore, all storage and facilities will be located outside of the 100-year floodplain. Therefore, the requirements in 40 CFR §257.3-1 have been met for the Landfill and Landfill operations.

5.7 PROTECTION OF ENDANGERED OR THREATENED SPECIES (40 CFR §257.3-2)

The location restriction criteria in 40 CFR §257.3-2 requires that facilities or practices shall not cause or contribute to the taking of any endangered or threatened species of plants, fish, or wildlife, and the facility or practice shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species as identified in 50 CFR Part 17.

As described in Part II, Section 9, Integrated Environmental Solutions, LLC (IES) performed a Protected Species Habitat Assessment (Assessment) of the Landfill Registration Boundary. Based on this Assessment, no federally listed critical habitat, federally protected, or candidate species were found to be located within the vicinity of the Landfill Registration Boundary. No habitat(s) for the state-listed species within the Landfill Registration Boundary were found in the Assessment. None of the vegetation within the Landfill Registration Boundary were considered unique or compose a unique vegetation type; therefore, it was determined that the Landfill and associated support facilities will not have an effect on any unique vegetation, vegetation communities, or habitat types. As a result of the Protected Species Habitat Assessment conducted by IES, it is concluded that the development and operation of this Landfill will not result in the destruction or adverse modification of the critical habitat of endangered or threatened species, or cause or contribute to the taking of threatened or endangered species or result in adverse impact to critical habitat of threatened or endangered species. Therefore, the requirements of 40 CFR §257.3-2 have been met for the Landfill.

5.8 PROTECTION OF SURFACE WATER (40 CFR §257.3-3)

The location restriction criteria in 40 CFR §257.3-2 requires that a facility not cause a discharge of pollutants into water of the United States that is in violation of the requirements of the National

Pollutant Discharge Elimination Systems (NPDES) under section 402 of the Clean Water Act and areawide or Statewide water quality management plan.

As described in Part II, Section 10, the Landfill Owner/Operator will comply with the Plant's Texas Pollutant Discharge Elimination (TPDES) permit, 40 CFR §257.81(b), and Section 3 of Part IV, Appendix IV.C. Therefore, the requirements in 40 CFR §257.3-3 have been met for the Landfill and site operations.

6 LANDFILL DESIGN AND OPERATING CRITERIA

This section describes that Landfill design criteria (in accordance with 30 TAC §352.701) and general landfilling methods, including operations and environmental protection.

A Process Flow Diagram is provided in Drawing I.B-6 and discussed in Section 2.2 of this Narrative that describes the originating point of each waste and waste classification code, means of conveyance utilized for the process flow steps, name and brief function of each component through which the waste passes, and the ultimate disposition of waste.

Part V – Site Operating Plan provides additional details related to Landfill operations.

6.1 SITE DEVELOPMENT METHODS AND DESIGN

The Landfill development method for the site is a combination of area excavation fill followed by aerial fill (i.e., above-grade waste placement) to reach the Landfill completion height. The Landfill will be developed in sequence with multiple cells (Cells 1 through 3). Each cell may be developed in multiple phases at the discretion of the Landfill Owner/Operator.

The excavation sideslopes will be no steeper than 3H:1V. The Landfill liner systems are described in Section 6.1.1 of this narrative, and Cell 3 will be constructed in accordance with procedures set forth in Appendix IV.B – Liner Construction Quality Assurance Plan. Aerial fill sideslopes will be no steeper than 3.5H:1V and the final aerial fill topslope will be no flatter than 3 percent. The maximum elevation of final cover will be no higher than 612 ft MSL. Final cover placement and closure of the Landfill will be in accordance with procedures set forth in the Closure Plan provided in Part VII – Closure and Post-Closure Care Plan submitted with this Application.

Part I.B – General Layout Drawings and Part IV – Landfill Criteria and Design Drawings include drawings depicting the Landfill development. Specifically, Part I, Appendix I.B and Part IV include the following:

- Part I, Appendix I.B – Drawing I.B-4 – Facility Layout Map, includes the existing site contours (April 2006 and November 2020 topography), Landfill Registration Boundary, Landfill limits of waste, and cell layout.
- Part IV – Drawing IV-2 – Excavation Plan, includes the excavation grades, Landfill limits of waste, and cell layout.
- Part IV – Drawing IV-4 – Landfill Completion Plan, includes final cover contours, including maximum elevation, surface water management system, and general Landfill layout at Landfill completion.

6.1.1 Liner Design (30 TAC §352.701 [40 CFR §257.70(b)])

The liner design for the Landfill is described in this section, including the liner systems for each of the cells (Cells 1 through 3). Cells 1 and 2 are considered an existing Landfill (consistent with §257.53); therefore, they are not subject to the requirements of §352.701 [§257.70(b)]. Cell 3 is considered a lateral expansion (consistent with §257.53) and will be constructed consistent with requirements in §352.701 [§257.70(b)].

The liner systems for each cell are comprised of the following (from top to bottom) as depicted on Drawing IV-8 in Part IV:

- Cell 1 (bottom liner; constructed in 2010):
  - 6-inch-thick compacted soil cover; and
  - 2-foot-thick low permeability soil liner (design hydraulic conductivity, $k \leq 1x10^{-7}$ cm/sec).
- Cell 2 (bottom and sideslope liner; constructed in 2014):
  - 1-foot-thick soil protective cover;
  - Double-sided geocomposite (non-woven geotextile on both sides of geonet); and
  - 3-foot-thick low permeability soil liner (hydraulic conductivity, $k \leq 1x10^{-7}$ cm/sec).
- Cell 3 (bottom and sideslope liner; Cell 3, Subcells 3A through 3D [constructed in 2021] and future subcells):
  - 2-foot-thick soil protective cover;
  - Double-sided geocomposite (non-woven geotextile on both sides of geonet);
  - 60-mil textured (both sides) high-density polyethylene (HDPE) geomembrane; and
  - 2-foot-thick low permeability soil liner (hydraulic conductivity, $k \leq 1x10^{-7}$ cm/sec).

Part II, Appendix II.A – Cell 3 Compliance Demonstration and Notification Letter provides a detailed Demonstration that Cell 3 meets requirements of 40 CFR 257.70(b)(1) through (4) and 257.70(d).

Liner construction and Construction Quality Assurance (CQA) procedures for Cell 3 are described in Part IV, Appendix IV.B; including construction procedures for engineering fill, compacted clay liner, geomembrane, geocomposite, protective cover, and leachate collection and removal system (LCRS).

6.1.2 Leachate Collection and Removal System (LCRS) (30 TAC §352.701 [40 CFR §257.70(d)])

A LCRS has been designed to control the accumulation of leachate and contact water within the waste disposal area during the active periods of landfilling, and after Landfill closure. The LCRS for Cells 1 and 2 was constructed in accordance with rules and regulations for CCR Landfill construction at the time of construction (prior to promulgation of 30 TAC 352 and 40 CFR Part 257). The LCRS for Cell 3 was designed in accordance with §352.701 [§257.70(d)], including maintaining leachate head over the composite liner of less than 30 centimeters. The LCRS layout is shown on Drawing IV-3 in Part IV of this Application. A description and design calculations for the Cell 3 LCRS is included in Part IV, Appendix IV.A – Leachate Collection and Removal System Plan. Information regarding materials and construction quality control and quality assurance are included in the Part IV, Appendix IV.B – Liner Construction Quality Assurance Plan. Representative details of the LCRS are presented on Drawing IV-9.

The LCRS for Cell 1 consists of leachate collection and removal piping that gravity drains leachate to the leachate evaporation pond. The LCRS for Cells 2 and 3 consists of a primary leachate drainage layer (i.e., geocomposite) placed over the bottom and sideslope liner system, leachate collection piping, and leachate collection sumps and pumps that discharge into a leachate forcemain that conveys leachate to the leachate evaporation pond. The geocomposite in Cells 2 and 3 consists of a HDPE geonet with a non-woven geotextile heat bonded to both sides of the geonet placed on the bottom and sideslopes. The geocomposite in Cell 3 will have hydraulic properties that will provide adequate drainage of leachate to the LCRS piping and sump, thereby maintaining less than 30-centimeter leachate head above the bottom liner system. Calculations demonstrating the minimum required material properties for the geocomposite and non-woven geotextile for Cell 3 are provided in Part IV, Appendix IV.A.

A 0.5-foot thick and 1-foot thick protective soil cover was placed over the liner system or geocomposite prior to waste placement in Cells 1 and 2, respectively. A 2-foot-thick protective cover will be placed over the geocomposite prior to waste placement in Cell 3. To facilitate drainage into the LCRS, chimney drains (also referred to as LCRS trenches), comprised of aggregate wrapped in a non-woven geotextile, have/will be constructed over the LCRS piping. Leachate entering the Cell 1 LCS piping gravity drains to the leachate evaporation pond. Leachate entering the Cells 2 and 3 LCS piping will discharge into below-grade sumps located within the lined cell at the perimeter of the Landfill. Leachate collected in the sumps will be removed via submersible pumps lowered into the sumps through a riser pipe extending up the Cell 2 and 3 sideslopes that discharges into forcemain piping. The leachate for the Cells 1 through 3 will be directed to the leachate evaporation pond for storage, evaporation, and/or disposal.

Additional descriptions of the LCRS piping and sump for Cell 3, including but not limited to sump sizing calculations; and demonstration of performance of pipes and perforations are presented in Part IV, Appendix IV.A. Leachate and contact water management, including storage and disposal is also presented in Part IV, Appendix IV.A.

6.1.3 Liner Construction Quality Assurance (CQA)

As presented in Part IV, Appendix IV.B – Liner CQA Plan has been prepared to provide the Landfill Owner/Operator, Design Engineer, CQA Professional of Record, and Contractor the needed guidance regarding CQA and quality control during construction of the bottom liner system and LCRS for Cell 3. This CQA Plan also provides the CQA Professional of Record the needed guidance for preparing the Liner Evaluation Report (LER) for Cell 3.

This CQA Plan addresses the testing methods and other requirements set forth in 30 TAC §352.701, 40 CFR §257.70, and current TCEQ guidance document, RG-534 (2017 version). The scope of this CQA Plan includes general requirements concerning roles, responsibilities, and qualifications of the parties involved; and instructions for these parties to implement the CQA program.

6.2 FUGITIVE DUST CONTROL (30 TAC §352.801 [40 CFR §257.80])

The Landfill and associated ancillary facilities will be operated under Part III – Fugitive Dust Control Plan that complies with 30 TAC §352.801 (40 CFR §257.80) and the Plant's air permit (TCEQ Permit No. 70861, Special Condition 25). The purpose of the Plan is to present measures to be implemented at the Landfill to effectively minimize CCR from becoming airborne during landfilling activities.

6.3 RUN-ON AND RUN-OFF CONTROL (30 TAC §352.811 [40 CFR §257.81])

6.3.1 General

Surface water within the Landfill Registration Boundary generally drains west to an existing channel where it flows to the southwestern Landfill Registration Boundary and flows west into an unnamed tributary that empties into Lake Creek Lake (an impoundment of Manos Creek). Manos Creek discharges into the Brazos River. Surface water runoff (uncontaminated) from the Landfill is conveyed to the perimeter stormwater management system, comprised of downchutes, drainage swales, and perimeter channels and is directed to an existing stormwater pond south of the Landfill. Discharge from the existing stormwater pond flows to the southwestern Landfill Registration Boundary and flows west into an unnamed tributary that empties into Lake Creek Lake.

Consistent with 30 TAC §352.811 [40 CFR §257.81(a)], the run-on and run-off control systems have been designed to prevent stormwater flow (run-on) onto the working face of the Landfill, and collect and control flow from the active portion (contact water – water that has come in contact with waste or leachate) of the Landfill from a 25-year, 24-hour storm event. Run-on and run-off from the working face of the Landfill will be handled in a manner that complies with the Texas Pollutant Discharge Elimination System (TPDES) consistent with 40 CFR §257.81(b) and Section 3 of Part IV, Appendix IV.C – Run-on and Run-off Control Plan. Run-on and run-off control systems are designed to convey post-closure (following final cover installation) run-on and runoff from a 25-year, 24-hour storm event. This includes the design of downchutes, drainage swales, and perimeter drainage channels to convey stormwater from the Landfill area to the existing stormwater pond.

6.3.2 Post-Development Site Drainage Patterns

Surface water (i.e., stormwater and contact water) will be managed in accordance with requirements in 30 TAC §352.811 (40 CFR §257.81). A complete description of the site drainage patterns for post-development Landfill conditions is presented in Part IV, Appendix IV.C of this Application. As presented in Part IV, Appendix IV.C, the surface water drainage features, aerial fill controls, and perimeter drainage system, have been designed for a 25-year, 24-hour storm event. The post-development hydrologic and hydraulic analysis is presented in Part IV, Appendix IV.C, including a description of the methodology, calculations, and results of said calculations.

6.3.3 Perimeter Drainage System

The stormwater perimeter drainage controls for the Landfill have been designed consistent with 30 TAC §352.811 (40 CFR §257.81), including being designed for a 25-year, 24-hour storm event. The perimeter drainage system is comprised of final cover controls (drainage swales and downchutes, as described in the subsequent subsections), perimeter drainage channels and an existing stormwater pond. The drainage features will be installed concurrent with the construction of up-gradient Landfill disposal cells, such that when the cell grades are above existing grade, down-gradient drainage features are in-place. Details and sizing criteria for the perimeter drainage system and associated calculations, including peak velocities, flow depths, and discharge rates are included in Part IV, Appendix IV.C of this Application.

6.3.4 Below Grade

Control of stormwater run-on and runoff within excavation areas will be achieved using temporary diversion berms, intercell berms, ditches, and containment berms as needed. The temporary stormwater control structures will be used to divert stormwater away from the working face, thus reducing the volume of contact water and leachate generated. Cells 2 and 3 utilize interim cell berms within the cell to minimize the amount of leachate generated during Landfill operations. Uncontaminated stormwater will be discharged consistent with the requirements of the Plant's TPDES permit.

Contact water will be contained within the exposed waste areas, including working face, by using temporary containment berms and directed to the LCRS, which discharges into the leachate evaporation pond in accordance with the procedures set forth in Part IV, Appendix IV.A of this Application. Water that infiltrates into the underlying waste will be managed as leachate.

6.3.5 Aerial Fill Controls

Additional stormwater controls will be necessary as the Landfill is brought above grade (i.e., aerial fill). Temporary diversion berms, channels, and containment berms will be used to separate and control uncontaminated and contact stormwater run-on and runoff for the aerial fill portions of the Landfill.

As intermediate and final cover are placed on the Landfill, vegetation will be established to provide erosion protection, as described in Part V, Site Operating Plan (SOP). Furthermore, as intermediate and final cover are placed, drainage features will be installed to control erosion and convey stormwater from the Landfill cover to the perimeter drainage system, as described in Sections 6.1.4.6 and 6.1.4.7. Drainage features installed on the intermediate and final cover have been designed to convey stormwater associated with the 25-year, 24-hour storm event. Design details and sizing calculations, including peak velocity, flow depth, and discharge rate, for intermediate and final cover drainage features are described in Part IV, Appendix IV.C. In all cases, surface water run-on and runoff will be managed consistent with the 30 TAC §352.811 (40 CFR §257.81).

In accordance with the Plant's air permit (TCEQ Permit No. 70861, Special Condition 25), the maximum working face size will not exceed one (1) acre and the maximum area of exposed waste will not exceed five (5) acres total (active area). Inactive areas will be covered with intermediate cover (12-inch soil layer or alternate intermediate cover) to limit dust emissions consistent with the Fugitive Dust Control Plan (see Part III). Contact water and leachate will be minimized by also implementing: (1) the site design and proper operating practices; and (2) ongoing placement of intermediate and final cover, as further described in Part VII - Closure and Post-Closure Care Plan. Details of the final cover design are provided on Drawing IV-10 (see Part IV) and Part VII of this Application.

6.3.6 Drainage Swales and Downchutes

Drainage swales (i.e., final cover topslope and sideslope swales) and downchutes are structural controls used to convey runoff from the Landfill cover to the perimeter drainage system and to reduce cover erosion by limiting uninterrupted flow lengths.

Drainage swales are designed as V-shaped channels, with 2(H):1(V) sideslope (berm side) and 3.5(H):1(V) sideslopes (Landfill side). The maximum horizontal spacing between drainage swales will be 175 horizontal feet on a 3.5(H):1(V) sideslope to maintain a soil loss at less than or equal to 3 tons/acre/year. Additionally, drainage swale sizing criteria is based on the contributing drainage area discharging to the swale.

Downchutes will be installed on the Landfill sideslopes (maximum 3.5(H):1(V) slope). The sizing criteria for downchutes is based on the contributing drainage area for the each downchute structure associated with drainage swales and overland flow draining to a specific downchute.

Calculations for soil between drainage swales and sizing of drainage are provided in Part IV, Appendix IV.C – Run-on and Run-off Control Plan. These structures will be installed on final cover, generally as depicted on Drawings IV.C1 and IV.C2, and as needed on intermediate cover to control erosion of the intermediate as the Landfill is developed.

6.4 SITE OPERATIONS

6.4.1 General Overview

Consistent with 30 TAC, Chapter 352, Subchapter G (40 CFR, Part 257, Subpart D), a SOP has been prepared and presented in Part V. The purpose of the SOP is to provide general guidance to the Landfill Owner/Operator for the day-to-day operation of the Landfill, as well as operating guidance for the Landfill Owner/Operator to maintain the Landfill in compliance with the engineering design and applicable regulatory requirements of the TCEQ and EPA. The SOP may also serve as a reference source and assist in personnel training. The SOP, the Registration, and Application will be retained by the Landfill Owner/Operator throughout the Landfill's operating life in accordance with 30 TAC §352.1321(c).

7 GROUNDWATER MONITORING AND CORRECTION ACTION

Consistent with 30 TAC, Chapter 352, Subchapter H (40 CFR, Part 257, Subpart D), Part II, Appendix II.B2 includes the results of a subsurface investigation conducted by the Landfill Owner/Operator within the Landfill Registration Boundary prior to construction of the Plant, Landfill and groundwater monitoring wells existing at the time of developing this Application. Included in Part II, Appendix II.B2 are geologic cross-sections, elevations, and gradient of groundwater from the subsurface investigations and subsequent groundwater monitoring. Details of the groundwater monitoring system and the Plan for performing groundwater sampling, analysis, and reporting are addressed in Part VI – Groundwater Monitoring and Corrective Action Plan.

8 CLOSURE AND POST-CLOSURE CARE

The Closure and Post-Closure Care Plan has been prepared consistent with 30 TAC §352, Subchapter J, as well as the relevant provisions of 40 CFR §257, Subpart D, adopted by reference.

8.1 FINAL COVER DESIGN (30 TAC §352.1221[40 CFR §257.102])

The final cover system for the Landfill was developed to meet or exceed the requirements of 30 TAC §352.1221 (40 CFR §257.102). As depicted on Drawing IV-10 (see Part IV), two separate multi-layer final cover systems will be used at the Landfill to provide a low maintenance cover and to reduce rainfall percolation through the final cover systems, thereby minimizing leachate generation within the Landfill. A soil-only final cover system will be constructed overlying Cells 1 and 2, which consist of soil-only (Cell 1) and soil-geocomposite (Cell 2) liner systems, as described in Part IV, Appendix IV.A – Leachate Collection and Removal System Plan. A composite final cover system, described in Part IV, Appendix IV.A, will be constructed overlying Cell 3, which consists of a composite liner system. At the discretion of the Landfill Owner/Operator, the composite final cover may be installed over Cells 1 and/or 2.

Beginning from the surface and working down, the final cover systems will be comprised of the following components:

- Soil-only final cover (overlying Cell 1 and 2):
    - Vegetation (native and/or introduced vegetation);
    - 18-inch-thick vegetative erosion layer, with the upper 6 inches capable of sustaining vegetation; and
    - 18-inch-thick clayey soil infiltration layer ($k \leq 1x10^{-7}$ cm/sec).
- Composite final cover (overlying Cell 3):
    - Vegetation (native and/or introduced vegetation);
    - 18-inch-thick vegetative erosion layer, with the upper 6 inches capable of sustaining vegetation;
    - Geocomposite (double-sided);
    - 60-mil HDPE geomembrane, or 40-mil linear low-density polyethylene (LLDPE) geomembrane (textured both sides); and
    - 18-inch-thick clayey soil infiltration layer ($k \leq 1x10^{-7}$ cm/sec).

A Closure and Post-Closure Care Plan has been prepared and provided in Part VII of this Application. The Plan includes the final closure schedule, sequence of final cover placement, certification of closure, provisions for extending closure timeframes, estimate of the maximum inventory of waste ever on site, and largest area that will ever require final cover at the Landfill.

8.2 POST CLOSURE CARE (30 TAC §352.1241 [40 CFR §257.104])

Post-closure care monitoring and maintenance will continue for a period of 30 years in accordance with 30 TAC §352.1241 [40 CFR §257.104(c)(1)] unless the Landfill is operating under assessment monitoring in accordance with §257.95 at the end of the post-closure care period. Post-closure care monitoring and maintenance will consist, at a minimum, of the following requirements to be carried out by the Landfill Owner/Operator, in accordance with §257.104(b):

- Maintaining the integrity and effectiveness of the final cover system, including making repairs to the final cover as necessary to correct the effects of settlement, subsidence, erosion, or other events;

- Preventing run-on and run-off from eroding or otherwise damaging the final cover;

- Maintaining the integrity and effectiveness of the LCRS; and

- Maintaining the groundwater monitoring system and monitoring groundwater.

A detailed description of the activities required during post-closure care and procedures for completion of the post-closure care period are described in Part VII of this Application.

9 FINANCIAL ASSURANCE (30 TAC §352.1101)

In accordance with 30 TAC §352.1101 in 30 TAC §352 Subchapter I, Landfill Owners/Operators are required to perform post-closure care, and establish and maintain financial assurance for the duration of the post-closure care period.

9.1 POST-CLOSURE CARE COST ESTIMATE (30 TAC §352.1101(B))

In accordance with 30 TAC §352.1101(b), a post-closure care cost estimate for the 30-year post-closure care period is provided in Part VIII – Post-Closure Cost Estimate and Financial Assurance Mechanism. The cost estimates are based on the Closure and Post-Closure Care Plan (see Part VII) and provide a cost for the routine monitoring and maintenance of the final cover system, LCRS, and groundwater monitoring system. A post-closure care cost estimate is provided for the following: (1) existing registered units, including Cells 1 and 2 and a portion of Cell 3 (inclusive of Subcells 3A through 3D); and (2) future units, such as the unconstructed portion of Cell 3.

9.2 FINANCIAL ASSURANCE MECHANISM (30 TAC §352.1101(C))

In accordance with 30 TAC §352.1101(c), no more than 90 days after the Executive Director's approval of the Application, a financial assurance mechanism acceptable to the Executive Director will be submitted for the cost of post-closure care in an amount no less than the amount specified in the approved cost estimate. Financial assurance for post-closure care shall be demonstrated in compliance with §352.1101, except as indicated in §352.1111 (relating to Exceptions). Part VIII includes a detailed description of financial assurance mechanism that will be used for post-closure care.

10 VERIFICATION (30 TAC §352.231(f))

In accordance with 30 TAC §352.231(f), I Bryon Kohls verify that the design, construction, and operation of the Landfill meets the requirements of 30 TAC §352.2.

Signature

1/13/2022

Date

APPENDIX I.A

APPLICATION FORMS

Texas Commission on Environmental Quality

Registration Application for Coal Combustion Residuals (CCR) Waste Management

I. General Information

1. Reason for Submittal

Type of Registration Application

☒ New ☐ Major Amendment ☐ Minor Amendment

☐ Notice of Deficiency (NOD) Response ☐ Transfer ☐ Name Change

☐ Other

2. Application Fees

☒ $150 Application Fee

Payment Method

☐ Check ☒ Online through ePay portal <www3.tceq.texas.gov/epay/>

If paid online, enter ePay Trace Number: 582EA000458289

3. Facility Information

Facility information must match regulated entity information on the Core Data Form.

Applicant: ☐ Owner ☐ Operator ☒ Owner/Operator

Facility TCEQ Solid Waste Registration No: 88448

Facility EPA ID: TXR000079082

Regulated Entity Reference No. (if issued): RN 105905657

Facility Name: Sandy Creek Energy Station Coal Combustion Residual Waste Management Facility

Facility (Area Code) Telephone Number: (254) 896-4317

Facility physical street address (city, state, zip code, county): 2157 Rattlesnake Road

Facility mailing address (city, state, zip code, county): Riesel, Texas, 76682, McLennan

Latitude (Degrees, Minutes Seconds): 31˚ 28’ 27”

Longitude (Degrees, Minutes Seconds): -96˚ 57’ 18”

4. Publicly Accessible Website

Provide the URL address of a publicly accessible website where the owner or operator of a CCR unit will post information.
http://www.sandycreekpower.net/

5. Facility Landowner(s) Information

Facility landowner(s) name: Sandy Creek Energy Associates LP ETAL

Facility landowner mailing address: C/O Duff And Phelps - PO Box 2629

City: Addison State: Texas Zip Code: 75001

(Area Code) Telephone Number: (254) 896-4200

Email Address (optional):

6. CCR Waste Management Unit(s)

☒ Landfill Unit(s) ☐ Surface Impoundment(s)

For each existing landfill, new landfill and lateral expansion, existing surface impoundment, and new surface impoundment and lateral expansion(s) provide information on type of waste, the registered unit(s) in which they are managed, and sampling and analytical methods.

Submit the following tables:

Table I.6. – CCR Waste Management Units;

Table I.6.A. – Waste Management Information;

Table I.6.B. – Waste Managed in Registered Units; and

Table I.6.C. – Sampling and Analytical Methods.

7. Description of Proposed Activities or Changes to Existing Facility

Provide a brief description of the proposed activities if application is for a new facility, or the proposed changes to an existing facility or registration conditions, if the application is for an amendment.
The Coal Combustion Residual Waste Management Facility (Landfill) and associated support facilities are located on the southwest corner of the Sandy Creek Energy Plant (Plant) property boundary, located in McLennan County As currently designed, the Landfill is one unit (Unit 002) that will ultimately occupy approximately 40.7 acres and consist of three cells referred to as Cell 1, Cell 2, and Cell 3. Cells 1 and 2 are existing active cells that were constructed in 2010 and 2014, respectively, with ongoing waste placement operations. A portion of Cell 3 (inclusive of Subcells 3A through 3D encompassing approximately 10.3 acres) was constructed in 2021 at the time of preparing this registration application. Future subcells within Cell 3 (Subcells 3E through 3G, with an approximate area of 6.7 acres) will be constructed and operated consistent with this registration application. The approximate areas of Cells 1, 2, and 3 are 8.1, 15.6, and 17.0 acres, respectively. Other facilities associated with the landfill include a stormwater pond and associated ditches, channels, and culverts, a leachate evaporation pond and associated piping, and an equipment maintenance building.

The primary wastes disposed in the landfill are fly ash and bottom ash generated during the coal combustion process at the Plant. Additionally, other Class 2 and Class 3 waste generated at the facility are disposed of at the landfill. Refer to the Site Operating Plan (SOP) for a detailed list of wastes disposed in the Landfill.

8. Primary Contact Information

Contact Name: Dana Perry Title: Business Manager

Contact mailing address: 2161 Rattlesnake Road
City: Riesel County: McLennan State: Texas Zip Code: 76682
(Area Code) Telephone Number: (254) 896-4218

Email Address (optional): dperry@sandycreekservices.com

9. Notice Publishing

Party responsible for publishing notice:
☐ Applicant ☒ Consultant ☐ Agent in Service

Contact Name: Brett DeVries, Ph.D., P.E. Title: Project Engineer

Contact mailing address: 1901 Central Drive, Suite 550
City: Bedford County: Tarrant State: Texas Zip Code: 76021
(Area Code) Telephone Number: (817) 358-6110

10. Alternative Language Notice

Is an alternative language notice required for this application? For determination, refer to Alternative Language Checklist on the Public Notice Verification Form (TCEQ-20244-Waste-NORI).

☐ Yes ☒ No

11. Public Place Location of Application

Name of the Public Place: **City of Riesel City Hall**
Physical Address: **104 Highway 6**
City: **Riesel** County: **McLennan** State: **Texas** Zip Code: **76682**
(Area code) Telephone Number: **(254) 896-6501**

12. Ownership Status of the Facility

☐ Corporation ☒ Limited Partnership

☐ Sole Proprietorship ☐ General Partnership ☐ Other (specify):

Does the Site Owner (Permittee/Registrant) own all the CCR units and all the facility property?

☐ Yes ☒ No

13. Property / Legal Description Information – See Part I, Appendix I.B – General Layout Drawings

Provide a legal description and supporting documents of the property where the management of CCR waste will occur; including a survey plat and a boundary metes and bounds description (30 TAC §352.231(g)).

Submit the following documents:

a. Property Legal Description
b. Property Metes and Bounds Description
c. Metes and Bounds Drawings
d. On-Site Easements Drawings

14. Operator Information

Identify the entity who will conduct facility operations, if the owner and operator are not the same.

Operator Name: Same as Owner

Operator mailing address:

City: State: Zip Code:

(Area Code) Telephone Number:

Email Address (optional):

15. Confidential Documents

Does the application contain confidential documents?

☐ Yes ☒ No

If "Yes", cross-reference the confidential documents throughout the application and submit as a separate attachment in a binder clearly marked "CONFIDENTIAL."

16. Permits and Construction Approvals – See Part I - General Registration Application Requirements

Permit or Approval	Received	Pending	Not Applicable
Hazardous Waste Management Program under the Texas Solid Waste Disposal Act	☒	☐	☐
Underground Injection Control Program under the Texas Injection Well Act	☐	☐	☒
National Pollutant Discharge Elimination System Program under the Clean Water Act and Waste Discharge Program under Texas Water Code, Chapter 26	☒	☐	☐
Prevention of Significant Deterioration Program under the Federal Clean Air Act (FCAA). Nonattainment Program under the FCAA	☒	☐	☐

National Emission Standards for Hazardous Air Pollutants Preconstruction Approval under the FCAA	☒	☐	☐
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐
Other (describe)	☐	☐	☐

17. Legal Authority – See Part I, Appendix I.C

The owner and operator of the facility shall submit verification of their legal status with the application. This shall be a one-page certificate of incorporation issued by the secretary of state. The owner or operator shall list all persons having over a 20% ownership in the facility.

18. TCEQ Core Data Form – Not Applicable

The TCEQ requires that a Core Data Form (TCEQ-10400) be submitted on all incoming applications, unless a Regulated Entity and Customer Reference Number has been issued by the TCEQ and no core data information has changed. For more information regarding the Core Data Form, call (512) 239-5175 or visit the TCEQ Website.

19. Other Governmental Entities Information

Coastal Management Program

Is the facility within the Coastal Management Program boundary?

☐ Yes ☒ No

Local Government Jurisdiction (If Applicable)

Within City Limits of: City of Riesel
Within Extraterritorial Jurisdiction of:

Is the facility located in an area in which the governing body of the municipality or county has prohibited the storage, processing or disposal of municipal or industrial solid waste?

☐ Yes ☒ No If "Yes", provide a copy of the ordinance or order as an attachment.

20. Attachments – See Appendix I.B – General Layout Drawings

Does the application include the following?

General Maps ☒ Yes ☐ No
General Topographic Map ☒ Yes ☐ No
Facility Layout Map ☒ Yes ☐ No
Surrounding Features Map ☒ Yes ☐ No
Process Flow Diagram ☒ Yes ☐ No
Land Ownership Map ☒ Yes ☐ No
Land Ownership List ☒ Yes ☐ No

Pre-printed Mailing Labels ☒ Yes ☐ No

Maps and drawings shall be legible and easily readable by eye without magnification. Scales and paper size shall be chosen based on the type of map submitted, the land area covered, and the amount of detail to be shown. See instructions for details regarding maps and drawings to be submitted in application.

21. Verification of Compliance – See Part I

Does the owner and operator verify that the design, construction, and operation of CCR landfill(s) and surface impoundment(s) meets the requirements of 30 TAC §352.231(f) (30 TAC §352.2; 40 CFR §257.52, and 40 CFR §§257.3-1 – 257.3-3).

☒ Yes ☐ No

II. Location Restrictions and Geology

See Instructions and Technical Guidance

22. Location Restrictions – See Part II – Location Restrictions Demonstration

Submit certifications and technical reports demonstrating compliance of CCR unit(s) with applicable location restrictions (30 TAC 352, Subchapter E) and comply with 30 TAC §352.231(d) and 30 TAC §352.4 for submission of engineering and geoscientific information.

A. **Placement above the uppermost aquifer** (30 TAC §352.601) (40 CFR §257.60). For those CCR units whose base is less than five feet above the upper limit of the uppermost aquifer, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.60(a) – (c).

B. **Wetlands** (30 TAC §352.611) (40 CFR §257.61). For CCR units located in wetlands, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.61(a) – (c).

C. **Fault areas** (30 TAC §352.621) (40 CFR §257.62). For CCR units located within 200 feet of the outermost damage zone of a fault, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.62(a) – (c).

D. **Seismic impact zones** (30 TAC §352.631) (40 CFR §257.63). For CCR units located in a seismic impact zone, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.63(a) – (c).

E. **Unstable areas** (30 TAC §352.641) (40 CFR §257.64). For CCR units located in unstable areas, please submit a copy of the demonstration showing evidence of compliance with 40 CFR §257.64(a) – (d).

23. Geology Summary Report – See Part I, Section 4 and – See Part II – Geology and Location Restriction Demonstration

Submit a summary of the geologic conditions at the facility, including the relation of the geologic condition to each CCR unit. The summary must include enough information and data and include sources and references for the information. Include all groundwater monitoring data required by 40 CFR Part 257, Subpart D, (30 TAC §352.241, §352.601, §352.621, §352.631, and §352.641) and submitted in accordance of 30 TAC §352.4.

Note: Previously prepared documents may be submitted but must be supplemented or updated as necessary to provide the requested information (30 TAC §352.241(b)).

III. Fugitive Dust Control Plan

24. Fugitive Dust Control Plan – See Part III – Fugitive Dust Control Plan

A. **Submit a copy of the CCR Fugitive Dust Control Plan** (30 TAC §352.801) (40 CFR §257.80(b)), or the most recently amended plan. The initial plan or subsequent amended plan must be certified by a qualified Texas licensed professional engineer (Texas P.E.) that the plan meets the requirements of 30 TAC Chapter 352.

B. **Submit the most recent Annual CCR Fugitive Dust Control Report** (30 TAC §352.801) (40 CFR §257.80(c)) and include the report information.

IV. Landfill Criteria

See Instructions and Technical Guidance – No. 30 Coal Combustion Residuals Landfill

25. Landfill(s) for CCR Waste

Provide the following information below if there is a landfill; if there is more than one landfill, separate information is required for each landfill.

A. **Landfill Characteristics – See Part I – General Registration Application Requirements, Part IV, Appendix IV.B – Liner Construction Quality Assurance Plan, and Part V – Site Operating Plan**

Describe the design, installation, construction, and operation of the landfill and submit a completed Table IV.A. – Landfill Characteristics.

B. **Liner Design – See Part I – General Registration Application Requirements and Part II, Appendix II.A – Cell 3 Compliance Demonstration and Notification Letter**

1. For existing landfills, provide attachments describing how the facility will comply with 30 TAC 352, Subchapter F (Design Criteria).
2. For new landfills or lateral expansions of existing landfills, submit pages describing how the facility will comply with 30 TAC §352.261 and 30 TAC §352.701.
3. Complete Table IV.B. - Landfill Liner System and specify the type of liner used for the landfill.

4. Provide attachments describing the design, installation, and operation of the liner and leak detection system. The description must demonstrate that the liner and leak detection system will prevent discharge to the land, groundwater, and surface water. Submit a quality assurance project plan (QAPP) to ensure that each analysis is performed appropriately.

C. Leachate Collection and Removal – See Part I – General Registration Application Requirements and Part IV, Appendix IV.A – Leachate Collection and Removal System Plan

Submit design information and description of leachate collection and removal system in accordance with 30 TAC §352.701.

Complete Table IV.C. - Landfill Leachate Collection System

D. Design of Liner and Leachate Collection and Removal System – See Part IV, Appendix IV.A – Leachate Collection and Removal System Plan

For a new landfill or lateral expansion of a CCR landfill, provide a qualified Texas P.E. certification and technical report that the design of the liner and the leachate collection and removal system meets the requirements of 30 TAC §352.711.

E. Run-on and Run-off Controls – See Part IV, Appendix IV.C – Run-on and Run-off Control Plan

At time of application, attach pages describing how the facility will comply with the run-on and run-off system plan for an existing, new, or lateral expansion of a CCR landfill information. Provide a qualified Texas P.E. certification and technical report that the run-on and run-off control system plans meet the requirements of 30 TAC §352.811.

F. Inspection for Landfills – See Part V – Site Operating Plan (specifically Appendix V.A, V.B, and V.C)

At time of application, attach pages describing how the facility will comply 30 TAC §352.841 and complete Table IV.D. – Inspection Schedule for Landfills. For existing CCR landfills, provide the most recent inspection report. All CCR landfills and any lateral expansions of a CCR landfill must be inspected for any structural weakness, malfunction, deterioration conditions which are disrupting or have the potential to disrupt the operation or safety of the CCR unit, or any other conditions which may cause harm to human health and environment at a frequency specified in 40 CFR §257.84(a) and (b).

V. Surface Impoundment Criteria – Not Applicable

See Instructions and Technical Guidance – No. 31 Coal Combustion Residuals Surface Impoundment

26. Surface Impoundment(s) for CCR Waste – Not Applicable

Provide the following information below if there is a surface impoundment; if there is more than one surface impoundment, separate information is required for each surface impoundment.

A. General Surface Impoundment(s) Characteristics

Provide information about the characteristics of the surface impoundment(s): incised, surface area (acres), storage volume (acres-feet), and depth (feet).

For all surface impoundment(s), include the following information:

1. Complete Table V.A. - Surface Impoundments Characteristics. List the surface impoundment(s) to be registered as a CCR unit(s), the wastes managed in each unit, and the rated capacity or size of each unit.
2. Describe the surface impoundment(s) and provide a plan view drawing with cross-sections, if available.
3. Specify the minimum freeboard to be maintained and the basis of the design to prevent overtopping resulting from normal or abnormal operation; overfilling; wind and wave action; rainfall; run-on; malfunctions of level controllers, alarms, and other equipment; and human error. Show that adequate freeboard will be available to prevent overtopping from a 100-year, 24-hour storm.
4. Waste Flow
   Describe the means that will be used to immediately shut off the flow of waste to the impoundment in the event of liner failure or to prevent overtopping.
5. Dike Construction ☐ Yes ☐ No

   If Yes, submit the dike certification (located at the end of the application).

   The structural integrity of the dike system must be certified by a qualified Texas P.E. before the registration is issued. If the impoundment is not being used, the dike system must be certified before it can be put into use. The certification must be sealed by a qualified Texas P.E., along with the engineering firm's name and registration number (30 TAC §352.4).

   A report shall accompany the dike certification which summarizes the activities, calculations, and laboratory and field analyses performed in support of the dike certification. Describe the design basis used in construction of the dikes. A QAPP should be included in the report to ensure that each analysis is performed appropriately and include:

   (1) Slope Stability Analysis

   (2) Hydrostatic and Hydrodynamic Analysis

   (3) Storm Loading

   (4) Rapid Drawdown

   Earthen dikes should have a protective cover to minimize wind and water erosion and to preserve the structural integrity of the dike. Describe the protective cover used and describe its installation and maintenance procedures.

B. Liner Design

For surface impoundment(s), provide information about how the facility will comply with 30 TAC §352.711 for existing CCR surface impoundments. For new and lateral expansion of CCR surface impoundments provide information on how the facility will comply with 30 TAC §352.261, and 30 TAC §352.721, see Instructions and Technical Guidance No. 31 Coal Combustion Residuals Surface Impoundment. The qualified Texas P.E. must certify that the design of the liner complies with the requirements of 30 TAC Chapter 352 and 40 CFR Part 257, Subpart D, where required.

Is the CCR surface impoundment unlined? ☐ Yes ☐ No

If “Yes”, the CCR unit is subject to the closure requirements under 30 TAC Chapter 352 and 40 CFR §257.101(a) to retrofit or close. A notification must be prepared stating that an assessment of corrective measures has been initiated.

1. Complete Table V.B. - Surface Impoundment Liner System for each surface impoundment to be registered.
2. Describe the design, installation and operation of liner and leak detection components. The description must demonstrate that the liner and leak detection system will prevent discharge to the land and surface water. Submit a QAPP report to ensure that each analysis is performed appropriately.
3. For new or laterally expansions of existing surface impoundments, provide a subsurface soil investigation report that must include:
    a. A description of all borings drilled, at the unit location, to test soils and characterize groundwater;
    b. A unit map drawn to scale showing the surveyed locations and elevations of the borings, including location of permanent identification markers ((30 TAC §352.731) and (40 CFR §257.73(a)(1));
    c. Cross-sections prepared from the borings depicting the generalized strata at the unit;
    d. Boring logs, including a description of materials encountered, and any discontinuities such as fractures, fissures, slickensides, lenses or seams;
    e. A description of the geotechnical data and the geotechnical properties of the subsurface soil materials, including the suitability of the soils and strata for the intended uses; and
    f. A demonstration that all geotechnical tests were performed in accordance with industry practices and recognized procedures.

C. Hazard Potential Classification

Provide the current hazard potential classification assessment and associated documentation, as required by 30 TAC §352.731 or §352.741 and 40 CFR §257.73(a)(2) or §257.74(a)(2). The qualified Texas P.E. must certify that the initial hazard potential classification and any subsequent periodic classification was conducted in accordance with the requirements of 30 TAC Chapter 352, where required.

Hazard Potential Classification:

D. Emergency Action Plan for High or Significantly High Hazard Potential

Provide the current Emergency Action Plan that has been certified by a qualified Texas P.E. and includes the following requirements from 30 TAC 352, Subchapter F and 40 CFR §257.73(a)(3)(i)(A) - (E) or 40 CFR §257.74 (a)(3)(i)(A) - (E). The qualified Texas P.E. must certify that the written Emergency Action Plan and any subsequent amendment of the plan complies with the requirements of 30 TAC 352, Subchapter F, where required.

Complete Table V.J. - Inspection of Surface Impoundments

E. Inflow Design Flood Control System Plan

Describe how the surface impoundment(s) system will manage stormwater run-on away from the surface impoundment(s) (30 TAC §352.821 and 40 CFR §257.82(a) and (c)). Stormwater run-on must be diverted away from a surface impoundment, based on the hazard potential. Where dikes are used to divert run-on, they must be protected from erosion. Include all analyses used to calculate run-on volumes. Provide the inflow design flood control system plan. Provide qualified Texas P.E. certification that the initial and periodic inflow design flood control system plans meet the requirements of 30 TAC §352.821, where required.

F. History of Construction for Existing CCR Surface Impoundment(s), or the Design and Construction Plans for New and Lateral Expansions

Provide information on the history of construction for each existing CCR surface impoundment (30 TAC §352.731 and 40 CFR §257.73(c)) or the design and construction plans for new and lateral expansions of each CCR surface impoundment (30 TAC §352.741) and (40 CFR §257.74(c)).

G. Structural Stability Assessment

Provide the most recent structural stability assessment of the surface impoundments. Include the combined capacity of all surface impoundment spillways with calculations; the peak discharge the unit must meet for all combined spillways; probable maximum flood-high hazard, 1,000-yr-significant high hazard, 100-yr-low hazard; identify if there were any structural stability deficiencies in last assessment; identify how these deficiencies were managed and corrected; and qualified Texas P.E. certification. The structural stability assessment must include all information required in 30 TAC §352.731 for existing surface impoundments or 30 TAC §352.741 for new or laterally expanding surface impoundments.

H. Safety Factor Assessment

The current safety factor assessment must be submitted with the application. It must include documentation that demonstrates whether the calculated factors of safety for each CCR surface impoundment achieve the minimum safety factors specified in 30 TAC 352, Subchapter F and 40 CFR §257.73(e)(1)(i) - (iv) and 40 CFR §257.74(e)(1)(i) - (iv) for the critical cross-section of the embankment. The critical cross-section is the cross-section anticipated to be the most susceptible to structural failure based on appropriate engineering considerations, including loading conditions. The safety factor assessments must be supported by appropriate engineering calculations and certified by a qualified Texas P.E.

VI. Groundwater Monitoring and Corrective Action (30 TAC 352, Subchapter H)

See Instructions and Technical Guidance – No. 32 Coal Combustion Residuals Groundwater Monitoring and Corrective Action

27. Groundwater Monitoring System – See Part VI – Groundwater Monitoring and Corrective Action Plan

A. Complete Table VI.A. - Unit Groundwater Detection Monitoring System.

B. Provide a map showing location of wells, groundwater elevations, and groundwater flow direction.

C. Provide attachments describing how the facility will comply with the requirements in 30 TAC §352.911 and provide a certification by a qualified Texas P.E or qualified Texas P.G. that the groundwater monitoring system design and construction meet the requirements of 30 TAC Chapter 352.

D. Provide a figure showing the geologic units and fill materials overlying the uppermost aquifer, materials comprising the uppermost aquifer, and materials comprising the confining unit defining the lower boundary of the uppermost aquifer, including, but not limited to, thicknesses, stratigraphy, lithology, hydraulic conductivities, porosities and effective porosities.

E. For a multiunit groundwater monitoring system, demonstrate that the groundwater monitoring system will be equally as capable of detecting monitored constituents at the waste boundary of the CCR unit as the individual groundwater monitoring system for each CCR unit by providing at minimum the following information:

1. Number, spacing, and orientation of each CCR unit;
2. Hydrogeologic setting; and
3. Site history.

F. Has there been any sampling concentrations of one or more constituents listed in Appendix IV detected at statistically significant levels above the groundwater protection standard (GWPS)? ☐ Yes ☒ No

G. Provide information on how monitoring wells have been constructed and cased in a manner that maintains the integrity of the monitoring well borehole and to prevent contamination of samples and the groundwater.

28. Groundwater Monitoring Sampling and Analysis Program – See Appendix VI.A – Groundwater Monitoring Sampling and Analysis Plan

Provide a sampling and analysis plan that includes procedures and techniques; sampling and analytical methods that are appropriate for groundwater sampling; and that address the requirements of 30 TAC §352.931 and 40 CFR §257.93. Provide a P.E or P.G. certification that describes the statistical method selected to evaluate the groundwater monitoring data and certifies that the selected statistical method is appropriate for evaluating the groundwater monitoring data for the CCR management area. Refer to TG-32 for information and guidance.

29. CCR Unit(s) in a Detection Monitoring Program – See Part VI - Groundwater Monitoring and Corrective Action Plan

Does the facility have CCR unit(s) in a Detection Monitoring Program?

☒ Yes ☐ No

If "Yes", Submit the following information:

A. Submit Table VI.C. – Facility CCR Units Under Detection Monitoring.

B. Provide a Background Evaluation Report.

C. Provide a report with the results of semiannual monitoring events.

1. Has a statistically significant increase (SSI) been detected for one or more of the constituents listed in Appendix III at any monitoring well?

   ☒ Yes ☐ No

2. Has a notification to the executive director been sent within 14 days?

   ☒ Yes ☐ No

3. Date assessment monitoring program will start: **N/A - ASD Prepared**
4. Do you plan to provide an alternative source demonstration (ASD)? Prepared

   ☐ Yes ☐ No

30. CCR Unit(s) in an Assessment Monitoring Program – See VI Groundwater Monitoring and Corrective Action Plan

Does the facility have CCR unit(s) in an Assessment Monitoring Program?

☐ Yes ☒ No
If "Yes", Submit information related for units.

A. Complete Table VI.D. – CCR Units Under Assessment Monitoring.

B. Provide, for each well in assessment monitoring status, the recorded concentrations lab sheets and results in a tabulated form.

C. Have the concentrations of all constituents listed in Appendices III and IV been at or below background values, using the statistical procedures in 30 TAC §352.931 and 40 CFR §257.93(g), for two consecutive sampling events for the CCR unit(s)? ☐ Yes ☐ No

If answer to above is yes, detection monitoring may resume. The owner or operator must prepare a notification stating that detection monitoring is resuming for the CCR unit and obtain written approval from the executive director.

D. Are there any concentrations of any constituent in Appendices III and IV above background values? ☐ Yes ☐ No

1. Has a notification to the executive director been sent within 14 days?

   ☐ Yes ☐ No

E. Date assessment of corrective measures will be initiated (must be within **90 days** of finding a statistically significant level above the GWPS) for the CCR unit(s):

F. Will you provide an ASD (see TG-32 for an acceptable submittal)? ☐ Yes ☐ No

G. Date assessment of corrective measures will be initiated if ASD is not accepted?

H. Complete Table VI.D-2. - Groundwater Detection Monitoring Parameters

Note: Refer to TG-32 regarding establishing a GWPS for each constituent in Appendix IV detected in the groundwater and attach as table.

I. Have you completed the assessment of corrective measures? ☐ Yes ☐ No
If "Yes", date assessment of corrective measures was completed:
If "No", date assessment of corrective measures will be completed:
Expected date of submittal of amendment (see note below):
Provide completed assessment of corrected measures materials.

Note: Within **30 days** of completing the assessment of corrective measures, and before remedy implementation, the owner or operator shall submit an application for amendment to the registration. In some circumstances, the assessment of corrective measures and selected remedy may be approved as part of the initial application for the CCR unit registration.

J. Have you selected a remedy? ☐ Yes ☐ No

Provide public meeting documentation under 30 TAC §352.961 and a report under 30 TAC §352.971 and 40 CFR §257.97.

VII. Closure and Post-Closure Care

See Instructions and Technical Guidance

Submit a full closure plan and post-closure plan and all information describing how the owner or operator will comply with 30 TAC 352, Subchapter J and 40 CFR §§257.100 - 257.104. The owner of property on which an existing disposal facility is located, following the closure of a unit, must also submit documentation that a notation has been placed in the deed to the facility that will in perpetuity notify any potential purchasers of the property that the land has been used to manage CCR wastes and its use is restricted (30 TAC §352.1221 and 40 CFR §257.102(i)). For CCR units, closed after October 19, 2015, that were closed before submission of the application, the applicant should submit documentation to show that notices required under 30 TAC 352, Subchapter K and 40 CFR §257.105 or §257.106 have been filed.

31. Closure Plan – See Part VII – Closure and Post-Closure Care Plan

This section applies to the owners and operators of all CCR units required to be registered. The applicant must close the facility in a manner that minimizes need for further maintenance and controls, or eliminates, to the extent necessary to protect human health and the environment, the post-closure release of CCR waste, chemical constituents of concern, leachate, contaminated rainfall, or waste decomposition products to the groundwater, surface waters, or to the atmosphere.

The type of unit to be closed can determine the level of detail sufficient for a closure plan. CCR units which have been certified closed after October 19, 2015, must provide documentation to demonstrate compliance with state and federal regulations.

For each unit to be registered, complete Table VII.A.1. - Unit Closure and list the CCR Unit components to be decontaminated, possible methods of decontamination, and possible methods of disposal of wastes and waste residues generated during unit closure. All ancillary components must be decontaminated, and the generated waste disposed of appropriately.

Information about CCR units closed or to be closed under alternative closure requirements must be provided in Table VII.A.2. - CCR Units Under Alternative Closure Notification.

Guidance on design of a closure cap and final cover for non-hazardous industrial solid wastes landfills is provided in EPA publication 530-SW-85-014, TCEQ Technical Guidance No. 3 and TCEQ publication, RG-534, “Guidance for Liner Construction and Testing for a Municipal Solid Waste Landfill”.

32. Post-Closure Care Plan – See Part VII – Closure and Post-Closure Care Plan

Provide a post-closure care plan that complies with the requirements of 30 TAC §352.1241. Post-closure care of each CCR unit must continue for at least 30 years after the date of completing closure of the unit and must consist of monitoring and reporting of the groundwater monitoring systems, in addition to the maintenance and monitoring of CCR unit. Continuation of certain security requirements may be necessary after the date of closure. Post-closure use of property on or in which waste remains after closure must never be allowed to disrupt the integrity of the containment system. In addition, submit the following information:

- The name, address, and phone number of the person or office to contact about the CCR unit during the post-closure period; and
- A discussion of the future use of the land associated with each unit.

Landfills and surface impoundments which have been certified closed after October 19, 2015, must be included in post-closure care plans, unless they have been determined to have been closed by waste removal equivalent to the closure standards in 30 TAC §352.1221 and 40 CFR §257.102 or 30 TAC §352.1231 and 40 CFR §257.103. If such a demonstration has been made pursuant to 40 CFR §257.102 or §257.103, but an equivalency determination has not been made, please submit a copy of the demonstration documentation. If an equivalency determination has been made, applicant should submit a copy of this determination.

VIII. Financial Assurance

33. Post-Closure Care Cost Estimate – See Part VIII, Appendix VIII.A – Post-Closure Care Cost Estimate

Financial assurance for post-closure care (30 TAC §352.1101) applies to owners or operators of all CCR units, except CCR units from which the owner or operator intends to remove wastes and perform clean closure. Provide a written cost estimate in current dollars of the total cost of the 30-year (or longer, if applicable under 30 TAC §352.1101(d)) post-closure care period to perform post-closure care requirements as prescribed in 30 TAC §352.1241. The cost estimate must be based on the costs of hiring a third party to conduct post-closure care maintenance.

Complete Table VIII.A.1 – Post-Closure Cost Summary for Existing Registered Units

Complete Table VIII.A.2. - Post-Closure Cost Summary for Proposed Registered Units

34. Financial Assurance Mechanism – See Part VIII, Appendix VIII.B – Financial Assurance Mechanism

The financial assurance for post-closure care is required in accordance with 30 TAC §352.1101. The applicant shall demonstrate the financial assurance within 90 days after approval of the registration with a financial mechanism acceptable to TCEQ in compliance with 30 TAC §352.1101(c) and 30 TAC §37, Subchapters A through D, except as indicated in 30 TAC §352.1111, in an amount no less than the amount specified in the approved Post-Closure Care Cost Summary. Provide a description of the proposed financial assurance mechanism.

Complete Table VIII.B. - Post-Closure Period, for the authorized post-closure period, to meet the requirements of 30 TAC §352.1241(a) through (c).

Signature Page

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

Applicant Signature: ____________________ Date: 1/13/22

Name and Official Title (type or print): Bryon Kohls and Project Director

Owner or Operator Signature: Same as applicant Date: ____________

Name and Official Title (type or print): ______________________________

To be completed by the owner or operator if the application is signed by an authorized representative for the operator

I, ______________________ hereby designate ______________________
(operator) (authorized representative)

as my representative and hereby authorize said representative to sign any application, submit additional information as may be requested by the Commission; and/or appear for me at any hearing or before the Texas Commission on Environmental Quality in conjunction with this request for a CCR waste management registration. I further understand that I am responsible for the contents of this application, for oral statements given by my authorized representative in support of the application, and for compliance with the terms and conditions of any registration which might be issued based upon this application.

____
Printed or Typed Name of Applicant or Principal Executive Officer

____
Signature

(Note: Application Must Bear Signature & Seal of Notary Public)

Subscribed and sworn to before me by the said Karma Cheri Neuenschwander on this 13 day of January, 2022.

My commission expires on the 26 day of July, 2023

(Seal) Notary Public in and for McLennan County, Texas

Registration Application for Coal Combustion Residuals Waste Management

(See instructions for P.E/P.G. seal requirements.)

Attachments and Tables	**Attachment No.**
General Information	**Part I**
Attachments – Application Form	**Appendix I.A**
Technical Report and Certification	N/A
Location Restrictions Certifications	**Part II**
Placement above the uppermost aquifer	**Part II**
Wetlands	**Part II**
Fault Areas	**Part II**
Seismic impact zones	**Part II**
Unstable areas	**Part II**
Geology Summary	**Part I**
CCR Fugitive Dust Control Plan	**Part III**
Annual CCR Fugitive Dust Control Report	**Appendix III.A**
Landfill Design and Operating Criteria	**Part IV**
Landfill Characteristics	**Part I**
Liner Design	**Part I and Part IV**
Leachate Collection and Removal	**Part IV, Appendix IV.A**
Run-on and Run-off Controls	**Part IV, Appendix IV.C**
Inspection for Landfills	**Part V, Appendix V.A, V.B, and V.C**
Surface Impoundment Design and Operating Criteria	N/A
General Surface Impoundment Characteristics	N/A
Liner Design	N/A
Hazard Potential Classification	N/A
Emergency Action Plan	N/A
Inflow Design Flood Control System Plan	N/A
Construction History/Design Plans	N/A
Structural Stability Assessment	N/A
Safety Factor Assessment	N/A
Groundwater Monitoring and Corrective Action	**Part VI**
Groundwater Monitoring System	**Part VI**
Groundwater Monitoring Sampling and Analysis Program	**Part VI, Appendix VI.A**
Detection Monitoring Program	**Part VI**
Assessment Monitoring Program	**Part VI**
Assessment of Corrective Measures	N/A
Remedy Report	N/A
Closure and Post-Closure Care	**Part VII**
Closure Plan	**Part VII**
Post-Closure Care	**Part VII**
Financial Assurance	**Part VIII**

Tables

Tables	Submitted	Not Applicable
Table I.6. - CCR Waste Management Units	☒	☐
Table I.6.A. - Waste Management Information	☒	☐
Table I.6.B. - Wastes Managed in Registered Units	☒	☐
Table I.6.C. - Sampling and Analytical Methods	☒	☐
Table IV.A. - Landfill Characteristics	☒	☐
Table IV.B. - Landfill Liner System	☒	☐
Table IV.C. - Landfill Leachate Collection System	☒	☐
Table IV.D. - Inspection Schedule of Landfills	☒	☐
Table V.A. - Surface Impoundments Characteristics	☐	☒
Table V.B. - Surface Impoundment Liner System	☐	☒
Table V.J. - Inspection of Surface Impoundments	☐	☒
Table VI.A. - Unit Groundwater Detection Monitoring System	☒	☐
Table VI.C. - CCR Units Under Detection Monitoring	☒	☐
Table VI.D. - CCR Units Under Assessment Monitoring	☐	☒
Table VI.D-2. - Groundwater Detection Monitoring Parameters	☒	☐
Table VII.A.1. - Unit Closure	☐	☒
Table VII.A.2. - CCR Units Under Alternative Closure Notification	☐	☒
Table VIII.A.1. - Post-Closure Cost Summary for Existing Registered Units	☒	☐
Table VIII.A.2. - Post-Closure Cost Summary for Proposed Registered Units	☒	☐
Table VIII.B. - Post-Closure Period	☐	☒
Engineering Certification(s) - Dike Construction	☐	☒

Additional Attachments as Applicable - Select all those apply and add as necessary

☐ TCEQ Core Data Form(s)
☐ Signatory Authority Delegation
☒ Fee Payment Receipt
☐ Confidential Documents
☐ Certificate of Fact (Certificate of Incorporation)
☐ Assumed Name Certificate

Table I.6. – CCR Waste Management Units

CCR Unit No.[1]	Unit Name	N.O.R. No.[1]	Unit Description[3]	Capacity	Unit Status[2]
002	Sandy Creek Energy Station CCR Waste Management Facility	88448	CCR Landfill	3,870,000 CY	Active

1 Registered Unit No. and N.O.R. No. cannot be reassigned to new units or used more than once.
2 Unit Status options: Active, Closed, Inactive (built but not managing waste), Proposed (not yet built), Never Built, Transferred, Post-Closure.
3 If a unit has been transferred, the applicant should indicate which facility/permit it has been transferred to in the Unit Description column.

Table I.6.A. – Waste Management Information

Waste No.[1]	Waste Type(s)	Source	Volume (tons/year)
1	Fly ash	Generated during the coal combustion process at the Plant and collected in the SDA and Fabric Filter	284,000
2	Bottom ash	Generated during the coal combustion process at the Plant	48,000
3	Filter cake from the water treatment building	Generated from the filtering water at the treatment building	500
4	Spent SCR catalyst	Generated from the select catalytic reduction (SCR) system used at the Plant to reduce nitrogen oxide emissions	400
5	Class 2 spent demineralizer resin	Generated from the Plant's process water treatment system	15
6	Cooling tower sediments and cooling water screenings	Generated from the condenser and cooling tower as a result of the heat developed during the process of boiling water at the Plant	1
7	Spent resin	Generated from the Plant's process water treatment system	15

1 Assign waste number sequentially. Do not remove waste number wastes which are no longer generated.

Table I.6.B. – Wastes Managed in Registered Units

Waste No.[1]	Waste	TCEQ Waste Form Codes and Classification Codes
1	Fly ash	00713032
2	Bottom ash	00703032
3	Filter cake from the water treatment building	00093192
4	Spent SCR catalyst	00523932
5	Class 2 spent demineralizer resin	00564032
6	Cooling tower sediments and cooling water screenings	00731142
7	Spent resin	00574032

1 from Table I.6.A., first column

Table I.6.C – Sampling and Analytical Methods

Waste No.[1]	Sampling Location	Sampling Method	Frequency	Parameter	Test Method	Desired Accuracy Level
1	Fly Ash Silo (at Plant)	See Note 2	See Note 2	See Note 4	See Note 4	See Note 4
2	Bottom ash storage (at Plant)					
3	Process Water Treatment System (at Plant)					
4	Selective Catalytic Reactor (at Plant)					
5	Process Water Treatment System (at Plant)					
6	Condenser and Cooling Tower (at Plant)					
7	Process Water Treatment System (at Plant)					

1 from Table I.6.A., first column

2 Waste classification and sampling methods are based on Toxic Characteristic Leaching Procedure (TCLP) and/or Process knowledge.

3 The Owner/Operator will obtain waste classification prior to disposal of waste within the landfill and after a process change that results in the generation of waste that changes the waste classification.

4 Parameters, test methods, and desired accuracy levels will be in accordance with TCEQ’s Guidelines for the Classificaiton and Coding of Industrial and Hazardous Waste.

Registration No.: ------
Registrant: Sandy Creek Energy Station

Table IV.A. – Landfills Characteristics

Registered Unit No.	Landfill	N.O.R. No.	Waste Nos.[1]	Rated Capacity	Dimensions[2]	Distance from lowest liner to groundwater	Action Leakage Rate (if required)	Unit will manage CCR Waste and non-CCR Waste (state all that apply)
002	Sandy Creek Energy Station CCR Waste Management Facility	88448	1 - 8	3,870,000 CY	Approx. 1,200 ft E-W, 1,500 ft N-S 138 ft Depth 40.7 acres - area	Greater than 1.52 meters (five feet), see note 3	N/A	CCR and non-CCR Waste (see Table I.6.B)

1 From Table I.6.A., first column
2 Dimensions should be provided as average length, width and depth, also include the surface acreage for the unit.
3 The shallowest geologic formation beneath the Landfill Registration Boundary that is capable of providing usable quantities of water is the Trinity Aquifer, located approximately 1,000 feet below the Landfill.

Registration No.: ------
Registrant: Sandy Creek Energy Station

Table IV.B. – Landfill Liner System

Registered Unit No.*	Landfill	Geomembrane Liner Material	Geomembrane Liner Permeability (cm/sec)	Geomembrane Liner Thickness	Soil Liner Material	Soil Liner Permeability (cm/sec)	Soil Liner Thickness
002 – Cell 1	Sandy Creek Energy Station CCR Waste Management Facility	N/A	N/A	N/A	Compacted Clay	$k \geq 1x1^{-7}$	3 - feet
002 – Cell 2		N/A	N/A	N/A	Compacted Clay	$k \geq 1x1^{-7}$	3 - feet
002 – Cell 3		HDPE – Textured both sides	$4x10^{-13}$	60-mil	Compacted Clay	$k \geq 1x1^{-7}$	2 - feet

* This number should match the Registration Unit No. given on Table IV.A.

Table IV.C. – Landfill Leachate Collection System

Registered Unit No.	Landfill Name	Drainage Media	Collection Pipes (including risers)	Filter Fabric	Geofabric	Sump Material
002 – Cell 1	Sandy Creek Energy Station CCR Waste Management Facility	Leachate collection Trench - Drainage aggregate wrapped in 6.5 oz./sy geotextile	4”Ø HDPE SDR 17 leachate collection pipe	6.5 oz./sy geotextile wrapped around drainage aggregate in leachate collection trenches	N/A	N/A – gravity drain to leachate evaporation pond
002 – Cell 2		Floor/Sidewall – 200- mil geocomposite (double-sided) Leachate collection trench – drainage aggregate wrapped in 8 oz./sy geotextile	6”Ø HDPE SDR 11 leachate collection pipe and 24” Ø HDPE SDR 11 sump riser pipe	8 oz./sy geotextile wrapped around drainage aggregate and leachate collection pipe in leachate collection trenches and leachate sump	N/A	Drainage aggregate wrapped in 8 oz./sy geotextile
002 – Cell 3		Floor/Sidewall – 270-mil geocomposite (double-sided) Leachate collection trench – drainage aggregate wrapped in 12 oz./sy geotextile	6”Ø HDPE SDR 9 leachate collection pipe and 18” Ø HDPE SDR 11 sump riser pipe	12 oz./sy geotextile wrapped around drainage aggregate and leachate collection pipe in leachate collection trenches and leachate sump	N/A	Drainage aggregate wrapped in 12 oz./sy geotextile

Table IV.D. – Inspection Schedule of Landfills

Facility Unit(s) and Basic Elements	Possible Error, Malfunction, or Deterioration	Frequency of Inspection
Unit 002 - Waste Spilled in route to landfill	Waste spilled in route to landfill.	Daily
Unit 002 - Landfill Structure and Slope	Sloughing, slumping, sliding, surface cracking, sinkholes, excessively steep slope, toe of slope movement, and vehicle damage.	Weekly
Unit 002 - Landfill Access Roads	Damage from vehicle traffic and erosion.	Monthly
Unit 002 - Intermediate Cover	Improper placement, thickness, erosion, vegetation, animal burrows, and for presence of waste or other contamination.	Weekly
Unit 002 - Final Cover	Improper placement, thickness, erosion, vegetation, animal burrows, and for presence of waste or other contamination.	Monthly
Unit 002 - Dust Emissions	Fugitive dust at the landfill and from haul trucks	Daily
Unit 002 - Erosion Control	Erosion of intermediate and final cover	Weekly (Interim), Monthly (Final)
Unit 002 - Ponding Water	Ponding water on landfill cover.	Weekly
Unit 002 - Run-on and Run-off Control Systems (Uncontaminated and Contact Water)	Damage to diversion berms, downchutes, perimeter drainage channels, culverts, detention basin(s) for damage.	Weekly
Unit 002 - Leachate Collection and Removal System	Damage to leachate riser pipes, sump pump/controls, and evaporation pond for damage and height of freeboard in the pond. Damage to isolation valves, protective cover, exposed geosynthetics, and leachate evaporation pond underdrain system for damage or blockage.	Weekly Monthly
Unit 002 - Groundwater Monitoring System	Damage, excess vegetation, and other deficiencies to the groundwater monitoring wells..	Monthly

Registration No.: ------
Registrant: Sandy Creek Energy Station

Table V.A. – Surface Impoundment Characteristics

Registered Unit No.	Surface Impoundment Name	N.O.R. No.	Waste Nos.[1]	Rated Capacity	Dimensions[2]	Distance from lowest liner to groundwater	Action Leakage Rate (if required)	Unit will manage CCR Waste and non-CCR Waste (state all that apply)
N/A								

1 From Table I.6.A., first column
2 Dimensions should be provided as average length, width and depth, also include the surface acreage for the unit.

Table V.B. – Surface Impoundment Liner System

Registered Unit No.*	Surface Impoundment Name	Geomembrane Liner Material	Geomembrane Liner Permeability (cm/sec)	Geomembrane Liner Thickness	Soil Liner Material	Soil Liner Permeability (cm/sec)	Soil Liner Thickness
N/A							

* This number should match the Registration Unit No. given on Table V.A.

Table V.J. – Inspection Schedule of Surface Impoundments

Facility Unit(s) and Basic Elements	Possible Error, Malfunction, or Deterioration	Frequency of Inspection
N/A		

Table VI.A. – Unit Groundwater Detection Monitoring Systems

Waste Management Unit/Area Name[1]	Sandy Creek Energy Station CCR Waste Management Facility					
Well Number(s):	BW-1	MW-1	MW-2	MW-3	MW-4	MW-5
Hydrogeologic Unit Monitored	Ozan & Wolfe City formations	Ozan & Wolfe City formations	Ozan & Wolfe City formations	Ozan & Wolfe City formations	Ozan & Wolfe City formations	Ozan & Wolfe City formations
Type (e.g., point of compliance, background, observation, etc.)	Background)	Point of compliance	Point of compliance	Point of compliance	Point of compliance	Point of compliance
Up or Down Gradient	Upgradient	Downgradient	Downgradient	Downgradient	Downgradient	Downgradient
Casing Diameter and Material	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Diameter and Material	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC	2” Sch. 40 PVC
Screen Slot Size (in.)	0.010	0.010	0.010	0.010	0.010	0.010
Top of Casing Elevation (Ft, Mean Sea Level *[MSL]*)	485.57	465.87	442.15	430.06	436.91	454.52
Grade or Surface Elevation (Ft, MSL)	482.70	462.85	439.18	427.09	433.73	451.70
Well Depth (Ft, Below Grade Surface *[BGS]*)	38.63	34.23	19.63	16.23	30	35
Well Depth (Ft, Below Top of Casing *[BTOC]*)	41.5	37.25	22.6	19.2	33.66	38.29
Screen Interval From (Ft, BGS) To (Ft, BGS)	From 28.30 To 38.30	From 23.89 To 33.89	From 9.3 To 19.3	From 5.9 To 15.9	From 20 To 30	From 25 To 35
Screen Interval From (Ft, BTOC) To (Ft, BTOC)	From 31.17 To 41.17	From 26.91 To 36.91	From 12.27 To 22.27	From 8.87 To 18.87	From 23.66 To 33.66	From 28.29 To 38.29

1 From Tables in Section I.; *MSL*: Mean Sea Level; *BGS*: Below Grade Surface; *BTOC*: Below Top of Casing

Registration No.: ------
Registrant: Sandy Creek Energy Station

Table VI.C. – CCR Units Under Detection Monitoring

N.O.R. Unit No.	Unit Description[1,2]	Well(s)	Constituent(s)	Date of SSI Determination	Date of Assessment Monitoring Notification[3]
88448	CCR Landfill	BW-1, MW-1, MW-2, MW-3	Appendix III	NA	NA

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.

2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.

3 Enter month, day, and year.

Registration No.: ------
Registrant: Sandy Creek Energy Station

Table VI.D. – CCR Units Under Assessment Monitoring

N.O.R. Unit No.	Unit Description[1,2]	Well(s)	Constituent(s)	Date of SSI Determination	Date of Assessment Monitoring Notification[3]
N/A					

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.

2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.

3 Enter month, day, and year

Table VI.D-2. – Groundwater Detection Monitoring Parameters

Parameter	Sampling Frequency	Analytical Method	Practical Quantification Limit (units)	Concentration Limit[1]
Boron	Semiannual	6010B	0.200	See Note 2
Calcium	Semiannual	6010B	5.00	See Note 2
Chloride	Semiannual	9056	25.0	See Note 2
Fluoride	Semiannual	9056	0.500	4.0
pH	Semiannual	9040C	0.100	See Note 2
Sulfate	Semiannual	9056	25.0	See Note 2
Total Dissolved Solids	Semiannual	160.1	10.0	See Note 2

1 The concentration limit is the basis for determining whether a release has occurred from the CCR unit/area.

2 MCL does not exist

Table VII.A.1. – Unit Closure

For each unit to be registered, list the unit components to be decontaminated, the possible methods of decontamination, and the possible methods of disposal of wastes and waste residues generated during unit closure.

Equipment or CCR Unit	Possible Methods of Decontamination[1]	Possible Methods of Disposal[1]
CCR Unit 002	Waste left in-place and installation of final cover	N/A
Landfill equipment	Wash off excessive waste material from equipment within landfill (active face)	N/A

1 Applicants may list more than one appropriate method.

Table VII.A.2. – CCR Units Under Alternative Closure Notification

Registered Unit No.	N.O.R. Unit No.	Unit Description[1,2]	Date of Receipt of Last Waste[3]	Date of Closure Notification[3]
N/A				

1 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been requested pursuant to 40 CFR §257.103.
2 Indicates a unit for which a 30 TAC Chapter 352/40 CFR Part 257, Subpart D alternative closure determination has been made pursuant to 40 CFR §257.103.
3 Enter month, day, and year.

Table VIII.A.1. – Post-Closure Cost Summary for Existing Registered Units

Unit	Cost
1.0 Engineering:	
1.1 Site Inspection: Security (signs and fencing, benchmarks, final cover)	$2,986
1.2 Correctional Plans and Specifications (engineering plans to correct erosion issues every other year)	$8,500
2.0 Site Monitoring:	
2.1 Groundwater Sampling and Analysis (6 wells x 2 sampling events/yr)	$18,000
2.2 Groundwater Well Plugging and Abandonment	$200
3.0 Construction and Maintenance:	
3.1 Cap and Sideslope Repairs and Revegetation	$1,700
3.2 Mowing and Vegetation Management	$3,400
3.3 Groundwater Monitoring system Maintenance	$2,500
3.4 Perimeter Fence and Gates Maintenance	$1,500
3.5 Access Roads Maintenance	$4,500
3.6 Drainage System Cleanout/Repairs	$3,500
4.0 Leachate Management:	
4.1 Leachate Management System Operation and Maintenance	$5,000
4.2 Decommissioning of Existing leachate Evaporation Pond	$2,333
4.3 Contaminated leachate disposal-profiling, transportation and disposal (all leachate discharged into evaporation pond)	N/A
5.0 Administration:	
5.1 Annual Report Preparation and Submittal to TCEQ	$4,500
Subtotal	$58,619
10% Contingency	$5,862
Third Party Administration and Project Management (2.5% of Subtotal)	$1,465
Estimated Annual PCC Cost Total	**$ 65,946 (2021 dollars)**
30 Year Post-Closure Costs	**$ 1,978,380 (2021 dollars)**

Table VIII.A.2. - Post-Closure Cost Summary for Proposed Registered Units

Unit	Cost
1.0 Engineering:	
1.1 Site Inspection: Security (signs and fencing, benchmarks, final cover)	N/A
1.2 Correctional Plans and Specifications (engineering plans to correct erosion issues every other year)	$1,675
2.0 Site Monitoring:	
2.1 Groundwater Sampling and Analysis (6 wells x 2 sampling events/yr)	N/A
2.2 Groundwater Well Plugging and Abandonment	N/A
3.0 Construction and Maintenance:	
3.1 Cap and Sideslope Repairs and Revegetation	$340
3.2 Mowing and Vegetation Management	$670
3.3 Groundwater Monitoring system Maintenance	N/A
3.4 Perimeter Fence and Gates Maintenance	N/A
3.5 Access Roads Maintenance	N/A
3.6 Drainage System Cleanout/Repairs	N/A
4.0 Leachate Management:	
4.1 Leachate Management System Operation and Maintenance	N/A
4.2 Decommissioning of Existing leachate Evaporation Pond	N/A
4.3 Contaminated leachate disposal-profiling, transportation and disposal (all leachate discharged into evaporation pond)	N/A
5.0 Administration:	
5.1 Annual Report Preparation and Submittal to TCEQ	N/A
Subtotal	$2,685
10% Contingency	$269
Third Party Administration and Project Management (2.5% of Subtotal)	$67
Estimated Annual PCC Cost Total	**$ 3,021 (2021 dollars)**
30 Year Post-Closure Costs	**$ 90,630 (2021 dollars)**

1 As units are added or deleted from these tables through future registration amendments, the remaining itemized unit costs should be updated for inflation when re-calculating the revised total cost in current dollars.

Table VIII.B. – Post-Closure Period

Unit Name	Date Certified Closed	Authorized Post-Closure Period (Yrs.)	Earliest Date Post-Closure Ends (See Note 1)
Sandy Creek Energy Station CCR Waste Management Facility	N/A	30 years	N/A

Note 1 – Post-Closure Care shall continue beyond the specified date until the Executive Director has approved the applicant’s request to reduce or terminate the post-closure period, consistent with 30 TAC §352.1241 – Post-Closure Care Requirements.

Surface Impoundments: Dike Construction – Not Applicable

For each surface impoundment dike, complete the following information:

"I, ________(licensed Professional Engineer), Texas P.E. License Number _________, of Registered Firm ________(Name), Registered Firm No.________ (Registration Number), certify under penalty of law that I have personally examined and am familiar with the design and construction of the dikes that are a portion of (surface impoundment unit name).

I further certify that I have evaluated the dike design and materials of construction using accepted engineering procedures, and have determined that the dike, including the portion of the dike providing freeboard, has structural integrity, and is constructed in accordance with applicable surface impoundment criteria per the following:

_____ Existing Diked Surface Impoundment – 40 CFR 257.73(a)(1) through (4) and 30 TAC Section 352.731.

______ New or Lateral Diked Surface Impoundment – 40 CFR 257.74(a)(1) through (4) and 30 TAC Section 352.741.

Date: ___________________"

"(Signature)"

"(Seal)"

Questions or Comments >>

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Actor Email: kkuntz@scsengineers.com
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Voucher	Fee Description	AR Number	Amount
540197	NONHAZARDOUS WASTE PERMIT - MODIFICATIONS		$100.00
540198	30 TAC 305.53B HWP NOTIFICATION FEE		$50.00
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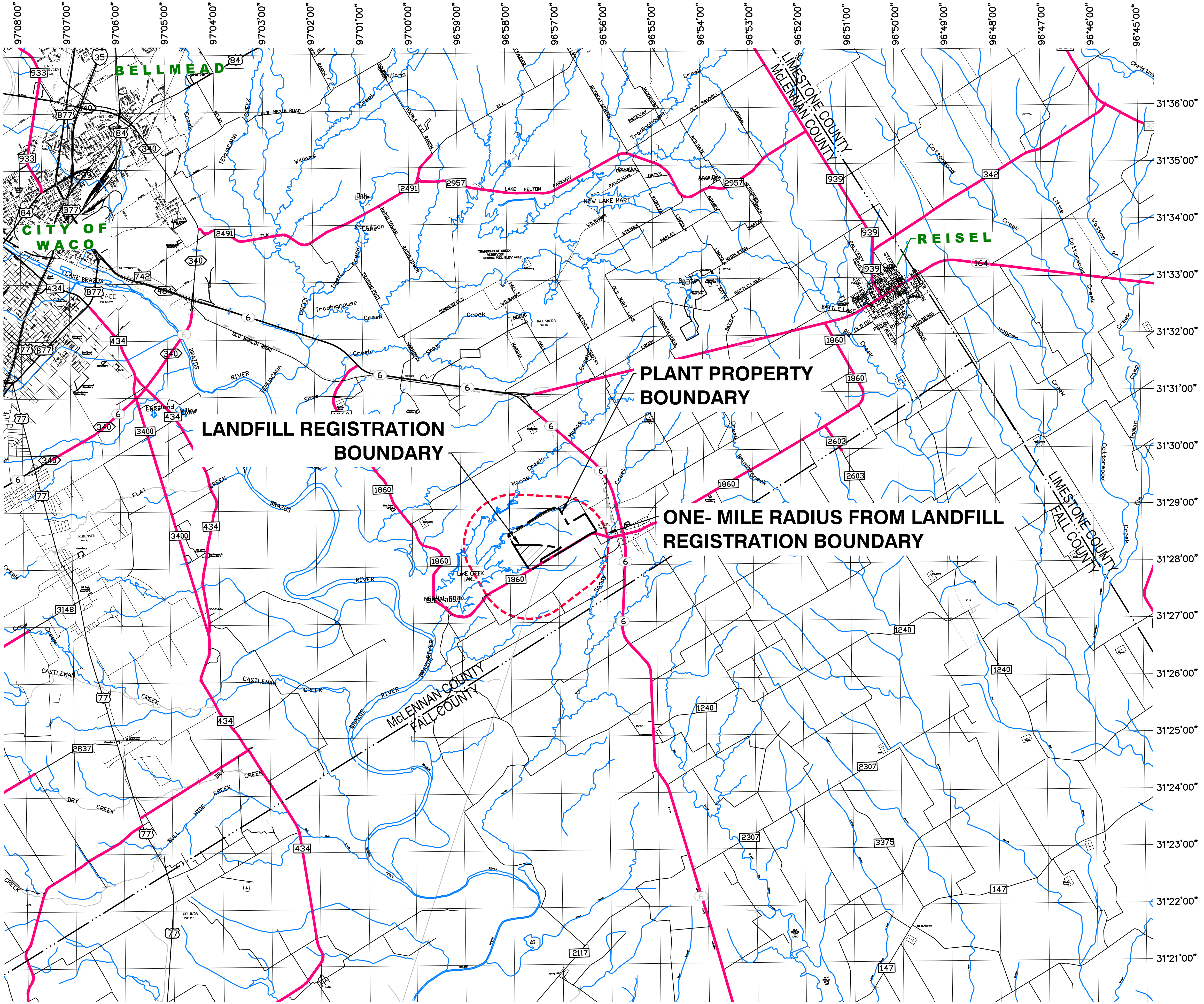
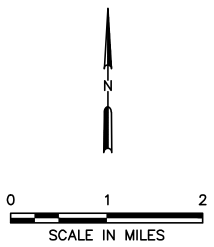
APPENDIX I.B

GENERAL LAYOUT DRAWINGS

- **Drawing I.B-1 – Site Location Map**
- **Drawing I.B-2 – General Topographic and Surrounding Features Map**
- **Drawing I.B-3 – Aerial Photograph**
- **Drawing I.B-4 – Facility Layout Map**
- **Drawing I.B-5 – Process Flow Diagram**
- **Drawing I.B-6 – Land Ownership Map**
- **Property/Legal Description of Registration Boundary**





LEGEND

— · —	PLANT PROPERTY BOUNDARY (SEE NOTE 1)
▨	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 2)
- - -	ONE MILE RADIUS FROM LANDFILL REGISTRATION BOUNDARY
1503	FARM TO MARKET ROAD
37	STATE HIGHWAY
38	STATE HIGHWAY LOOP
82	US NUMBERED HIGHWAY
~	STREAM
— ·· —	COUNTY LINE
96°55'30"	LONGITUDE LINES
31°22'00"	LATITUDE LINES

1. INFORMATION SHOWN IS FORM THE TEXAS DEPARTMENT OF TRANSPORTATION DIGITAL COUNTY MAPBOOK 2014.
2. THE LANDFILL REGISTRATION BOUNDARY IS DEFINED IN PART 1 – GENERAL REGISTRATION APPLICATION REQUIREMENTS, SECTION 1 AND DEPICTED ON THE PROPERTY/LEGAL DESCRIPTION OF THE REGISTRATION BOUNDARY PROVIDED IN APPENDIX I.B.

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
SITE LOCATION MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

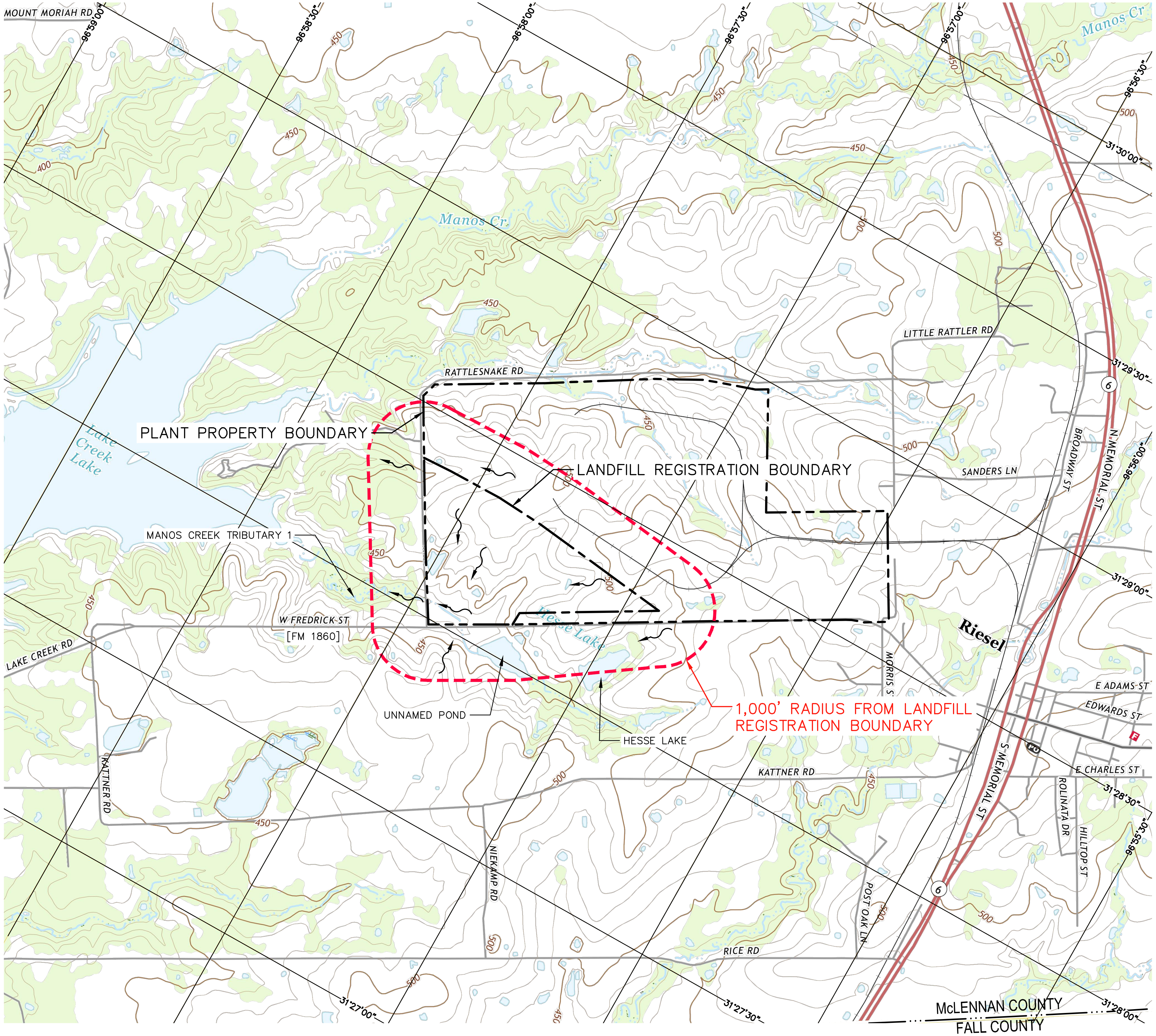
PROJ. NO. 16221047.00	DWN. BY: ORA	Q/A RVW BY: BJD
DSN. BY: BJD	CHK. BY: BJD	APP. BY: BJD

CADD FILE: I.B–1 – SITE LOCATION MAP

DATE: 10/2021

SCALE: AS SHOWN

DRAWING NO.
I.B-1



N

0 1000 2000

SCALE IN FEET

LEGEND

- PLANT PROPERTY BOUNDARY
- LANDFILL REGISTRATION BOUNDARY (SEE NOTE 3)
- 560 EXISTING CONTOURS (SEE NOTE 1)
- 100–YEAR FLOOD PLAIN (SEE NOTE 2)
- 96°56'30" LATITUDE/LONGITUDE LINES
- COUNTY LINE
- 1000' RADIUS FROM LANDFILL REGISTRATION BOUNDARY
- SURFACE WATER FLOW DIRECTION (APPROX.)

ROAD CLASSIFICATION

Expressway	🟥	Local Connector	▬
Secondary Hwy	🟥	Local Road	▬
Ramp	🟥	4WD	- - -

Interstate Route US Route State Route

NOTES:

1. CONTOURS SHOWN ARE FROM THE 24K QUAD MAP FOR AXTELL, TEXAS (2016) PRODUCED BY THE UNITED STATES GEOLOGICAL SURVEY.
2. 100–YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48293C0125C, DATED 09/16/11.
3. THE LANDFILL REGISTRATION BOUNDARY IS DEFINED IN PART 1 – GENERAL REGISTRATION APPLICATION REQUIREMENTS, SECTION 1 AND DEPICTED ON THE PROPERTY/LEGAL DESCRIPTION OF THE REGISTRATION BOUNDARY PROVIDED IN APPENDIX I.B.

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
GENERAL TOPOGRAPHIC AND
SURROUNDING FEATURES MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00	DWN. BY: ORA	Q/A RVW BY: BJD
DSN. BY: BJD	CHK. BY: BJD	APP. BY: BJD

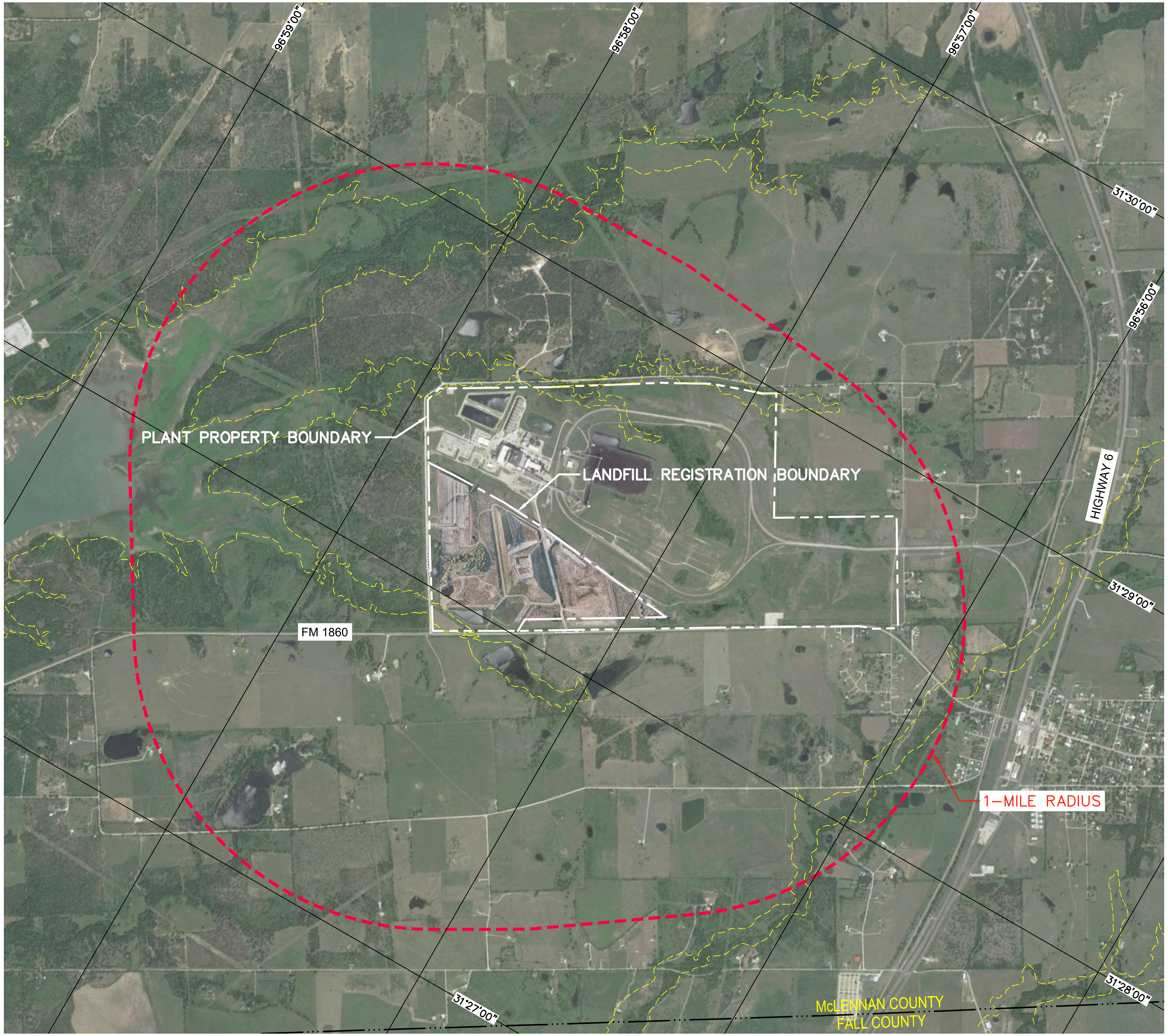
CADD FILE:
I.B–2 – GENERAL TOPOGRAPHIC AND SURROUNDING FEATURES MAP

DATE:
11/2021

SCALE:
AS SHOWN

DRAWING NO.
I.B-2

1/13/2022 9:01 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\I.B-2 – GENERAL TOPOGRAPHIC AND SURROUNDING FEATURES MAP



0 1000 2000
SCALE IN FEET

LEGEND

PLANT PROPERTY BOUNDARY
LANDFILL REGISTRATION BOUNDARY
100-YEAR FLOOD PLAIN (SEE NOTE 2)
96°55'30" LATITUDE/LONGITUDE LINES
COUNTY LINE
ONE MILE RADIUS FROM LANDFILL REGISTRATION BOUNDARY

NOTES:

1. AERIAL SHOWN WAS SOURCED FROM GOOGLE EARTH, IMAGERY DATED 05/05/21.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48309C0600D, DATED 12/20/19.

BRETT J. DeVRIES
128061
Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
AERIAL PHOTOGRAPH MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

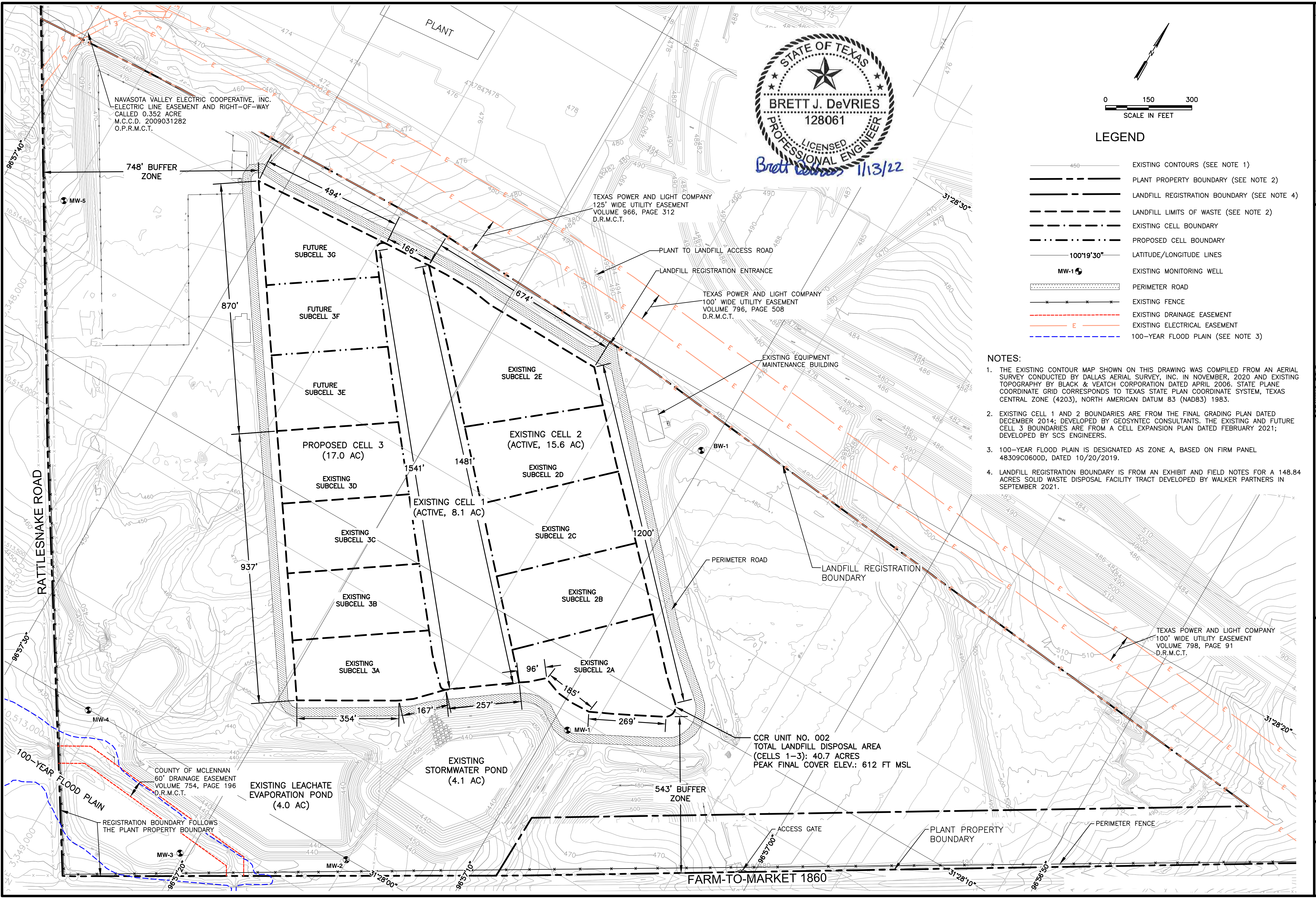
CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE: I.B-3 – AERIAL PHOTOGRAPH
DATE: 11/2021
SCALE: AS SHOWN
DRAWING NO. **I.B-3**

1/13/2022 11:02 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\I.B-3 – AERIAL PHOTOGRAPH



BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
— · —	PLANT PROPERTY BOUNDARY (SEE NOTE 2)
— · —	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 4)
— — —	LANDFILL LIMITS OF WASTE (SEE NOTE 2)
— · —	EXISTING CELL BOUNDARY
— · · —	PROPOSED CELL BOUNDARY
100°19'30"	LATITUDE/LONGITUDE LINES
MW-1 ●	EXISTING MONITORING WELL
▨	PERIMETER ROAD
—×—×—	EXISTING FENCE
- - - -	EXISTING DRAINAGE EASEMENT
— E —	EXISTING ELECTRICAL EASEMENT
- - - -	100-YEAR FLOOD PLAIN (SEE NOTE 3)

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. EXISTING CELL 1 AND 2 BOUNDARIES ARE FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS. THE EXISTING AND FUTURE CELL 3 BOUNDARIES ARE FROM A CELL EXPANSION PLAN DATED FEBRUARY 2021; DEVELOPED BY SCS ENGINEERS.
3. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48309C0600D, DATED 10/20/2019.
4. LANDFILL REGISTRATION BOUNDARY IS FROM AN EXHIBIT AND FIELD NOTES FOR A 148.84 ACRES SOLID WASTE DISPOSAL FACILITY TRACT DEVELOPED BY WALKER PARTNERS IN SEPTEMBER 2021.

1/13/2022 11:14 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\I.B-4 - Facility Layout

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
FACILITY LAYOUT MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

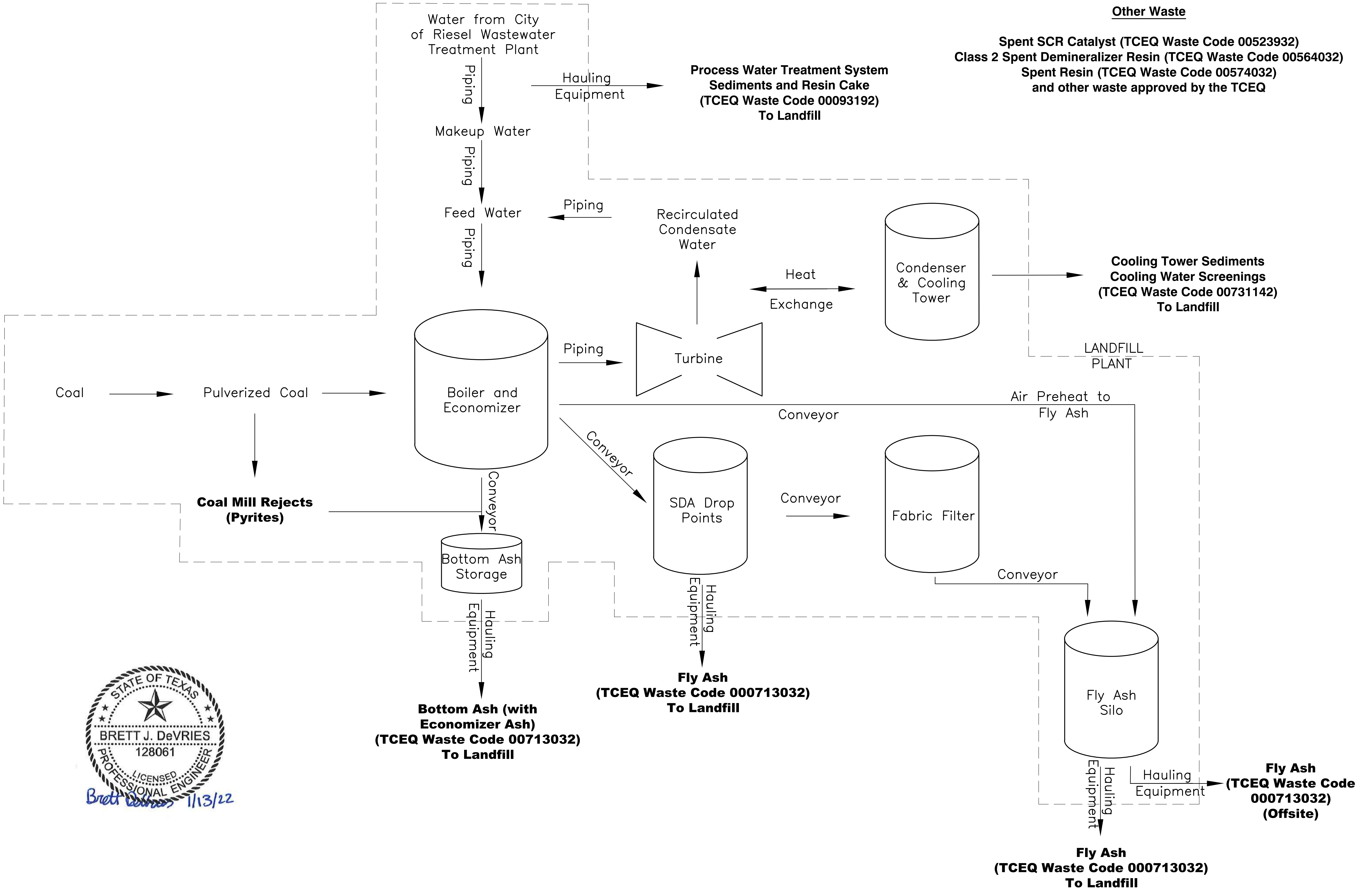
PROJ. NO. 16221059.00	DSN. BY: BJD
DWN. BY: ORA	CHK. BY: BJD
Q/A RVW BY: BJD	APP. BY: BJD

CADD FILE:
I.B-4 - FACILITY LAYOUT

DATE:
11/2021

SCALE:
AS SHOWN

DRAWING NO.
I.B-4



BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

REV | DATE | DESCRIPTION | BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
PROCESS FLOW DIAGRAM

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

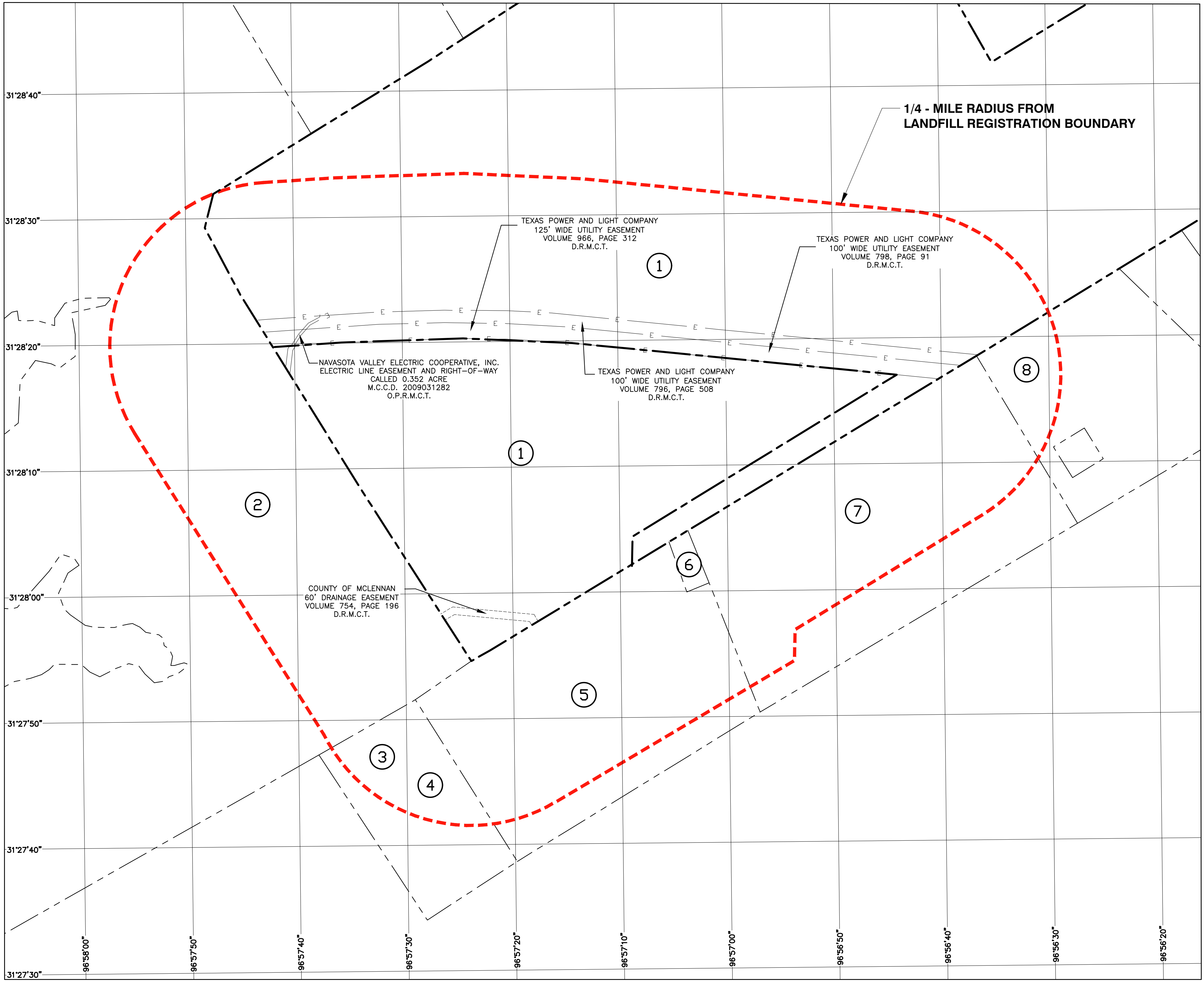
CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE: I.B-5 – FLOW DIAGRAM
DATE: 11/2021
SCALE: AS SHOWN
DRAWING NO.
I.B-5

1/13/2022 11:21 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\I.B-5 – Flow Diagram



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SCALE IN FEET

LEGEND

PLANT PROPERTY BOUNDARY
LANDFILL REGISTRATION BOUNDARY (SEE NOTE 4)
ADJACENT PROPERTY BOUNDARY
1/4 MILE RADIUS LINE (SEE NOTE 2)
96°55'30" LATITUDE/LONGITUDE LINES
3 ELECTRICAL EASEMENT
DRAINAGE EASEMENT

NOTES:

1. Ⓧ CORRESPONDS TO LANDOWNERS LISTED ON LANDOWNERS LIST PROVIDED IN PART I, SECTION 3.
2. PROPERTY OWNERS WITHIN 1/4 MILE OF THE LANDFILL REGISTRATION BOUNDARY ARE SHOWN, BASED ON AN ONLINE REVIEW OF MCLENNAN COUNTY APPRAISAL DISTRICTS PROPERTY RECORDS, AS OF OCTOBER 2021. MCLENNAN COUNTY DID NOT IDENTIFY MINERAL INTEREST IN ITS ONLINE REAL PROPERTY APPRAISAL RECORDS.
3. LANDOWNER PROPERTY BOUNDARIES INDICATED ARE APPROXIMATE.
4. THE LANDFILL REGISTRATION BOUNDARY IS DEFINED IN PART 1 – GENERAL REGISTRATION APPLICATION REQUIREMENTS, SECTION 1 AND DEPICTED ON THE PROPERTY/LEGAL DESCRIPTION OF THE REGISTRATION BOUNDARY PROVIDED IN APPENDIX I.B.

BRETT J. DeVRIES
128061
Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LAND OWNERSHIP MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221047.00
DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

CADD FILE: I.B-6 – LAND OWNERS MAP

DATE: 10/2021

SCALE: AS SHOWN

DRAWING NO.
I.B-6

Walker Partners
engineers | surveyors

823 Washington Ave., Suite 100
Waco, Texas 76701

149.384 ACRE SOLID WASTE DISPOSAL FACILITY TRACT LOCATED IN THE JOSE DAVID SANCHEZ SURVEY, ABSTRACT 36 McLENNAN COUNTY, TEXAS

FIELD NOTES FOR A 149.384 ACRE TRACT OF LAND LOCATED IN THE JOSE DAVID SANCHEZ SURVEY, ABSTRACT 36, McLENNAN COUNTY, TEXAS, AND BEING A PORTION OF A CALLED 697.842 ACRE TRACT DESCRIBED IN A DEED TO SANDY CREEK ENERGY ASSOCIATES, LP, A DELAWARE LIMITED PARTNERSHIP RECORDED UNDER McLENNAN COUNTY CLERK’S DOCUMENT 2007031852 OF THE OFFICIAL PUBLIC RECORDS OF McLENNAN COUNTY, TEXAS. SAID 149.384 ACRE TRACT BEING MORE PARTICULARLY SHOWN ON THE ATTACHED EXHIBIT DRAWING AND FURTHER DESCRIBED BY METES AND BOUNDS AS FOLLOWS:

BEGINNING AT A MAG NAIL WITH A WASHER STAMPED “WALKER PARTNERS” SET IN THE NORTHWEST RIGHT-OF-WAY LINE OF FARM-TO-MARKET HIGHWAY 1860 (100’ WIDE) AT ITS INTERSECTION WITH THE APPROXIMATE CENTER OF RATTLESNAKE ROAD (APPROXIMATE 50’ WIDE OCCUPIED RIGHT-OF-WAY) MARKING THE MOST SOUTHERLY CORNER OF SAID 697.842 ACRE TRACT AND OF THE HEREIN DESCRIBED TRACT;

THENCE N 32°34’35” W – 1502.81’ WITH THE SOUTHWEST LINE OF SAID 697.842 ACRE TRACT AND THE APPROXIMATE CENTER OF RATTLESNAKE ROAD TO A 5/8” IRON ROD WITH A CAP STAMPED “RON CARROLL RPLS 2025” FOUND FOR AN ANGLE POINT OF THE 697.842 ACRE TRACT AND OF THE HEREIN DESCRIBED TRACT;

THENCE N 31°26’17” W – 1474.19’ – WITH THE SOUTHWEST LINE OF SAID 697.842 ACRE TRACT AND THE APPROXIMATE CENTER OF RATTLESNAKE ROAD TO A POINT IN THE SOUTH LINE OF A CALLED (125’ WIDE) UTILITY EASEMENT DESCRIBED IN A DEED TO TEXAS POWER & LIGHT COMPANY RECORDED IN VOLUME 966, PAGE 312 OF THE DEED RECORDS OF McLENNAN COUNTY, TEXAS FOR THE WEST CORNER OF THE HEREIN DESCRIBED TRACT, FROM WHICH A 5/8” IRON ROD FOUND IN THE APPROXIMATE CENTER OF RATTLESNAKE ROAD MARKING AN ANGLE POINT OF THE SOUTHWEST LINE OF THE 697.842 ACRE TRACT BEARS N 31°26’17” W – 575.16’:

THENCE WITH THE SAID SOUTH LINE OF THE CALLED 125’ WIDE UTILITY EASEMENT THE FOLLOWING FOUR CALLS:

1) **N 86°07’54” E – 537.67’** TO AN ANGLE POINT,
2) **N 87°57’54” E – 980.24’** TO AN ANGLE POINT,
3) **S 87°27’06” E – 875.36’** TO AN ANGLE POINT,
4) **S 84°26’06” E – 2622.85’** TO A POINT FOR THE MOST EASTERLY OR NORTHEAST CORNER OF THE HEREIN DESCRIBED TRACT, FROM WHICH A 1/2” IRON ROD FOUND IN THE NORTHWEST RIGHT-OF-WAY LINE OF SAID HIGHWAY 1860 (PER TEXAS DEPARTMENT OF TRANSPORTATION RIGHT-OF-WAY MAPS DATED APRIL 10, 1957), MARKING AN ANGLE POINT IN THE SOUTHEAST LINE OF SAID 697.842 ACRE TRACT BEARS S 31°29’02” E – 200.00’ AND S 58°30’58” W – 2539.11’, ALSO FROM THE SAID MOST EASTERLY OR NORTHEAST CORNER OF THE HEREIN DESCRIBED TRACT ANOTHER 1/2” IRON ROD FOUND IN THE NORTHWEST RIGHT-OF-WAY LINE OF THE HIGHWAY, MARKING AN ANGLE POINT IN THE SOUTHEAST LINE OF THE 697.842 ACRE TRACT BEARS S 31°29’02” E – 200.00’ AND N 58°30’58” E – 987.49’;

THENCE S 58°30’58” W – 2489.26’ ALONG A LINE BEING 200.00’ NORTHWEST OF AND PARALLEL WITH THE SAID NORTHWEST RIGHT-OF-WAY LINE OF HIGHWAY 1860 AND THE SOUTHEAST LINE OF SAID 697.842 ACRE TRACT TO A POINT FOR AN INSIDE CORNER OF THE HEREIN DESCRIBED TRACT;

THENCE S 01°05’55” W – 236.00’ TO A POINT IN THE SAID NORTHWEST LINE OF HIGHWAY 1860 FOR AN OUTSIDE CORNER OF THE HEREIN DESCRIBED TRACT OF THE HEREIN DESCRIBED TRACT;

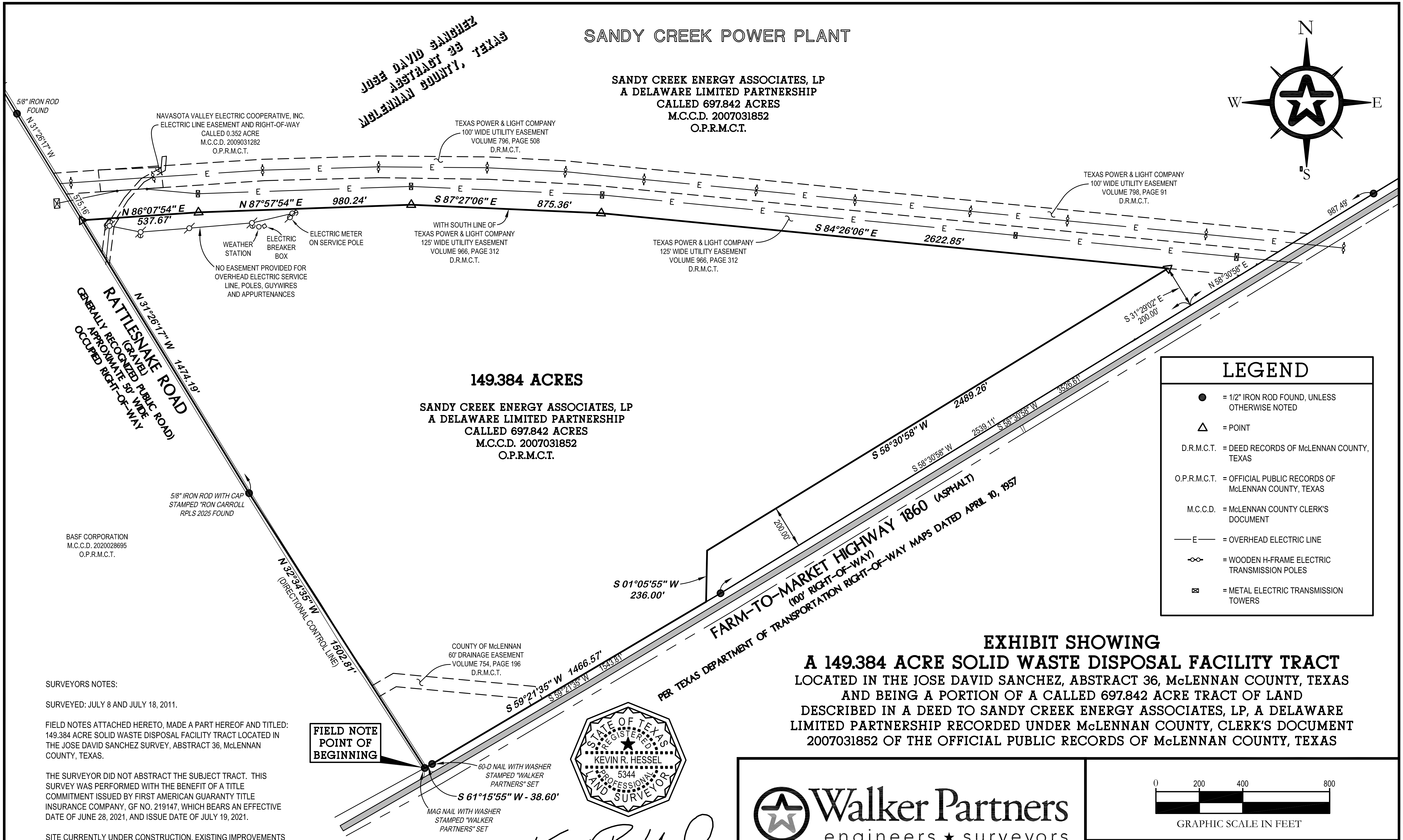
THENCE WITH THE COMMON LINE OF SAID 697.842 ACRE TRACT AND SAID NORTHWEST RIGHT-OF-WAY LINE OF HIGHWAY 1860 THE FOLLOWING TWO CALLS

1) **S 59°21’35” W – 1466.57’** TO A 60D NAIL WITH WASHER STAMPED “WALKER PARTNERS” SET FOR AN ANGLE POINT,
2) **S 61°15’55” W – 38.60’** RETURNING TO THE **POINT OF BEGINNING** AND CONTAINING 149.384 ACRES OF LAND AS SURVEYED BY KEVIN R. HESSEL, REGISTERED PROFESSIONAL LAND SURVEYOR, NO. 5344 ON JULY 8 AND JULY 18, 2011. BEARINGS CITED WITHIN THIS DESCRIPTION ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, NAD 83, TEXAS CENTRAL ZONE ACQUIRED FROM GLOBAL POSITIONING SYSTEM OBSERVATIONS.

KEVIN R. HESSEL, R.P.L.S. 5344

KEVIN R. HESSEL
5344

PREPARED: SEPTEMBER 20, 2021
REVISED: SEPTEMBER 28, 2021
PROJ NO. 1-03477.01
PLAT NO. B1-0523
FIELD NOTE NO. 01_149.384 AC
MAP CHECKED: SEPTEMBER 28, 2021



LEGEND

●	= 1/2" IRON ROD FOUND, UNLESS OTHERWISE NOTED
△	= POINT
D.R.M.C.T.	= DEED RECORDS OF McLENNAN COUNTY, TEXAS
O.P.R.M.C.T.	= OFFICIAL PUBLIC RECORDS OF McLENNAN COUNTY, TEXAS
M.C.C.D.	= McLENNAN COUNTY CLERK'S DOCUMENT
—E—	= OVERHEAD ELECTRIC LINE
-○○-	= WOODEN H-FRAME ELECTRIC TRANSMISSION POLES
⊠	= METAL ELECTRIC TRANSMISSION TOWERS

EXHIBIT SHOWING
A 149.384 ACRE SOLID WASTE DISPOSAL FACILITY TRACT

LOCATED IN THE JOSE DAVID SANCHEZ, ABSTRACT 36, McLENNAN COUNTY, TEXAS AND BEING A PORTION OF A CALLED 697.842 ACRE TRACT OF LAND DESCRIBED IN A DEED TO SANDY CREEK ENERGY ASSOCIATES, LP, A DELAWARE LIMITED PARTNERSHIP RECORDED UNDER McLENNAN COUNTY, CLERK'S DOCUMENT 2007031852 OF THE OFFICIAL PUBLIC RECORDS OF McLENNAN COUNTY, TEXAS

SURVEYORS NOTES:

SURVEYED: JULY 8 AND JULY 18, 2011.

FIELD NOTES ATTACHED HERETO, MADE A PART HEREOF AND TITLED: 149.384 ACRE SOLID WASTE DISPOSAL FACILITY TRACT LOCATED IN THE JOSE DAVID SANCHEZ SURVEY, ABSTRACT 36, McLENNAN COUNTY, TEXAS.

THE SURVEYOR DID NOT ABSTRACT THE SUBJECT TRACT. THIS SURVEY WAS PERFORMED WITH THE BENEFIT OF A TITLE COMMITMENT ISSUED BY FIRST AMERICAN GUARANTY TITLE INSURANCE COMPANY, GF NO. 219147, WHICH BEARS AN EFFECTIVE DATE OF JUNE 28, 2021, AND ISSUE DATE OF JULY 19, 2021.

SITE CURRENTLY UNDER CONSTRUCTION, EXISTING IMPROVEMENTS ARE NOT SHOWN HEREON.

KEVIN R. HESSEL
5344

PREPARED: SEPTEMBER 20, 2021
REVISED BOUNDARY: SEPTEMBER 28, 2021

Walker Partners
engineers ★ surveyors
823 Washington Ave. ● Waco, Texas 76701
Phone: 1-254-714-1402 ● T.B.P.E. Registration No. 8053
T.B.P.L.S. Registration No. 10032500

0 200 400 800
GRAPHIC SCALE IN FEET

PLAT NO. B1-0523 PROJ. NO. 1-03477.01 DRAFTED 09/20/21
TAB 17X11 F/N NO. 01 FB/PG ______ DRAWN BY DBS
DWG. NAME 1-03477EXHIB_WDF MAP CHK'D 09/20/21

APPENDIX I.C

LEGAL AUTHORITY

Corporations Section
P.O.Box 13697
Austin, Texas 78711-3697

Jose A. Esparza
Deputy Secretary of State

Office of the Secretary of State

The undersigned, as Deputy Secretary of State of Texas, does hereby certify that the attached is a true and correct copy of each document on file in this office as described below:

Brazos Sandy Creek Electric Cooperative, Inc.
Filing Number: 800847176

Certificate of Formation	July 23, 2007

In testimony whereof, I have hereunto signed my name officially and caused to be impressed hereon the Seal of State at my office in Austin, Texas on August 03, 2021.

Jose A. Esparza
Deputy Secretary of State

FILED
In the Office of the
Secretary of State of Texas
JUL 2 3 2007
Corporations Section

ARTICLES OF INCORPORATION

OF

BRAZOS SANDY CREEK ELECTRIC COOPERATIVE, INC.

The undersigned natural persons, all being over the age of twenty-one (21) years, adopt the following Articles of Incorporation of Brazos Sandy Creek Electric Cooperative, Inc. (referred to as the "Cooperative") under Chapter 161 of the Texas Utilities Code (referred to as the "Act"):

ARTICLE 1

NAME

The name of the Cooperative is Brazos Sandy Creek Electric Cooperative, Inc.

ARTICLE 2

PURPOSES

The purpose of the Cooperative is to transact and engage in any and all lawful business that may be authorized by the Electric Cooperative Corporation Act of the State of Texas, V.T.C.A. Utilities Code, Section 161 et seq, and any other law affecting or pertaining to Texas electric cooperatives, including the provision of electric and other services as may be authorized pursuant to the provisions of the Public Utilities Regulatory Act, as now enacted and as may be subsequently amended or superseded.

ARTICLE 3

INCORPORATORS

The names and street addresses of the five (5) incorporators are:

Name	Address
Ronnie Robinson	P.O. Box 729 Comanche, Texas 76442
Rick Haile	P.O. Box 357 McGregor, Texas 76657
Clifton Karnei	2404 LaSalle Avenue Waco, Texas 76706
Dennis McWhorter	4148 Jozye Road Madisonville, Texas 77864

Larry Bays	3015 CR 397 Dublin, Texas 76446

ARTICLE 4

DIRECTORS

The number of directors shall be no less than five (5) directors but no more than seven (7) directors. The initial board of directors of the Cooperative will consist of five (5) directors, and the names and addresses of the persons who are to serve as directors until the first annual meeting of members or until their successors are elected and qualified are:

Name	Address
Ronnie Robinson	P.O. Box 729 Comanche, Texas 76442
Rick Haile	P.O. Box 357 McGregor, Texas 76657
Clifton Karnei	2404 LaSalle Avenue Waco, Texas 76706
Dennis McWhorter	4148 Jozye Road Madisonville, Texas 77864
Larry Bays	3015 CR 397 Dublin, Texas 76446

ARTICLE 5

PRINCIPAL OFFICE AND REGISTERED AGENT

The street address of the principal office of the Cooperative is 2404 LaSalle Avenue, Waco, Texas 76706. The name and address of the agent whom process may be served is Clifton Karnei, 2404 LaSalle Avenue, Waco, Texas 76706.

ARTICLE 6

DURATION

The Cooperative shall continue in perpetuity.

ARTICLE 7

MEMBERS

The Cooperative will have a member or members. The determination of membership matters is reserved to the board of directors by the bylaws of the Cooperative.

ARTICLE 8

LIMITATION ON LIABILITY OF DIRECTORS AND OFFICERS

To the fullest extent permitted by Texas statutory or decisional law, as the same exists or may hereafter be amended or interpreted, a director or officer of the Cooperative shall not be liable to the Cooperative or its members for any act or omission in such director's or officer's capacity as a director or officer, respectively. Any repeal or amendment of this Article or adoption of any other provision of the Articles of Incorporation inconsistent with this Article, by the members of the Cooperative shall be prospective only and shall not adversely affect any limitation on the liability to the Cooperative or its members of a director or officer of the Cooperative existing at the time of such repeal, amendment or adoption of an inconsistent provision.

ARTICLE 9

INDEMNIFICATION

The Cooperative may indemnify a person who was, is, or is threatened to be made a named defendant or respondent in litigation or other proceedings because the person is or was an officer or other person related to the Cooperative. As provided in the Cooperative's bylaws, the directors shall have the power to define the requirements and limitations for the Cooperative to indemnify officers, directors, or others related to the Cooperative.

ARTICLE 10

CONSTRUCTION

All references in these Articles of Incorporation to statutes, regulations, or other sources of legal authority shall refer to the authorities cited, or their successors, as they may be amended from time to time.

ARTICLE 11

NON-PROFIT CORPORATION

The Cooperative shall operate without profit to its members. Upon dissolution, after all liabilities or obligations of the Cooperative have been satisfied, all of the Cooperative's assets shall be distributed to the participating members of the Cooperative who were active when the certificate of dissolution was filed.

We execute these Articles of Incorporation as of the 23rd day of July 2007.

Ronnie Robinson

Ronnie Robinson

Rick Haile

Rick Haile

Clifton Karnei

Clifton Karnei

Dennis McWhorter

Dennis McWhorter

Larry Bays

Larry Bays

Corporations Section
P.O.Box 13697
Austin, Texas 78711-3697

Jose A. Esparza
Deputy Secretary of State

Office of the Secretary of State

The undersigned, as Deputy Secretary of State of Texas, does hereby certify that the attached is a true and correct copy of each document on file in this office as described below:

Sandy Creek Energy Associates, L.P.
Filing Number: 800259979

Registration of Limited Partnership October 20, 2003

In testimony whereof, I have hereunto signed my name officially and caused to be impressed hereon the Seal of State at my office in Austin, Texas on August 03, 2021.

Jose A. Esparza
Deputy Secretary of State

Come visit us on the internet at https://www.sos.texas.gov/

Phone: (512) 463-5555 Fax: (512) 463-5709 Dial: 7-1-1 for Relay Services
Prepared by: SOS-WEB TID: 10266 Document: 1069674410004

Form 306
(revised 9/03)

Return in Duplicate to:
Secretary of State
P.O. Box 13697
Austin, TX 78711-3697
FAX: 512/463-5709

Filing Fee: $750

Application for Registration Pursuant to Article 9.02 Texas Revised Limited Partnership Act

This space reserved for office use.

FILED
In the Office of the
Secretary of State of Texas
OCT 20 2003
Corporations Section

1. The name of the limited partnership is as set forth below:

Sandy Creek Energy Associates, L.P.

The name must not be the same as, deceptively similar to or similar to that of an existing corporate, limited liability company, or limited partnership name on file with the secretary of state. A preliminary check for "name availability" is recommended.

2A. The name of the limited partnership in its jurisdiction of formation does not contain the words "Limited Partnership," "Limited," or the abbreviations "L.P.," "LP," or "Ltd." The name of the limited partnership with the word or abbreviation that it elects to add for use in Texas is:

2B. The limited partnership name is not available in Texas. The assumed name under which the partnership will qualify and transact business in Texas is:

3. Its federal employer identification number is: 05-0587389

☐ Federal employer identification number information is not available at this time.

4. It was formed under the laws of: (set forth state or other jurisdiction) Delaware

and the date of its formation was September 5, 2003

5. The principal office address in the state or country of the corporation's jurisdiction of formation is:
(If the corporation does not maintain an office address in its jurisdiction of formation, then provide the registered office address of its registered agent in the jurisdiction of incorporation in the space provided below.)

1209 Orange Street, Wilmington, County of New Castele, Delaware 19801

6. Its proposed registered agent in Texas is the individual or organization named below:

C T Corporation System

and the street address of its proposed registered office, which is the business office address of its proposed registered agent in Texas, is: (A post office box address is not sufficient, please provide street address.)

c/o C T Corporation System, 350 N. St. Paul Street, Dallas, Texas 75201

Address City State Zip/Postal Code

TX055 - 9/03/03 C T System Online

8. The purpose or purposes of the limited partnership that it proposes to pursue in the transaction of business in Texas are set forth below.

Any lawful activity for which limited partnerships may be organized under the laws of Texas.

9. The limited partnership hereby appoints the Secretary of State of Texas as its agent for service of process under the circumstances set forth in Section 9.10(b) of the Texas Revised Limited Partnership Act.

10. The name, mailing address and street address of the business or residence of each general partner is as follows:

NAME	MAILING ADDRESS (city, state & zip)	STREET ADDRESS (city, state & zip)
Sandy Creek GP, Inc	Two Tower Center, 20th Floor	
	East Brunswick, NJ 08816	

11. As of the date of filing, the undersigned certifies that the foreign limited partnership currently exists as a valid entity under the laws of the jurisdiction of its formation.

12. The date on which the foreign limited partnership intends to transact business in Texas, or the date on which the limited partnership first transacted business in Texas is set forth below:

October 25, 2003

Effective Date of Filing

☒ The document is to be effective when the document is filed by the secretary of state.

OR

☐ This document will become effective at a later date, which is not more than ninety (90) days from the date of its filing by the secretary of state. The delayed effective date is:

Execution

The undersigned, as general partner of the limited partnership, signs this document subject to the penalties imposed by law for the submission of a false or fraudulent document.

Sandy Creek Energy Associates, L.P.
By: Sandy Creek GP, Inc., its general partner

By: 10-20-2003
V.P. and Treasurer
Signature of General Partner Date

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
REGISTRATION APPLICATION
TCEQ REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

PART II
LOCATION RESTRICTION DEMONSTRATION

Prepared for:

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

SANDY CREEK SERVICES, LLC
2161 Rattlesnake Road
Riesel, Texas 76682

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – January 2022
SCS Project No. 16221059.00

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STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

1 PE CERTIFICATION

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

I, Brett DeVries, Ph.D., P.E., hereby certify that this Location Restrictions Demonstration for placement above the uppermost aquifer, wetlands, seismic impact zone, fault areas, and unstable areas for the Sandy Creek Energy Station Coal Combustion Residual Waste Management Facility meets the requirements in 30 TAC §352.601 (40 CFR §257.60(a)), §352.611 (§257.61(a)), §352.621 (§257.62), §352.631 (§257.63), and 352.641 (§257.64). This Demonstration was prepared by or under my supervision. I am a duly licensed Professional Engineer under the laws of the State of Texas.

Brett DeVries, Ph.D., P.E.
(printed or typed name)

License number __128061____________________

My license renewal date is __9/30/2022______

2 INTRODUCTION

This Geology and Location Restriction Demonstration has been prepared for Sandy Creek Services, LLC (Owner and Operator) of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill), located in McLennan County. This Demonstration has been prepared consistent with Title 30 of the Texas Administrative Code (30 TAC), Chapter 352, Subchapter E and such provisions of Title 40 of the Code of Federal Regulations (40 CFR), Part 257, Subpart D, as are incorporated by reference.

The Landfill and associated support facilities are located on the southwest corner of the Plant Property Boundary. As currently designed, the Landfill is one unit (Unit 002) that will ultimately occupy approximately 40.7 acres and consist of three cells, referred to as Cells 1 through 3 (Appendix I.B, Drawing I.B-4). Cells 1 and 2 are existing active cells that were constructed in 2010 and 2014, respectively, with ongoing waste placement operations. A portion of Cell 3 (inclusive of Subcells 3A through 3D encompassing approximately 10.3 acres) was constructed in 2021 prior to and during the time of preparing this Location Restriction Demonstration.

Cells 1 and 2 were constructed in accordance with rules and regulations for coal combustion residual (CCR) Landfills at the time of construction (prior to promulgation of 30 TAC 352 and 40 CFR Part 257), and are not subject to the requirements of 30 TAC §352.601 (40 CFR §257.60(a)), §352.611 (§257.61(a)), §352.621 (§257.62), and §352.631 (§257.63). However, existing CCR Landfills, such as Cells 1 and 2, that receive CCR both before and after October 14, 2015, must not be located in an unstable area unless the Landfill Owner/Operator demonstrates that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted. An Unstable Areas Compliance Demonstration for Cells 1 and 2 was developed by SCS Engineers on October 1, 2018 prior to the October 17, 2018 deadline (see Appendix II.B1).

Cell 3 (including subcells) is considered a lateral expansion (consistent with §257.53), and will be constructed and operated consistent with this Application. Furthermore, Cell 3 will comply with the above mentioned regulations related to placement above the uppermost aquifer, wetlands, fault areas, unstable areas, and seismic impact zone. Prior to construction of Subcells 3A through 3D, a Compliance Demonstration was developed and notifications provided to the Texas Commission on Environmental Quality (TCEQ) on June 11, 2021 in accordance with 40 CFR §257.106(f)(1) and (2) as provided in Appendix II.A.

Furthermore, in accordance with §257.52, any CCR landfill or lateral expansion of a CCR unit will continue to be subject to the requirements in §§ 257.3–1, 257.3–2, and 257.3–3. This appendix addresses §257.3–1, §257.3–2, and §257.3–3, related to floodplains, endangered species, and surface water, respectively.

3 PLACEMENT ABOVE THE UPPERMOST AQUIFER (30 TAC §352.601 [40 CFR §257.60])

"(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer."

As defined in 40 CFR §257.53, an "Aquifer" is a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs. The shallowest geologic formation beneath the Landfill Registration Boundary that is capable of providing usable quantities of water is the Trinity Aquifer, located approximately 1,000 feet below the Landfill. The geology between the Landfill ground surface and the top of the Trinity Aquifer consists of low-permeability sediments. Shallow geology in the vicinity of the Landfill Registration Boundary is described below.

The Landfill is located in the Blackland Prairies province of the Texas Gulf Coastal plains. This area is located northeast of the Central Texas uplift. Geology of the Blackland Prairies consist of chalks and marls that weather to deep, black clay soils (Physiographic Map of Texas 1996). The Landfill is underlain by two integrated formations, the Lower Taylor Marl Formation (Ozan Formation) and the Wolfe City Formation, of the Upper Cretaceous period. In general, the subsurface stratigraphy consists predominantly of high plasticity yellow-brown clays, weathered clayshale, and marl units of fluvial and shallow marine origin (Geotechnical Design Report Revision 0. Sandy Creek Power Partners, Apr. 2009 provided in Appendix VI.B). The Ozan Formation consists of a calcareous claystone with increasing upward contents of silt and sand. The Ozan Formation is generally medium gray and contains some glauconite, phosphate pellets, hematite, and pyrite nodules. The Ozan Formation is up to 500 feet in thickness and grades upward to the Wolfe City Formation (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970). The Wolfe City Formation is up to 300 feet in thickness. Based on the geologic map (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970), the approximate thickness of the Wolfe City formation at the Landfill is estimated to be 150 feet. The Wolfe City Formation consists of marl, sand, sandstone, and clay interbedded with thin sandstone and un-cemented sand lenses, and containing glauconite, phosphate and hematite nodules. It is generally dark gray to light gray and brown. (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970).

The formations directly underlying the Landfill are considered to be a confining unit to the State-defined aquifer. The shallowest state-defined aquifer beneath the Landfill is the Trinity Aquifer. As depicted on the Trinity Aquifer Distribution Map (Figure 3 in Appendix II.A), the top of the Trinity is estimated to be located more than 1,000 feet below the ground surface. (Groundwater Atlas of the United States, USGS, Reston, VA, 1996).

In conclusion and as determined in the Compliance Demonstration for Cell 3 (see Appendix II.A), the base of Cell 3 will be located no less than five feet from the uppermost aquifer; therefore, the requirement in 40 CFR §257.60(a) is met for Cell 3.

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the Demonstration meets the requirements of paragraph (a) of §257.60 was provided in the Compliance Demonstation, related to placement above the uppermost aquifer, for Cell 3 prior to construction of Cell 3, Subcells 3A through 3D (see Appendix II.A, Section 3.1), and is also provided at the beginning of this Demonstration; therefore, the requirements in 40 CFR §257.60(b) have been met for Cell 3.

"(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by §257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of §257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

A Compliance Demonstration for Cell 3, related to placement above the upper most aquifer (see Appendix II.A, Section 3.1), was developed prior to the date of initial receipt of CCR in Cell 3 (Subcells 3A through 3D). This Location Restriction Demonstration was also developed prior to initial receipt of CCR in future subcells in Cell 3; therefore, the requirements in 40 CFR §257.60(c)(2), (3), and (5) have been met for Cell 3.

"(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the internet requirements specified in §257.107(e)."

The Compliance Demonstration for Cell 3 (see Appendix II.A) was placed in the Site Operating Record and on the Landfill's publically accessible website, and a notification letter was submitted to the TCEQ. This Application, including this Location Restriction Demonstration, will be placed in the Site Operating Record and on the Landfill's publically accessible website, and submitted to the TCEQ; therefore, the requirements in 40 CFR §257.60(d) have been met for Cell 3.

4 WETLANDS (30 TAC §352.611 [40 CFR §257.61])

“(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section.

> *(1) Where applicable under section 404 of the Clean Water Act or applicable state wetlands laws, a clear and objective rebuttal of the presumption that an alternative to the CCR unit is reasonably available that does not involve wetlands.*
>
> *(2) The construction and operation of the CCR unit will not cause or contribute to any of the following:*
>
> > *(i) A violation of any applicable state or federal water quality standard;*
> >
> > *(ii) A violation of any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act;*
> >
> > *(iii) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and*
> >
> > *(iv) A violation of any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.*
>
> *(3) The CCR unit will not cause or contribute to significant degradation of wetlands by addressing all of the following factors:*
>
> > *(i) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the CCR unit;*
> >
> > *(ii) Erosion, stability, and migration potential of dredged and fill materials used to support the CCR unit;*
> >
> > *(iii) The volume and chemical nature of the CCR;*
> >
> > *(iv) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of CCR;*
> >
> > *(v) The potential effects of catastrophic release of CCR to the wetland and the resulting impacts on the environment; and*
> >
> > *(vi) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.*

(4) To the extent required under section 404 of the Clean Water Act or applicable state wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent reasonable as required by paragraphs (a)(1) through (3) of this section, then minimizing unavoidable impacts to the maximum extent reasonable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and reasonable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

(5) Sufficient information is available to make a reasoned determination with respect to the demonstrations in paragraphs (a)(1) through (4) of this section."

An onsite Jurisdictional Assessment Survey of existing aquatic features, located in the vicinity of Cell 3 was performed by Integrated Environmental Solutions, LLC (IES). Based on this assessment, one pond, four ditches, and one erosion feature were identified and delineated; however, none of these features were identified as Waters of the United States (WOTUS), nor were wetlands identified within the area to be disturbed by development of Cell 3. Following the onsite Jurisdictional Assessment Survey, IES prepared and submitted an Approved Jurisdiction Determination (AJD) request to U.S. Army Corps of Engineers (USACOE), Fort Worth Regulatory Branch. This AJD and USACOE approval is included in Appendix II.A, Attachment 1. As a result of the Jurisdictional Assessment Survey conducted by IES and the approval by USACOE, the requirements in 40 CFR §257.61(a) have been met for Cell 3.

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the demonstration meets the requirements of paragraph (a) of §257.61 was provided in the Compliance Demonstration, related to wetlands, for Cell 3 prior to construction of Cell 3, Subcells 3A through 3D (see Appendix II.A, Section 3.2), and is also provided at the beginning of this Demonstration; therefore, the requirements in 40 CFR §257.61(b) have been met for Cell 3.

"(c) The owner or operator of the CCR unit must complete the demonstrations required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

> *(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).*
>
> *(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).*
>
> *(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstrations showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."*

A Compliance Demonstration for Cell 3, related to wetlands (see Appendix II.A, Section 3.2), was developed prior to the date of initial receipt of CCR in Cell 3 (Subcells 3A through 3D). The Approved Jurisdictional Determination was also developed prior to initial receipt of waste in future subcells in Cell 3; therefore, the requirements in 40 CFR §257.61(c)(2), (3), and (5) have been met for Cell 3.

"(d) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e)."

The Compliance Demonstration for Cell 3 (see Appendix II.A) was placed in the Site Operating Record and on the Landfill's publically accessible internet site, and a notification letter was submitted to the TCEQ. Additionally, this Application, including this Location Restriction Demonstration will be placed in the Site Operating Record and on the Landfill's publically accessible internet site, and submitted to the TCEQ; therefore, the requirements in 40 CFR §257.61(d) have been met for Cell 3.

5 FAULT AREAS (30 TAC §352.621 [40 CFR §257.62])

"(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit."

Available geologic maps indicate that the Landfill is located between two fault zones: the Balcones Fault Zone and the Mexia-Talco-Luling Fault Zone. The Balcones Fault Zone is located approximately 12 miles west of the Landfill, and the Mexia-Talco-Luling Fault Zone is located approximately 16 miles to the east. The closest fault lies within the Balcones Fault Zone, approximately one mile south of the Landfill (see Figure 4 – Geologic Map in Appendix II.A), and is probably structurally related to this family of faults (Horton et al., 2017). No scarps or other signs of recent fault movement have been observed on the Landfill Registration Boundary.

Based on review of the available geologic maps and as determined in the Compliance Demonstration for Cell 3 (see Appendix II.A, Section 3.3), Cell 3 is not located within 60 meters (200 feet) of a fault that has had displacement in Holocene time; therefore, the requirements in 40 CFR §257.62 have been met for Cell 3.

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the Demonstration meets the requirements of paragraph (a) of §257.62 was provided in the Compliance Demonstration, related to fault areas, for Cell 3 prior to construction of Cell 3, Subcells 3A through 3D (see Appendix II.A1, Section 3.3), and is also provided at the beginning of this Demonstration; therefore, the requirements in 40 CFR §257.62(b) have been met for Cell 3.

"(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by §257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

A Compliance Demonstration for Cell 3, related to fault areas (see Appendix II.A, Section 3.3), was developed prior to the date of initial receipt of CCR in Cell 3 (Subcells 3A through 3D). This Location Restriction Demonstration was also developed prior to initial receipt of CCR in future subcells in Cell 3; therefore, the requirements in40 CFR §257.62(c)(2), (3), and (5) have been met for Cell 3.

"(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e)."

The Compliance Demonstration for Cell 3 (see Appendix II.A) was placed in the Site Operating Record and on the Landfill's publically accessible internet site, and a notification letter was submitted to the TCEQ. This Application, including Location Restriction Demonstration will be placed in the Site Operating Record and on the Landfill's publically accessible internet site, and submitted to the TCEQ; therefore, the requirements in 40 CFR §257.62(d) have been met for Cell 3.

6 SEISMIC IMPACT ZONES (30 TAC §352.631 [40 CFR §257.63])

"(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site."

40 CFR §257.53 defines a Seismic Impact Zone as an area having a 2 percent or greater probability that the maximum expected horizontal acceleration, expressed as a percentage of earth's gravitational pull (g) will exceed 0.10 g in 50 years. Therefore, if the maximum horizontal acceleration is less than or equal to 0.10 g, then the design of Cell 3 will not need to incorporate an evaluation of seismic effects.

Areas within the United States where seismic effects need to be evaluated, as determined by the United States Geological Survey (USGS), are shown on the Figure in Appendix B of Appendix II.A. As indicated on this Figure, the Landfill (inclusive of Cell 3) is not located within a seismic impact zone as defined by 40 CFR §257.53. Therefore, an evaluation of the seismic effects on the Landfill design is not required for this Landfill and the requirements in 40 CFR §257.63 have been met for Cell 3.

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the Demonstration meets the requirements of paragraph (a) of §257.63 was provided in the Compliance Demonstation, related to seismic impact zones, for Cell 3 prior to construction of Cell 3, Subcells 3A through 3D (see Appendix II.A, Section 3.4), and is also provided at the beginning of this Demonstration; therefore, the requirements in 40 CFR §257.63(b) have been met for Cell 3.

"(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by §257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of §257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

A Compliance Demonstration for Cell 3, related to seismic impact zones (see Appendix II.A, Section 3.4), was developed prior to the date of initial receipt of CCR in Cell 3 (Subcells 3A through 3D). This Location Restriction Demonstration was also developed prior to initial receipt of CCR in future subcells in Cell 3; therefore, the requirements in 40 CFR §257.63(c)(2), (3), and (5) have been met for Cell 3.

"(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the Internet requirements specified in §257.107(e)."

The Compliance Demonstration for Cell 3 (see Appendix II.A) was placed in the Site Operating Record and on the Landfill's publically accessible internet site, and a notification letter was submitted to the TCEQ. Additionally, this Application, including this Location Restriction Demonstration, will be placed in the Site Operating Record and on the Landfill's publically accessible internet site, and sent to the TCEQ; therefore, the requirements in 40 CFR §257.63(d) have been met for Cell 3.

7 UNSTABLE AREAS (30 TAC §352.641 [40 CFR §257.64])

"(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."

As determined in the Unstable Areas Compliance Demonstration for Cells 1 and 2 (see Appendix II.B1) and Cell 3 (see Appendix II.A, Section 3.5), the Landfill is not located in an unstable area, and the design of the Landfill has been developed in accordance with accepted good engineering practices related to unstable areas to ensure the integrity of the structural components of the Landfill will not be disrupted. Therefore, the requirements in 40 CFR §257.64(a) have been met for the Landfill.

"(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

"(1) On-site or local soil conditions that may result in significant differential settling;"

As determined in the Unstable Areas Compliance Demonstration for Cells 1 and 2 (see Appendix II.B1, Appendices A and B), Cell 3 (see Appendix II.A, Section 3.5), and as discussed in Section 2 of this Demonstration, the Landfill is not located in on-site or local soil conditions that may result in significant differential settling. The Landfill soils consist primarily of stiff to hard clays overlaying hard clayshale weathered from shale bedrock. Because the clays are stiff to hard, they are not susceptible to appreciable differential settlement that would affect the performance of the CCR landfill. Settlement and the inducted stresses on the liner system were analyzed for Cell 3 as provided in Appendix II.B3. As a result of this analysis, it was concluded that foundation settlement and associated strain will not adversely affect the performance of the bottom liner system in Cell 3. Therefore, the requirements in 40 CFR §257.64(b)(1) have been met for the Landfill.

"(2) On-site or local geologic or geomorphologic features; and"

As determined in the Unstable Areas Compliance Demonstration for Cells 1 and 2 (see Appendix II.B1, Appendices A, B, and E), Cell 3 (see Appendix II.A, Section 3.5), and discussed in Section 2 of this Demonstration, the Landfill is not located in on-site or local geologic or geomorphologic features that are unstable. Geologic cross sections, provided in Appendix II.B2 show stiff to hard clays overlaying hard clayshale weathered from shale bedrock. These geologic features provide a stable foundation for the Landfill. This assessment is confirmed by the slope stability analysis conducted the Cells 1 and 2 (see Appendix II.B1, Appendix D) and Cell 3 (see Appendix II.A, Attachment 2, Appendix D). Therefore, the requirements in 40 CFR §257.64(b)(2) have been met for the Landfill.

"(3) On-site or local human-made features or events (both surface and subsurface)."

As shown by the geologic cross section in Appendix II.B2, the Landfill is not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development of the Landfill, the area within the Landfill Registration Boundary was historically used for agricultural purposes with minimal disturbance.

As previously discussed, groundwater or surface water is unlikely to cause instability. The Landfill is designed with adequate run-on and run-off control systems as demonstrated in Appendix IV.D - Run-on and Run-off Control Plan, and is constructed no less than five feet from the uppermost aquifer (Trinity Aquifer) as indicated in Section 4 of this appendix.

As a result of the above mentioned analysis, the requirements in 40 CFR §257.64(b)(3) have been met for the Landfill.

"(c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the Demonstration meets the requirements of paragraph (a) of §257.64 was provided in the Demonstrations for Cells 1 through 3 (see Appendices II.A and II.B1) and is provided at the beginning of this Unstable Areas Compliance Demonstration; therefore, the requirements in 40 CFR §257.60(c) have met for the Landfill.

"(d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.

(1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by §257.105(e).

(4) An owner or operator of an existing CCR surface impoundment or existing CCR landfill who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (d)(1) of this section is subject to the requirements of § 257.101(b)(1) or (d)(1), respectively.

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

An Unstable Areas Compliance Demonstration for Cells 1 and 2 was developed by SCS Engineers on October 1, 2018 prior to the October 17, 2018 deadline (see Appendix II.B1); and a Compliance Demonstration for Cell 3 (see Appendix II.A) that included an Unstable Areas Compliance Demonstration was developed prior to the date of initial receipt of CCR in Cell 3 (Subcells 3A through 3D). Additionally, this Unstable Areas Demonstration was also developed prior to initial receipt of waste in future subcells in Cell 3; therefore, the requirements in 40 CFR §257.64(d)(2), (3), and (5) and §257.64(e) have been met for the Landfill.

"(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e)."

The Unstable Areas Compliance Demonstration for Cells 1 and 2 (see Appendix II.B1) and a Compliance Demonstrations for Cell 3 (see Appendix II.A) was placed in the Site Operating Record and on the Landfill's publicly accessible website, and a notification letter for Cell 3 was submitted to the TCEQ. This Application, including the Unstable Areas Compliance Demonstration, will be placed in the Site Operating Record and on the Landfill's publicly accessible website, and submitted to the TCEQ. Therefore, the requirements in 40 CFR §257.64(e) have been met for the Landfill.

8 FLOODPLAINS (40 CFR §257.3-1)

"(a) Facilities or practices in floodplains shall not restrict the flow of the base flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste, so as to pose a hazard to human life, wildlife, or land or water resources.

(b) As used in this section:

(1) Based flood means a flood that has a 1 percent or greater chance of recurring in any year or a flood of a magnitude equaled or exceeded once in 100 years on the average over a significantly long period.

(2) Floodplain means the lowland and relatively flat areas adjoining inland and coastal waters, including flood-prone areas of offshore islands, which are inundated by the base flood.

(3) Washout means the carrying away of solid waste by waters of the base flood."

A small portion of the Landfill Registration Boundary is within a 100-year floodplain. The floodplain limits were obtained from the current effective Flood Insurance Rate Map (Panel 48309C0600D) obtained from FEMA for portions of McLennan County. The floodplain limits have been established as Zone A, which indicates that no flood elevations have yet been determined along these locations within the Landfill Registration Boundary. The 100-year floodplain is shown on Drawings I.B-3 and I.B-4 in Appendix I.B.

The waste disposal footprint is located entirely outside the limits of the 100-year floodplain, and no development, levee, or other flood protection improvement are proposed within the floodplain. Landfill operations and development will not restrict the flow or reduce the temporary storage capacity of the 100-year floodplain; nor will Landfill operations result in washout of solid waste associated with the 100-year floodplain. Furthermore, all storage and facilities will be located outside of the 100-year floodplain. Therefore, the requirements in 40 CFR §257.3-1 have been met for the Landfill and site operations.

9 ENDANGERED SPECIES (40 CFR §257.3-2)

"(a) Facilities or practices shall not cause or contribute to the taking of any endangered or threatened species of plants, fish, or wildlife.

(b) The facility or practice shall not result in the destruction or adverse modification of the critical habitat of endangered or threatened species as identified in 50 CFR part 17.

(c) As used in this section:

(1) Endangered or threatened species means any species listed as such pursuant to section 4 of the Endangered Species Act.

(2) Destruction or adverse modification means a direct or indirect alteration of critical habitat which appreciably diminishes the likelihood of the survival and recovery of threatened or endangered species using that habitat.

(3) Taking means harassing, harming, pursuing, hunting, wounding, killing, trapping, capturing, or collecting or attempting to engage in such conduct."

A Protected Species Habitat Assessment of the Landfill Registration Boundary was performed by Integrated Environmental Solutions, LLC (IES), as provided in Appendix II.C. Based on this Assessment; four species were listed as federally protected, one species was listed as a candidate species, and two species were conditionally listed as threatened; however, no federally listed critical habitat for these species were found within the Landfill Registration Boundary. There were 14 state-listed threatened and endangered species for McLennan County; however, there was no habitat(s) for the state-listed species found within the Landfill Registration Boundary. None of the vegetation within the Landfill Registration Boundary were considered unique or compose a unique vegetation type; therefore, it was determined that the Landfill and supporting facility will not have an effect on any unique vegetation, vegetation communities, or habitat types. As a result of the Protected Species Habitat Assessment conducted by IES, it is concluded that the development and operation of this Landfill will not result in the destruction or adverse modification of the critical habitat of endangered or threatened species, or cause or contribute to the taking of threatened or endangered species or result in adverse impact to critical habitat of threatened or endangered species. Therefore, the requirements of 40 CFR §257.3-2 have been met for the Landfill.

10 SURFACE WATER (40 CFR §257.3-3)

"(a) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of pollutants into waters of the United States that is in violation of the requirements of the National Pollutant Discharge Elimination System (NPDES) under section 402 of the Clean Water Act, as amended.

(b) For purposes of section 4004(a) of the Act, a facility shall not cause a discharge of dredged material or fill material to waters of the United States that is in violation of the requirements under section 404 of the Clean Water Act, as amended.

(c) A facility or practice shall not cause non-point source pollution of waters of the United States that violates applicable legal requirements implementing an areawide or Statewide water quality management plan that has been approved by the Administrator under section 208 of the Clean Water Act, as amended.

(d) Definitions of the terms Discharge of dredged material, Point source, Pollutant, Waters of the United States, and Wetlands can be found in the Clean Water Act, as amended, 33 U.S.C. 1251 et seq., and implementing regulations, specifically 33 CFR part 323 (42 FR 37122, July 19, 1977).

The Landfill Owner/Operator will comply with the Plant's Texas Pollutant Discharge Elimination (TPDES) permit, 40 CFR §257.81(b), and Section 3 of Part IV, Appendix IV.C – Run-on and Run-off Control Plan. Therefore, the requirements in 40 CFR §257.3-3 have been met for the Landfill and site operations.

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APPENDIX II.A

CELL 3 COMPLIANCE DEMONSTRATION AND NOTIFICATION LETTER

SCS ENGINEERS

Environmental Consulting & Contracting

June 11, 2021
Project No. 1620091.00

Ms. Gulay Aki
Industrial and Hazardous Waste Permits Section, MC-130
Coal Combustion Residuals Program
Waste Permits Division
Texas Commission on Environmental Quality
P. O. Box 13087
Austin, Texas 78711-3087

Re: Sandy Creek Energy Station
TCEQ Solid Waste Registration No. 88448; EPA ID: TXR000079082
Cell 3 – Location Restrictions and Design Criteria Notification

Dear Ms. Aki:

On the behalf of Sandy Creek Energy Associates LP. (Sandy Creek), SCS Engineers is providing this notification in accordance 40 CFR §106(e) and (f) (30 TAC §352.1311) to the Texas Commission on Environmental Quality (TCEQ) with the location restriction and design criteria compliance demonstration for Cell 3 at the Sandy Creek Energy Station has been placed in the site's operating record as well as on the Sandy Creek's publically accessible internet site (http://www.sandycreekpower.net/). In accordance with 40 CFR §106(f)(1), this notification is being provided within 60 days of commencing construction of a new CCR unit (i.e., Cell 3).

If you have any questions related to the above described permit modification, please feel free to contact Mr. Brett DeVries, Ph.D., P.E. at 817-358-6110.

Sincerely,

Brett DeVries, Ph.D., P.E.
Project Engineer
SCS ENGINEERS
TBPE No. F-3407

Ryan Kuntz, P.E.
Vice President / Satellite Office Manager
SCS ENGINEERS

cc: Dana Perry – Sandy Creek Energy Statoin
TCEQ Region 9 Office

Sandy Creek Energy Station
Solid Waste Disposal Facility
McLennan County, TX

Cell 3 Compliance Demonstration

2161 Rattlesnake Road,
P.O. Box 370,
Riesel, TX 76682

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED PROFESSIONAL ENGINEER
6/7/21

SCS ENGINEERS

TBPE Reg. No. F-3407
16220089.00 | Revision 0 – June 2021

1901 Central Dr., Suite 550
Bedford, TX 76021
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BRETT J. DeVRIES
128061

6/7/21

SCS Engineers
TBPE Reg. #F-3407

1 P.E. CERTIFICATION

BRETT J. DeVRIES 128061 6/7/21	I, Brett DeVries, Ph.D., P.E., hereby certify that the location restrictions demonstration for placement above the uppermost aquifer, wetlands, seismic impact zone, fault areas, and unstable areas as well as the design criteria for the Sandy Creek Solid Waste Disposal Facility Cell 3 at the Sandy Creek Energy Station meets the requirements in 40 CFR 257.60(a), 257.61(a), 257.62, 257.63, 257.64, and 257.70. This certification is based on the enclosed Compliance Demonstration for the Sandy Creek Solid Waste Disposal Facility Cell 3 prepared by or under the supervision of SCS Engineers. I am a duly licensed Professional Engineer under the laws of the State of Texas. Brett DeVries, Ph.D., P.E.
	(printed or typed name) License number __128061__________________ My license renewal date is __9/30/2021______ Pages or sheets covered by this seal: Pages 1 through 15 and Attachments 1, 2, 3, and 4.

2 INTRODUCTION AND PROJECT SUMMARY

The following Compliance Demonstration has been prepared for Cell 3 of Sandy Creek Services, LLC's Sandy Creek Energy Station Solid Waste Disposal Facility (Facility) as required by Title 40, Code of Federal Regulation (CFR) §257.60, 257.61, §257.62, §257.63, §257.64, and §257.70, as stated below.

The coal combustion residual (CCR) landfill is classified as an existing landfill as defined under §257.53, which was constructed and commenced operation prior to October 14, 2015. The landfill is currently comprised of two CCR disposal cells, Cells 1 and 2 (see Figure 1), which commenced receiving waste in early 2013 and October 2014, respectively. The approximate area of Cells 1 and 2 are 10.0 and 14.3 acres, respectively. Cell 3 of the facility is proposed for construction as a lateral expansion of a CCR unit, and incorporates an approximate area of 17.0 acres (see Figure 2).

The primary wastes disposed in the landfill are dry scrubber ash and bottom ash generated during the coal combustion process at the onsite power plant. Incidental waste generated during the operation of the power plant may also be disposed of in the landfill, as described in the initial registration notification to TCEQ and the most recent version of the facility's Operations Plan.

This compliance demonstration addresses the construction of Cell 3. Existing Cell 1 and 2, and future Cell 4 has not been developed, is not addressed by this demonstration, and will require a similar compliance demonstration prior to placing CCR in Cell 4.

3 LOCATION RESTRICTIONS

3.1 40 CFR §257.60 "PLACEMENT ABOVE THE UPPERMOST AQUIFER"

"(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must be constructed with a base that is located no less than 1.52 meters (five feet) above the upper limit of the uppermost aquifer, or must demonstrate that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the CCR unit and the uppermost aquifer due to normal fluctuations in groundwater elevations (including the seasonal high water table). The owner or operator must demonstrate by the dates specified in paragraph (c) of this section that the CCR unit meets the minimum requirements for placement above the uppermost aquifer."

As defined in 40 CFR §257.53, an "Aquifer" is a geologic formation, group of formations, or portion of a formation capable of yielding usable quantities of groundwater to wells or springs. The shallowest geologic formation beneath the facility that is capable of providing usable quantities of water is the Trinity Aquifer, located about 1,000 feet below the facility. The geology between the facility ground surface and the top of the Trinity consists of low-permeability sediments. Shallow facility geology is described below.

The disposal facility is located in the Blackland Prairies province of the Texas Gulf Coastal plains. This area is located northeast of the Central Texas uplift. Geology of the Blackland Prairies consist of chalks and marls that weather to deep, black clay soils (Physiographic Map of Texas 1996). The facility is underlain by two integrated formations, the Lower Taylor Marl Formation (Ozan Formation) and the Wolfe City Formation, of the Upper Cretaceous period. In general, the subsurface stratigraphy consists predominantly of high plasticity yellow-brown clays, weathered clayshale, and marl units of fluvial and shallow marine origin (Geotechnical Design Report Revision 0. Sandy Creek Power Partners, Apr. 2009). The Ozan Formation consists of a calcareous claystone with increasing upward contents of silt and sand. The Ozan Formation is generally medium gray and contains some glauconite, phosphate pellets, hematite, and pyrite nodules. The Ozan Formation is up to 500 feet in thickness and grades upward to the Wolfe City Formation (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970.). The Wolfe City formation is up to 300 feet in thickness. Based on the geologic map (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970), the approximate thickness of the Wolfe City formation at the facility is estimated to be 150 feet. The Wolfe City Formation consists of marl, sand, sandstone, and clay interbedded with thin sandstone and un-cemented sand lenses, and containing glauconite, phosphate and hematite nodules. It is generally dark gray to light gray and brown. (Geologic Atlas of Texas, Waco Sheet, Texas Bureau of Economic Geology, 1970.).

The formations directly underlying the facility are considered to be a confining unit to the State-defined aquifer. The shallowest state-defined aquifer beneath the facility is the Trinity Aquifer. As depicted on Figure 3 – Trinity Aquifer Distribution Map, the top of the Trinity is estimated to be located approximately 1,000 feet below the ground surface. (Groundwater Atlas of the United States, USGS, Reston, VA, 1996.).

In conclusion, the base of Cell 3 will be located no less than five feet from the uppermost aquifer; therefore, the requirement in 40 CFR §257.60(a) is met.

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is

the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the demonstration meets the requirements of paragraph (a) of §257.60, is provided at the beginning of this compliance demonstration; therefore**, the requirements in 40 CFR §257.60(b) are met.**

"(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of §257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

This compliance demonstration has been developed prior to the date of initial receipt of CCR in Cell 3 and will be placed in the facility's operating record; therefore, **the requirements in 40 CFR §257.60(c)(2), (3), and (5) are met..**

"(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the internet requirements specified in §257.107(e)."

The compliance demonstration (specifically related to placement above the uppermost aquifer) will be placed in the facility's operating record and on the Owner's publically assessable internet facility, and a notification letter will be to the TCEQ; therefore, **the requirements in 40 CFR §257.60(d) are met.**

3.2 40 CFR §257.61 "WETLANDS"

"(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in wetlands, as defined in §232.2 of this chapter, unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that the CCR unit meets the requirements of paragraphs (a)(1) through (5) of this section.

(1) Where applicable under section 404 of the Clean Water Act or applicable state wetlands laws, a clear and objective rebuttal of the presumption that an alternative to the CCR unit is reasonably available that does not involve wetlands.

(2) The construction and operation of the CCR unit will not cause or contribute to any of the following:

> *(i) A violation of any applicable state or federal water quality standard;*
>
> *(ii) A violation of any applicable toxic effluent standard or prohibition under section 307 of the Clean Water Act;*
>
> *(iii) Jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of a critical habitat, protected under the Endangered Species Act of 1973; and*
>
> *(iv) A violation of any requirement under the Marine Protection, Research, and Sanctuaries Act of 1972 for the protection of a marine sanctuary.*

(3) The CCR unit will not cause or contribute to significant degradation of wetlands by addressing all of the following factors:

> *(i) Erosion, stability, and migration potential of native wetland soils, muds and deposits used to support the CCR unit;*
>
> *(ii) Erosion, stability, and migration potential of dredged and fill materials used to support the CCR unit;*
>
> *(iii) The volume and chemical nature of the CCR;*
>
> *(iv) Impacts on fish, wildlife, and other aquatic resources and their habitat from release of CCR;*
>
> *(v) The potential effects of catastrophic release of CCR to the wetland and the resulting impacts on the environment; and*
>
> *(vi) Any additional factors, as necessary, to demonstrate that ecological resources in the wetland are sufficiently protected.*

(4) To the extent required under section 404 of the Clean Water Act or applicable state wetlands laws, steps have been taken to attempt to achieve no net loss of wetlands (as defined by acreage and function) by first avoiding impacts to wetlands to the maximum extent reasonable as required by paragraphs (a)(1) through (3) of this section, then minimizing unavoidable impacts to the maximum extent reasonable, and finally offsetting remaining unavoidable wetland impacts through all appropriate and reasonable compensatory mitigation actions (e.g., restoration of existing degraded wetlands or creation of man-made wetlands); and

(5) Sufficient information is available to make a reasoned determination with respect to the demonstrations in paragraphs (a)(1) through (4) of this section."

An onsite jurisdictional assessment survey of existing aquatic features, located with the footprint of Cell 3 was performed by Integrated Environmental Solutions, LLC (IES). Based on this assessment, one pond, four ditches, and one erosion feature were identified and delineated; however, none of these features were identified as Waters of the United States (WOTUS), nor were wetlands identified within the area to be disturbed by development of Cell 3. Following the onsite jurisdictional assessment survey, IES prepared and submitted an

Approved Jurisdiction Determination (ADJ) request to U.S. Army Corps of Engineers (USACOE), Fort Worth Regulatory Branch. This ADJ and USACOE approval is included in **Attachment 1.** As a result of the jurisdictional assessment determination conducted by IES, **the requirements in 40 CFR §257.61(a) are met.**

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the demonstration meets the requirements of paragraph (a) of §257.61, is provided at the beginning of this compliance demonstration; therefore**, the requirements in 40 CFR §257.61(b) are met.**

"(c) The owner or operator of the CCR unit must complete the demonstrations required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstrations showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

This compliance demonstration has been developed prior to the date of initial receipt of CCR in Cell 3 and will be placed in the facility's operating record; therefore, **the requirements in 40 CFR §257.61(c)(2), (3), and (5) are met.**

"(d) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e)."

This compliance demonstration (specifically related to wetlands) will be placed in the facility's operating record and on the Owner's publically assessable internet site and a notification letter will be sent to the TCEQ; therefore, **the requirements in 40 CFR §257.61(d) are met.**

3.3 40 CFR §257.62 "FAULT AREAS"

"(a) New CCR landfills, existing and new CCR surface impoundments, and all laerail expansions of CCR units must not be located within 60 meters (200 feet) of the outermost damage zone of a fault that has had displacement in Holocene time unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that an alternative setback distance of less than 60 meters (200 feet) will prevent damage to the structural integrity of the CCR unit."

Available geologic maps indicate that the facility is located between two fault zones: the Balcones Fault Zone and the Mexia-Talco-Luling Fault Zone. The Balcones Fault Zone is located approximately 12 miles west of the facility, and the Mexia-Talco-Luling Fault Zone is located approximately 16 miles to the east. The closest fault lies within the Balcones Fault Zone, approximately one mile south of the facility (**see Figure 4 – Geologic Map**), and is probably structurally related to this family of faults (Horton et al., 2017). No scarps or other signs of recent fault movement have been observed on facility property.

Based on review of the available demonstration, the facility is not located within 60 meters (200 feet) of a fault that has had displacement in Holocene time; therefore, **the requirements in 40 CFR §257.62 are met.**

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the demonstration meets the requirements of paragraph (a) of §257.62 is provided at the beginning of this compliance demonstration; therefore, **the requirements in 40 CFR §257.62(b) are met.**

"(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by § 257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of § 257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

This compliance demonstration has been developed prior to the date of initial receipt of CCR in Cell 3 and will be placed in the facility's operating record; therefore, **the requirements in 40 CFR §257.62(c)(2), (3), and (5) are met.**

"(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e)."

This compliance demonstration (specifically related to fault areas) will be placed in the facility's operating record and on the Owner's publically assessable internet site, and a notification letter sent to the TCEQ; therefore, **the requirements in 40 CFR §257.62(d) are met.**

3.4 40 CFR §257.63 "SEISMIC IMPACT ZONES"

"(a) New CCR landfills, existing and new CCR surface impoundments, and all lateral expansions of CCR units must not be located in seismic impact zones unless the owner or operator demonstrates by the dates specified in paragraph (c) of this section that all structural components including liners, leachate collection and removal systems, and surface water control systems, are designed to resist the maximum horizontal acceleration in lithified earth material for the site."

40 CFR §257.53 defines a seismic impact zone is defined as an area having a 2 percent or greater probability that the maximum expected horizontal acceleration, expresses as a percentage of earth's gravitational pull (g) will exceed 0.10 g in 50 years. Therefore, if the maximum horizontal acceleration is less than or equal to 0.10 g, then the design of Cell 3 will not need to incorporate an evaluation of seismic effects.

Areas within the United States where seismic effects need to be evaluated, as determined by the United States Geological Survey (USGS), are shown on the figure in **Attachment 2 - Appendix B2.** As indicated on this figure, the facility (inclusive of Cell 3) is not located within a seismic impact zone as defined by 40 CFR §257.53. Therefore, an evaluation of the seismic effects on the landfill design is not required for this landfill and **the requirements in 40 CFR §257.63 are met.**

"(b) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the demonstration meets the requirements of paragraph (a) of §257.63 is provided at the beginning of this compliance demonstration; therefore**, the requirements in 40 CFR §257.63(b) are met.**

"(c) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (c)(1) or (2) of this section.

(1) For an existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by §257.105(e).

(4) An owner or operator of an existing CCR surface impoundment who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date specified in paragraph (c)(1) of this section is subject to the requirements of §257.101(b)(1).

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

This compliance demonstration has been developed prior to the date of initial receipt of CCR in Cell 3 and will be placed in the facility's operating record; therefore, **the requirements in 40 CFR §257.63(c)(2), (3), and (5) are met.**

"(d) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in §257.105(e), the notification requirements specified in §257.106(e), and the Internet requirements specified in §257.107(e)."

The compliance demonstration (specifically related to seismic impact zones) will be placed in the facility's operating record and on the Owner's publically assessable internet site, and a notification letter will be sent to the TCEQ; therefore, **the requirements in 40 CFR §257.63(d) are met.**

3.5 40 CFR §257.64 "UNSTABLE AREAS"

"(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."

As provided in **Attachment 2** and as described below, Cell 3 is not located in an unstable area and the design of the cell has been developed in accordance with accepted good engineered practices to ensure the integrity of the structural components of the cell will not be disrupted; therefore, **the requirements in 40 CFR §257.64(a) are met.**

"(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;"

As provided in **Appendices A and B of Attachment 2**, Cell 3 is not located in on-site or local soil conditions that may result in significant differential settling. The facility soils consist primarily of stiff to hard clays overlaying hard clayshale weathered from shale bedrock. Because the clays are stiff to hard, they are not susceptible to appreciable differential settlement that would affect the performance of the CCR landfill. As a result, **the requirements in 40 CFR §257.64(b)(1) are met.**

"(2) On-site or local geologic or geomorphologic features; and"

As discussed in **Appendices A, B, and E of Attachment 2,** Cell 3 is not located in on-site or local geologic or geomorphologic features that are unstable. Geologic cross sections, provided in **Appendix C of Attachment 2**, shows stiff to hard clays overlaying hard clayshale weathered from shale bedrock. These geologic features provide a stable foundation for the CCR landfill. This assessment is confirmed by the slope stability analysis provided in **Appendix D of Attachment 2.** As a result, **the requirements in 40 CFR §257.64(b)(2) are met.**

"(3) On-site or local human-made features or events (both surface and subsurface)."

As shown by the geologic cross section in **Appendix C of Attachment 2**, Cell 3 is not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development for the landfill, the historical facility use was agricultural with minimal facility disturbance.

As discussed in **Appendix E of Attachment 2**, groundwater or surface water is unlikely to cause instability. The facility is designed with adequate run-on and run-off control systems, and is constructed above the no less than five feet from the uppermost aquifer (Trinity Aquifer) as indicated in Section 3.1 of this demonstration.

As a result of the above mentioned analysis, **the requirements in 40 CFR §257.64(b)(3) are met.**

"(c) The owner or operator of the CCR unit must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority stating that the demonstration meets the requirements of paragraph (a) of this section."

A qualified professional engineer certification, stating that the demonstration meets the requirements of paragraph (a) of §257.64 is provided at the beginning of this compliance demonstration; therefore**, the requirements in 40 CFR §257.60(c) are met.**

"(d) The owner or operator of the CCR unit must complete the demonstration required by paragraph (a) of this section by the date specified in either paragraph (d)(1) or (2) of this section.

(1) For an existing CCR landfill or existing CCR surface impoundment, the owner or operator must complete the demonstration no later than October 17, 2018.

(2) For a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit, the owner or operator must complete the demonstration no later than the date of initial receipt of CCR in the CCR unit.

(3) The owner or operator has completed the demonstration required by paragraph (a) of this section when the demonstration is placed in the facility's operating record as required by §257.105(e).

(4) An owner or operator of an existing CCR surface impoundment or existing CCR landfill who fails to demonstrate compliance with the requirements of paragraph (a) of this section by the date

specified in paragraph (d)(1) of this section is subject to the requirements of § 257.101(b)(1) or (d)(1), respectively.

(5) An owner or operator of a new CCR landfill, new CCR surface impoundment, or any lateral expansion of a CCR unit who fails to make the demonstration showing compliance with the requirements of paragraph (a) of this section is prohibited from placing CCR in the CCR unit."

This compliance demonstration has been developed prior to the date of initial receipt of CCR in Cell 3 and will be placed in the facility's operating record; therefore, **the requirements in 40 CFR §257.64(d)(2), (3), and (5) are met.**

"(e) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(e), the notification requirements specified in § 257.106(e), and the Internet requirements specified in § 257.107(e)."

The compliance demonstration (specifically related to placement unstable areas) will be placed in the facility's operating record and on the Owner's publically assessable internet site, and a notification letter will be sent to the TCEQ; therefore, **the requirements in 40 CFR §257.64(e) are met.**

4 DESIGN CRITERIA

4.1 40 CFR §257.70 "DESIGN CRITERIA FOR NEW CCR LANDFILLS AND ANY LATERAL EXPANSION OF A CCR LANDFILL"

"(a)(1) New CCR landfills and any lateral expansion of a CCR landfill must be designed, constructed, operated, and maintained with either a composite liner that meets the requirements of paragraph (b) of this section or an alternative composite liner that meets the requirements in paragraph (c) of this section, and a leachate collection and removal system that meets the requirements of paragraph (d) of this section."

Cell 3 is designed with a composite liner (consisting of 2 feet of compacted clay liner, 60-mil geomembrane, 270-mil geocomposite, and 2 feet of protective cover) and a leachate collection and removal system as described below that meet the requirements of 40 CFR 257.70(b)(1) through (4) and 257.70(d); therefore, **the requirements in 40 CFR §257.70(a) are met.** Note that the composite liner for Cell 3 is not considered an alternative composite liner; therefore, **40 CFR §257.70(c) are not applicable.**

"(b) A composite liner must consist of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick. The GM or upper liner component must be installed in direct and uniform contact with the compacted soil or lower liner component. The composite liner must be:

(1) Constructed of materials that have appropriate chemical properties and sufficient strength and thickness to prevent failure due to pressure gradients (including static head and external hydrogeologic forces), physical contact with the CCR or leachate to which they are exposed, climatic conditions, the stress of installation, and the stress of daily operation"

Cell 3 is designed with a composite liner, as shown on **Figure 5**, consisting of the following layers from top to bottom:

- Two (2) feet of protective cover comprised of onsite soils;
- Double-sided 270-mil thick drainage geocomposite (8-oz/sy non-woven geotextile heat-bonded to both sides of a HDPE geonet) on the sideslopes and floor of the liner system;
- A 60-mil thick textured (both-sides) HDPE geomembrane; and
- Two (2) feet of compacted clay soil with a hydraulic conductivity of no more than $1 \mathrm{x} 10^{-7}$ cm/sec.

A review of chemical resistance demonstration for geocomposite and HDPE geomembrane provided by geomembrane manufacturers indicates that the geocomposite and HDPE geomembrane is chemically resistant to the CCR and CCR-generated leachate.

The proposed liner layers have sufficient strength and thickness to prevent failure due to pressure gradients, climatic conditions, installation stresses, and daily operation stresses expected in Cell 3. An initial minimum 3-foot thick lift of CCR will be placed across the liner in each subcell during initial CCR placement above the protective cover layer to protect the underlying liner components from construction and CCR placement traffic. During initial CCR placement, thicker protective soil cover at least 3 feet thick (i.e., an additional 1-foot layer over protective cover) can be used to protect the underlying geosynthetics from truck traffic.

In conclusion, Cell 3 is designed to be constructed with materials consistent with §257.70(b)(1); **therefore, the requirements in 40 CFR §257.70(b)(1) are met.**

"(2) Constructed of materials that provide appropriate shear resistance of the upper and lower component interface to prevent sliding of the upper component including on slopes;"

Liner slope stability calculations were performed for Cell 3 and are included in **Appendix D of Attachment 2.** The liner slope stability calculations confirmed that the upper and lower component interfaces for the Cell 3 liner materials provide appropriate shear resistance to prevent sliding. Interface friction testing results are included in **Appendix D3 of Attachment 2.** As a result of the above mentioned analysis, **the requirements in 40 CFR §257.70(b)(2) are met.**

"(3) Placed upon a foundation or base capable of providing support to the liner and resistance to pressure gradients above and below the liner to prevent failure of the liner due to settlement, compression, or uplift; and"

- **Foundation Differential Settlement, Compression and Uplift (Heave):** Cell 3 is not located in on-site or local soil conditions that may result in significant differential settling. The facility soils consist primarily of stiff to hard clays overlaying hard clayshale weathered from shale bedrock. Since the clays are stiff to hard, they are not susceptible to appreciable differential settlement, compression, or uplift (heave) that would affect the performance of the CCR landfill; therefore, will provide a foundation capable of providing support to the liner and prevent failure of the liner due to settlement, compression, and uplift. Additional information on unstable areas is provided within **Appendices A and B of Attachment 2.**
- **Foundation Uplift (Hydrostatic Forces):** In addition, as indicted in Section 3.1 of the demonstration, the base of Cell 3 will be located no less than five feet from the uppermost aquifer (Trinity Aquifer); therefore, long-term uplift or liner failure as a result of hyrostatic forces from groundwater associated with this aquifer will not occur. Furthermore, due to the presence of localized shallow groundwater, unrelated to the Trinity Aquifer, as evident from water level readings in the facilities local groundwater monitoring network, the base of Cell 3 was also conservatively designed with at least five feet of separation from highest recorded groundwater level readings at the time of construction. Therefore, short- and long-term uplift or liner failure as a result of hydrostatic forces from shallow localized groundwater will not occur.

As a result of the above mentioned analysis, **the requirements in 40 CFR §257.70(b)(3) are met.**

"(4) Installed to cover all surrounding earth likely to be in contact with the CCR or leachate."

The composite liner is designed to cover the entire footprint of Cell 3 as shown on **Figure 5.** No CCR or leachate in Cell 3 will be in contact with areas outside the composite liner; therefore, **the requirements in 40 CFR §257.70(b)(4) are met**

"(d) The leachate collection and removal system must be designed, constructed, operated, and maintained to collect and remove leachate from the landfill during the active life and post-closure care period. The leachate collection and removal system must be:

(1) Designed and operated to maintain less than a 30-centimeter depth of leachate over the composite liner or alternative composite liner;"

The leachate collection and removal system has been designed to drain leachate from Cell 3 through a 270-mil thick double-sided drainage geocomposite, as described above, installed over the HDPE geomembrane to a centrally located leachate collection trench. The leachate collection trench will be comprised of a perforated 6-inch HDPE standard dimension ratio (SDR) 9 pipe encased in aggregate and wrapped with a 12-oz/sy non-woven geotextile. This leachate collection trench will drain to an aggregate filled sump where leachate will be removed from the cell using an electric submersible pump. This submersible pump will be equipped with a level sensor that monitors the leachate levels within the sump and turns on at preset levels, thereby controlling the leachate head on the liner. Details of the leachate collection and removal system are provided on **Figure 6.**

The leachate collection sump and pump has been designed and sized to limit maximum head above the bottom liner system at the outside edge of the sumps to within the thickness of the geocomposite (i.e., less than 30 centimeters above the bottom liner). The leachate collection sump will be at least 3 feet deep with minimum dimensions of 45 by 45 feet at the landfill floor and 27 by 27 feet at the sump base. The leachate collection sumps have been designed to provide storage of approximately 9,325 gallons of leachate (note, this capacity excludes approximately 6 inches of lost storage required for the pump head volume). The sump will provide approximately 1.25 day of leachate storage for the maximum calculated leachate generation rate, as provided in the sump design calculations provided in Attachment 4.5. The sump will be backfilled with drainage stone meeting the gradation having 100 percent passing 2-inch sieve and 0 to 5 percent the 1/2-inch sieve.

In the unlikely event of a pump failure, the leachate storage capacity of the sump will provide adequate storage capacity to prevent accumulation of leachate on the liner outside the sump for a period of approximately 1.25 days.

The Hydrologic Evaluation of Landfill Performance (HELP) Model was used to evaluate leachate generation and the leachate head on the Cell 3 liner. Based on the model results, the depth of leachate over the composite liner will be maintained below the maximum allowable 30-centimeter (1-foot) head. This evaluation is provided in **Attachment 3.**

Based on the design of the leachate collection and removal system and results of the evaluation of leachate generation and depth on over the liner, Cell 3 is designed and will be operated to maintain less than a 30-centimeter depth of leachate over the liner; therefore, **the requirements in 40 CFR §257.70(d)(1) are met.**

"(2) Constructed of materials that are chemically resistant to the CCR and any non-CCR waste managed in the CCR unit and the leachate expected to be generated, and of sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment used at the CCR unit; and"

The LCRS design consists of leachate collection piping, geocomposite leachate drainage layer, drainage aggregate within the leachate collection trench and sump, non-woven geotextile filter fabric around drainage aggregate, and a leachate collection sump and pump, as shown on **Figures 5 and 6.** All materials used in the construction of the LCRS are chemically resistant to the CCR and CCR-generated leachate. The leachate collection piping will be comprised of 6-inch HDPE SDR 9 perforated pipe within the leachate collection trench and solid pipe for leachate clean-out risers and 18-inch HDPE SDR 17 perforated pipe within the leachate collection sump for housing the pump and solid pipe for installing or removing the pump for maintenance. The HDPE collection and removal pipe was evaluated for pipe strength using construction/operation loads and post-closure loads to evaluate the required pipe sizing to prevent crushing, buckling, or deflection of the pipe during operation and post-closure care. Based on the pipe strength calculations in **Attachments 4.1A and B**, the selected HDPE pipe will have sufficient strength to prevent collapse under the pressures exerted by the CCR, cover materials, and equipment used in the operation of Cell 3, based on the equipment currently operational in Cell 2 at the facility. As a result of the above mentioned analysis and the materials incorporated into Cell 3, **the requirements in 40 CFR §257.70(d)(2) are met.**

The geocomposite consists of a high density polyethylene (HDPE) geonet with an 8 oz/sy non-woven geotextile heat bonded to both sides of the geonet. The geocomposite installed at the landfill will have hydraulic properties that will provide adequate drainage of leachate to the leachate collection piping and sump, thereby maintaining less than 30-cm leachate head above the bottom liner system. The manufactured thickness of the geocomposite is 270-mil (approximately 0.27 inches), which was reduced for compression depending on the amount of CCR and soil cover for each condition modeled in HELP. The reduction in thickness of the geocomposite drainage layer, as well as reduction factors associated with creep and environmental conditions, were considered to account for changes in long-term performance.

To evaluate the performance of the geocomposite layer, the hydraulic conductivity value used in the HELP model was adjusted such that the maximum depth of leachate in the geocomposite (for peak daily flow) was less than or approximately equal to the thickness of the geocomposite (i.e., less than 0.27 inches). In this manner leachate flow above the geomembrane was confined in the geocomposite layer only. The minimum allowable transmissivity was calculated based on the hydraulic conductivity and reduced geocomposite thickness and compared to published transmissivity values for 270-mil geocomposite.

This evaluation was performed to confirm that typical 270-mil geocomposites have drainage characteristics sufficient for maintaining leachate flow in the geocomposite layer. The geocomposite performance demonstration is included in **Attachent 4.3**, and is based on the worst-case conditions for leachate generation (active 10-foot of CCR) and soil/CCR loading (intermediate 120-foot and 178-foot of waste). As presented in the demonstration, a 270-mil geocomposite has sufficient drainage capacity to meet drainage criteria during the greatest leachate generation and worst-case soil/CCR loading conditions during landfill development. Calculations demonstrating the minimum required material properties for the geocomposite are presented in **Attachment 4.3.**

As a result of the above mentioned analysis, **the requirements in 40 CFR §257.70(d)(2) are met.**

"(3) Designed and operated to minimize clogging during the active life and post-closure care period."

The leachate collection and removal system is designed with a non-woven geotextile filter fabric both on the geocomposite geonet and around installed drainage aggregate as shown on **Figures 5 and 6.** The non-woven geotextile filter fabric minimizes the movement of fine particles into the leachate collection pipes to prevent clogging as shown by the filter calculations in **Attachment 4.2.** The leachate collection and removal system is designed with cleanout riser pipes as shown on **Figure 6** to allow pipe cleaning (if required) and mitigate any potential clogging. As a result of the above mentioned analysis and the materials incorporated into Cell 3, **the requirements in 40 CFR §257.70(d)(2) are met.**

"(e) Prior to construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system meets the requirements of this section."

> A qualified professional engineer certification, stating that the demonstration meets the requirements of §257.70 is provided at the beginning of this compliance demonstration; therefore**, the requirements in 40 CFR §257.70(e) are met.**

"(f) Upon completion of construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that the design of the composite liner (or, if applicable, alternative composite liner) and the leachate collection and removal system have been constructed in accordance with the requirements of this section."

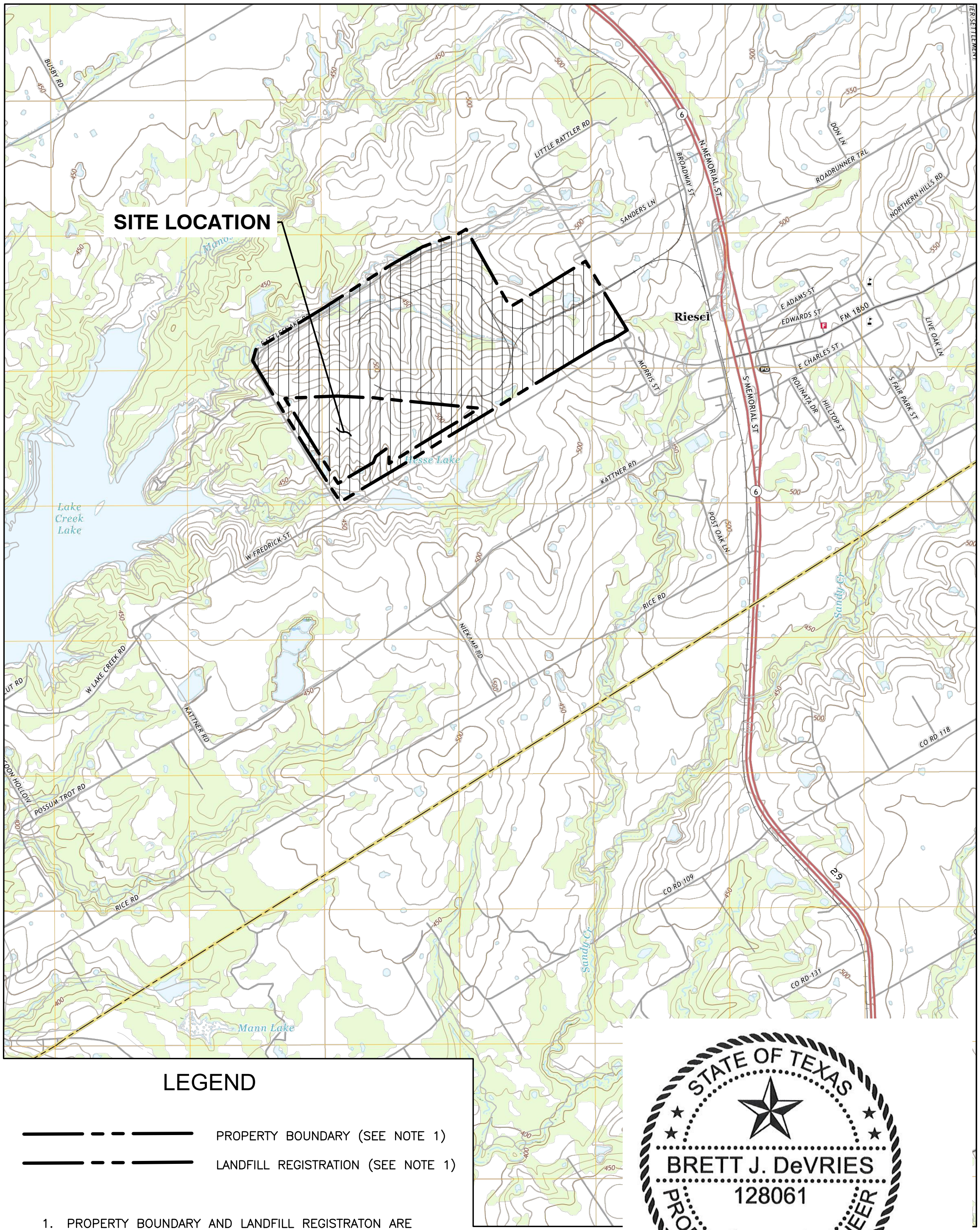
> A liner evaluation report (LER) will be developed by a qualified professional engineer upon completion of Cell 3 construction to certify that the composite liner and the leachate collection and removal system have been constructed in accordance with the requirements of this §257.70; therefore, **the requirements in 40 CFR §257.70 will be met.**

"(g) The owner or operator of the CCR unit must comply with the recordkeeping requirements specified in § 257.105(f), the notification requirements specified in § 257.106(f), and the Internet requirements specified in § 257.107(f)."

> This compliance demonstration (specifically related to design criteria) and the LER will be placed in the facility's operating record and on the Owner's publically assessable internet site, and a notification letter will be sent to the TCEQ; therefore, **the requirements in 40 CFR §257.70(g) will be met.**

Figures

Figure 1 – Site Location Map
Figure 2 – Cell 3 Location Map
Figure 3 – Trinity Aquifer Distribution Map
Figure 4 – Geologic Map
Figure 5 – Liner Details
Figure 6 – Leachate Collection System Details



LEGEND

▬ ‒ ‒ ▬	PROPERTY BOUNDARY (SEE NOTE 1)
▬ ‒ ‒ ▬	LANDFILL REGISTRATION (SEE NOTE 1)

1. PROPERTY BOUNDARY AND LANDFILL REGISTRATON ARE FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS.

RIESEL QUADRANGLE
TEAXS–MCLEENNAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2019

N

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SCALE IN FEET

QUADRANGLE LOCATION

BRETT J. DeVRIES
128061

6/7/21

FOR INFORMATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
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△			
△			
△			
△			

DRAWING TITLE
SITE LOCATION MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
SOLID WASTE DISPOSAL FACILITY
CELL3, COMPLIANCE DEMONSTRATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16220089.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE:
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DATE:
02/2021

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FIGURE NO.
1

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LEGEND

450	EXISTING CONTOURS (SEE NOTE 1, SEE NOTE 4)
	PROPERTY BOUNDARY (SEE NOTE 2)
	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 2)
	EXISTING LANDFILL LIMITS OF WASTE (SEE NOTE 2)
	EXISTING CELL BOUNDARY
	PROPOSED CELL BOUNDARY
N 10,516,500 E 3,347,000	STATE PLANE COORDINATES
MW-1	EXISTING MONITORING WELL

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMENBER, 2020. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. PROPERTY BOUNDARY, LANDFILL REGISTRATION BOUNDARY, EXISTING LANDFILL LIMITS OF WASTE, AND EXISTING CELL BOUNDARY ARE FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS.

BRETT J. DeVRIES
128061
6/7/21

FOR INFORMATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CELL 3 LOCATION MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
SOLID WASTE DISPOSAL FACILITY
CELL 3, COMPLIANCE DEMONSTRATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

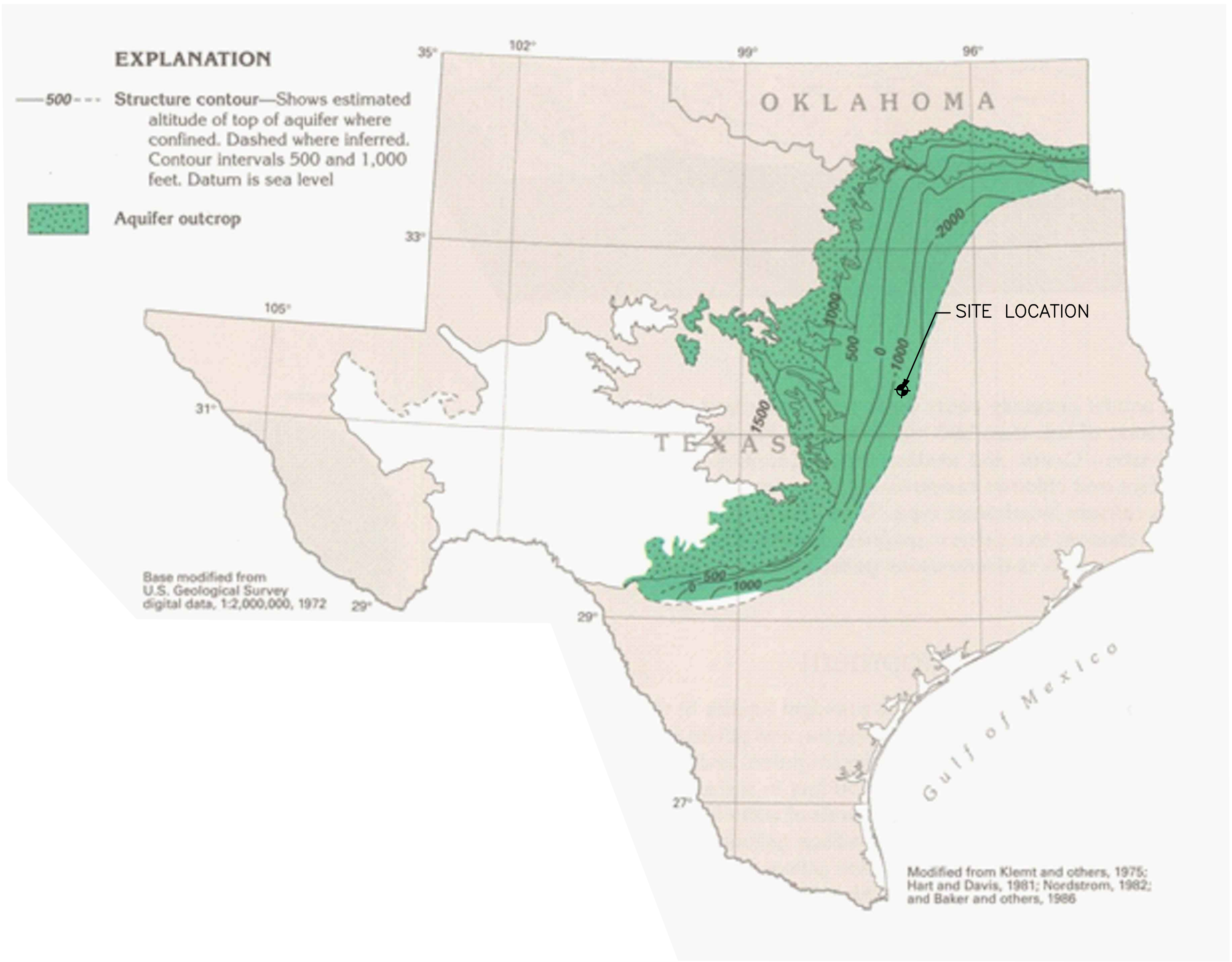
PROJ. NO. 16220089.00	DWN. BY: ORA	Q/A RVW BY: BJD
DSN. BY: BJD	CHK. BY: BJD	APP. BY: BJD

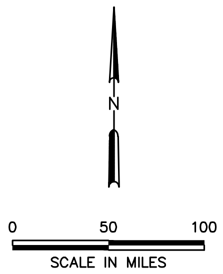
CADD FILE: SITE LOCATION MAP

DATE: 02/2021

SCALE: AS SHOWN

FIGURE NO. 2





SOURCE:
GROUNDWATER ATLAS OF THE UNITED STATES,
USGS, RESTON, VA, 1996.

BRETT J. DeVRIES
128061

6/7/21

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DRAWING TITLE
TRINITY AQUIFER DISTRIBUTION MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION SOLID WASTE DISPOSAL FACILITY CELL 3, COMPLIANCE DEMONSTRATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
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PROJ. NO. 16220089.00
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TRINITY AQUIFER DISTRIBUTION MAP

DATE:
02/2021

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FIGURE NO.
3

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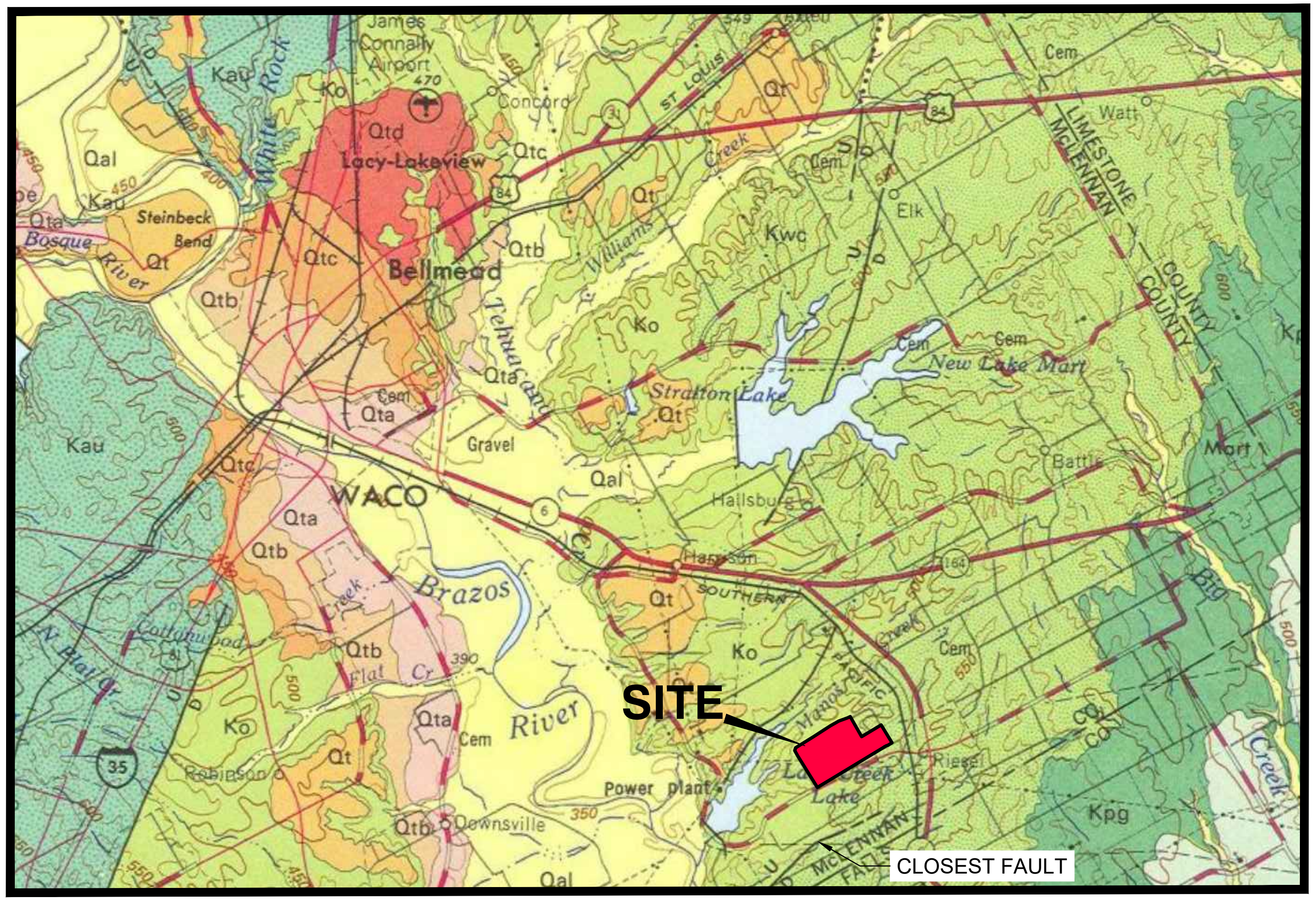

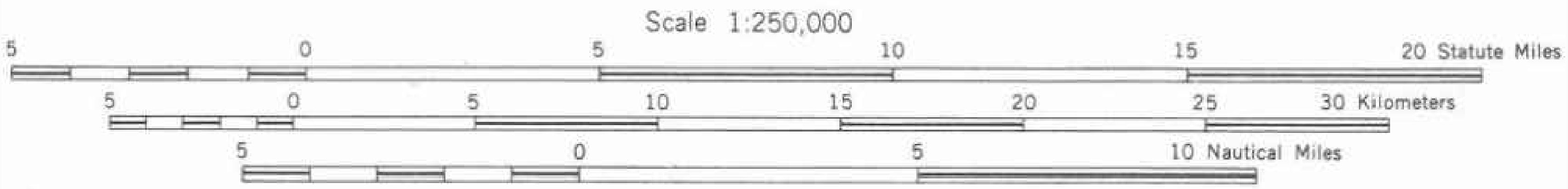

CONTOUR INTERVAL 50 FEET

TRANSVERSE MERCATOR PROJECTION

1960 MAGNETIC DECLINATION FOR THIS SHEET VARIES FROM 9°30′ EASTERLY FOR THE CENTER OF THE WEST EDGE TO 8°30′ EASTERLY FOR THE CENTER OF THE EAST EDGE. MEAN ANNUAL CHANGE IS 0°02′ WESTERLY.

GEOLOGIC ATLAS OF TEXAS, WACO SHEET

LLOYD WILLIAM STEPHENSON MEMORIAL EDITION

REPRINTED 1979

BRETT J. DeVRIES
128061

Brett DeVries 6/7/21

EXPLANATION

Qal

Alluvium

Qta	Qt	Qt 1
Qtb		Qt 2
Qtc		Qt 3
Qtd		

Fluviatile terrace deposits

Kpg Kwc
Ko

Pecan Gap Chalk, Wolfe City Formation, and Ozan Formation ("lower Taylor marl")

Kknm Kke
Kn
Knm

Kemp Clay, Nacatoch Sand, Neylandville Formation, and Marlbrook Marl ("upper Taylor marl")

.... U ——— D — — —

Fault

U, *upthrown;* D, *downthrown side; dotted where concealed; dashed where inferred*

SOURCE:
BUREAU OF ECONOMIC GEOLOGY, UNIVERSITY OF TEXAS AT AUSTIN.

NOTES:

1. PROPERTY BOUNDARY IS FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS.

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DRAWING TITLE
GEOLOGIC MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
SOLID WASTE DISPOSAL FACILITY
CELL 3, COMPLIANCE DEMONSTRATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

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EXH – GEOLOGIC MAP

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FIGURE NO.
4

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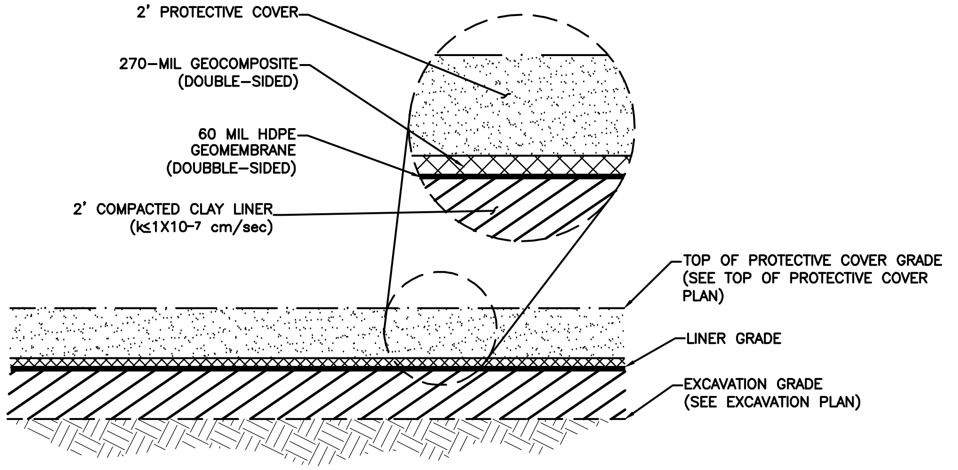
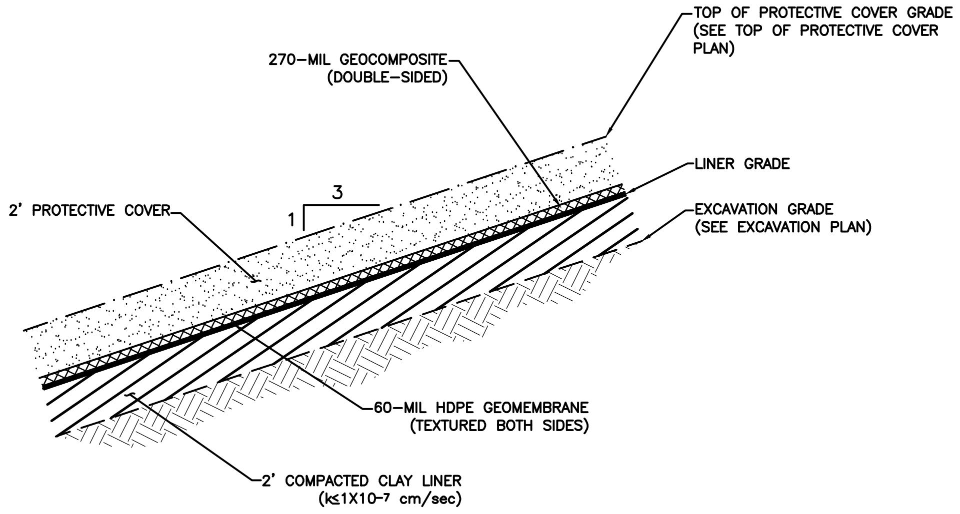
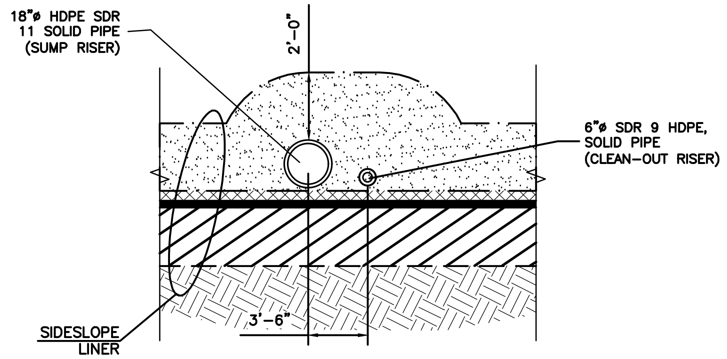


BOTTOM LINER
NTS



SIDESLOPE LINER
NTS



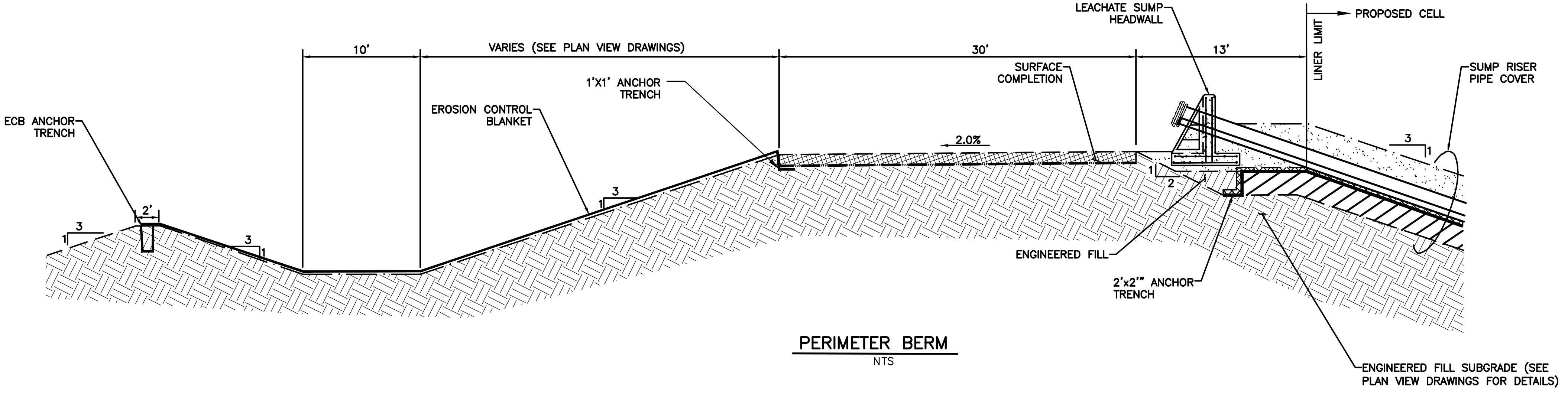
SUMP RISER PIPE COVER
NTS

NOTES:

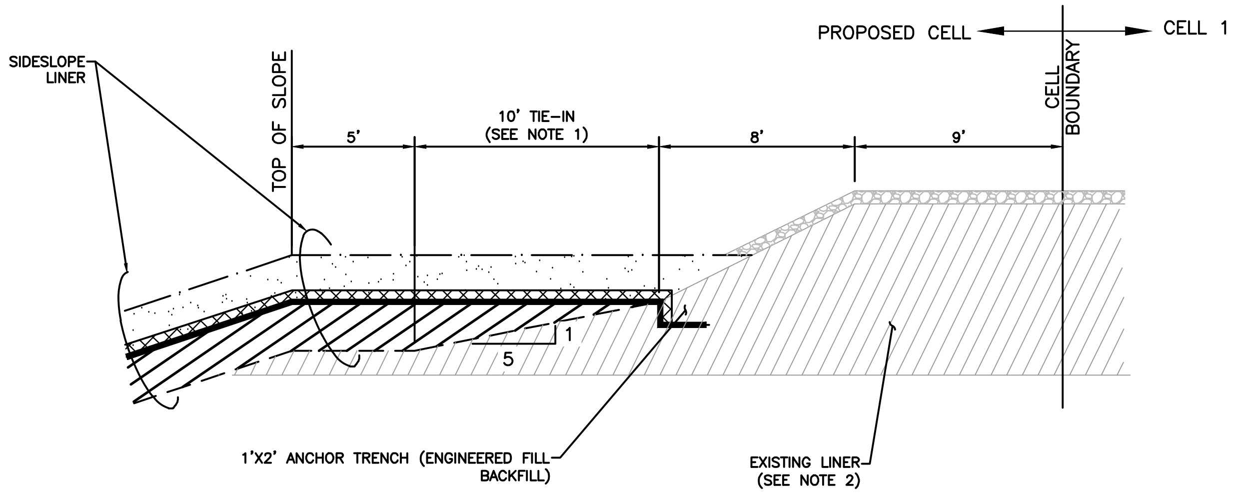
1. THE EDGE OF THE PREVIOUSLY INSTALLED LINER WILL BE UNCOVERED, EXPOSED, AND CUT BACK ON A SLOPE SO THAT THE ENTIRE EXISTING LINER EDGE IS TIED TO NEW CONSTRUCTION. THE LENGTH OF THE TIE–IN AREA SHOULD BE AT LEAST 10 FEET (I.E., 5 FEET PER FOOT THICKNESS OF LINER). THE SURFACE OF THE EXISTING LINER WILL BE SCARIFIED (ROUGHENED) PRIOR TO SUBSEQUENT SOIL PLACEMENT.
2. EXISTING COMPACTED CLAY CONSISTENT OF APPROX. 3 FEET OF COMPACTED CLAY OVERLAY BY APPROX. 6 INCHES COMPACTED SOIL COVER.

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED PROFESSIONAL ENGINEER

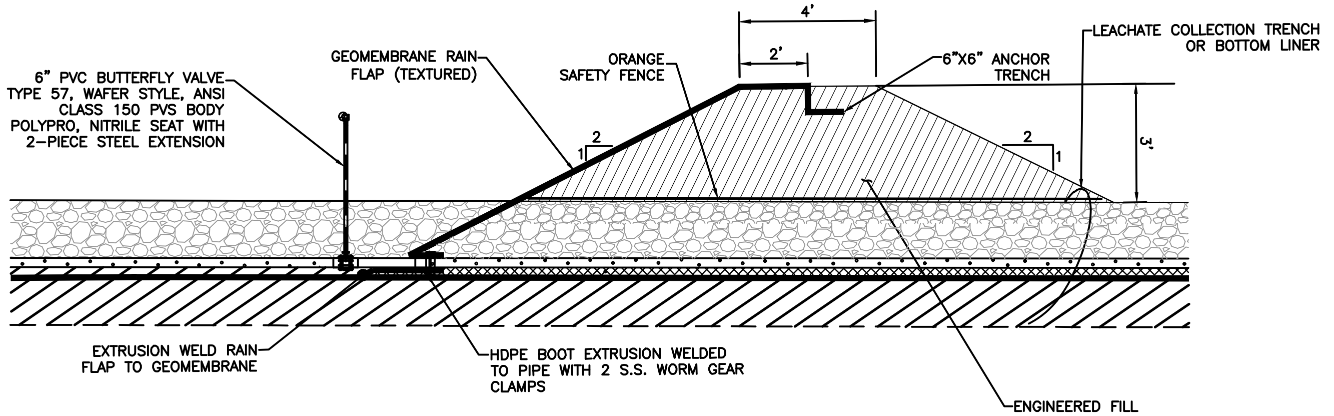
6/7/21



PERIMETER BERM
NTS



LINER TIE–IN
NTS



INTERCELL BERM
NTS

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DRAWING TITLE
LINER DETAILS

PROJECT TITLE
SANDY CREEK ENERGY STATION
SOLID WASTE DISPOSAL FACILITY
CELL 3, COMPLIANCE DEMONSTRATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
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PROJ. NO. 16220089.00
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DWN. BY: ORA
CHK. BY: BJD
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SCALE:
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FIGURE NO.
5

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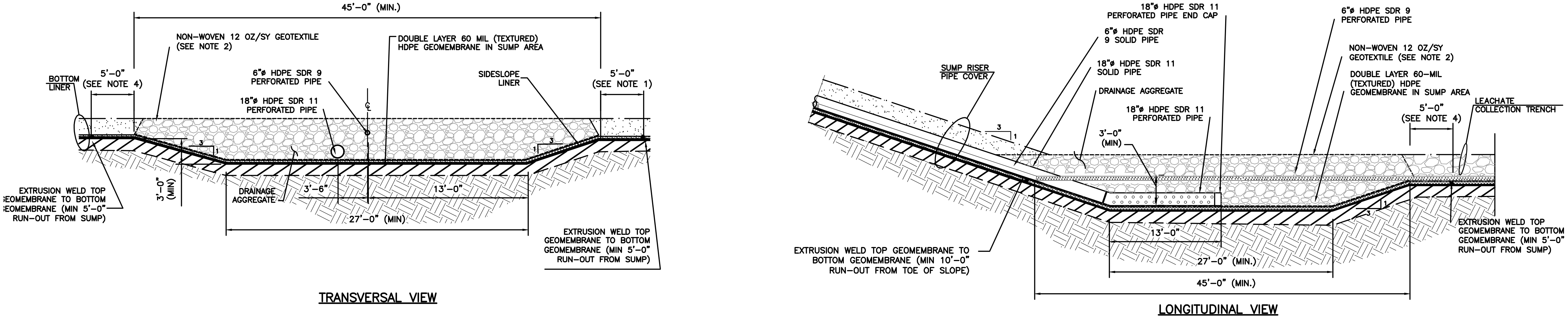
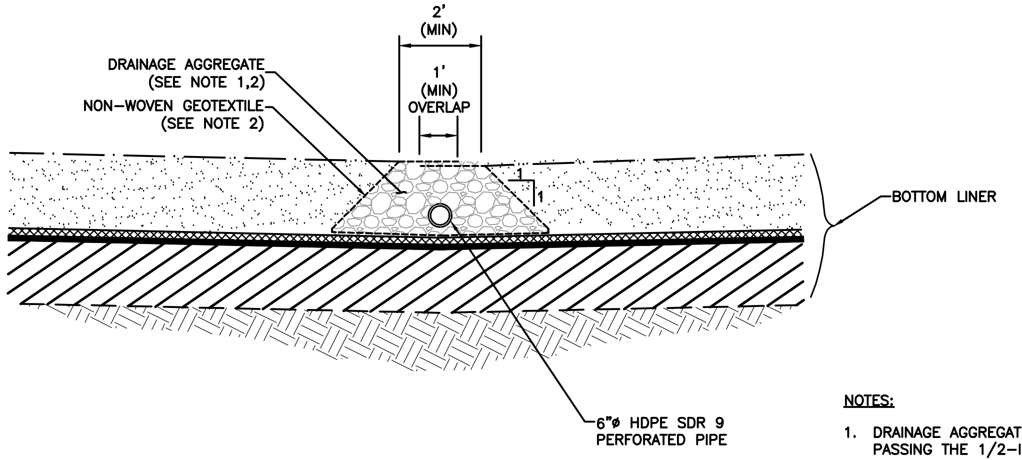


TRANSVERSAL VIEW

LONGITUDINAL VIEW

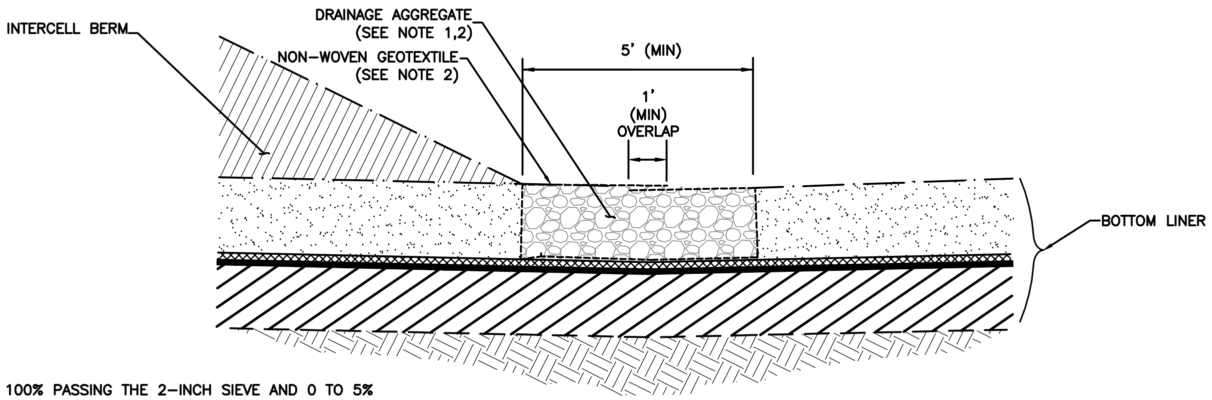
LEACHATE COLLECTION SUMP

NTS



LEACHATE COLLECTION TRENCH

NTS

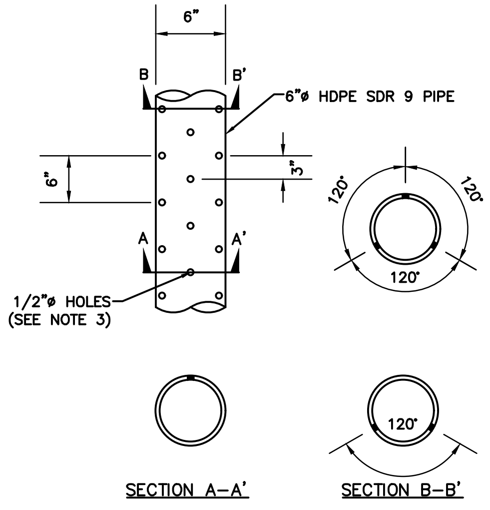


CHIMNEY DRAIN

NTS

NOTES:

1. DRAINAGE AGGREGATE SHALL HAVE A GRADATION OF 100% PASSING THE 2-INCH SIEVE AND 0 TO 5% PASSING THE 1/2-INCH SIEVE. THE PERCENT OF CALCIUM CARBONATE BY WEIGHT FOR THE DRAINAGE AGGREGATE SHALL NOT EXCEED 15 PERCENT, AS DETERMINED BY JLT-S-105-89 OR ASTM D3042 MODIFIED.
2. DRAINAGE AGGREGATE SHALL BE COMPLETELY WRAPPED WITH 12 oz/sy NON-WOVEN GEOTEXTILE.
3. HDPE PIPE PERFORATIONS SHALL BE 1/2"ø. THREE ROWS OF PERFORATIONS WILL BE INSTALLED: ONE ROW OF PERFORATIONS WILL BE LOCATED AT THE TOP OF THE PIPE (0 DEGREE LOCATION); ONE AT 120 DEGREES; AND ONE AT THE 240 DEGREE LOCATION. PERFORATIONS SHALL BE PLACED EVERY 6" IN A ROW WITH THE TOP ROW STAGGERED 3" FROM THE PERFORATIONS IN THE ADJACENT ROWS.
4. DOUBLE LAYER TEXTURED GEOMEMBRANE WITHIN THE SUMP SHALL TRANSITION TO A SINGLE LAYER OF TEXTURED GEOMEMBRANE 5 FEET FROMT HE CREST OF SUMP SLOPE.

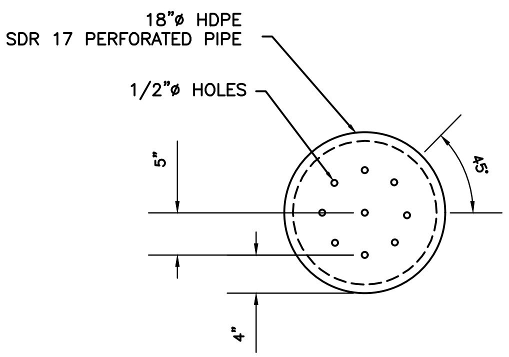


SECTION A–A'

SECTION B–B'

6" ø HDPE SDR 9 PERFORATED PIPE

NTS



LEACHATE SUMP PERFORATED PIPE END CAP

NTS

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128061

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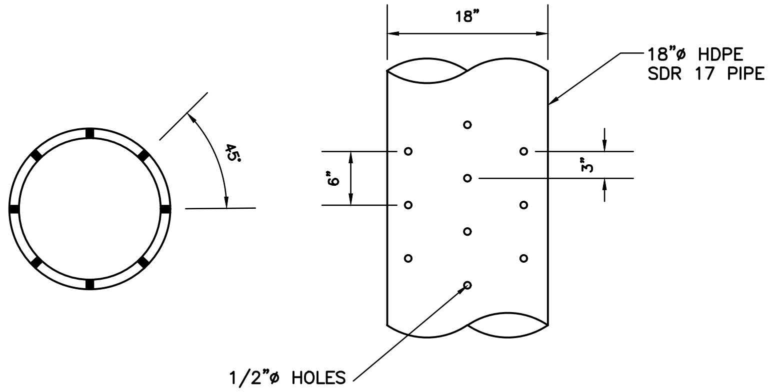

18"ø HDPE SDR 17 PERFORATION

NTS

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LEACHATE COLLECTION
SYSTEM DETAILS

PROJECT TITLE
SANDY CREEK ENERGY STATION
SOLID WASTE DISPOSAL FACILITY
CELL 3, COMPLIANCE DEMONSTRATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

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PROJ. NO. 16220089.00	DWN. BY: ORA	Q/A RVW BY: BJD
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FIGURE NO.
6

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ATTACHMENT 1

JURISDICTIONAL ASSESSMENT

integrated environmental solutions

04 November 2020

Ms. Jennifer Walker
U.S. Army Corps of Engineers
819 Taylor Street, Rm. 3A37
Fort Worth, TX 76102-2120

Re: **Approved Jurisdictional Determination Request**
Sandy Creek Engineering Station – Proposed Landfill Cell 3 - Waters of the United States Delineation
Approximately 28 acres located at the northeast corner of W. Frederick Street and Rattlesnake Road, west of Riesel, McLennan County, Texas

Dear Ms. Walker,

Integrated Environmental Solutions, LLC. (IES) performed a site survey to identify any aquatic features that meet a definition of a water of the United States on approximately 28 acres located northeast corner of W. Frederick Street and Rattlesnake Road, west of Riesel, McLennan County, Texas (**Attachment A, Figure 1**). This report will ultimately assess and delineate potentially jurisdictional aquatic features to ensure compliance with Sections 401 and 404 of the Clean Water Act (CWA).

The proposed project is to construct Cell 3 of the landfill within the project site. **As this project is in support of a proposed development, IES is requesting that the USACE review our delineation and provide an Approved Jurisdictional Determination.**

INTRODUCTION

Waters of the United States are protected under guidelines outlined in Sections 401 and 404 of the CWA, in Executive Order (EO) 11990 (Protection of Wetlands), and by the review process of the Texas Commission on Environmental Quality (TCEQ). Agencies that regulate impacts to the nation's water resources within Texas include the U.S. Army Corps of Engineers (USACE), the U.S. Environmental Protection Agency (USEPA), the U.S. Fish and Wildlife Service (USFWS), and the TCEQ. The USACE has the primary regulatory authority for enforcing Section 404 requirements for waters of the United States.

Navigable Waters Protection Rule (Effective 22 June 2020)

On 22 June 2020, the Navigable Waters Protection Rule became effective. The final regulations were published on 21 April 2020 with a 60-day waiting period before becoming a final rule. The streamlined regulations have redefined waters of the United States as the following at 33 Code of Federal Regulations (CFR) 328.3 (a) as:

1. *The territorial seas, and waters which are currently used or were used in the past, or may be susceptible to use in interstate or foreign commerce, including waters which are subject to the ebb and flow of the tide;*
2. *Tributaries;*
3. *Lakes and ponds, and impoundments of jurisdictional waters; and*
4. *Adjacent wetlands.*

The following features are excluded from jurisdiction at 33 CFR 328.3 (b) as:

1. *Lake/pond/impoundment or wetland that does not contribute surface water flow directly or indirectly to an (a)(1) water and is not inundated by flooding from an (a)(1)-(a)(3) water in a typical year, surface water channel that does not contribute surface water flow directly or indirectly to an (a)(1) water in a typical year, or Water or water feature that is not identified in (a)(1)-(a)(4) and does not meet the other (b)(1) sub-categories;*
2. *Groundwater, including groundwater drained through subsurface drainage systems;*
3. *Ephemeral feature, including an ephemeral stream, swale, gully, rill, or pool;*
4. *Diffuse stormwater run-off over upland or directional sheet flow over upland;*
5. *Ditch that is not an (a)(1) or (a)(2) water;*
6. *Prior converted cropland;*
7. *Artificially irrigated area, including fields flooded for agricultural production, that would revert to upland should application of irrigation water to that area cease;*
8. *Artificial lake/pond constructed or excavated in upland or a non-jurisdictional water, so long as the artificial lake or pond is not an impoundment of a jurisdictional water;*
9. *Water-filled depression constructed/excavated in upland/non-jurisdictional water incidental to mining/construction or pit excavated in upland/non-jurisdictional water to obtain fill/sand/gravel;*
10. *Stormwater control feature constructed or excavated in upland or in a non-jurisdictional water to convey, treat, infiltrate, or store stormwater runoff;*
11. *Groundwater recharge, water reuse, or a wastewater recycling structure constructed or excavated in upland or in a non-jurisdictional water; and*
12. *Waste treatment system.*

Further definitions located at 33 CFR 328.3 (c) include:

(1) *Adjacent wetlands*. The term adjacent wetland means wetlands that:

   i. Abut, meaning to touch at least one point or side of, a water identified in paragraph (a)(1), (2), or (3) of this section;
   ii. Are inundated by flooding from a water identified in paragraph (a)(1), (2), or (3) of this section in a typical year;
   iii. Are physically separated from a water identified in paragraph (a)(1), (2), or (3) of this section only by an artificial dike, barrier, or similar artificial structure so long as that structure allows for a direct hydrologic surface connection between the wetlands and the water identified in paragraph (a)(1), (2), or (3) of the section in atypical year, such as through a culvert, flood or tide gate, pump, or similar artificial feature. An adjacent wetland is jurisdictional in its entirety when a road or similar artificial structure divides the wetland, as long as the structure allows for direct hydrologic connection through or over that structure in a typical year.

(6) *Lakes and ponds, and impoundments of jurisdictional waters*. The term lakes and ponds, and impoundments of jurisdictional waters means standing bodies of open water that contribute surface water flow to a water identified in paragraph (a)(1) of this section in a typical year either directly or through one or more waters identified in paragraph (a)(2), (3), or (4) of this section. A lake, pond, or impoundment of a jurisdictional water does not lose its jurisdictional status if it contributes surface water flow to a downstream jurisdictional water in a typical year through a channelized nonjurisdictional surface water feature, through a culvert, dike, spillway, or similar artificial feature, or through a debris pile, boulder field, or similar natural feature. A lake or pond, or impoundment of a jurisdictional water is also jurisdictional if it is inundated by flooding from a water identified in paragraph (a)(1), (2), or (3) of this section in a typical year.

(12) *Tributary*. The term tributary means a river, stream, or similar naturally occurring surface water channel that contributes surface water flow to a water identified in paragraph (a)(1) of this section in a typical year either directly or through one or more waters identified in paragraph (a)(2), (3), or (4) of this section. A tributary must be perennial or intermittent in a typical year. The alteration or relocation of a tributary does not modify its jurisdictional status as long as it continues to satisfy the flow conditions

of this definition. A tributary does not lose its jurisdictional status if it contributes surface water flow to a downstream jurisdictional water in a typical year through a channelized nonjurisdictional surface water feature, through a subterranean river, through a culvert, dam, tunnel, or similar artificial feature, or through a debris pile, boulder field, or similar natural feature. The term tributary includes a ditch that either relocates a tributary, is constructed in a tributary, or is constructed in an adjacent wetland as long as the ditch satisfies the flow conditions of this definition.

METHODOLOGY

Prior to conducting fieldwork, the U.S. Geological Survey (USGS) topographic map (**Attachment A, Figures 2A** and **2B**), the *Soil Survey of McLennan County, Texas*, and the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) digital soil databases for McLennan County (**Attachment A, Figure 3**), the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) (**Attachment A, Figure 4**), and recent and historic aerial photographs of the proposed survey area were studied to identify possible aquatic features that could meet the definition of waters of the United States and areas prone to wetland development. Mr. Rudi Reinecke of IES conducted the delineation in the field in accordance with the USACE procedures on 20 October 2020.

Wetland determinations and delineations were performed on location using the methodology outlined in the 1987 Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineer Wetland Delineation Manual: Great Plains Region (Version 2.0). The presence of a wetland is determined by the positive indication of three criteria (i.e., hydrophytic vegetation, hydrology, and hydric soils). Potential jurisdictional boundaries for other water features (i.e., non-wetland) were delineated in the field at the ordinary high-water mark (OHWM). The 33 CFR 328.3 (c)(7) defines OHWM as the line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas.

Water feature boundaries were recorded on a Trimble GeoExplorer XT Global Positioning System (GPS) unit capable of sub-meter accuracy. Photographs were also taken at representative points within the survey area (**Attachment B**). Routine wetland determination data forms are provided in **Attachment C**.

RESULTS

Background Review

Topographic Setting

The USGS topographic map (Riesel 7.5' Quadrangle 1957, revised 1958) illustrates the site to be on a hill that slopes generally to the southwest. The topography ranges from 440 to 490 feet above mean sea level (amsl). There are no aquatic features mapped on the topographic map (*see* **Attachment A, Figure 2A**). The 2019 version of the Riesel 7.5' Quadrangle map illustrates a pond located on the southwest corner of the project site (*see* **Attachment A, Figure 2B**).

Soils

The *Soil Survey of McLennan County, Texas* identified three soil map units within the survey area: Heiden clay, 1 to 3 percent slopes; Heiden clay, 5 to 8 percent slopes; and Riesel gravelly fine sandy loam, 1 to 3 percent slopes. None were listed as a hydric soil on the Hydric Soils of Texas list prepared by the National Technical Committee for Hydric Soils (accessed 02 November 2020, McLennan County, Texas) (*see* **Attachment A, Figure 3**). Hydric soils are described as those soils that are sufficiently wet in the upper part to develop anaerobic conditions during the growing season.

FEMA FIRM

The FEMA FIRM (McLennan County; Map Panel 48309C0600D; effective 20 December 2019) shows the entire project site to be within Zone X (Areas determined to be outside the 0.2 percent annual chance floodplain) (*see* **Attachment A, Figure 4**). The FEMA FIRM does not illustrate any water features within the project site.

Weather History

The weather history for Wunderground.com Crunk Family Seed weather station (KTXWACO74) recorded no precipitation immediately prior to and during the field evaluation, with a total of 1.42 inches during the 30-day period prior to the site visit. The Antecedent Precipitation Tool (APT) indicated that the conditions on-site at the time of the evaluation were considered hydrologically "normal conditions" based on the 30-year climactic average (31.470374, -96.956868) (**Attachment D**).

Field Investigation

The property was undeveloped and was historically used for agriculture practices. Recently, Sandy Creek Energy Station developed the property for a power generating station with attendant features. The site has been secondarily affected by the construction of attendant features (i.e., the landfill to the east; a staging area to the west; and settling/retention ponds to the south). There were two general plant communities identified – grassland and broadleaf woods. The grassland was characterized as a rangeland comprised of forbs and grasses such as Bermudagrass (*Cynodon dactylon*), King Ranch bluestem (*Bothriochloa ischaemum*), meadow dropseed (*Sporobolus asper*), Missouri goldenrod (*Solidago missouriensis*), silver bluestem (*Bothriochloa laguroides*), giant ragweed (Ambrosia trifida), sumpweed (*Iva annua*), snow-the-prairie (*Euphorbia bicolor*), heath aster (*Symphyotrichum ericoides*), annual sunflower (*Helianthus annuus*), Johnsongrass (*Sorghum halepense*), sideoats grama (*Bouteloua curtipendula*), oldfield threeawn (*Aristita oligantha*), lemon beebalm (*Monarda citriodora*), annual broomweed (*Amphiachyris dracunculoides*), white tridens (*Tridens albescens*), and balloon vine (*Cardiospermum halicacabum*). There were scattered honey mesquite (*Prosopis glandulosa*) and willow baccharis (*Baccharis salicina*) shrubs colonizing the grassland. The broadleaf woods community was located in the west-central portion of the project site that had numerous structures that were in various stages of deterioration. This community was likely a result of the old farmstead. The community was dominated by sugarberry (*Celtis laevigata*), honey mesquite, and honey locust (*Gleditsia triacanthos*) trees and shrubs.

Water from the survey area flows west into an unnamed tributary that empties into Lake Creek Lake (an impoundment of Manos Creek). Manos Creek provides flow into Brazos River, which is considered a Navigable water of the United States. **Table 1** and the following paragraphs detail the aquatic features identified within the survey area at the time of evaluation (*see* **Attachment A, Figure 5**).

Table 1. Aquatic Features Identified Within the Survey Area

Water Identification	Hydrology Characteristics	Area (Acre)	Length (Linear Feet)
Pond 1	Semi-Permanently Inundated	0.08	--
Erosion Feature 1	Ephemeral	0.01	143
Ditch 1	Ephemeral	0.38	1,636
Ditch 2	Ephemeral	0.16	207
Ditch 3	Ephemeral	0.41	338
Ditch 4	Ephemeral	0.04	463

Pond 1 was a small, artificial pond excavated into the hillside with a berm constructed across the hillside contours in the middle portion of the site. The pond was shallowly inundated at the time of the survey with the OHWM and limits of wetland fringe higher in elevation than the observed water level. The pond was delineated in the field based on the interface of hydrophytic and upland vegetation. The hydrophytic vegetation growing around the pond included spikerush (*Eleocharis palustris*) and duck potato (*Sagitaria latifolia*). Historic aerial photography viewed on historicaerials.com indicates that the pond was constructed prior to 1981 with no visual evidence of any connection to other aquatic features. As indicated from the topographic maps, the pond was excavated into a hillside sloping toward the south and southwest to Lake Creek Lake (off-site). The pond intercepts sheetflow from higher elevations and direct precipitation. Pond 1 appeared to be isolated on the landscape as no aquatic features with an OHWM or with wetland characteristics were observed entering or exiting the limits of the pond at the time of the evaluation nor were any indication of connectivity identified in any historic aerial photography. The pond's source of hydrology appeared to be solely from hillside sheetflow and direct precipitation. Based on the pond's location in the watershed

and the presence of water indicated on recent aerial photography the hydrology is estimated to be semi-permanently inundated.

Ditches were identified as constructed channels around the eastern and southern limits of the project site. All of the ditches were vegetated with upland grasses and forbs as described in the grassland community type. These ditches were constructed as part of the overall landfill and energy station drainage system. These functioned to direct surface water into settling ponds or away from retention ponds. Ditch 1 follows the eastern project limits, paralleling the existing landfill. Ditch 1 conveys water to the south, under a dirt access road and empties into a settling pond southeast of the project site. Ditch 2 originates at the dirt access road and conveys water south to a lined retention pond south of the project site. Ditch 3 is located along the southern boundary of the project site that directs water to the west away from the lined retention pond. A small berm separates Ditches 2 and 3. Ditch 3 is a very broad conveyance that near its terminus downcuts into an erosion feature (Erosion Feature 1). Ditch 4 is located around the perimeter of the lined retention pond, conveying water away from the pond. A berm separates Ditches 3 and 4 in the vicinity of the project site, but these features connect southwest of the project site.

Erosion Feature 1 is an active erosional cut that forms near the end of Ditch 3. This erosion feature is located where Ditch 3 matched the existing grade, but the slope increases in this area resulting in the overland flow increasing velocity. This erosion feature was identified in the field based on a distinct headcut that was approximately 2 feet deep and approximately 3 feet wide. The erosion feature conveys surface runoff to the southwest and ultimately connects to Ditch 4. There was no water observed in the feature, flowing or pooled, and as such meets the flow classification of ephemeral.

POTENTIAL JURISDICTIONAL ASSESSMENT

Table 2 provides an overview of the jurisdictional assessment of the aquatic features located within the survey area under the Navigable Waters Protection Rule. Under this rule, there are no aquatic features located within the survey area that would be considered a water of the United States. Ditches 1 through 4 and Erosion Feature 1 are ephemeral aquatic features and as such are excluded from the definition of a water of the United States. Pond 1 is isolated feature in the landscape that does not contribute water flow through a surface connection to any intermittent or perennial water; therefore, it would not meet a definition of a jurisdictional pond or impoundment under the Navigable Waters Protection Rule.

CONCLUSIONS

To summarize the delineation, a pond, four ditches, and an erosion feature were identified and delineated within the survey area. A summary of these features' characteristics is presented in **Table 1** and a summary of the jurisdictional assessment is presented in **Table 2** under the Navigable Waters Protection Rule. Under the Navigable Waters Protection Rule, none of the identified aquatic features would be waters of the United States.

Table 2. Jurisdictional Assessment of Aquatic Features

Water Identification	Water of the United States	Navigable Waters Protection Rule Classification	33 CFR 328.3 Definition
Pond 1	No	Isolated Pond	(b)(8)
Ditch 1	No	Ephemeral Aquatic Feature	(b)(3)
Ditch 2	No	Ephemeral Aquatic Feature	(b)(3)
Ditch 3	No	Ephemeral Aquatic Feature	(b)(3)
Ditch 4	No	Ephemeral Aquatic Feature	(b)(3)
Erosion Feature 1	No	Ephemeral Aquatic Feature	(b)(3)

In support of the engineering and permitting of this proposed Cell 3 of the landfill, IES is requesting that the USACE review this report and provide an Approved Jurisdictional Determination for these project limits.

IES appreciates the opportunity to work with you and the Fort Worth Regulatory Branch on this project and look forward to your review. If you have any comments, questions, or concerns, please do not hesitate to contact us. We can be reached at 972-562-7672 or by email at rreinecke@intenvsol.com.

Sincerely,

Integrated Environmental Solutions, LLC.

Rudi Reinecke
Vice President

Attachments

Copy: Ryan Kunz, P.E.; SCS Engineers
Dana Perry; Sandy Creek Services, LLC

File ref: 04.306.003

ATTACHMENT A

Figures

Figure 1.
General Location Map

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

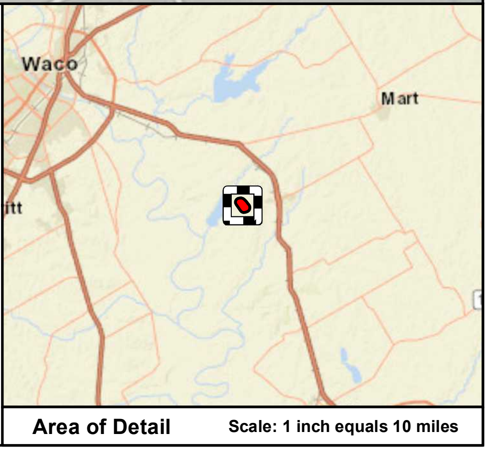
1 in = 1,000 feet

Feet
0 1,000

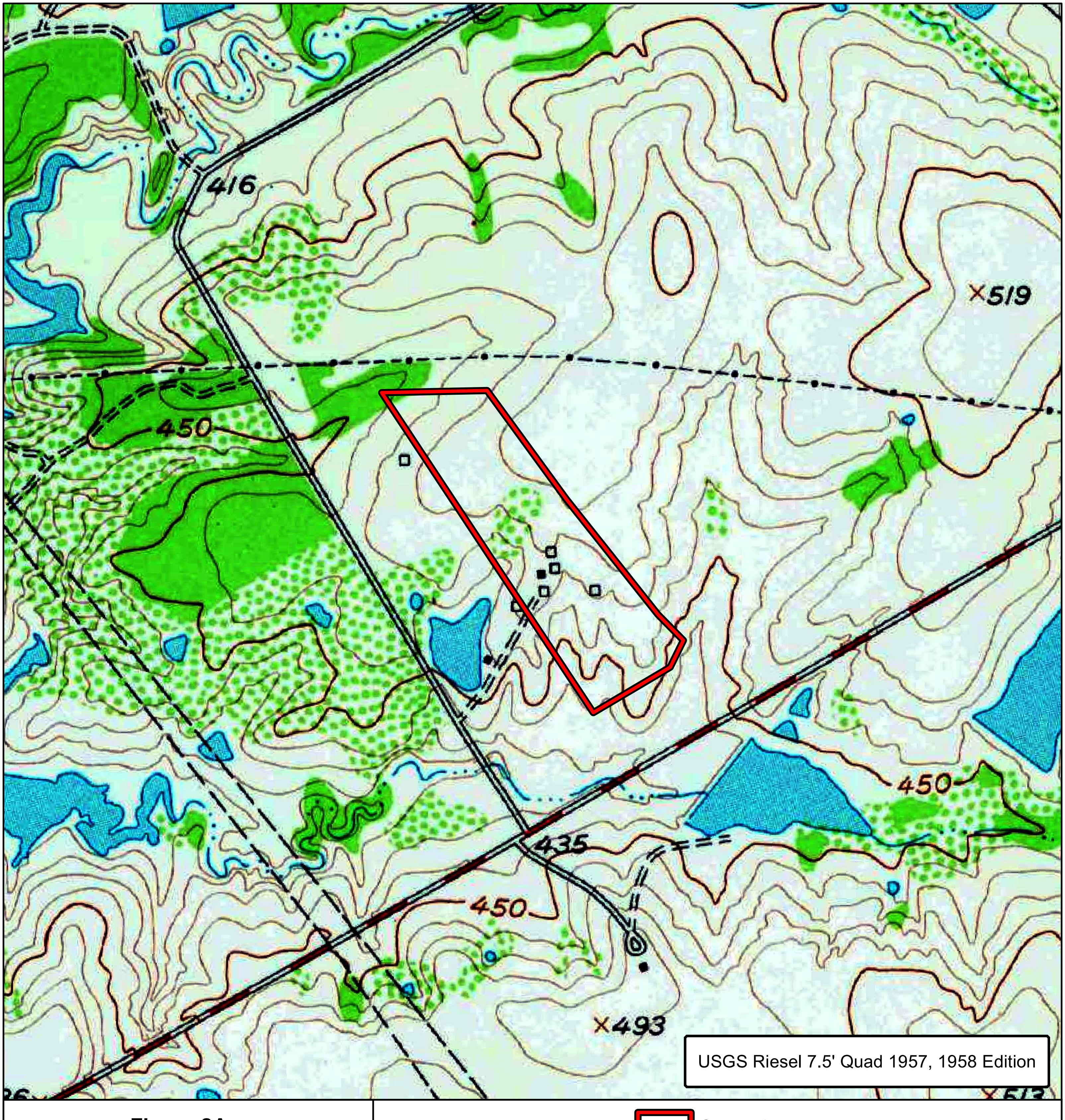
File Ref. 04.306.003
Date: 11/1/2020

N
W E
S

🟥 Survey Area



Area of Detail **Scale: 1 inch equals 10 miles**



USGS Riesel 7.5' Quad 1957, 1958 Edition

🟥 Survey Area

Figure 2A.
Topographic Setting

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 750 feet

Feet
0 750

N
W E
S

File Ref. 04.306.003
Date: 11/1/2020

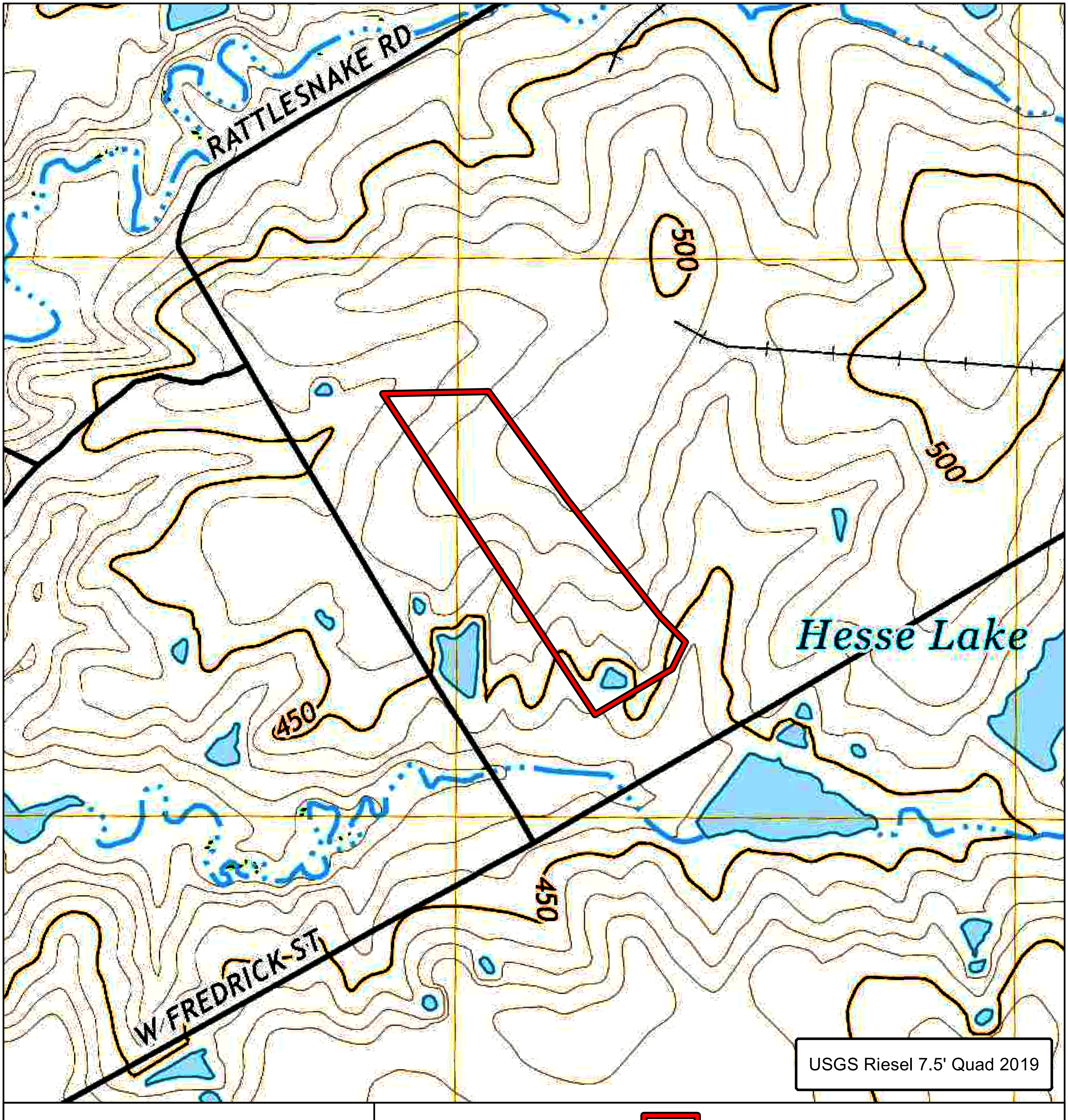


Figure 2B.
Topographic Setting

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 750 feet

Feet
0 750

N
W E
S

🟥 Survey Area

File Ref. 04.306.003
Date: 11/1/2020

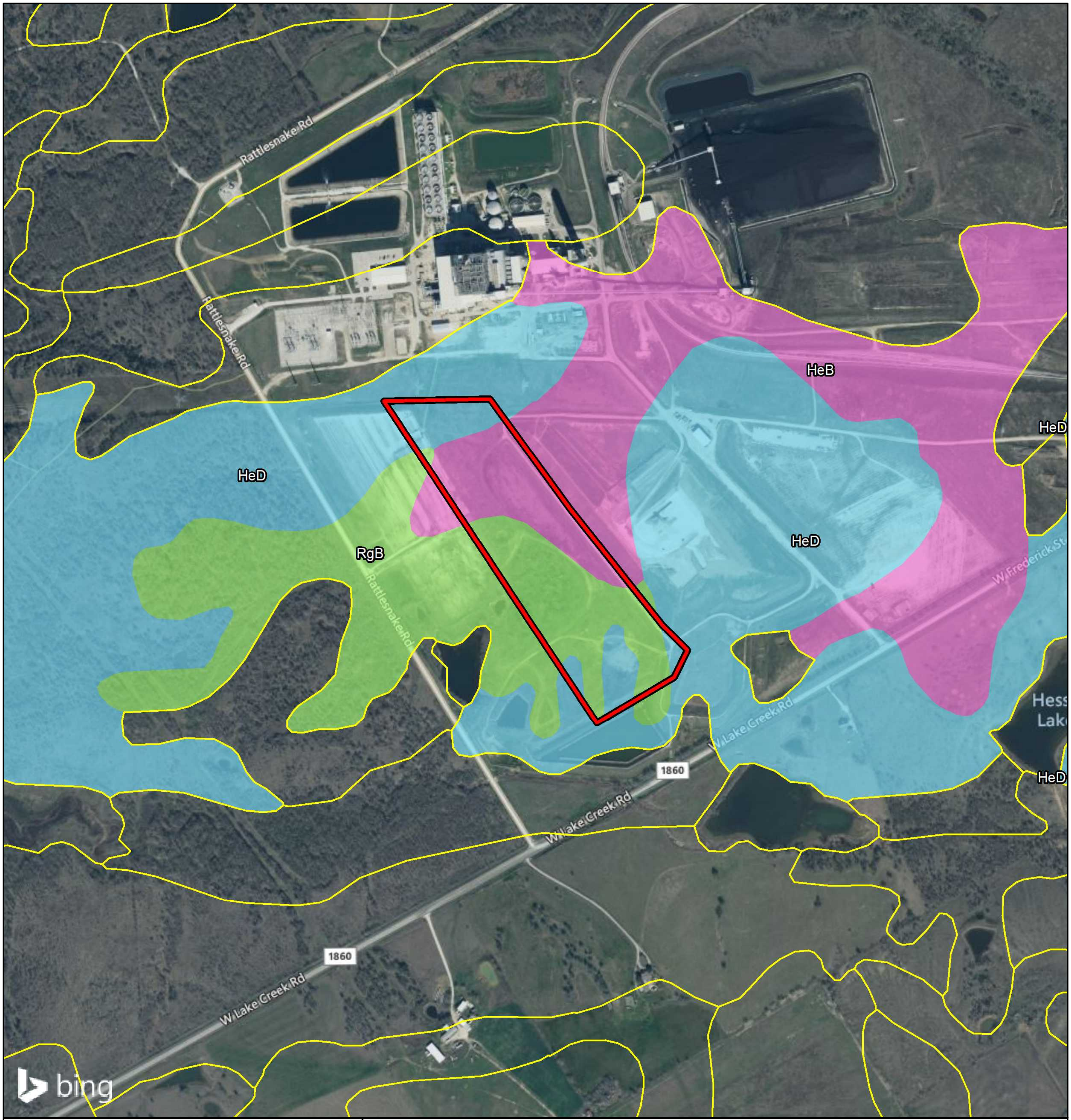


Figure 3.
Soils Map

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 750 feet

Feet
0 750

File Ref. 04.306.003
Date: 11/1/2020

▭ Survey Area

Soil Map Units

🟪 HeB - Heiden clay, 1 to 3 percent slopes

🟦 HeD - Heiden clay, 5 to 8 percent slopes

🟩 RgB - Riesel gravelly fine sandy loam, 1 to 3 percent slopes

🟨 Soil map units outside survey area

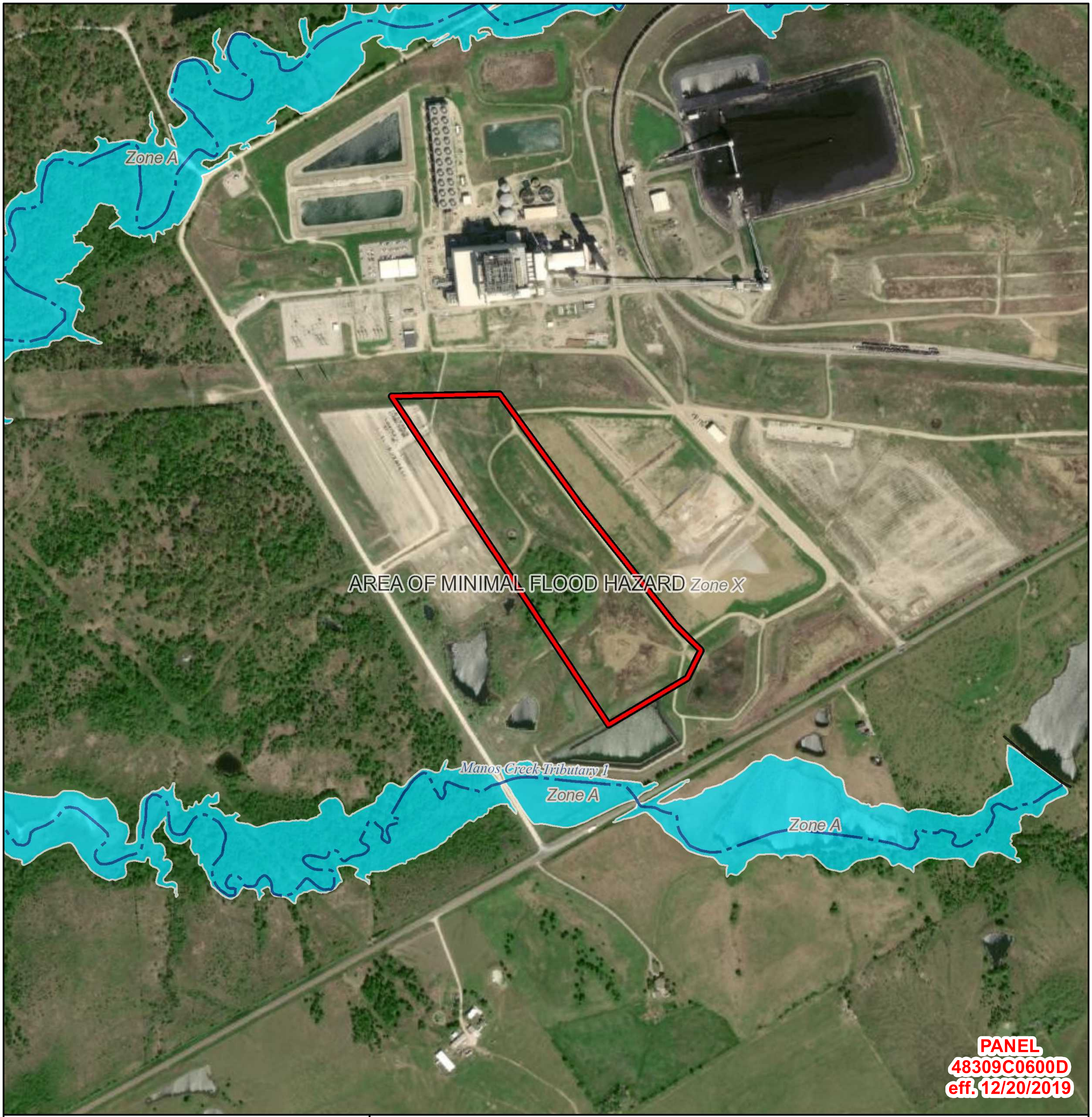


Figure 4.
Federal Emergency Management Agency Flood Insurance Rate Map

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 750 feet

Feet
0 750

N
W E
S

File Ref. 04.306.003
Date: 11/1/2020

🟥 Survey Area

FEMA FIRM Zone Descriptions

☐	Zone X - Areas determined to be outside the 0.2% annual chance floodplain
🟧	Zone X - Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood
🟦	Zone A - Special Flood Hazard Areas subject to inundation by the 1% annual chance flood; No base flood elevations determined
🟦	Zone AE - Special Flood Hazard Areas subject to inundation by the 1% annual chance flood; Base flood elevations determined
▨	Zone AE - Floodway areas in Zone AE

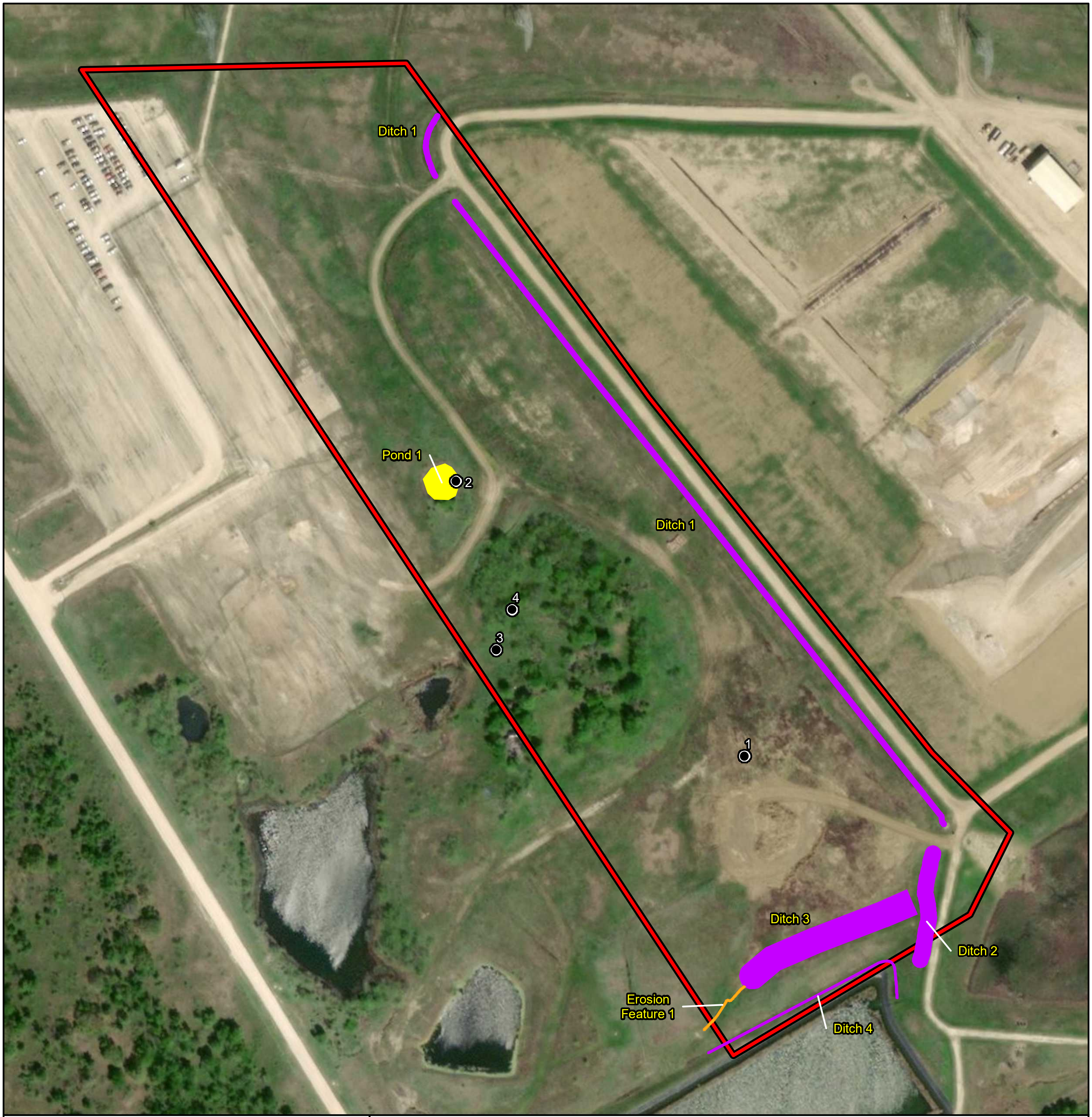


Figure 5.
Aquatic Resources Identified within the Survey Area

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 250 feet

Feet
0 250

N
W E
S

File Ref. 04.306.003
Date: 11/1/2020

🟥 Survey Area

● Wetland Determination Data Form

Aquatic Resources

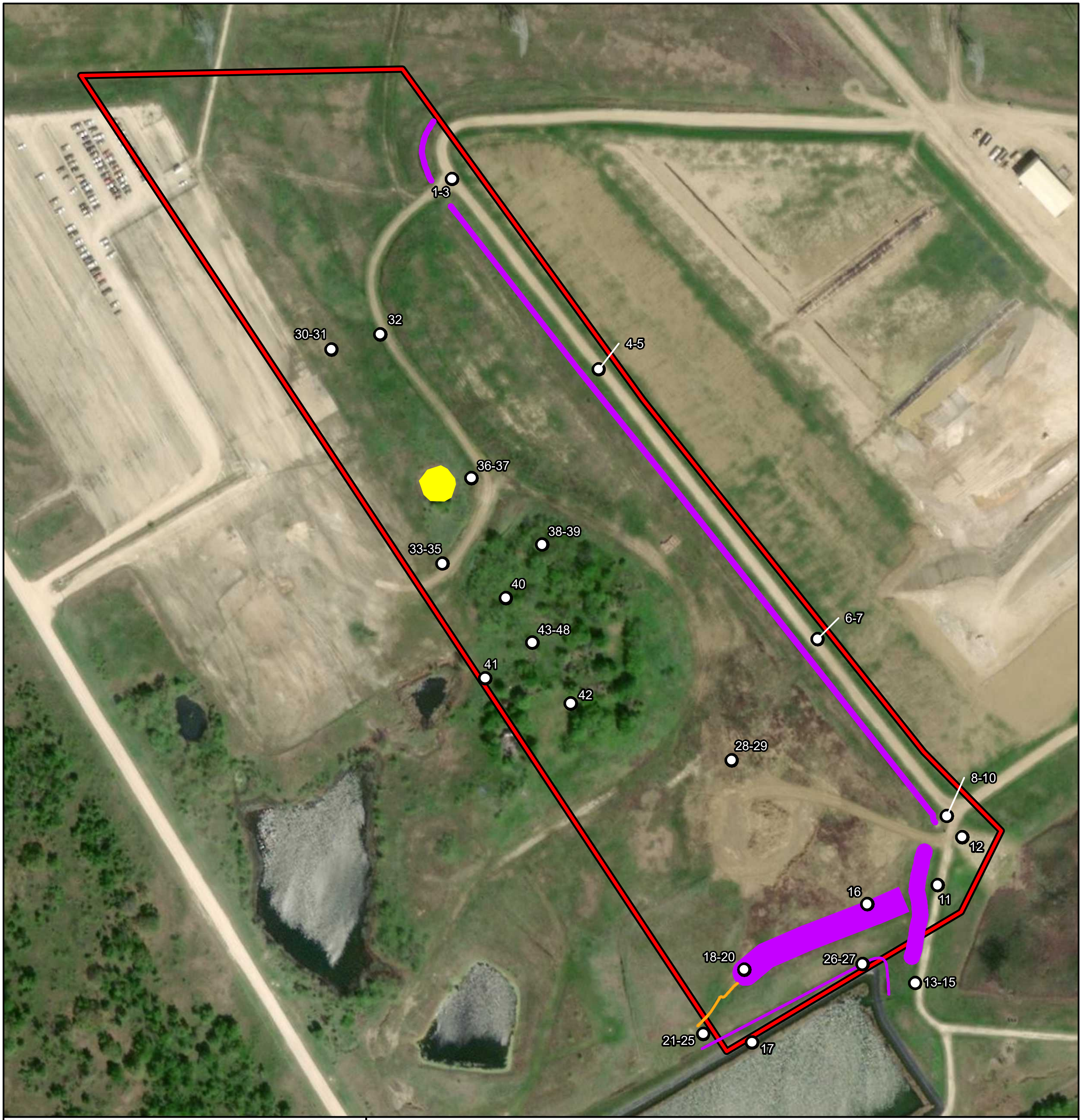
🟨 Artificial Pond

🟪 Ditch

🟧 Erosion Feature

ATTACHMENT B

Site Photographs



Photograph Location Map

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 250 feet

File Ref. 04.306.003
Date: 11/1/2020

▭ Survey Area
○ Site Photograph

Aquatic Resources

🟨 Artificial Pond
🟪 Ditch
🟧 Erosion Feature


Photograph 1


Photograph 2


Photograph 3


Photograph 4


Photograph 5


Photograph 6


Photograph 7


Photograph 8


Photograph 9


Photograph 10


Photograph 11


Photograph 12


Photograph 13


Photograph 14


Photograph 15


Photograph 16


Photograph 17


Photograph 18


Photograph 19


Photograph 20


Photograph 21


Photograph 22


Photograph 23


Photograph 24


Photograph 25


Photograph 26


Photograph 27


Photograph 28


Photograph 29


Photograph 30


Photograph 31


Photograph 32


Photograph 33


Photograph 34


Photograph 35


Photograph 36


Photograph 37


Photograph 38


Photograph 39


Photograph 40


Photograph 41


Photograph 42


Photograph 43


Photograph 44


Photograph 45


Photograph 46


Photograph 47


Photograph 48

ATTACHMENT C

Routine Wetland Determination Data Forms

Project/Site: Sandy Creek Energy Station City/County: Riesel/McLennan Sampling Date: 10/20/2020
Applicant/Owner: Sandy Creek Energy Station State: Texas Sampling Point: 1
Investigator(s): RK Reinecke Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Hill Slope Local relief (concave, convex, none): None Slope %: 0
Subregion (LRR): J - Southwestern Prairies Lat: N Long: W Datum: NAD 1983
Soil Map Unit Name: Riesel gravelly fine sandy loam, 1 to 3 percent slopes NWI Classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes	☐	No	☒
Hydric Soil Present?	Yes	☐	No	☒
Wetland Hydrology Present?	Yes	☐	No	☒

Is the Sampled Area within a wetland? **Yes** ☐ **No** ☒

Remarks: Grassland community

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot Size: 30' Radius)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *None*			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot Size: 15' Radius)			
1. *Baccharis salicina*	5	Y	FAC
2.			
3.			
4.			
5.			
= Total Cover	5		
Herb Stratum (Plot Size: 5' Radius)			
1. *Sorghum halepense*	5	N	FACU
2. *Solidago missouriensis*	5	N	NL - UPL
3. *Iva annua*	3	N	FAC
4. *Symphyotrichum ericoides*	10	N	FACU
5. *Cynodon dactylon*	45	Y	FACU
6. *Bouteloua curtipendula*	8	N	NL - UPL
7. *Croton texensis*	25	Y	NL - UPL
8. *Tridens albescens*	3	N	FAC
9.			
10.			
= Total Cover	104		
Woody Vine Stratum (Plot Size: 30' Radius)			
1. *None*			
2.			
= Total Cover			

% Bare Ground in Herb Stratum 20

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): 1 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 33 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply By:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

____ 1 - Rapid Test for Hydrophytic Vegetation
____ 2 - Dominance Test is > 50%
____ 3 - Prevalence Index is ≤ 3.0[1]
____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
____ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks: Herbaceous community

SOILS

Sampling Point: 1

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-14	5Y 4/3	45	10YR 5/6	5	C	M	Clay	Mixed soil
	5y 4/6	45	10YR 5/6	5	C	M	Clay	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16
  (MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 CM Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16)
- ☐ **(LRR H outside of MLRA 72 & 73)**
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless distributed or problematic.

Restrictive Layer (if present):

Type: N/A

Depth (inches): N/A

Hydric Soil Present? Yes ☐ **No** ☒

Remarks: This is a mixed soil that does not match the mapped soil type. Based on a review of recent aerials, this was a stockpile location for the construction of the power plant.

HYDROLOGY

Wetland Hydrology Indicators:

Primary indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Water Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
  (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
  (**where tilled**)
- ☐ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes? ☐ No? ☒ Depth (inches): N/A

Water Table Present? Yes? ☐ No? ☒ Depth (inches): N/A

Saturation Present? Yes? ☐ No? ☒ Depth (inches): N/A
(includes capillary fringe)

Wetland Hydrology Present? Yes ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No indicators of hydrology in the plot

Project/Site: Sandy Creek Energy Station City/County: Riesel/McLennan Sampling Date: 10/20/2020
Applicant/Owner: Sandy Creek Energy Station State: Texas Sampling Point: 2
Investigator(s): RK Reinecke Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Hill Slope Local relief (concave, convex, none): Concave Slope %: 0
Subregion (LRR): J - Southwestern Prairies Lat: N Long: W Datum: NAD 1983
Soil Map Unit Name: Riesel gravelly fine sandy loam, 1 to 3 percent slopes NWI Classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present? Yes ☒ No ☐
Hydric Soil Present? Yes ☒ No ☐
Wetland Hydrology Present? Yes ☒ No ☐

Is the Sampled Area within a wetland? **Yes** ☒ **No** ☐

Remarks: This is a littoral fringe associated with an artificial upland live stock watering pond

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot Size: Depression)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *None*			
2.			
3.			
4.			
	= Total Cover		

Sapling/Shrub Stratum (Plot Size: Depression)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *None*			
2.			
3.			
4.			
5.			
	= Total Cover		

Herb Stratum (Plot Size: Depression)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *Eleocharis palustris*	40	Y	OBL
2. *Sagittaria latifolia*	20	Y	OBL
3. *Cardiospermum halicacabum*	15	Y	FAC
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	75 = Total Cover		

Woody Vine Stratum (Plot Size: Depression)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *None*			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 30 - Open Water

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): 3 (A)
Total Number of Dominant Species Across All Strata: 3 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 100 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply By:
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column Totals:	(A)	(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

	1 -	Rapid Test for Hydrophytic Vegetation
X	2 -	Dominance Test is > 50%
	3 -	Prevalence Index is ≤ 3.0[1]
	4 -	Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
		Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks: Littoral fringe around an upland artificial stock pond

SOILS

Sampling Point: 2

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	10 YR 3/1	95	10YR 5/8	5	C	PL	Si Cl	

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5) (**LRR F**)
- ☐ 1 cm Muck (A9) (**LRR F, G, H**)
- ☐ Depleted below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ 2.5 cm Mucky Peat or Peat (S2) (**LRR G, H**)
- ☐ 5 cm Mucky Peat or Peat (S3) (**LRR F**)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☒ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ High Plains Depressions (F16
  (**MLRA 72 & 73 of LRR H**)

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 CM Muck (A9) (**LRR I, J**)
- ☐ Coast Prairie Redox (A16) (**LRR F, G, H**)
- ☐ Dark Surface (S7) (**LRR G**)
- ☐ High Plains Depressions (F16)
  (**LRR H outside of MLRA 72 & 73**)
- ☐ Reduced Vertic (F18)
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless distributed or problematic.

Restrictive Layer (if present):

Type: N/A

Depth (inches): N/A

Hydric Soil Present? **Yes** ☒ **No** ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary indicators (minimum of one required; check all that apply)

- ☒ Surface Water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☒ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☒ Inundation Visible on Aerial Imagery (B7)
- ☒ Water Stained Leaves (B9)
- ☐ Salt Crust (B11)
- ☒ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Dry-Season Water Table (C2)
- ☒ Oxidized Rhizospheres on Living Roots (C3)
  (**where not tilled**)
- ☐ Presence of Reduced Iron (C4)
- ☐ Thin Muck Surface
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Surface Soil Cracks (B6)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Drainage patterns (B10)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
  (**where tilled**)
- ☒ Crayfish Burrows (C8)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☒ FAC-Neutral Test (D5)
- ☐ Frost-Heave Hummocks (D7) (**LRR F**)

Field Observations:

Surface Water Present? Yes? ☒ No? ☐ Depth (inches): 0-12

Water Table Present? Yes? ☐ No? ☒ Depth (inches): N/A

Saturation Present? Yes? ☒ No? ☐ Depth (inches): 0
(includes capillary fringe)

Wetland Hydrology Present? **Yes** ☒ **No** ☐

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: Closed depression with berm on the southwest side - artificial livestock pond

Project/Site: Sandy Creek Energy Station	City/County: Riesel/McLennan	Sampling Date: 10/20/2020

Applicant/Owner: Sandy Creek Energy Station	State: Texas	Sampling Point: 3

Investigator(s): RK Reinecke	Section, Township, Range: N/A

Landform (hillslope, terrace, etc.): Hill Slope	Local relief (concave, convex, none): None	Slope %: 3-5

Subregion (LRR): J - Southwestern Prairies	Lat: N	Long: W	Datum: NAD 1983

Soil Map Unit Name: Riesel gravelly fine sandy loam, 1 to 3 percent slopes	NWI Classification: None

Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)

Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐

Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ☒
Hydric Soil Present?	Yes ☐	No ☒
Wetland Hydrology Present?	Yes ☐	No ☒

Is the Sampled Area within a wetland? **Yes** ☐ **No** ☒

Remarks: Open area of woods near western project boundary

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot Size: 30' Radius)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *None*			
2.			
3.			
4.			
	= Total Cover		
Sapling/Shrub Stratum (Plot Size: 15' Radius)			
1. *Prosopis glandulosa*	5	Y	FACU
2.			
3.			
4.			
5.			
	= Total Cover		
Herb Stratum (Plot Size: 5' Radius)			
1. *Cardiospermum halicacabum*	100	Y	FAC
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	= Total Cover		
Woody Vine Stratum (Plot Size: 30' Radius)			
1. *None*			
2.			
	= Total Cover		

% Bare Ground in Herb Stratum 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-):	1	(A)
Total Number of Dominant Species Across All Strata:	2	(B)
Percent of Dominant Species That Are OBL, FACW, or FAC:	50	(A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply By:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

- ____ 1 - Rapid Test for Hydrophytic Vegetation
- ____ 2 - Dominance Test is > 50%
- ____ 3 - Prevalence Index is ≤ 3.0[1]
- ____ 4 - Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
- ____ Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☐ **No** ☒

Remarks:

SOILS

Sampling Point: 3

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-4	10YR 4/2	100					Sa Lo	Gravelly
4-12	7.5YR 4/4	100					Sa Lo	Gravelly

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Stratified Layers (A5) **(LRR F)**
☐ 1 cm Muck (A9) (**LRR F, G, H)**
☐ Depleted below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
☐ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1)
☐ Loamy Gleyed Matrix (F2)
☐ Depleted Matrix (F3)
☐ Redox Dark Surface (F6)
☐ Depleted Dark Surface (F7)
☐ Redox Depressions (F8)
☐ High Plains Depressions (F16
(MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

☐ 1 CM Muck (A9) **(LRR I, J)**
☐ Coast Prairie Redox (A16) **(LRR F, G, H)**
☐ Dark Surface (S7) **(LRR G)**
☐ High Plains Depressions (F16)
☐ **(LRR H outside of MLRA 72 & 73)**
☐ Reduced Vertic (F18)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless distributed or problematic.

Restrictive Layer (if present):

Type: N/A
Depth (inches): N/A

Hydric Soil Present? Yes ☐ **No** ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Water Stained Leaves (B9)
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Dry-Season Water Table (C2)
☐ Oxidized Rhizospheres on Living Roots (C3)
(where not tilled)
☐ Presence of Reduced Iron (C4)
☐ Thin Muck Surface
☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

☐ Surface Soil Cracks (B6)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Drainage patterns (B10)
☐ Oxidized Rhizospheres on Living Roots (C3)
(where tilled)
☐ Crayfish Burrows (C8)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ FAC-Neutral Test (D5)
☐ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes? ☐ No? ☒ Depth (inches): N/A
Water Table Present? Yes? ☐ No? ☒ Depth (inches): N/A
Saturation Present? (includes capillary fringe) Yes? ☐ No? ☒ Depth (inches): N/A

Wetland Hydrology Present? Yes ☐ **No** ☒

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: hill slope - no concave or converging slope landforms

Project/Site: Sandy Creek Energy Station City/County: Riesel/McLennan Sampling Date: 10/20/2020
Applicant/Owner: Sandy Creek Energy Station State: Texas Sampling Point: 4
Investigator(s): RK Reinecke Section, Township, Range: N/A
Landform (hillslope, terrace, etc.): Hill Slope Local relief (concave, convex, none): None Slope %: 0-1
Subregion (LRR): J - Southwestern Prairies Lat: N Long: W Datum: NAD 1983
Soil Map Unit Name: Riesel gravelly fine sandy loam, 1 to 3 percent slopes NWI Classification: None
Are climatic / hydrologic conditions on the site typical for this time of year? Yes ☒ No ☐ (If no, explain in Remarks.)
Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Significantly disturbed? Are "Normal Circumstances" present? Yes ☒ No ☐
Are vegetation, ☐ Soil, ☐ Or hydrology ☐ Naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes ☐	No ☒	Is the Sampled Area within a wetland?	**Yes** ☐	**No** ☒
Hydric Soil Present?	Yes ☐	No ☒			
Wetland Hydrology Present?	Yes ☐	No ☒			

Remarks: Broadleaf woods community

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot Size: 30' Radius)	Absolute % Coverage	Dominant Species?	Indicator Status
1. *Prosopis glandulosa*	50	Y	FACU
2. *Celtis laevigata*	50	Y	FAC
3. *Gleditsia triacanthos*	5	N	FACU
4.			
	105	= Total Cover	
Sapling/Shrub Stratum (Plot Size: 15' Radius)			
1. *Celtis laevigata*	10	Y	FAC
2.			
3.			
4.			
5.			
		= Total Cover	
Herb Stratum (Plot Size: 5' Radius)			
1. *Cissus trifoliata*	5	Y	FACU
2. *Cardiospermum halicacabum*	5	Y	FAC
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
	10	= Total Cover	
Woody Vine Stratum (Plot Size: 30' Radius)			
1. *None*			
2.			
		= Total Cover	

% Bare Ground in Herb Stratum 95

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC (excluding FAC-): 3 (A)
Total Number of Dominant Species Across All Strata: 5 (B)
Percent of Dominant Species That Are OBL, FACW, or FAC: 60 (A/B)

Prevalence Index Worksheet:

Total % Cover of:		Multiply By:	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column Totals:		(A)	(B)

Prevalence Index = B/A=

Hydrophytic Vegetation Indicators:

	1 -	Rapid Test for Hydrophytic Vegetation
Yes	2 -	Dominance Test is > 50%
	3 -	Prevalence Index is ≤ 3.0[1]
	4 -	Morphological Adaptations[1] (Provide supporting data in Remarks or on a separate sheet)
		Problematic Hydrophytic Vegetation[1] (Explain)

[1] Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Hydrophytic Vegetation Present? **Yes** ☒ **No** ☐

Remarks:

SOILS

Sampling Point: 4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-5	10YR 3/2	100					Sa Lo	Gravelly
5-12	7.5YR 4/4	100					Sa Lo	Gravelly

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. [2]Location: PL=Pore Lining, M=Matrix

Hydric Soil indicators: (Applicable to all LRRs, unless otherwise noted.)

☐ Histosol (A1)
☐ Histic Epipedon (A2)
☐ Black Histic (A3)
☐ Hydrogen Sulfide (A4)
☐ Stratified Layers (A5) **(LRR F)**
☐ 1 cm Muck (A9) **(LRR F, G, H)**
☐ Depleted below Dark Surface (A11)
☐ Thick Dark Surface (A12)
☐ Sandy Mucky Mineral (S1)
☐ 2.5 cm Mucky Peat or Peat (S2) **(LRR G, H)**
☐ 5 cm Mucky Peat or Peat (S3) **(LRR F)**
☐ Sandy Gleyed Matrix (S4)
☐ Sandy Redox (S5)
☐ Stripped Matrix (S6)
☐ Loamy Mucky Mineral (F1)
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(MLRA 72 & 73 of LRR H)

Indicators for Problematic Hydric Soils[3]:

☐ 1 CM Muck (A9) **(LRR I, J)**
☐ Coast Prairie Redox (A16) **(LRR F, G, H)**
☐ Dark Surface (S7) **(LRR G)**
☐ High Plains Depressions (F16)
☐ **(LRR H outside of MLRA 72 & 73)**
☐ Reduced Vertic (F18)
☐ Red Parent Material (TF2)
☐ Very Shallow Dark Surface (TF12)
☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless distributed or problematic.

Restrictive Layer (if present):

Type: N/A
Depth (inches): N/A

Hydric Soil Present? Yes ☐ No ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary indicators (minimum of one required; check all that apply)

☐ Surface Water (A1)
☐ High Water Table (A2)
☐ Saturation (A3)
☐ Water Marks (B1)
☐ Sediment Deposits (B2)
☐ Drift Deposits (B3)
☐ Algal Mat or Crust (B4)
☐ Iron Deposits (B5)
☐ Inundation Visible on Aerial Imagery (B7)
☐ Water Stained Leaves (B9)
☐ Salt Crust (B11)
☐ Aquatic Invertebrates (B13)
☐ Hydrogen Sulfide Odor (C1)
☐ Dry-Season Water Table (C2)
☐ Oxidized Rhizospheres on Living Roots (C3)
(where not tilled)
☐ Presence of Reduced Iron (C4)
☐ Thin Muck Surface
☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

☐ Surface Soil Cracks (B6)
☐ Sparsely Vegetated Concave Surface (B8)
☐ Drainage patterns (B10)
☐ Oxidized Rhizospheres on Living Roots (C3)
(where tilled)
☐ Crayfish Burrows (C8)
☐ Saturation Visible on Aerial Imagery (C9)
☐ Geomorphic Position (D2)
☐ FAC-Neutral Test (D5)
☐ Frost-Heave Hummocks (D7) **(LRR F)**

Field Observations:

Surface Water Present? Yes? ☐ No? ☒ Depth (inches): N/A
Water Table Present? Yes? ☐ No? ☒ Depth (inches): N/A
Saturation Present? (includes capillary fringe) Yes? ☐ No? ☒ Depth (inches): N/A

Wetland Hydrology Present? Yes ☐ No ☒

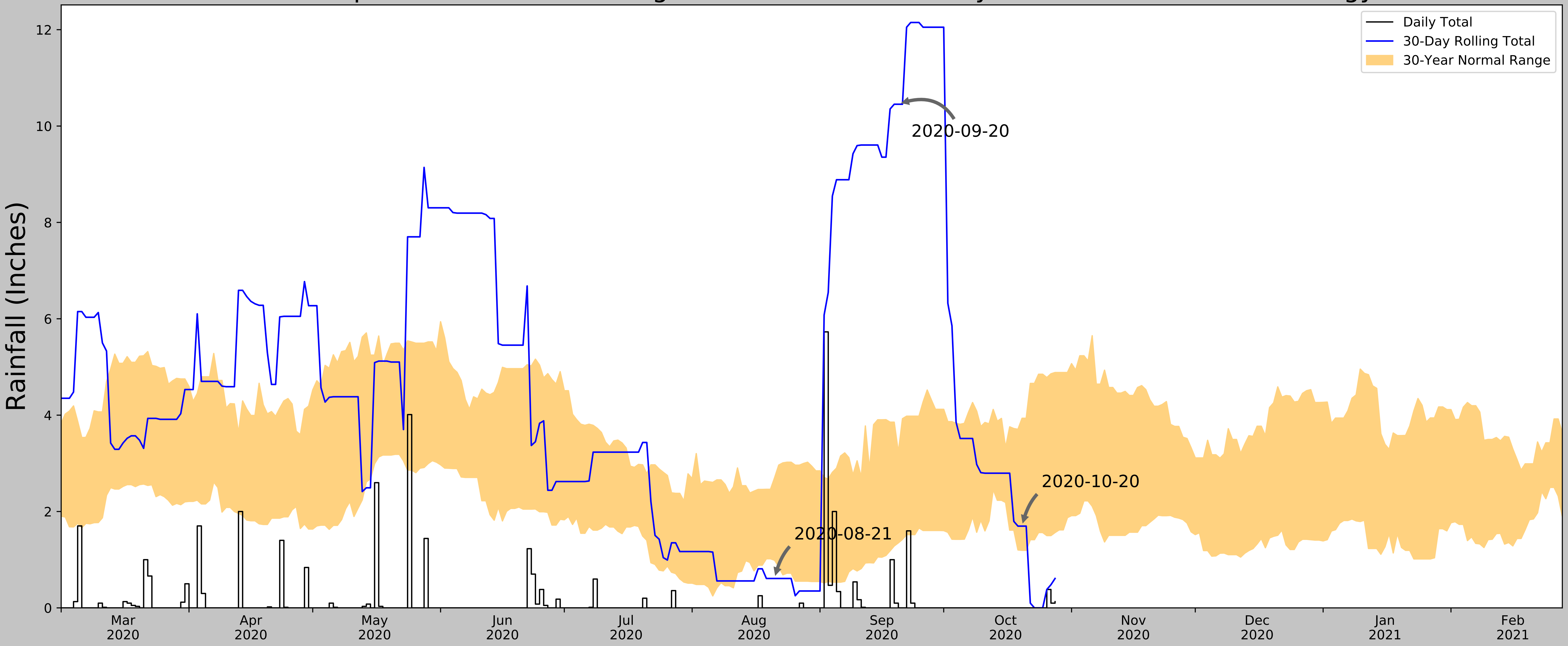
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No local topography that includes converging slopes or concave depressions.

ATTACHMENT D

Antecedent Precipitation Tool Output

Antecedent Precipitation vs Normal Range based on NOAA's Daily Global Historical Climatology Network



Coordinates	31.470374, -96.956868
Observation Date	2020-10-20
Elevation (ft)	482.46
Drought Index (PDSI)	Moderate wetness (2020-09)
WebWIMP H_2O Balance	Wet Season

30 Days Ending	30th %ile (in)	70th %ile (in)	Observed (in)	Wetness Condition	Condition Value	Month Weight	Product
2020-10-20	1.194095	3.935827	1.69685	Normal	2	3	6
2020-09-20	1.349213	3.229134	10.452756	Wet	3	2	6
2020-08-21	0.988583	2.703543	0.610236	Dry	1	1	1
Result							Normal Conditions - 13

Weather Station Name	Coordinates	Elevation (ft)	Distance (mi)	Elevation Δ	Weighted Δ	Days (Normal)	Days (Antecedent)
MARLIN	31.305, -96.8767	407.152	12.366	75.308	6.496	10301	88
WACO 7.7 ESE	31.5174, -97.0665	381.89	7.23	100.57	3.981	98	0
LORENA 8.0 E	31.3987, -97.079	417.979	8.739	64.481	4.496	36	1
WACO 3.3 SE	31.5383, -97.1395	482.94	11.738	0.48	5.288	85	0
WACO 4.2 SE	31.5195, -97.1427	470.144	11.462	12.316	5.299	33	0
AXTELL 1.9 SW	31.6378, -96.992	470.144	11.752	12.316	5.433	297	1
WACO 2.2 ESE	31.5564, -97.1495	500.984	12.809	18.524	6.001	6	0
MARLIN 0.9 ESE	31.3063, -96.8784	407.152	12.245	75.308	6.432	53	0
WACO 1.6 SE	31.5533, -97.1635	554.134	13.453	71.674	7.018	1	0
MART 7.5 NNW	31.6464, -96.8624	575.131	13.374	92.671	7.257	27	0
WACO 4.1 NE	31.6166, -97.1403	399.934	14.79	82.526	7.876	1	0
WACO DAM	31.6003, -97.2169	495.079	17.75	12.619	8.212	399	0
WACO RGNL AP	31.6189, -97.2283	500.0	18.994	17.54	8.88	16	0

Figure and tables made by the
Antecedent Precipitation Tool
Version 1.0

Written by Jason Deters
U.S. Army Corps of Engineers

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS, FORT WORTH DISTRICT
P.O. BOX 17300
FORT WORTH, TX 76102-0300

April 19, 2021

Regulatory Division

SUBJECT: Project Number SWF-2020-00489, Sandy Creek Landfill Cell 3

Ms. Dana L Perry
Business Manager
Sandy Creek Energy Station
P.O. Box 370
Riesel, TX 76682
dperry@sandycreekservices.com

Dear Ms. Perry:

This letter is in regard to information received November 6, 2020, and subsequent information received February 3, 11, March 15, and 19, 2021, concerning a request for an approved jurisdictional determination (AJD) at the Sandy Creek Landfill Cell 3, located near the City of Riesel, McLennan County, Texas. This project has been assigned Project Number SWF-2020-00489. Please include this number in all future correspondence concerning this project.

We have reviewed the site in question in accordance with Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act of 1899. Under Section 404, the USACE regulates the discharge of dredged and fill material into waters of the United States, including wetlands. Our responsibility under Section 10 is to regulate any work in, or affecting, navigable waters of the United States.

Based on the report submitted, and other information available to us, waters of the United States under Section 404 do not exist on the site. We concur with the delineation of waters that is made in the above referenced report. This AJD is valid for a period of no more than five years from the date of this letter unless new information warrants revision of the delineation before the expiration date.

This determination does not convey any property rights, either in real estate or material or any exclusive privileges, nor does it authorize any injury to property or invasion of rights or Federal, State, or local laws or regulations. This determination does not eliminate the requirements to obtain State or local permits or approvals as needed.

Department of the Army authorization would be required for the discharge of dredged or fill material into any areas identified as waters of the United States. If you anticipate a discharge, please provide us with a detailed description of the proposed project, a suitable map of the proposed project area showing the location of proposed discharges, the type and amount of material (temporary or permanent), if any, to be discharged, and plan and cross-section views of the proposed project. Please note that it is unlawful to start work without a Department of the Army permit if one is required.

The Applicant may accept or appeal this AJD or provide new information in accordance with the enclosed Notification of Administration Appeal Options and Process and Request for Appeal (NAAOP-RFA). If the Applicant elects to appeal this AJD, the Applicant must complete Section II (Request for Appeal or Objections to an Initial Proffered Permit) of the enclosure and return it to the Division Engineer, ATTN: CESWD-PD-O Appeals Review Officer, U.S. Army Corps of Engineers, 1100 Commerce Street, Dallas, Suite 831, Texas 75242-0216 within 60 days of the date of this notice. Failure to notify the USACE within 60 days of the date of this notice means you accept the AJD in its entirety and waive all rights to appeal the AJD.

Thank you for your interest in our nation's water resources. If you have any questions concerning our regulatory program please refer to our website at http://www.swf.usace.army.mil/Missions/Regulatory or contact Mr. Frederick J. Land at the address above, by telephone (817) 851-5624, or by email at Fred.J.Land@usace.army.mil, and refer to your assigned project number.

Please help the regulatory program improve its service by completing the survey on the following website: http://corpsmapu.usace.army.mil/cm_apex/f?p=regulatory_survey.

Sincerely,

LAND.FREDERICK.JOSEPH.1221334139

Digitally signed by LAND.FREDERICK.JOSEPH.1221334139
Date: 2021.04.19 12:03:28 -05'00'

For: Brandon W. Mobley
Chief, Regulatory Division

Enclosures

U.S. ARMY CORPS OF ENGINEERS
REGULATORY PROGRAM
APPROVED JURISDICTIONAL DETERMINATION FORM (INTERIM)
NAVIGABLE WATERS PROTECTION RULE

I. ADMINISTRATIVE INFORMATION

Completion Date of Approved Jurisdictional Determination (AJD): 4/15/2021
ORM Number: SWF-2020-00489
Associated JDs: N/A
Review Area Location[1]: State/Territory: Texas City: Riesel County/Parish/Borough: McLennan
Center Coordinates of Review Area: Latitude 31.470226 Longitude -96.956688

II. FINDINGS

A. Summary: Check all that apply. At least one box from the following list MUST be selected. Complete the corresponding sections/tables and summarize data sources.

☐ The review area is comprised entirely of dry land (i.e., there are no waters or water features, including wetlands, of any kind in the entire review area). Rationale: N/A

☐ There are “navigable waters of the United States” within Rivers and Harbors Act jurisdiction within the review area (complete table in Section II.B).

☐ There are “waters of the United States” within Clean Water Act jurisdiction within the review area (complete appropriate tables in Section II.C).

☒ There are waters or water features excluded from Clean Water Act jurisdiction within the review area (complete table in Section II.D).

B. Rivers and Harbors Act of 1899 Section 10 (§ 10)[2]

t§ 10 Name	§ 10 Size		§ 10 Criteria	Rationale for § 10 Determination
N/A.	N/A.	N/A	N/A.	N/A.

C. Clean Water Act Section 404

Territorial Seas and Traditional Navigable Waters ((a)(1) waters):[3]

(a)(1) Name	(a)(1) Size		(a)(1) Criteria	Rationale for (a)(1) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

Tributaries ((a)(2) waters):

(a)(2) Name	(a)(2) Size		(a)(2) Criteria	Rationale for (a)(2) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

Lakes and ponds, and impoundments of jurisdictional waters ((a)(3) waters):

(a)(3) Name	(a)(3) Size		(a)(3) Criteria	Rationale for (a)(3) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

Adjacent wetlands ((a)(4) waters):

(a)(4) Name	(a)(4) Size		(a)(4) Criteria	Rationale for (a)(4) Determination
N/A.	N/A.	N/A.	N/A.	N/A.

---

[1] Map(s)/figure(s) are attached to the AJD provided to the requestor.

[2] If the navigable water is not subject to the ebb and flow of the tide or included on the District’s list of Rivers and Harbors Act Section 10 navigable waters list, do NOT use this document to make the determination. The District must continue to follow the procedure outlined in 33 CFR part 329.14 to make a Rivers and Harbors Act Section 10 navigability determination.

[3] A stand-alone TNW determination is completed independently of a request for an AJD. A stand-alone TNW determination is conducted for a specific segment of river or stream or other type of waterbody, such as a lake, where upstream or downstream limits or lake borders are established. A stand-alone TNW determination should be completed following applicable guidance and should NOT be documented on the AJD Form.

D. Excluded Waters or Features

Excluded waters ((b)(1) – (b)(12)):[4]

Exclusion Name	Exclusion Size		Exclusion[5]	Rationale for Exclusion Determination
Pond 1	0.08	acre(s)	(b)(8) Artificial lake/pond constructed or excavated in upland or a non-jurisdictional water, so long as the artificial lake or pond is not an impoundment of a jurisdictional water that meets (c)(6).	Artificially created pond in an upland and outside of FEMA FIRM 100y floodplain. No direct connection to downstream waters. See file.
Erosion Feature 1	143	linear feet	(b)(3) Ephemeral feature, including an ephemeral stream, swale, gully, rill, or pool.	Erosional gully lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. A review of historic aerial imagery demonstrates that it's not a rerouted stream, but an area of recent erosion. Field indicators show it is erosional gully.
Ditch 1	1,636	linear feet	(b)(5) Ditch that is not an (a)(1) or (a)(2) water, and those portions of a ditch constructed in an (a)(4) water that do not satisfy the conditions of (c)(1).	Artificial ditch constructed in uplands and outside of FEMA FIRM 100y floodplain, lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. Historic aerial imagery demonstrates that it's not a rerouted stream, but a ditch dug in uplands that drain only uplands.
Ditch 2	207	linear feet	(b)(5) Ditch that is not an (a)(1) or (a)(2) water, and those portions of a ditch constructed in an (a)(4) water that do not satisfy the conditions of (c)(1).	Artificial ditch constructed in uplands and outside of FEMA FIRM 100y floodplain, lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. Historic aerial imagery demonstrates that it's not a rerouted stream, but a ditch

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[4] Some excluded waters, such as (b)(2) and (b)(4), may not be specifically identified on the AJD form unless a requestor specifically asks a Corps district to do so. Corps districts may, in case-by-case instances, choose to identify some or all of these waters within the review area.

[5] Because of the broad nature of the (b)(1) exclusion and in an effort to collect data on specific types of waters that would be covered by the (b)(1) exclusion, four sub-categories of (b)(1) exclusions were administratively created for the purposes of the AJD Form. These four sub-categories are not new exclusions, but are simply administrative distinctions and remain (b)(1) exclusions as defined by the NWPR.

D. Excluded Waters or Features

Excluded waters ((b)(1) – (b)(12)):[4]				
Exclusion Name	Exclusion Size		Exclusion[5]	Rationale for Exclusion Determination
Pond 1	0.08	acre(s)	(b)(8) Artificial lake/pond constructed or excavated in upland or a non-jurisdictional water, so long as the artificial lake or pond is not an impoundment of a jurisdictional water that meets (c)(6).	Artificially created pond in an upland and outside of FEMA FIRM 100y floodplain. No direct connection to downstream waters. See file.
Erosion Feature 1	143	linear feet	(b)(3) Ephemeral feature, including an ephemeral stream, swale, gully, rill, or pool.	Erosional gully lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. A review of historic aerial imagery demonstrates that it's not a rerouted stream, but an area of recent erosion. Field indicators show it is erosional gully.
Ditch 1	1,636	linear feet	(b)(5) Ditch that is not an (a)(1) or (a)(2) water, and those portions of a ditch constructed in an (a)(4) water that do not satisfy the conditions of (c)(1).	Artificial ditch constructed in uplands and outside of FEMA FIRM 100y floodplain, lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. Historic aerial imagery demonstrates that it's not a rerouted stream, but a ditch dug in uplands that drain only uplands.
Ditch 2	207	linear feet	(b)(5) Ditch that is not an (a)(1) or (a)(2) water, and those portions of a ditch constructed in an (a)(4) water that do not satisfy the conditions of (c)(1).	Artificial ditch constructed in uplands and outside of FEMA FIRM 100y floodplain, lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. Historic aerial imagery demonstrates that it's not a rerouted stream, but a ditch

---

[4] Some excluded waters, such as (b)(2) and (b)(4), may not be specifically identified on the AJD form unless a requestor specifically asks a Corps district to do so. Corps districts may, in case-by-case instances, choose to identify some or all of these waters within the review area.

[5] Because of the broad nature of the (b)(1) exclusion and in an effort to collect data on specific types of waters that would be covered by the (b)(1) exclusion, four sub-categories of (b)(1) exclusions were administratively created for the purposes of the AJD Form. These four sub-categories are not new exclusions, but are simply administrative distinctions and remain (b)(1) exclusions as defined by the NWPR.

Excluded waters ((b)(1) – (b)(12)):[4]				
Exclusion Name	Exclusion Size		Exclusion[5]	Rationale for Exclusion Determination
				dug in uplands that drain only uplands.
Ditch 3	338	linear feet	(b)(5) Ditch that is not an (a)(1) or (a)(2) water, and those portions of a ditch constructed in an (a)(4) water that do not satisfy the conditions of (c)(1).	Artificial ditch constructed in uplands and outside of FEMA FIRM 100y floodplain, lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, or algae accumulation in the channel observed. Historic aerial imagery demonstrates that it's not a rerouted stream, but a ditch dug in uplands that drain only uplands.
Ditch 4	463	linear feet	(b)(5) Ditch that is not an (a)(1) or (a)(2) water, and those portions of a ditch constructed in an (a)(4) water that do not satisfy the conditions of (c)(1).	Artificial ditch constructed in uplands and outside of FEMA FIRM 100y floodplain lacking indicators such as OHWM, OBL/FACW vegetation, hydric soils, macro-invertebrates, algae accumulation in the channel observed. Historic aerial imagery demonstrates that it's not a rerouted stream, but a ditch dug in uplands that drain only uplands.

III. SUPPORTING INFORMATION

A. Select/enter all resources that were used to aid in this determination and attach data/maps to this document and/or references/citations in the administrative record, as appropriate.

☒ Information submitted by, or on behalf of, the applicant/consultant: See file.
This information is sufficient for purposes of this AJD.
Rationale: N/A

☐ Data sheets prepared by the Corps: N/A

☒ Photographs: Aerial and Other: Site photographs 10/20/20, Historic Aerial Photos from https://www.historicaerials.com/viewer from 1954, 1955, 1981, 1995. Other aerial photos submitted by consultant, see file.

☒ Corps site visit(s) conducted on: 2/3/21

☐ Previous Jurisdictional Determinations (AJDs or PJDs): N/A

☒ Antecedent Precipitation Tool: *provide detailed discussion in Section III.B*.

☒ USDA NRCS Soil Survey: Soil Survey of McLennan County, Texas, Dated 1992

☒ USFWS NWI maps: NWI, Accessed in ORM Maps and USFWS NWI Mapper.

☒ USGS topographic maps: Riesel 7.5' Quadrangle 1957, revised 1958, and new 2019 maps.

Other data sources used to aid in this determination:

Data Source (select)	Name and/or date and other relevant information
USGS Sources	N/A.
USDA Sources	N/A.
NOAA Sources	N/A.
USACE Sources	N/A.
State/Local/Tribal Sources	N/A.
Other Sources	N/A.

B. Typical year assessment(s): Typical year assessment was performed using the Antecedent Precipitation Tool demonstrating normal rainfall conditions at time of consultant's delineation; however, this information is immaterial to the determination because all of these features are "preamble waters" or otherwise never regulated under Clean Water Act jurisdiction.

C. Additional comments to support AJD: These features include an isolated stock pond, "tank," that is not connected, several ditches dug in uplands that drain only uplands, and an erosional gully. None of these features are currently or have ever been regulated under the Clean Water Act jurisdiction. The ditches do not connect waters, they are not rerouted streams, they do not extend the OHWM of a waters, and they were not dug in wetlands.

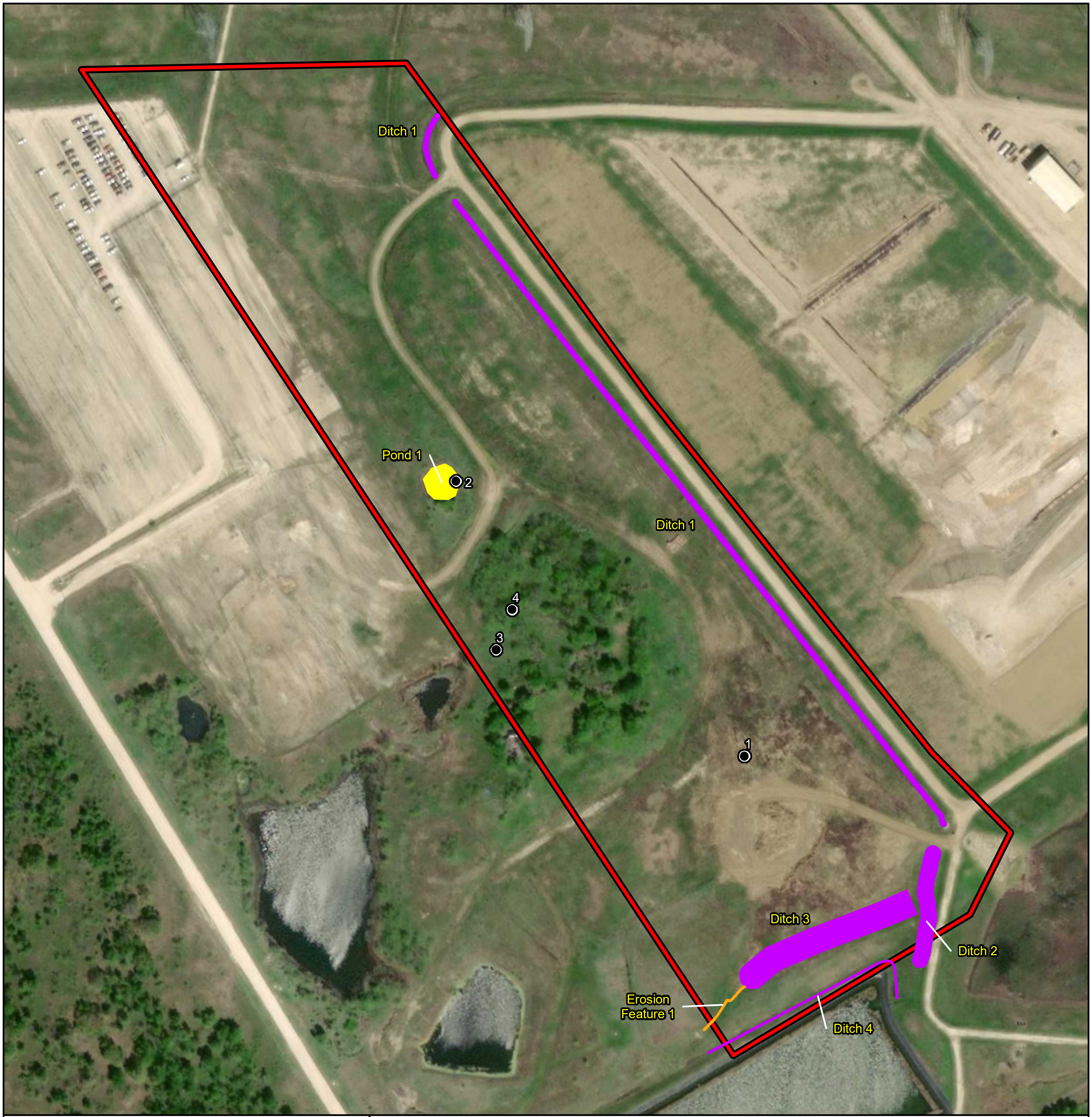

Figure 5.
Aquatic Resources Identified within the Survey Area

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 250 feet

Feet
0 250

File Ref. 04.306.003
Date: 11/1/2020

N
W E
S

▭ Survey Area
● Wetland Determination Data Form

Aquatic Resources

🟨 Artificial Pond
🟪 Ditch
🟧 Erosion Feature

NOTIFICATION OF ADMINISTRATIVE APPEAL OPTIONS AND PROCESS AND REQUEST FOR APPEAL

Applicant: Dana L. Perry, Sandy Creek Landfill	File Number: SWF-2020-00489	Date: April 19, 2021

Attached is:	See Section below:
INITIAL PROFFERED PERMIT (Standard Permit or Letter of permission)	A
PROFFERED PERMIT (Standard Permit or Letter of permission)	B
PERMIT DENIAL	C
APPROVED JURISDICTIONAL DETERMINATION	D
PRELIMINARY JURISDICTIONAL DETERMINATION	E

SECTION I - The following identifies your rights and options regarding an administrative appeal of the above decision. Additional information may be found at http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/appeals.aspx or Corps regulations at 33 CFR Part 331.

A: INITIAL PROFFERED PERMIT: You may accept or object to the permit.

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- OBJECT: If you object to the permit (Standard or LOP) because of certain terms and conditions therein, you may request that the permit be modified accordingly. You must complete Section II of this form and return the form to the district engineer. Your objections must be received by the district engineer within 60 days of the date of this notice, or you will forfeit your right to appeal the permit in the future. Upon receipt of your letter, the district engineer will evaluate your objections and may: (a) modify the permit to address all of your concerns, (b) modify the permit to address some of your objections, or (c) not modify the permit having determined that the permit should be issued as previously written. After evaluating your objections, the district engineer will send you a proffered permit for your reconsideration, as indicated in Section B below.

B: PROFFERED PERMIT: You may accept or appeal the permit

- ACCEPT: If you received a Standard Permit, you may sign the permit document and return it to the district engineer for final authorization. If you received a Letter of Permission (LOP), you may accept the LOP and your work is authorized. Your signature on the Standard Permit or acceptance of the LOP means that you accept the permit in its entirety, and waive all rights to appeal the permit, including its terms and conditions, and approved jurisdictional determinations associated with the permit.
- APPEAL: If you choose to decline the proffered permit (Standard or LOP) because of certain terms and conditions therein, you may appeal the declined permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

C: PERMIT DENIAL: You may appeal the denial of a permit under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

D: APPROVED JURISDICTIONAL DETERMINATION: You may accept or appeal the approved JD or provide new information.

- ACCEPT: You do not need to notify the Corps to accept an approved JD. Failure to notify the Corps within 60 days of the date of this notice, means that you accept the approved JD in its entirety, and waive all rights to appeal the approved JD.
- APPEAL: If you disagree with the approved JD, you may appeal the approved JD under the Corps of Engineers Administrative Appeal Process by completing Section II of this form and sending the form to the division engineer. This form must be received by the division engineer within 60 days of the date of this notice.

E: PRELIMINARY JURISDICTIONAL DETERMINATION: You do not need to respond to the Corps regarding the preliminary JD. The Preliminary JD is not appealable. If you wish, you may request an approved JD (which may be appealed), by contacting the Corps district for further instruction. Also you may provide new information for further consideration by the Corps to reevaluate the JD.

SECTION II - REQUEST FOR APPEAL or OBJECTIONS TO AN INITIAL PROFFERED PERMIT

REASONS FOR APPEAL OR OBJECTIONS: (Describe your reasons for appealing the decision or your objections to an initial proffered permit in clear concise statements. You may attach additional information to this form to clarify where your reasons or objections are addressed in the administrative record.)

ADDITIONAL INFORMATION: The appeal is limited to a review of the administrative record, the Corps memorandum for the record of the appeal conference or meeting, and any supplemental information that the review officer has determined is needed to clarify the administrative record. Neither the appellant nor the Corps may add new information or analyses to the record. However, you may provide additional information to clarify the location of information that is already in the administrative record.

POINT OF CONTACT FOR QUESTIONS OR INFORMATION:

If you have questions regarding this decision and/or the appeal process you may contact:

Mr. Frederick Land
(817) 851-5624
Fred.j.land@usace.army.mil

If you only have questions regarding the appeal process you may also contact:
Mr. Elliott Carman
Administrative Appeals Review Officer (CESWD-PD-O)
U.S. Army Corps of Engineers 1100
Commerce Street, Suite 831 Dallas , Texas
75242-1317
469-487-7061

RIGHT OF ENTRY: Your signature below grants the right of entry to Corps of Engineers personnel, and any government consultants, to conduct investigations of the project site during the course of the appeal process. You will be provided a 15 day notice of any site investigation, and will have the opportunity to participate in all site investigations.

Signature of appellant or agent.	Date:	Telephone number:

ATTACHMENT 2

UNSTABLE AREAS COMPLIANCE DEMONSTRATION

Sandy Creek Energy Station
Solid Waste Disposal Facility
McLennan County, TX

Cell 3 Compliance Demonstration
Attachment 2 – Unstable Areas Compliance Demonstration

Prepared for:

2161 Rattlesnake Road,
P.O. Box 370,
Riesel, TX 76682

SCS ENGINEERS

TBPE Reg. No. F-3407
16220089.00 | Revision 0 – June 2021

1901 Central Dr., Suite 550
Bedford, TX 76021
817-571-2288

BRETT J. DeVRIES
128061

6/7/21

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Appendix B – Liquefaction and Settlement Potential Evaluation

Appendix C – Boring Locations, Geologic Cross Section, and Boring Logs

Appendix D – Slope Stability Analysis

Appendix E – Seepage Potential and Karst Condition Assessment

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6/7/21

SCS Engineers
TBPE Reg. #F-3407

1.0 INTRODUCTION AND OBJECTIVE

The following Unstable Areas Compliance Demonstration has been prepared for Cell 3 at Sandy Creek Services, LLC's Sandy Creek Energy Station Solid Waste Disposal Facility (Facility) as required by Title 40, Code of Federal Regulation (CFR) §257.64.

The CCR landfill is classified as an existing landfill as defined under §257.53, which was constructed and commenced operation prior to October 14, 2015. The landfill is currently comprised of two CCR disposal cells, Cells 1 and 2 (see **Compliance Demonstration - Figure 2**), which commenced receiving waste in early 2013 and October 2014, respectively. The approximate area of Cells 1 and 2 are 10.0 and 14.3 acres, respectively. Cell 3 of the facility is proposed for construction as a lateral expansion of a CCR unit, and incorporates an approximate area of 17.0 acres (see **Compliance Demonstration - Figure 2**).

The primary wastes disposed of in the landfill are dry scrubber ash and bottom ash generated during the facility's coal combustion process. Incidental waste generated during the facility's operation may also be disposed of in the landfill, as described in the initial registration notification to TCEQ and the most recent version of the facility's Operations Plan.

This compliance demonstration addresses the construction of Cell 3. Existing Cell 1 and 2, and future Cell 4 has not been developed, is not addressed by this demonstration, and will require compliance demonstration to placing CCR in Cell 4.

2.0 UNSTABLE AREAS RESTRICTIONS

2.1 40 CFR §257.64 "UNSTABLE AREAS."

"(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."

"(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;"

As discussed in **Appendices A** and **B**, and as shown by the geologic cross section from the 2010 Engineering Report prepared by Black & Veatch Corp. (see **Appendix C**), the Cell 3 CCR unit is not located in on-site or local soil conditions that may result in significant differential settling. The site soils consist primarily of stiff to hard clays overlaying hard clayshale weathered from shale bedrock. Because the clays are stiff to hard, they are not susceptible to appreciable differential settlement that would affect the performance of the CCR landfill. As a result, **the requirements in 40 CFR §257.64(b)(1) are met.**

"(2) On-site or local geologic or geomorphologic features; and"

As discussed in **Appendices A**, **B**, and **E**, and as shown by the geologic cross section in **Appendix C**, the Cell 3 CCR unit is not located in on-site or local geologic or geomorphologic features that are unstable. The cross section shows stiff to hard clays overlaying hard clayshale weathered from shale bedrock. These geologic features provide a stable foundation for the CCR landfill. This assessment is confirmed by the slope stability analysis in **Appendix D** that indicates the slope stability safety factors are acceptable. As a result, **the requirements in 40 CFR §257.64(b)(2) are met.**

(3) "On-site or local human-made features or events (both surface and subsurface)."

As shown by the geologic cross section in **Appendix C**, the Cell 3 CCR unit is not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development for the landfill, the historical site use was agricultural with minimal site disturbance.

As discussed in **Appendix E**, groundwater or surface water is unlikely to cause instability. The facility is designed with adequate run-on and run-off control systems, and is constructed above the water table.

As a result of the above mentioned analysis, **the requirements in 40 CFR §257.64(b)(3) are met.**

3.0 REFERENCES

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

Geosyntec Consultants, 2016 Run-on and Run-off Control System Plan for Solid Waste Disposal Facility Registration No. 88448, Sandy Creek Energy Station, McLennan County, Texas.

SCS Engineers, 2020, April 2020 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, TX.

SCS Engineers, 2020, November 2020 Groundwater Monitoring Well, Sandy Creek Energy Station, Sandy Creek Services, LLC.

USGS seismic impact zones map website: https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

Appendix A

Site Description and Geologic Summary

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6/7/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Appendix A

APPENDIX A – SITE DESCRIPTION AND GEOLOGIC SUMMARY

Site Information

The Sandy Creek Solid Waste Disposal Facility encompasses approximately 65 acres, and is located in an agricultural area historically used for pasture and open land. The site location is west of the City of Riesel, McLennan County, Texas. The facility is located near Highway 1860 and Rattlesnake Road.

Regional Geology

The disposal facility site is located in the Blackland Prairies province of the Texas Gulf Coastal plains. This area is located northeast of the Central Texas uplift. Geology of the Blackland Prairies consist of chalks and marls that weather to deep, black clay soils (Physiographic Map of Texas 1996). The site is underlain by two integrated formations, the Lower Taylor Marl Formation (Ozan Formation) and the Wolfe City Formation. In general, the subsurface stratigraphy consists predominantly of high plasticity yellow-brown clays, weathered clayshale, and marl units of fluvial and shallow marine origin (Geotechnical Design Report Revision 0. Sandy Creek Power Partners, Apr. 2009).

Previous Geologic Investigations

The disposal facility area was investigated by Sandy Creek Power Partners prior to construction by performing 11 borings within and adjacent to the facility footprint. One boring was instrumented with a piezometer. The borings extended to depths of up to 73 feet. Split spoon and Shelby tube soil samples were collected from these 11 borings, and from 40 nearby borings for investigation of the generating station, for laboratory testing that includes:

- Moisture content
- Atterberg limits
- Grain size analyses
- Permeability
- Consolidation
- Unconfined compressive strength
- Triaxial compression (unconsolidated undrained and consolidated undrained with pore water pressure measurement)

The boring locations and a geologic cross section are shown in Appendix C.

Based on the results of the subsurface investigation performed prior to disposal facility construction, the soils below the liner system within the facility footprint consist primarily of stiff to hard, fissured, fat clays overlying hard clayshale weathered from shale bedrock. The overconsolidation ratio of the clays is in the range of 2 to 4.

References

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

SCS Engineers, 2020, April 2020 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, Texas.

Appendix B

Liquefaction and Settlement Potential Evaluation

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Brett 5/11/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Appendix B

APPENDIX B – LIQUEFACTION AND SETTLEMENT POTENTIAL EVALUATION

Based on the results of the site investigation borings and laboratory soil test results, the disposal facility soils are not subject to liquefaction or settlement concerns for the performance of the disposal facility.

Liquefaction is the process by which a saturated, loose, cohesionless soil influenced by external forces suddenly loses its shear strength and behaves as a fluid. The external forces result from ground motion from an earthquake. The disposal facility site soils in borings consist primarily of stiff to hard clay that is not subject to liquefaction. In addition, liquefaction is not a concern given the low magnitude (<0.04g, 2 percent in 50 years) of maximum ground accelerations expected in the area; see Attachment B1.

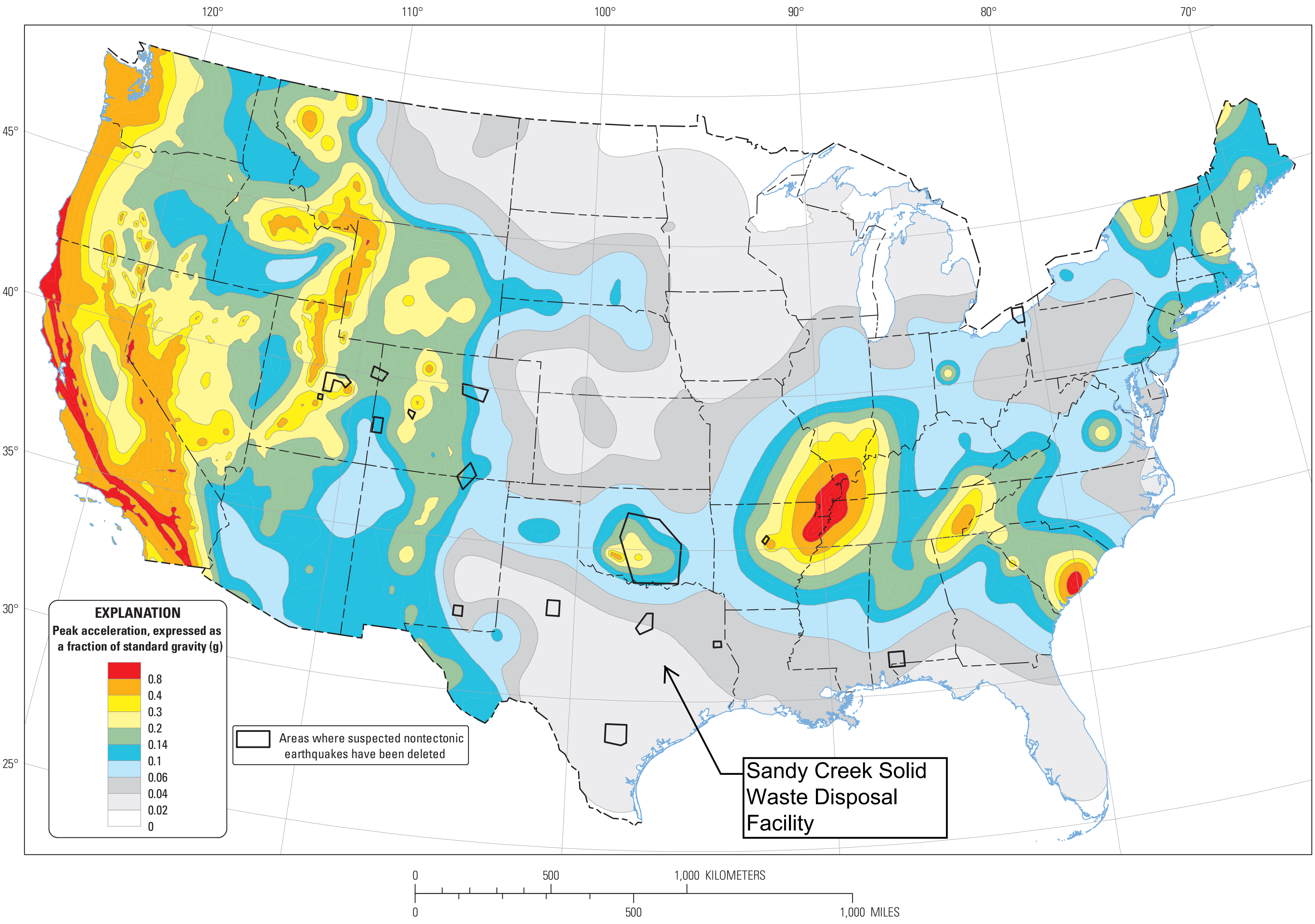
Settlement below a disposal facility can be a concern if the facility is underlain by extensive soft, fine-grained soils. Soft soils are subject to consolidation settlement depending on the load over the soft soils. The disposal facility soils consist of stiff to hard clay. Because the clays are stiff to hard rather than soft, consolidation settlement is not a concern for the performance of the disposal facility.

References

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

USGS seismic impact zones map website:
https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf



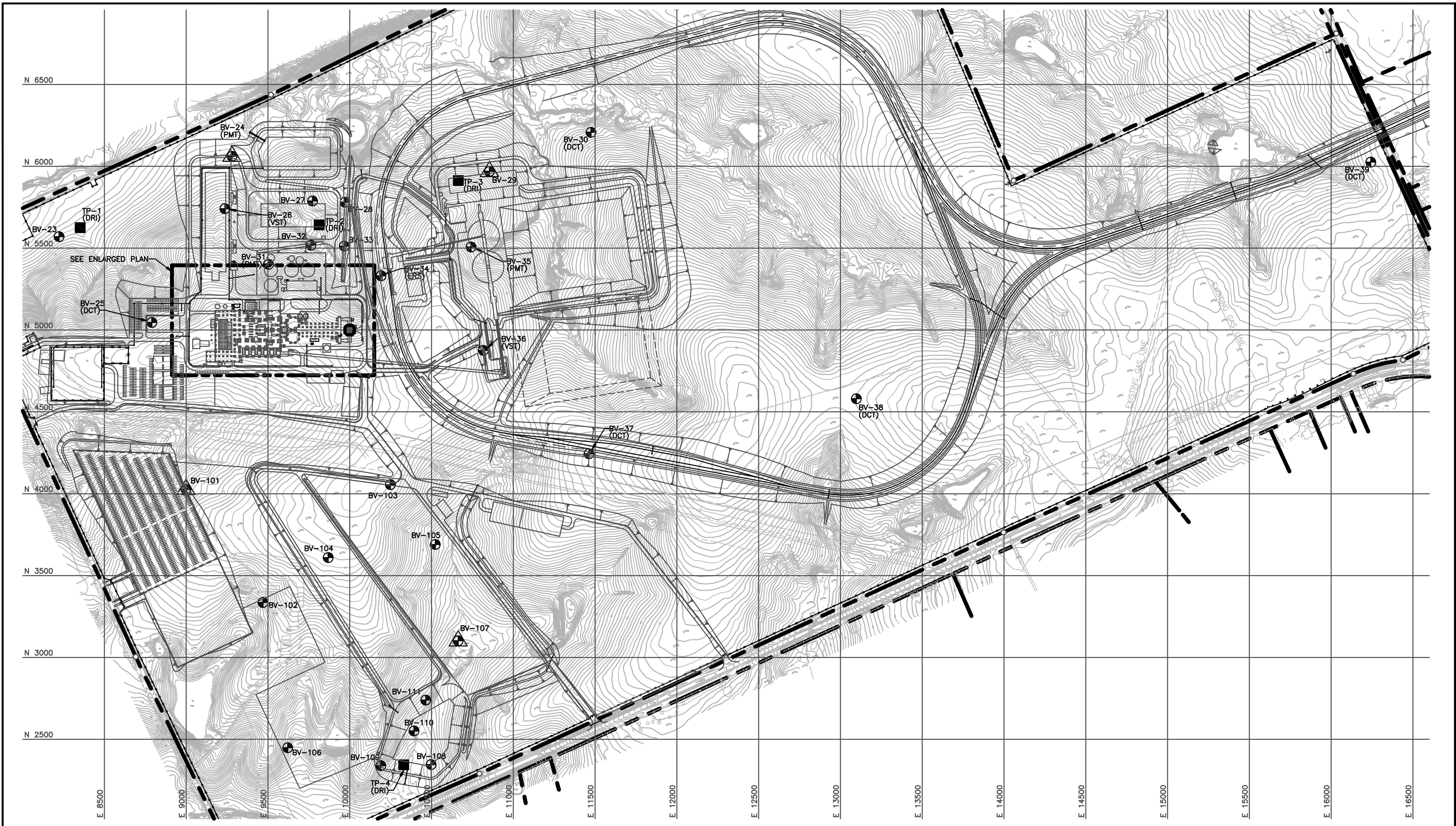
Sandy Creek Solid Waste Disposal Facility

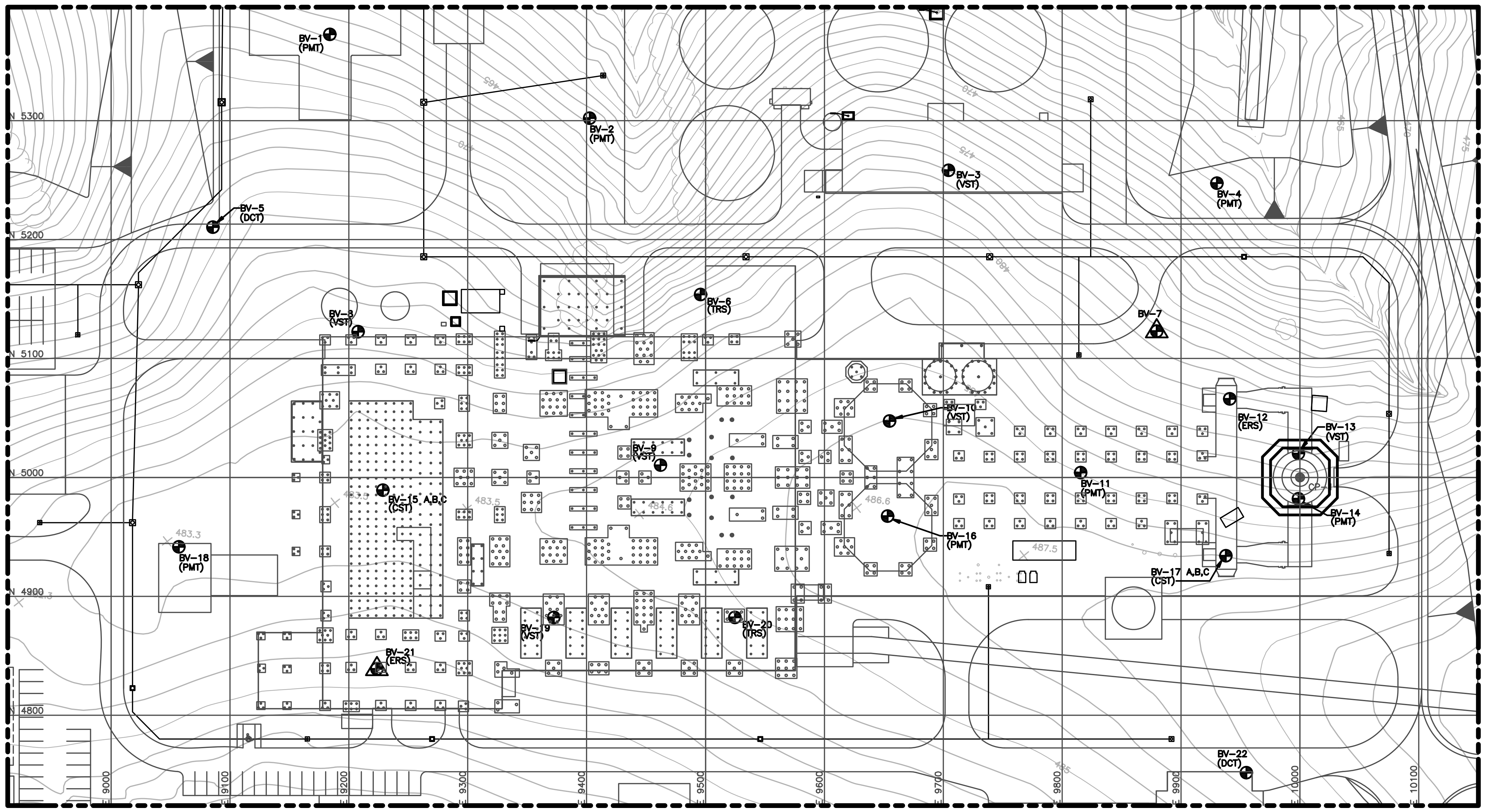
Two-percent probability of exceedance in 50 years map of peak ground acceleration

Source: USGS seismic impact zones map - https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

Appendix C

Boring Locations, Geologic Cross Section, and Boring Logs





BORING LOCATIONS

LOCATION NO.	PLANT GRID NORTHING	PLANT GRID EASTING	STATE PLANE NORTHING	STATE PLANE EASTING	SOIL DRILLING (FT)	ROCK/MARL DRILLING (FT)	REMARKS
BV–1	5372.69	9183.98	10516296.99	3348576.40	50	TOP	PRESSUREMETER TESTING
BV–2	5302.16	9402.55	10516252.73	3348801.76	50	30	PRESSUREMETER TESTING
BV–3	5258.34	9704.39	10516244.84	3349106.65	50	TOP	VANE SHEAR TEST
BV–4	5247.51	9930.16	10516260.72	3349332.13	50	TOP	PRESSUREMETER TESTING
BV–5	5210.50	9085.63	10516124.33	3348497.86	10	–	DYNAMIC CONE TEST
BV–6	5153.86	9495.83	10516116.47	3348911.88	50	30	THERMAL RESISITIVITY SAMPLE
BV–7	5123.01	9879.53	10516131.11	3349296.54	50	TOP	PIEZOMETER
BV–8	5122.58	9207.76	10516051.43	3348629.51	50	30	VANE SHEAR TEST
BV–9	5010.34	9462.12	10515969.98	3348895.34	50	30	VANE SHEAR TEST
BV–10	5047.43	9654.83	10516029.54	3349082.33	50	30	VANE SHEAR TEST
BV–11	5004.06	9815.58	10516005.45	3349247.07	50	30	PRESSURE METER TEST
BV–12	5066.09	9940.97	10516081.83	3349364.26	50	TOP	ELECTRICAL RESISTIVITY SAMPLE
BV–13	5020.13	9998.74	10516043.01	3349427.06	50	TOP	VANE SHEAR TEST
BV–14	4982.05	9998.74	10516005.20	3349431.55	50	30	PRESSUREMETER TESTING
BV–15 A,B,C	4989.27	9228.63	10515921.52	3348665.96	50	50	CROSSHOLE SEISMIC TEST; SAMPLE BORING "A"
BV–16	4967.44	9653.13	10515949.92	3349090.07	50	TOP	PRESSUREMETER TESTING
BV–17 A,B,C	4934.12	9937.68	10515950.40	3349376.57	50	50	CROSSHOLE SEISMIC TEST; SAMPLE BORING "A"
BV–18	4941.61	9057.00	10515853.94	3348501.16	50	TOP	PRESSUREMETER TESTING
BV–19	4882.26	9372.41	10515832.21	3348821.37	50	TOP	VANE SHEART TEST
BV–20	4882.26	9524.72	10515850.18	3348972.62	50	30	THERMAL RESISTIVITY SAMPLE
BV–21	4838.92	9223.59	10515771.61	3348678.70	50	30	ELECTRICAL RESISTIVITY SAMPLE
BV–22	4751.65	9954.93	10515771.24	3349415.22	10	–	DYNAMIC CONE TEST
BV–23	5570.30	8223.48	10516379.91	3347599.29	60	TOP	
BV–24	6061.39	9280.50	10516992.27	3348590.98	50	30	PRESSUREMETER TESTING; PIEZOMETER
BV–25	5046.39	8790.72	10515926.57	3348224.38	10	–	DYNAMIC CONE TEST
BV–26	5741.22	9237.12	10516669.21	3348585.69	50	TOP	VANE SHEAR TEST
BV–27	5788.27	9772.89	10516779.15	3349112.17	50	TOP	
BV–28	5781.05	9971.82	10516795.44	3349310.56	50	TOP	
BV–29	5968.82	10854.20	10517086.00	3350164.62	50	TOP	PIEZOMETER
BV–30	6207.80	11475.28	10517396.58	3350753.17	10	–	DYNAMIC CONE TEST
BV–31	5400.92	9503.72	10516362.74	3348890.57	50	30	PRESSUREMETER TESTING
BV–32	5517.78	9763.70	10516509.46	3349134.95	50	TOP	
BV–33	5512.53	9967.23	10516528.26	3349337.67	50	TOP	
BV–34	5331.33	10191.76	10516374.81	3349582.02	50	30	ELECTRICAL RESISTIVITY SAMPLE
BV–35	5507.28	10741.94	10516614.44	3350107.59	50	TOP	PRESSUREMETER TESTING
BV–36	4875.69	10816.78	10515996.09	3350256.42	50	30	VANE SHEAR TEST
BV–37	4244.12	11462.80	10515445.14	3350972.45	10	–	DYNAMIC CONE TEST
BV–38	4580.25	13097.57	10515971.80	3352556.14	10	–	DYNAMIC CONE TEST
BV–39	6025.94	16242.36	10517778.39	3355508.42	10	–	DYNAMIC CONE TEST
BV–101	4026.14	8999.50	10514938.08	3348552.06	50	TOP	PIEZOMETER
BV–102	3335.46	9470.07	10514307.74	3349100.83	50	TOP	
BV–103	4055.68	10248.88	10515114.81	3349789.23	50	TOP	
BV–104	3609.90	9868.75	10514627.29	3349464.35	50	TOP	
BV–105	3689.96	10523.55	10514784.05	3350105.13	50	TOP	
BV–106	2448.49	9621.23	10513444.80	3349355.58	50	TOP	
BV–107	3101.00	10663.15	10514216.41	3350313.15	50	TOP	PIEZOMETER
BV–108	2345.42	10497.71	10513445.85	3350238.09	50	TOP	
BV–109	2338.85	10190.45	10513403.08	3349933.75	50	TOP	
BV–110	2550.91	10393.32	10513637.59	3350110.19	50	TOP	
BV–111	2739.34	10464.88	10513833.14	3350159.02	50	TOP	
TP–1	5625.45	8352.16	10516449.85	3347720.56	15	–	
TP–2	5642.52	9813.60	10516639.22	3349169.78	15	–	
TP–3	5913.13	10663.96	10517008.25	3349982.28	15	–	
TP–4	2344.08	10330.80	10513424.83	3350072.50	15	–	

LEGEND

⊕ BV–1	BORING LOCATION
△ BV–1	BORING WITH PIEZOMETER LOCATION
■ TP–1	TEST PIT LOCATION
(PMT)	PRESSUREMETER TESTING
(VST)	VANE SHEAR TEST
(CST)	CROSSHOLE SEISMIC TEXT, SAMPLE BORING "A"
(DCT)	DYNAMIC CONE TEST
(TRS)	THERMAL RESISITIVITY SAMPLE
(ERS)	ELECTRICAL RESISITIVITY SAMPLE
(DRI)	DOUBLE RING INFILTROMETER

NOTES

1. ELECTRICAL RESISTIVITY SAMPLE TO BE TAKEN AT DESIGNATED LOCATIONS AT APPROXIMATE DEPTHS OF 2', 4', 10', 15', 20', 30', AND BOTTOM OF BORING.
2. CROSSHOLE SEISMIC TEST REQUIRES 3–100' CASED HOLES LOCATED IN A LINE AT 10' SPACING.
3. THERMAL RESISTIVITY SAMPLE TO BE TAKEN AT DESIGNATED LOCATIONS AT DEPTHS INDICATED BY PURCHASER. SAMPLE TO BE PLACED IN SEALED 5 GALLON BUCKET.

FOR ENGINEERING REPORT
FIGURE 3-1
BORING LOCATION AND INSITU TEST PLAN

NOT TO BE USED
FOR CONSTRUCTION

6°46'31.01"
PLANT GRID
STATE PLANE

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
C	04/11/2008	GENERAL REVISIONS	BEZ	JJD			
B	07/27/2007	REVISED TABLE	SLS	JJD			
A	07/20/2007	ISSUED FOR CONTRACT	SLS	JJD			

300' 150' 0 300' 600'
1"=300'
50' 25' 0 50' 100'
1"=50'

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS

SIGNED ____________

DATE ________ REG NO. ________

BLACK & VEATCH CORPORATION
SCPP
SANDY CREEK ENERGY STATION

ENGINEER JCB
DRAWN SLS
CHECKED
DATE

SANDY CREEK ENERGY STATION
UNIT 1

SUBSURFACE INVESTIGATION
BORING LOCATION AND ISITU TEST PLAN

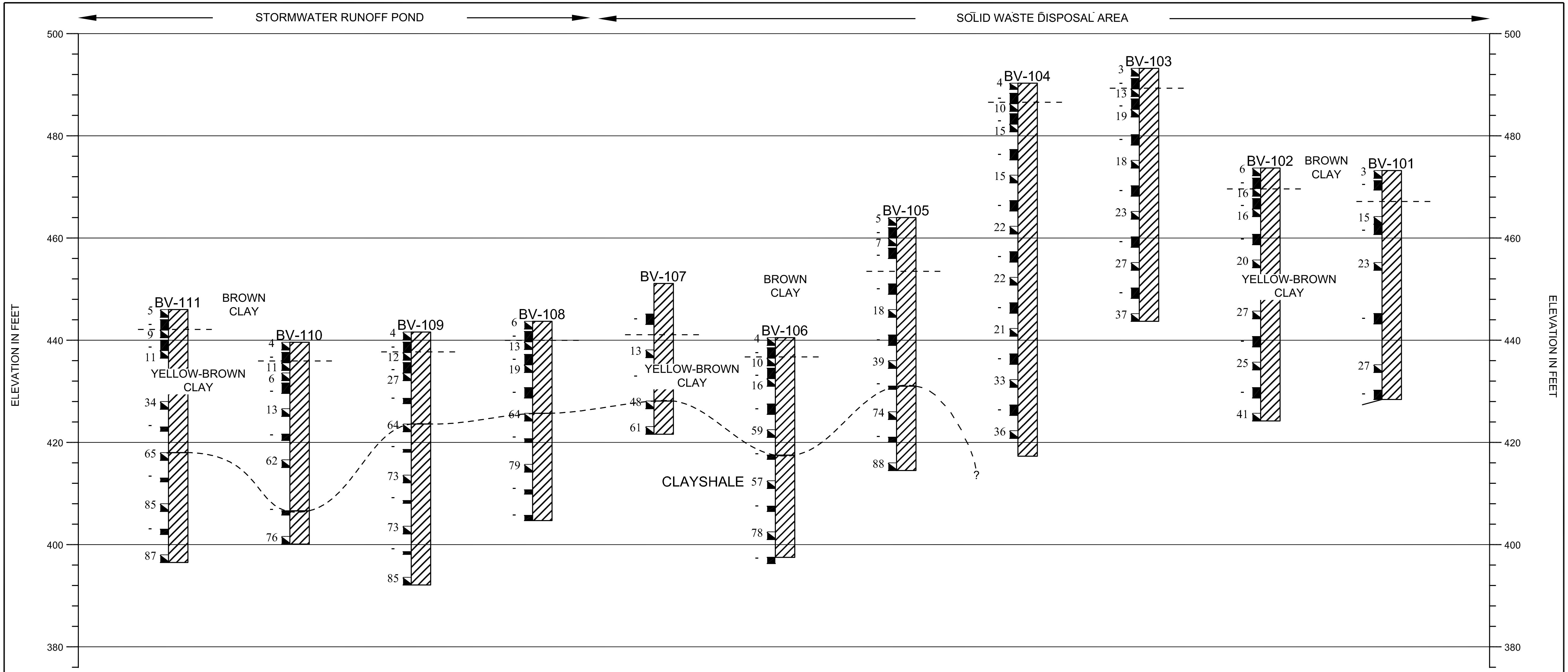
PROJECT DRAWING NUMBER
149060–DS–0001

REV
C

CODE

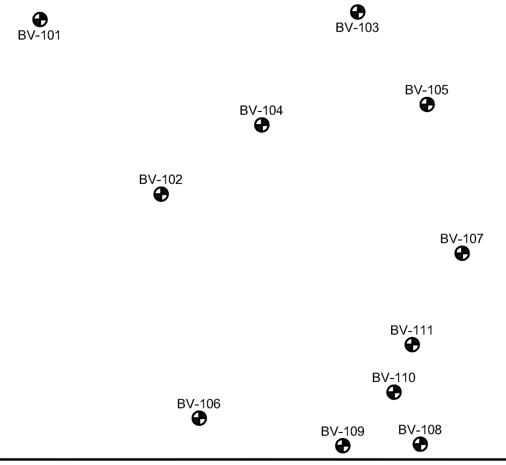
AREA

SEA33930 E1 ACAD 16.1s (LMS Tech)
A1ASL017 1=1
04/11/08 11:24:18



This cross section is included as part of the report and is based on interpretations of the soil borings presented in the report. Actual subsurface conditions may vary from those in this cross section due to conditions not detected during the subsurface investigation. Groundwater levels were generally not measured due to the use of rotary wash drilling.

PLAN VIEW



LEGEND

▨ CLAY/CLAYSHALE

◪ Standard penetration test

■ Undisturbed thin wall Shelby tube

1	N-VALUE
NR	N-VALUE NOT RECORDED
80	RQD Value
- - -	INDICATES AN APPROXIMATE OR GRADUAL CHANGE

Horizontal
Scale: 1"=(proportional)'

Vertical
Scale: 1"=20'

PROJECT Sandy Creek Energy Station	LOCATION Reisel, Texas
CLIENT Sandy Creek Energy Associates	
PROJECT NO 149060	

FOR ENGINEERING REPORT
FIGURE 5-1
SOLID WASTE DISPOSAL FACILITY (SWDF)
AREA CROSS SECION

GENERAL NOTES

1. SEE DRAWING 149060–SS–01101 FOR STAGE 1 BASE PLAN.
2. SEE DRAWING 149060–SS–01102 FOR STAGE 2 BASE PLAN.
3. SEE DRAWING 149060–SS–01103 FOR STAGE 3 BASE PLAN.
4. DISTURBED AREAS OF NON–ACTIVE CELLS SHALL BE VEGETATED IN ACCORDANCE WITH STATE AND LOCAL BEST MANAGEMENT GUIDELINES FOR STORM WATER POLLUTION PREVENTION.
5. SEE DRAWING 149060–SS–01250 FOR DRAWN DOWN PIPE SECTIONS AND DETAILS.

JOH57765 E1
A1ASL017 1=1
10/08/10 12:54:54
ACAD 16.1s (LMS Tech)

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	18/OCT/10	GENERAL REVISIONS	JCB	JCB	BAG	BAG	MWM
0	29/JUN/09	INITIAL ISSUE	SAC	JCB	BMH	BTM	MWM

80' 40' 0 80' 160'
1"=80'

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS
SIGNED
DATE REG NO.

BLACK & VEATCH CORPORATION
TEXAS FIRM NO. F-258
SCPP
SANDY CREEK ENERGY STATION

ENGINEER JCB
DRAWN SAC
CHECKED BMH
DATE 29/JUN/09

SANDY CREEK ENERGY STATION
UNIT 1

SOLID WASTE DISPOSAL FACILITY
35 YEAR BASE PLAN

PROJECT DRAWING NUMBER 149060–SS–01100
REV 1
CODE
AREA

Appendix A

Boring and Piezometer Logs

BLACK & VEATCH

BORING LOG

BORING NO. BV-101

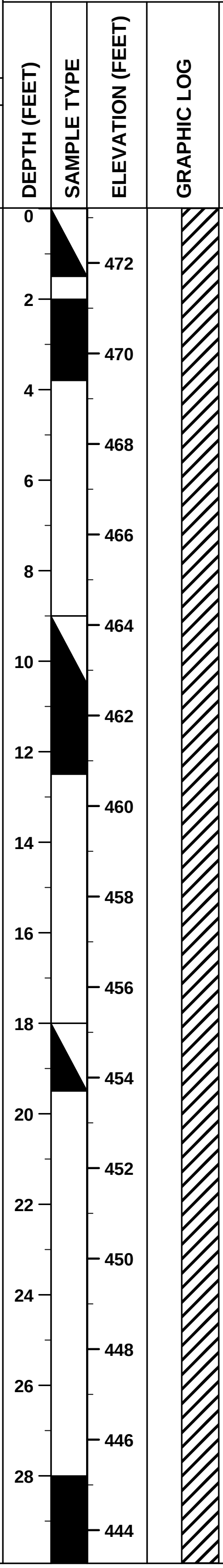
SHEET 1 OF 2

CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 4026.0'	E 8990.0'	473.2 ft (MSL)	44.8 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Side of hill; weed cover	PLANT	08/08/2007	08/08/2007

LOGGED BY	CHECKED BY	APPROVED BY
JJ Deeken	V Bhadriraju	BL Christensen



SOIL SAMPLING								
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING								
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
SPT	1	2	1	2	3	0.2	CLAY; brown; soft; moist; low plasticity; w/some sand & gravel (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. @4' PP=4.5 tsf
TW	2	1.8	-	-	-	1.5	grading yellow-brown; stiff; w/some gypsum seams; trace cemented clay seams	
SPT	3	6	7	8	15	1.5	grading w/1/4" cemented clay nodules	
							cemented clay nodules grades out	PP=4.25 tsf
TW	4	2.0	-	-	-	2.0		
SPT	5	7	11	12	23	1.5	grading w/some cementation	
TW	6	2.0	-	-	-	1.4	grading mottled gray	

BLACK & VEATCH

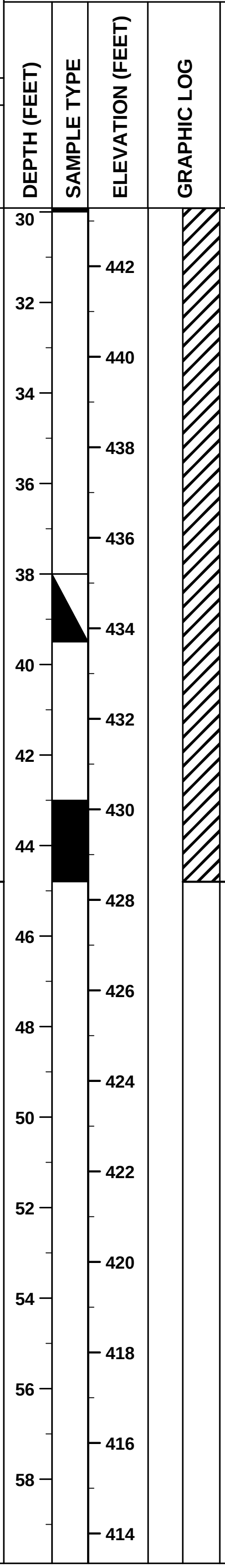
BORING LOG

BORING NO. BV-101

SHEET 2 OF 2

CLIENT	Sandy Creek Energy Associates
PROJECT	Sandy Creek Energy Station
PROJECT NO.	149060
PROJECT LOCATION	Reisel, Texas
COORDINATES	N 4026.0' E 8990.0'
GROUND ELEVATION (DATUM)	473.2 ft (MSL)
TOTAL DEPTH	44.8 (feet)
SURFACE CONDITIONS	Side of hill; weed cover
COORDINATE SYSTEM	PLANT
DATE START	08/08/2007
DATE FINISHED	08/08/2007
LOGGED BY	JJ Deeken
CHECKED BY	V Bhadriraju
APPROVED BY	BL Christensen

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	CLASSIFICATION OF MATERIALS	REMARKS
SPT	7	10	13	14	27	1.5	grading very stiff	
TW	8	1.8	-	-	-	1.8	grading dark gray; fissile	
								Bottom of boring @ 44.8'. Water level not recorded. Boring backfilled w/ bentonite chips.



BLACK & VEATCH

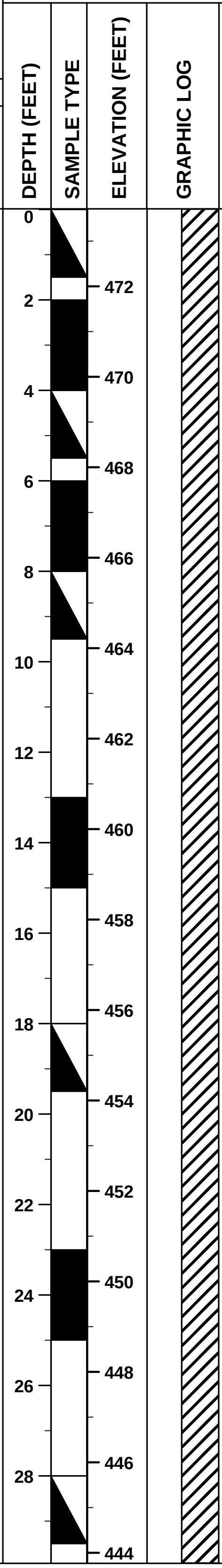
BORING LOG

BORING NO. BV-102
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3335.0' E 9470.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS High weeds; boring offset 150' east	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07	**DATE FINISHED** 8/3/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD
SPT	1	3	3	3	6	0.9
TW	2	2.0	-	-	-	2.0
SPT	3	7	8	8	16	1.5
TW	4	2.0	-	-	-	2.0
SPT	5	7	8	8	16	1.3
TW	6	2.0	-	-	-	2.0
SPT	7	7	9	11	20	1.5
TW	8	2.0	-	-	-	2.0
SPT	9	10	12	15	27	1.5



CLASSIFICATION OF MATERIALS

CLAY: brown; firm; moist; high plasticity
(6" Topsoil)

@ 3.0' grading gray-brown; very stiff; w/some sand & 1" subrounded gravel
sand grades out

grading mottled yellow-brown-gray

grading w/occasional white cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@4' PP>4.5 tsf

4/11/2008 1:21 PM SCEA - Sandy Creek Energy Station

BLACK & VEATCH

BORING LOG

BORING NO. BV-102
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 3335.0' E 9470.0'
GROUND ELEVATION (DATUM)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS High weeds; boring offset 150' east
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/3/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30					
							32		442			
TW	10	2.0	-	-	-	2.0	34		440			
							36		438			
SPT	11	9	11	14	25	1.5	38		436			
							40		434			
							42		432			
TW	12	2.0	-	-	-	2.0	44		430			
							46		428			
SPT	13	15	18	23	41	1.5	48		426		grading hard	
							50		424			Bottom of boring at 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							52		422			
							54		420			
							56		418			
							58		416			
									414			

BLACK & VEATCH

BORING LOG

BORING NO. BV-103
SHEET 1 OF 2

CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 4056.0'	E 10249.0'	493.2 ft (MSL)	49.5 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Rolling hills, tall weeds	Plant	8/1/07	8/1/07

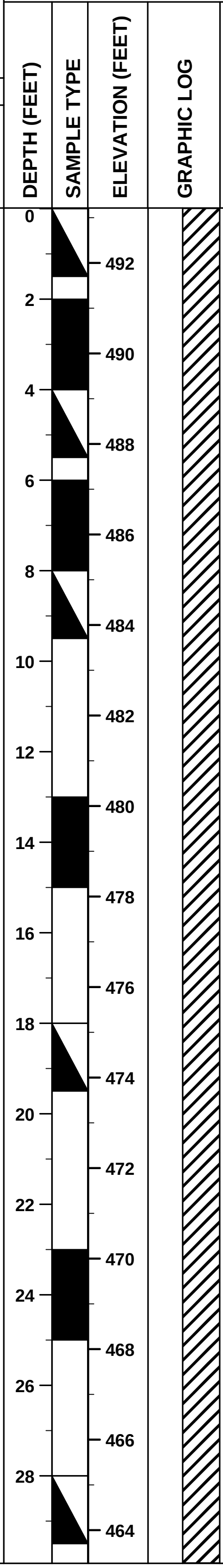
LOGGED BY	CHECKED BY	APPROVED BY
JJ Deeken	JJ Deeken	BL Christensen

SOIL SAMPLING

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
SPT	1	2	2	1	3	0.8
TW	2	2.0	-	-	-	2.0
SPT	3	2	5	8	13	1.5
TW	4	2.0	-	-	-	1.6
SPT	5	5	8	11	19	1.5
TW	6	2.0	-	-	-	2.0
SPT	7	6	8	10	18	1.5
TW	8	2.0	-	-	-	2.0
SPT	9	7	11	12	23	1.5

ROCK CORING

CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD



CLASSIFICATION OF MATERIALS

CLAY: brown; soft; moist; high plasticity (6" Topsoil)

grading stiff

grading yellow-brown & gray seams

grading very stiff

grading w/quartz seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

@2' PP=2.0 tsf

@4' PP=2.5 tsf

@6' PP=4.5 tsf

Reacts w/HCL

PP=4.5 tsf

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BORING LOG

BORING NO. BV-103
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 4056.0' E 10249.0'
GROUND ELEVATION (DATUM) 493.2 ft (MSL)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS Rolling hills, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/1/07
DATE FINISHED 8/1/07
LOGGED BY JJ Deeken
CHECKED BY JJ Deeken
APPROVED BY BL Christensen

SOIL SAMPLING												
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD						
							30			▨		
									462	▨		
							32			▨		
								■	460	▨	grading iron oxide staining	PP=4.5 tsf
TW	10	2.0	-	-	-	2.0	34	■		▨		
									458	▨		
							36			▨	@ 36.0' quartz seams grades out	
									456	▨		
							38	◣		▨		
SPT	11	7	12	15	27	1.5		◣	454	▨		
							40			▨		
									452	▨		
							42			▨		
								■	450	▨	grading blue-gray	PP=4.5 tsf
TW	12	2.0	-	-	-	2.0	44	■		▨		
									448	▨		
							46			▨		
									446	▨		
							48	◣		▨	grading hard	
SPT	13	11	17	20	37	1.5		◣	444	▨		
							50					Bottom of boring at 49.5'. Water level not recorded. Boring backfilled with bentonite chips.
									442			
							52					
									440			
							54					
									438			
							56					
									436			
							58					
									434			

BLACK & VEATCH

BORING LOG

BORING NO. BV-104
SHEET 1 OF 3

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3609.0' E 9869.0'	**GROUND ELEVATION (DATUM)** 490.3 ft (MSL)	**TOTAL DEPTH** 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING												
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD						
SPT	1	2	2	2	4	1.2	0		490		CLAY: brown; soft; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
							2		488		grading stiff	
TW	2	2.0	-	-	-	1.7						@2' PP=1.75 tsf
							4		486			@4' PP=2.0 tsf
SPT	3	2	4	6	10	1.5					grading yellow-brown & occasional gray clay seams	
							6		484			
TW	4	2.0	-	-	-	2.0						
							8		482			PP>4.5 tsf
SPT	5	5	6	9	15	1.5						
							10		480			
							12		478			
TW	6	2.0	-	-	-	2.0	14		476			
							16		474			
							18		472			
SPT	7	6	6	9	15	1.5						
							20		470			
							22		468			
											grading fissile	
TW	8	2.0	-	-	-	2.0	24		466			
							26		464			
							28		462		grading very stiff; w/1/4" quartz seams	
SPT	9	7	10	12	22	1.5						

BORING LOG

BORING NO. BV-104
SHEET 2 OF 3

CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 3609.0'	E 9869.0'	490.3 ft (MSL)	73.0 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Top of hill, tall weeds	Plant	8/1/07	8/1/07

LOGGED BY	CHECKED BY	APPROVED BY
JJ Deeken	V Bhadriraju	BL Christensen

SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30		460	▨		
							32		458	▨		
								■		▨	grading w/some 1/8" quartz grains	PP>4.5 tsf
TW	10	2.0	-	-	-	2.0	34	■	456	▨		
							36		454	▨		
							38	◣	452	▨	grading iron oxide staining	
SPT	11	7	10	12	22	1.5		◣		▨		
							40		450	▨		
							42		448	▨		
								■		▨		PP>4.5 tsf
TW	12	2.0	-	-	-	2.0	44	■	446	▨		
							46		444	▨		
							48	◣	442	▨		
SPT	13	8	9	12	21	1.5		◣		▨		
							50		440	▨		
							52		438	▨		
TW	14	2.0	-	-	-	2.0	54	■	436	▨		
							56		434	▨		
							58	◣	432	▨	grading hard; w/occasional quartz seams	
SPT	15	10	14	19	33	1.5		◣		▨		

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BORING LOG

BORING NO. BV-104
SHEET 3 OF 3

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 3609.0' E 9869.0'
GROUND ELEVATION (DATUM) 490.3 ft (MSL)
TOTAL DEPTH 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/1/07
DATE FINISHED 8/1/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

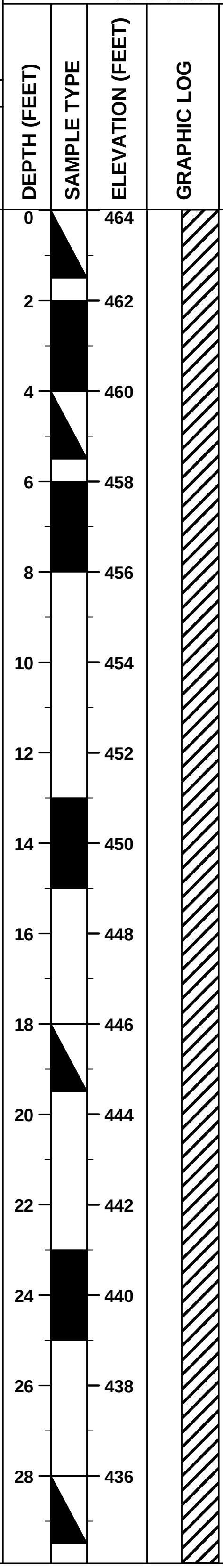
SOIL SAMPLING												
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY						
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							60		430			
							62		428			
											grading blue-gray & yellow-brown seams; quartz seams grades out	PP>4.5 tsf
TW	16	2.0	-	-	-	2.0	64		426			
							66		424			
							68		422			
SPT	17	14	16	20	36	1.5						
							70		420			
							72		418			
												Bottom of boring at 73.0'. Water level not recorded. Boring backfilled w/ bentonite chips.
							74		416			
							76		414			
							78		412			
							80		410			
							82		408			
							84		406			
							86		404			
							88		402			

BLACK & VEATCH

BORING LOG

BORING NO. BV-105
SHEET 1 OF 2

CLIENT: Sandy Creek Energy Associates
PROJECT: Sandy Creek Energy Station
PROJECT NO.: 149060
PROJECT LOCATION: Reisel, Texas
COORDINATES: N 3690.0' E 10524.0'
GROUND ELEVATION (DATUM): 464.0 ft (MSL)
TOTAL DEPTH: 49.5 (feet)
SURFACE CONDITIONS: Side hill, tall weeds
COORDINATE SYSTEM: Plant
DATE START: 8/1/07
DATE FINISHED: 8/1/07
LOGGED BY: JJ Deeken
CHECKED BY: V Bhadriraju
APPROVED BY: BL Christensen



SOIL SAMPLING								
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING								
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
SPT	1	2	2	3	5	0.8	CLAY: brown; firm; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. @2' PP=2.0 tsf @3.5' PP=2.0 tsf @6' PP=2.8 tsf
							grading stiff	
TW	2	2.0	-	-	-	1.5		
							grading firm	
SPT	3	3	3	4	7	1.5		
							grading yellow-brown & gray seams; very stiff	
TW	4	2.0	-	-	-	1.7		
							grading fissile	PP>4.5 tsf
TW	5	2.0	-	-	-	2.0		
SPT	6	6	8	10	18	1.5		PP>4.5 tsf
							grading w/occasional cemented quartz seams	PP>4.5 tsf
TW	7	2.0	-	-	-	1.8		
							grading blue-gray; hard; gray seams grades out	PP>4.5 tsf
SPT	8	12	15	24	39	1.5		

BORING LOG

BORING NO. BV-105
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 3690.0' E 10524.0'
GROUND ELEVATION (DATUM) 464.0 ft (MSL)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS Side hill, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/1/07
DATE FINISHED 8/1/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING												
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY						
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30		434	▨		
							32		432	▨		
TW	9	0.6	-	-	-	0.6		■		▨	33.0 CLAYSHALE; gray; hard; moist; high plasticity; fissile	TW refusal
							34		430	▨		
							36		428	▨		
							38		426	▨	grading w/frequent cemetations	
SPT	10	21	32	42	74	1.5		◣		▨		
							40		424	▨		
							42		422	▨		
TW	11	0.9	-	-	-	0.9		■		▨		Thick walled tube driven 100 blows
							44		420	▨		
							46		418	▨		
							48		416	▨		
SPT	12	32	42	46	88	1.5		◣		▨		
							50		414			Bottom of boring at 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							52		412			
							54		410			
							56		408			
							58		406			

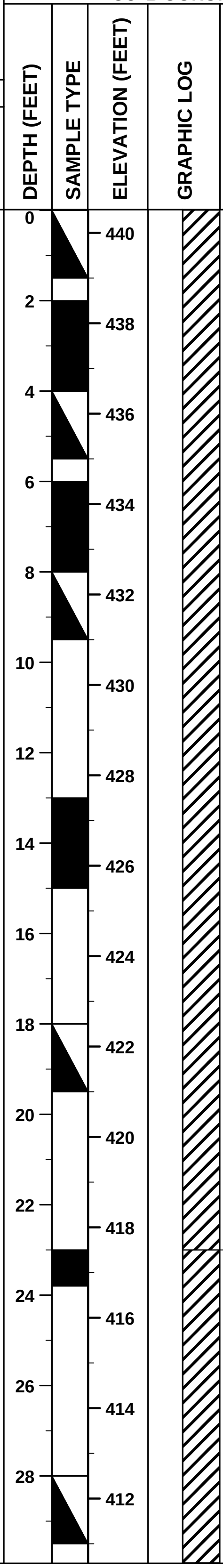
BLACK & VEATCH

BORING LOG

BORING NO. BV-106
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2448.0' E 9621.0'
GROUND ELEVATION (DATUM)
TOTAL DEPTH 44.2 (feet)
SURFACE CONDITIONS Valley, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/3/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	2	2	4	1.0
TW	2	2.0	-	-	-	1.1
SPT	3	2	5	5	10	0.1
TW	4	2.0	-	-	-	2.0
SPT	5	4	6	10	16	0.1
TW	6	2.0	-	-	-	1.8
SPT	7	14	26	33	59	1.5
TW	8	0.8	-	-	-	0.8
SPT	9	20	25	32	57	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; soft; moist; high plasticity; w/trace coarse sand & 1" gravel (6" Topsoil)

grading stiff

grading dark gray; w/some gravel

grading very stiff

grading hard; w/frequent light gray partings; occasional cemented clay seams; gravel grades out

23.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@4' PP=2.2 tsf
Gravel in SPT3

Gravel in SPT5

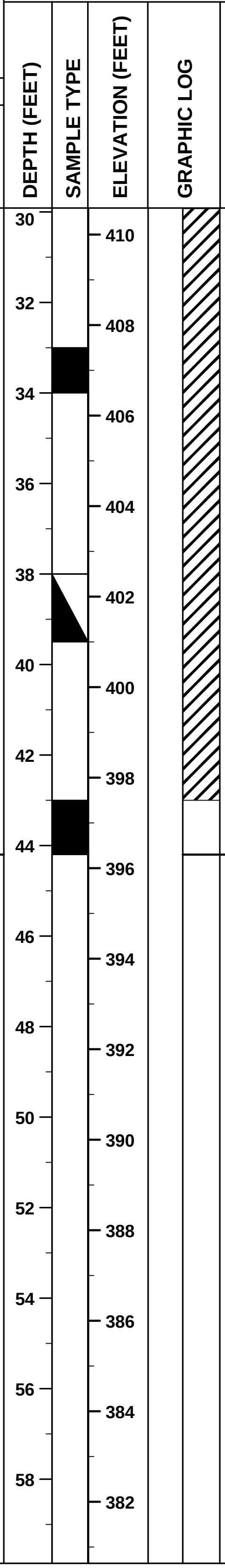
PP>4.5 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-106
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2448.0' E 9621.0'
GROUND ELEVATION (DATUM)
TOTAL DEPTH 44.2 (feet)
SURFACE CONDITIONS Valley, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/3/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen



SOIL SAMPLING								
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING								
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
TW	10	1.0	-	-	-	1.0		Thick walled tube pushed 8", then driven 2".
SPT	11	26	35	43	78	1.5		
TW	12	1.2	-	-	-	1.2		Thick walled tube pushed 4", then driven 10".
								Bottom of boring at 44.2' Water level not recorded. Boring backfilled w/ bentonite chips.

BLACK & VEATCH

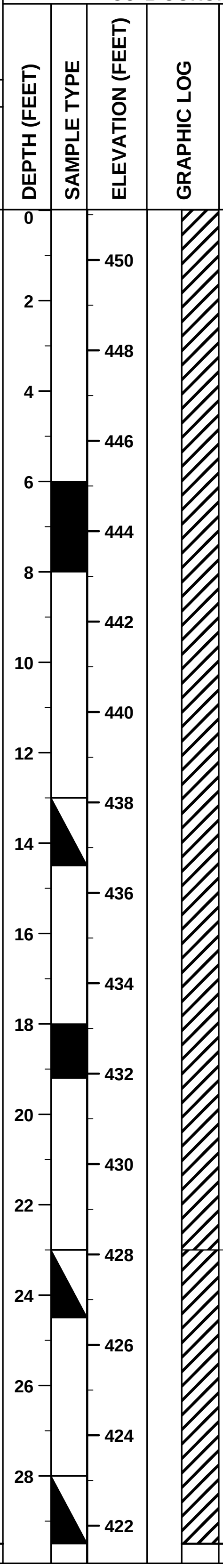
BORING LOG

BORING NO. BV-107

SHEET 1 OF 1

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3101.0' E 10663.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 29.5 (feet)
SURFACE CONDITIONS Natural drainage path, brush cover	**COORDINATE SYSTEM** Plant	**DATE START** 08/09/2007	**DATE FINISHED** 08/09/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	



SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
TW	1	2.0	-	-	-	1.2
SPT	2	4	6	7	13	1.5
TW	3	1.2	-	-	-	1.2
SPT	4	16	20	28	48	1.5
SPT	5	19	25	36	61	1.5

CLASSIFICATION OF MATERIALS	REMARKS
CLAY; brown; moist; high plasticity; w/some gravel; trace sand (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
grading very stiff	PP=2.5 tsf
grading mottled yellow-brown-gray; stiff	
grading dark gray; moist; slightly fissile; w/some cemented clay seams & gravel	TW refusal @ 19.2'
23.0 CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/some gravel	Harder drilling
	Bottom of boring at 29.5'. Water level not recorded. Piezometer installed on 08/ 09/07.

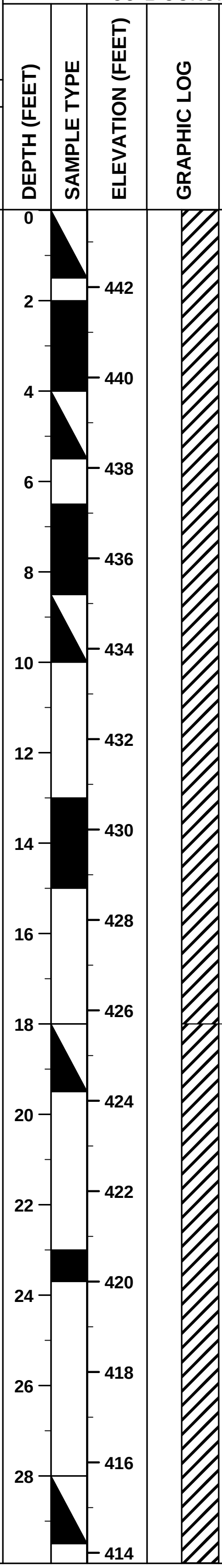
BLACK & VEATCH

BORING LOG

BORING NO. BV-108
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2345.0' E 10497.0'	**GROUND ELEVATION (DATUM)** 443.7 ft (MSL)
TOTAL DEPTH 39.0 (feet)	**SURFACE CONDITIONS** Hill; weeds	**COORDINATE SYSTEM** Plant
DATE START 08/02/2007	**DATE FINISHED** 08/02/2007	**LOGGED BY** JJ Deeken
CHECKED BY V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING							CLASSIFICATION OF MATERIALS	REMARKS
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY		
ROCK CORING								
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
SPT	1	3	3	3	6	1.2	CLAY; brown; firm; moist; high plasticity; w/some sand & 1" gravel (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
TW	2	2.0	-	-	-	2.0	grading yellow-brown	TW-2 disturbed
SPT	3	3	6	7	13	1.5	grading stiff	@2' PP=3.2 tsf @4' PP=3.2 tsf
TW	4	2.0	-	-	-	2.0		TW4 PP=4.0 tsf
SPT	5	7	9	10	19	1.5	grading very stiff; w/some quartz sand	
TW	6	2.0	-	-	-	2.0	grading mottled dark gray	PP>4.5 tsf
							18.0	PP>4.5 tsf
SPT	7	16	26	38	64	1.5	CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/occasional cementation @ 19.5' grading dark gray	
TW	8	0.7	-	-	-	0.7		PP>4.5 tsf
SPT	9	20	33	46	79	1.5		PP>4.5 tsf



BLACK & VEATCH

BORING LOG

BORING NO. BV-108
SHEET 2 OF 2

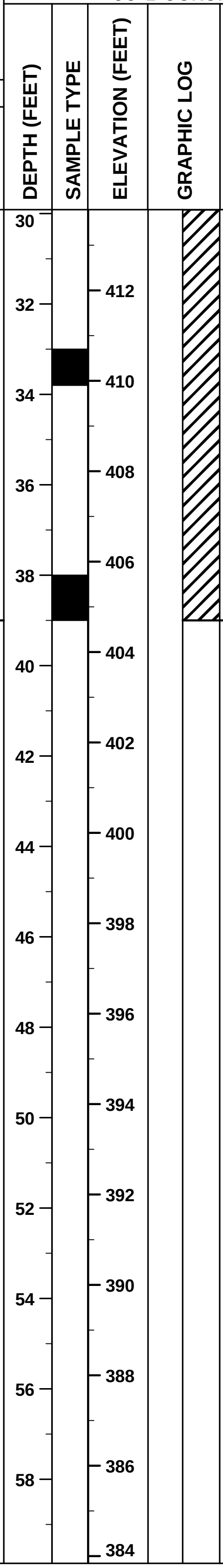
CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2345.0'	E 10497.0'	**GROUND ELEVATION (DATUM)** 443.7 ft (MSL)	**TOTAL DEPTH** 39.0 (feet)

SURFACE CONDITIONS Hill; weeds	**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007

LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
TW	10	0.8	-	-	-	0.8
TW	11	1.0	-	-	-	1.0



CLASSIFICATION OF MATERIALS

REMARKS

Bottom of boring @ 39.0'. Water level not recorded. Boring backfilled w/ bentonite chips.

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BORING LOG

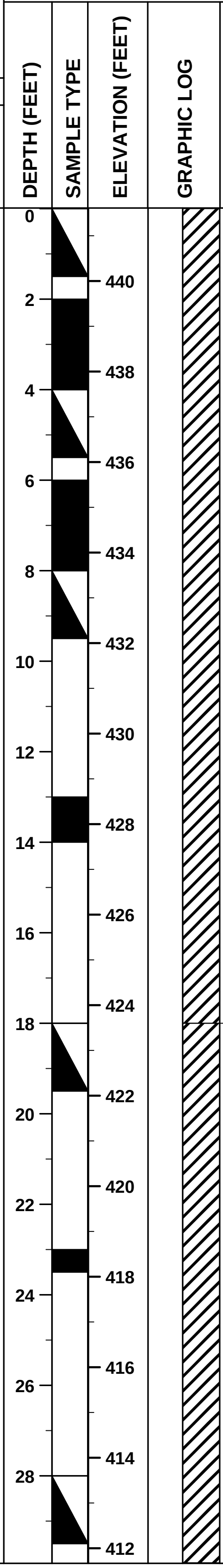
BORING NO. BV-109

SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2339.0' E 10190.0'
GROUND ELEVATION (DATUM) 441.6 ft (MSL)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS Valley; tall weeds
COORDINATE SYSTEM Plant
DATE START 08/02/2007
DATE FINISHED 08/02/2007
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD
SPT	1	3	2	2	4	1.1
TW	2	2.0	-	-	-	1.0
SPT	3	3	6	6	12	1.4
TW	4	2.0	-	-	-	2.0
SPT	5	8	12	15	27	1.5
TW	6	1.0	-	-	-	1.0
SPT	7	17	27	37	64	1.5
TW	8	0.5	-	-	-	0.5
SPT	9	21	32	41	73	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; soft; moist; high plasticity (6" Topsoil)

grading yellow-brown

grading stiff

grading very stiff

grading dark gray

18.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/frequent cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

PP=2.0 tsf

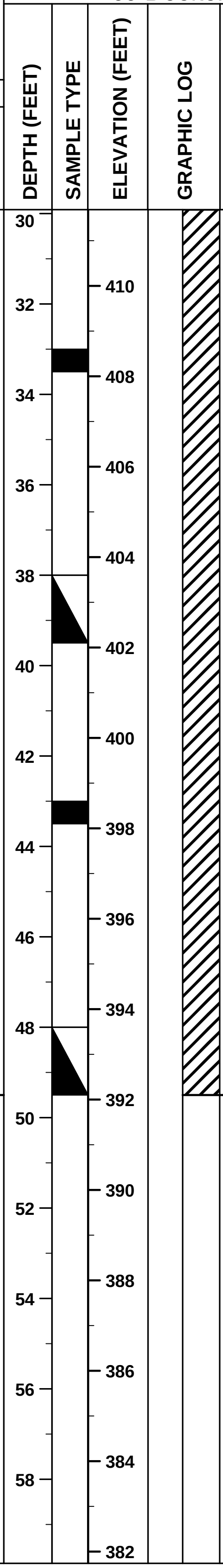
BLACK & VEATCH

BORING LOG

BORING NO. BV-109
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2339.0' E 10190.0'	**GROUND ELEVATION (DATUM)** 441.6 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Valley; tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
TW	10	0.5	-	-	-	0.5
SPT	11	22	32	41	73	1.5
TW	12	0.5	-	-	-	0.5
SPT	13	27	39	46	85	1.5



CLASSIFICATION OF MATERIALS

REMARKS

Tube end crushed.

Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.

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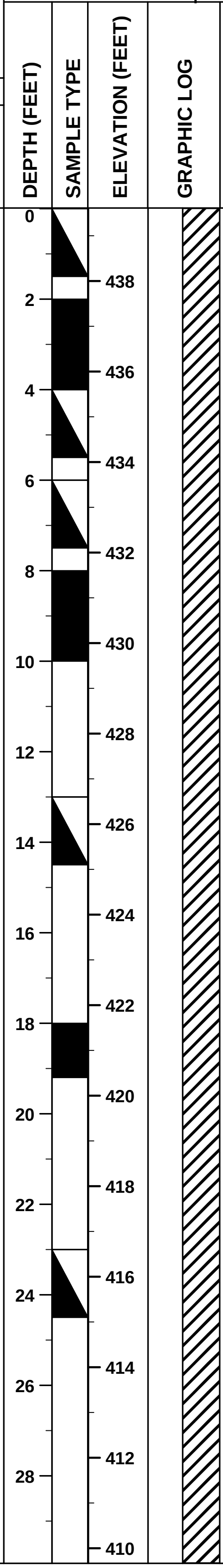
BORING LOG

BORING NO. BV-110
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2551.0' E 10393.0'
GROUND ELEVATION (DATUM) 439.6 ft (MSL)
TOTAL DEPTH 39.5 (feet)
SURFACE CONDITIONS Valley/tall weeds
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/4/07
LOGGED BY DE Campbell
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	WOH	2	2	4	1.2
TW	2	2.0	-	-	-	1.1
SPT	3	3	4	7	11	1.0
SPT	4	3	3	3	6	1.3
TW	5	2.0	-	-	-	2.0
SPT	6	3	5	8	13	1.3
TW	7	1.2	-	-	-	1.2
SPT	8	18	26	36	62	1.5



CLASSIFICATION OF MATERIALS

CLAY: brown; soft; moist; high plasticity; w/trace subrounded red fine gravel (6" Topsoil)

grading stiff

grading yellow-brown; firm

@ 10.0' grading mottled gray

grading w/trace cementation; gravel grades out

grading gray

grading hard; w/occasional cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@2' PP=1.5 tsf

PP=2.25 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-110
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2551.0'	E 10393.0'	**GROUND ELEVATION (DATUM)** 439.6 ft (MSL)	**TOTAL DEPTH** 39.5 (feet)
SURFACE CONDITIONS Valley/tall weeds	**COORDINATE SYSTEM** Plant		**DATE START** 8/3/07	**DATE FINISHED** 8/4/07
LOGGED BY DE Campbell	**CHECKED BY** V Bhadriraju		**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30			▨		
							32		408	▨		
TW	9	0.8	-	-	-	0.8	34	■	406	▨	33.0 CLAYSHALE: gray; hard; moist; high plasticity; fissile; w/trace cementation	Tube end crushed.
							36		404	▨		
SPT	10	22	34	43	76	1.5	38	◣	402	▨		
							40		400			Bottom of boring @ 39.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							42		398			
							44		396			
							46		394			
							48		392			
							50		390			
							52		388			
							54		386			
							56		384			
							58		382			
									380			

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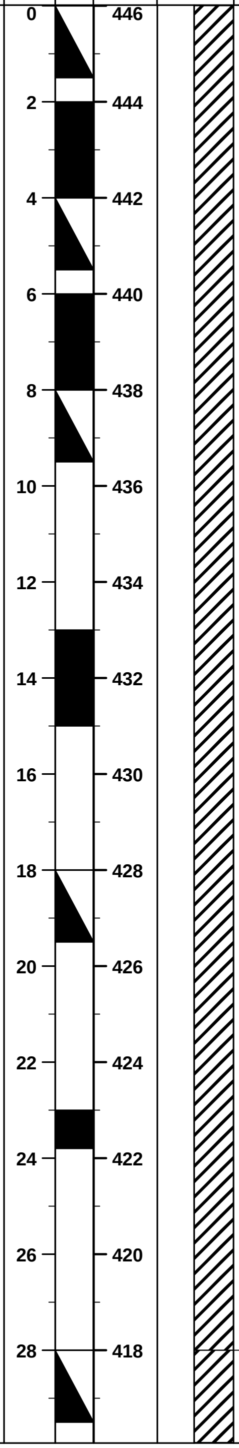
BORING LOG

BORING NO. BV-111
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2739.0' E 10465.0'
GROUND ELEVATION (DATUM) 446.0 ft (MSL)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS tall weeds in valley, heavy rain
COORDINATE SYSTEM Plant
DATE START 08/02/2007
DATE FINISHED 08/02/2007
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	2	3	5	1.2
TW	2	2.0	-	-	-	1.5
SPT	3	2	4	5	9	1.4
TW	4	2.0	-	-	-	1.8
SPT	5	2	4	7	11	1.5
TW	6	2.0	-	-	-	2.0
SPT	7	10	15	19	34	1.5
TW	8	0.8	-	-	-	0.8
SPT	9	20	27	38	65	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; firm; moist; high plasticity
(6" Topsoil)

grading stiff

grading yellow; w/trace sand

@ 9.0' grading yellow-brown

grading hard; w/some sand
@ 18.5' grading w/1" gravel

@ 19.5' grading gray-brown

grading w/occasiional quartz seams

28.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/trace cementation

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

@6' PP=1.5 tsf

@8' PP=3.5 tsf

PP>4.5 tsf

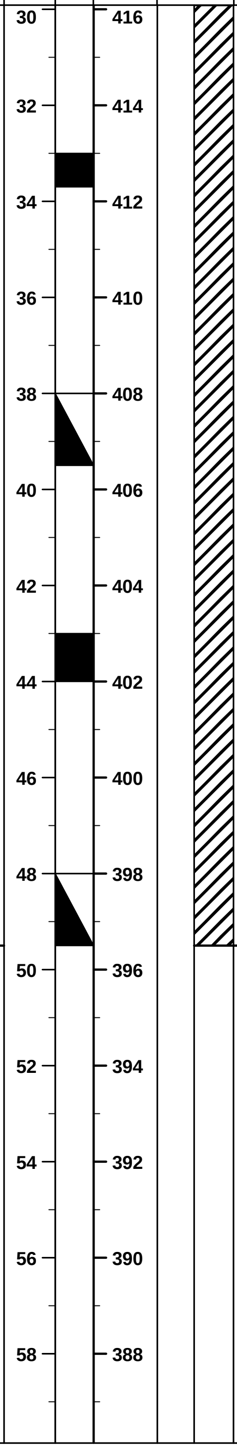
PP>4.5 tsf

BORING LOG

BORING NO. BV-111
SHEET 2 OF 2

CLIENT: Sandy Creek Energy Associates
PROJECT: Sandy Creek Energy Station
PROJECT NO.: 149060
PROJECT LOCATION: Reisel, Texas
COORDINATES: N 2739.0' E 10465.0'
GROUND ELEVATION (DATUM): 446.0 ft (MSL)
TOTAL DEPTH: 49.5 (feet)
SURFACE CONDITIONS: tall weeds in valley, heavy rain
COORDINATE SYSTEM: Plant
DATE START: 08/02/2007
DATE FINISHED: 08/02/2007
LOGGED BY: JJ Deeken
CHECKED BY: V Bhadriraju
APPROVED BY: BL Christensen

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
CORE SIZE	**RUN NUMBER**	**RUN LENGTH**	**RUN RECOVERY**	**RQD RECOVERY**	**PERCENT RECOVERY**	**RQD**
TW	10	0.7	-	-	-	0.7
SPT	11	23	44	41	85	1.5
TW	12	1.0	-	-	-	1.0
SPT	13	30	40	47	87	1.5



CLASSIFICATION OF MATERIALS

grading dry to moist

REMARKS

Thick walled tube driven.

Thick walled tube driven.

Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.

Appendix D

Slope Stability Analysis

SCS ENGINEERS Environmental Consultants & Contractors

June 2021
File No. 16220089.00

TECHNICAL MEMORANDUM

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED
PROFESSIONAL ENGINEER
6/7/21

SCS Engineers
TBPE Reg. #F-3407

ANALYSIS BY: Keith Gilkey
Deb Nelson

REVIEWED BY: Phil Gearing
Dave Hendron
Brett DeVries

SUBJECT: Slope Stability Analysis
Unstable Areas Compliance Demonstration Report
Cell 3
Sandy Creek Solid Waste Disposal Facility
Sandy Creek Energy Station

BACKGROUND AND PURPOSE

The following slope stability analysis has been prepared to calculate slope stability safety factors for Cell 3 of Sandy Creek Services, LLC's Sandy Creek Energy Station Solid Waste Disposal Facility (Facility). Future CCR units beyond Cell 3 are not addressed and are not discussed further herein. The slope stability analysis is part of the Unstable Areas Compliance Demonstration to meet Title 40, Code of Federal Regulation (CFR) §257.64. The analyses cross section locations are shown in **Attachment D2**. Cell 3 has waste slopes of 3.5 horizontal to 1 vertical (3.5H:1V).

CONCLUSION

Based on the slope stability analysis results in **Attachments D1** and **D4**, SCS Engineers (SCS) calculated slope stability safety factors in the range of 1.53 to 1.79 for Cell 3 using the peak interface friction value of the geomembrane liner. **These results meet the recommended minimum safety factor of 1.5.** The 1.5 minimum slope stability safety factor is based on industry practice for solid waste landfills.

SCS calculated slope stability safety factors in the range of 1.098 to 1.110 for Cell 3 for analyses using the residual interface friction value of the geomembrane liner. **These results meet the recommendation for minimum safety factors exceeding 1.0.** The recommendation for safety factors greater than 1.0 for residual interface friction is based on Stark and Choi (2004), and Thiel and Richardson (2002).

SOIL SHEAR STRENGTH EVALUATION

The soil properties from field and laboratory testing of the site prior to landfill construction are contained in the 2010 Geotechnical Design Report by Black & Veatch (B&V) and the 2009 Engineering

Report by B&V. The site soils are highly plastic, stiff, fissured clays overlying a hard clayshale formed by weathering of the underlying shale bedrock.

The properties of the stiff, fissured clay soils that SCS summarized from information in the aforementioned Reports are given in **Attachment D3**. The test results summarized and plotted in **Attachment D3** show that a conservative, representative undrained shear strength for the clay strata is about 3,000 psf. Therefore, SCS used a value of 3,000 psf in the slope stability analyses.

The slope stability analyses shown in **Attachments D1** and **D4** were performed by SCS for both undrained and drained clay shear strengths. Based on the shear strength test results summarized in **Attachment D3**, SCS used an undrained shear strength of 3,000 psf for the stiff, fissured clay layers and a conservative, representative drained shear strength of 20 degrees for the clay layers. The drained shear strength of 20 degrees is also consistent with drained shear strength recommendations from Stark and Hussain (2012) for clays with liquid limits and clay fraction contents similar to those shown by testing of the Sandy Creek site stiff, fissured clays in **Attachment D3**.

GEOSYNTHETIC INTERFACE FRICTION SHEAR STRENGTH EVALUATION

Geosynthetic interface friction test results for the materials proposed for the Cell 3 liner system were not yet available. SCS performed the Cell 3 slope stability analyses using assumed geosynthetic interface friction values typical for liner construction for MSW landfills. The assumed values were obtained from interface friction tests performed for other SCS landfill projects in Texas with soils similar to those present at Sandy Creek. A peak interface friction value of 20 degrees was obtained from testing the clay liner/textured geomembrane interface for a Texas landfill with clay similar to the Sandy Creek clay. To be conservative, SCS used a peak interface friction of 17 degrees in the Cell 3 slope stability analyses.

The residual interface friction between the clay liner and textured geomembrane liner interface was estimated using the average liquid limit of 69 (**Attachment D3**) and Figure 4 from Stark and Eid (1994). Figure 4 indicates that the residual friction angle with a clay liquid limit of 69 is approximately 10 to 12 degrees. To be conservative, SCS used a residual interface friction angle for the clay liner and textured geomembrane liner interface of 9 degrees in the Cell 3 slope stability analyses.

PORE WATER PRESSURE EVALUATION

For the groundwater piezometric surface, SCS used a piezometric surface for the stability analyses selected based on the groundwater levels in the 2020 Semiannual Groundwater Monitoring Report. The groundwater piezometric surface is below the Cell 3 liner system.

The slope stability analyses assume that the clay liner is not fully saturated and there will be no buildup of pore water pressure within the clay liner below the geomembrane liner. The conditions of saturation of the compacted clay liner must be verified during construction. Specifically, observations must be made throughout construction to prohibit placement of the geomembrane liner on any areas where the compacted clay materials are observed or shown to be saturated.

SLOPE STABILITY ANALYSIS RESULTS

The calculated safety factors for the Cell 3 waste slopes are shown in the summary table in **Attachment D1**. The slopes were analyzed using the Spencer method for circular failure and the Janbu method for sliding block failure.

The stability analysis results in **Attachments D1** and **D4** indicate that the Cell 3 waste slopes have calculated safety factors in the range of 1.53 to 1.79 for peak interface friction when a textured geomembrane liner underlain by the compacted clay liner and overlain by a double-sided geonet geocomposite is used on both floor and sidewalls of the Cell 3 liner system. The safety factors calculated with undrained clay shear strength are in reasonably good agreement with the safety factors calculated with drained clay shear strength. The safety factors are greater than the recommended minimum factor of 1.5 when the peak interface friction value between the clay liner and textured geomembrane is used in the analyses.

The Cell 3 waste slopes have calculated safety factors in the range of 1.098 to 1.110 for residual interface friction between the textured geomembrane liner and compacted clay liner. The safety factors meet the recommendation of a minimum safety factor greater than 1.0 when the residual interface friction value is used in the analyses.

MATERIAL PROPERTIES

Material properties utilized for the undrained clay shear strength slope stability analyses are as shown in the table below, based on the values used for the 2009 stability analyses by B&V for Cells 1 and 2, and an undrained shear strength (cohesion) of 3,000 psf determined by SCS. The geosynthetic liner properties are based on typical values obtained from interface friction testing for SCS solid waste projects in Texas with soils similar to the Sandy Creek site, and the undrained residual strength of clays reported by Stark and Eid (1994).

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Protective Soil Layer	120	20	0
Byproduct	103	27	0
Geosynthetic Liner (Textured Geomembrane, Residual Strength)	58	9	0
Geosynthetic Liner (Textured Geomembrane, Peak Strength)	58	17	0
Compacted Clay Layer	120	0	2,000
Yellow Brown Clay (A)	125	0	3,000
Yellow Brown Clay (B)	125	0	3,000
Yellow Brown Clay (C)	125	0	3,000
ClayShale	130	0	7,000

Material properties utilized for the drained clay shear strength slope stability analyses are as shown in the table below, based on the values used for the 2009 stability analyses by B&V for Cells 1 and 2, and a drained clay shear strength (friction angle) of 20 degrees determined by SCS. The geosynthetic liner properties are based on typical values obtained from interface friction testing for SCS solid waste projects in Texas with soils similar to the Sandy Creek site, and the drained residual strength of clays reported by Stark and Eid (1994).

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Protective Soil Layer	120	20	0
Byproduct	103	27	0
Geosynthetic Liner (Textured Geomembrane, Residual Strength)	58	9	0
Geosynthetic Liner (Textured Geomembrane, Peak Strength)	58	17	0
Compacted Clay Layer	120	20	0
Yellow Brown Clay (A)	125	20	0
Yellow Brown Clay (B)	125	20	0
Yellow Brown Clay (C)	125	20	0
ClayShale	130	0	7,000

REFERENCES

Black & Veatch Corp., Sandy Creek Energy Station, Byproduct Storage Area – Slope Stability, 2009.

Black & Veatch Corp., Sandy Creek Energy Station, Engineering Report – Revision 1, 2010, Sandy Creek Services LLC.

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Koerner, G.R. and D. Narejo, 2005, Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces, GRI Report #30.

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SCS Engineers, 2018, Blossom Prairie Landfill, Soil-Geosynthetic Interface Friction Test Results, Blossom, TX.

Stark, Timothy D. and Manzoor Hussain, 2012, Empirical Correlations – Drained Shear Strength for Slope Stability Analyses, Journal of Geotechnical and Geoenvironmental Engineering, American Society of Civil Engineers.

Stark, T.D. and H. Choi, 2004, Technical Note: Peak Versus Residual Interface Strengths for Landfill Liner and Cover Design, Geosynthetics International, Vol. 11, No. 6.

Stark, Timothy and Hisham Eid, 1994, Drained Residual Strength of Cohesive Soils, Journal of Geotechnical Engineering, Vol. 120, No. 5, American Society of Civil Engineers.

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Thiel, Richard and Gregory Richardson, 2002, GCL Design Guidance Series Part 2: GCL Design for Slope Stability, GFR Magazine, Vol. 20, No. 6.

Geo-Slope International, Ltd., GeoStudio 2016, Version 8.16.2.14053, Slope/W slope stability software.

Attachments:	Calculations organized as follows:
	D1 – Factor of Safety Summary Table
	D2 – Cross Section Locations
	D3 – Clay Test Result Summary Tables and Shear Strength Plots
	D4 – Slope/W Outputs

Slope/W input checked by: Brandon Suchomel

DLN/lmh/PEG/DMH/EJN

Attachment D1

Factor of Safety Summary Table

BRETT J. DeVRIES
128061

6/17/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Attachment D1

Slope Stability Analyses
Factors of Safety Results Summary
Sandy Creek Energy Station - Cell 3 Filling

Byproduct Storage Area Cross Section 1		
Soil and Geomembrane Properties	**Calculated Safety Factor**	**Recommended Min. Safety Factor**
Circular Slip Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 17^{o}	1.532	1.5
Circular Slip Method Drained Clay Shear Strength = 20^{o} Geomembrane Interface Friction of 17^{o}	1.633	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 17^{o}	1.546	1.5
Sliding Block Method Drained Clay Shear Strength = 20^{o} Geomembrane Interface Friction of 17^{o}	1.546	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 9^{o}	1.098	>1.0
Sliding Block Method Drained Clay Shear Strength = 20^{o} Geomembrane Interface Friction of 9^{o}	1.098	>1.0

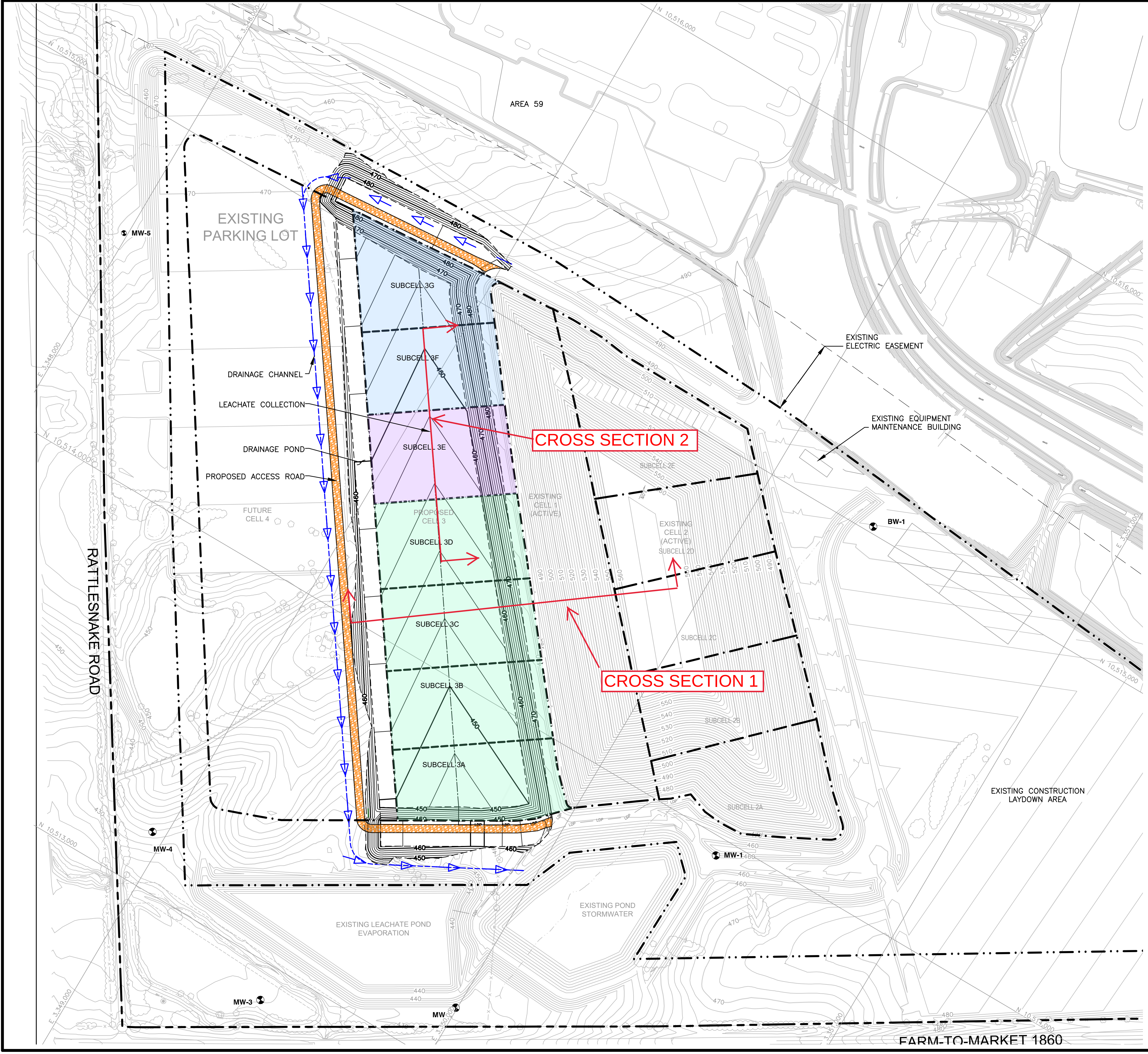
Byproduct Storage Area Cross Section 2		
Soil and Geomembrane Properties	**Calculated Safety Factor**	**Recommended Min. Safety Factor**
Circular Slip Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 17^{o}	1.790	1.5
Circular Slip Method Drained Clay Shear Strength = 20^{o} Geomembrane Interface Friction of 17^{o}	1.711	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 17^{o}	1.552	1.5
Sliding Block Method Drained Clay Shear Strength = 20^{o} Geomembrane Interface Friction of 17^{o}	1.548	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 9^{o}	1.110	>1.0
Sliding Block Method Drained Clay Shear Strength = 20^{o} Geomembrane Interface Friction of 9^{o}	1.105	>1.0

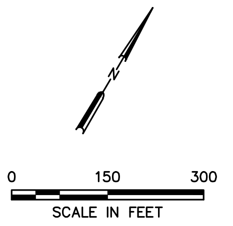
Created by: KRG, 12/31/2020
Last Revision by: PEG, 1/14/2021
Checked by: PEG, 1/14/2021

I:\16220089\Deliverables\Unstable Areas Demonstration\Appendices\Appendix D\[Attachment D1_Factor of Safety Results Summary Table.xlsx]FS Results Summary

Attachment D2

Cross Section Locations





LEGEND

450	EXISTING CONTOURS (SEE NOTE 1, SEE NOTE 4)
	PROPERTY BOUNDARY (SEE NOTE 2)
	PERMIT BOUNDARY (SEE NOTE 2)
	PERMITTED LIMITS OF WASTE (SEE NOTE 2)
	EXISTING CELL BOUNDARY
	PROPOSED CELL BOUNDARY
N 10,516,500 E 3,347,000	STATE PLANE COORDINATES
MW-1	EXISTING MONITORING WELL
LDP LDP LDP	EXISTING FORCEMAIN PIPE
450	PROPOSED EXCAVATION CONTOUR
	PROPOSED LEACHATE COLLECTION
LDP LDP LDP	PROPOSED LEACHATE COLLECTION
	PROPOSED DRAINAGE CHANNEL
▨	PROPOSED ACCESS ROAD
🟩	PHASE 1 (SUBCELLS A–D)
🟪	PHASE 2 (SUBCELL E)
🟦	PHASE 3 (SUBCELLS F–G)

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED USING EXISTING TOPOGRAPHY DATED APRIL 2006 AND DESIGN GRADES CREATED BY BLACK & VEATCH CORPORATION; DESIGN GRADES DEVELOPED BY GEOSYTEC CONSULTANTS, INC. FOR THE LEACHATE EVAPORATION POND AREA. CELL 2 EXCAVATION SURVEY CONDUCTED BY WALKER PARTNERS DATED 7 JANUARY 2013; AND AREA 59 EXISTING TOPOGRAPHY SURVEY CONDUCTED BY WALKER PARTNERS DATED 9 MAY 2013. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL) AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. PROPERTY BOUNDARY, PERMIT BOUNDARY, PERMITTED LIMITS OF WASTE, AND EXISTING CELL BOUNDARY ARE FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS.
3. CONTOURS SHOWN OUTSIDE CELLS 1, 2, AND 3 ARE EXISTING CONTOURS (SEE NOTE 1) AND WITHIN CELLS 1 AND 2 ARE TOP OF WASTE (SEE NOTE 4).
4. INTERIM TOP OF WASTE GRADES ARE IN ACCORDANCE WITH THE SUBCELL 2E FILLING PLAN DEVELOPED BY GEOSYNTEC CONSULTING, DATED JUNE 2014.

CROSS SECTION LOCATIONS

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EXCAVATION PLAN

PROJECT TITLE
**SANDY CREEK ENERGY STATION
SOLID WATE DISPOSAL FACILITY
CELL 3 CONSTRUCTION**

CLIENT
**SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682**

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16220089.00
DSN. BY: BJD
DWN. BY: JLJ
CHK. BY: BJD
Q/A RVW BY: RRK
APP. BY: RRK

CADD FILE: EXCAVATION PLAN

DATE: 10/2020

SCALE: AS SHOWN

DRAWING NO.
1

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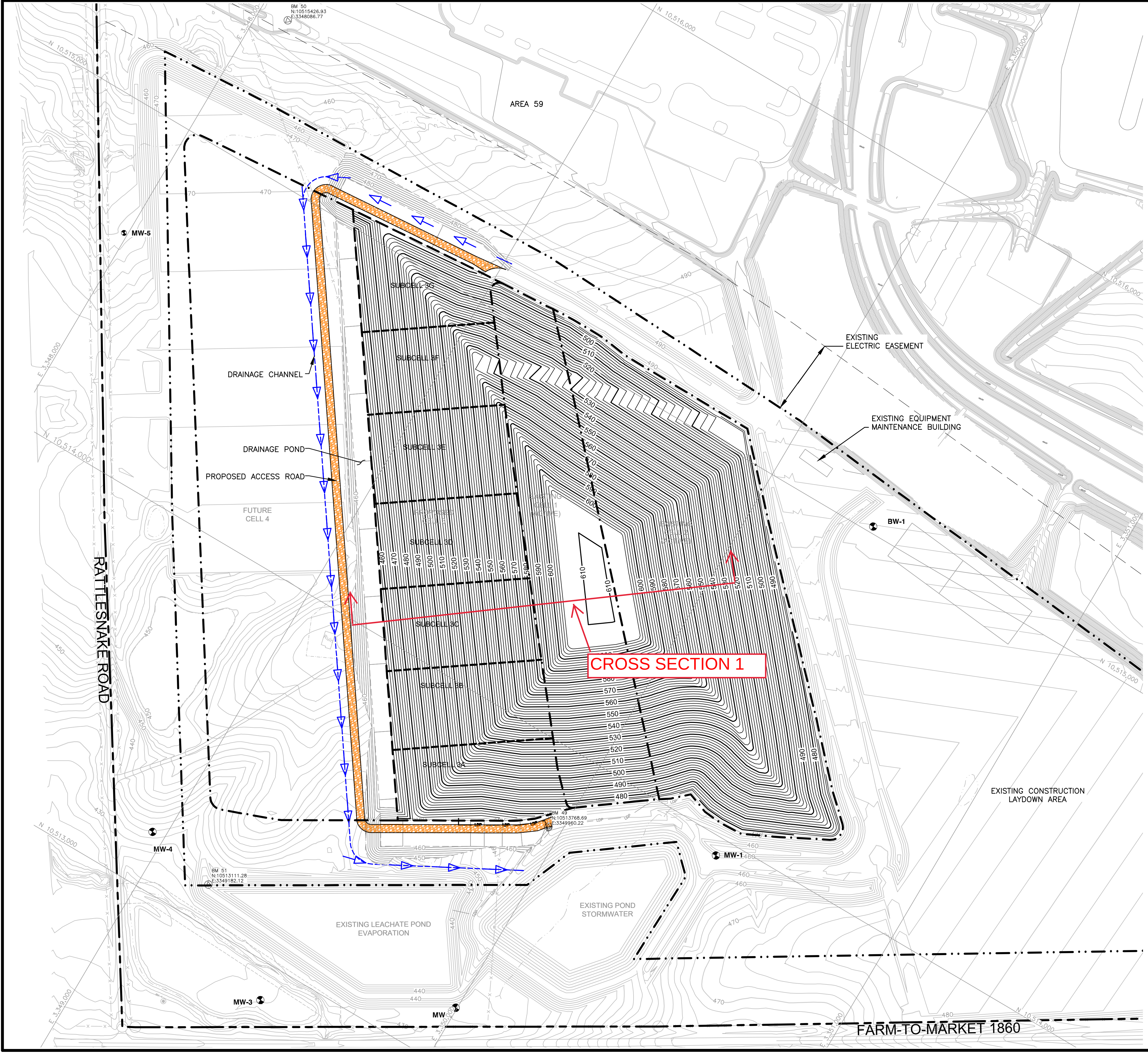

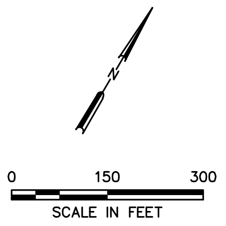

LEGEND

450	EXISTING CONTOURS (SEE NOTE 1, SEE NOTE 4)
	PROPERTY BOUNDARY (SEE NOTE 2)
	PERMIT BOUNDARY (SEE NOTE 2)
	PERMITTED LIMITS OF WASTE (SEE NOTE 2)
	EXISTING CELL BOUNDARY
	PROPOSED CELL BOUNDARY
N 10,516,500 E 3,347,000	STATE PLANE COORDINATES
MW-1	EXISTING MONITORING WELL
LDP	EXISTING FORCEMAIN PIPE
450	PROPOSED INTERIM GRADE CONTOUR
LDP	PROPOSED LEACHATE COLLECTION
	PROPOSED DRAINAGE CHANNEL
🟧	PROPOSED ACCESS ROAD

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED USING EXISTING TOPOGRAPHY DATED APRIL 2006 AND DESIGN GRADES CREATED BY BLACK & VEATCH CORPORATION; DESIGN GRADES DEVELOPED BY GEOSYTEC CONSULTANTS, INC. FOR THE LEACHATE EVAPORATION POND AREA. CELL 2 EXCAVATION SURVEY CONDUCTED BY WALKER PARTNERS DATED 7 JANUARY 2013; AND AREA 59 EXISTING TOPOGRAPHY SURVEY CONDUCTED BY WALKER PARTNERS DATED 9 MAY 2013. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (FT, MSL) AS DEFINED BY THE USGS NATIONAL GEODETIC VERTICAL DATUM (NGVD) OF 1929. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. PROPERTY BOUNDARY, PERMIT BOUNDARY, PERMITTED LIMITS OF WASTE, AND EXISTING CELL BOUNDARY ARE FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS.
3. CONTOURS SHOWN OUTSIDE CELLS 1, 2, AND 3 ARE EXISTING CONTOURS (SEE NOTE 1) AND WITHIN CELLS 1 AND 2 ARE TOP OF WASTE (SEE NOTE 4).
4. INTERIM TOP OF WASTE GRADES ARE IN ACCORDANCE WITH THE SUBCELL 2E FILLING PLAN DEVELOPED BY GEOSYNTEC CONSULTING, DATED JUNE 2014.

CROSS SECTION LOCATIONS

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
PHASE 3 INTERIM COVER PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
SOLID WATE DISPOSAL FACILITY
CELL 3 CONSTRUCTION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16220089.00	DWN. BY: JLJ	Q/A RVW BY: RRK
DSN. BY: BJD	CHK. BY: BJD	APP. BY: RRK

CADD FILE: INTERIM COVER

DATE: 10/2020

SCALE: AS SHOWN

DRAWING NO. 2

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Attachment D3

Clay Test Result Summary Tables and Shear Strength Plots

Laboratory Soil Test Results
Sandy Creek Energy Station

Boring No.	Sample No.	Depth (feet)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	P200 Content (%)	% Clay
BV-1	3	5-6.5	25	74	23	51		
BV-1	5	12-13.5	20	66	27	39		
BV-1	7	22-23.5	23	68	26	42		
BV-2	2	6-7.5	25	74	29	45		
BV-2	6	22-23.5	23					
BV-2	10	42.43.5	18					
BV-2	12	52-53.5	17					
BV-3	3	4-4.5	21	73	28	45		
BV-3	6	15-16.5	21					
BV-3	11	25-26.5	25	71	27	44		
BV-3	15	40-	22					
BV-4	3	7-8.5	27					
BV-4	7	27-28.5	22	69	27	42		
BV-4	11	46-47.5	19					
BV-6	4	13-14.5	26	66	25	41		
BV-6	6	23-24.5	25	66	27	39		
BV-6	10	43-44.5	23	70	30	40		
BV-7	3	6-7.5	26	72	27	45		
BV-7	7	23-24.5	26	71	30	41		
BV-7	9	33-34.5	28					
BV-7	11	43-44.5	23	68	27	41		
BV-8	5	12-15	23	71	31	40		
BV-8	7	20-21.5	26	72	28	44		
BV-8	11	30-35	21					
BV-8	14	40-41.5	23					
BV-8	18	60-61.5	18	66	27	39	98	58
BV-9	2	6-7.5	19	60	20	40		
BV-9	10	35-40	23	65	23	42		
BV-9	13	45-50	21	68	25	43		
BV-10	4	9-10.5	24	75	28	47		
BV-10	8	20-21.5	28					
BV-10	12	35-40	Sample Not Received by the Lab					
BV-10	14	48-49.5	23	78	25	53		
BV-11	4	13-14.5	26	81	23	58		
BV-11	8	32-33.5	24	78	23	55		
BV-11	14	65-66.5	19	69	21	48		
BV-12	4	6-7.5	26	78	23	55		
BV-12	9	39-40.5	24					
BV-13	4	8-9.5	23	80	21	59		
BV-13	8	20-21.5	25	72	23	49		
BV-13	12	30-31.5	24					
BV-13	15	45-46.5	19	75	25	50		
BV-14	2	8-9.5	22	73	21	52		
BV-14	8	37-38.5	22	77	23	54		
BV-14	11	53-54.5	19					
BV-15A	5	8-9.5	28					
BV-15A	7	18-19.5	27	57	23	34	98	50
BV-15A	13	48-49.5	26	70	28	42		
BV-15A	17	78-79.5	20	68	21	47	92	47
BV-16	3	12-13.5	24	73	22	51		
BV-16	5	22-23.5	26					
BV-16	7	32-33.5	26	78	25	53		
BV-16	9	42-43.5	26	72	27	45		
BV-17A	13	48-49.5	22					
BV-17A	15	68-69.5	19					
BV-18	3	12-13.5	23	72	21	51		

Laboratory Soil Test Results
Sandy Creek Energy Station

Boring No.	Sample No.	Depth (feet)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	P200 Content (%)	% Clay
BV-18	10	48-49.5	25	66	26	41		
BV-19	9	25-26.5	23	77	22	55		
BV-19	29	48-49.5	Sample Not Received by the Lab					
BV-20	6	18-19.5	25	67	23	44		
BV-20	8	28-29.5	28					
BV-20	10	38-39.5	29	69	25	44		
BV-20	14	58-59.5	20	66	26	40	99	48
BV-21	3	4-5.5	18	52	17	35		
BV-21	6	10-11.5	25					
BV-21	11	33-34.5	26	77	27	50		
BV-21	13	43-44.5	25					
BV-24	3	6-7.5	23	61	23	38	98	58
BV-24	5	17-18.5	26	68	22	46		
BV-24	7	26-27.5	16	60	24	36		
BV-26	3	5-6.5	24	69	27	42		
BV-26	6	15-16.5	25					
BV-26	9	25-26.5	25	66	25	41		
BV-26	12	35-36.5	19					
BV-31	5	19-20.5	2	66	25	37		
BV-31	7	27-28.5	25	69	24	45		
BV-31	10	50-51.5	18	56	22	34		
BV-34	4	6-7.5	25	72	27	45		
BV-34	9	39-40.5	24					
BV-34	11	59-60.5	21	57	23	34		
BV-35	3	6-7.5	25	67	27	40		
BV-35	6	17-18.5	26					
BV-35	8	27-28.5	25	68	29	39		
BV-35	10	37-38.5	19					
BV-35	11	45-46.5	20	62	28	34		
BV-35		59-60.5					92	42
BV-36	4	6-7.5	22	70	26	44		
BV-36	7	15-16.5	24					
BV-36	12	30-31.5	24	67	24	43		
BV-36	15	45-46.5	22	66	27	39	92	43
BV-36	16	50-51.5	20					

Minimum:	2	52	17	34	92	42
Maximum:	29	81	31	59	99	58
Average:	23	69	25	44	96	49

Created by: LMH Date: 9/11/2018
Last revision by: LMH Date: 9/11/2018
Checked by: DLN Date: 9/24/2018

I:\16215106\[Moisture Content_Atterberg Limits.xlsx]Moisture and Atterberg

Soil Shear Strength Test Results
Sandy Creek Energy Station

							Unconsolidated Undrained Compression		CU Bar *
Boring No.	Depth (ft)		Moisture Content (%)	Dry Density (pcf)	Vane Shear TV (tsf)	Unconfined Compression (ksf)	Confining Pressure (lb/in^2)	Shear Strength (ksf)	Drained Friction Angle (degrees)
BV-1	8	8			2.25				
BV-1	19	19			2.25				
BV-2	8-9	8	11.9	110.1		3.87			
BV-2	18	18			2.5				
BV-2	18-19.8	18	22.8	101.1			14	2.89	
BV-2	18-19.8	18	22.4	103.7			7	3.78	
BV-2	38-38.5	38	15.6	97.6		3.08			
BV-3	8	8			2				
BV-3	8-9	8-9	26.8	99.9			3	4.61	
BV-3	8-9	8-9	23.7	99.8			7	4.05	
BV-3	20-21	20	27.6	96.8		3.29			
BV-3	45-46.1	45	20.8	103.9		4.39			
BV-4	3-5	3	35.4	88.4			7	1.71	
BV-4	3-5	3	28.9	91.2			4	1.26	
BV-6	18-20	18	27.9	97.3			31	3.94	
BV-6	18-20	18	25.2	99.3			21	3.87	
BV-6	18-20	18	44.9	82.9			10	2.57	
BV-6	73-73.5	73	7.1	107.5		0.62			
BV-7	8-9	8	33.6	86		1.73			
BV-7	28-29	28	25.9	98.9			14	3.54	
BV-7	48-49	48	20.1	106.4		3.58			
BV-9	40-41.5	40	23.7	101			56	5.06	
BV-9	40-41.5	40	27.2	92.6			14	4.28	
BV-10	6-7	6	22.5	102.3					
BV-10	11	11			2				
BV-10	15	15			1.5				
BV-10	19	19			2				
BV-11	8-10	8	36.2	90.6	2.25				
BV-11	18-20	18	25.7	99.8			31	3.66	
BV-11	18-20	18	26.3	97.7			21	3.11	
BV-11	18-20	18	27.7	96.9			10	3.37	
BV-11	83	83		137.6		23.93			
BV-12	10-12	10	24.7	101.7			28	5.04	
BV-12	10-12	10	32.9	93.8			14	3.28	
BV-12	10-12	10	25.8	100.1			7	2.38	
BV-12	19-21	19	3.7	119.3		3.29			
BV-13	6-7.5	6	5.7	116.4		7.92			
BV-13	15-16	15	14.5	101.8		2			
BV-13	25-26	25	26.3	98.5			31	3.2	
BV-13	25-26	25	30.5	96.5			11	3.75	
BV-13	40-40.7	40	18.8	96.6		6.36			
BV-14	13-15	13	24.9	100.1		2.54			
BV-14	17	17			1.5				
BV-14	25	25			1.5				
BV-14	23-25	23	28.1	97.2			10	2.16	
BV-14	23-25	23	26.2	100			21	3.23	
BV-14	23-25	23	25.9	99.6			31	3.06	
BV-15A	13-15	13	22.3	104.4		3.25			

Soil Shear Strength Test Results
Sandy Creek Energy Station

							Unconsolidated Undrained Compression		CU Bar *
Boring No.	Depth (ft)		Moisture Content (%)	Dry Density (pcf)	Vane Shear TV (tsf)	Unconfined Compression (ksf)	Confining Pressure (lb/in^2)	Shear Strength (ksf)	Drained Friction Angle (degrees)
BV-15A	33-34.7	33	43.5	75.9			56	0.33	
BV-15A	33-34.7	33	24.2	103.3			24	6.73	
BV-15A	33-34.7	33	25.4	99.9			14	5.01	
BV-15A	43-44.6	43	23.4	101.4		3.52			
BV-15A	58-58.6	58	48.1	73.6		0.14			
BV-16	11	11			2.5				
BV-16	20	20			2				
BV-16	28	28			2				
BV-16	18-20	18	20.7	103.5			28	4.07	
BV-16	18-20	18	25.8	99.1			14	2.82	
BV-16	18-20	18	25.6	100.1			7	2	
BV-17	13-15	13	25.6	100.6			28	3.97	
BV-17	13-15	13	25.2	98			7	2.32	
BV-17	23-25	23	22.3	102.6		3.84			
BV-17	43-44.8	43	24.7	100.9		5.48			
BV-17A	6-8	6	23.5	101.6					
BV-18	8				2.5				
BV-18	18	18			2.5				
BV-18	18-20	18	25.5	99.8			28	3.88	
BV-18	18-20	18	24	101.8			14	3.54	
BV-18	18-20	18	27.6	96.6			7	2.1	
BV-19	10-12	10	24.2	100.9			14	3.05	
BV-19	10-12	10	23.9	99.6			4	2.47	
BV-19	19-21	19	22.3	103.8		2.92			
BV-19	20	20			2.25				
BV-19	24	24			2.25				
BV-19	26	26			2.125				
BV-20	13-15	13	29.1	91.9			28	2.97	
BV-20	13-15	13	26.4	97.7			7	2.84	
BV-20	43-35	43	25.8	96.4					
BV-20	68-68.8	68	20.6	105.2		7.43			
BV-20	78-78.5	78	31.8	96.2		0.97			
BV-21	18-19.8	18	23.4	105.6			28	7.33	
BV-21	18-19.8	18	23.8	105.5			14	7.62	
BV-21	18-19.8	18	24	99.3			7	1.95	
BV-22	6	6			2.25				
BV-24	16	16			1.25				
BV-34	14-16	14	24.4	99.2		3.37			
BV-34	49-49.9	49	23.3	104.9		3.48			
BV-35	9	9			2				
BV-27, 28, 32, & 33			18.1	104.0					20.6
BV-36	25-26.2	25	23.4	108.2			35	4.82	
BV-36	25-26.2	25	16.4	116.4			17	5.13	
BV-36	40-41.4	40	25.7	102.0			42	5.41	
BV-36	40-41.4	40	24	101.9			28	3.81	
BV-37 & 39			18.8	104.4					23.1
BV-103			17.7	103.0					24.6
BV-104			17.4	102.0					16.0

Soil Shear Strength Test Results
Sandy Creek Energy Station

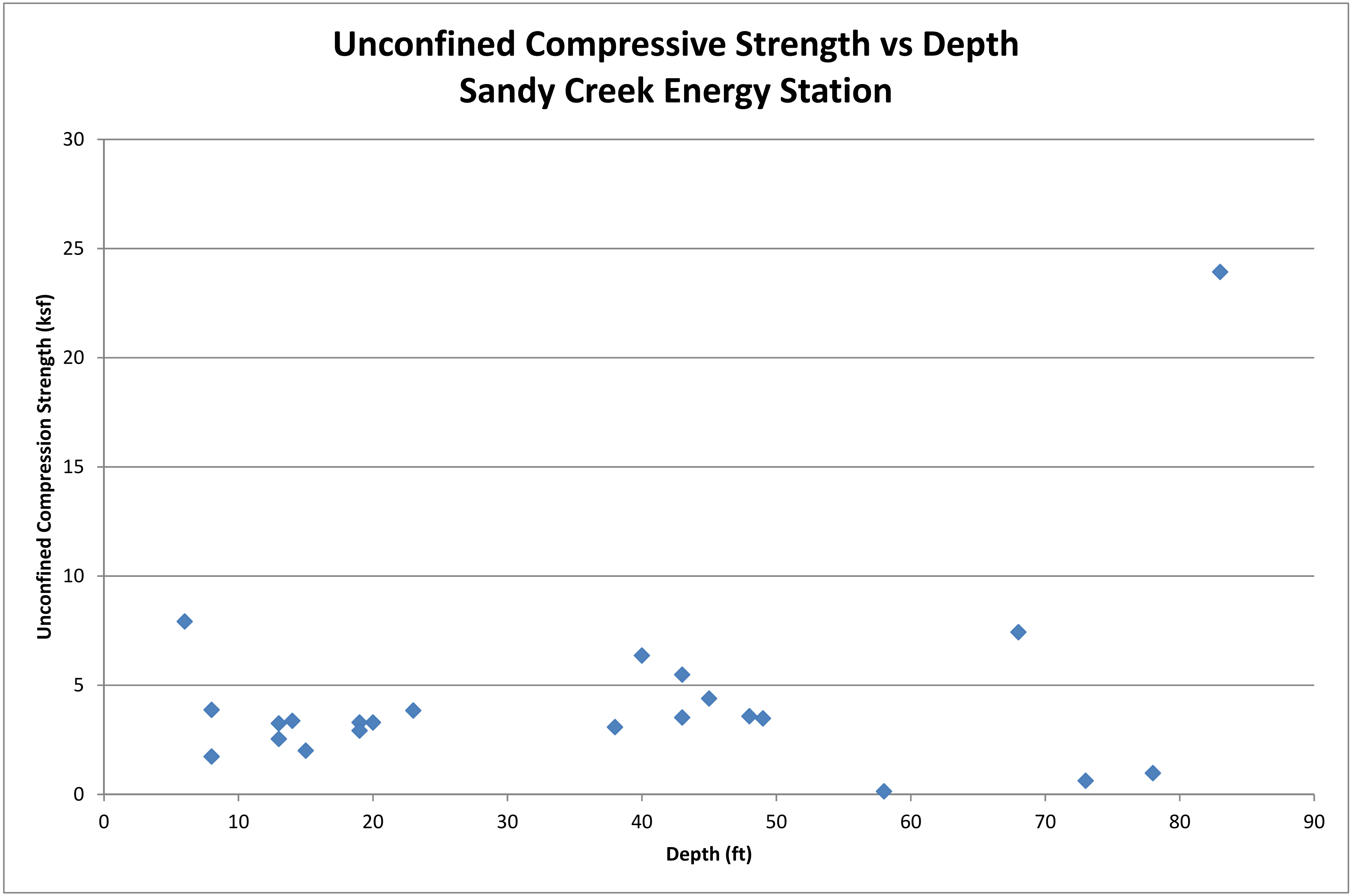
							Unconsolidated Undrained Compression		CU Bar *
Boring No.	**Depth (ft)**		**Moisture Content (%)**	**Dry Density (pcf)**	**Vane Shear TV (tsf)**	**Unconfined Compression (ksf)**	**Confining Pressure (lb/in^2)**	**Shear Strength (ksf)**	**Drained Friction Angle (degrees)**
BV-105			17.7	103.0					30.8
BV-108	38-38.8	38	19.3	108.2			28	9.15	
TP-3			17.2	102.2					20.5

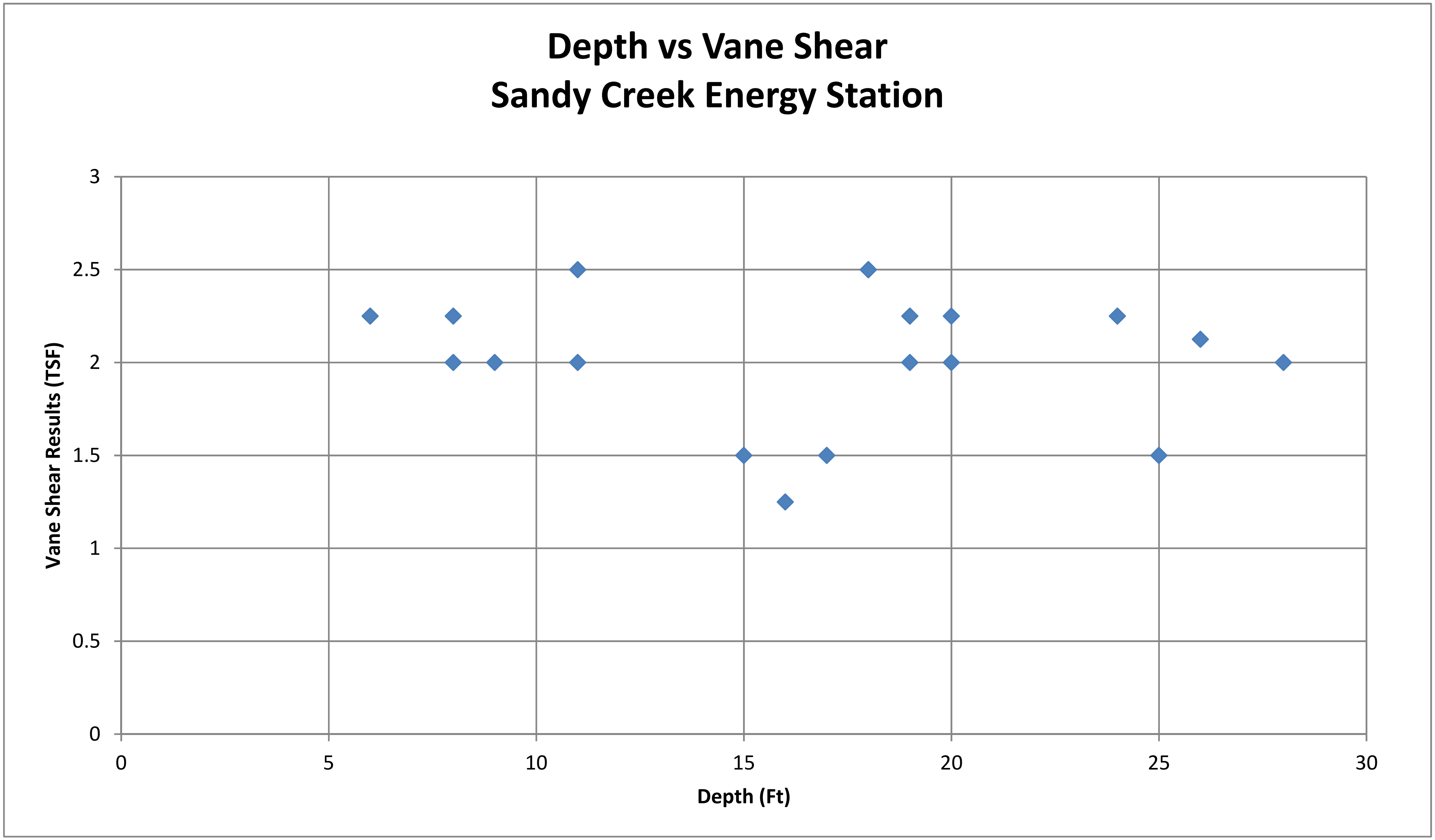
Minimum:			3.7	73.6	1.3	0.14		0.33	16.0
Maximum:			48.1	137.6	2.5	23.93		9.15	30.8
Average:			24.3	100.4	2.1	4.39		3.72	22.6

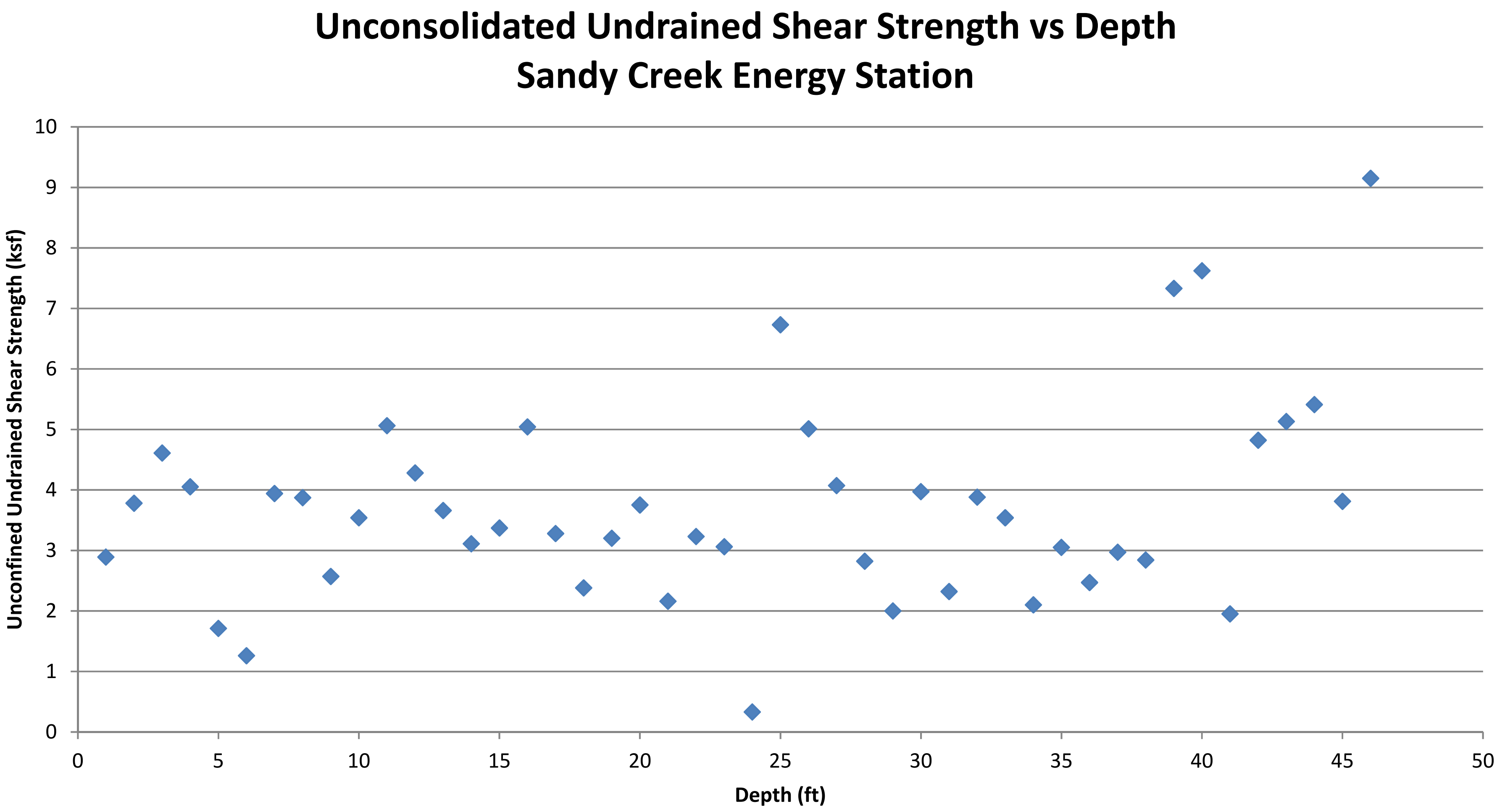
Note: * CU Bar tests were performed on remolded samples.

Created by:	KRG	Date:	9/12/2018
Last revision by:	KRG	Date:	9/24/2018
Checked by:	DLN	Date:	9/24/2018

I:\16215106\[Geotechnical Lab Results.xlsx]Sheet1


Unconfined Compressive Strength vs Depth
Sandy Creek Energy Station


Depth vs Vane Shear
Sandy Creek Energy Station
Vane Shear Results (TSF)
0
0.5
1
1.5
2
2.5
3
Depth (Ft)
0
5
10
15
20
25
30


Unconsolidated Undrained Shear Strength vs Depth
Sandy Creek Energy Station
Unconfined Undrained Shear Strength (ksf)
0
1
2
3
4
5
6
7
8
9
10
Depth (ft)
0
5
10
15
20
25
30
35
40
45
50

Attachment D4

Slope/W Outputs

BRETT J. DeVRIES
128061

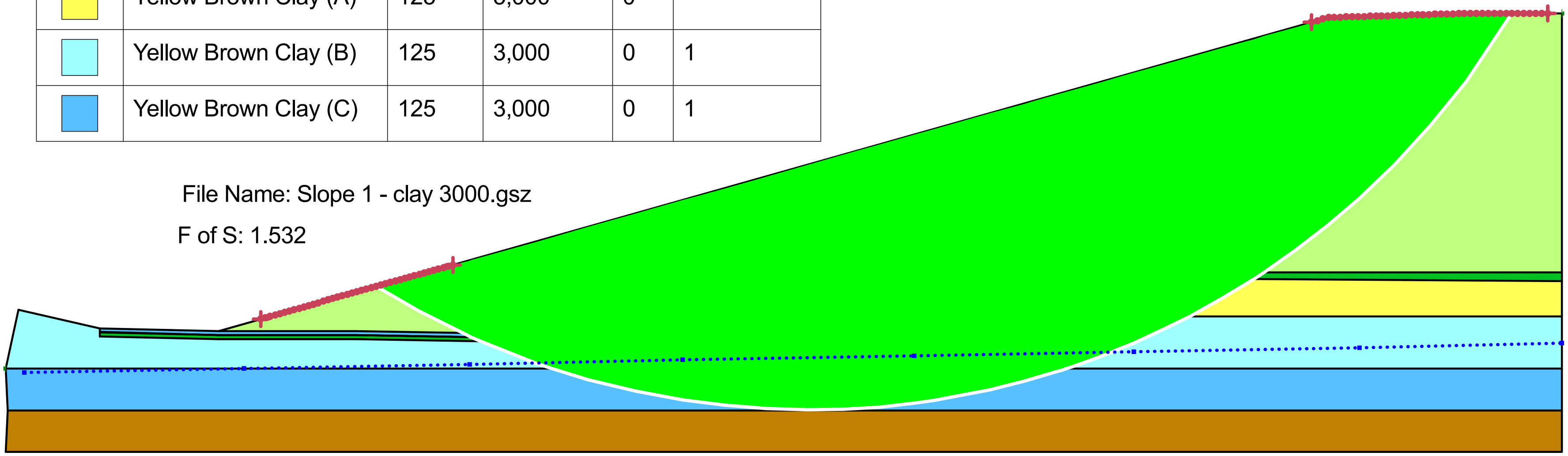
6/17/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Appendix D4

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	2,000	0	
🟦	Soil Protective Layer	120	0	20	
🟥	Textured Geomembrane	58	0	17	
🟨	Yellow Brown Clay (A)	125	3,000	0	
🟦	Yellow Brown Clay (B)	125	3,000	0	1
🟦	Yellow Brown Clay (C)	125	3,000	0	1

File Name: Slope 1 - clay 3000.gsz

F of S: 1.532



Sandy Creek Energy Station Cross Section 1

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gearing, Phillip
Revision Number: 85
Date: 1/14/2021
Time: 12:34:14 PM
Tool Version: 8.16.5.15361
File Name: Slope 1 - clay 3000.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Sandy Creek Energy Station Cross Section 1

Kind: SLOPE/W
Method: Spencer
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf

Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (122, 463.6497) ft
Left-Zone Right Coordinate: (214, 489.6384) ft
Left-Zone Increment: 40
Right Projection: Range
Right-Zone Left Coordinate: (625, 605.7401) ft
Right-Zone Right Coordinate: (738, 610) ft
Right-Zone Increment: 40
Radius Increments: 15

Slip Surface Limits

Left Coordinate: (0, 440) ft
Right Coordinate: (745, 610) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	9	438
Coordinate 2	114	440
Coordinate 3	222	442
Coordinate 4	324	444
Coordinate 5	435	446
Coordinate 6	540	448
Coordinate 7	648	450
Coordinate 8	745	452

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	745	400
Point 3	1	420
Point 4	745	420
Point 5	0	440

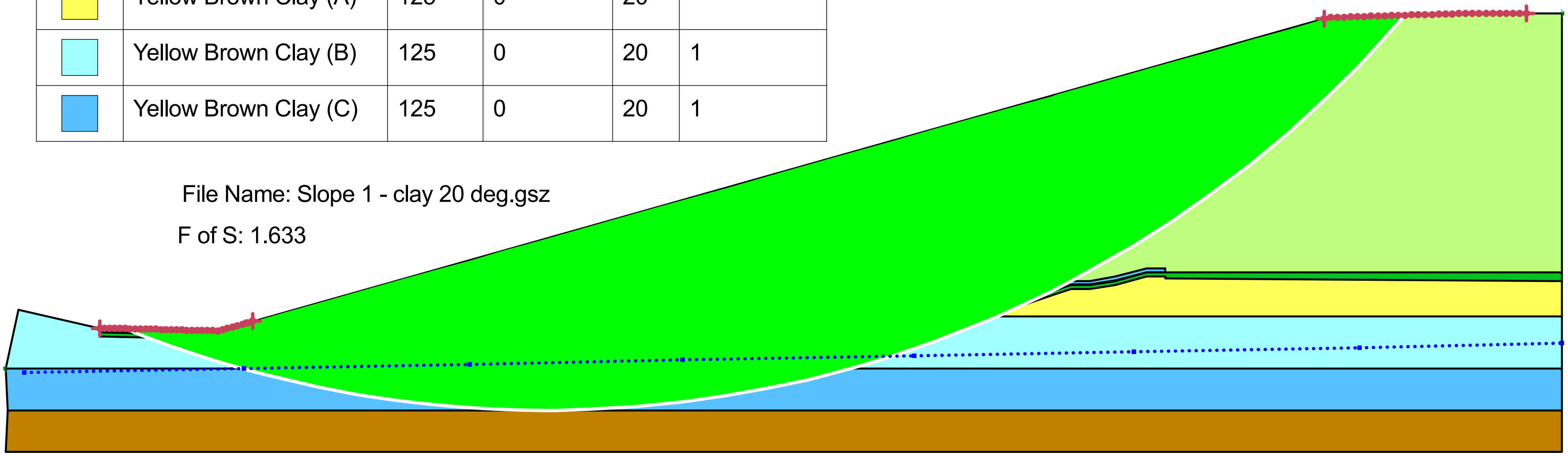
Point 6	745	440
Point 7	6	468
Point 8	45	455.3
Point 9	100	455.3
Point 10	168	454
Point 11	279	452.1
Point 12	384	454
Point 13	444	456
Point 14	504	476
Point 15	510	478
Point 16	519	478
Point 17	531	480
Point 18	546	484
Point 19	555	484
Point 20	102	456
Point 21	633	608
Point 22	699	610
Point 23	745	610
Point 24	168	456
Point 25	279	454
Point 26	384	456
Point 27	444	458
Point 28	504	478
Point 29	510	480
Point 30	519	480
Point 31	531	482
Point 32	546	486
Point 33	555	486
Point 34	168	456.1
Point 35	279	454.1
Point 36	384	456.1
Point 37	444	458.1
Point 38	504	478.1
Point 39	510	480.1
Point 40	519	480.1
Point 41	531	482.1

Point 42	546	486.1
Point 43	555	486.1
Point 44	745	484
Point 45	745	482
Point 46	102	454
Point 47	102	456.1
Point 48	471	465
Point 49	745	465
Point 50	102	458
Point 51	168	458
Point 52	279	456
Point 53	384	458
Point 54	444	460
Point 55	504	480
Point 56	510	482
Point 57	519	482
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459

Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	14,890
Region 2	Yellow Brown Clay (C)	3,5,6,4	14,890
Region 3	Textured Geomembrane	28,29,30,31,32,33,43,42,41,40,39,38,37,36,35,34,47,65,64,67,20,68,25,26,27	51.098
Region 4	Yellow Brown Clay (A)	48,14,15,16,17,18,19,61,45,49	4,289.5
Region 5	Byproduct	60,43,62,23,22,21,50,51,52,53,54,55,63,56,57,58,59	49,546
Region 6	Compacted Clay Layer	64,8,46,10,11,12,13,48,14,15,16,17,18,19,61,45,44,62,43,33,32,31,30,29,28,27,26,25,68,20,67	1,683.6
Region 7	Soil Protective Layer	66,69,65,47,34,35,36,37,38,39,40,41,42,43,60,59,58,57,56,63,55,54,53,52,51,50	969
Region 8	Yellow Brown Clay (B)	64,65,69,7,5,6,49,48,13,12,11,10,46,8	13,882

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	0	20	
🟦	Soil Protective Layer	120	0	20	
🟥	Textured Geomembrane	58	0	17	
🟨	Yellow Brown Clay (A)	125	0	20	
🟦	Yellow Brown Clay (B)	125	0	20	1
🟦	Yellow Brown Clay (C)	125	0	20	1



File Name: Slope 1 - clay 20 deg.gsz

F of S: 1.633

Sandy Creek Energy Station Cross Section 1

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 68
Date: 1/14/2021
Time: 2:02:49 PM
Tool Version: 8.16.5.15361
File Name: Slope 1 - clay 20 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Sandy Creek Energy Station Cross Section 1

Kind: SLOPE/W
Method: Spencer
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf

Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (45, 459) ft
Left-Zone Right Coordinate: (118.00003, 462.5198) ft
Left-Zone Increment: 30
Right Projection: Range
Right-Zone Left Coordinate: (630.99996, 607.435) ft
Right-Zone Right Coordinate: (728, 610) ft
Right-Zone Increment: 30
Radius Increments: 20

Slip Surface Limits

Left Coordinate: (0, 440) ft
Right Coordinate: (745, 610) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	9	438
Coordinate 2	114	440
Coordinate 3	222	442
Coordinate 4	324	444
Coordinate 5	435	446
Coordinate 6	540	448
Coordinate 7	648	450
Coordinate 8	745	452

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	745	400
Point 3	1	420
Point 4	745	420
Point 5	0	440

Point 6	745	440
Point 7	6	468
Point 8	45	455.3
Point 9	100	455.3
Point 10	168	454
Point 11	279	452.1
Point 12	384	454
Point 13	444	456
Point 14	504	476
Point 15	510	478
Point 16	519	478
Point 17	531	480
Point 18	546	484
Point 19	555	484
Point 20	102	456
Point 21	633	608
Point 22	699	610
Point 23	745	610
Point 24	168	456
Point 25	279	454
Point 26	384	456
Point 27	444	458
Point 28	504	478
Point 29	510	480
Point 30	519	480
Point 31	531	482
Point 32	546	486
Point 33	555	486
Point 34	168	456.1
Point 35	279	454.1
Point 36	384	456.1
Point 37	444	458.1
Point 38	504	478.1
Point 39	510	480.1
Point 40	519	480.1
Point 41	531	482.1

Point 42	546	486.1
Point 43	555	486.1
Point 44	745	484
Point 45	745	482
Point 46	102	454
Point 47	102	456.1
Point 48	471	465
Point 49	745	465
Point 50	102	458
Point 51	168	458
Point 52	279	456
Point 53	384	458
Point 54	444	460
Point 55	504	480
Point 56	510	482
Point 57	519	482
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

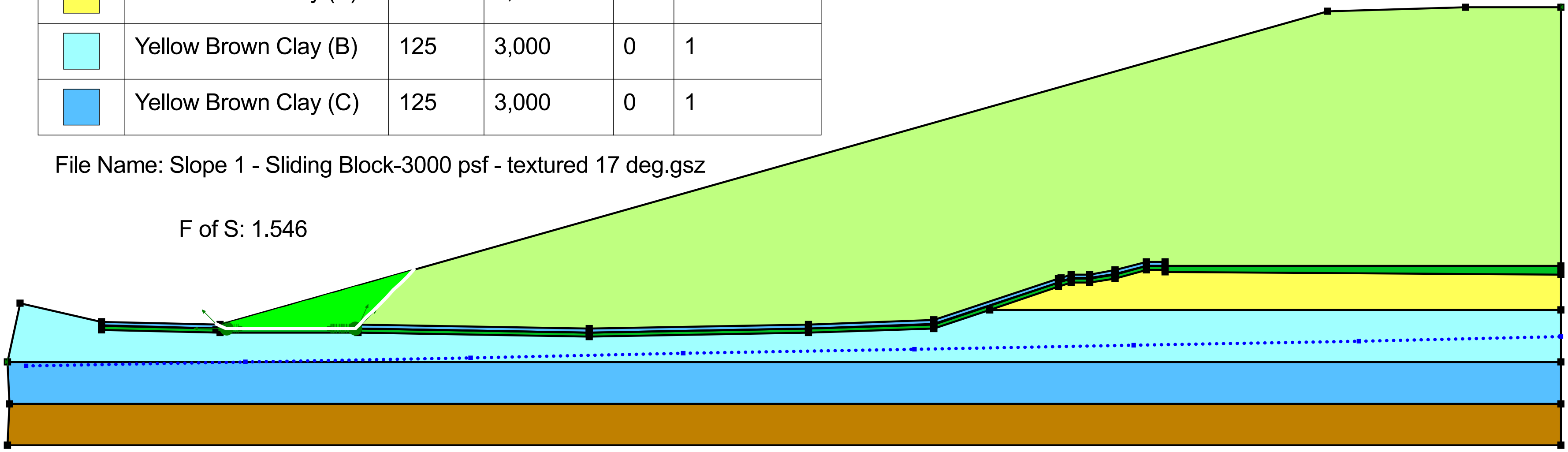
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	14,890
Region 2	Yellow Brown Clay (C)	3,5,6,4	14,890
Region 3	Textured Geomembrane	27,28,29,30,31,32,33,43,42,41,40,39,38,37	11.1
Region 4	Yellow Brown Clay (A)	48,14,15,16,17,18,19,61,45,49	4,289.5
Region 5	Byproduct	60,43,62,23,22,21,50,51,52,53,54,55,63,56, 57,58,59	49,546
Region 6	Compacted Clay Layer	64,8,46,10,11,12,13,48,14,15,16,17,18,19,61, 45,44,62,43,33,32,31,30,29,28,27,26,25,68,20,67	1,683.6
Region 7	Soil Protective Layer	66,69,65,47,34,35,36,37,38,39,40,41,42,43, 60,59,58,57,56,63,55,54,53,52,51,50	969
Region 8	Textured Geomembrane	65,64,67,20,68,25,26,27,37,36,35,34,47	39.998
Region 9	Yellow Brown Clay (B)	64,65,69,7,5,6,49,48,13,12,11,10,46,8,70	13,882

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	2,000	0	
🟦	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	17	
🟨	Yellow Brown Clay (A)	125	3,000	0	
🟦	Yellow Brown Clay (B)	125	3,000	0	1
🟦	Yellow Brown Clay (C)	125	3,000	0	1

File Name: Slope 1 - Sliding Block-3000 psf - textured 17 deg.gsz

F of S: 1.546



Sandy Creek Energy Station Cross Section 1

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 78
Date: 1/14/2021
Time: 2:10:29 PM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Sliding Block-3000 psf - textured 17 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Sandy Creek Energy Station Cross Section 1

- Kind: SLOPE/W
- Method: Janbu
- Settings
    - PWP Conditions Source: Piezometric Line with Ru
    - Apply Phreatic Correction: No
- Slip Surface
    - Direction of movement: Right to Left
    - Use Passive Mode: No
    - Slip Surface Option: Block
    - Critical slip surfaces saved: 1
    - Resisting Side Maximum Convex Angle: 1 °
    - Driving Side Maximum Convex Angle: 5 °

Restrict Block Crossing: No
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °

Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 440) ft
Right Coordinate: (745, 610) ft

Slip Surface Block

Left Grid

Upper Left: (102.14, 456.09) ft
Lower Left: (102.14, 456.02) ft
Lower Right: (111.29, 456.02) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 2

Right Grid

Upper Left: (154.33, 456.07) ft
Lower Left: (154.33, 456.01) ft
Lower Right: (167.74, 456.02) ft
X Increments: 25
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	9	438
Coordinate 2	114	440
Coordinate 3	222	442
Coordinate 4	324	444
Coordinate 5	435	446
Coordinate 6	540	448
Coordinate 7	648	450
Coordinate 8	745	452

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	745	400

Point 3	1	420
Point 4	745	420
Point 5	0	440
Point 6	745	440
Point 7	6	468
Point 8	45	455.3
Point 9	100	455.3
Point 10	168	454
Point 11	279	452.1
Point 12	384	454
Point 13	444	456
Point 14	504	476
Point 15	510	478
Point 16	519	478
Point 17	531	480
Point 18	546	484
Point 19	555	484
Point 20	102	456
Point 21	633	608
Point 22	699	610
Point 23	745	610
Point 24	168	456
Point 25	279	454
Point 26	384	456
Point 27	444	458
Point 28	504	478
Point 29	510	480
Point 30	519	480
Point 31	531	482
Point 32	546	486
Point 33	555	486
Point 34	168	456.1
Point 35	279	454.1
Point 36	384	456.1
Point 37	444	458.1
Point 38	504	478.1

Point 39	510	480.1
Point 40	519	480.1
Point 41	531	482.1
Point 42	546	486.1
Point 43	555	486.1
Point 44	745	484
Point 45	745	482
Point 46	102	454
Point 47	102	456.1
Point 48	471	465
Point 49	745	465
Point 50	102	458
Point 51	168	458
Point 52	279	456
Point 53	384	458
Point 54	444	460
Point 55	504	480
Point 56	510	482
Point 57	519	482
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

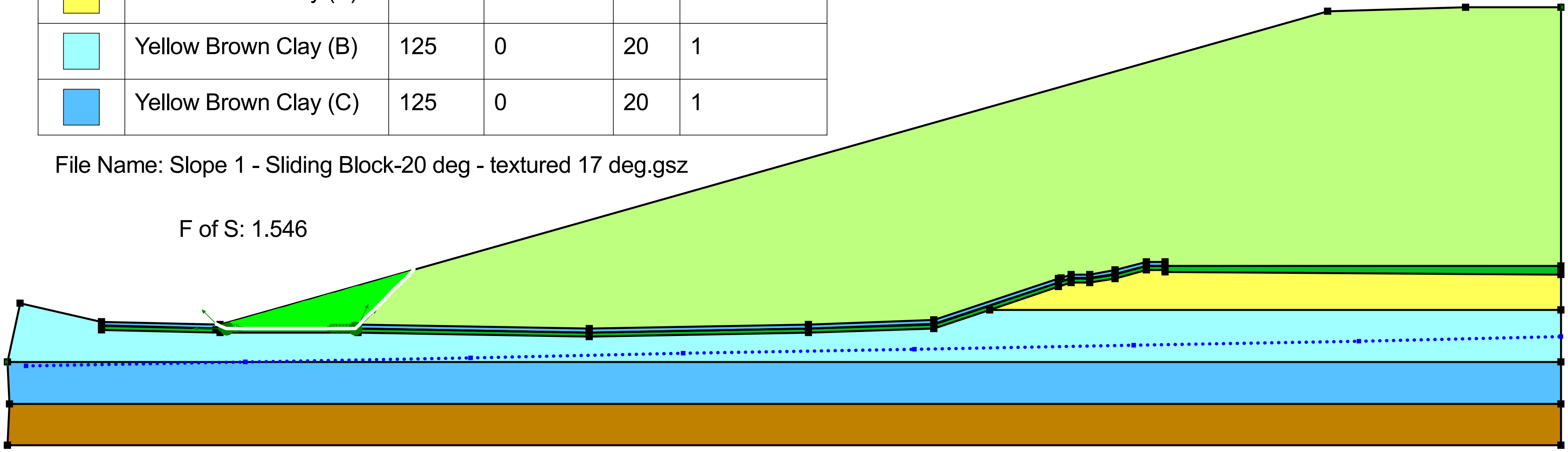
Regions

	Material	Points	Area (ft^2)
Region 1	Clay Shale	1,2,4,3	14,890
Region 2	Yellow Brown Clay (C)	3,5,6,4	14,890
Region 3	Textured Geomembrane	27,28,29,30,31,32,33,43,42,41,40,39,38,37	11.1
Region 4	Yellow Brown Clay (A)	48,14,15,16,17,18,19,61,45,49	4,289.5
Region 5	Byproduct	60,43,62,23,22,21,50,51,52,53,54,55,63, 56,57,58,59	49,546
Region 6	Compacted Clay Layer	64,8,46,10,11,12,13,48,14,15,16,17,18,19,61, 45,44,62,43,33,32,31,30,29,28,27,26,25,68,20,67	1,683.6
Region 7	Soil Protective Layer	66,69,65,47,34,35,36,37,38,39,40,41,42,43,60, 59,58,57,56,63,55,54,53,52,51,50	969
Region 8	Textured Geomembrane	65,64,67,20,68,25,26,27,37,36,35,34,47	39.998
Region 9	Yellow Brown Clay (B)	64,65,69,7,5,6,49,48,13,12,11,10,46,8,70	13,882

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	0	20	
🟦	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	17	
🟨	Yellow Brown Clay (A)	125	0	20	
🟦	Yellow Brown Clay (B)	125	0	20	1
🟦	Yellow Brown Clay (C)	125	0	20	1

File Name: Slope 1 - Sliding Block-20 deg - textured 17 deg.gsz

F of S: 1.546



Sandy Creek Energy Station Cross Section 1

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 75
Date: 1/11/2021
Time: 7:42:06 AM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Sliding Block-20 deg - textured 17 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Sandy Creek Energy Station Cross Section 1

- Kind: SLOPE/W
- Method: Janbu
- Settings
  - PWP Conditions Source: Piezometric Line with Ru
  - Apply Phreatic Correction: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Block
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °

Restrict Block Crossing: No
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °

Pore Water Pressure
    Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 440) ft
Right Coordinate: (745, 610) ft

Slip Surface Block

Left Grid

Upper Left: (102.14, 456.09) ft
Lower Left: (102.14, 456.02) ft
Lower Right: (111.29, 456.02) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 2

Right Grid

Upper Left: (154.33, 456.07) ft
Lower Left: (154.33, 456.01) ft
Lower Right: (167.74, 456.02) ft
X Increments: 25
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	9	438
Coordinate 2	114	440
Coordinate 3	222	442
Coordinate 4	324	444
Coordinate 5	435	446
Coordinate 6	540	448
Coordinate 7	648	450
Coordinate 8	745	452

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	745	400

Point 3	1	420
Point 4	745	420
Point 5	0	440
Point 6	745	440
Point 7	6	468
Point 8	45	455.3
Point 9	100	455.3
Point 10	168	454
Point 11	279	452.1
Point 12	384	454
Point 13	444	456
Point 14	504	476
Point 15	510	478
Point 16	519	478
Point 17	531	480
Point 18	546	484
Point 19	555	484
Point 20	102	456
Point 21	633	608
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Point 34	168	456.1
Point 35	279	454.1
Point 36	384	456.1
Point 37	444	458.1
Point 38	504	478.1

Point 39	510	480.1
Point 40	519	480.1
Point 41	531	482.1
Point 42	546	486.1
Point 43	555	486.1
Point 44	745	484
Point 45	745	482
Point 46	102	454
Point 47	102	456.1
Point 48	471	465
Point 49	745	465
Point 50	102	458
Point 51	168	458
Point 52	279	456
Point 53	384	458
Point 54	444	460
Point 55	504	480
Point 56	510	482
Point 57	519	482
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

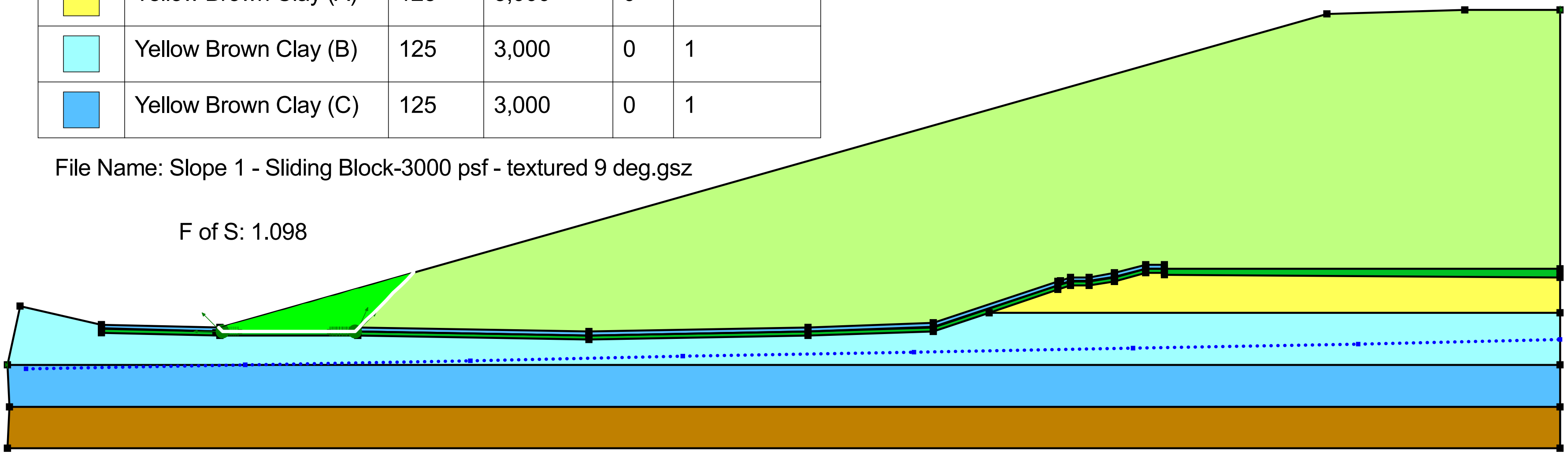
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	14,890
Region 2	Yellow Brown Clay (C)	3,5,6,4	14,890
Region 3	Textured Geomembrane	27,28,29,30,31,32,33,43,42,41,40,39,38,37	11.1
Region 4	Yellow Brown Clay (A)	48,14,15,16,17,18,19,61,45,49	4,289.5
Region 5	Byproduct	60,43,62,23,22,21,50,51,52,53,54,55,63,56,57,58,59	49,546
Region 6	Compacted Clay Layer	64,8,46,10,11,12,13,48,14,15,16,17,18,19,61,45,44,62,43,33,32,31,30,29,28,27,26,25,68,20,67	1,683.6
Region 7	Soil Protective Layer	66,69,65,47,34,35,36,37,38,39,40,41,42,43,60,59,58,57,56,63,55,54,53,52,51,50	969
Region 8	Textured Geomembrane	65,64,67,20,68,25,26,27,37,36,35,34,47	39.998
Region 9	Yellow Brown Clay (B)	64,65,69,7,5,6,49,48,13,12,11,10,46,8,70	13,882

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	2,000	0	
🟦	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	9	
🟨	Yellow Brown Clay (A)	125	3,000	0	
🟦	Yellow Brown Clay (B)	125	3,000	0	1
🟦	Yellow Brown Clay (C)	125	3,000	0	1

File Name: Slope 1 - Sliding Block-3000 psf - textured 9 deg.gsz

F of S: 1.098



Sandy Creek Energy Station Cross Section 1

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 68
Date: 1/14/2021
Time: 8:21:19 AM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Sliding Block-3000 psf - textured 9 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Sandy Creek Energy Station Cross Section 1

Kind: SLOPE/W
Method: Janbu
Settings
- PWP Conditions Source: Piezometric Line with Ru
- Apply Phreatic Correction: No

Slip Surface
- Direction of movement: Right to Left
- Use Passive Mode: No
- Slip Surface Option: Block
- Critical slip surfaces saved: 1
- Resisting Side Maximum Convex Angle: 1 °
- Driving Side Maximum Convex Angle: 5 °

Restrict Block Crossing: No
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °

Pore Water Pressure

Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 3,000 psf

Phi': 0 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 3,000 psf

Phi': 0 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Cohesion': 7,000 psf

Phi': 0 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb

Unit Weight: 58 pcf

Cohesion': 0 psf

Phi': 9 °

Phi-B: 0 °

Pore Water Pressure

Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 440) ft

Right Coordinate: (745, 610) ft

Slip Surface Block

Left Grid

- Upper Left: (102.14, 456.09) ft
- Lower Left: (102.14, 456.02) ft
- Lower Right: (111.29, 456.02) ft
- X Increments: 10
- Y Increments: 3
- Starting Angle: 135 °
- Ending Angle: 180 °
- Angle Increments: 2

Right Grid

- Upper Left: (154.33, 456.07) ft
- Lower Left: (154.33, 456.01) ft
- Lower Right: (167.74, 456.02) ft
- X Increments: 25
- Y Increments: 3
- Starting Angle: 45 °
- Ending Angle: 65 °
- Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	9	438
Coordinate 2	114	440
Coordinate 3	222	442
Coordinate 4	324	444
Coordinate 5	435	446
Coordinate 6	540	448
Coordinate 7	648	450
Coordinate 8	745	452

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	745	400

Point 3	1	420
Point 4	745	420
Point 5	0	440
Point 6	745	440
Point 7	6	468
Point 8	45	455.3
Point 9	100	455.3
Point 10	168	454
Point 11	279	452.1
Point 12	384	454
Point 13	444	456
Point 14	504	476
Point 15	510	478
Point 16	519	478
Point 17	531	480
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Point 38	504	478.1

Point 39	510	480.1
Point 40	519	480.1
Point 41	531	482.1
Point 42	546	486.1
Point 43	555	486.1
Point 44	745	484
Point 45	745	482
Point 46	102	454
Point 47	102	456.1
Point 48	471	465
Point 49	745	465
Point 50	102	458
Point 51	168	458
Point 52	279	456
Point 53	384	458
Point 54	444	460
Point 55	504	480
Point 56	510	482
Point 57	519	482
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

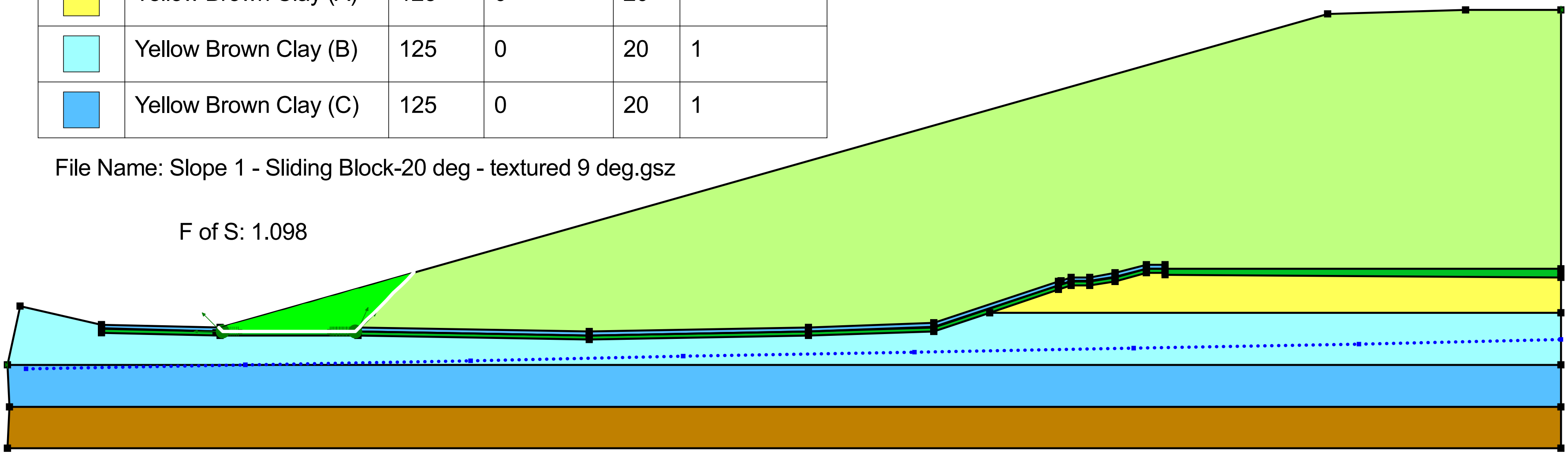
Regions

	Material	Points	Area (ft^2)
Region 1	Clay Shale	1,2,4,3	14,890
Region 2	Yellow Brown Clay (C)	3,5,6,4	14,890
Region 3	Textured Geomembrane	27,28,29,30,31,32,33,43,42,41,40,39,38,37	11.1
Region 4	Yellow Brown Clay (A)	48,14,15,16,17,18,19,61,45,49	4,289.5
Region 5	Byproduct	60,43,62,23,22,21,50,51,52,53,54,55,63,56, 57,58,59	49,546
Region 6	Compacted Clay Layer	64,8,46,10,11,12,13,48,14,15,16,17,18,19, 61,45,44,62,43,33,32,31,30,29,28,27,26,25,68,20,67	1,683.6
Region 7	Soil Protective Layer	66,69,65,47,34,35,36,37,38,39,40,41,42,43,60,59, 58,57,56,63,55,54,53,52,51,50	969
Region 8	Textured Geomembrane	65,64,67,20,68,25,26,27,37,36,35,34,47	39.998
Region 9	Yellow Brown Clay (B)	64,65,69,7,5,6,49,48,13,12,11,10,46,8,70	13,882

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	0	20	
🟦	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	9	
🟨	Yellow Brown Clay (A)	125	0	20	
🟦	Yellow Brown Clay (B)	125	0	20	1
🟦	Yellow Brown Clay (C)	125	0	20	1

File Name: Slope 1 - Sliding Block-20 deg - textured 9 deg.gsz

F of S: 1.098



Sandy Creek Energy Station Cross Section 1

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 77
Date: 1/11/2021
Time: 8:14:07 AM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Sliding Block-20 deg - textured 9 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Sandy Creek Energy Station Cross Section 1

Kind: SLOPE/W
Method: Janbu
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Block
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °

Restrict Block Crossing: No
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °

Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 9 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 440) ft
Right Coordinate: (745, 610) ft

Slip Surface Block

Left Grid

Upper Left: (102.14, 456.09) ft
Lower Left: (102.14, 456.02) ft
Lower Right: (111.29, 456.02) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °
Angle Increments: 2

Right Grid

Upper Left: (154.33, 456.07) ft
Lower Left: (154.33, 456.01) ft
Lower Right: (167.74, 456.02) ft
X Increments: 25
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	9	438
Coordinate 2	114	440
Coordinate 3	222	442
Coordinate 4	324	444
Coordinate 5	435	446
Coordinate 6	540	448
Coordinate 7	648	450
Coordinate 8	745	452

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	745	400

Point 3	1	420
Point 4	745	420
Point 5	0	440
Point 6	745	440
Point 7	6	468
Point 8	45	455.3
Point 9	100	455.3
Point 10	168	454
Point 11	279	452.1
Point 12	384	454
Point 13	444	456
Point 14	504	476
Point 15	510	478
Point 16	519	478
Point 17	531	480
Point 18	546	484
Point 19	555	484
Point 20	102	456
Point 21	633	608
Point 22	699	610
Point 23	745	610
Point 24	168	456
Point 25	279	454
Point 26	384	456
Point 27	444	458
Point 28	504	478
Point 29	510	480
Point 30	519	480
Point 31	531	482
Point 32	546	486
Point 33	555	486
Point 34	168	456.1
Point 35	279	454.1
Point 36	384	456.1
Point 37	444	458.1
Point 38	504	478.1

Point 39	510	480.1
Point 40	519	480.1
Point 41	531	482.1
Point 42	546	486.1
Point 43	555	486.1
Point 44	745	484
Point 45	745	482
Point 46	102	454
Point 47	102	456.1
Point 48	471	465
Point 49	745	465
Point 50	102	458
Point 51	168	458
Point 52	279	456
Point 53	384	458
Point 54	444	460
Point 55	504	480
Point 56	510	482
Point 57	519	482
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

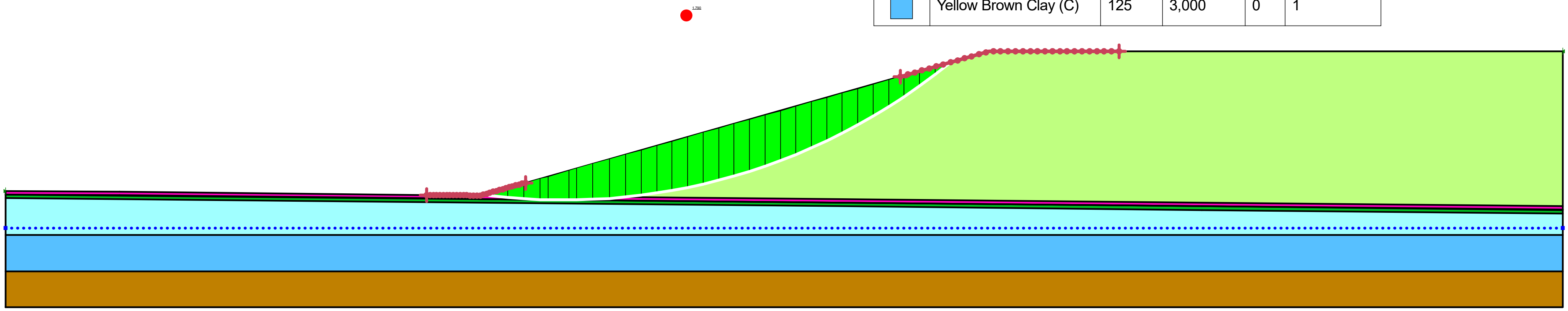
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	14,890
Region 2	Yellow Brown Clay (C)	3,5,6,4	14,890
Region 3	Textured Geomembrane	27,28,29,30,31,32,33,43,42,41,40,39,38,37	11.1
Region 4	Yellow Brown Clay (A)	48,14,15,16,17,18,19,61,45,49	4,289.5
Region 5	Byproduct	60,43,62,23,22,21,50,51,52,53,54,55,63,56,57,58,59	49,546
Region 6	Compacted Clay Layer	64,8,46,10,11,12,13,48,14,15,16,17,18,19,61,45,44, 62,43,33,32,31,30,29,28,27,26,25,68,20,67	1,683.6
Region 7	Soil Protective Layer	66,69,65,47,34,35,36,37,38,39,40,41,42,43,60,59,58, 57,56,63,55,54,53,52,51,50	969
Region 8	Textured Geomembrane	65,64,67,20,68,25,26,27,37,36,35,34,47	39.998
Region 9	Yellow Brown Clay (B)	64,65,69,7,5,6,49,48,13,12,11,10,46,8,70	13,882

Sandy Creek Energy Station
File Name: Slope 2 - clay 3000 psf.gsz

F of S: 1.790

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	2,000	0	
🟪	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	17	
🟦	Yellow Brown Clay (B)	125	3,000	0	1
🟦	Yellow Brown Clay (C)	125	3,000	0	1



Cross Section 2

File Information

File Version: 8.16
Title: Sandy Creek Energy Station
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 60
Date: 1/14/2021
Time: 8:29:37 AM
Tool Version: 8.16.5.15361
File Name: Slope 2 - clay 3000 psf.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Cross Section 2

- Description: Cross Section located along leachate line in Cell 3
- Kind: SLOPE/W
- Method: Spencer
- Settings
  - PWP Conditions Source: Piezometric Line with Ru
  - Apply Phreatic Correction: No
- Slip Surface
  - Direction of movement: Right to Left
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Optimize Critical Slip Surface Location: No

Tension Crack
    Tension Crack Option: (none)
F of S Distribution
    F of S Calculation Option: Constant
Advanced
    Number of Slices: 30
    F of S Tolerance: 0.001
    Minimum Slip Surface Depth: 0.1 ft
    Search Method: Root Finder
    Tolerable difference between starting and converged F of S: 3
    Maximum iterations to calculate converged lambda: 20
    Max Absolute Lambda: 2

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf

Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (233.25046, 462.2975) ft
Left-Zone Right Coordinate: (288, 469.0922) ft
Left-Zone Increment: 30
Right Projection: Range
Right-Zone Left Coordinate: (496, 528.09929) ft
Right-Zone Right Coordinate: (617, 542) ft
Right-Zone Increment: 30
Radius Increments: 20

Slip Surface Limits

Left Coordinate: (0, 464.6) ft
Right Coordinate: (863, 542) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	444
Coordinate 2	863	444

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	863	400
Point 3	0	420
Point 4	863	420
Point 5	0	440
Point 6	863	440
Point 7	0	460.6
Point 8	63	460
Point 9	263	458
Point 10	463	456
Point 11	663	454
Point 12	863	452
Point 13	0	462.6
Point 14	63	462
Point 15	263	460
Point 16	463	458
Point 17	663	456
Point 18	863	454
Point 19	0	462.7
Point 20	63	462.1

Point 21	263	460.1
Point 22	463	458.1
Point 23	663	456.1
Point 24	863	454.1
Point 25	266	462
Point 26	545	542
Point 27	863	542
Point 28	258.43991	460.1456
Point 29	0	464.6
Point 30	63	464
Point 31	263	462
Point 32	463	460
Point 33	663	458
Point 34	863	456

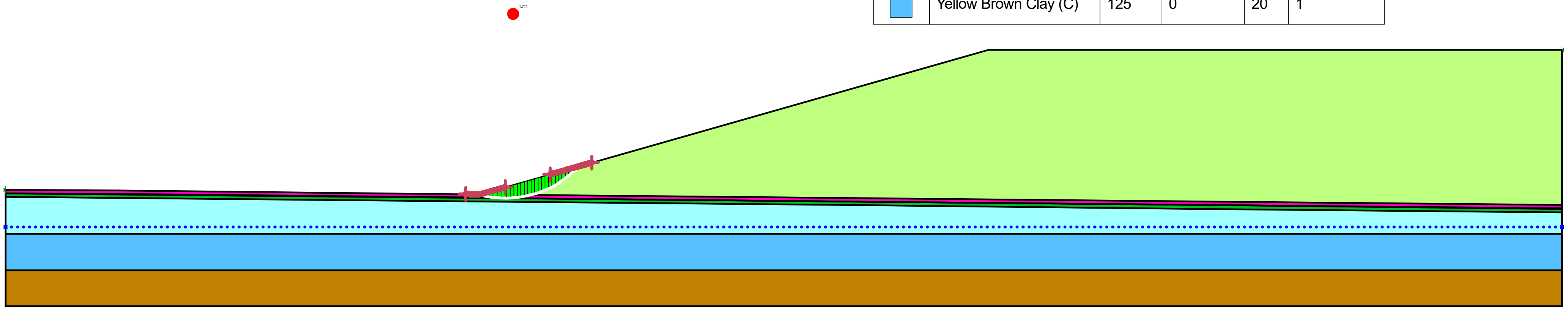
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	17,260
Region 2	Yellow Brown Clay (C)	3,5,6,4	17,260
Region 3	Compacted Clay Layer	11,12,18,17,16,15,14,13,7,8,9,10	1,726
Region 4	Yellow Brown Clay (B)	7,5,6,12,11,10,9,8	14,079
Region 5	Textured Geomembrane	22,21,28,20,19,13,14,15,16,17,18,24,23	86.3
Region 6	Byproduct	26,27,34,33,32,25,31	38,517
Region 7	Soil Protective Layer	30,29,19,20,28,21,22,23,24,34,33,32,25,31	1,642.7

Sandy Creek Energy Station
File Name: Slope 2 - clay 20 deg.gsz

F of S: 1.711

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	0	20	
🟪	Soil Protective Layer	120	0	20	
🟥	Textured Geomembrane	58	0	17	
🟦	Yellow Brown Clay (B)	125	0	20	1
🟦	Yellow Brown Clay (C)	125	0	20	1



Cross Section 2

File Information

File Version: 8.16
Title: Sandy Creek Energy Station
Created By: Gilkey, Keith
Last Edited By: Gearing, Phillip
Revision Number: 64
Date: 1/14/2021
Time: 12:57:46 PM
Tool Version: 8.16.5.15361
File Name: Slope 2 - clay 20 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Cross Section 2

Description: Cross Section located along leachate line in Cell 3
Kind: SLOPE/W
Method: Spencer
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Entry and Exit
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Optimize Critical Slip Surface Location: No

Tension Crack
    Tension Crack Option: (none)

F of S Distribution
    F of S Calculation Option: Constant

Advanced
    Number of Slices: 30
    F of S Tolerance: 0.001
    Minimum Slip Surface Depth: 0.1 ft
    Search Method: Root Finder
    Tolerable difference between starting and converged F of S: 3
    Maximum iterations to calculate converged lambda: 20
    Max Absolute Lambda: 2

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf

Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (255, 462.08) ft
Left-Zone Right Coordinate: (277, 465.97163) ft
Left-Zone Increment: 30
Right Projection: Range
Right-Zone Left Coordinate: (301.775, 473) ft
Right-Zone Right Coordinate: (325, 479.58865) ft
Right-Zone Increment: 30
Radius Increments: 20

Slip Surface Limits

Left Coordinate: (0, 464.6) ft
Right Coordinate: (863, 542) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	444
Coordinate 2	863	444

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	863	400
Point 3	0	420
Point 4	863	420
Point 5	0	440
Point 6	863	440
Point 7	0	460.6
Point 8	63	460
Point 9	263	458
Point 10	463	456
Point 11	663	454
Point 12	863	452
Point 13	0	462.6
Point 14	63	462
Point 15	263	460
Point 16	463	458
Point 17	663	456
Point 18	863	454
Point 19	0	462.7
Point 20	63	462.1

Point 21	263	460.1
Point 22	463	458.1
Point 23	663	456.1
Point 24	863	454.1
Point 25	266	462
Point 26	545	542
Point 27	863	542
Point 28	258.43991	460.1456
Point 29	0	464.6
Point 30	63	464
Point 31	263	462
Point 32	463	460
Point 33	663	458
Point 34	863	456

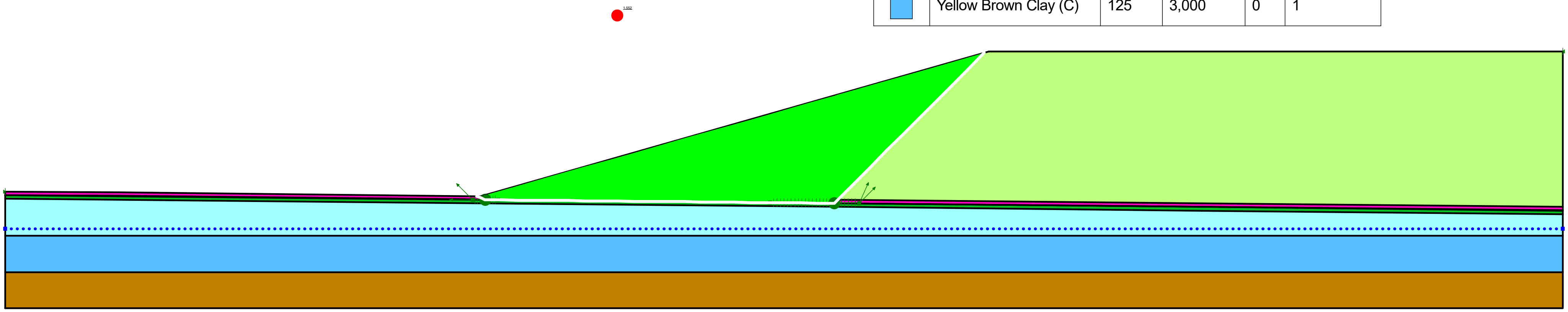
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	17,260
Region 2	Yellow Brown Clay (C)	3,5,6,4	17,260
Region 3	Compacted Clay Layer	11,12,18,17,16,15,14,13,7,8,9,10	1,726
Region 4	Yellow Brown Clay (B)	7,5,6,12,11,10,9,8	14,079
Region 5	Textured Geomembrane	22,21,28,20,19,13,14,15,16,17,18,24,23	86.3
Region 6	Byproduct	26,27,34,33,32,25,31	38,517
Region 7	Soil Protective Layer	30,29,19,20,28,21,22,23,24,34,33,32,25,31	1,642.7

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	2,000	0	
🟪	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	17	
🟦	Yellow Brown Clay (B)	125	3,000	0	1
🟦	Yellow Brown Clay (C)	125	3,000	0	1

Sandy Creek Energy Station
File Name: Slope 2 - Sliding Block-3000 psf - textured 17 deg.gsz

F of S: 1.552



Cross Section 2

File Information

File Version: 8.16
Title: Sandy Creek Energy Station
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 75
Date: 1/14/2021
Time: 8:40:26 AM
Tool Version: 8.16.5.15361
File Name: Slope 2 - Sliding Block-3000 psf - textured 17 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Cross Section 2

Description: Cross Section located along leachate line in Cell 3
Kind: SLOPE/W
Method: Janbu
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Block
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Restrict Block Crossing: No

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
  Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 464.6) ft
Right Coordinate: (863, 542) ft

Slip Surface Block

Left Grid
  Upper Left: (258.8, 460.125) ft
  Lower Left: (258.8, 460.05) ft
  Lower Right: (273.1, 459.925) ft
  X Increments: 10
  Y Increments: 3
  Starting Angle: 135 °
  Ending Angle: 180 °

Angle Increments: 2

Right Grid

Upper Left: (423.57, 458.48) ft

Lower Left: (423.57, 458.41) ft

Lower Right: (473.11, 457.92) ft

X Increments: 25

Y Increments: 3

Starting Angle: 45 °

Ending Angle: 65 °

Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	444
Coordinate 2	863	444

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	863	400
Point 3	0	420
Point 4	863	420
Point 5	0	440
Point 6	863	440
Point 7	0	460.6
Point 8	63	460
Point 9	263	458
Point 10	463	456
Point 11	663	454
Point 12	863	452
Point 13	0	462.6
Point 14	63	462
Point 15	263	460

Point 16	463	458
Point 17	663	456
Point 18	863	454
Point 19	0	462.7
Point 20	63	462.1
Point 21	263	460.1
Point 22	463	458.1
Point 23	663	456.1
Point 24	863	454.1
Point 25	266	462
Point 26	545	542
Point 27	863	542
Point 28	258.43991	460.1456
Point 29	0	464.6
Point 30	63	464
Point 31	263	462
Point 32	463	460
Point 33	663	458
Point 34	863	456

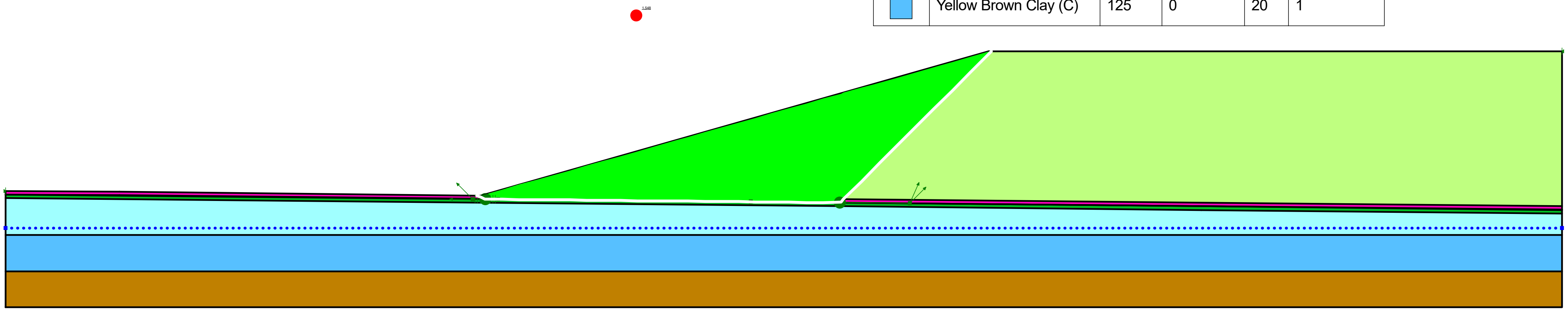
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	17,260
Region 2	Yellow Brown Clay (C)	3,5,6,4	17,260
Region 3	Compacted Clay Layer	11,12,18,17,16,15,14,13,7,8,9,10	1,726
Region 4	Yellow Brown Clay (B)	7,5,6,12,11,10,9,8	14,079
Region 5	Textured Geomembrane	22,21,28,20,19,13,14,15,16,17,18,24,23	86.3
Region 6	Byproduct	26,27,34,33,32,25,31	38,517
Region 7	Soil Protective Layer	30,29,19,20,28,21,22,23,24,34,33,32,25,31	1,642.7

Sandy Creek Energy Station
File Name: Slope 2 - Sliding Block-clay 20 deg - textured 17 deg.gsz

F of S: 1.548

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	0	20	
🟪	Soil Protective Layer	120	0	20	
🟥	Textured Geomembrane	58	0	17	
🟦	Yellow Brown Clay (B)	125	0	20	1
🟦	Yellow Brown Clay (C)	125	0	20	1



Cross Section 2

File Information

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Title: Sandy Creek Energy Station
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 65
Date: 1/11/2021
Time: 9:13:09 AM
Tool Version: 8.16.5.15361
File Name: Slope 2 - Sliding Block-clay 20 deg - textured 17 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Cross Section 2

Description: Cross Section located along leachate line in Cell 3
Kind: SLOPE/W
Method: Janbu
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Block
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Restrict Block Crossing: No

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 17 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 464.6) ft
Right Coordinate: (863, 542) ft

Slip Surface Block

Left Grid
Upper Left: (258.8, 460.125) ft
Lower Left: (258.8, 460.05) ft
Lower Right: (273.1, 459.925) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °

Angle Increments: 2

Right Grid

Upper Left: (413.14, 458.56) ft

Lower Left: (413.14, 458.5) ft

Lower Right: (501.33, 457.64) ft

X Increments: 25

Y Increments: 3

Starting Angle: 45 °

Ending Angle: 65 °

Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	444
Coordinate 2	863	444

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	863	400
Point 3	0	420
Point 4	863	420
Point 5	0	440
Point 6	863	440
Point 7	0	460.6
Point 8	63	460
Point 9	263	458
Point 10	463	456
Point 11	663	454
Point 12	863	452
Point 13	0	462.6
Point 14	63	462
Point 15	263	460

Point 16	463	458
Point 17	663	456
Point 18	863	454
Point 19	0	462.7
Point 20	63	462.1
Point 21	263	460.1
Point 22	463	458.1
Point 23	663	456.1
Point 24	863	454.1
Point 25	266	462
Point 26	545	542
Point 27	863	542
Point 28	258.43991	460.1456
Point 29	0	464.6
Point 30	63	464
Point 31	263	462
Point 32	463	460
Point 33	663	458
Point 34	863	456

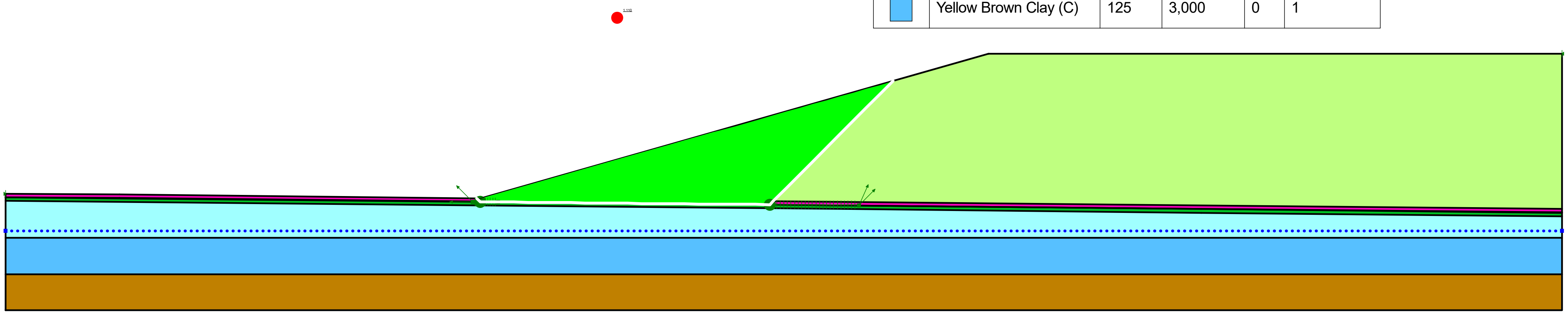
Regions

	Material	Points	Area (ft^2)
Region 1	Clay Shale	1,2,4,3	17,260
Region 2	Yellow Brown Clay (C)	3,5,6,4	17,260
Region 3	Compacted Clay Layer	11,12,18,17,16,15,14,13,7,8,9,10	1,726
Region 4	Yellow Brown Clay (B)	7,5,6,12,11,10,9,8	14,079
Region 5	Textured Geomembrane	22,21,28,20,19,13,14,15,16,17,18,24,23	86.3
Region 6	Byproduct	26,27,34,33,32,25,31	38,517
Region 7	Soil Protective Layer	30,29,19,20,28,21,22,23,24,34,33,32,25,31	1,642.7

Sandy Creek Energy Station
File Name: Slope 2 - Sliding Block-3000 psf - textured 9 deg.gsz

F of S: 1.110

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	2,000	0	
🟪	Soil Protective Layer	120	0	20	
🟪	Textured Geomembrane	58	0	9	
🟦	Yellow Brown Clay (B)	125	3,000	0	1
🟦	Yellow Brown Clay (C)	125	3,000	0	1



Cross Section 2

File Information

File Version: 8.16
Title: Sandy Creek Energy Station
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 77
Date: 1/14/2021
Time: 8:50:19 AM
Tool Version: 8.16.5.15361
File Name: Slope 2 - Sliding Block-3000 psf - textured 9 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Cross Section 2

Description: Cross Section located along leachate line in Cell 3
Kind: SLOPE/W
Method: Janbu
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Block
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Restrict Block Crossing: No

        Optimize Critical Slip Surface Location: No
        Tension Crack
            Tension Crack Option: (none)
    F of S Distribution
        F of S Calculation Option: Constant
    Advanced
        Number of Slices: 30
        F of S Tolerance: 0.001
        Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 3,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 9 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 464.6) ft
Right Coordinate: (863, 542) ft

Slip Surface Block

Left Grid
Upper Left: (258.8, 460.125) ft
Lower Left: (258.8, 460.05) ft
Lower Right: (273.1, 459.925) ft
X Increments: 10
Y Increments: 3
Starting Angle: 135 °
Ending Angle: 180 °

Angle Increments: 2

Right Grid

Upper Left: (423.57, 458.48) ft
Lower Left: (423.57, 458.41) ft
Lower Right: (473.11, 457.92) ft
X Increments: 25
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	444
Coordinate 2	863	444

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	863	400
Point 3	0	420
Point 4	863	420
Point 5	0	440
Point 6	863	440
Point 7	0	460.6
Point 8	63	460
Point 9	263	458
Point 10	463	456
Point 11	663	454
Point 12	863	452
Point 13	0	462.6
Point 14	63	462
Point 15	263	460

Point 16	463	458
Point 17	663	456
Point 18	863	454
Point 19	0	462.7
Point 20	63	462.1
Point 21	263	460.1
Point 22	463	458.1
Point 23	663	456.1
Point 24	863	454.1
Point 25	266	462
Point 26	545	542
Point 27	863	542
Point 28	258.43991	460.1456
Point 29	0	464.6
Point 30	63	464
Point 31	263	462
Point 32	463	460
Point 33	663	458
Point 34	863	456

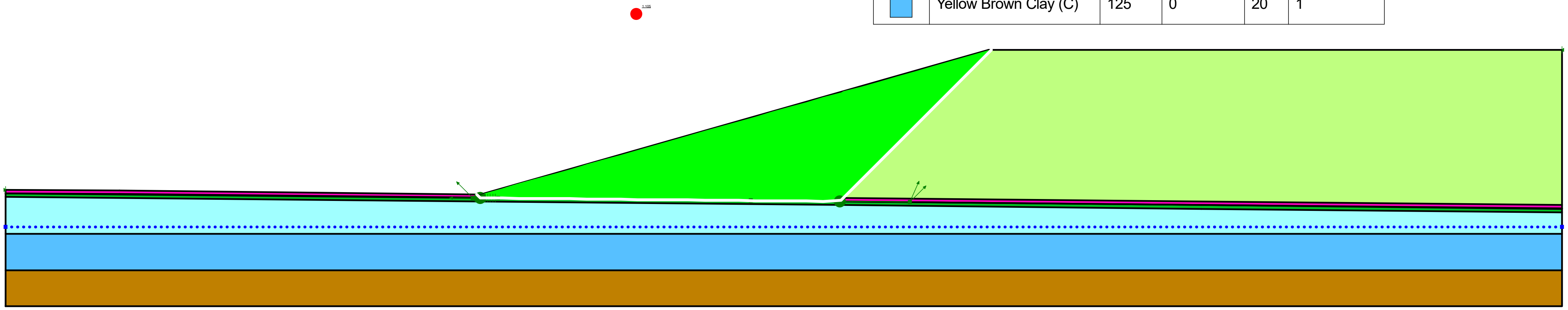
Regions

	Material	Points	Area (ft²)
Region 1	Clay Shale	1,2,4,3	17,260
Region 2	Yellow Brown Clay (C)	3,5,6,4	17,260
Region 3	Compacted Clay Layer	11,12,18,17,16,15,14,13,7,8,9,10	1,726
Region 4	Yellow Brown Clay (B)	7,5,6,12,11,10,9,8	14,079
Region 5	Textured Geomembrane	22,21,28,20,19,13,14,15,16,17,18,24,23	86.3
Region 6	Byproduct	26,27,34,33,32,25,31	38,517
Region 7	Soil Protective Layer	30,29,19,20,28,21,22,23,24,34,33,32,25,31	1,642.7

Sandy Creek Energy Station
File Name: Slope 2 - Sliding Block-clay 20 deg - textured 9 deg.gsz

F of S: 1.105

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line
🟩	Byproduct	103	0	27	
🟫	Clay Shale	130	7,000	0	1
🟩	Compacted Clay Layer	120	0	20	
🟪	Soil Protective Layer	120	0	20	
🟥	Textured Geomembrane	58	0	9	
🟦	Yellow Brown Clay (B)	125	0	20	1
🟦	Yellow Brown Clay (C)	125	0	20	1



Cross Section 2

File Information

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Title: Sandy Creek Energy Station
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 67
Date: 1/11/2021
Time: 9:31:56 AM
Tool Version: 8.16.5.15361
File Name: Slope 2 - Sliding Block-clay 20 deg - textured 9 deg.gsz
Directory: I:\16220089\Data and Calculations\Stability Analysis\

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Cross Section 2

Description: Cross Section located along leachate line in Cell 3
Kind: SLOPE/W
Method: Janbu
Settings
    PWP Conditions Source: Piezometric Line with Ru
    Apply Phreatic Correction: No
Slip Surface
    Direction of movement: Right to Left
    Use Passive Mode: No
    Slip Surface Option: Block
    Critical slip surfaces saved: 1
    Resisting Side Maximum Convex Angle: 1 °
    Driving Side Maximum Convex Angle: 5 °
    Restrict Block Crossing: No

Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft

Materials

Soil Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Clay Shale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Textured Geomembrane

Model: Mohr-Coulomb
Unit Weight: 58 pcf
Cohesion': 0 psf
Phi': 9 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Slip Surface Limits

Left Coordinate: (0, 464.6) ft
Right Coordinate: (863, 542) ft

Slip Surface Block

Left Grid
    Upper Left: (258.8, 460.125) ft
    Lower Left: (258.8, 460.05) ft
    Lower Right: (273.1, 459.925) ft
    X Increments: 10
    Y Increments: 3
    Starting Angle: 135 °
    Ending Angle: 180 °

Angle Increments: 2

Right Grid

Upper Left: (413.14, 458.56) ft
Lower Left: (413.14, 458.5) ft
Lower Right: (501.33, 457.64) ft
X Increments: 25
Y Increments: 3
Starting Angle: 45 °
Ending Angle: 65 °
Angle Increments: 2

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	444
Coordinate 2	863	444

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	863	400
Point 3	0	420
Point 4	863	420
Point 5	0	440
Point 6	863	440
Point 7	0	460.6
Point 8	63	460
Point 9	263	458
Point 10	463	456
Point 11	663	454
Point 12	863	452
Point 13	0	462.6
Point 14	63	462
Point 15	263	460

Point 16	463	458
Point 17	663	456
Point 18	863	454
Point 19	0	462.7
Point 20	63	462.1
Point 21	263	460.1
Point 22	463	458.1
Point 23	663	456.1
Point 24	863	454.1
Point 25	266	462
Point 26	545	542
Point 27	863	542
Point 28	258.43991	460.1456
Point 29	0	464.6
Point 30	63	464
Point 31	263	462
Point 32	463	460
Point 33	663	458
Point 34	863	456

Regions

	Material	Points	Area (ft^2)
Region 1	Clay Shale	1,2,4,3	17,260
Region 2	Yellow Brown Clay (C)	3,5,6,4	17,260
Region 3	Compacted Clay Layer	11,12,18,17,16,15,14,13,7,8,9,10	1,726
Region 4	Yellow Brown Clay (B)	7,5,6,12,11,10,9,8	14,079
Region 5	Textured Geomembrane	22,21,28,20,19,13,14,15,16,17,18,24,23	86.3
Region 6	Byproduct	26,27,34,33,32,25,31	38,517
Region 7	Soil Protective Layer	30,29,19,20,28,21,22,23,24,34,33,32,25,31	1,642.7

Appendix E

Seepage Potential and Karst Condition Assessment

BRETT J. DeVRIES
128061

6/7/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Appendix E

APPENDIX E – SEEPAGE POTENTIAL AND KARST CONDITION ASSESSMENT

The disposal facility is designed and constructed to include storm water run-on and run-off management and leachate control systems. The storm water management system consists of drainage ditches, diversion berms, culverts, storm water pipes, and a storm water run-off pond to convey and contain storm water away from the disposal facility. The leachate control system within Cell 2 consists of a double-sided geocomposite drainage layer overlying the compacted clay liner and a series of 4-inch-diameter perforated pipes spaced approximately 50 feet apart that drain in the direction of the storm water runoff pond. The Cell 3 leachate control system will consist of a geocomposite drainage layer overlying the geomembrane and compacted clay liner and a 6-inch-diameter perforated pipe covered by drainage aggregate encapsulated in nonwoven filter fabric running along the length of the cell to a collection sump located at the toe of the south slope. These leachate control system components are designed to limit leachate head buildup within the waste over the liner. The landfill composite liner system elevation is above the groundwater elevation. There are no concerns that storm water, leachate, or groundwater movement will impact the stability of the landfill.

As noted in **Appendix A**, karst features were not observed in the borings within and adjacent to the disposal facility. Regionally, the site geology is not known for karst features. The site soils are clays overlying clay shale weathered from shale bedrock that are not subject to karst conditions.

References

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

Geosyntec Consultants, 2016, Run-on and Run-off Control System Plan for Solid Waste Disposal Facility Registration No. 88448, Sandy Creek Energy Station, McLennan County, TX.

SCS Engineers, 2020, April 2020 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, TX.

SCS Engineers, 2020, November 2020 Groundwater Monitoring Well, Sandy Creek Energy Station, Sandy Creek Services, LLC.

DLN/lmh/DMH/EJN

ATTACHMENT 3

LEACHATE GENERATION

Sandy Creek Energy Station
Solid Waste Disposal Facility
McLennan County, TX

Cell 3 Compliance Demonstration
Attachment 3 – Leachate Generation

Prepared for:

Sandy Creek Services, LLC
2161 Rattlesnake Road
Riesel, Texas 76682

BRETT J. DeVRIES
128061

6/7/21

SCS ENGINEERS

TBPE Reg. No. F-3407
16220089.00 | Revision 0 – June 2021

1901 Central Dr., Suite 550
Bedford, TX 76021
817-571-2288

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  1.1 INTRODUCTION AND OBJECTIVE 1
  1.2 LEACHATE COLLECTION SYSTEM 1
  1.3 METHOD OF ANALYSIS 2
  1.4 MODEL SETUP 2
    1.4.1 Phases 2
    1.4.2 Climatological Data 2
    1.4.3 Landfill Profiles 3
      1.4.3.1 Compacted Clay Liner and Flexible Membrane Liner 3
      1.4.3.2 Leachate Drainage System Layer 3
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1.0 LEACHATE GENERATION

1.1 INTRODUCTION AND OBJECTIVE

The following Unstable Areas Compliance Demonstration has been prepared for Cell 3 at Sandy Creek Services, LLC's Sandy Creek Energy Station Solid Waste Disposal Facility (Facility) as required by Title 40, Code of Federal Regulation (CFR) §257.70(d(1); as well as the requirements of Title 30 Texas Administrative Code (TAC) §352.701, specifically related to maintaining less than 30-centimeter (12-inches) depth of leachate over the composite liner. Note that the Texas Commission on Environmental Quality (TCEQ) has adopted the above mentioned CFR rule by reference.

The coal combustion residual (CCR) landfill is classified as an existing landfill as defined under §257.53, which was constructed and commenced operation prior to October 14, 2015. The landfill is currently comprised of two CCR disposal cells, Cells 1 and 2 (see **Figure 1**), which commenced receiving waste in early 2013 and October 2014, respectively. The approximate area of Cells 1 and 2 are 10.0 and 14.3 acres, respectively. Cell 3 of the facility is proposed for construction as a lateral expansion of a CCR unit, and incorporates an approximate area of 17.0 acres (see **Figure 2**).

The primary wastes disposed of in the landfill are dry scrubber ash and bottom ash generated during the facility's coal combustion process. Incidental waste generated during the facility's operation may also be disposed of in the landfill, as described in the initial registration notification to TCEQ and the most recent version of the facility's Operations Plan.

This compliance demonstration addresses the construction of Cell 3. Future Cell 4 has not been developed, is not addressed by this demonstration, and will require compliance demonstration to placing CCR in Cell 4.

1.2 LEACHATE COLLECTION SYSTEM

The barrier components of the bottom/sideslope liner system will be comprised of a 24-inch thick compacted clay liner overlain by a 60-mil high density polyethylene (HDPE) geomembrane liner. Above these barrier layers, the leachate collection system (LCS) will include a 270-mil lateral drainage layer (geocomposite, consisting of high density polyethylene (HDPE) geonet with a non-woven geotextile head bonded to both sides of the geonet) that will convey leachate to the leachate collection piping and sump, and overlain by a 24-inch-thick protective soil cover (onsite soils, which will have a hydraulic conductivity (k) less than 1.0 x 10^{-4} cm/sec). The leachate collection piping will be covered by drainage stone encapsulated in non-woven filter fabric. The bottom liner system of each cell will slope to drain at a minimum 2 percent toward a perforated leachate collection pipe located in the center of each cell. This leachate generation model is based on a maximum flow length to the LCS pipe of 210 feet at a 2 percent slope within Cell 3.

Leachate generated at the landfill will enter the LCS piping by either: (1) infiltrating through the protective soil cover and into underlying geocomposite, which drains to the leachate collection piping; or (2) infiltrating through the gravel chimney drains installed over the LCS piping. The LCS piping will be sloped at a minimum 1 percent to drain leachate into a leachate collection sump located at the perimeter of the cell. Furthermore, the active and interim conditions were analyzed for landfill operations during periods of no leachate recirculation.

The layout and design details of the LCS are depicted on the Figure 5 and 6.

1.3 METHOD OF ANALYSIS

The HELP model Version 4.0 (Beta) is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of the disposal facility. The model accepts weather, soil, and design data. It uses solution techniques that account for key factors affecting water movement in a landfill, including: surface storage; snowmelt; runoff; infiltration; evapotranspiration; vegetative growth; soil moisture storage; lateral subsurface drainage; leachate recirculation; unsaturated vertical drainage; and leakage through soil, geomembrane, and composite liners (EPA, 2020). Output includes peak daily, monthly and annual leachate generation and peak leachate depth over the liner for the respective periods.

1.4 MODEL SETUP

1.4.1 Phases

The landfill was modeled as a one-acre unit area for the following conditions of landfill development:

- Case 1 - Active condition with 10 feet of CCR, daily cover, and 0% runoff potential;
- Case 2 - Interim condition with 120 feet of CCR, intermediate cover, and 90% runoff potential;
- Case 3 – Interim condition with 178 feet of CCR, intermediate cover, and 90% runoff potential.

In the HELP model, runoff is represented by two terms, “Runoff Potential” and “Curve Number (CN)”, each of which is used differently by the model. Runoff Potential (i.e., Runoff Area) represents the percentage of the area being modeled that is sloped such that it is possible for runoff to occur.

The Curve Number (CN) is similar to the Runoff Potential in that it is used by the HELP model to estimate the volume of runoff from the landfill cover for a given storm event. The HELP model uses the CN value within a subroutine based on the Curve Number Method to calculate runoff. Unlike the Runoff Potential, the CN value incorporates the effects of soil characteristics (hydraulic conductivity), vegetative cover, and antecedent moisture content in the soil (i.e., initial soil moisture content).

The Runoff Potential was user-selected as zero percent for the active condition, since precipitation contacting these areas will be contained at the working face by containment berms. For the interim conditions, the Runoff Potential was user-selected as 90 percent as this represents areas of the landfill that are well graded and have temporary drainage features in place allowing most of the stormwater to runoff. The remaining 10 percent of the area is assumed to retain runoff through incidental surface storage, thus allowing some amount of infiltration into the underlying CCR.

The HELP model results for the above conditions were reviewed in terms of peak daily leachate depth to confirm compliance with the regulatory requirement of maintaining less than 30-centimeters of leachate over the bottom liner system.

1.4.2 Climatological Data

The climatological data required by the HELP model is dependent on the geographical location, leaf area index, evaporative zone depth, and the number of years to be modeled. From these user inputs, the HELP model generates synthetic precipitation, temperature, and solar radiation data.

For the HELP model presented in this demonstration, the leaf area index (LAI) was assumed zero for the active condition (representing bare soil cover) and 2.0 for the interim conditions (representing fair vegetative cover). The LAI values correspond to the anticipated vegetative cover at each development condition. The evaporative zone depth was assumed to be 6 inches for the active condition and 12 inches for the interim conditions.

The precipitation data was modeled using the HELP program's synthetic weather daily generation option for Waco, Texas for 10 year modeling periods. HELP model default mean monthly precipitation data for Waco, Texas was modified to match the mean monthly precipitation for the vicinity of the site. Monthly precipitation data (from 1941 to 2020) was obtained for Waco Regional Airport Station (USW00013959) from National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center's (NCDC) Climate Data Online (CDO) service. Mean monthly precipitation data used in the modeling is presented in this appendix.

The temperature, relative humidity, and solar radiation data were modeled for Waco, Texas using the synthetic daily weather generation for the modeling periods.

Output from the HELP model includes the peak daily, monthly, and annual precipitation, temperature, and solar radiation.

1.4.3 Landfill Profiles

The landfill profile or layer characteristics for each condition of landfill development are presented in the HELP Model Summary Sheets included in this appendix. Information provided in the table includes the layer thickness, porosity, field capacity, wilting point, and hydraulic conductivity used by the model for each layer. Default soil and waste characteristics (i.e., hydraulic conductivity, porosity, field capacity, and wilting point) in the HELP model were used for the landfill profiles for the active condition. However, as described below, the hydraulic conductivity was adjusted based on confining pressure for the interim and final conditions. These assumptions are considered representative of onsite soils or waste to be disposed at the site.

1.4.3.1 Compacted Clay Liner and Flexible Membrane Liner

The 24-inch-thick compacted clay liner was modeled as a barrier layer using default values from the HELP model table of soil characteristics (HELP default texture 16). The flexible geomembrane liner (60 mil HDPE), which is placed directly over the compacted clay liner, was also modeled using default values from the HELP model table of soil, waste, and geosynthetics characteristics (HELP default texture 35). The geomembrane liner was modeled for good installation quality which is represented by four defects per acre and a pinhole density of one hole/acre (Berger and Schroeder, 2013).

1.4.3.2 Leachate Drainage System Layer

The LCS drainage layer is a geonet drainage layer with a geotextile adhered to both sides (referred to as a geocomposite). The manufactured thickness of the geocomposite is 270-mil (approximately 0.27 inches), which was reduced for compression depending on the amount of waste and soil cover for each condition modeled in HELP.

1.4.3.3 Protective Soil Cover

The protective soil cover was assumed to be a 24-inch-thick clayey soil with a hydraulic conductivity of 1.7×10^{-5} cm/s. HELP default texture 15, high plasticity clay (CH) was selected to reflect soils available on site. Re-compacted soil samples of onsite soils may indicate permeability values less than the values assumed in the HELP model. Therefore, a more permeable clay was selected to simulate higher percolation through protective cover. Default soil characteristics were used for the protective soil cover (HELP default texture 15).

1.4.3.4 CCR

The CCR layers described in Section 1.4.1 were utilized for the various landfill conditions in the HELP model. The waste material was modeled using default HELP model properties for high-density electric plant fly ash (HELP default texture 30). For active condition and interim conditions with 120 ft. and 178 ft. of CCR, which correspond to recently placed CCR in relatively loose state, the HELP default hydraulic conductivity (5.0 x 10^{-5} cm/s) was used.

1.4.3.5 Daily and Intermediate Cover

CCR landfills are not required to have daily cover, therefore, the active condition was modeled with no daily cover, and interim conditions were modeled with a 12-inch layer of intermediate soil. The intermediate cover were assumed to be clayey soil, with a hydraulic conductivity of 1.7 x 10^{-5} cm/s. Default soil characteristics were used for the intermediate cover soils (HELP default texture 15).

1.5 HELP MODEL RESULTS

The HELP model results are presented in the attached HELP Model Summary Sheets. Additionally, the HELP model output files are also provided in this appendix. **As presented in the HELP model output, the depth of leachate over the bottom liner is predicted to be confined to the geocomposite lateral drainage layer, which is below the 30 centimeter regulatory requirement, whether during periods of with or without leachate recirculation.**

1.6 REFERENCES

Tolaymat, T. and Kruase, M. “Hydrologic Evaluation of Landfill Performance 4.0, User Manual”, Version 4.0 (Beta), Environmental Protection Agency/Center for Environmental Solutions and Emergency Management, 2020.

APPENDIX A

HELP MODEL SUMMARY

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Inclusive of Appendix A

SANDY CREEK ENERGY STATION SOLID WASTE DISPOSAL FACILITY
HELP MODEL SUMMARY SHEET

Prep'd By:SDS
Chkd By: BG
Date: February 2021

HELP MODEL INPUT PARAMETERS		ACTIVE (10' CCR)	INTERIM (120' CCR)	INTERIM (178' CCR)
		CASE 1	CASE 2	CASE 3
GENERAL INFORMATION	No. of Years	10	30	50
	Ground Cover	BARE	GOOD	GOOD
	Model Area (acre)	1	1	1
	Runoff Area (%)	0	90	90
	Maximum Leaf Area Index	0.0	2.0	2.0
	Evaporative Zone Depth (inch)	6	12	12
INTERMEDIATE (Texture = 15)	Thickness (in)	-	12	12
	Porosity (vol/vol)	-	0.4750	0.4750
	Field Capacity (vol/vol)	-	0.3780	0.3780
	Wilting Point (vol/vol)	-	0.2650	0.2650
	Hyd. Conductivity (cm/s)	-	1.7E-05	1.7E-05
CCR (Texture = 30)	Thickness (in)	120	1440	2136
	Porosity (vol/vol)	0.5410	0.5410	0.5410
	Field Capacity (vol/vol)	0.1870	0.1870	0.1870
	Wilting Point (vol/vol)	0.0470	0.0470	0.0470
	Hyd. Conductivity (cm/s)	5.0E-05	5.0E-05	5.0E-05
PROTECTIVE COVER (Texture = 15)	Thickness (in)	24	24	24
	Porosity (vol/vol)	0.4750	0.4750	0.4750
	Field Capacity (vol/vol)	0.3780	0.3780	0.3780
	Wilting Point (vol/vol)	0.2650	0.2650	0.2650
	Hyd. Conductivity (cm/s)	1.7E-05	1.7E-05	1.7E-05
LEACHATE COLLECTION (Texture = 0)	Thickness (in)	0.27	0.23	0.21
	Porosity (vol/vol)	0.8500	0.8500	0.8500
	Field Capacity (vol/vol)	0.0100	0.0100	0.0100
	Wilting Point (vol/vol)	0.0050	0.0050	0.0050
	Hyd. Conductivity (cm/s)	10.00	6.00	2.00
	Slope (%)	2.0	2.0	2.0
	Slope Length (ft)	210	210	210
FLEXIBLE MEMBRANE LINER (Texture = 35)	Thickness (in)	0.06	0.06	0.06
	Hyd. Conductivity (cm/s)	2.0E-13	2.0E-13	2.0E-13
	Pinhole Density (holes/acre)	1	1	1
	Install. Defects (holes/acre)	4	4	4
	Placement Quality	GOOD	GOOD	GOOD
COMPACTED CLAY LINER (Texture =16)	Thickness (in)	24	24	24
	Porosity (vol/vol)	0.4270	0.4270	0.4270
	Field Capacity (vol/vol)	0.4180	0.4180	0.4180
	Wilting Point (vol/vol)	0.3670	0.3670	0.3670
	Hyd. Conductivity (cm/s)	1.0E-07	1.0E-07	1.0E-07
PRECIPITATION	Average Annual (in)	33.78	31.26	31.65
RUNOFF	Average Annual (in)	0.00	5.09	5.21
EVAPOTRANSPIRATION	Average Annual (in)	24.43	22.76	22.97
LATERAL DRAINAGE (LCS)	Average Annual (cf/year)	34,157	14,213	13,978
LATERAL DRAINAGE (LCS)	Average Annual (cf/day)	93.6	38.9	38.3
LATERAL DRAINAGE (LCS)	Peak daily (cf/day)	406	110	113
HEAD ON LINER	Average daily (in)	0.021	0.009	0.028
HEAD ON LINER	Peak daily (in)	0.041	0.019	0.057

APPENDIX B

HELP MODEL RESULTS – CASE 1

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Inclusive of Appendix B

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Sandy Creek Landfill Cell 3 (10' CCR) **Simulated On:** 2/18/2021 14:19

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 120 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.2675 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer
C - Clay (Low Density)
Material Texture Number 15

Thickness = 24 inches
Porosity = 0.475 vol/vol
Field Capacity = 0.378 vol/vol
Wilting Point = 0.265 vol/vol
Initial Soil Water Content = 0.4009 vol/vol
Effective Sat. Hyd. Conductivity = 1.70E-05 cm/sec

Layer 3

Type 2 - Lateral Drainage Layer
Drainage Net (0.5 cm)
Material Texture Number 20

Thickness = 0.27 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.0341 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E+01 cm/sec
Slope = 2 %
Drainage Length = 210 ft

Layer 4

Type 4 - Flexible Membrane Liner
HDPE Membrane
Material Texture Number 35

Thickness = 0.06 inches
Effective Sat. Hyd. Conductivity = 2.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 4 Holes/Acre
FML Placement Quality = 3 Good

Layer 5

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness = 24 inches
Porosity = 0.427 vol/vol
Field Capacity = 0.418 vol/vol
Wilting Point = 0.367 vol/vol
Initial Soil Water Content = 0.427 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were specified by the user.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 97.1
Fraction of Area Allowing Runoff = 0 %
Area projected on a horizontal plane = 1 acres
Evaporative Zone Depth = 6 inches
Initial Water in Evaporative Zone = 1.605 inches
Upper Limit of Evaporative Storage = 3.246 inches
Lower Limit of Evaporative Storage = 0.282 inches
Initial Snow Water = 0 inches
Initial Water in Layer Materials = 51.979 inches
Total Initial Water = 51.979 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 31.54 Degrees
Maximum Leaf Area Index = 0
Start of Growing Season (Julian Date) = 55 days

End of Growing Season (Julian Date) = 336 days
Average Wind Speed = 11 mph
Average 1st Quarter Relative Humidity = 74 %
Average 2nd Quarter Relative Humidity = 69 %
Average 3rd Quarter Relative Humidity = 65 %
Average 4th Quarter Relative Humidity = 70 %

Note: Evapotranspiration data was obtained for Riesel, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.04875	2.3985	2.729125	3.41525	4.5525	3.112625
1.852125	1.8645	3.065375	3.5715	2.438375	2.31575

Note: Precipitation was simulated using NOAA data for the following weather stations:
WACO REGIONAL AIRPORT, TX US, WACO DAM, TX US, MARLIN, TX US

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
46.8	50.9	58.1	66.6	74.2	81.6
85.5	85.4	78.9	68.9	57.4	49.2

Note: Temperature was simulated using NOAA data for the following weather stations:
WACO REGIONAL AIRPORT, TX US, WACO DAM, TX US, MARLIN, TX US
Solar radiation was simulated using NSRDB data for the following location:

Average Annual Totals Summary

Title: Sandy Creek Landfill Cell 3 - Active (10' CCR)
Simulated on: 2/18/2021 14:19

	Average Annual Totals for Years 1 - 10*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	33.78	[6.73]	122,603.3	100.00
Runoff	0.000	[0]	0.0000	0.00
Evapotranspiration	24.430	[3.521]	88,679.5	72.33
Subprofile1				
Lateral drainage collected from Layer 3	9.4098	[2.7177]	34,157.6	27.86
Percolation/leakage through Layer 5	0.000010	[0.000002]	0.0366	0.00
Average Head on Top of Layer 4	0.0048	[0.0014]	---	---
Water storage				
Change in water storage	-0.0644	[2.3425]	-233.9	-0.19

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Sandy Creek Landfill Cell 3 - Active (10' CCR)
Simulated on: 2/18/2021 14:19

	Peak Values for Years 1 - 10*	
	(inches)	(cubic feet)
Precipitation	4.20	15,246.0
Runoff	0.000	0.0000
Subprofile1		
Drainage collected from Layer 3	0.1119	406.4
Percolation/leakage through Layer 5	0.000000	0.0003
Average head on Layer 4	0.0207	---
Maximum head on Layer 4	0.0413	---
Location of maximum head in Layer 3	0.97	(feet from drain)
Other Parameters		
Snow water	0.6003	2,179.1
Maximum vegetation soil water	0.5264	(vol/vol)
Minimum vegetation soil water	0.0470	(vol/vol)

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Sandy Creek Landfill Cell 3 - Active (10' CCR)
Simulated on: 2/18/2021 14:20
Simulation period: 10 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	31.2564	0.2605
2	9.8248	0.4094
3	0.0052	0.0193
4	0.0000	0.0000
5	10.2480	0.4270
Snow water	0.0000	---

APPENDIX C

HELP MODEL RESULTS – CASE 2

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Inclusive of Appendix C

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Sandy Creek Landfill Cell 3 (120' CCR) **Simulated On:** 2/19/2021 15:24

Layer 1
Type 1 - Vertical Percolation Layer (Cover Soil)
C - Clay (Low Density)
Material Texture Number 15

Thickness = 12 inches
Porosity = 0.475 vol/vol
Field Capacity = 0.378 vol/vol
Wilting Point = 0.265 vol/vol
Initial Soil Water Content = 0.3493 vol/vol
Effective Sat. Hyd. Conductivity = 1.70E-05 cm/sec

Layer 2
Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 1440 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.2675 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 3
Type 1 - Vertical Percolation Layer
C - Clay (Low Density)
Material Texture Number 15

Thickness = 24 inches
Porosity = 0.475 vol/vol
Field Capacity = 0.378 vol/vol
Wilting Point = 0.265 vol/vol
Initial Soil Water Content = 0.4009 vol/vol
Effective Sat. Hyd. Conductivity = 1.70E-05 cm/sec

Layer 4
Type 2 - Lateral Drainage Layer
Geocomposite Drainage Net

Material Texture Number 123

Thickness = 0.23 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.0341 vol/vol
Effective Sat. Hyd. Conductivity = 6.00E+00 cm/sec
Slope = 2 %
Drainage Length = 210 ft

Layer 5

Type 4 - Flexible Membrane Liner
HDPE Membrane
Material Texture Number 35

Thickness = 0.06 inches
Effective Sat. Hyd. Conductivity = 2.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 4 Holes/Acre
FML Placement Quality = 3 Good

Layer 6

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16

Thickness = 24 inches
Porosity = 0.427 vol/vol
Field Capacity = 0.418 vol/vol
Wilting Point = 0.367 vol/vol
Initial Soil Water Content = 0.427 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water were specified by the user.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 87.1
Fraction of Area Allowing Runoff = 90 %
Area projected on a horizontal plane = 1 acres
Evaporative Zone Depth = 12 inches
Initial Water in Evaporative Zone = 4.192 inches
Upper Limit of Evaporative Storage = 5.7 inches
Lower Limit of Evaporative Storage = 3.18 inches
Initial Snow Water = 0 inches

Initial Water in Layer Materials	=	409.269	inches
Total Initial Water	=	409.269	inches
Total Subsurface Inflow	=	0	inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude	=	31.54	Degrees
Maximum Leaf Area Index	=	2	
Start of Growing Season (Julian Date)	=	55	days
End of Growing Season (Julian Date)	=	336	days
Average Wind Speed	=	11	mph
Average 1st Quarter Relative Humidity	=	74	%
Average 2nd Quarter Relative Humidity	=	69	%
Average 3rd Quarter Relative Humidity	=	65	%
Average 4th Quarter Relative Humidity	=	70	%

Note: Evapotranspiration data was obtained for Riesel, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.04875	2.3985	2.729125	3.41525	4.5525	3.112625
1.852125	1.8645	3.065375	3.5715	2.438375	2.31575

Note: Precipitation was simulated using NOAA data for the following weather stations:
WACO REGIONAL AIRPORT, TX US, WACO DAM, TX US, MARLIN, TX US

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
46.8	50.9	58.1	66.6	74.2	81.6
85.5	85.4	78.9	68.9	57.4	49.2

Note: Temperature was simulated using NOAA data for the following weather stations:
WACO REGIONAL AIRPORT, TX US, WACO DAM, TX US, MARLIN, TX US
Solar radiation was simulated using HELP v3.07 data files for the following location:
WACO, TEXAS (Latitude: 31.54)

Average Annual Totals Summary

Title: Sandy Creek Landfill Cell 3 - Intermediate (120' CCR)
Simulated on: 2/19/2021 15:25

	Average Annual Totals for Years 1 - 30*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	31.26	[8.3]	113,455.7	100.00
Runoff	5.085	[2.942]	18,459.6	16.27
Evapotranspiration	22.759	[4.6]	82,615.5	72.82
Subprofile1				
Lateral drainage collected from Layer 4	3.9154	[0.9363]	14,212.9	12.53
Percolation/leakage through Layer 6	0.000008	[0.000001]	0.0290	0.00
Average Head on Top of Layer 5	0.0033	[0.0008]	---	---
Water storage				
Change in water storage	-0.5048	[2.6951]	-1,832.3	-1.61

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Sandy Creek Landfill Cell 3 - Intermediate (120' CCR)
Simulated on: 2/19/2021 15:25

	Peak Values for Years 1 - 30*	
	(inches)	(cubic feet)
Precipitation	4.64	16,843.2
Runoff	3.892	14,127.5
Subprofile1		
Drainage collected from Layer 4	0.0304	110.4
Percolation/leakage through Layer 6	0.000000	0.0002
Average head on Layer 5	0.0094	---
Maximum head on Layer 5	0.0187	---
Location of maximum head in Layer 4	0.46 (feet from drain)	
Other Parameters		
Snow water	1.2103	4,393.4
Maximum vegetation soil water	0.4722 (vol/vol)	
Minimum vegetation soil water	0.2650 (vol/vol)	

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Sandy Creek Landfill Cell 3 - Intermediate
Simulated on: 2/19/2021 15:25
Simulation period: 30 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	3.8061	0.3172
2	370.4277	0.2572
3	9.6390	0.4016
4	0.0052	0.0227
5	0.0000	0.0000
6	10.2480	0.4270
Snow water	0.0000	---

APPENDIX D

HELP MODEL RESULTS – CASE 3

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6/7/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Appendix D

HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE
HELP MODEL VERSION 4.0 BETA (2018)
DEVELOPED BY USEPA NATIONAL RISK MANAGEMENT RESEARCH LABORATORY

Title: Sandy Creek Landfill Cell 3 (178' CCR) **Simulated On:** 2/19/2021 15:13

Layer 1

Type 1 - Vertical Percolation Layer (Cover Soil)
C - Clay (Low Density)
Material Texture Number 15

Thickness = 12 inches
Porosity = 0.475 vol/vol
Field Capacity = 0.378 vol/vol
Wilting Point = 0.265 vol/vol
Initial Soil Water Content = 0.3493 vol/vol
Effective Sat. Hyd. Conductivity = 1.70E-05 cm/sec

Layer 2

Type 1 - Vertical Percolation Layer (Waste)
High-Density Electric Plant Coal Fly Ash
Material Texture Number 30

Thickness = 2174.4 inches
Porosity = 0.541 vol/vol
Field Capacity = 0.187 vol/vol
Wilting Point = 0.047 vol/vol
Initial Soil Water Content = 0.2675 vol/vol
Effective Sat. Hyd. Conductivity = 5.00E-05 cm/sec

Layer 3

Type 1 - Vertical Percolation Layer
C - Clay (Low Density)
Material Texture Number 15

Thickness = 24 inches
Porosity = 0.475 vol/vol
Field Capacity = 0.378 vol/vol
Wilting Point = 0.265 vol/vol
Initial Soil Water Content = 0.4009 vol/vol
Effective Sat. Hyd. Conductivity = 1.70E-05 cm/sec

Layer 4

Type 2 - Lateral Drainage Layer
Geocomposite Drainage Net

Material Texture Number 123
Thickness = 0.21 inches
Porosity = 0.85 vol/vol
Field Capacity = 0.01 vol/vol
Wilting Point = 0.005 vol/vol
Initial Soil Water Content = 0.0341 vol/vol
Effective Sat. Hyd. Conductivity = 2.00E+00 cm/sec
Slope = 2 %
Drainage Length = 210 ft

Layer 5

Type 4 - Flexible Membrane Liner
HDPE Membrane
Material Texture Number 35
Thickness = 0.06 inches
Effective Sat. Hyd. Conductivity = 2.00E-13 cm/sec
FML Pinhole Density = 1 Holes/Acre
FML Installation Defects = 4 Holes/Acre
FML Placement Quality = 3 Good

Layer 6

Type 3 - Barrier Soil Liner
Liner Soil (High)
Material Texture Number 16
Thickness = 24 inches
Porosity = 0.427 vol/vol
Field Capacity = 0.418 vol/vol
Wilting Point = 0.367 vol/vol
Initial Soil Water Content = 0.427 vol/vol
Effective Sat. Hyd. Conductivity = 1.00E-07 cm/sec

Note: Initial moisture content of the layers and snow water
were specified by the user.

General Design and Evaporative Zone Data

SCS Runoff Curve Number = 87.1
Fraction of Area Allowing Runoff = 90 %
Area projected on a horizontal plane = 1 acres
Evaporative Zone Depth = 12 inches
Initial Water in Evaporative Zone = 4.192 inches
Upper Limit of Evaporative Storage = 5.7 inches
Lower Limit of Evaporative Storage = 3.18 inches
Initial Snow Water = 0 inches

Initial Water in Layer Materials = 605.72 inches
Total Initial Water = 605.72 inches
Total Subsurface Inflow = 0 inches/year

Note: SCS Runoff Curve Number was calculated by HELP.

Evapotranspiration and Weather Data

Station Latitude = 31.54 Degrees
Maximum Leaf Area Index = 2
Start of Growing Season (Julian Date) = 55 days
End of Growing Season (Julian Date) = 336 days
Average Wind Speed = 11 mph
Average 1st Quarter Relative Humidity = 74 %
Average 2nd Quarter Relative Humidity = 69 %
Average 3rd Quarter Relative Humidity = 65 %
Average 4th Quarter Relative Humidity = 70 %

Note: Evapotranspiration data was obtained for Riesel, Texas

Normal Mean Monthly Precipitation (inches)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
2.04875	2.3985	2.729125	3.41525	4.5525	3.112625
1.852125	1.8645	3.065375	3.5715	2.438375	2.31575

Note: Precipitation was simulated using NOAA data for the following weather stations: WACO REGIONAL AIRPORT, TX US, WACO DAM, TX US, MARLIN, TX US

Normal Mean Monthly Temperature (Degrees Fahrenheit)

Jan/Jul	Feb/Aug	Mar/Sep	Apr/Oct	May/Nov	Jun/Dec
46.8	50.9	58.1	66.6	74.2	81.6
85.5	85.4	78.9	68.9	57.4	49.2

Note: Temperature was simulated using NOAA data for the following weather stations: WACO REGIONAL AIRPORT, TX US, WACO DAM, TX US, MARLIN, TX US
Solar radiation was simulated using HELP v3.07 data files for the following location: WACO, TEXAS (Latitude: 31.54)

Average Annual Totals Summary

Title: Sandy Creek Landfill Cell 3 - Intermediate (178' CCR)
Simulated on: 2/19/2021 15:14

	Average Annual Totals for Years 1 - 50*			
	(inches)	[std dev]	(cubic feet)	(percent)
Precipitation	31.65	[7.62]	114,904.7	100.00
Runoff	5.206	[2.655]	18,899.4	16.45
Evapotranspiration	22.970	[4.353]	83,382.7	72.57
Subprofile1				
Lateral drainage collected from Layer 4	3.8508	[0.9389]	13,978.3	12.17
Percolation/leakage through Layer 6	0.000017	[0.000003]	0.0624	0.00
Average Head on Top of Layer 5	0.0098	[0.0024]	---	---
Water storage				
Change in water storage	-0.3735	[2.4382]	-1,355.7	-1.18

* Note: Average inches are converted to volume based on the user-specified area.

Peak Values Summary

Title: Sandy Creek Landfill Cell 3 - Intermediate (178' CCR)
Simulated on: 2/19/2021 15:14

	Peak Values for Years 1 - 50*	
	(inches)	(cubic feet)
Precipitation	4.64	16,843.2
Runoff	3.892	14,127.5
Subprofile1		
Drainage collected from Layer 4	0.0311	112.7
Percolation/leakage through Layer 6	0.000000	0.0004
Average head on Layer 5	0.0288	---
Maximum head on Layer 5	0.0572	---
Location of maximum head in Layer 4	1.30	(feet from drain)
Other Parameters		
Snow water	1.6906	6,137.0
Maximum vegetation soil water	0.4722	(vol/vol)
Minimum vegetation soil water	0.2650	(vol/vol)

Final Water Storage in Landfill Profile at End of Simulation Period

Title: Sandy Creek Landfill Cell 3 - Intermediate (178' CCR)
Simulated on: 2/19/2021 15:14
Simulation period: 50 years

	Final Water Storage	
Layer	(inches)	(vol/vol)
1	4.0387	0.3366
2	563.3882	0.2591
3	9.3622	0.3901
4	0.0099	0.0472
5	0.0000	0.0000
6	10.2480	0.4270
Snow water	0.0000	---

ATTACHMENT 4

LEACHATE COLLECTION SYSTEM DESIGN CALCULATIONS

- **4.1 – PIPE STRENGTH CALCULATIONS**
- **4.2 – GEOTEXTILE FILTER CALCULATIONS**
- **4.3 – GEOCOMPOSITE CALCULATIONS**
- **4.4 – PIPE CAPACITY CALCULTIONS**
- **4.5 – LEACHATE SUMP DESIGN CALCULATIONS**

ATTACHMENT 4.1

PIPE STRENGTH CALCULATIONS

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Inclusive of Attachment 4.1

Required:

Analyze the structural stability of the 6-inch diameter high density polyethylene leachate collection pipes related to wall crushing, deflection, and wall buckling failures associated with the worst case loading conditions.

Method:

A. Determine the critical load under the following two conditions:

1. Construction loading
2. Overburden loading

B. Use the critical loading pressure to analyze pipe stability under the following three possible

1. Wall crushing
2. Deflection
3. Wall buckling

References:

1. Bass, J., *Avoiding Failure of Leachate Collection and Cap Drainage Systems* , Pollution Technology Review No. 138, Noyes Data Corporation, 1986.
2. Texas Natural Resource Conservation Commission, *Leachate Collection System Handbook* , 30 TAC 330.201, 1993.
3. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, Draft Design Document titled *Technical Note XXX - Considerations for HDPE Pipe Section for Deep Fill Applications, 2002.*
4. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, *The Performance Pipe Engineering Manual* , Vol. 2, 2002.
5. Caterpillar Tractor Company, C*aterpillar Product Brochure: 836H Landfill Compactor (www.cat.com),* 2007.

Solution:

A. Determine critical loading for construction versus overburden conditions.

1. Construction Loading:

Assume: CAT 836H Landfill Compactor with an even load distribution (Ref. 5)

Loaded weight =	130,000	lb
Tire pressure =	40	psi
Number of tires =	4	

For a circular tire imprint:

$$F = \frac{\text{Loaded Weight}}{\text{Number of Tires}}$$

Where: F= Force exerted by one tire (lb)

F =	32,500	lb

Determine radius of contact for circular tire imprint:

$$r = (F / \pi p)^{1/2}$$

Where:
r = Radius of contact (in)
F = Force exerted by one tire (lb)
p = Tire pressure (psi)

r =	16.1	in

Use Boussinesq's solution to find the stress at a point below a uniformly loaded circular area:

$$y = p(1 - ((r/z)^2 + 1)^{-3/2})$$

Where:
y = Change in vertical stress (psi)
p = Tire pressure (psi)
r = Radius of contact (in)
z = Protective cover thickness (in)

z = 24 in

y =	17.1	psi

Assume only one wheel load on pipe and add 50% for impact loading:

$P_L = 1.5y$

Where: $P_L =$ Maximum live load (psi)

$P_L =$ 25.6 psi

$P_D = zw$

Where:
$P_D =$ Maximum dead load (psi)
$z =$ Protective cover thickness
$w =$ Unit weight of protective cover

$z =$ 24 in
$w =$ 120 pcf

$P_D =$ 1.7 psi

$P_{Tconst} = P_L + P_D$

Where: $P_{T,\ const} =$ Maximum construction load (psi)

$P_{T,\ const} =$ 27.3 psi

2. Overburden loading (postclosure load):

For maximum overburden load on pipe:

2.0	ft gravel & cover @	120	pcf =	240	psf
3.5	ft final & interim cover @	120	pcf =	420	psf
178.0	ft CCR @	103	pcf =	18,334	psf
			Σ =	18,994	psf

Daily cover is not placed on exposed ash. Interim cover is placed in areas not receiving ash. Operator will scrape off interim cover in those areas prior to placing additional ash.

$P_{Toverburd} =$ 18,994 psf

$P_{Toverburd} =$ 132 psi

Determine critical loading condition:

Construction loading:	$P_{Tconst} =$	27.3	psi
Overburden loading:	$P_{Toverburd} =$	132	psi

Conclusion: Overburden loading is most critical to the structural stability of the pipe and will be used to determine the design overburden pipe stress.

3. Determine design overburden stress:

Adjust critical stress to account for loss of strength in the pipe due to perforations:

$$P_{DES} = 12P_T / (12-1_p) \qquad \text{(Ref. 1)}$$

Where:

1_p = Cumulative length of perforations per foot of pipe
P_T = Critical pipe stress (psi)
P_{DES} = Pipe stress adjusted for loss of strength (psi), used as design pressure

6	holes/foot
0.5	in/hole

1_p =	3.0	in/ft

From determination of critical loading:

P_T =	132.0	psi

P_{DES} =	176	psi

Note: Soil arching is incorporated into the following calculations, using methods proposed by CPChem for HDPE solid wall pipe. The calculations are applicable to any solid wall HDPE pipe meeting industry standards for composition and manufacture.

B. Pipe Stability Analyses

1. Wall crushing (ring compressive stress) (Ref. 3)

Vertical Arching Factor (VAF) $= 0.88 - 0.71\ (S_A-1) / (S_A+2.5)$

Hoop thrust stiffness ratio $(S_A) = 1.43\ (M_s r_m/Et)$

Where:

M_s = One dimensional modulus of soil (psi) (Ref. 3)
r_m = Mean pipe radius, = $(D_o+D_i)/4$
D_o = Pipe outside diameter (in)
D_i = Pipe inside diameter (in)
E = Pipe modulus of elasticity (psi)
t = Pipe wall thickness (in)
DR = Dimension Ratio, D_o/t
σ_{yield}= HDPE compressive strength at yield (psi) = 1,600 psi (Ref. 4)

Assumed overburden stress (psi) : 176
Backfill type : Gravel, 95% Std. Proctor
Ms (from Table 1, below) (psi) : 8,400

Table 1. Typical Design Values for Constrained Modulus, M_s (Ref. 3)

Vertical Soil Stress (psi)	Gravelly Sand/Gravels at 95% SPD (psi)	Gravelly Sand/Gravels @ 90% SPD (psi)	Gravelly Sand/Gravels @ 85% SPD (psi)
10	3000	1500	500
20	3500	1700	650
40	4500	2100	900
60	5500	2500	1150
80	6000	2900	1300
100	6500	3200	1450
150	7750	-	-
200	9000	-	-

SPD = Standard Proctor Density

* Based on the linear relationship generated between Vertical Soil Stress (150 and 200 psi) and respective M_s (psi), linear interpolation was used to calculate a MS value of 8,400 psi at a Vertical Soil Stress of 176 psi.

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6-INCH DIAMETER HDPE PIPE

$P_{RD} = (VAF)\, P_{DES}$ (Ref. 3)

$\sigma_{actual} = P_{RD}(DR) / 2$ (Ref. 3)

Where:

P_{RD} = Radial-directed earth pressure

σ_{actual} = Actual sidewall crushing (compressive) stress

D_o (in) = 6

E (psi) = 28,200 (Ref. 4)

M_s (psi) = 8,400 (Ref. 3, Table 1 above)

σ_{yield}= 1,600 (Ref. 4)

Factor of Safety (FS) = $\sigma_{yield}/\sigma_{actual}$

DR	$\mathbf{P_{DES}}$	**t**	$\mathbf{r_m}$	$\mathbf{S_A}$	**VAF**	$\mathbf{P_{RD}}$ **(psf)**	$\boldsymbol{\sigma_{actual}}$ **(psi)**	**FS**
9	176	0.67	2.67	1.70	0.76	19,290	603	2.7
11	176	0.55	2.73	2.13	0.71	17,912	684	2.3
13.5	**176**	**0.44**	**2.78**	**2.66**	**0.65**	**16,509**	**774**	**2.1**
15.5	176	0.39	2.81	3.09	0.61	15,579	838	1.9
17	176	0.35	2.82	3.41	0.59	14,969	884	1.8
19	176	0.32	2.84	3.83	0.56	14,252	940	1.7
21	176	0.29	2.86	4.26	0.54	13,626	994	1.6
26	176	0.23	2.88	5.32	0.49	13,626	1,230	1.3

For pipe wall crushing, a minimum FS of 2.0 is desired. From above, a DR of 11 is required for the deepest portions of the landfill. However, higher DR pipe may be used for shallower portions of landfill provided calculations are performed during final design to confirm pipe crushing resistance for selected pipe.

2. Pipe Deflection

Rigidity Factor (R_F) = $12E_s(DR-1)^3 / E$
Secant Modulus of Soil (E_S) = $M_s (1+\mu)(1-2\mu)/(1-\mu)$
Soil Strain (ε_s) = $wH_c(100) / (0.75E_s)$
Deflection (%) = $D_F\varepsilon_S$
Dimension Ratio (DR) = D_o/t
Where:

Hc = height of fill (ft) = see below
w = average weight of fill (pcf) = see below
μ = soil Poisson ratio = 0.4
P_{DES} substituted for HcW (psi) = 176
M_s (psi) = 8,400
E_s (psi) = 3,920

DR	**E_s**	**E**	**R_F**	**D_F**	**ε_S (%)**	**Deflection (%)**
9	**3,920**	**28,200**	**854**	**1.15**	**5.99**	**6.88**
11	3,920	28,200	1,668	1.32	5.99	7.90
13.5	3,920	28,200	3,258	1.49	5.99	8.92
15.5	3,920	28,200	5,085	1.64	5.99	9.82
17	3,920	28,200	6,832	1.72	5.99	10.30
19	3,920	28,200	9,728	1.81	5.99	10.84

D_F = Deformation Factor obtained from table, attached.

For pipe deflection under the design loading, a target maximum deflection of 7.5 percent is desired. A pipe with DR value of **9** exhibits calculated deflection of less than 7.5 percent.

3. Pipe wall buckling (Ref. 3)

$P_{cr} = 1.63 ((RB'M_sE) / (DR-1)^3)^{0.5}$ (Ref. 3)
$H(ft) = P_{DES}/w$
$B' = 1 / (1+4e^{(-0.065H)})$ (Ref. 3)
$FS = P_{cr} / P_{DES}$

Where:

P_{cr} = Critical buckling pressure (psi)
B' = Elastic support coefficient
R = Groundwater buoyancy factor (=1)
H = Height of fill (ft)
E = Modulus of Elasticity of pipe (psi)
P_{DES} = Design pipe external loading (psi)
FS = Factor of safety against wall buckling

Assumptions: H (ft) = 184
B' = 1.00 (calculated using above equation)
E (psi) = 28,200

DR	**R**	**B'**	**M_s**	**P_{cr}**	**P_{DES}**	**FS**
9	1	1.00	8,400	1,109	176	6.30
11	1	1.00	8,400	793	176	4.51
13.5	1	1.00	8,400	568	176	3.23
15.5	1	1.00	8,400	454	176	2.58
17	1	1.00	8,400	392	176	2.23
19	1	1.00	8,400	329	176	1.87
21	**1**	**1.00**	**8,400**	**280**	**176**	**1.59**
26	1	1.00	8,400	201	176	1.14

For pipe buckling, a minimum FS value of 2.0 is desired. Pipe with DR value of 15.5 or less is acceptable.

Conclusion:

Based on the analysis presented above, in consideration of wall crushing, buckling, and allowable pipe deflection, 6-inch diameter HDPE pipe with a maximum DR value of **9** (wall thickness of 0.39 inches) is conservatively selected for deeper portions of landfill.

Required:

Analyze the structural stability of the 18-inch diameter high density polyethylene sump riser pipes related to wall crushing, deflection, and wall buckling failures associated with the worst case loading conditions.

Method:

A. Determine the critical load under the following two conditions:

1. Construction loading
2. Overburden loading

B. Use the critical loading pressure to analyze pipe stability under the following three possible failure conditions:

1. Wall crushing
2. Wall buckling
3. Deflection

References:

1. Bass, J., *Avoiding Failure of Leachate Collection and Cap Drainage Systems* , Pollution Technology Review No. 138, Noyes Data Corporation, 1986.
2. Texas Natural Resource Conservation Commission, *Leachate Collection System Handbook* , 30 TAC 330.201, 1993.
3. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, Draft Design Document titled *Technical Note XXX - Considerations for HDPE Pipe Section for Deep Fill Applications, 2002.*
4. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, *The Performance Pipe Engineering Manual* , Vol. 2, 2002.
5. Caterpillar Tractor Company, C*aterpillar Product Brochure: 836H Landfill Compactor (www.cat.com),* 2007.

Solution:

A. Determine critical loading for construction versus overburden conditions.

1. Construction Loading:

Assume: CAT 836H Landfill Compactor with an even load distribution (Ref. 5)

Loaded weight = 130,000 lb
Tire pressure = 40 psi
Number of tires = 4

For a circular tire imprint:

$$F = \frac{\text{Loaded Weight}}{\text{Number of Tires}}$$

Where: F= Force exerted by one tire (lb)

F =	32,500	lb

Determine radius of contact for circular tire imprint:

$$r = (F / \pi p)^{1/2}$$

Where:
r = Radius of contact (in)
F = Force exerted by one tire (lb)
p = Tire pressure (psi)

r =	16.1	in

Use Boussinesq's solution to find the stress at a point below a uniformly loaded circular area:

$$y = p(1-((r/z)^2+1)^{-3/2})$$

Where:
y = Change in vertical stress (psi)
p = Tire pressure (psi)
r = Radius of contact (in)
z = Protective cover thickness (in)

z = 24 in

y =	17.1	psi

Assume only one wheel load on pipe and add 50% for impact loading:

$P_L = 1.5y$

Where: P_L = Maximum live load (psi)

P_L =	25.6	psi

$P_D = zw$

Where:
P_D = Maximum dead load (psi)
z = Protective cover thickness
w = Unit weight of protective cover

z =	24	in
w =	120	pcf

P_D =	1.7	psi

$P_{Tconst} = P_L + P_D$

Where: $P_{T,\ const}$ = Maximum construction load (psi)

$P_{T,\ const}$ =	27.3	psi

2. Overburden loading (postclosure load):

For maximum overburden load on pipe:

2.0	ft gravel & cover @	120	pcf =	240	psf
3.5	ft final & interim cover @	120	pcf =	420	psf
178.0	ft CCR @	103	pcf =	18,334	psf
			Σ =	18,994	psf

Daily cover is not placed on exposed ash. Interim cover is placed in areas not receiving ash. Operator will scrape off interim cover in those areas prior to placing additional ash.

$P_{Toverburd}$ = 18,994 psf

$P_{Toverburd}$ =	132	psi

Determine critical loading condition:

Construction loading:	P_{Tconst} =	27.3	psi
Overburden loading:	$P_{Toverburd}$ =	132	psi
Design loading = Construction loading:	P_{DES} =	27.3	psi

Conclusion: Construction loading is most critical to the structural stability of the pipe and will be used to determine the design overburden pipe stress.

B. Pipe Stability Analyses

1. Wall crushing (ring compressive stress) (Ref. 3)

Vertical Arching Factor (VAF) $= 0.88 - 0.71\ (S_A-1) / (S_A+2.5)$
Hoop Thrust Stiffness Ratio (S_A) $= 1.43\ (M_s r_m/Et)$

Where:

M_s = One dimensional modulus of soil (psi) (Ref. 3)
r_m = Mean pipe radius, $= (D_o+D_i)/4$
D_o = Pipe outside diameter (in)
D_i = Pipe inside diameter (in)
E = Pipe modulus of elasticity (psi)
t = Pipe wall thickness (in)
DR = Dimension Ratio, D_o/t
σ_{yield}= HDPE compressive strength at yield (psi) = 1,600 psi (Ref. 4)

Assumed overburden stress (psi) : 27.3
Backfill type : Gravel, 95% Std. Proctor
Ms (from Table 1, below) (psi) : 3,646 (Ref. 3)

Table 1. Typical Design Values for Constrained Modulus, M_s (Ref. 3)

Vertical Soil Stress (psi)	**Gravelly Sand/Gravels at 95% SPD (psi)**	**Gravelly Sand/Gravels @ 90% SPD (psi)**	**Gravelly Sand/Gravels @ 85% SPD (psi)**
10	3000	1500	500
20	3500	1700	650
40	4500	2100	900
60	5500	2500	1150
80	6000	2900	1300
100	6500	3200	1450

SPD = Standard Proctor Density

* Based on the linear relationship generated between Vertical Soil Stress (20 and 40 psi) and respective Ms (psi), linear interpolation was used to calculate a MS value of 3,646 psi at a Vertical Soil Stress of 27.3 psi.

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PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE

$P_{RD} = (VAF)\ P_{DES}$ (Ref. 3)

$\sigma_{actual} = P_{RD}(DR) / 2$ (Ref. 3)

Where:

P_{RD} = Radial-directed earth pressure

σ_{actual} = Actual sidewall crushing (compressive) stress

D_o (in) = 18

E (psi) = 28,200 (Ref. 4)

M_s (psi) = 3,646 (Ref. 3)

σ_{yield}= 1,600 (Ref. 4)

Factor of Safety (FS) = $\sigma_{yield}/\sigma_{actual}$

DR	**P_{DES}**	**t**	**r_m**	**S_A**	**VAF**	**P_{RD} (psf)**	**σ_{actual} (psi)**	**FS**
15.5	27	1.16	8.42	1.34	0.82	3,212	173	9.3
17	27	1.06	8.47	1.48	0.79	3,123	184	8.7
19	27	0.95	8.53	1.66	0.77	3,014	199	8.0
21	27	0.86	8.57	1.85	0.74	2,915	213	7.5
26	27	0.69	8.65	2.31	0.69	2,699	244	6.6
32.5	**27**	**0.55**	**8.72**	**2.91**	**0.63**	**2,473**	**279**	**5.7**

For pipe wall crushing, a minimum FS of 2.0 desired. From above, a DR of **32.5** or less is acceptable for use in the leachate sumps and as sideslope riser piping.

2. Pipe Deflection

Rigidity Factor (R_F) = $12E_s(DR-1)^3 / E$
Secant Modulus of Soil (E_S) = $M_s\ (1+\mu)(1-2\mu)/(1-\mu)$
Soil Strain (ε_s) = $wH_c(100) / (0.75E_s)$
Deflection (%) = $D_F\varepsilon_S$
Dimension Ratio (DR) = D_o/t

Where:

Hc = height of fill (ft) =	see below
w = average weight of fill (pcf) =	see below
μ = soil Poisson ratio =	0.4
P_{DES} substituted for HcW (psi) =	27.3
M_s (psi) =	3,646
E_s (psi) =	1,701

DR	**E_s**	**E**	**R_F**	**D_F**	**ε_s (%)**	**Deflection (%)**
15.5	1,701	28,200	2,207	1.42	2.14	3.04
17	1,701	28,200	2,966	1.52	2.14	3.25
19	1,701	28,200	4,223	1.68	2.14	3.59
21	1,701	28,200	5,792	1.75	2.14	3.74
26	1,701	28,200	11,313	2	2.14	4.28
32.5	**1,701**	**28,200**	**22,630**	**2**	**2.14**	**4.28**

D_F = Deformation Factor obtained from table, attached.

For pipe deflection under the design loading, a maximum deflection of 7.5 percent is desired. From above, a DR of **32.5** or less is acceptable for use in the leachate sumps and as sideslope riser piping.

3. Pipe wall buckling (Ref. 3)

$P_{cr} = 1.63\ ((RB'M_sE) / (DR\text{-}1)^3)^{0.5}$ (Ref. 3)
$H\ (ft) = P_{DES}/w$
$B' = 1 / (1+4e^{(-0.065H)})$ (Ref. 3)
$FS = P_{cr} / P_{DES}$

Where:

P_{cr} = Critical buckling pressure (psi)
B' = Elastic support coefficient
R = Groundwater buoyancy factor (=1)
H = Height of fill (ft)
E = Modulus of Elasticity of pipe (psi)
P_{DES} = Design pipe external loading (psi)
FS = Factor of safety against wall buckling

Assumptions:
H (ft) = 184
B' = 1.00 (calculated using above equation)
E (psi) = 28,200

DR	R	B'	Ms	P_{cr}	P_{DES}	FS
9	1	1.00	3,646	730	43.4	16.83
11	1	1.00	3,646	523	43.4	12.04
13.5	1	1.00	3,646	374	43.4	8.62
15.5	1	1.00	3,646	299	43.4	6.90
17	1	1.00	3,646	258	43.4	5.95
19	1	1.00	3,646	216	43.4	4.99
21	1	1.00	3,646	185	43.4	4.26
26	1	1.00	3,646	132	43.4	3.05
32.5	**1**	**1.00**	**3,646**	**93**	**43.4**	**2.15**

For pipe buckling, a minimum FS value of 2.0 is desired. From above, a DR of **32.5** or less is acceptable for use in the leachate sumps and as sideslope riser piping.

Conclusion:
Based on the analysis presented above, in consideration of wall crushing, buckling, and allowable pipe deflection, 18-inch diameter HDPE pipe with a maximum DR value of **32.5** (wall thickness of 0.55 inches) is required in landfill sumps and for sidewall risers. Pipe with lower DR values may be used to provide additional stability.

ATTACHMENT 4.2

GEOTEXTILE FILTER CALCULATIONS

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6/7/21

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TBPE Reg. #F-3407
Inclusive of Attachment 4.2

SANDY CREEK DISPOSAL FACILITY
NON-WOVEN GEOTEXTILE DESIGN

Required:

Evaluate that the following non-woven geotextiles meet or exceed the required properties for retention, hydraulic conductivity, porosity, puncture resistance, and survivability for the specified design conditions:

A. Non-Woven Geotextile (12 oz/sy) to be installed around granular drainage aggregate located in the chimney drain and leachate collection sump within Cell 3.

B. Non-Woven Geotextile (8 oz/sy) located on the top/bottom of the drainage geocomposite

Although it is anticipated that the protective cover soil installed at the landfill will have a hydraulic conductivity less than 1 x 10^{-4} cm/s, the geotextile design calculations were performed conservatively assuming a protective cover soil with a hydraulic conductivity of greater than and less than 1 x 10^{-4} cm/s. Therefore, these calculations were performed for the following cases:

Case 1: Hydraulic conductivity greater than or equal to 1 x 10^{-4} cm/s.

Case 2: Hydraulic conductivity less than 1 x 10^{-4} cm/s.

Method:

Evaluate the geotextile properties for retention, hydraulic conductivity, porosity, puncture resistance, and survivability in accordance to Reference 2, as described herein.

Reference:

1. GSE Lining Technology Inc., Product Data Sheet "GSE Nonwoven Geotextiles", 2007
2. Koerner, R.M., Designing With Geosynthetics, third edition, 1994

Solution:

A. Non-Woven Geotextile (12 oz/sy) to be installed around granular drainage aggregate located in the chimney drain and leachate collection sump within Cell 3.

Retention (Case 1 and Case 2):

The apparent opening size (O_{95}) was determined ; **(Ref. 1)**

$O_{95} <$ 0.15 mm

AASHTO's Task Force # 25 report as referenced on pp. 101 of Reference 2 recommends that the following criteria be used to check the geotextile retention properties:

- For soil ≤ 50% passing the No. 200 sieve: $O_{95} < 0.59$mm (i.e., AOS of the fabric ≥ No. 30 sieve); and
- For soil > 50% passing the No. 200 sieve: $O_{95} < 0.30$mm (i.e., AOS of the fabric ≥ the No. 50 sieve).

Since the O_{95} or AOS of the 12 oz/sy geotextile is less than 0.30 mm, it meets the retention criteria for any soil.

Hydraulic Conductivity (k):

For Case 1:

$$q_{allow} = q_{ult} [(1/FS_{SCB} \text{ x } FS_{CR} \text{ x } FS_{IN} \text{ x } FS_{CC} \text{ x } FS_{BC})]$$ **(Ref. 2, pp. 159)**

Where:
$q_{allow=}$ allowable flow rate
$q_{ult=}$ ultimate flow rate
$FS_{SCB} =$ factor-of-safety for soil clogging and binding
$FS_{CR} =$ factor-of-safety for creep reduction of void space
$FS_{IN} =$ factor-of-safety for adjacent materials intruding into the geotextile's void space
$FS_{CC} =$ factor-of-safety for chemical clogging
$FS_{BC} =$ factor-of-safety for biological clogging

$q_{ult=}$	0.232	cm/sec	**(Ref. 1)**
$FS_{SCB} =$	7.5	(Long-term, fine soil)	**(Ref. 2, pp. 160)**
$FS_{CR} =$	1.65	(Long-term installation)	
$FS_{IN} =$	1.2	(Moderate normal stresses)	
$FS_{CC} =$	2.00	(Leachate unknown)	
$FS_{BC} =$	26.0	(Leachate unknown)	

Calculated factor-of-safety = 772.20

$q_{allow=}$	3.00E-04	cm/s

3.00E-04 > 1.00E-04 cm/s

Global F.S.$_{8oz/sy}$ = [q_{allow}/q_{soil}] = 3.00

After applying average partial factors-of-safety for the geotextile, a global factor of safety for clogging of 3 is determined and is acceptable.

For Case 2:

For protective cover material that has a hydraulic conductivity less than 1 x 10^{-4} cm/s, it is assumed that the hydraulic conductivity of the geotextile will be much greater than the hydraulic conductivity of the protective cover material. Therefore, the minimum hydraulic conductivity is not calculated for this case (i.e., the hydraulic conductivity of the nor woven geotextile will be sufficient to prevent head from developing in the protective cover).

Porosity (Case 1 and Case 2):

The selected non-woven geotextile should have enough openings, that the performance of the non-woven geotextile will not be significantly impaired in the event of blockage of some openings. Giroud recommends a non-woven geotextile porosity of greater than 30%. As per Giroud, the porosity of a non-woven geotextile can be calculated using the following equation.

$n = 1-[m/\rho t] \times 100$ **(Ref. 2, pp. 128)**

Where:
n = geotextile porosity, %
m = geotextile mass per unit area, lb/sf
t = geotextile thickness, ft
ρ = density of filaments, lb/cf

m = 0.083
t = 0.01
ρ = 182
n = 95.4 ***> 30%, therefore, ok***

Puncture Resistance (Case 1 and Case 2):

The selected geotextile must protect the underlying geonet and geomembrane components from damage due to the drainage aggregate. This component can be evaluated based on the puncture resistance of the geotextile. The manufacturer’s values for puncture resistance are based on a point load puncture failure (ASTM D4833). The steel rod used to puncture the geotextile is 0.31 in. in diameter. The puncture value of 190 lbs can be converted to 2,520 psi for the 12 oz/sy geotextile.

Assuming a compacted CCR density of approximately 115 lb/cf (CCR and soil), the height of fill would need to be over 3,500 ft high to exert a pressure approaching 2,520 psi. Since the maximum above ground and below ground fill height is significantly below 3,500 ft, the geotextile is adequate to protect the underlying liner components from damage due to static weights of the final waste body.

Survivability (Case 1 and Case 2):

Depending on the severity of an application a geotextile will be used for, the required strength parameters may vary. This assessment is also referred to as a " Survivability" analysis.

Based on Reference 2 pp. 303, geotextile properties are selected based on the subgrade conditions and the operating equipment used during the cell construction. A "Low" rating (see table below) is assumed for the 12 oz/sy geotextile.

Subgrade Conditions	**Construction Equipment Ground Pressure, 6 to 12 in. of Cover: Initial Lift Thickness**		
	Low Pressure (4 psi)	**Med. Pressure (> 4 psi)**	**High Pressure (>8 psi)**
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level such that any shallow depressions and humps do not exceed 6 in. in depth or height. All larger depressions are filled. Alternatively a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 1 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very High
Minimal site preparation is required. Trees may be felled, de-limbed, and left in place. Stumps should be cut to project not more than 6 in. ± above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders, Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very High	Not Recommended

Notes regarding the above table:

Recommendations given above are for 6 to 12 in. initial lift thickness. The recommended pressure for other initial lift thicknesses is listed below:

1. 12 to 18 in. - Reduce survivability requirement by one level
2. 18 to 24 in. - Reduce survivability requirement by two levels
3. >24 in. - Reduce survivability requirement by three levels

Survivability levels are in increasing order: low, moderate, high and very high. For special construction techniques such as pre-rutting, increase survivability requirement one level. Placement of excessive initial cover material thickness may cause bearing failure of soft subgrade. *Source* After Christopher and Holtz [146]

Using the table above, a rating of "High" was initially chosen based on optimum subgrade condition (which will be provided by the liner) and a high ground pressure of > 8 psi. However, since the soil protective cover will be 24 inches (all placed in one lift), the survivability requirement may be reduced by two levels (see Note #2) from "High to Low". Additionally, "Low" ground pressure equipment will be used on all sideslope areas to protect the liner components and a minimum of 24 inches of initial soil thickness will be maintained beneath equipment over the liner.

Based on Reference 2 pp.304, the physical property requirements for the evaluated geotextile are provided below.

PHYSICAL PROPERTY REQUIREMENTS[a]
GEOTEXTILES<50% ELONGATION/GEOTEXTILES>50% ELONGATION[b,c]

Survivability Level	**Grab Strength ASTM D4632 (lb.)**	**Puncture Resistance ASTM D4833 (lb.)**	**Trapezoidal Tear Strength ASTM D4533 (lb.)**
Medium	180/115	70/40	70/40
High	270/180	100/75	100/75

[a] Values shown are minimum average roll values. Strength values are in the weaker principal direction.

[b] Elongation (strain) at failure as determined by ASTM D4632, Grab Tensile.

[c] The values of geotextile elongation do not imply the allowable consolidation properties of the subgrade soil. These must be determined by a separate investigation.

Survivability (Case 1 and Case 2):

Since the table "Physical Property Requirements" provided on Pg. 4.3-4 does not provide physical property requirements for a "low" survivability level, the "medium" survivability level values were used for comparison. Given below are the manufacturer's specifications in comparison for the evaluated 12 oz/sy non-woven geotextile ***(Reference 1, w/ >50% elongation)*** .

Grab Strength (ASTM D4632) = 320 lbs >115 lbs, therefore ok
Puncture Resistance (ASTM D4833) = 190 lbs > 40 lbs, therefore ok
Trapezoid Tear Strength (ASTM D4533) = 125 lbs > 40 lbs, therefore ok

Therefore, the evaluated 12 oz/sy geotextile meets the "LOW" survivability criteria

Summary of required properties for non-woven geotextile installed around the drainage aggregate located in chimney drains and leachate collection sump for both Case 1 & Case 2: (Reference 1)

Apparent opening size	<	0.30	mm
Hydraulic conductivity	>	1×10^{-4}	cm/sec
Porosity	>	30.0	%
Grab tensile strength	≥	115	lbs
Puncture resistance	≥	40	lbs
Trapezoid tear strength	≥	40	lbs

Overall Conclusion:

The evaluated 12 oz/sy non-woven geotextile filter fabric is sufficient to allow proper flow of the leachate without clogging based on the 3 criteria analyzed: retention, hydraulic conductivity, and porosity and is adequate to provide protection to the underlying liner components based on the 2 criteria analyzed: puncture resistance and survivability.

B. Non-Woven Geotextile (8 oz/sy) located on the top/bottom of the drainage geocomposite.

Retention (Case 1 and Case 2):

The apparent opening size (O_{95}) was determined; **(Ref. 1)**

$O_{95} <$ 0.18 mm

AASHTO's Task Force # 25 report as referenced on pp. 101 of Reference 2 recommends that the following criteria be used to check the geotextile retention properties:

- For soil ≤ 50% passing the No. 200 sieve: $O_{95} < 0.59$mm (i.e., AOS of the fabric ≥ No. 30 sieve); and
- For soil > 50% passing the No. 200 sieve: $O_{95} < 0.30$mm (i.e., AOS of the fabric ≥ the No. 50 sieve).

Since the O_{95} or AOS of the 8 oz/sy geotextile is less than 0.30 mm, it meets the retention criteria for any soil.

Hydraulic Conductivity (k):

For Case 1:

$q_{allow} = q_{ult} [(1/FS_{SCB} \times FS_{CR} \times FS_{IN} \times FS_{CC} \times FS_{BC})]$ **(Ref. 2, pp. 159)**

Where:
$q_{allow=}$ the allowable flow rate
$q_{ult=}$ the ultimate flowrate
$FS_{SCB} =$ the factor of safety for soil clogging and binding
$FS_{CR} =$ the factor of safety for creep reduction of void space

$FS_{IN} =$ the factor of safety for adjacent materials intruding into the geotextile's void space
$FS_{CC} =$ the factor of safety for chemical clogging
$FS_{BC} =$ the factor of safety for biological clogging

$q_{ult=}$	0.3	cm/sec	**(Ref. 1)**
$FS_{SCB} =$	7.5	(Long-term, fine soil)	**(Ref. 2, pp. 160)**
$FS_{CR} =$	1.65	(Long-term installation)	
$FS_{IN} =$	1.2	(Moderate normal stresses)	
$FS_{CC} =$	2.00	(Leachate unknown)	
$FS_{BC} =$	26.0	(Leachate unknown)	

Calculated factor-of-safety = 772.20

$q_{allow=}$	3.89E-04	cm/s

3.89E-04 > 1.00E-04 therefore, ok

Global F.S.$_{8oz/sy}$ = [q_{allow}/q_{soil}] = 3.89

After applying average partial factors-of-safety for the geotextile, a global factor of safety for clogging of 3.9 is determined and is acceptable.

For Case 2:

For protective cover material that has a hydraulic conductivity less than 1 x 10^{-4} cm/s, it is assumed that the hydraulic conductivity of the geotextile will be much greater than the hydraulic conductivity of the protective cover material. Therefore, the minimum hydraulic conductivity is not calculated for this case (i.e., the hydraulic conductivity of the nor woven geotextile will be sufficient to prevent head from developing in the protective cover).

Porosity (Case 1 and Case 2):

The selected geotextile should have enough openings to ensure that blocking of a few of them will not significantly impair the performance of the geotextile filter. Giroud recommends a non-woven porosity of greater than 30%. As per Giroud, the porosity of a non-woven geotextile can be calculated using the following equation

$n = 1\text{-}[m/\rho t] \times 100$ **(Ref. 2, pp. 128)**

Where:
n = geotextile porosity, %
m = geotextile mass per unit area, lb/sf
t = geotextile thickness, ft
ρ = density of filaments, lb/cf

m = 0.056
t = 0.0075
ρ = 91
n = 91.8 ***> 30%, therefore, ok***

Puncture Resistance (Case 1 and Case 2):

The selected geotextile must protect the underlying geonet and geomembrane components from damage due to the protective cover. This component can be evaluated based on the puncture resistance of the geotextile. The manufacturer's values for puncture resistance are based on a point load puncture failure (ASTM D4833). The steel rod used to puncture the geotextile is 0.31 in. in diameter. The puncture value of 120 lbs can be converted to 1,589 psi for the 8 oz/sy geotextile.

Now, assuming a compacted waste density of approximately 115 lb/cf, the height of fill would need to be over 2,200 ft high to exert a pressure approaching 1,589 psi. Since our maximum above ground and below ground fill height is significantly below 2,200 ft, the geotextile is adequate to protect the underlying liner components from damage due to static weights of the final waste body.

Survivability (Case 1 and Case 2):

Depending on the severity of an application a geotextile will be used for, the required strength parameters may vary. This assessment is also referred to as a " Survivability" analysis.

Based on Reference 2 pp. 303, geotextile properties are selected based on the subgrade conditions and the operating equipment used during the cell construction. A "Low" rating (see table below) is assumed for the 8 oz/sy geotextile.

Subgrade Conditions	**Construction Equipment Ground Pressure, 6 to 12 in. of Cover: Initial Lift Thickness**		
	Low Pressure (4 psi)	**Med. Pressure (> 4 psi)**	**High Pressure (>8 psi)**
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level such that any shallow depressions and humps do not exceed 6 in. in depth or height. All larger depressions are filled. Alternatively a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 1 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very High
Minimal site preparation is required. Trees may be felled, de-limbed, and left in place. Stumps should be cut to project not more than 6 in. ± above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders, Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very High	Not Recommended

Notes regarding the above table:

Recommendations given above are for 6 to 12 in. initial lift thickness. The recommended pressure for other initial lift thicknesses is listed below:

1. 12 to 18 in. - Reduce survivability requirement by one level
2. 18 to 24 in. - Reduce survivability requirement by two levels
3. >24 in. - Reduce survivability requirement by three levels

Survivability levels are in increasing order: low, moderate, high and very high. For special construction techniques such as pre-rutting, increase survivability requirement one level. Placement of excessive initial cover material thickness may cause bearing failure of soft subgrade. *Source* After Christopher and Holtz [146]

Using the table above, a rating of "High" was initially chosen based on optimum subgrade condition (which will be provided by the liner) and a high ground pressure of > 8 psi. However, since the soil protective cover will be 24 inches (all placed in one lift), the survivability requirement may be reduced by two levels (see Note #2) from "High to Low". Additionally, "Low" ground pressure equipment will be used on all sideslope areas to protect the liner components and a minimum of 24 inches of initial soil thickness will be maintained beneath equipment over the liner.

Based on Reference 2 pp.304, the physical property requirements for the evaluated geotextile are provided below.

PHYSICAL PROPERTY REQUIREMENTS[a]
GEOTEXTILES<50% ELONGATION/GEOTEXTILES>50% ELONGATION[b,c]

Survivability Level	**Grab Strength ASTM D4632 (lb.)**	**Puncture Resistance ASTM D4833 (lb.)**	**Trapezoidal Tear Strength ASTM D4533 (lb.)**
Medium	180/115	70/40	70/40
High	270/180	100/75	100/75

[a] Values shown are minimum average roll values. Strength values are in the weaker principal direction.

[b] Elongation (strain) at failure as determined by ASTM D4632, Grab Tensile.

[c] The values of geotextile elongation do not imply the allowable consolidation properties of the subgrade soil. These must be determined by a separate investigation.

Survivability (Case 1 and Case 2):

Since the table "Physical Property Requirements" provided on Pg. 4.3-8 does not provide physical property requirements for a "low" survivability level, the "medium" survivability level values were used for comparison. Given below are the manufacturer's specifications in comparison for the evaluated 8 oz/sy non-woven geotextile ***(Reference 1, w/ >50% elongation)*** .

Grab Strength (ASTM D4632) = 220 lbs >115 lbs, therefore ok
Puncture Resistance (ASTM D4833) = 120 lbs > 40 lbs, therefore ok
Trapezoid Tear Strength (ASTM D4533) = 95 lbs > 40 lbs, therefore ok

Therefore, the evaluated 8 oz/sy geotextile meets the "LOW" survivability criteria

Summary of required properties for non-woven geotextile adhered to the geocomposite for both Case 1 & Case 2: (Reference 1)

Apparent opening size	=	0.30	mm
Hydraulic conductivity	=	1×10^{-4}	cm/sec
Porosity	=	30.0	%
Grab tensile strength	=	115	lbs
Puncture resistance	=	40	lbs
Trapezoid tear strength	=	40	lbs

Overall Conclusion:

The evaluated 8 oz/sy geotextile filter fabric is sufficient to allow proper flow of the leachate without clogging based on the 3 criteria analyzed: retention, hydraulic conductivity, and porosity and is adequate to provide protection to the underlying liner components based on the 2 criteria analyzed: puncture resistance and survivability.

ATTACHMENT 4.3

GEOCOMPOSITE CALCULATIONS

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SCS Engineers
TBPE Reg. #F-3407
Inclusive of Attachment 4.3

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
GEOCOMPOSITE FLOW CAPACITY DEMONSTRATION

Required:

Determine the hydraulic conductivity of the geocomposite drainage layer in the leachate collection system for use in the HELP model. This demonstration is based on the worst case conditions for leachate generation (active 10-foot of waste) and loading (intermediate 120-foot for Cell 3 only and 178-foot of waste if Cell 4 is built in the future west of Cell 3).

Method:

1. Determine the geocomposite thickness under the expected loading conditions.
2. Determine reduction factors for strength and environmental conditions based on expected duration in each stage of landfill development.
3. Compute the required minimum hydraulic conductivity of the geocomposite using the calculated reduction factors. The minimum hydraulic conductivity for the HELP modeling is designated as the minimum value that keeps the depth of leachate over the liner confined to the geocomposite drainage layer.
4. Using the hydraulic conductivity values from Method No. 3. (above), calculate minimum transmissivity values for the geocomposite.
5. Obtain values for geocomposite transmissivity from manufacturer's data, and compare with the transmissivity values developed in Method Nos. 3. and 4. (above) to confirm that geocomposite properties used in the HELP model are respresentative of available geocomposites. The minimum transmissivity for the geocomposite shall exhibit a minimum factor-of-safety of 1.5 when compared to the manufacturer's data

References:

1. Koerner, R.M., *Designing With Geosynthetics, Second Edition* , 1990.
2. Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, pp. 285-380
3. GSE, PermaNet HL (bi-planar) Double-sided Geocomposite Transmissivity Data.

Solution:

1. Estimate geocomposite thickness for the worst case leachate generation and loading conditions, based on an initial thickness of 270 mils:

Assume the geocomposite will undergo linear compression due to weight of soil (i.e., daily cover or intermediate cover and protective cover) and waste.

Unloaded Geocomposite Thickness =	0.27	in
Compressibility at 15,000 psf =	65	%, as provided by manufacturers
Unit Weight of Soil Only =	120	pcf
Composite Unit Weight of CCR =	103	pcf

Table 1 - Geocomposite Thickness

Fill Condition	d_{CCR}[1] (ft)	d_S[2] (ft)	P[3] (psf)	t[4] (in)
Active, 0%	10	2.0	1,270	0.27
Interim, 90%	120	3.0	12,720	0.23
Interim, 90%	178	3.0	18,694	0.21

[1] d_{CCR} is the depth of CCR above the geocomposite.

[2] d_S is the depth of soil (i.e., protective and intermediate) above the geocomposite.

[3] P is the pressure on the geocomposite due to the weight of the waste and soil

[4] t is the thickness of the geocomposite after being subjected to linear compression.
t is calculated by equation (Initial Thickness) - (Max. Compression) x P/30,000.

2. Reduction Factors for Strength and Environmental Conditions

Table 2 - Reduction Factors

Environmental Condition	Range	Fill Condition		
		Active (10' Waste)	Interim (120' Waste)	Interim (178' Waste)
Geotextile Intrusion [1]	1.0 - 1.2	1.00	1.10	1.20
Creep Deformation [1,2]	1.1 - 2.0	1.10	1.20	1.65
Chemical Clogging [1,3]	1.5 - 2.0	1.50	1.80	2.00
Biological Clogging [3]	1.1 - 1.3	1.10	1.10	1.10
Composite Reduction Factor[4]	1.7 - 7.5	1.82	2.61	4.36

Notes:

[1] Range values for geotextile intrusion, creep deformation, and chemical clogging were obtained from Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers",*Geosynthetics International* , Vol. 7, Nos. 4-6, pp. 285-380.

[2] Based on product literature, geocomposites/geonets will exhibit creep deformation reduction of 1.2 at 15,000 psf.

[3] Range values for biological clogging were obtained from GRI Standard GC8, Geosynthetic Institute, 2013, "Determination of the Allowable Flow Rate of a Drainage Geocomposite".

[4] The Composite Reduction Factor is the product of all of the factors for the respective fill condition.

3. Develop and confirm assumptions for hydraulic conductivity (k) of the geocomposite for HELP model.

Table 3 - Assumed Hydraulic Conductivity

Fill Condition	d_W[1] (ft)	P[2] (psf)	t[3] (in)	Reduction Factor	k_{min}[5] (cm/s)	Peak Leachate Head (in)[6]
Active, 0%	10	1,270	0.27	1.82	10.00	0.04
Interim, 90%	120	12,720	0.23	2.61	6.00	0.02
Interim, 90%	178	18,694	0.21	4.36	2.00	0.06

[1] d_W is the depth of waste above the geocomposite from Table 1.

[2] P is the pressure on the geocomposite due to the weight of the waste and soil from Table 1.

[3] t is the calculated geocomposite thickness from Table 1.

[4] Reduction Factors from Table 2.

[5] k is the assumed hydraulic conductivity value for HELP model. Reduction Factors will be applied to determine required minimum manufacturer transmissivity values, below.

[6] As calculated by HELP model, assuming no leachate recirulation.

4. Using the hydraulic conductivity values from Table 3 (above), calculate minimum transmissivity values for use during design and specifying geocomposites.

$$T_{min} = ((t * 2.54 \text{ cm/in}) * k_{min}) * \text{Reduction Factor}$$

Table 4 - Minimum Required Transmissivity for Geocomposite Design

Fill Condition	P (psf)	t (in)	k_{min} (cm/s)	Reduction Factor	T_{min} (cm^2/sec)	**$T_{min\ Required}$ (m^3/sec/m)**
Active, 0%	1,270	0.27	10.00	1.82	1.24E+01	**1.24E-03**
Interim, 90%	12,720	0.23	6.00	2.61	9.16E+00	**9.16E-04**
Interim, 90%	18,694	0.21	2.00	4.36	4.65E+00	**4.65E-04**

5. Compare T_{min} values from Method No. 4 (above) with published manufacturer transmissivity values.

Table 5 - Comparison of Manufacturer's Reported Transmissivity to the Minimum Required Transmissivity

			GSE PermaNet HL (bi-planar) Double-Sided		
Fill Condition	P (psf)	Minimum Required T Value[3] (m^2/sec)	P (psf)	T_{min}[1] (m^3/sec/m)	**Factor of Safety**
Active, 0%	1,270	1.24E-03	1,270	7.20E-02	**57.8**
Interim, 90%	12,720	9.16E-04	12,720	8.50E-03	**9.3**
Interim, 90%	18,694	4.65E-04	18,694	1.00E-03	**2.2**

[1] Geocomposite Transmissivity values determined from tests with hydraulic gradient of 0.02. If higher gradient used by manufacturer to determine transmissivity, manufacturer will be required to certify that geocomposite will provide comparable drainage as described in Table 4, above.

[2] The product shown in the table is provided to demonstrate the availability of products that will meet or exceed the required drainage characteristics. Other manufactured products, either bi-planar or tri-planar geocomposites are acceptable if confirmed to meet the minimum required transmissivity values indicated in Table 5 (above), while providing a minimum factor-of-safety of 1.5.

ATTACHMENT 4.4

PIPE CAPACITY CALCULTIONS

BRETT J. DeVRIES
128061

6/7/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Attachment 4.4

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
LEACHATE COLLECTION
PIPING FLOW CAPACITY

Prep'd By: SDS
Chkd By: BJD
Date: February 2021

Required:

Demonstrate that the 6-inch diameter (SDR 9) leachate collection piping has sufficient capacity to convey leachate during the worst case leachate generation conditions. Due to pipe availability, SDR 9 is expected to be the thickest wall pipe installed at landfill. The critcal case was analyzed:
Case 1: Pipe in the central leachate trench (1% slope)

Method:

A. Use leachate production rates determined from the HELP model analysis (see Attachment 3) as comparison to capacity of 6-inch diameter DR 9 leachate collection piping.
B. Determine required hole size (perforations) based on characteristics of the surrounding drainage media.

References:

1. Bass, J., *Avoiding failure of Leachate Collection and Cap Drainage Systems* , Pollution Technology Review No. 138, Noyles Data Corporation, 1986.
2. Texas Natural Resource Conservation Commission, Leachate Collection System Handbook, 30 TAC 330.201, 1993

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
LEACHATE COLLECTION
PIPING FLOW CAPACITY

Prep'd By: SDS
Chkd By: BJD
Date: February 2021

Solution - Flow Capacity of Pipe (A - Case 1 - Central Pipe):

Determine the average and peak daily flow rate estimate:

The following table summarizes the fill conditions that are likely to be present and have the greatest contribution of leachate into the LCS. The average and peak flow rate (lateral drainage in the LCS layer) is shown for each condition. All flow rates are per acre.

From the HELP model (Attachment 3):

CONDITION	AVERAGE ANNUAL		PEAK DAILY	
	cf/y/ac	g/d/ac	cf/d/ac	g/d/ac
Active, 10' Waste	34,158	700	406	3,040
Interim, 60' Waste	12,946	265	89	665

Cell 3 drains to a single leachate collection sump.

Maximum leachate production (and drainage) expected in the collection pipe is predicted to occur assuming the following scenario:

1.	Active, 10' Waste	5.0	ac
2.	Interim, 60' Waste	12.0	ac
	Total =	17.0	ac

CONDITION	AREA ac	AVERAGE g/d/ac	AVERAGE gpd	AVERAGE cfs
Active, 10' Waste	5.0	700	3,500	0.0054
Interim, 60' Waste	12.0	265	3,186	0.0049
		Total =	6,686	0.0103
With applied Factor of Safety of 1.5:		Total =	10,029	0.0155

CONDITION	AREA ac	PEAK g/d/ac	PEAK gpd	PEAK cfs
Active, 10' Waste	5.0	3,040	15,199	0.0235
Interim, 60' Waste	12.0	665	7,980	0.0123
		Total =	23,179	0.0358
With applied Factor of Safety of 1.5:		Total =	34,769	0.0538

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
LEACHATE COLLECTION
PIPING FLOW CAPACITY

Determination of flow capacity (Q_{full}) for a 6-inch diameter perforated pipe:

$$Q_{full} = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

Where: A = Cross-sectional area of pipe, with d representing the inside diameter in feet

R = Hydraulic radius of pipe in feet under full flow conditions

From Pipe Structural Stability Calculations:

Outside Diameter (in) =	6.625	
Dimension Ratio (DR) =	9.0	
Wall Thickness (t) =	0.736	
ID =	5.153	in
=	0.429	ft

$$A = \frac{\Pi \times d^2}{4}$$

A = 0.145 sq ft

$$R = \frac{d}{4}$$

R = 0.107 ft

S = Design slope of pipe S = 0.010 ft / ft

n = Manning's number n = 0.009 for HDPE smooth pipe

Q_{full} = 0.541 cfs

Compare Q_{max} and Q_{full} (Average Flow Rate):

Q_{full} = 0.541 cfs >> Q_{max} = 0.0155 cfs

Compare Q_{max} and Q_{full} (Peak Flow Rate):

Q_{full} = 0.541 cfs >> Q_{max} = 0.0538 cfs

Conclusion:
6-inch diameter HDPE pipe with a DR of 9 exceeds the required flow capacity for both average and peak flow rates.

Solution - Perforations Configuration (B):

Pipe perforations must allow free passage of leachate and also prevent migration of drainage media into collection pipes. Therefore, size of perforations depends on media particle size.

$$\frac{D_{85}\text{ of Filter}}{\text{Hole Diameter (d)}} \geq 1.7$$

Where: D_{85} = Particle size for which 85% of all particles are smaller than the following:

For the drainage media with gradation having 100 percent passing 2-inch sieve and 0 to 5 percent the 1/2-inch sieve, the D_{85} will be greater than 1-inch, therefore 1-inch was used in this calculation for conservatism.

D_{85} = 25 mm
= 0.985 in

Standard hole diameter: d = 0.5 in

Check values to find that:

$$\frac{D_{85}\text{ of Filter}}{\text{Hole Diameter}} = 2.0 \quad \geq 1.7 \quad \text{(acceptable)}$$

In Addition:

A minimum open area of 1 square inch per foot of drainage pipe is recommended by the U.S. Soil Conservation Service and the U.S. Bureau of Reclamation, as represented by the 6 perforations per foot required for leachate collection pipe, see Figure 6.

Conclusion:
Perforations will consist of 0.5-inch diameter holes with a minimum ope area of 1 square inch per foot of drainage pipe, as analyzed above.

ATTACHMENT 4.5

LEACHATE SUMP DESIGN CALCULATIONS

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128061

6/7/21

SCS Engineers
TBPE Reg. #F-3407
Inclusive of Attachment 4.5

Required:

Determine the required size of the leachate collection sump, based on the conditions of landfill development when it is anticipated that the leachate collected in an individual sump will be the greatest. **These calculations are for a leachate collection sump with a maximum contributing Cell 3 area of 17 acres.**

Method:

A. Evaluate the average leachate flow rate into the leachate collection sump, based on the greatest leachate generation potential.
B. Evaluate the storage capacity and minimum storage time of the leachate sump, based on the specified sump geometry.
C. Calculate the average daily pump cycle time, based on a specified pump size.

References:

1. Texas Natural Resource Conservation Commission, *Leachate Collection System Handbook* , 30 TAC 330.201, 1993.

Solution:

A. Evaluate the average leachate flow rate into the leachate collection sump, based on the greatest leachate generation potential.

The following table summarizes the fill conditions that are likely to be present and have the greatest contribution of leachate into the LCS and sump system. The average generation rates (lateral drainage in the LCS layer) are shown for each condition. All flow rates are per acre.

Average annual leachate generation rates are from the HELP model output, as provided in Attachment 3:

CONDITION	Average Leachate Generation		Assumed Area	Leachate Collection
	(cf/y/ac)	(cf/d/ac)	(ac) [1]	(cfd)
Active, 10' Waste	34,158	93.6	5	468
Interim, 120' Waste	16,187	44.3	12	532
Total	50,345	137.9	17	1,000

[1] Assumes an active area of 5 acres and the remaining of the 17 acres are at interim grades

B. Evaluate the storage capacity and minimum storage time of the leachate sump, based on the specified sump geometry.

$$V_{REQ} = V_C / P$$

V_C = Volume, Leachate collection rate, (cfd)
P = Porosity

Assumed porosity of drainage stone: P = 0.35

Condition	V_C (cfd) [1]	V_{REQ} (cfd)
Active, 10' Waste	468	1,337
Interim, 120' Waste	532	1,521
Total	**1,000**	**2,857**

[1] The leachate collection rates shown are consistent with those calculated in Method A, above.

Selection of Sump Geometry:

Assumed sideslope of sump = (X)H : 1V = 3 ft

Assumed depth of sump = 3 ft

$$V_{TOT} = \frac{X_T^{2} h_T}{3} - \frac{X_B^{2} h_B}{3} - B$$

Where:
X_T = Length of top side
X_B = Length of bottom side
h_T = Height of pyramid with (X)H:1V sideslope and width X_T
h_B = Height of pyramid with (X)H:1V sideslope and width X_B

X_T = 45 ft
X_B = 27 ft
h_T = 7.50 ft
h_B = 4.50 ft
B = 407 cu ft (Pump head vol. of 6" in bottom of sump)

V_{TOT} = 3,562 cu ft total sump volume
= 1,247 cu ft leachate capacity
= 9,325 gallons leachate capacity

Number of days storage for conditions:

$$\text{STORAGE} = \frac{V_{TOT}}{V_{REQ}}$$

V_{REQ} = 2,857 cu. ft.
V_{TOT} = 3,562 cfd

Storage = 1.25 days

C. <u>Calculate the average daily pump cycle time, based on a specified pump size.</u>

Specified Submersible Pump Capacity (gpm) : 15

Total Leachate Collection: 1,000 cfd
Total Leachate Collection: 7,481 gal/day
Maximum Pump Time: 8 hours/day

<u>Notes:</u>

[1] Pump cycles will be determined at time of pump selection, based on manufacturer's operational recommendations. Although there may be periods of landfill development (i.e., active, 10-foot waste) when the pump will operate continuously throughout the day, as waste elevations increase and the leachate collection rates decrease, the pump time will also decrease.

[2] A lower or higher capacity pump may be substituted for the 15 gpm pump, provided the sump drawdown criteria maintains less than the required 30-centimeter depth of the bottom liner.

<u>Conclusion:</u>

Based on above calculations, the leachate collection sumps will have sufficient capacity for storage of leachate during the time period of greatest leachate generation and subsequent contribution to the LCS. As such, the sump will have the following minimum dimensions. The sump design will provide for at least 1 day of leachate storage within the sump, without exceeding the 30 centimeters of leachate head over the bottom liner system.

Sump Top Dimension (X_T) = **45** ft
Sump Bottom Dimension ($X_{B)}$ = **27** ft
Sump Sideslopes = **3** (X)H:1V
Sump Design Depth = **3** ft

APPENDIX II.B1

UNSTABLE AREAS COMPLIANCE DEMONSTRATION FOR CELLS 1 AND 2

SCS ENGINEERS

Unstable Areas
Compliance Demonstration
Cells 1 and 2

Sandy Creek Solid Waste Disposal Facility

Prepared for:

SANDY CREEK ENERGY STATION
2161 Rattlesnake Road
Riesel, TX 76682

Prepared by:

SCS ENGINEERS
TBPE Registration No. F-3407
1901Central Drive, Suite 550
Bedford, Texas 76021

October 1, 2018
File No. 16215106.00

Offices Nationwide
www.scsengineers.com

Unstable Areas Compliance Demonstration
Cells 1 and 2

Sandy Creek Solid Waste Disposal Facility

Prepared for:

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3.0 References 2

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2 Cell 1 and Cell 2 Location

Appendices

A Site Description and Geologic Summary
B Liquefaction and Settlement Potential Evaluation
C Boring Locations, Geologic Cross Section, and Boring Logs
D Slope Stability Analysis
E Seepage Potential and Karst Condition Assessment

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P.E. Certification

BRETT J. DeVRIES
128061

I, Brett DeVries, Ph.D., P.E., hereby certify that the unstable areas demonstration prepared for the Sandy Creek Solid Waste Disposal Facility Cells 1 and 2 at the Sandy Creek Energy Station meets the requirements in 40 CFR 257.64(a). This certification is based on the enclosed October 2018 Unstable Areas Compliance Demonstration for the Sandy Creek Solid Waste Disposal Facility Cells 1 and 2 prepared by SCS Engineers. I am a duly licensed Professional Engineer under the laws of the State of Texas.

10/1/2018
(signature) (date)

Brett DeVries, Ph.D., P.E.
(printed or typed name)

License number 128061

My license renewal date is 9/30/2019.

Pages or sheets covered by this seal:
Pages 1, 2; Figure 1; Appendix A, B, D, and E

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1.0 INTRODUCTION AND PROJECT SUMMARY

On behalf of Sandy Creek Energy Station, LLC, SCS Engineers (SCS) has prepared the enclosed Unstable Areas Restriction Compliance Demonstration for the Sandy Creek Solid Waste Disposal Facility existing Cells 1 and 2 (existing coal combustion residual [CCR] landfill) as required by 40 CFR §257.64.

Future proposed CCR units (Cells 3 and 4) have not been developed. When developed, Cells 3 and 4 will be classified as a lateral expansion of an existing CCR landfill, as defined in 40 CFR §257.53. This document addresses exclusively Cells 1 and 2. Future CCR units beyond Cells 1 and 2 are not addressed and are not discussed further herein; thereby, in accordance with §257.64, additional unstable areas restriction compliance demonstration will be required prior to placing CCR in cells 3 and 4.

Figure 1 shows the site location. **Figure 2** shows the Cells 1 and 2 locations.

2.0 UNSTABLE AREAS RESTRICTIONS

§257.64 ***"Unstable areas."***

"(a) An existing or new CCR landfill, existing or new CCR surface impoundment, or any lateral expansion of a CCR unit must not be located in an unstable area unless the owner or operator demonstrates by the dates specified in paragraph (d) of this section that recognized and generally accepted good engineering practices have been incorporated into the design of the CCR unit to ensure that the integrity of the structural components of the CCR unit will not be disrupted."

"(b) The owner or operator must consider all of the following factors, at a minimum, when determining whether an area is unstable:

(1) On-site or local soil conditions that may result in significant differential settling;"

As discussed in **Appendices A** and **B**, and as shown by the geologic cross section from the 2010 Engineering Report prepared by Black & Veatch Corp. (see **Appendix C**), the Cells 1 and 2 CCR units are not located in on-site or local soil conditions that may result in significant differential settling. The site soils consist primarily of stiff to hard clays overlaying hard clayshale weathered from shale bedrock. Because the clays are stiff to hard, they are not susceptible to appreciable differential settlement that would affect the performance of the CCR landfill.

"(2) On-site or local geologic or geomorphologic features; and"

As discussed in **Appendices A**, **B**, and **E**, and as shown by the geologic cross section in **Appendix C**, the Cells 1 and 2 CCR units are not located in on-site or local geologic or geomorphologic features that are unstable. The cross section shows stiff to hard clays overlaying hard clayshale weathered from shale bedrock. These geologic features provide a stable foundation for the CCR landfill. This assessment is confirmed by the slope stability analysis in **Appendix D** that indicates the slope stability safety factors are acceptable.

(3) "On-site or local human-made features or events (both surface and subsurface)."

As shown by the geologic cross section in **Appendix C**, the Cells 1 and 2 CCR units are not located in on-site or local human-made features or events (both surface and subsurface) that are unstable. Prior to development for the landfill, the historical site use was agricultural with minimal site disturbance.

As discussed in **Appendix E**, groundwater or surface water is unlikely to cause instability. The facility is designed with adequate run-on and run-off control systems, and is constructed above the water table.

3.0 REFERENCES

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

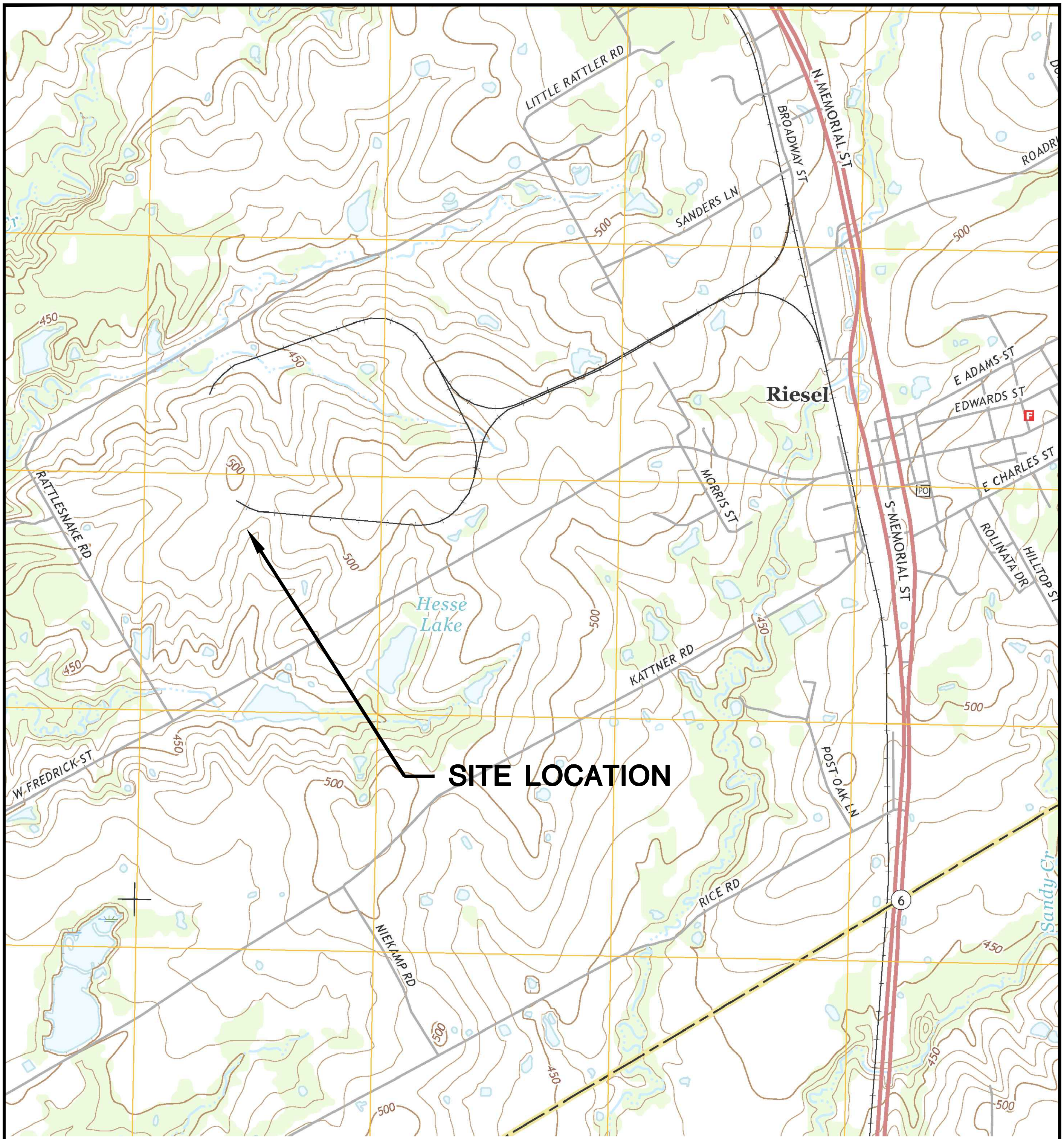
Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

SCS Engineers, 2018, June 2018 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, Texas.

USGS seismic impact zones map website:
https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

FIGURES

1 Site Location Map
2 Cell 1 and Cell 2 Location



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RIESEL QUADRANGLE
TEXAS–MCLENNAN CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)
2016
SCALE: 1" = 2,000'

CLIENT	LS POWER DEVELOPMENT, LLC	SITE	UNSTABLE AREAS COMPLIANCE DEMONSTRATION REPORT SANDY CREEK SOLID WASTE DISPOSAL FACILITY RIESEL, TEXAS	SITE LOCATION MAP

				ENGINEER		
PROJECT NO.	16215106.00	DRAWN BY:	ZB		SCS ENGINEERS 2830 DAIRY DRIVE MADISON, WI 53718-6751 PHONE: (608) 224-2830	FIGURE
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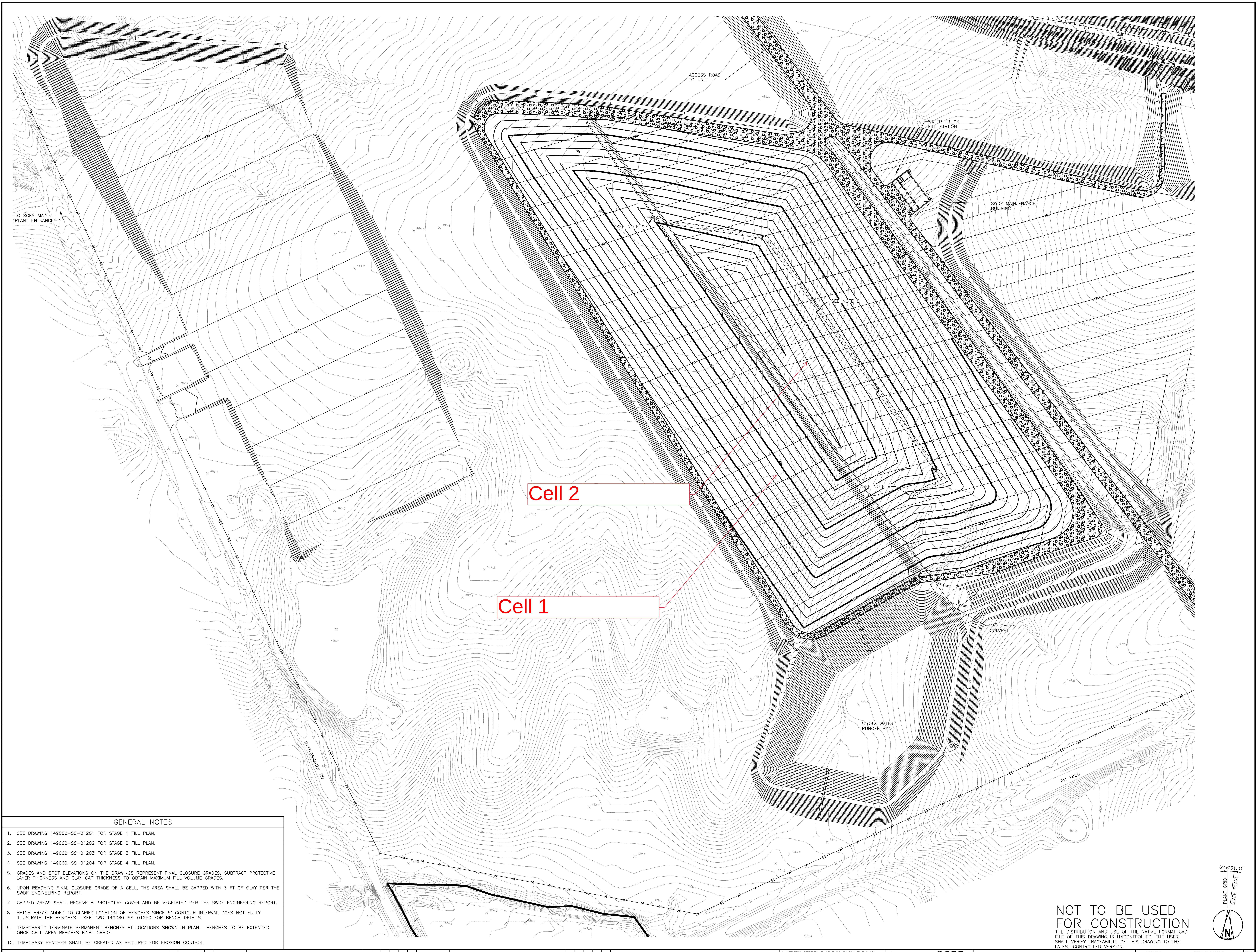

GENERAL NOTES

1. SEE DRAWING 149060–SS–01201 FOR STAGE 1 FILL PLAN.
2. SEE DRAWING 149060–SS–01202 FOR STAGE 2 FILL PLAN.
3. SEE DRAWING 149060–SS–01203 FOR STAGE 3 FILL PLAN.
4. SEE DRAWING 149060–SS–01204 FOR STAGE 4 FILL PLAN.
5. GRADES AND SPOT ELEVATIONS ON THE DRAWINGS REPRESENT FINAL CLOSURE GRADES. SUBTRACT PROTECTIVE LAYER THICKNESS AND CLAY CAP THICKNESS TO OBTAIN MAXIMUM FILL VOLUME GRADES.
6. UPON REACHING FINAL CLOSURE GRADE OF A CELL, THE AREA SHALL BE CAPPED WITH 3 FT OF CLAY PER THE SWDF ENGINEERING REPORT.
7. CAPPED AREAS SHALL RECEIVE A PROTECTIVE COVER AND BE VEGETATED PER THE SWDF ENGINEERING REPORT.
8. HATCH AREAS ADDED TO CLARIFY LOCATION OF BENCHES SINCE 5' CONTOUR INTERVAL DOES NOT FULLY ILLUSTRATE THE BENCHES. SEE DWG 149060–SS–01250 FOR BENCH DETAILS.
9. TEMPORARILY TERMINATE PERMANENT BENCHES AT LOCATIONS SHOWN IN PLAN. BENCHES TO BE EXTENDED ONCE CELL AREA REACHES FINAL GRADE.
10. TEMPORARY BENCHES SHALL BE CREATED AS REQUIRED FOR EROSION CONTROL.

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.

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0	30/JUN/09	INITIAL ISSUE	SAC	JCB	BMH	BTM	MWM

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS

SIGNED ____________

DATE ________ REG NO. ________

BLACK & VEATCH CORPORATION
TEXAS FIRM NO. F-258

SCPP
SANDY CREEK ENERGY STATION

ENGINEER JCB
DRAWN SAC
CHECKED BMH
DATE 29/JUN/09

SANDY CREEK ENERGY STATION
UNIT 1

SOLID WASTE DISPOSAL FACILITY
FILL PLAN – STAGE 2

PROJECT
DRAWING NUMBER 149060–SS–01202
REV 1
CODE
AREA

APPENDIX A

Site Description and Geologic Summary

Site Description and Geologic Summary

Site Information

The Sandy Creek Solid Waste Disposal Facility encompasses approximately 69 acres, and is located in an agricultural area historically used for pasture and open land. The site location is west of the City of Riesel, McLennan County, Texas. The facility is located near Highway 1860 and Rattlesnake Road.

Regional Geology

The disposal facility site is located in the Blackland Prairies province of the Texas Gulf Coastal plains. The site is underlain by the Lower Taylor Marl Formation (Ozan Formation). In general, the subsurface stratigraphy consists predominantly of high plasticity yellow-brown clays, weathered clayshale, and marl units of fluvial and shallow marine origin (Geotechnical Design Report Revision 0. Sandy Creek Power Partners, Apr. 2009). Shallow groundwater occurs approximately 10 to 20 feet below ground. Regionally, the Lower Taylor Marl Formation is not known for karst features. No karst features were identified in site investigations.

Previous Geologic Investigations

The disposal facility area was investigated by Sandy Creek Power Partners prior to construction by performing 11 borings within and adjacent to the facility footprint. One boring was instrumented with a piezometer. The borings extended to depths of up to 73 feet. Split spoon and Shelby tube soil samples were collected from these 11 borings, and from 40 nearby borings for investigation of the generating station, for laboratory testing that includes:

- Moisture content
- Atterberg limits
- Grain size analyses
- Permeability
- Consolidation
- Unconfined compressive strength
- Triaxial compression (unconsolidated undrained and consolidated undrained with pore water pressure measurement)

The boring locations and a geologic cross section are shown in **Appendix C**.

Based on the results of the subsurface investigation performed prior to disposal facility construction, the soils below the liner system within the facility footprint consist primarily of stiff to hard, fissured, fat clays overlying hard clayshale weathered from shale bedrock. The overconsolidation ratio of the clays is in the range of 2 to 4.

References

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

SCS Engineers, 2018, June 2018 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, Texas.

DLN/JL/jsn/MRH

APPENDIX B

Liquefaction and Settlement Potential Evaluation

Liquefaction and Settlement Potential Evaluation

Based on the results of the site investigation borings and laboratory soil test results, the disposal facility soils are not subject to liquefaction or settlement concerns for the performance of the disposal facility.

Liquefaction is the process by which a saturated, loose, cohesionless soil influenced by external forces suddenly loses its shear strength and behaves as a fluid. The external forces result from ground motion from an earthquake. The disposal facility site soils in borings consist primarily of stiff to hard clay that is not subject to liquefaction. In addition, liquefaction is not a concern given the low magnitude (<0.04g, 2 percent in 50 years) of maximum ground accelerations expected in the area; see **Attachment B1.**

Settlement below a disposal facility can be a concern if the facility is underlain by extensive soft, fine-grained soils. Soft soils are subject to consolidation settlement depending on the load over the soft soils. The disposal facility soils consist of stiff to hard clay. Because the clays are stiff to hard rather than soft, consolidation settlement is not a concern for the performance of the disposal facility.

References

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

USGS seismic impact zones map website:
https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

DLN/jsn/MRH

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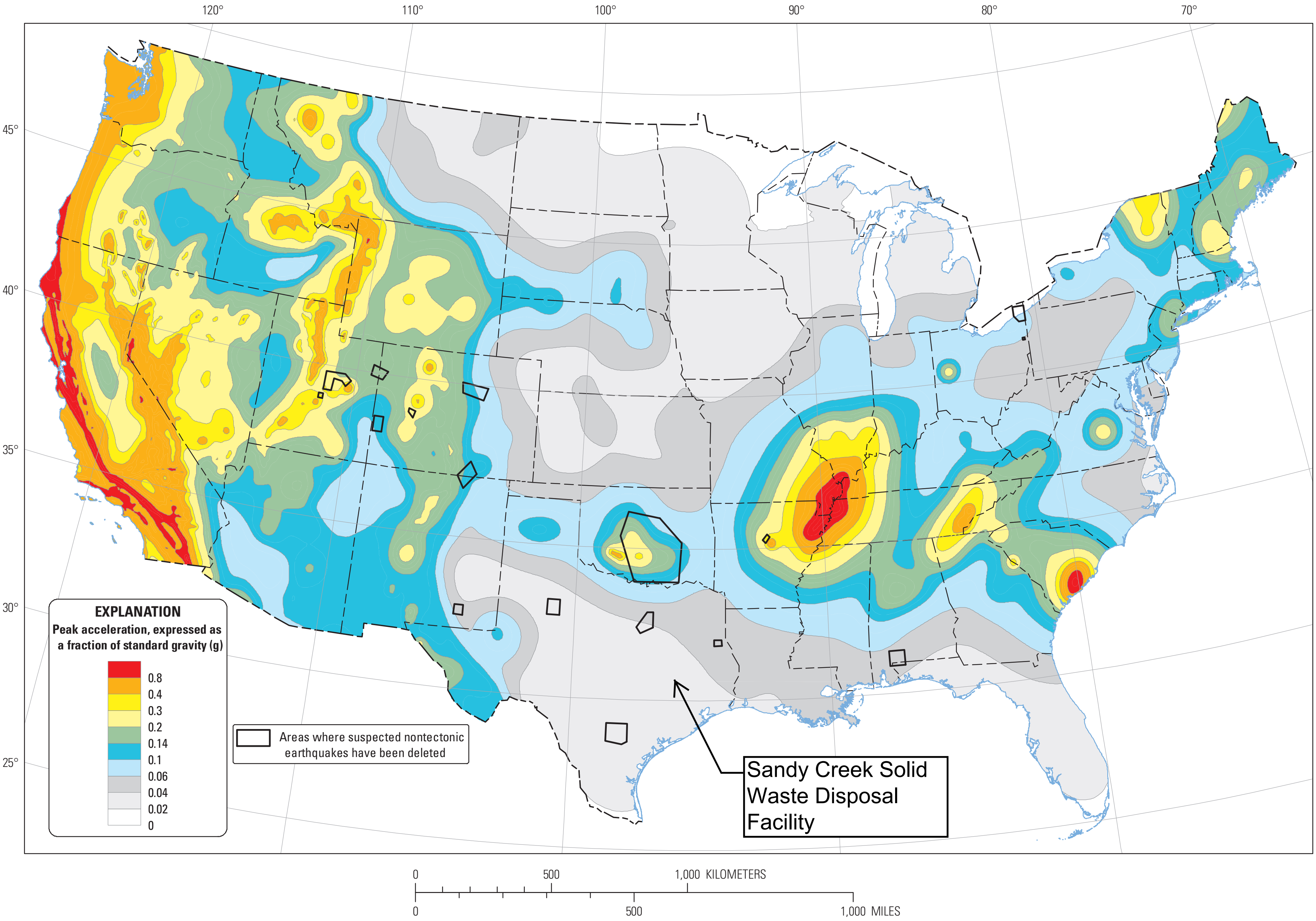
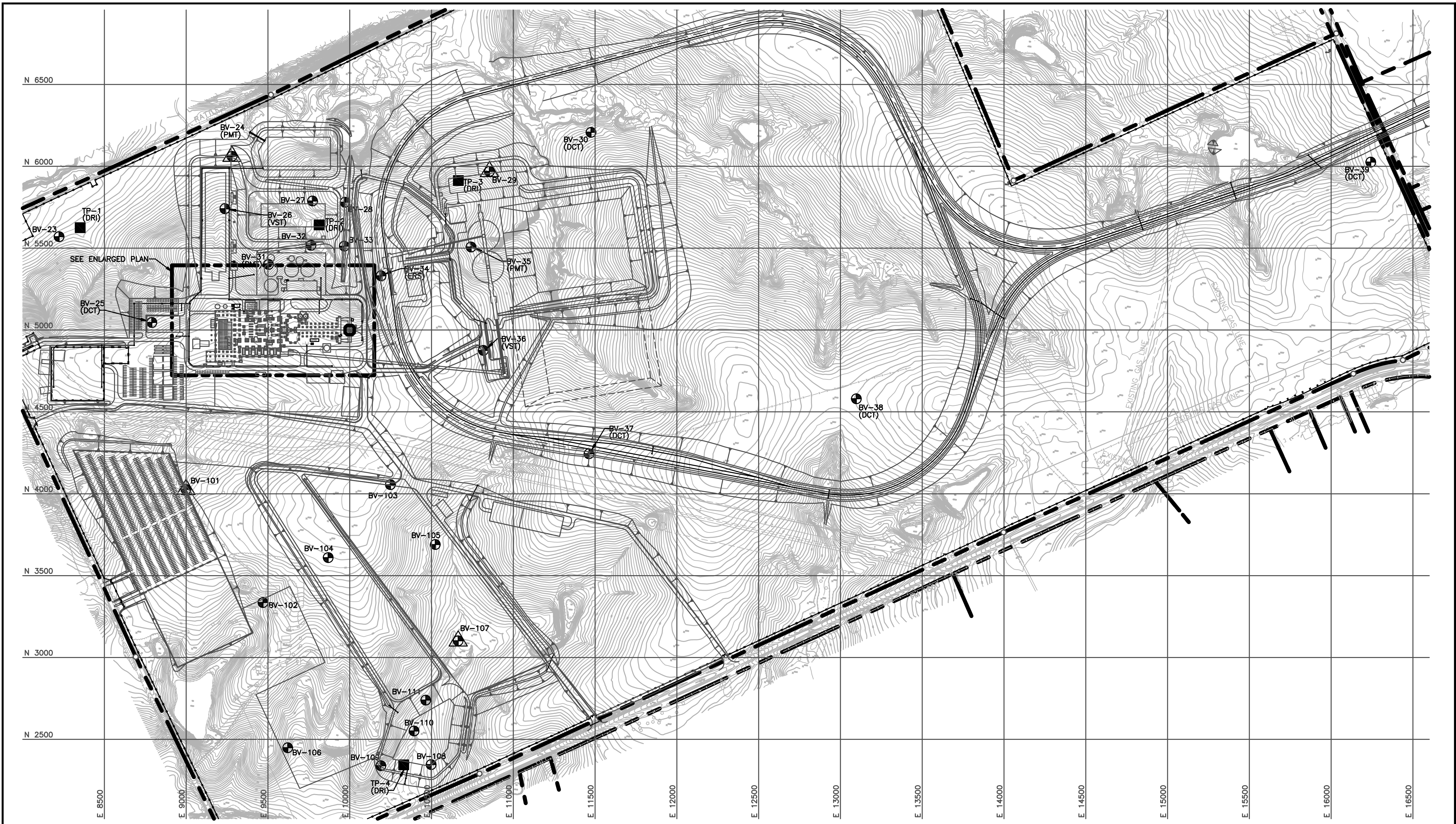


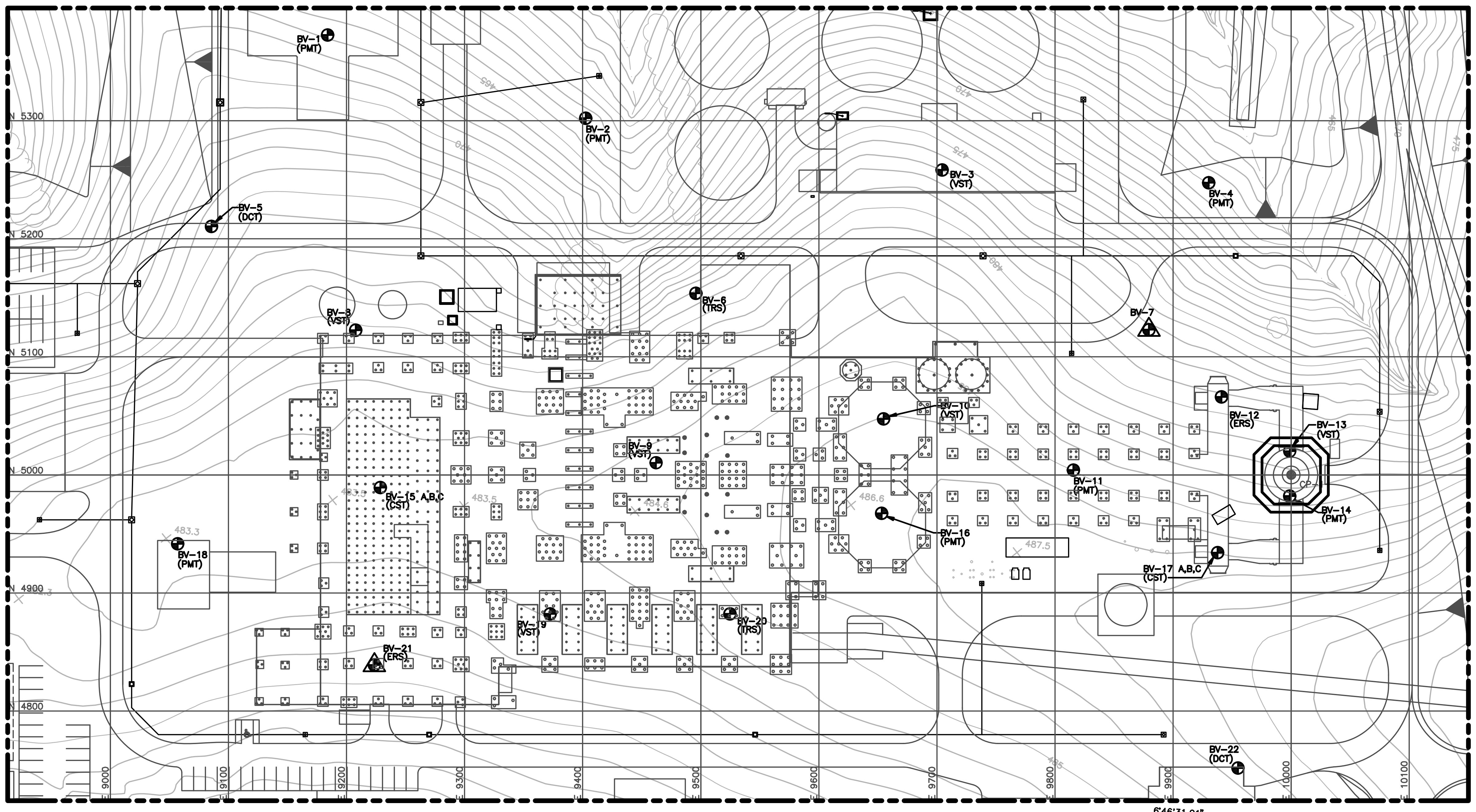
Two-percent probability of exceedance in 50 years map of peak ground acceleration

Source: USGS seismic impact zones map - https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga2pct.pdf

APPENDIX C

Boring Locations, Geologic Cross Section, and Boring Logs





BORING LOCATIONS

LOCATION NO.	PLANT GRID NORTHING	PLANT GRID EASTING	STATE PLANE NORTHING	STATE PLANE EASTING	SOIL DRILLING (FT)	ROCK/MARL DRILLING (FT)	REMARKS
BV-1	5372.69	9183.98	10516296.99	3348576.40	50	TOP	PRESSUREMETER TESTING
BV-2	5302.16	9402.55	10516252.73	3348801.76	50	30	PRESSUREMETER TESTING
BV-3	5258.34	9704.39	10516244.84	3349106.65	50	TOP	VANE SHEAR TEST
BV-4	5247.51	9930.16	10516260.72	3349332.13	50	TOP	PRESSUREMETER TESTING
BV-5	5210.50	9085.63	10516124.33	3348497.86	10	–	DYNAMIC CONE TEST
BV-6	5153.86	9495.83	10516116.47	3348911.88	50	30	THERMAL RESISITIVITY SAMPLE
BV-7	5123.01	9879.53	10516131.11	3349296.54	50	TOP	PIEZOMETER
BV-8	5122.58	9207.76	10516051.43	3348629.51	50	30	VANE SHEAR TEST
BV-9	5010.34	9462.12	10515969.98	3348895.34	50	30	VANE SHEAR TEST
BV-10	5047.43	9654.83	10516029.54	3349082.33	50	30	VANE SHEAR TEST
BV-11	5004.06	9815.58	10516005.45	3349247.07	50	30	PRESSURE METER TEST
BV-12	5066.09	9940.97	10516081.83	3349364.26	50	TOP	ELECTRICAL RESISTIVITY SAMPLE
BV-13	5020.13	9998.74	10516043.01	3349427.06	50	TOP	VANE SHEAR TEST
BV-14	4982.05	9998.74	10516005.20	3349431.55	50	30	PRESSUREMETER TESTING
BV-15 A,B,C	4989.27	9228.63	10515921.52	3348665.96	50	50	CROSSHOLE SEISMIC TEST; SAMPLE BORING "A"
BV-16	4967.44	9653.13	10515949.92	3349090.07	50	TOP	PRESSUREMETER TESTING
BV-17 A,B,C	4934.12	9937.68	10515950.40	3349376.57	50	50	CROSSHOLE SEISMIC TEST; SAMPLE BORING "A"
BV-18	4941.61	9057.00	10515853.94	3348501.16	50	TOP	PRESSUREMETER TESTING
BV-19	4882.26	9372.41	10515832.21	3348821.37	50	TOP	VANE SHEART TEST
BV-20	4882.26	9524.72	10515850.18	3348972.62	50	30	THERMAL RESISTIVITY SAMPLE
BV-21	4838.92	9223.59	10515771.61	3348678.70	50	30	ELECTRICAL RESISTIVITY SAMPLE
BV-22	4751.65	9954.93	10515771.24	3349415.22	10	–	DYNAMIC CONE TEST
BV-23	5570.30	8223.48	10516379.91	3347599.29	60	TOP	
BV-24	6061.39	9280.50	10516992.27	3348590.98	50	30	PRESSUREMETER TESTING; PIEZOMETER
BV-25	5046.39	8790.72	10515926.57	3348224.38	10	–	DYNAMIC CONE TEST
BV-26	5741.22	9237.12	10516669.21	3348585.69	50	TOP	VANE SHEAR TEST
BV-27	5788.27	9772.89	10516779.15	3349112.17	50	TOP	
BV-28	5781.05	9971.82	10516795.44	3349310.56	50	TOP	
BV-29	5968.82	10854.20	10517086.00	3350164.62	50	TOP	PIEZOMETER
BV-30	6207.80	11475.28	10517396.58	3350753.17	10	–	DYNAMIC CONE TEST
BV-31	5400.92	9503.72	10516362.74	3348890.57	50	30	PRESSUREMETER TESTING
BV-32	5517.78	9763.70	10516509.46	3349134.95	50	TOP	
BV-33	5512.53	9967.23	10516528.26	3349337.67	50	TOP	
BV-34	5331.33	10191.76	10516374.81	3349582.02	50	30	ELECTRICAL RESISTIVITY SAMPLE
BV-35	5507.28	10741.94	10516614.44	3350107.59	50	TOP	PRESSUREMETER TESTING
BV-36	4875.69	10816.78	10515996.09	3350256.42	50	30	VANE SHEAR TEST
BV-37	4244.12	11462.80	10515445.14	3350972.45	10	–	DYNAMIC CONE TEST
BV-38	4580.25	13097.57	10515971.80	3352556.14	10	–	DYNAMIC CONE TEST
BV-39	6025.94	16242.36	10517778.39	3355508.42	10	–	DYNAMIC CONE TEST
BV-101	4026.14	8999.50	10514938.08	3348552.06	50	TOP	PIEZOMETER
BV-102	3335.46	9470.07	10514307.74	3349100.83	50	TOP	
BV-103	4055.68	10248.88	10515114.81	3349789.23	50	TOP	
BV-104	3609.90	9868.75	10514627.29	3349464.35	50	TOP	
BV-105	3689.96	10523.55	10514784.05	3350105.13	50	TOP	
BV-106	2448.49	9621.23	10513444.80	3349355.58	50	TOP	
BV-107	3101.00	10663.15	10514216.41	3350313.15	50	TOP	PIEZOMETER
BV-108	2345.42	10497.71	10513445.85	3350238.09	50	TOP	
BV-109	2338.85	10190.45	10513403.08	3349933.75	50	TOP	
BV-110	2550.91	10393.32	10513637.59	3350110.19	50	TOP	
BV-111	2739.34	10464.88	10513833.14	3350159.02	50	TOP	
TP-1	5625.45	8352.16	10516449.85	3347720.56	15	–	
TP-2	5642.52	9813.60	10516639.22	3349169.78	15	–	
TP-3	5913.13	10663.96	10517008.25	3349982.28	15	–	
TP-4	2344.08	10330.80	10513424.83	3350072.50	15	–	

LEGEND

⊕ BV-1	BORING LOCATION
△ BV-1	BORING WITH PIEZOMETER LOCATION
■ TP-1	TEST PIT LOCATION
(PMT)	PRESSUREMETER TESTING
(VST)	VANE SHEAR TEST
(CST)	CROSSHOLE SEISMIC TEXT, SAMPLE BORING "A"
(DCT)	DYNAMIC CONE TEST
(TRS)	THERMAL RESISITIVITY SAMPLE
(ERS)	ELECTRICAL RESISITIVITY SAMPLE
(DRI)	DOUBLE RING INFILTROMETER

NOTES

1. ELECTRICAL RESISTIVITY SAMPLE TO BE TAKEN AT DESIGNATED LOCATIONS AT APPROXIMATE DEPTHS OF 2', 4', 10', 15', 20', 30', AND BOTTOM OF BORING.
2. CROSSHOLE SEISMIC TEST REQUIRES 3–100' CASED HOLES LOCATED IN A LINE AT 10' SPACING.
3. THERMAL RESISTIVITY SAMPLE TO BE TAKEN AT DESIGNATED LOCATIONS AT DEPTHS INDICATED BY PURCHASER. SAMPLE TO BE PLACED IN SEALED 5 GALLON BUCKET.

FOR ENGINEERING REPORT
FIGURE 3-1
BORING LOCATION AND INSITU TEST PLAN

NOT TO BE USED
FOR CONSTRUCTION

6°46'31.01"
PLANT GRID
STATE PLANE

300' 150' 0 300' 600'
1"=300'
50' 25' 0 50' 100'
1"=50'

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
C	04/11/2008	GENERAL REVISIONS	BEZ	JJD			
B	07/27/2007	REVISED TABLE	SLS	JJD			
A	07/20/2007	ISSUED FOR CONTRACT	SLS	JJD			

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS

SIGNED

DATE REG NO.

BLACK & VEATCH CORPORATION
SCPP
SANDY CREEK ENERGY STATION

ENGINEER JCB
DRAWN SLS
CHECKED
DATE

SANDY CREEK ENERGY STATION
UNIT 1

SUBSURFACE INVESTIGATION
BORING LOCATION AND ISITU TEST PLAN

PROJECT 149060–DS–0001
DRAWING NUMBER
REV C
CODE
AREA

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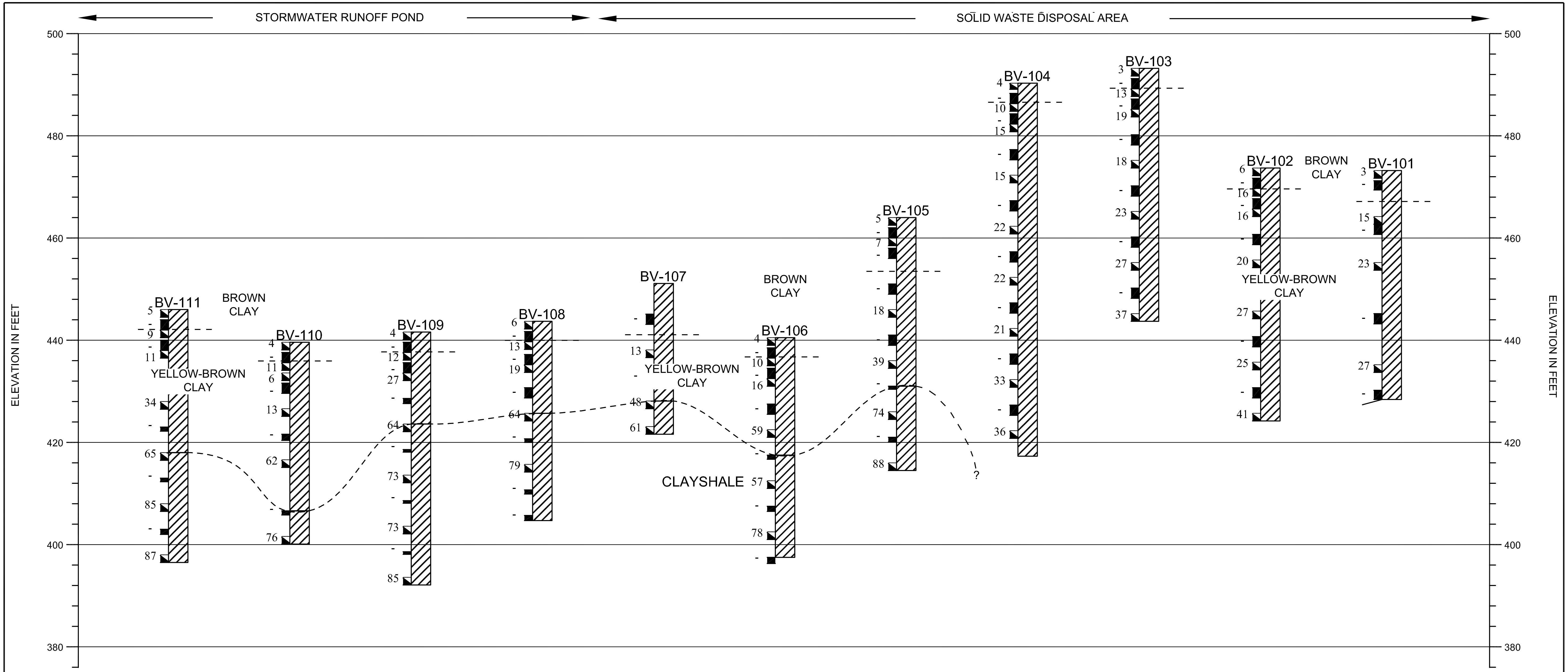
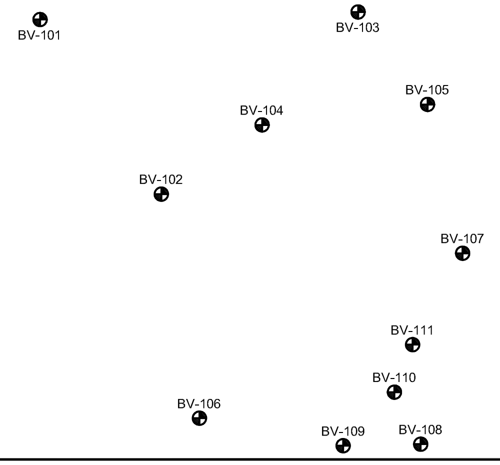
A1ASL017
04/11/08



This cross section is included as part of the report and is based on interpretations of the soil borings presented in the report. Actual subsurface conditions may vary from those in this cross section due to conditions not detected during the subsurface investigation. Groundwater levels were generally not measured due to the use of rotary wash drilling.

PLAN VIEW



LEGEND

▨ CLAY/CLAYSHALE

◪ Standard penetration test

■ Undisturbed thin wall Shelby tube

1 ◪ N-VALUE

NR ◪ N-VALUE NOT RECORDED

80 ▯ RQD Value

- - - INDICATES AN APPROXIMATE OR GRADUAL CHANGE

Horizontal Scale: 1"=(proportional)'

Vertical Scale: 1"=20'

PROJECT
Sandy Creek Energy Station

LOCATION
Reisel, Texas

CLIENT
Sandy Creek Energy Associates

PROJECT NO
149060

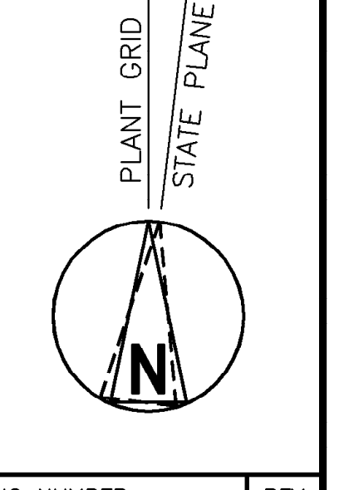
FOR ENGINEERING REPORT
FIGURE 5-1
SOLID WASTE DISPOSAL FACILITY (SWDF)
AREA CROSS SECION

GENERAL NOTES

1. SEE DRAWING 149060–SS–01101 FOR STAGE 1 BASE PLAN.
2. SEE DRAWING 149060–SS–01102 FOR STAGE 2 BASE PLAN.
3. SEE DRAWING 149060–SS–01103 FOR STAGE 3 BASE PLAN.
4. DISTURBED AREAS OF NON–ACTIVE CELLS SHALL BE VEGETATED IN ACCORDANCE WITH STATE AND LOCAL BEST MANAGEMENT GUIDELINES FOR STORM WATER POLLUTION PREVENTION.
5. SEE DRAWING 149060–SS–01250 FOR DRAWN DOWN PIPE SECTIONS AND DETAILS.

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FORMAT CAD FILE OF THIS DRAWING IS UNCONTROLLED. THE USER SHALL VERIFY TRACEABILITY OF THIS DRAWING TO THE LATEST CONTROLLED VERSION.



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A1ASL017
10/08/10

NO	DATE	REVISIONS AND RECORD OF ISSUE	DRN	DES	CHK	PDE	APP
1	18/OCT/10	GENERAL REVISIONS	JCB	JCB	BAG	BAG	MWM
0	29/JUN/09	INITIAL ISSUE	SAC	JCB	BMH	BTM	MWM

80' 40' 0 80' 160'
1"=80'

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS
SIGNED ______
DATE ______ REG NO. ______

BLACK & VEATCH CORPORATION
TEXAS FIRM NO. F-258
SCPP
SANDY CREEK ENERGY STATION

ENGINEER JCB
DRAWN SAC
CHECKED BMH
DATE 29/JUN/09

SANDY CREEK ENERGY STATION
UNIT 1

SOLID WASTE DISPOSAL FACILITY
35 YEAR BASE PLAN

PROJECT DRAWING NUMBER
149060–SS–01100
REV 1
CODE
AREA

Appendix A

Boring and Piezometer Logs

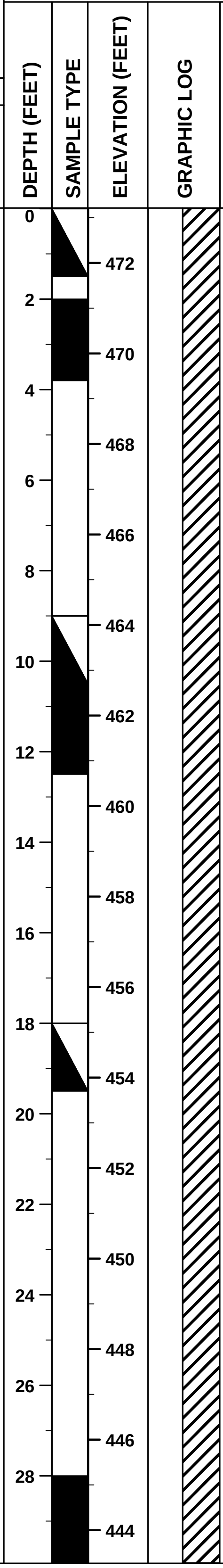
BORING LOG

BORING NO. BV-101

SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 4026.0' E 8990.0'	**GROUND ELEVATION (DATUM)** 473.2 ft (MSL)	**TOTAL DEPTH** 44.8 (feet)
SURFACE CONDITIONS Side of hill; weed cover	**COORDINATE SYSTEM** PLANT	**DATE START** 08/08/2007	**DATE FINISHED** 08/08/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	**RUN NUMBER**	**RUN LENGTH**	**RUN RECOVERY**	**RQD RECOVERY**	**PERCENT RECOVERY**	**RQD**		
SPT	1	2	1	2	3	0.2	CLAY; brown; soft; moist; low plasticity; w/some sand & gravel (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
TW	2	1.8	-	-	-	1.5	grading yellow-brown; stiff; w/some gypsum seams; trace cemented clay seams	@4' PP=4.5 tsf
SPT	3	6	7	8	15	1.5	grading w/1/4" cemented clay nodules	
							cemented clay nodules grades out	PP=4.25 tsf
TW	4	2.0	-	-	-	2.0		
SPT	5	7	11	12	23	1.5	grading w/some cementation	
							grading mottled gray	
TW	6	2.0	-	-	-	1.4		



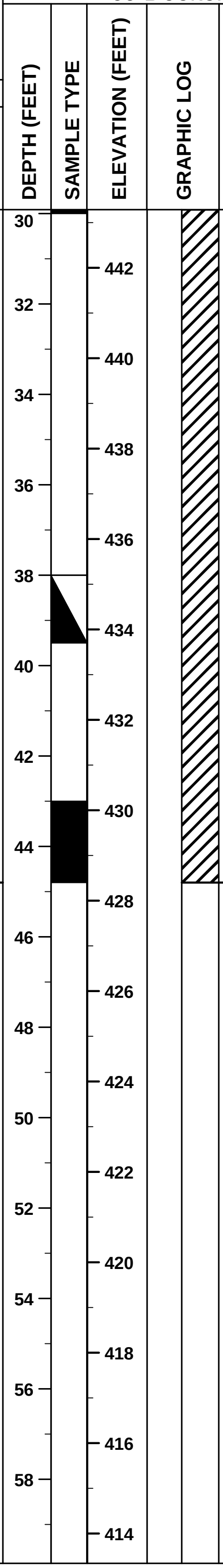
4/11/2008 1:21 PM SCEA - Sandy Creek Energy Station

BLACK & VEATCH

BORING LOG

BORING NO. BV-101
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 4026.0' E 8990.0'	**GROUND ELEVATION (DATUM)** 473.2 ft (MSL)	**TOTAL DEPTH** 44.8 (feet)
SURFACE CONDITIONS Side of hill; weed cover	**COORDINATE SYSTEM** PLANT	**DATE START** 08/08/2007	**DATE FINISHED** 08/08/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	



SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	CLASSIFICATION OF MATERIALS	REMARKS
SPT	7	10	13	14	27	1.5	grading very stiff	
TW	8	1.8	-	-	-	1.8	grading dark gray; fissile	
								Bottom of boring @ 44.8'. Water level not recorded. Boring backfilled w/ bentonite chips.

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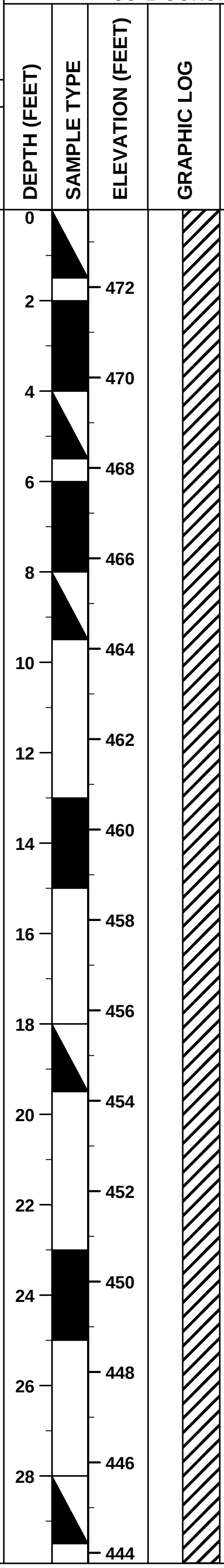
BORING LOG

BORING NO. BV-102
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 3335.0' E 9470.0'
GROUND ELEVATION (DATUM)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS High weeds; boring offset 150' east
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/3/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	3	3	3	6	0.9
TW	2	2.0	-	-	-	2.0
SPT	3	7	8	8	16	1.5
TW	4	2.0	-	-	-	2.0
SPT	5	7	8	8	16	1.3
TW	6	2.0	-	-	-	2.0
SPT	7	7	9	11	20	1.5
TW	8	2.0	-	-	-	2.0
SPT	9	10	12	15	27	1.5



CLASSIFICATION OF MATERIALS

CLAY: brown; firm; moist; high plasticity
(6" Topsoil)

@ 3.0' grading gray-brown; very stiff; w/some sand & 1" subrounded gravel
sand grades out

grading mottled yellow-brown-gray

grading w/occasional white cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@4' PP>4.5 tsf

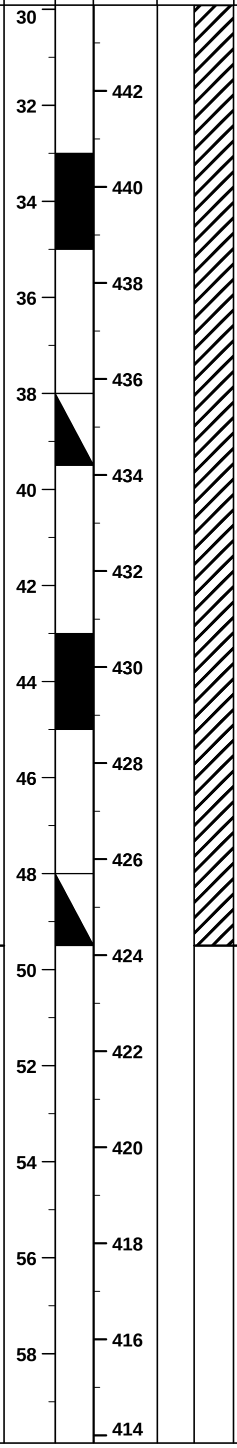
BLACK & VEATCH

BORING LOG

BORING NO. BV-102
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 3335.0' E 9470.0'
GROUND ELEVATION (DATUM)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS High weeds; boring offset 150' east
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/3/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING									
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING									
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD			
TW	10	2.0	-	-	-	2.0	34		
SPT	11	9	11	14	25	1.5			
TW	12	2.0	-	-	-	2.0	44		
SPT	13	15	18	23	41	1.5		grading hard	
							50		Bottom of boring at 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.



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BORING LOG

BORING NO. BV-103

SHEET 1 OF 2

CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

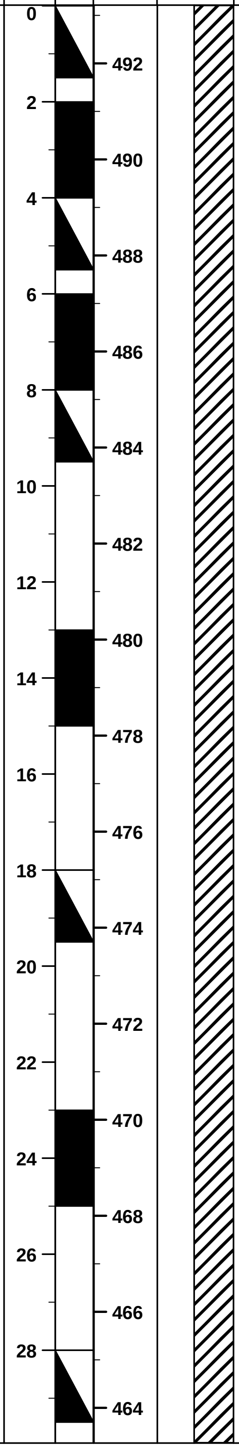
PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 4056.0'	E 10249.0'	493.2 ft (MSL)	49.5 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Rolling hills, tall weeds	Plant	8/1/07	8/1/07

LOGGED BY	CHECKED BY	APPROVED BY
JJ Deeken	JJ Deeken	BL Christensen

SOIL SAMPLING / ROCK CORING

SAMPLE TYPE CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	CLASSIFICATION OF MATERIALS	REMARKS
SPT	1	2	2	1	3	0.8	CLAY: brown; soft; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. @2' PP=2.0 tsf @4' PP=2.5 tsf
TW	2	2.0	-	-	-	2.0	grading stiff	
SPT	3	2	5	8	13	1.5	grading yellow-brown & gray seams	
TW	4	2.0	-	-	-	1.6		@6' PP=4.5 tsf
SPT	5	5	8	11	19	1.5	grading very stiff	Reacts w/HCL
TW	6	2.0	-	-	-	2.0		PP=4.5 tsf
SPT	7	6	8	10	18	1.5		
TW	8	2.0	-	-	-	2.0		
SPT	9	7	11	12	23	1.5	grading w/quartz seams	



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BORING LOG

BORING NO. BV-103
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 4056.0' E 10249.0'	**GROUND ELEVATION (DATUM)** 493.2 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Rolling hills, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** JJ Deeken	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30		462	▨		
TW	10	2.0	-	-	-	2.0	34	■	460	▨	grading iron oxide staining	PP=4.5 tsf
							36			▨	@ 36.0' quartz seams grades out	
SPT	11	7	12	15	27	1.5		◣		▨		
TW	12	2.0	-	-	-	2.0	44	■	450	▨	grading blue-gray	PP=4.5 tsf
SPT	13	11	17	20	37	1.5	48	◣		▨	grading hard	
							50					Bottom of boring at 49.5'. Water level not recorded. Boring backfilled with bentonite chips.

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BORING LOG

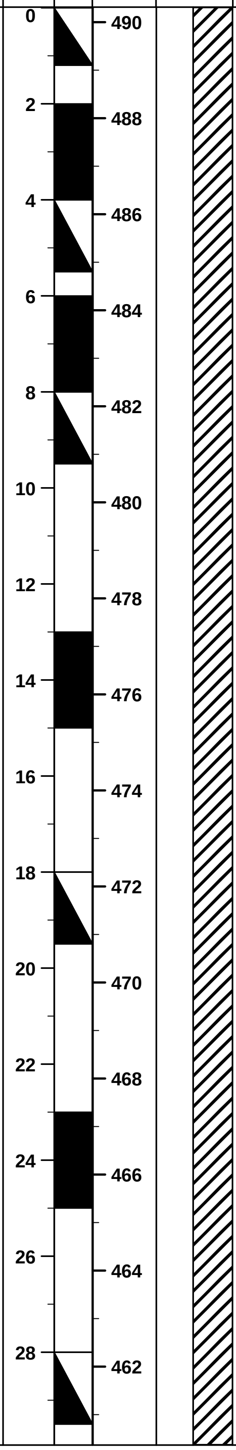
BORING NO. BV-104
SHEET 1 OF 3

CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 3609.0'	E 9869.0'	490.3 ft (MSL)	73.0 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Top of hill, tall weeds	Plant	8/1/07	8/1/07

LOGGED BY	CHECKED BY	APPROVED BY
JJ Deeken	V Bhadriraju	BL Christensen



SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	CLASSIFICATION OF MATERIALS	REMARKS
SPT	1	2	2	2	4	1.2	CLAY: brown; soft; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
							grading stiff	
TW	2	2.0	-	-	-	1.7		
SPT	3	2	4	6	10	1.5	grading yellow-brown & occasional gray clay seams	@2' PP=1.75 tsf @4' PP=2.0 tsf
TW	4	2.0	-	-	-	2.0		
SPT	5	5	6	9	15	1.5		PP>4.5 tsf
TW	6	2.0	-	-	-	2.0		
SPT	7	6	6	9	15	1.5		
							grading fissile	
TW	8	2.0	-	-	-	2.0		
							grading very stiff; w/1/4" quartz seams	
SPT	9	7	10	12	22	1.5		

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BORING LOG

BORING NO. BV-104
SHEET 2 OF 3

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3609.0'	E 9869.0'	**GROUND ELEVATION (DATUM)** 490.3 ft (MSL)	**TOTAL DEPTH** 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds	**COORDINATE SYSTEM** Plant		**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
	LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30		460	▨		
							32		458	▨		
								■		▨	grading w/some 1/8" quartz grains	PP>4.5 tsf
TW	10	2.0	-	-	-	2.0	34	■	456	▨		
							36		454	▨		
							38	◣	452	▨	grading iron oxide staining	
SPT	11	7	10	12	22	1.5		◣		▨		
							40		450	▨		
							42		448	▨		
								■		▨		PP>4.5 tsf
TW	12	2.0	-	-	-	2.0	44	■	446	▨		
							46		444	▨		
							48	◣	442	▨		
SPT	13	8	9	12	21	1.5		◣		▨		
							50		440	▨		
							52		438	▨		
TW	14	2.0	-	-	-	2.0	54	■	436	▨		
							56		434	▨		
							58	◣	432	▨	grading hard; w/occasional quartz seams	
SPT	15	10	14	19	33	1.5		◣		▨		

BLACK & VEATCH

BORING LOG

BORING NO. BV-104
SHEET 3 OF 3

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3609.0' E 9869.0'	**GROUND ELEVATION (DATUM)** 490.3 ft (MSL)	**TOTAL DEPTH** 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							60		430	▨		
							62		428	▨		
								■		▨	grading blue-gray & yellow-brown seams; quartz seams grades out	PP>4.5 tsf
TW	16	2.0	-	-	-	2.0	64	■	426	▨		
							66		424	▨		
SPT	17	14	16	20	36	1.5	68	◩	422	▨		
							70		420	▨		
							72		418	▨		
												Bottom of boring at 73.0'. Water level not recorded. Boring backfilled w/ bentonite chips.
							74		416			
							76		414			
							78		412			
							80		410			
							82		408			
							84		406			
							86		404			
							88		402			

BLACK & VEATCH

BORING LOG

BORING NO. BV-105

SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3690.0' E 10524.0'	**GROUND ELEVATION (DATUM)** 464.0 ft (MSL)
TOTAL DEPTH 49.5 (feet)	**SURFACE CONDITIONS** Side hill, tall weeds	**COORDINATE SYSTEM** Plant
DATE START 8/1/07	**DATE FINISHED** 8/1/07	**LOGGED BY** JJ Deeken
CHECKED BY V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	ELEVATION (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD				
SPT	1	2	2	3	5	0.8	0	464	CLAY: brown; firm; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. @2' PP=2.0 tsf @3.5' PP=2.0 tsf @6' PP=2.8 tsf
TW	2	2.0	-	-	-	1.5	2	462	grading stiff	
SPT	3	3	3	4	7	1.5	4	460	grading firm	
TW	4	2.0	-	-	-	1.7	6	458	grading yellow-brown & gray seams; very stiff	
							8	456		
							10	454		
							12	452		
TW	5	2.0	-	-	-	2.0	14	450	grading fissile	PP>4.5 tsf
							16	448		
SPT	6	6	8	10	18	1.5	18	446		PP>4.5 tsf
							20	444		
							22	442		
TW	7	2.0	-	-	-	1.8	24	440	grading w/occasional cemented quartz seams	PP>4.5 tsf
							26	438		
SPT	8	12	15	24	39	1.5	28	436	grading blue-gray; hard; gray seams grades out	PP>4.5 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-105
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3690.0' E 10524.0'	**GROUND ELEVATION (DATUM)** 464.0 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Side hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE, SAMPLE NUMBER, SET 6 INCHES, 2ND 6 INCHES, 3RD 6 INCHES, N VALUE, SAMPLE RECOVERY

ROCK CORING: CORE SIZE, RUN NUMBER, RUN LENGTH, RUN RECOVERY, RQD RECOVERY, PERCENT RECOVERY, RQD

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	ELEVATION (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
							30	434		
							32	432		
TW	9	0.6	-	-	-	0.6	33.0		CLAYSHALE; gray; hard; moist; high plasticity; fissile	TW refusal
							34	430		
							36	428		
							38	426	grading w/frequent cemetations	
SPT	10	21	32	42	74	1.5				
							40	424		
							42	422		
TW	11	0.9	-	-	-	0.9				Thick walled tube driven 100 blows
							44	420		
							46	418		
							48	416		
SPT	12	32	42	46	88	1.5				
										Bottom of boring at 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							50	414		
							52	412		
							54	410		
							56	408		
							58	406		

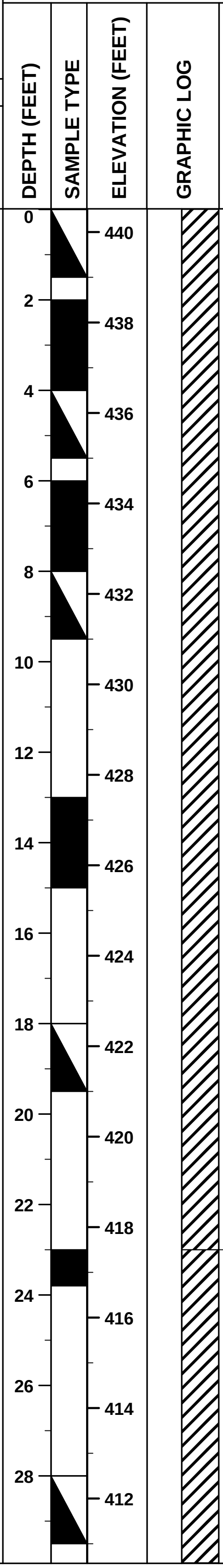
BLACK & VEATCH

BORING LOG

BORING NO. BV-106
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2448.0' E 9621.0'
GROUND ELEVATION (DATUM)
TOTAL DEPTH 44.2 (feet)
SURFACE CONDITIONS Valley, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/3/07
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	2	2	4	1.0
TW	2	2.0	-	-	-	1.1
SPT	3	2	5	5	10	0.1
TW	4	2.0	-	-	-	2.0
SPT	5	4	6	10	16	0.1
TW	6	2.0	-	-	-	1.8
SPT	7	14	26	33	59	1.5
TW	8	0.8	-	-	-	0.8
SPT	9	20	25	32	57	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; soft; moist; high plasticity; w/trace coarse sand & 1" gravel (6" Topsoil)

grading stiff

grading dark gray; w/some gravel

grading very stiff

grading hard; w/frequent light gray partings; occasional cemented clay seams; gravel grades out

23.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@4' PP=2.2 tsf
Gravel in SPT3

Gravel in SPT5

PP>4.5 tsf

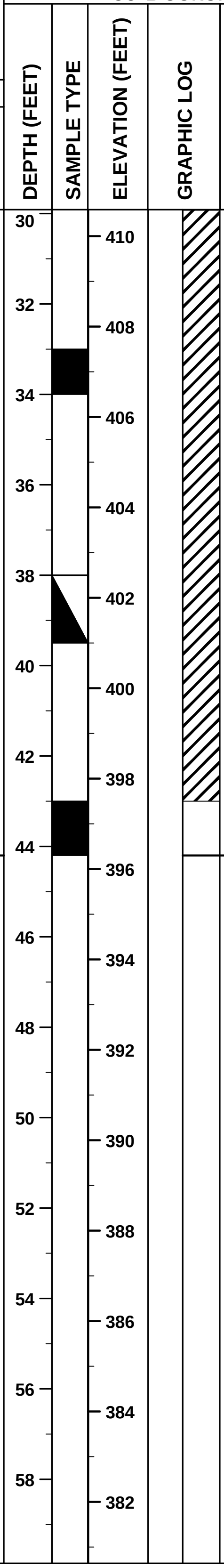
BLACK & VEATCH

BORING LOG

BORING NO. BV-106
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2448.0' E 9621.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 44.2 (feet)
SURFACE CONDITIONS Valley, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07	**DATE FINISHED** 8/3/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING							**CLASSIFICATION OF MATERIALS**	**REMARKS**
SAMPLE TYPE	**SAMPLE NUMBER**	**SET 6 INCHES**	**2ND 6 INCHES**	**3RD 6 INCHES**	**N VALUE**	**SAMPLE RECOVERY**		
ROCK CORING								
CORE SIZE	**RUN NUMBER**	**RUN LENGTH**	**RUN RECOVERY**	**RQD RECOVERY**	**PERCENT RECOVERY**	**RQD**		
TW	10	1.0	-	-	-	1.0		Thick walled tube pushed 8", then driven 2".
SPT	11	26	35	43	78	1.5		
TW	12	1.2	-	-	-	1.2		Thick walled tube pushed 4", then driven 10".
								Bottom of boring at 44.2' Water level not recorded. Boring backfilled w/ bentonite chips.



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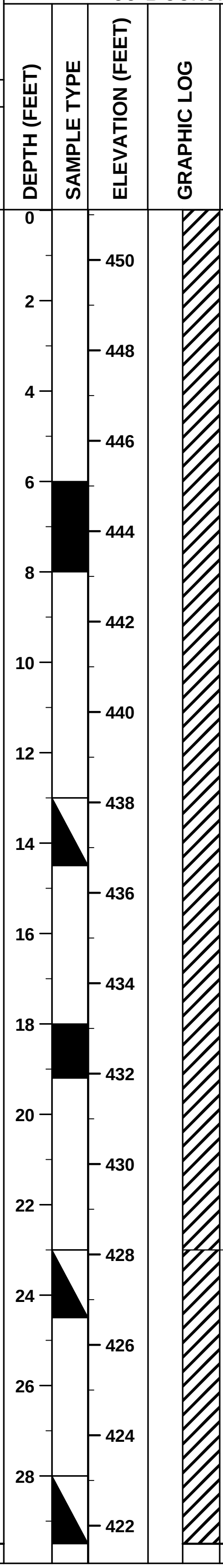
BORING LOG

BORING NO. BV-107
SHEET 1 OF 1

CLIENT: Sandy Creek Energy Associates
PROJECT: Sandy Creek Energy Station
PROJECT NO.: 149060
PROJECT LOCATION: Reisel, Texas
COORDINATES: N 3101.0' E 10663.0'
GROUND ELEVATION (DATUM):
TOTAL DEPTH: 29.5 (feet)
SURFACE CONDITIONS: Natural drainage path, brush cover
COORDINATE SYSTEM: Plant
DATE START: 08/09/2007
DATE FINISHED: 08/09/2007
LOGGED BY: JJ Deeken
CHECKED BY: V Bhadriraju
APPROVED BY: BL Christensen



SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	CLASSIFICATION OF MATERIALS	REMARKS
							<u>CLAY</u>; brown; moist; high plasticity; w/some gravel; trace sand (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
							grading very stiff	PP=2.5 tsf
TW	1	2.0	-	-	-	1.2		
SPT	2	4	6	7	13	1.5	grading mottled yellow-brown-gray; stiff	
TW	3	1.2	-	-	-	1.2	grading dark gray; moist; slightly fissile; w/some cemented clay seams & gravel	TW refusal @ 19.2'
							23.0	
SPT	4	16	20	28	48	1.5	<u>CLAYSHALE</u>; gray; hard; moist; high plasticity; fissile; w/some gravel	Harder drilling
								Bottom of boring at 29.5'. Water level not recorded. Piezometer installed on 08/09/07.
SPT	5	19	25	36	61	1.5		

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BORING LOG

BORING NO. BV-108
SHEET 1 OF 2

CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 2345.0'	E 10497.0'	443.7 ft (MSL)	39.0 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Hill; weeds	Plant	08/02/2007	08/02/2007

LOGGED BY	CHECKED BY	APPROVED BY
JJ Deeken	V Bhadriraju	BL Christensen

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
SPT	1	3	3	3	6	1.2	CLAY; brown; firm; moist; high plasticity; w/some sand & 1" gravel (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
TW	2	2.0	-	-	-	2.0	grading yellow-brown	TW-2 disturbed @2' PP=3.2 tsf
SPT	3	3	6	7	13	1.5	grading stiff	@4' PP=3.2 tsf
TW	4	2.0	-	-	-	2.0		TW4 PP=4.0 tsf
SPT	5	7	9	10	19	1.5	grading very stiff; w/some quartz sand	
TW	6	2.0	-	-	-	2.0	grading mottled dark gray	PP>4.5 tsf
SPT	7	16	26	38	64	1.5	18.0 CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/occasional cementation @ 19.5' grading dark gray	PP>4.5 tsf
TW	8	0.7	-	-	-	0.7		PP>4.5 tsf
SPT	9	20	33	46	79	1.5		PP>4.5 tsf

DEPTH (FEET): 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28

ELEVATION (FEET): 442, 440, 438, 436, 434, 432, 430, 428, 426, 424, 422, 420, 418, 416, 414

SAMPLE TYPE

GRAPHIC LOG

BORING LOG

BORING NO. BV-108
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2345.0' E 10497.0'	**GROUND ELEVATION (DATUM)** 443.7 ft (MSL)	**TOTAL DEPTH** 39.0 (feet)
SURFACE CONDITIONS Hill; weeds	**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING												
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY						
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							30			▨		
							32		412	▨		
TW	10	0.8	-	-	-	0.8	34	■	410	▨		
							36		408	▨		
							38		406	▨		
TW	11	1.0	-	-	-	1.0		■		▨		
							40		404			Bottom of boring @ 39.0'. Water level not recorded. Boring backfilled w/ bentonite chips.
							42		402			
							44		400			
							46		398			
							48		396			
							50		394			
							52		392			
							54		390			
							56		388			
							58		386			
									384			

BLACK & VEATCH

BORING LOG

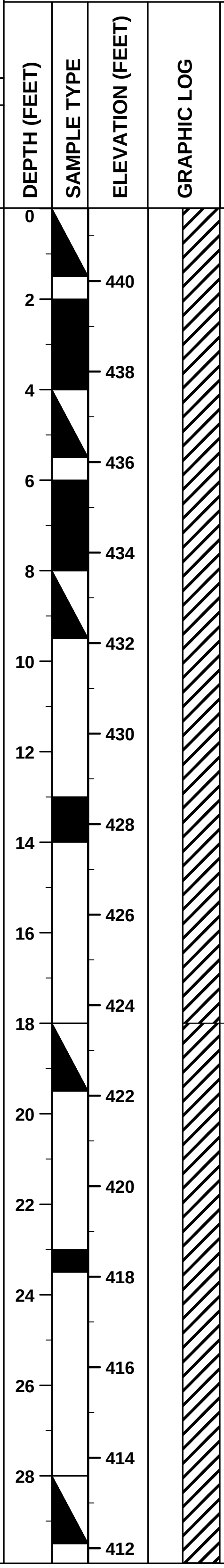
BORING NO. BV-109

SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060	
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2339.0'	E 10190.0'	**GROUND ELEVATION (DATUM)** 441.6 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)	
SURFACE CONDITIONS Valley; tall weeds		**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007	
LOGGED BY JJ Deeken		**CHECKED BY** V Bhadriraju		**APPROVED BY** BL Christensen	

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE / CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD
SPT	1	3	2	2	4	1.1
TW	2	2.0	-	-	-	1.0
SPT	3	3	6	6	12	1.4
TW	4	2.0	-	-	-	2.0
SPT	5	8	12	15	27	1.5
TW	6	1.0	-	-	-	1.0
SPT	7	17	27	37	64	1.5
TW	8	0.5	-	-	-	0.5
SPT	9	21	32	41	73	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; soft; moist; high plasticity (6" Topsoil)

grading yellow-brown

grading stiff

grading very stiff

grading dark gray

18.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/frequent cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

PP=2.0 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-109

SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates

PROJECT Sandy Creek Energy Station

PROJECT NO. 149060

PROJECT LOCATION Reisel, Texas

COORDINATES N 2339.0' E 10190.0'

GROUND ELEVATION (DATUM) 441.6 ft (MSL)

TOTAL DEPTH 49.5 (feet)

SURFACE CONDITIONS Valley; tall weeds

COORDINATE SYSTEM Plant

DATE START 08/02/2007

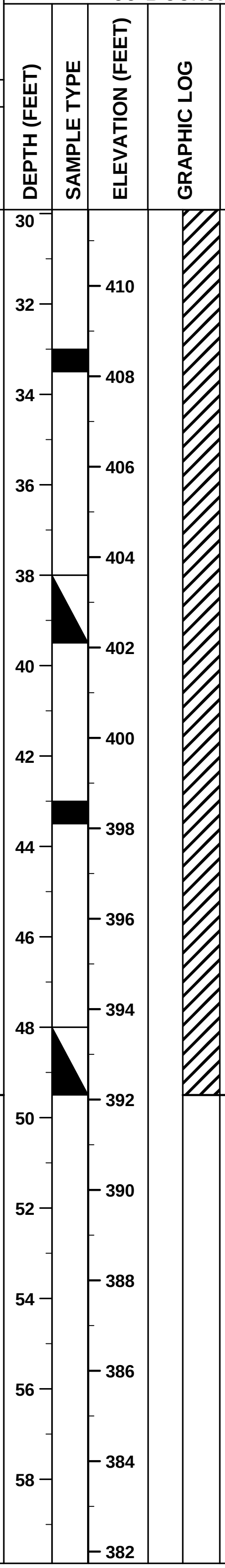
DATE FINISHED 08/02/2007

LOGGED BY JJ Deeken

CHECKED BY V Bhadriraju

APPROVED BY BL Christensen

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	CLASSIFICATION OF MATERIALS	REMARKS
TW	10	0.5	-	-	-	0.5		Tube end crushed.
SPT	11	22	32	41	73	1.5		
TW	12	0.5	-	-	-	0.5		
SPT	13	27	39	46	85	1.5		
								Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.



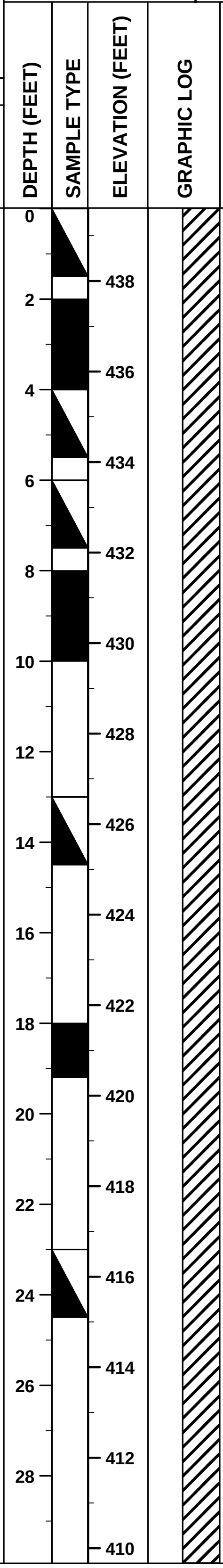
BORING LOG

BORING NO. BV-110
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2551.0' E 10393.0'	**GROUND ELEVATION (DATUM)** 439.6 ft (MSL)	**TOTAL DEPTH** 39.5 (feet)
SURFACE CONDITIONS Valley/tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07	**DATE FINISHED** 8/4/07
LOGGED BY DE Campbell	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	WOH	2	2	4	1.2
TW	2	2.0	-	-	-	1.1
SPT	3	3	4	7	11	1.0
SPT	4	3	3	3	6	1.3
TW	5	2.0	-	-	-	2.0
SPT	6	3	5	8	13	1.3
TW	7	1.2	-	-	-	1.2
SPT	8	18	26	36	62	1.5



CLASSIFICATION OF MATERIALS

<u>CLAY</u>: brown; soft; moist; high plasticity; w/trace subrounded red fine gravel (6" Topsoil)

grading stiff

grading yellow-brown; firm

@ 10.0' grading mottled gray

grading w/trace cementation; gravel grades out

grading gray

grading hard; w/occasional cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@2' PP=1.5 tsf

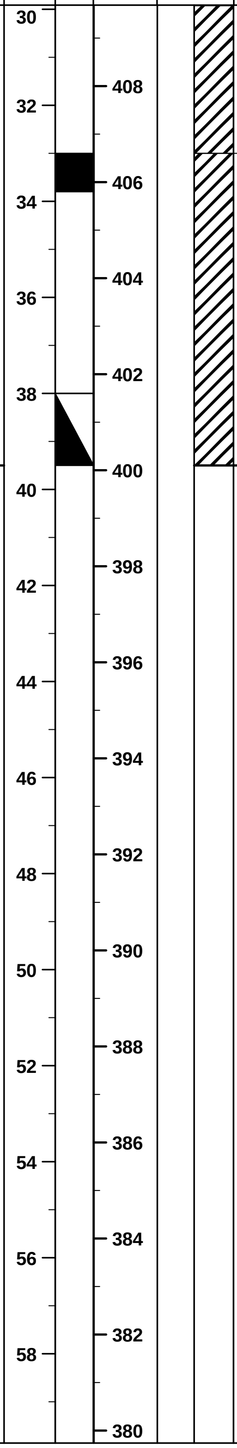
PP=2.25 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-110
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2551.0' E 10393.0'
GROUND ELEVATION (DATUM) 439.6 ft (MSL)
TOTAL DEPTH 39.5 (feet)
SURFACE CONDITIONS Valley/tall weeds
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/4/07
LOGGED BY DE Campbell
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen



SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	DEPTH (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
TW	9	0.8	-	-	-	0.8	33.0	<u>CLAYSHALE</u>: gray; hard; moist; high plasticity; fissile; w/trace cementation	Tube end crushed.
SPT	10	22	34	43	76	1.5			
									Bottom of boring @ 39.5'. Water level not recorded. Boring backfilled w/ bentonite chips.

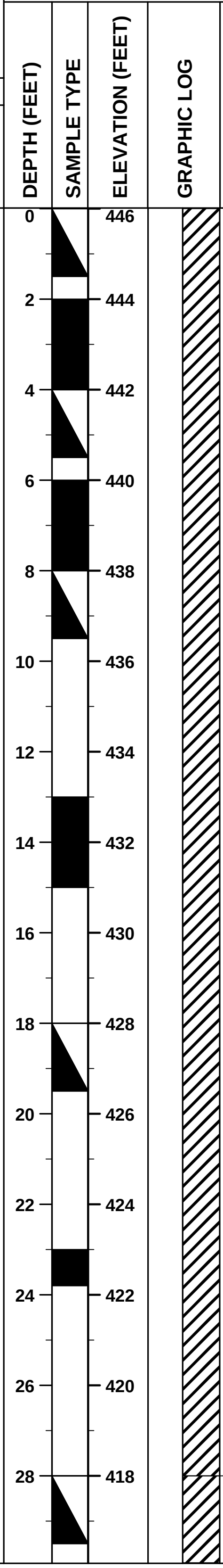
BLACK & VEATCH

BORING LOG

BORING NO. BV-111
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2739.0' E 10465.0'
GROUND ELEVATION (DATUM) 446.0 ft (MSL)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS tall weeds in valley, heavy rain
COORDINATE SYSTEM Plant
DATE START 08/02/2007
DATE FINISHED 08/02/2007
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	2	3	5	1.2
TW	2	2.0	-	-	-	1.5
SPT	3	2	4	5	9	1.4
TW	4	2.0	-	-	-	1.8
SPT	5	2	4	7	11	1.5
TW	6	2.0	-	-	-	2.0
SPT	7	10	15	19	34	1.5
TW	8	0.8	-	-	-	0.8
SPT	9	20	27	38	65	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; firm; moist; high plasticity
(6" Topsoil)

grading stiff

grading yellow; w/trace sand

@ 9.0' grading yellow-brown

grading hard; w/some sand
@ 18.5' grading w/1" gravel

@ 19.5' grading gray-brown

grading w/occasiional quartz seams

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/trace cementation

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

@6' PP=1.5 tsf

@8' PP=3.5 tsf

PP>4.5 tsf

PP>4.5 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-111
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2739.0' E 10465.0'	**GROUND ELEVATION (DATUM)** 446.0 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS tall weeds in valley, heavy rain	**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007
	LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	DEPTH (FEET)	ELEVATION (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
							30	416		
							32	414		
TW	10	0.7	-	-	-	0.7				Thick walled tube driven.
							34	412		
							36	410		
							38	408	grading dry to moist	
SPT	11	23	44	41	85	1.5				
							40	406		
							42	404		
TW	12	1.0	-	-	-	1.0				Thick walled tube driven.
							44	402		
							46	400		
							48	398		
SPT	13	30	40	47	87	1.5				
										Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							50	396		
							52	394		
							54	392		
							56	390		
							58	388		

APPENDIX D

Slope Stability Analysis

September 27, 2018
File No. 16215106.00

TECHNICAL MEMORANDUM

ANALYSIS BY: Keith Gilkey
Deb Nelson

REVIEWED BY: Phil Gearing
Dave Hendron

SUBJECT: Slope Stability Review and Analyses
Unstable Areas Compliance Demonstration Report
Cells 1 and 2 (Stages 1 and 2)
Sandy Creek Solid Waste Disposal Facility
Sandy Creek Energy Station

BACKGROUND & PURPOSE

The original slope stability analyses conducted by Black & Veatch (B&V) in 2009 investigated the 4H:1V slopes of the disposal facility (dry ash landfill) through four filling stages (Stages 1 through 4) of the design storage area lifetime. The purpose of the SCS Engineers (SCS) slope stability analysis is to review the previous analyses conducted by B&V for Cells 1 and 2 (Stages 1 and 2). The slope stability analysis review is part of the Unstable Areas Compliance Demonstration to meet 40 CFR 257. 64. The analyses cross section locations are shown in **Attachment D2**. Cells 1 and 2 are the existing coal combustion residual (CCR) landfill. Future CCR units beyond Cells 1 and 2 are not addressed and are not discussed further herein.

CONCLUSION

SCS reviewed the 2009 slope stability analyses for Cells 1 and 2 (Stages 1 and 2) of the waste disposal facility. We concur that the slope geometry; material properties for the drainage/ protective layer, byproduct (waste), and clayshale; and the piezometric surface used for undrained clay shear strength analyses are appropriate. Based on our review of the clay shear strength (both drained and undrained) test results, SCS determined that a lower undrained clay shear strength than the values used in 2009 should be used for the slope stability analyses. SCS also determined that slope stability analyses using the drained clay shear strength should be performed in addition to the undrained clay shear strength analyses for comparison with the stability analyses made using undrained shear strength values. The soil shear strength evaluation is discussed in more detail below. When the safety factors are compared, analyses made using either shear strength should compare well with each other.

Based on the slope stability analysis results in **Attachments D1** and **D4**, SCS calculated slope stability safety factors in the range of 1.54 to 1.84 for Cells 1 and 2 that meet the recommended minimum safety factor of 1.5. The 1.5 minimum slope stability safety factor is based on industry practice for solid waste landfills.

SOIL SHEAR STRENGTH EVALUATION

The soil properties from field and laboratory testing of the site prior to landfill construction are contained in the 2010 Geotechnical Design Report by B&V and the 2009 Engineering Report by B&V. The site soils are highly plastic, stiff, fissured clays overlying a hard clayshale formed by weathering of the underlying shale bedrock. The properties of the stiff, fissured clay soils that SCS summarized from information in the aforementioned Reports are given in **Attachment D3**. The 2009 slope stability analysis performed by B&V is based on their interpretation of the undrained shear strength for the stiff, fissured clay soils that significantly increases with depth below the landfill. The test results summarized and plotted in **Attachment D3** do not support an increasing undrained shear strength of the stiff, fissured clays with depth. The data show that the minimum shear strength for these clay strata is about 2,000 psf. Therefore, SCS used a value of 2,000 psf in the slope stability analyses performed for this review.

The slope stability analyses shown in **Attachments D1** and **D4** were performed by SCS for both undrained and drained clay shear strengths. Based on the test results summarized in **Attachment D3**, SCS used an undrained shear strength of 2,000 psf for the stiff, fissured clay layers and a drained shear strength of 20 degrees for the clay layers. The drained shear strength of 20 degrees is consistent with drained shear strength testing conducted by B&V and with recommendations from Stark and Hussain (2012) for clays with liquid limits and clay fraction contents similar to those shown by testing of the Sandy Creek site stiff, fissured clays in **Appendix D3**.

PORE WATER PRESSURE EVALUATION

The 2009 slope stability analyses by B&V assumed a piezometric surface that is 10 feet above the landfill liner to account for pore water pressure within the waste and soils. SCS also used a piezometric surface that is 10 feet above the landfill liner for the stability analyses using undrained clay shear strength. SCS assumed that this piezometric surface is “perched” above the normal groundwater piezometric surface in the clay soils underlying the landfill.

With respect to the normal groundwater piezometric surface, SCS used two piezometric surfaces for the stability analyses using the drained clay shear strength of 20 degrees mentioned previously. The lower piezometric surface corresponds to groundwater levels approximately 10 feet below ground surface (bgs) (near elevation 460 feet above mean sea level (amsl)) and approximately 20 feet bgs (near elevation 450 feet amsl). The lower piezometric surfaces were selected based on the groundwater levels in the 2018 Semiannual Groundwater Monitoring Report.

SLOPE STABILITY ANALYSIS RESULTS

The calculated safety factors for the Stage 1 and Stage 2 waste slopes are shown in the summary table in **Attachment D1**. The slopes were analyzed using the Spencer method for circular failure that is consistent with the 2009 slope stability analyses performed by B&V.

B&V recommended a minimum safety factor of 1.5 for the waste slopes, and SCS is in agreement with the recommended 1.5 minimum safety factor. The stability analysis results by SCS in **Attachments D1**and **D4** indicate that the Cell 1 and Cell 2 (Stage 1 and Stage 2) waste slopes have calculated safety factors in the range of 1.54 to 1.84. The safety factors calculated with undrained clay shear strength are in reasonably good agreement with the safety factors calculated with drained clay shear strength and both result in a minimum factor of safety greater than 1.5. The Cell 1 and Cell 2 waste slope stability safety factors meet the recommendation of a safety factor of 1.5 or greater.

REFERENCES

1. Black & Veatch Corp., Sandy Creek Energy Station, Byproduct Storage Area – Slope Stability, 2009.
2. Black & Veatch Corp., Sandy Creek Energy Station, Engineering Report – Revision 1, 2010, Sandy Creek Services LLC.
3. Black & Veatch Corp., Sandy Creek Energy Station, Geotechnical Design Report – Revision 0, 2009, Sandy Creek Services LLC.
4. SCS Engineers, 2018, June 2018 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, Texas.
5. Stark, Timothy D. and Manzoor Hussain, 2012, Empirical Correlations – Drained Shear Strength for Slope Stability Analyses, Journal of Geotechnical and Geoenvironmental Engineering, American Society of Civil Engineers.
6. Geo-Slope International, Ltd., GeoStudio 2016, Version 8.16.2.14053, Slope/W slope stability software.

MATERIAL PROPERTIES

- Material properties utilized for the undrained clay shear strength slope stability analyses are as shown in the table below, based on the values used for the 2009 stability analyses by B&V and an undrained shear strength (cohesion) of 2,000 psf determined by SCS.

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Drainage / Protective Layer	120	32	0
Byproduct	103	27	0
Compacted Clay Layer	120	0	2,000
Yellow Brown Clay (A)	125	0	2,000

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Yellow Brown Clay (B)	125	0	2,000
Yellow Brown Clay (C)	125	0	2,000
ClayShale	130	0	7,000

- Material properties utilized for the drained clay shear strength slope stability analyses are as shown in the table below, based on the values used for the 2009 stability analyses by B&V and a drained clay shear strength (friction angle) of 20 degrees determined by SCS.

Material	Unit Weight (pcf)	Friction Angle (degrees)	Cohesion (psf)
Drainage / Protective Layer	120	32	0
Byproduct	103	27	0
Compacted Clay Layer	120	20	0
Yellow Brown Clay (A)	125	20	0
Yellow Brown Clay (B)	125	20	0
Yellow Brown Clay (C)	125	20	0
ClayShale	130	0	7,000

Attachments: Calculations organized as follows:

D1 - Factor of Safety Summary Table
D2 – Cross Section Locations
D3 – Clay Test Result Summary Tables and Shear Strength Plots
D4 – Slope/W Outputs

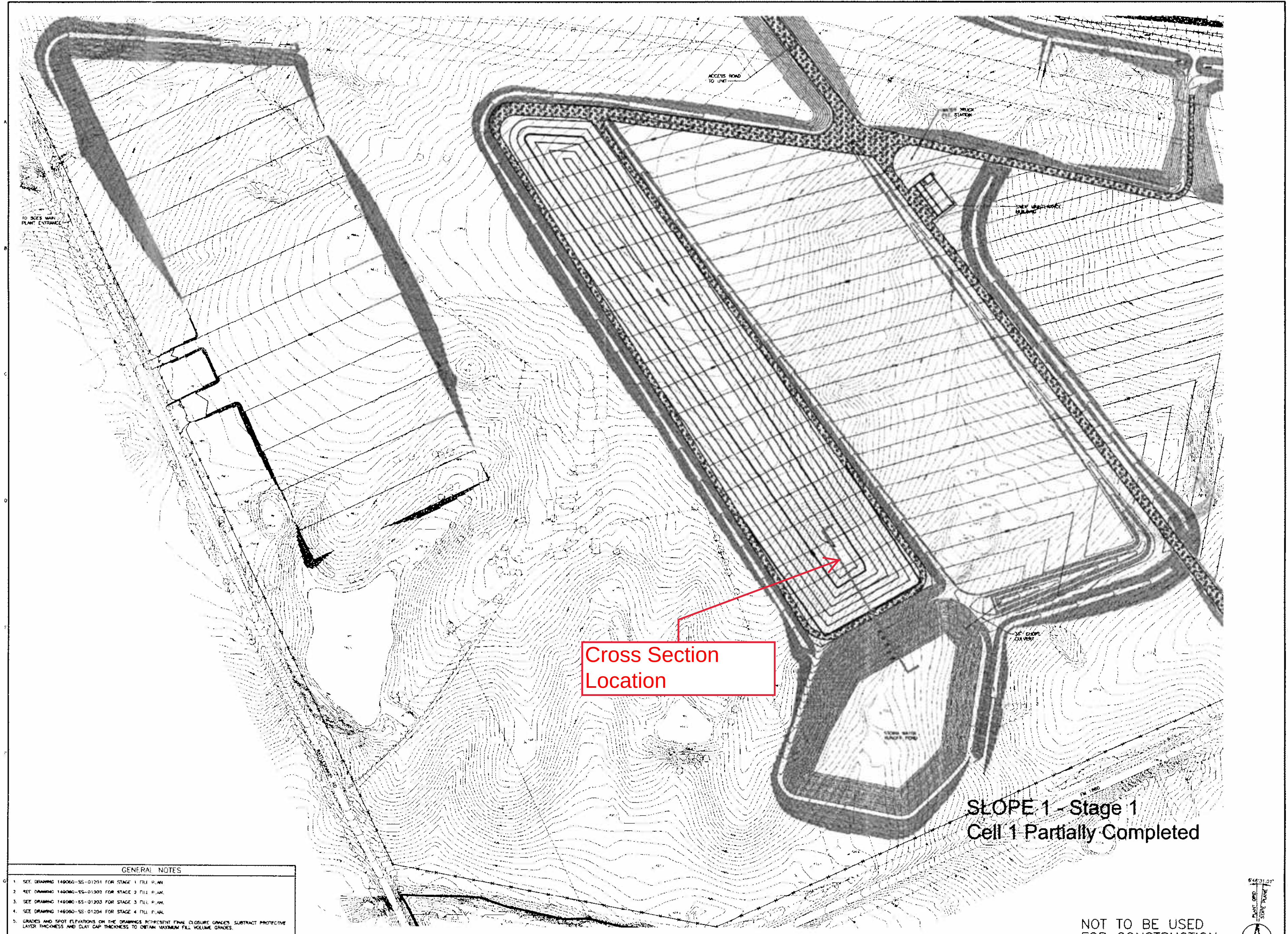
BSS/DLN/jsn/DMH/MRH

Slope Stability Analyses
Factors of Safety Results Summary
Sandy Creek Energy Station - Unstable Areas Compliance Demonstration Report

Byproduct Storage Area Stage 1 Slope		
Soil Properties and Pore Pressures	**SCS Calculated Safety Factor**	**Recommended Min. Safety Factor**
Underdrained Clay Shear Strength of 2,000 psf, Piezometric Surface 10 feet above Liner	1.631	1.5
Drained Clay Shear Strength of 20°, Upper Piezometric Surface 10 feet above Liner, Lower Piezometric Surface at El. 460	1.543	1.5
Drained Clay Shear Strength of 20°, Upper Piezometric Surface 10 feet above Liner, Lower Piezometric Surface at El. 450	1.543	1.5

Byproduct Storage Area Stage 2 Slope		
Soil Properties and Pore Pressures	**SCS Calculated Safety Factor**	**Recommended Min. Safety Factor**
Underdrained Clay Shear Strength of 2,000 psf, Piezometric Surface 10 feet above Liner	1.575	1.5
Drained Clay Shear Strength of 20°, Upper Piezometric Surface 10 feet above Liner, Lower Piezometric Surface at El. 460	1.838	1.5
Drained Clay Shear Strength of 20°, Upper Piezometric Surface 10 feet above Liner, Lower Piezometric Surface at El. 450	1.840	1.5

Created by: BSS, 9/7/18
Last Revision by: KRG, 9/25/18
Checked by: DLN, 9/25/18



GENERAL NOTES

1. SEE DRAWING 149060-SS-01201 FOR STAGE 1 FILL PLAN.
2. SEE DRAWING 149060-SS-01202 FOR STAGE 2 FILL PLAN.
3. SEE DRAWING 149060-SS-01203 FOR STAGE 3 FILL PLAN.
4. SEE DRAWING 149060-SS-01204 FOR STAGE 4 FILL PLAN.
5. GRADES AND SPOT ELEVATIONS ON THE DRAWINGS REPRESENT FINAL CLOSURE GRADES. SUBTRACT PROTECTIVE LAYER THICKNESS AND CLAY CAP THICKNESS TO OBTAIN MAXIMUM FILL VOLUME GRADES.
6. UPON REACHING FINAL CLOSURE GRADE OF A CELL, THE AREA SHALL BE CAPPED WITH 3 FT OF CLAY PER THE SWDF ENGINEERING REPORT.
7. CAPPED AREAS SHALL RECEIVE A PROTECTIVE COVER AND BE VEGETATED PER THE SWDF ENGINEERING REPORT.

NOT TO BE USED FOR CONSTRUCTION

THE DISTRIBUTION AND USE OF THE NATIVE FILE FORMAT OF THIS DRAWING OUTSIDE OF BLACK & VEATCH IS UNCONTROLLED AND SHALL BE USED FOR REFERENCE PURPOSES ONLY.

NO	DATE	REVISIONS AND RECORD OF ISSUE
0	30/JUN/09	INITIAL ISSUE

I HEREBY CERTIFY THAT THIS DOCUMENT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY REGISTERED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF TEXAS

SIGNED
DATE REG NO.

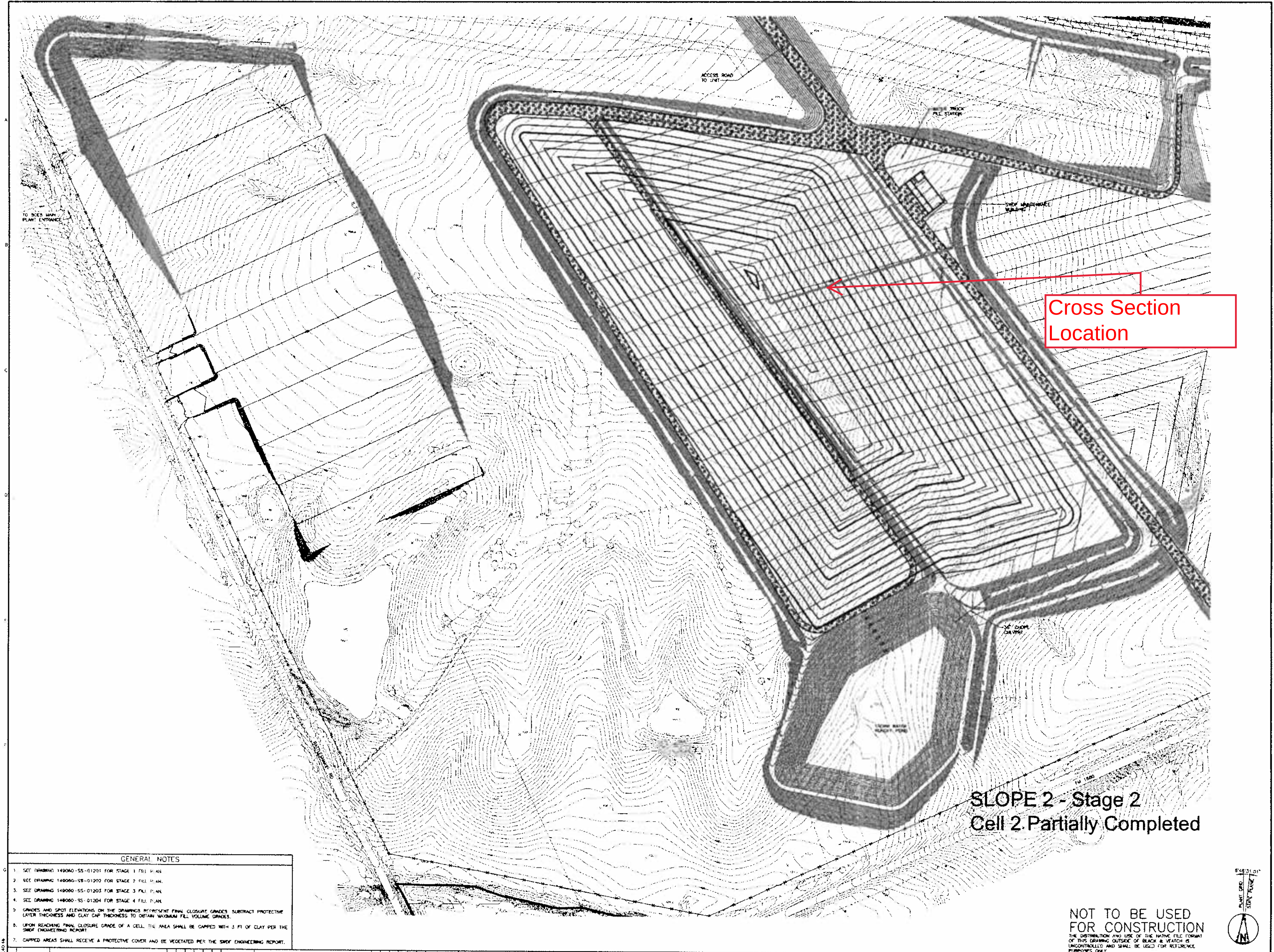
BLACK & VEATCH CORPORATION SCPP

ENGINEER JOB
DRAWN BAC
CHECKED
DATE 26/JUN/09

SANDY CREEK ENERGY STATION
UNIT 1

SOLID WASTE DISPOSAL FACILITY
FILL PLAN - STAGE 1

PROJECT DRAWING NUMBER
149060-SS-01201
REV 0



Cross Section Location

SLOPE 2 - Stage 2
Cell 2 Partially Completed

GENERAL NOTES

1. SEE DRAWING 149060-SS-01201 FOR STAGE 1 FILL PLAN.
2. SEE DRAWING 149060-SS-01202 FOR STAGE 2 FILL PLAN.
3. SEE DRAWING 149060-SS-01203 FOR STAGE 3 FILL PLAN.
4. SEE DRAWING 149060-SS-01204 FOR STAGE 4 FILL PLAN.
5. GRADES AND SPOT ELEVATIONS ON THE DRAWINGS REPRESENT FINAL CLOSURE GRADES. SUBTRACT PROTECTIVE LAYER THICKNESS AND CLAY CAP THICKNESS TO OBTAIN MAXIMUM FILL VOLUME GRADES.
6. UPON REACHING FINAL CLOSURE GRADE OF A CELL, THE AREA SHALL BE CAPPED WITH 3 FT OF CLAY PER THE SWDF ENGINEERING REPORT.
7. CAPPED AREAS SHALL RECEIVE A PROTECTIVE COVER AND BE VEGETATED PER THE SWDF ENGINEERING REPORT.

NO	DATE	REVISIONS AND RECORD OF ISSUE
0	30/JUN/09	INITIAL ISSUE

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SIGNED ____________

DATE ____________ REG NO. ____________

BLACK & VEATCH CORPORATION SCPP

ENGINEER JCR DRAWN SAC
CHECKED BMH DATE 26/JUN/09

SANDY CREEK ENERGY STATION
UNIT 1

SOLID WASTE DISPOSAL FACILITY
FILL PLAN – STAGE 2

PROJECT DRAWING NUMBER 149060-SS-01202 REV 0

CORE

AREA

COL38621
ACAD 16.1s (LMS Tech)
08/30/09 11:40:44

Laboratory Soil Test Results
Sandy Creek Energy Station

Boring No.	Sample No.	Depth (feet)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	P200 Content (%)	% Clay
BV-1	3	5-6.5	25	74	23	51		
BV-1	5	12-13.5	20	66	27	39		
BV-1	7	22-23.5	23	68	26	42		
BV-2	2	6-7.5	25	74	29	45		
BV-2	6	22-23.5	23					
BV-2	10	42.43.5	18					
BV-2	12	52-53.5	17					
BV-3	3	4-4.5	21	73	28	45		
BV-3	6	15-16.5	21					
BV-3	11	25-26.5	25	71	27	44		
BV-3	15	40-	22					
BV-4	3	7-8.5	27					
BV-4	7	27-28.5	22	69	27	42		
BV-4	11	46-47.5	19					
BV-6	4	13-14.5	26	66	25	41		
BV-6	6	23-24.5	25	66	27	39		
BV-6	10	43-44.5	23	70	30	40		
BV-7	3	6-7.5	26	72	27	45		
BV-7	7	23-24.5	26	71	30	41		
BV-7	9	33-34.5	28					
BV-7	11	43-44.5	23	68	27	41		
BV-8	5	12-15	23	71	31	40		
BV-8	7	20-21.5	26	72	28	44		
BV-8	11	30-35	21					
BV-8	14	40-41.5	23					
BV-8	18	60-61.5	18	66	27	39	98	58
BV-9	2	6-7.5	19	60	20	40		
BV-9	10	35-40	23	65	23	42		
BV-9	13	45-50	21	68	25	43		
BV-10	4	9-10.5	24	75	28	47		
BV-10	8	20-21.5	28					
BV-10	12	35-40	Sample Not Received by the Lab					
BV-10	14	48-49.5	23	78	25	53		
BV-11	4	13-14.5	26	81	23	58		
BV-11	8	32-33.5	24	78	23	55		
BV-11	14	65-66.5	19	69	21	48		
BV-12	4	6-7.5	26	78	23	55		
BV-12	9	39-40.5	24					
BV-13	4	8-9.5	23	80	21	59		
BV-13	8	20-21.5	25	72	23	49		
BV-13	12	30-31.5	24					
BV-13	15	45-46.5	19	75	25	50		
BV-14	2	8-9.5	22	73	21	52		
BV-14	8	37-38.5	22	77	23	54		
BV-14	11	53-54.5	19					
BV-15A	5	8-9.5	28					
BV-15A	7	18-19.5	27	57	23	34	98	50
BV-15A	13	48-49.5	26	70	28	42		
BV-15A	17	78-79.5	20	68	21	47	92	47
BV-16	3	12-13.5	24	73	22	51		
BV-16	5	22-23.5	26					
BV-16	7	32-33.5	26	78	25	53		
BV-16	9	42-43.5	26	72	27	45		
BV-17A	13	48-49.5	22					
BV-17A	15	68-69.5	19					
BV-18	3	12-13.5	23	72	21	51		

Laboratory Soil Test Results
Sandy Creek Energy Station

Boring No.	Sample No.	Depth (feet)	Moisture Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	P200 Content (%)	% Clay
BV-18	10	48-49.5	25	66	26	41		
BV-19	9	25-26.5	23	77	22	55		
BV-19	29	48-49.5	Sample Not Received by the Lab					
BV-20	6	18-19.5	25	67	23	44		
BV-20	8	28-29.5	28					
BV-20	10	38-39.5	29	69	25	44		
BV-20	14	58-59.5	20	66	26	40	99	48
BV-21	3	4-5.5	18	52	17	35		
BV-21	6	10-11.5	25					
BV-21	11	33-34.5	26	77	27	50		
BV-21	13	43-44.5	25					
BV-24	3	6-7.5	23	61	23	38	98	58
BV-24	5	17-18.5	26	68	22	46		
BV-24	7	26-27.5	16	60	24	36		
BV-26	3	5-6.5	24	69	27	42		
BV-26	6	15-16.5	25					
BV-26	9	25-26.5	25	66	25	41		
BV-26	12	35-36.5	19					
BV-31	5	19-20.5	2	66	25	37		
BV-31	7	27-28.5	25	69	24	45		
BV-31	10	50-51.5	18	56	22	34		
BV-34	4	6-7.5	25	72	27	45		
BV-34	9	39-40.5	24					
BV-34	11	59-60.5	21	57	23	34		
BV-35	3	6-7.5	25	67	27	40		
BV-35	6	17-18.5	26					
BV-35	8	27-28.5	25	68	29	39		
BV-35	10	37-38.5	19					
BV-35	11	45-46.5	20	62	28	34		
BV-35		59-60.5					92	42
BV-36	4	6-7.5	22	70	26	44		
BV-36	7	15-16.5	24					
BV-36	12	30-31.5	24	67	24	43		
BV-36	15	45-46.5	22	66	27	39	92	43
BV-36	16	50-51.5	20					

Minimum:			2	52	17	34	92	42
Maximum:			29	81	31	59	99	58
Average:			23	69	25	44	96	49

Created by: LMH Date: 9/11/2018
Last revision by: LMH Date: 9/11/2018
Checked by: DLN Date: 9/24/2018

I:\16215106\[Moisture Content_Atterberg Limits.xlsx]Moisture and Atterberg

Soil Shear Strength Test Results
Sandy Creek Energy Station

							Unconsolidated Undrained Compression		CU Bar *
Boring No.	Depth (ft)		Moisture Content (%)	Dry Density (pcf)	Vane Shear TV (tsf)	Unconfined Compression (ksf)	Confining Pressure (lb/in^2)	Shear Strength (ksf)	Drained Friction Angle (degrees)
BV-1	8	8			2.25				
BV-1	19	19			2.25				
BV-2	8-9	8	11.9	110.1		3.87			
BV-2	18	18			2.5				
BV-2	18-19.8	18	22.8	101.1			14	2.89	
BV-2	18-19.8	18	22.4	103.7			7	3.78	
BV-2	38-38.5	38	15.6	97.6		3.08			
BV-3	8	8			2				
BV-3	8-9	8-9	26.8	99.9			3	4.61	
BV-3	8-9	8-9	23.7	99.8			7	4.05	
BV-3	20-21	20	27.6	96.8		3.29			
BV-3	45-46.1	45	20.8	103.9		4.39			
BV-4	3-5	3	35.4	88.4			7	1.71	
BV-4	3-5	3	28.9	91.2			4	1.26	
BV-6	18-20	18	27.9	97.3			31	3.94	
BV-6	18-20	18	25.2	99.3			21	3.87	
BV-6	18-20	18	44.9	82.9			10	2.57	
BV-6	73-73.5	73	7.1	107.5		0.62			
BV-7	8-9	8	33.6	86		1.73			
BV-7	28-29	28	25.9	98.9			14	3.54	
BV-7	48-49	48	20.1	106.4		3.58			
BV-9	40-41.5	40	23.7	101			56	5.06	
BV-9	40-41.5	40	27.2	92.6			14	4.28	
BV-10	6-7	6	22.5	102.3					
BV-10	11	11			2				
BV-10	15	15			1.5				
BV-10	19	19			2				
BV-11	8-10	8	36.2	90.6	2.25				
BV-11	18-20	18	25.7	99.8			31	3.66	
BV-11	18-20	18	26.3	97.7			21	3.11	
BV-11	18-20	18	27.7	96.9			10	3.37	
BV-11	83	83		137.6		23.93			
BV-12	10-12	10	24.7	101.7			28	5.04	
BV-12	10-12	10	32.9	93.8			14	3.28	
BV-12	10-12	10	25.8	100.1			7	2.38	
BV-12	19-21	19	3.7	119.3		3.29			
BV-13	6-7.5	6	5.7	116.4		7.92			
BV-13	15-16	15	14.5	101.8		2			
BV-13	25-26	25	26.3	98.5			31	3.2	
BV-13	25-26	25	30.5	96.5			11	3.75	
BV-13	40-40.7	40	18.8	96.6		6.36			
BV-14	13-15	13	24.9	100.1		2.54			
BV-14	17	17			1.5				
BV-14	25	25			1.5				
BV-14	23-25	23	28.1	97.2			10	2.16	
BV-14	23-25	23	26.2	100			21	3.23	
BV-14	23-25	23	25.9	99.6			31	3.06	
BV-15A	13-15	13	22.3	104.4		3.25			

Soil Shear Strength Test Results
Sandy Creek Energy Station

							Unconsolidated Undrained Compression		CU Bar *
Boring No.	Depth (ft)		Moisture Content (%)	Dry Density (pcf)	Vane Shear TV (tsf)	Unconfined Compression (ksf)	Confining Pressure (lb/in^2)	Shear Strength (ksf)	Drained Friction Angle (degrees)
BV-15A	33-34.7	33	43.5	75.9			56	0.33	
BV-15A	33-34.7	33	24.2	103.3			24	6.73	
BV-15A	33-34.7	33	25.4	99.9			14	5.01	
BV-15A	43-44.6	43	23.4	101.4		3.52			
BV-15A	58-58.6	58	48.1	73.6		0.14			
BV-16	11	11			2.5				
BV-16	20	20			2				
BV-16	28	28			2				
BV-16	18-20	18	20.7	103.5			28	4.07	
BV-16	18-20	18	25.8	99.1			14	2.82	
BV-16	18-20	18	25.6	100.1			7	2	
BV-17	13-15	13	25.6	100.6			28	3.97	
BV-17	13-15	13	25.2	98			7	2.32	
BV-17	23-25	23	22.3	102.6		3.84			
BV-17	43-44.8	43	24.7	100.9		5.48			
BV-17A	6-8	6	23.5	101.6					
BV-18	8				2.5				
BV-18	18	18			2.5				
BV-18	18-20	18	25.5	99.8			28	3.88	
BV-18	18-20	18	24	101.8			14	3.54	
BV-18	18-20	18	27.6	96.6			7	2.1	
BV-19	10-12	10	24.2	100.9			14	3.05	
BV-19	10-12	10	23.9	99.6			4	2.47	
BV-19	19-21	19	22.3	103.8		2.92			
BV-19	20	20			2.25				
BV-19	24	24			2.25				
BV-19	26	26			2.125				
BV-20	13-15	13	29.1	91.9			28	2.97	
BV-20	13-15	13	26.4	97.7			7	2.84	
BV-20	43-35	43	25.8	96.4					
BV-20	68-68.8	68	20.6	105.2		7.43			
BV-20	78-78.5	78	31.8	96.2		0.97			
BV-21	18-19.8	18	23.4	105.6			28	7.33	
BV-21	18-19.8	18	23.8	105.5			14	7.62	
BV-21	18-19.8	18	24	99.3			7	1.95	
BV-22	6	6			2.25				
BV-24	16	16			1.25				
BV-34	14-16	14	24.4	99.2		3.37			
BV-34	49-49.9	49	23.3	104.9		3.48			
BV-35	9	9			2				
BV-27, 28, 32, & 33			18.1	104.0					20.6
BV-36	25-26.2	25	23.4	108.2			35	4.82	
BV-36	25-26.2	25	16.4	116.4			17	5.13	
BV-36	40-41.4	40	25.7	102.0			42	5.41	
BV-36	40-41.4	40	24	101.9			28	3.81	
BV-37 & 39			18.8	104.4					23.1
BV-103			17.7	103.0					24.6
BV-104			17.4	102.0					16.0

Soil Shear Strength Test Results
Sandy Creek Energy Station

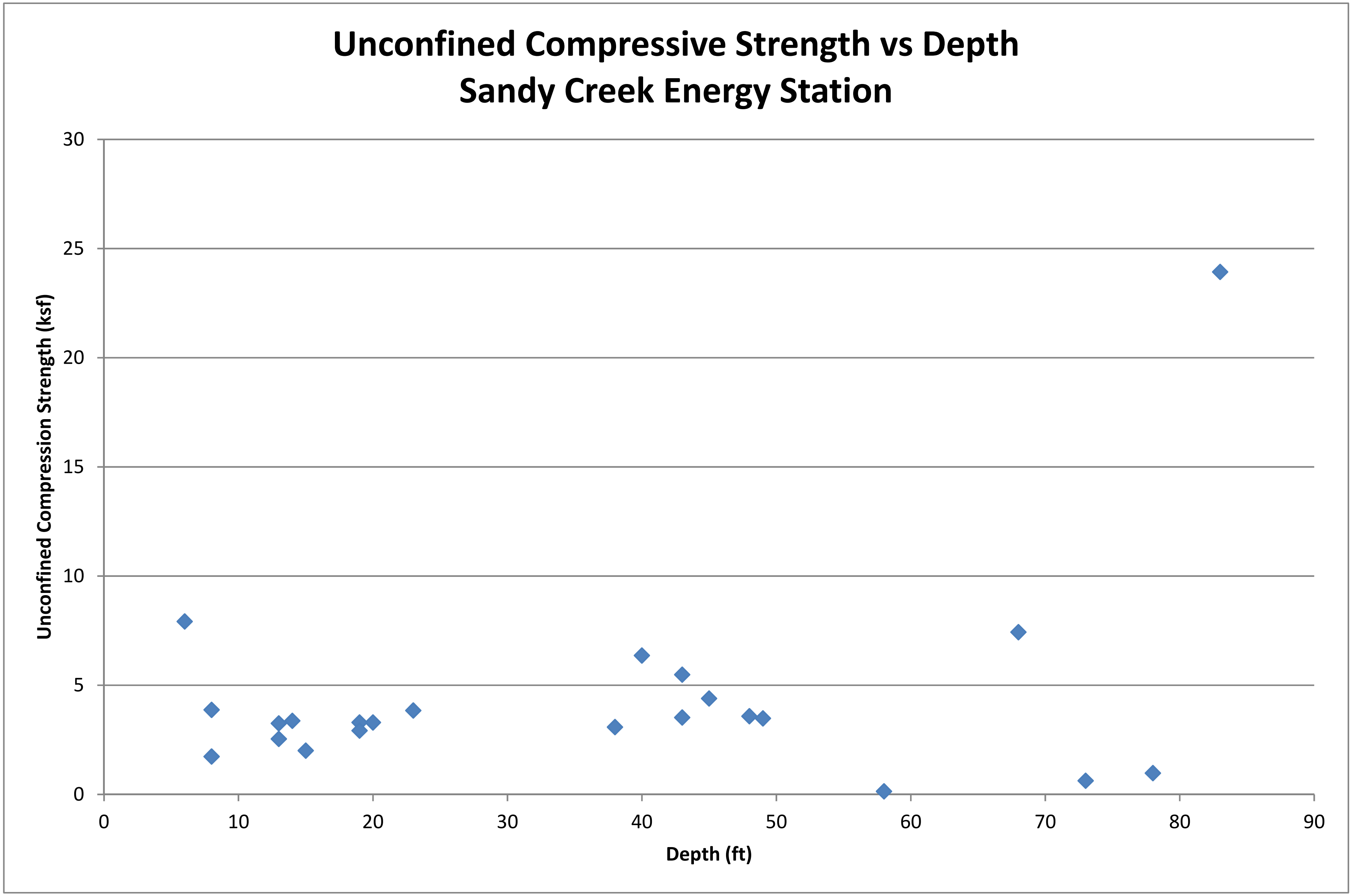
							Unconsolidated Undrained Compression		CU Bar *
Boring No.	Depth (ft)		Moisture Content (%)	Dry Density (pcf)	Vane Shear TV (tsf)	Unconfined Compression (ksf)	Confining Pressure (lb/in^2)	Shear Strength (ksf)	Drained Friction Angle (degrees)
BV-105			17.7	103.0					30.8
BV-108	38-38.8	38	19.3	108.2			28	9.15	
TP-3			17.2	102.2					20.5

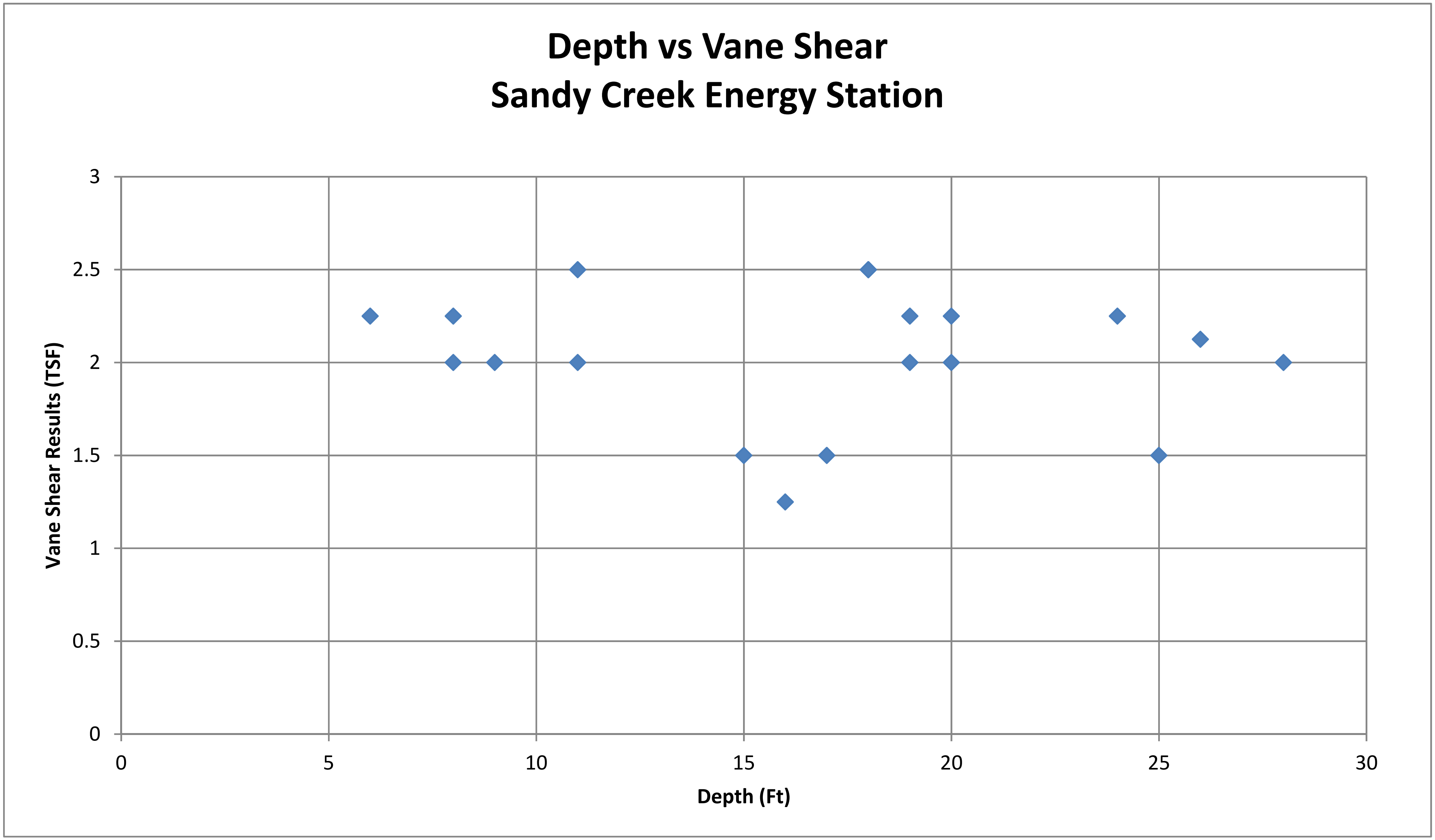
Minimum:	3.7	73.6	1.3	0.14		0.33	16.0
Maximum:	48.1	137.6	2.5	23.93		9.15	30.8
Average:	24.3	100.4	2.1	4.39		3.72	22.6

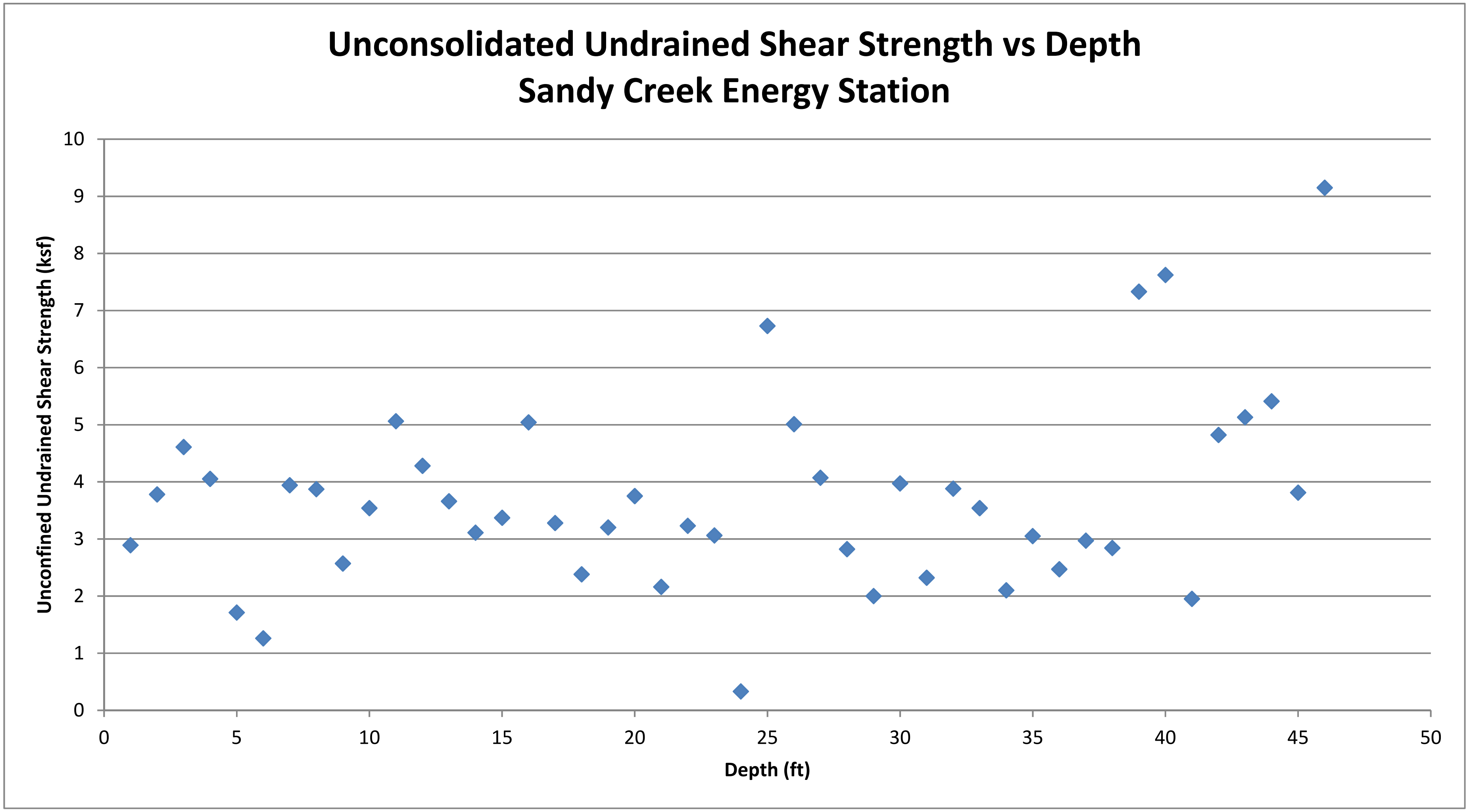
Note: * CU Bar tests were performed on remolded samples.

Created by: KRG Date: 9/12/2018
Last revision by: KRG Date: 9/24/2018
Checked by: DLN Date: 9/24/2018

I:\16215106\[Geotechnical Lab Results.xlsx]Sheet1


Unconfined Compressive Strength vs Depth
Sandy Creek Energy Station
Unconfined Compression Strength (ksf)
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
Depth (ft)


Depth vs Vane Shear
Sandy Creek Energy Station
Vane Shear Results (TSF)
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
Depth (Ft)

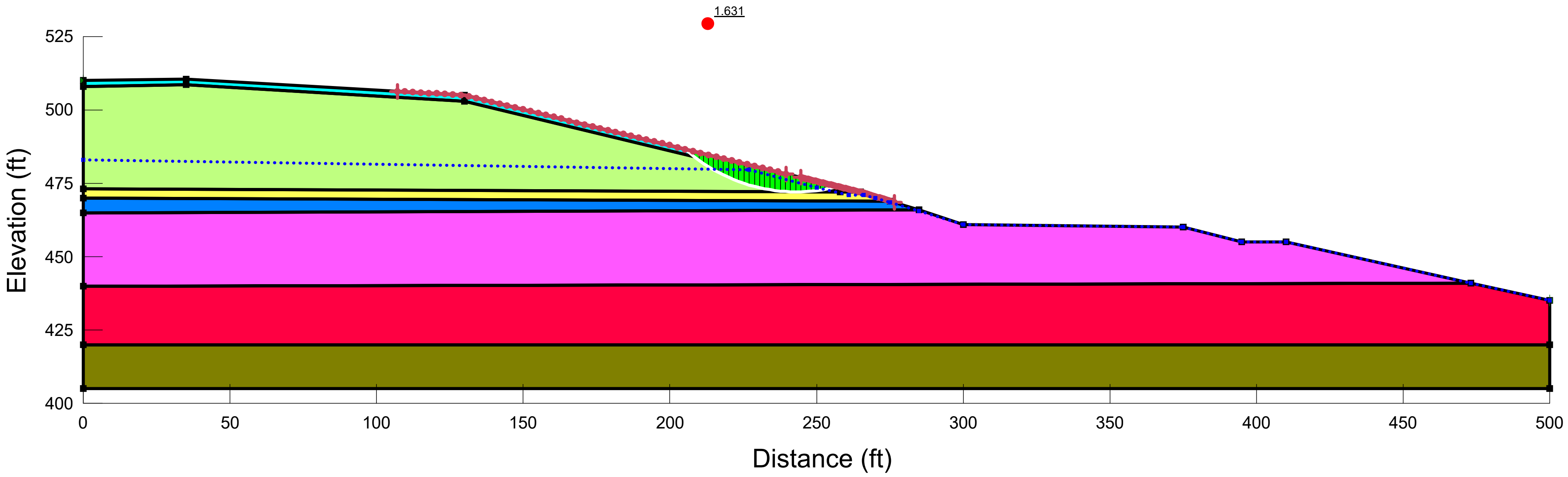


Unconsolidated Undrained Shear Strength vs Depth
Sandy Creek Energy Station

F of S: 1.631

Slope 1 - Stage 1_Check_clay_2000.gsz

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line	Include Ru in PWP
🟩	Byproduct	Mohr-Coulomb	103	0	27	1	No
🟫	ClayShale	Mohr-Coulomb	130	7,000	0	1	No
🟨	Compacted Clay Layer	Mohr-Coulomb	120	2,000	0	1	No
🟦	Drainage / Protective Layer	Mohr-Coulomb	120	0	32	1	No
🟦	Yellow Brown Clay (A)	Mohr-Coulomb	125	2,000	0	1	No
🟪	Yellow Brown Clay (B)	Mohr-Coulomb	125	2,000	0	1	No
🟥	Yellow Brown Clay (C)	Mohr-Coulomb	125	2,000	0	1	No



2_Sandy Creek Stage 1 - SCS Version (Drained strength)

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gearing, Phillip
Revision Number: 93
Date: 9/25/2018
Time: 11:13:17 AM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Stage 1_Check_clay_2000.gsz
Directory: I:\16215106\Calculations\Stability\
Last Solved Date: 9/25/2018
Last Solved Time: 11:13:42 AM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2_Sandy Creek Stage 1 - SCS Version (Drained strength)

Description: Sandy Creek Energy Station Stage 1
Kind: SLOPE/W
Method: Spencer
Settings
  PWP Conditions Source: Piezometric Line with Ru
  Apply Phreatic Correction: No
Slip Surface
  Direction of movement: Left to Right
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Drainage / Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure

Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

ClayShale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (107, 506.33158) ft

Left-Zone Right Coordinate: (239.5, 478.23333) ft
Left-Zone Increment: 50
Right Projection: Range
Right-Zone Left Coordinate: (244.54545, 477) ft
Right-Zone Right Coordinate: (276.5, 468.55) ft
Right-Zone Increment: 50
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 510) ft
Right Coordinate: (500, 435) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	483
Coordinate 2	227	479.5
Coordinate 3	250	473.5
Coordinate 4	261	471
Coordinate 5	266	471
Coordinate 6	270	470
Coordinate 7	275	468.5
Coordinate 8	285	465.5
Coordinate 9	300	461
Coordinate 10	375	460
Coordinate 11	395	455
Coordinate 12	410	455
Coordinate 13	473	441
Coordinate 14	500	435

Points

	X (ft)	Y (ft)
Point 1	0	405
Point 2	500	405

Point 3	500	420
Point 4	0	420
Point 5	0	440
Point 6	500	435
Point 7	410	455
Point 8	395	455
Point 9	375	460
Point 10	300	461
Point 11	285	466
Point 12	0	465
Point 13	473	441
Point 14	0	470
Point 15	275	469
Point 16	265	472
Point 17	0	473
Point 18	130	505
Point 19	35	510.5
Point 20	0	510
Point 21	0	508
Point 22	35	508.5
Point 23	130	503
Point 24	258	472

Regions

	Material	Points	Area (ft²)
Region 1	ClayShale	4,1,2,3	7,500
Region 2	Yellow Brown Clay (C)	5,13,6,3,4	10,183
Region 3	Yellow Brown Clay (B)	5,12,11,10,9,8,7,13	10,000
Region 4	Yellow Brown Clay (A)	12,14,15,11	1,120
Region 5	Compacted Clay Layer	14,17,24,16,15	801.5
Region 6	Byproduct	23,24,17,21,22	6,330
Region 7	Drainage / Protective Layer	21,20,19,18,16,24,23,22	503.5

Current Slip Surface

Slip Surface: 20,981

F of S: 1.631
Volume: 244.36361 ft³
Weight: 26,641.502 lbs
Resisting Moment: 544,211.46 lbs-ft
Activating Moment: 333,589.07 lbs-ft
Resisting Force: 9,050.3296 lbs
Activating Force: 5,548.3571 lbs
F of S Rank (Analysis): 1 of 28,611 slip surfaces
F of S Rank (Query): 1 of 28,611 slip surfaces
Exit: (257.39245, 473.85962) ft
Entry: (205.21131, 486.61501) ft
Radius: 56.834455 ft
Center: (243.19532, 528.89231) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	205.98115	485.94789	-382.12591	40.234034	25.141015	0
Slice 2	207.52084	484.65987	-303.23482	119.74642	74.82587	0
Slice 3	209.09801	483.43343	-228.22206	197.31491	100.53697	0
Slice 4	210.71265	482.26546	-156.89429	262.95991	133.98477	0
Slice 5	212.3273	481.18072	-90.760275	324.18542	165.18072	0
Slice 6	213.94194	480.17365	-29.472317	380.99018	194.12419	0
Slice 7	215.62431	479.20335	29.455934	438.00674	208.16704	0
Slice 8	217.37442	478.27145	85.922251	493.84288	207.84594	0
Slice 9	219.12452	477.41592	137.6237	543.03541	206.56758	0
Slice 10	220.87463	476.63299	184.7947	585.73558	204.28958	0
Slice 11	222.62474	475.91944	227.63646	622.06371	200.97072	0

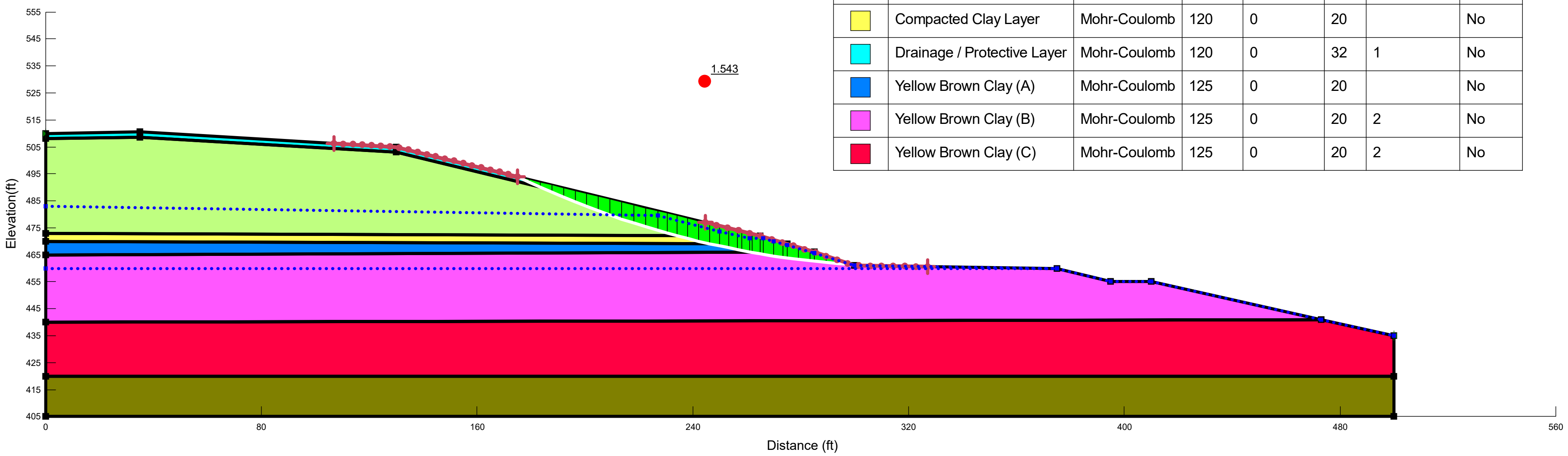
Slice 12	224.37484	475.27249	266.32206	652.11186	196.56972	0
Slice 13	226.12495	474.68977	301.00053	675.94592	191.04422	0
Slice 14	227.88462	474.16669	318.39864	693.36172	191.05323	0
Slice 15	229.65385	473.70215	318.58596	704.70333	196.73662	0
Slice 16	231.42308	473.29778	315.01855	710.28103	201.39629	0
Slice 17	233.19231	472.95228	307.77794	710.07464	204.9804	0
Slice 18	234.96154	472.66455	296.93191	704.04285	207.43338	0
Slice 19	236.73077	472.43372	282.53564	692.12258	208.69497	0
Slice 20	238.5	472.25909	264.63258	674.22791	208.69924	0
Slice 21	240.26923	472.14014	243.25514	650.24852	207.37348	0
Slice 22	242.03846	472.07652	218.42517	620.04772	204.63691	0
Slice 23	243.80769	472.06804	190.15426	583.4598	200.39918	0
Slice 24	245.57692	472.11468	158.44397	540.28681	194.55864	0
Slice 25	247.34615	472.21657	123.2858	490.29436	187.0002	0
Slice 26	249.11538	472.37402	84.661072	433.20653	177.59278	0
Slice 27	250.69268	472.55887	48.903053	376.19541	166.76379	0
Slice 28	252.07805	472.76067	16.663505	320.54558	154.83566	0
Slice 29	253.24039	472.95463	-11.923558	268.58118	136.84895	0
Slice 30	254.63066	473.22809	-48.704125	195.1389	121.93632	0

Slice 31	256.47185	473.63842	-100.42	68.361094	42.716752	0

F of S: 1.543

Slope 1 - Stage 1_Check-20_deg-2 water surfaces_El_460.gsz

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line	Include Ru in PWP
🟩	Byproduct	Mohr-Coulomb	103	0	27	1	No
🟫	ClayShale	Mohr-Coulomb	130	7,000	0	2	No
🟨	Compacted Clay Layer	Mohr-Coulomb	120	0	20		No
🟦	Drainage / Protective Layer	Mohr-Coulomb	120	0	32	1	No
🟦	Yellow Brown Clay (A)	Mohr-Coulomb	125	0	20		No
🟪	Yellow Brown Clay (B)	Mohr-Coulomb	125	0	20	2	No
🟥	Yellow Brown Clay (C)	Mohr-Coulomb	125	0	20	2	No



2_Sandy Creek Stage 1 - SCS Version (Drained strength)

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 91
Date: 9/13/2018
Time: 11:59:17 AM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Stage 1_Check-20_deg-2 water surfaces_El_460.gsz
Directory: I:\16215106\Calculations\Stability\
Last Solved Date: 9/13/2018
Last Solved Time: 11:59:32 AM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2_Sandy Creek Stage 1 - SCS Version (Drained strength)

Description: Sandy Creek Energy Station Stage 1
Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions Source: Piezometric Line with Ru
- Apply Phreatic Correction: No

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit

        - Critical slip surfaces saved: 1
        - Resisting Side Maximum Convex Angle: 1 °
        - Driving Side Maximum Convex Angle: 5 °
        - Optimize Critical Slip Surface Location: No
        - Tension Crack
            - Tension Crack Option: (none)
    - F of S Distribution
        - F of S Calculation Option: Constant
    - Advanced
        - Number of Slices: 30
        - F of S Tolerance: 0.001
        - Minimum Slip Surface Depth: 0.1 ft
        - Search Method: Root Finder
        - Tolerable difference between starting and converged F of S: 3
        - Maximum iterations to calculate converged lambda: 20
        - Max Absolute Lambda: 2

Materials

Drainage / Protective Layer

- Model: Mohr-Coulomb
- Unit Weight: 120 pcf
- Cohesion': 0 psf
- Phi': 32 °
- Phi-B: 0 °
- Pore Water Pressure
    - Piezometric Line: 1
    - Include Ru in PWP: No

Byproduct

- Model: Mohr-Coulomb
- Unit Weight: 103 pcf
- Cohesion': 0 psf
- Phi': 27 °
- Phi-B: 0 °
- Pore Water Pressure
    - Piezometric Line: 1
    - Include Ru in PWP: No

Compacted Clay Layer

- Model: Mohr-Coulomb
- Unit Weight: 120 pcf
- Cohesion': 0 psf
- Phi': 20 °
- Phi-B: 0 °
- Pore Water Pressure

Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

ClayShale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (107, 506.33158) ft
Left-Zone Right Coordinate: (175, 494) ft
Left-Zone Increment: 20

Right Projection: Range
Right-Zone Left Coordinate: (244.54545, 477) ft
Right-Zone Right Coordinate: (327, 460.64) ft
Right-Zone Increment: 20
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 510) ft
Right Coordinate: (500, 435) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	483
Coordinate 2	227	479.5
Coordinate 3	250	473.5
Coordinate 4	261	471
Coordinate 5	266	471
Coordinate 6	270	470
Coordinate 7	275	468.5
Coordinate 8	285	465.5
Coordinate 9	300	461
Coordinate 10	375	460
Coordinate 11	395	455
Coordinate 12	410	455
Coordinate 13	473	441
Coordinate 14	500	435

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	460
Coordinate 2	375	460

Points

	X (ft)	Y (ft)
Point 1	0	405
Point 2	500	405
Point 3	500	420
Point 4	0	420
Point 5	0	440
Point 6	500	435
Point 7	410	455
Point 8	395	455
Point 9	375	460
Point 10	300	461
Point 11	285	466
Point 12	0	465
Point 13	473	441
Point 14	0	470
Point 15	275	469
Point 16	265	472
Point 17	0	473
Point 18	130	505
Point 19	35	510.5
Point 20	0	510
Point 21	0	508
Point 22	35	508.5
Point 23	130	503
Point 24	258	472

Regions

	Material	Points	Area (ft²)
Region 1	ClayShale	4,1,2,3	7,500
Region 2	Yellow Brown Clay (C)	5,13,6,3,4	10,183
Region 3	Yellow Brown Clay (B)	5,12,11,10,9,8,7,13	10,000
Region 4	Yellow Brown Clay (A)	12,14,15,11	1,120
Region 5	Compacted Clay Layer	14,17,24,16,15	801.5
Region 6	Byproduct	23,24,17,21,22	6,330

Region 7	Drainage / Protective Layer	21,20,19,18,16,24,23,22	503.5

Current Slip Surface

Slip Surface: 4,820
F of S: 1.543
Volume: 633.44821 ft³
Weight: 72,487.878 lbs
Resisting Moment: 9,069,422.2 lbs-ft
Activating Moment: 5,878,938.1 lbs-ft
Resisting Force: 26,093.759 lbs
Activating Force: 16,913.961 lbs
F of S Rank (Analysis): 1 of 4,851 slip surfaces
F of S Rank (Query): 1 of 4,851 slip surfaces
Exit: (298.60431, 461.46523) ft
Entry: (175, 494) ft
Radius: 335.08867 ft
Center: (320.53232, 795.83566) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	177.13017	492.99133	-793.87826	48.466849	30.285449	0
Slice 2	181.39051	491.01031	-674.36151	143.09609	89.41636	0
Slice 3	185.66265	489.09616	-559.02941	229.19781	116.78212	0
Slice 4	189.94657	487.24795	-447.82262	301.91657	153.83417	0
Slice 5	194.23048	485.46988	-340.99218	369.5047	188.27205	0
Slice 6	198.5144	483.76073	-238.46327	431.92014	220.07431	0
Slice 7	202.79832	482.1194	-140.16559	489.11916	249.21866	0
Slice 8	207.08224	480.54481	-46.033013	541.05613	275.68187	0
Slice 9	211.44618	479.00903	45.601017	589.83979	277.3035	0

Slice 10	215.89013	477.51356	134.64313	634.56951	254.72521	0
Slice 11	220.33408	476.08683	219.39494	672.59414	230.91653	0
Slice 12	224.77803	474.72795	299.91364	703.90672	205.84476	0
Slice 13	228.76865	473.56176	341.75585	726.22555	195.8971	0
Slice 14	232.30594	472.57545	345.72075	741.09088	201.45114	0
Slice 15	236.08863	471.56825	0	759.96367	276.60415	0
Slice 16	240.1167	470.54587	0	784.11844	285.39577	0
Slice 17	244.14478	469.57643	0	802.49511	292.08433	0
Slice 18	248.07941	468.67954	0	816.88176	297.32065	0
Slice 19	251.64393	467.90886	0	827.02866	301.01381	0
Slice 20	254.93178	467.23532	0	831.96062	302.8089	0
Slice 21	257.28785	466.77027	0	833.38462	303.3272	0
Slice 22	259.5	466.35554	0	826.1704	300.70144	0
Slice 23	261.44316	465.99829	0	816.46728	297.16979	0
Slice 24	263.44316	465.64972	-352.54266	804.08251	292.6621	0
Slice 25	265.5	465.2973	-330.55142	787.2649	286.54099	0
Slice 26	268	464.89658	-305.54644	750.90436	273.30684	0
Slice 27	271.65644	464.33488	-270.49655	694.22402	252.67688	0
Slice 28	274.15644	463.97278	-247.90119	652.39661	237.45295	0

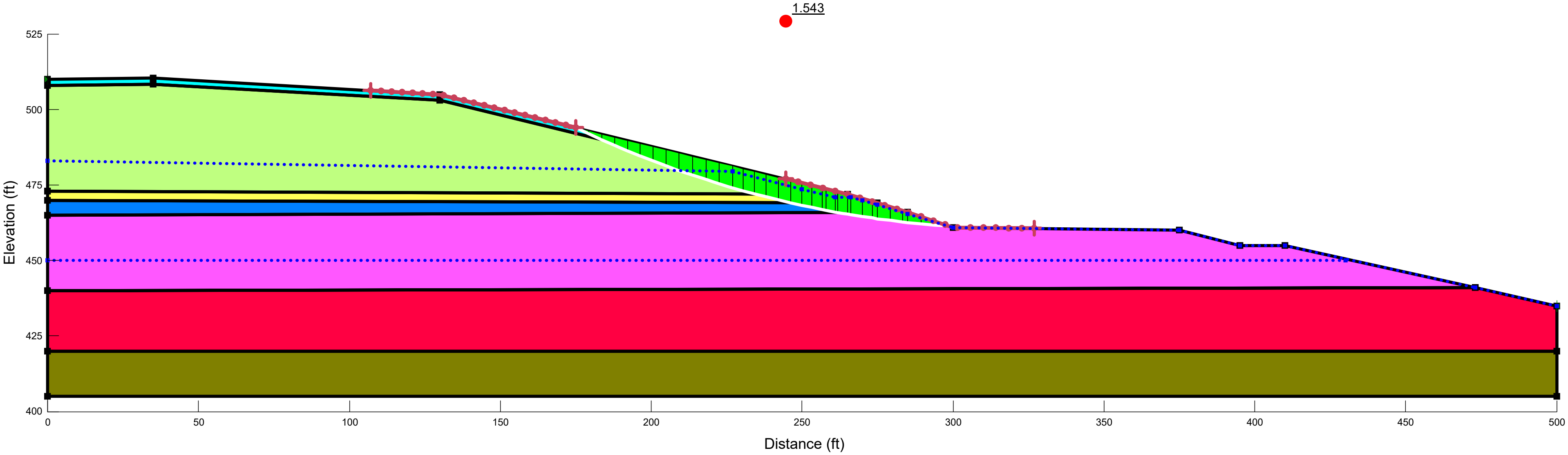
Slice 29	277.08815	463.58186	-223.50776	595.6793	216.80953	0
Slice 30	281.26445	463.06241	-191.09447	507.56869	184.7399	0
Slice 31	284.1763	462.72611	-170.10902	442.2426	160.96314	0
Slice 32	287.23427	462.41308	-150.57595	358.57205	130.50955	0
Slice 33	291.7028	461.997	-124.61279	224.60517	81.749598	0
Slice 34	296.17133	461.64119	-102.41013	81.169804	29.543393	0
Slice 35	298.50495	461.47178	-91.838849	3.4082442	1.2404994	0

F of S: 1.543

Slope 1 - Stage 1_Check-20_deg-2 water surfaces_El_450.gsz

File Version: 8.16

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Piezometric Line	Include Ru in PWP
🟩	Byproduct	Mohr-Coulomb	103	0	27	1	No
🟫	ClayShale	Mohr-Coulomb	130	7,000	0	2	No
🟨	Compacted Clay Layer	Mohr-Coulomb	120	0	20		No
🟦	Drainage / Protective Layer	Mohr-Coulomb	120	0	32	1	No
🟦	Yellow Brown Clay (A)	Mohr-Coulomb	125	0	20		No
🟪	Yellow Brown Clay (B)	Mohr-Coulomb	125	0	20	2	No
🟥	Yellow Brown Clay (C)	Mohr-Coulomb	125	0	20	2	No



2_Sandy Creek Stage 1 - SCS Version (Drained strength)

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gilkey, Keith
Revision Number: 89
Date: 9/13/2018
Time: 9:49:15 AM
Tool Version: 8.16.5.15361
File Name: Slope 1 - Stage 1_Check-20_deg-2 water surfaces_El_450.gsz
Directory: I:\16215106\Calculations\Stability\
Last Solved Date: 9/13/2018
Last Solved Time: 9:50:30 AM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

2_Sandy Creek Stage 1 - SCS Version (Drained strength)

Description: Sandy Creek Energy Station Stage 1
Kind: SLOPE/W
Method: Spencer
Settings
- PWP Conditions Source: Piezometric Line with Ru
- Apply Phreatic Correction: No

Slip Surface
- Direction of movement: Left to Right
- Use Passive Mode: No
- Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1
Resisting Side Maximum Convex Angle: 1 °
Driving Side Maximum Convex Angle: 5 °
Optimize Critical Slip Surface Location: No
Tension Crack
    Tension Crack Option: (none)

F of S Distribution
    F of S Calculation Option: Constant

Advanced
    Number of Slices: 30
    F of S Tolerance: 0.001
    Minimum Slip Surface Depth: 0.1 ft
    Search Method: Root Finder
    Tolerable difference between starting and converged F of S: 3
    Maximum iterations to calculate converged lambda: 20
    Max Absolute Lambda: 2

Materials

Drainage / Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Byproduct

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Compacted Clay Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure

Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

ClayShale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (107, 506.33158) ft
Left-Zone Right Coordinate: (175, 494) ft
Left-Zone Increment: 20

Right Projection: Range
Right-Zone Left Coordinate: (244.54545, 477) ft
Right-Zone Right Coordinate: (327, 460.64) ft
Right-Zone Increment: 20
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 510) ft
Right Coordinate: (500, 435) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	483
Coordinate 2	227	479.5
Coordinate 3	250	473.5
Coordinate 4	261	471
Coordinate 5	266	471
Coordinate 6	270	470
Coordinate 7	275	468.5
Coordinate 8	285	465.5
Coordinate 9	300	461
Coordinate 10	375	460
Coordinate 11	395	455
Coordinate 12	410	455
Coordinate 13	473	441
Coordinate 14	500	435

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	450
Coordinate 2	430	450

Points

	X (ft)	Y (ft)
Point 1	0	405
Point 2	500	405
Point 3	500	420
Point 4	0	420
Point 5	0	440
Point 6	500	435
Point 7	410	455
Point 8	395	455
Point 9	375	460
Point 10	300	461
Point 11	285	466
Point 12	0	465
Point 13	473	441
Point 14	0	470
Point 15	275	469
Point 16	265	472
Point 17	0	473
Point 18	130	505
Point 19	35	510.5
Point 20	0	510
Point 21	0	508
Point 22	35	508.5
Point 23	130	503
Point 24	258	472

Regions

	Material	Points	Area (ft²)
Region 1	ClayShale	4,1,2,3	7,500
Region 2	Yellow Brown Clay (C)	5,13,6,3,4	10,183
Region 3	Yellow Brown Clay (B)	5,12,11,10,9,8,7,13	10,000
Region 4	Yellow Brown Clay (A)	12,14,15,11	1,120
Region 5	Compacted Clay Layer	14,17,24,16,15	801.5
Region 6	Byproduct	23,24,17,21,22	6,330

Region 7	Drainage / Protective Layer	21,20,19,18,16,24,23,22	503.5

Current Slip Surface

Slip Surface: 4,820
F of S: 1.543
Volume: 633.44821 ft³
Weight: 72,487.878 lbs
Resisting Moment: 9,069,422.2 lbs-ft
Activating Moment: 5,878,938.1 lbs-ft
Resisting Force: 26,093.759 lbs
Activating Force: 16,913.961 lbs
F of S Rank (Analysis): 1 of 4,851 slip surfaces
F of S Rank (Query): 1 of 4,851 slip surfaces
Exit: (298.60431, 461.46523) ft
Entry: (175, 494) ft
Radius: 335.08867 ft
Center: (320.53232, 795.83566) ft

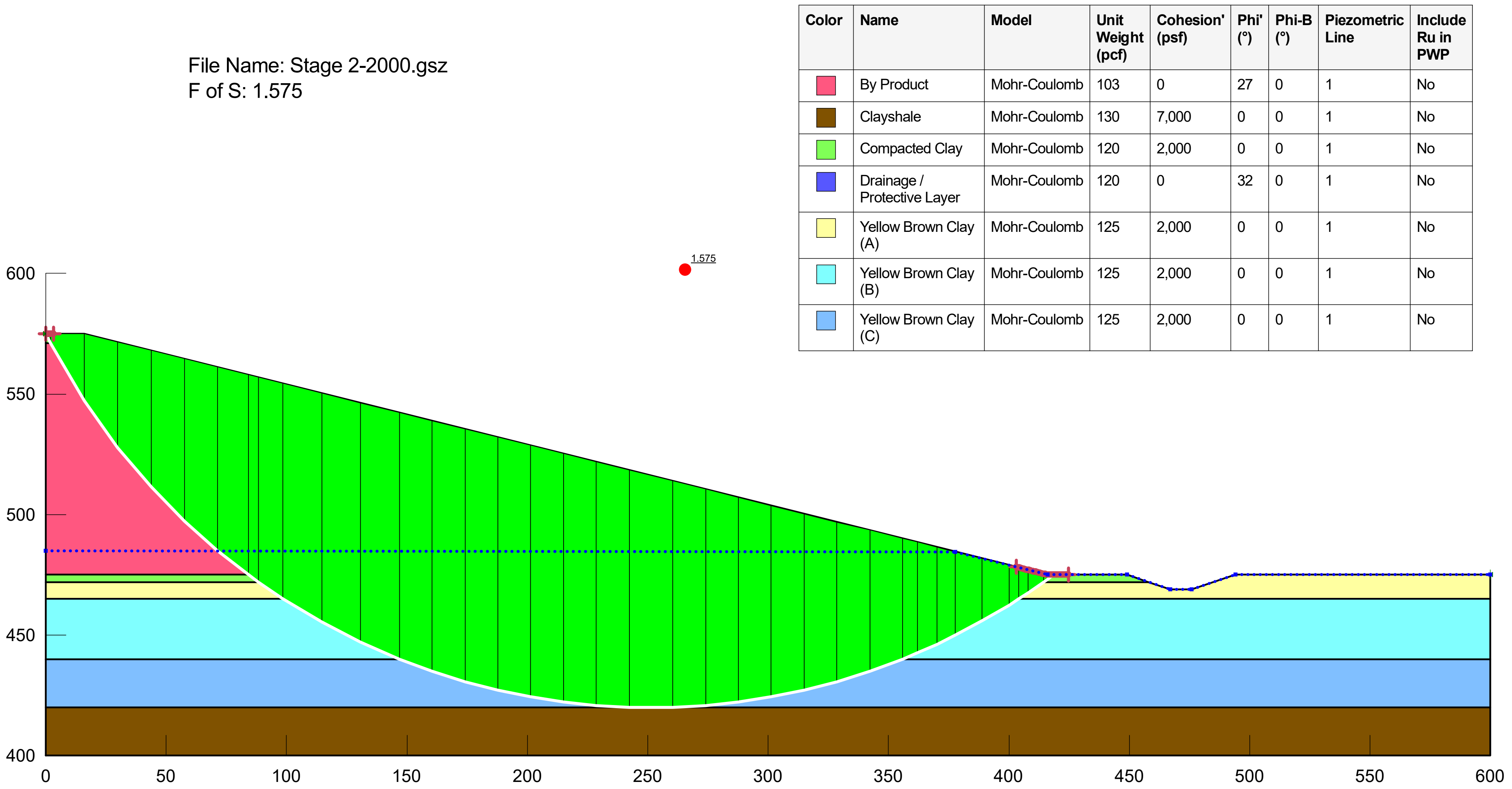
Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	177.13017	492.99133	-793.87826	48.466849	30.285449	0
Slice 2	181.39051	491.01031	-674.36151	143.09609	89.41636	0
Slice 3	185.66265	489.09616	-559.02941	229.19781	116.78212	0
Slice 4	189.94657	487.24795	-447.82262	301.91657	153.83417	0
Slice 5	194.23048	485.46988	-340.99218	369.5047	188.27205	0
Slice 6	198.5144	483.76073	-238.46327	431.92014	220.07431	0
Slice 7	202.79832	482.1194	-140.16559	489.11916	249.21866	0
Slice 8	207.08224	480.54481	-46.033013	541.05613	275.68187	0
Slice 9	211.44618	479.00903	45.601017	589.83979	277.3035	0

Slice 10	215.89013	477.51356	134.64313	634.56951	254.72521	0
Slice 11	220.33408	476.08683	219.39494	672.59414	230.91653	0
Slice 12	224.77803	474.72795	299.91364	703.90672	205.84476	0
Slice 13	228.76865	473.56176	341.75585	726.22555	195.8971	0
Slice 14	232.30594	472.57545	345.72075	741.09088	201.45114	0
Slice 15	236.08863	471.56825	0	759.96367	276.60415	0
Slice 16	240.1167	470.54587	0	784.11844	285.39577	0
Slice 17	244.14478	469.57643	0	802.49511	292.08433	0
Slice 18	248.07941	468.67954	0	816.88176	297.32065	0
Slice 19	251.64393	467.90886	0	827.02866	301.01381	0
Slice 20	254.93178	467.23532	0	831.96062	302.8089	0
Slice 21	257.28785	466.77027	0	833.38462	303.3272	0
Slice 22	259.5	466.35554	0	826.1704	300.70144	0
Slice 23	261.44316	465.99829	0	816.46728	297.16979	0
Slice 24	263.44316	465.64972	-976.54266	804.08251	292.6621	0
Slice 25	265.5	465.2973	-954.55142	787.2649	286.54099	0
Slice 26	268	464.89658	-929.54644	750.90436	273.30684	0
Slice 27	271.65644	464.33488	-894.49655	694.22402	252.67688	0
Slice 28	274.15644	463.97278	-871.90119	652.39661	237.45295	0

Slice 29	277.08815	463.58186	-847.50776	595.6793	216.80953	0
Slice 30	281.26445	463.06241	-815.09447	507.56869	184.7399	0
Slice 31	284.1763	462.72611	-794.10902	442.2426	160.96314	0
Slice 32	287.23427	462.41308	-774.57595	358.57205	130.50955	0
Slice 33	291.7028	461.997	-748.61279	224.60517	81.749598	0
Slice 34	296.17133	461.64119	-726.41013	81.169804	29.543393	0
Slice 35	298.50495	461.47178	-715.83885	3.4082442	1.2404994	0

File Name: Stage 2-2000.gsz
F of S: 1.575



Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Phi-B (°)	Piezometric Line	Include Ru in PWP
🟥	By Product	Mohr-Coulomb	103	0	27	0	1	No
🟫	Clayshale	Mohr-Coulomb	130	7,000	0	0	1	No
🟩	Compacted Clay	Mohr-Coulomb	120	2,000	0	0	1	No
🟦	Drainage / Protective Layer	Mohr-Coulomb	120	0	32	0	1	No
🟨	Yellow Brown Clay (A)	Mohr-Coulomb	125	2,000	0	0	1	No
🟦	Yellow Brown Clay (B)	Mohr-Coulomb	125	2,000	0	0	1	No
🟦	Yellow Brown Clay (C)	Mohr-Coulomb	125	2,000	0	0	1	No

Stage 2

File Information

File Version: 8.16
Created By: Gilkey, Keith
Last Edited By: Gearing, Phillip
Revision Number: 26
Date: 9/25/2018
Time: 11:53:44 AM
Tool Version: 8.16.5.15361
File Name: Stage 2-2000.gsz
Directory: I:\16215106\Calculations\Stability\
Last Solved Date: 9/25/2018
Last Solved Time: 11:54:06 AM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Stage 2

- Kind: SLOPE/W
- Method: Spencer
- Settings
  - PWP Conditions Source: Piezometric Line with Ru
  - Apply Phreatic Correction: No
- Slip Surface
  - Direction of movement: Left to Right
  - Use Passive Mode: No
  - Slip Surface Option: Entry and Exit
  - Critical slip surfaces saved: 1
  - Resisting Side Maximum Convex Angle: 1 °
  - Driving Side Maximum Convex Angle: 5 °
  - Optimize Critical Slip Surface Location: No

Tension Crack
Tension Crack Option: (none)
F of S Distribution
F of S Calculation Option: Constant
Advanced
Number of Slices: 30
F of S Tolerance: 0.001
Minimum Slip Surface Depth: 0.1 ft
Search Method: Root Finder
Tolerable difference between starting and converged F of S: 3
Maximum iterations to calculate converged lambda: 20
Max Absolute Lambda: 2

Materials

Compacted Clay

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Drainage / Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

By Product

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 1
Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 2,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Clayshale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
  Piezometric Line: 1
  Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0, 575) ft
Left-Zone Right Coordinate: (3.11517, 575) ft
Left-Zone Increment: 50
Right Projection: Range

Right-Zone Left Coordinate: (402.96485, 478.25879) ft
Right-Zone Right Coordinate: (424.77607, 475) ft
Right-Zone Increment: 50
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 575) ft
Right Coordinate: (600, 475) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	485
Coordinate 2	377.8	484.5
Coordinate 3	416	475
Coordinate 4	449	475
Coordinate 5	467	469
Coordinate 6	476	469
Coordinate 7	494	475
Coordinate 8	600	475

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	600	400
Point 3	0	420
Point 4	600	420
Point 5	0	440
Point 6	600	440
Point 7	0	465
Point 8	600	465
Point 9	0	472
Point 10	467	469

Point 11	476	469
Point 12	449	475
Point 13	600	475
Point 14	0	475
Point 15	416	475
Point 16	0	571
Point 17	16	571
Point 18	400	475
Point 19	0	573
Point 20	16	573
Point 21	408	475
Point 22	0	575
Point 23	16	575
Point 24	494	475
Point 25	458	472

Regions

	Material	Points	Area (ft²)
Region 1	Clayshale	1,3,4,2	12,000
Region 2	Yellow Brown Clay (C)	5,6,4,3	12,000
Region 3	Yellow Brown Clay (B)	7,8,6,5	15,000
Region 4	Yellow Brown Clay (A)	7,9,25,10,11,24,13,8	4,477.5
Region 5	Compacted Clay	9,14,18,21,15,12,25	1,360.5
Region 6	By Product	14,16,17,18	19,968
Region 7	Compacted Clay	16,19,20,21,18,17	808
Region 8	Drainage / Protective Layer	19,22,23,15,21,20	824

Current Slip Surface

Slip Surface: 403
F of S: 1.575
Volume: 30,587.114 ft³
Weight: 3,449,035.3 lbs
Resisting Moment: 2.6630332e+008 lbs-ft
Activating Moment: 1.6901128e+008 lbs-ft
Resisting Force: 828,248.56 lbs
Activating Force: 525,888.74 lbs
F of S Rank (Analysis): 1 of 28,611 slip surfaces

F of S Rank (Query): 1 of 5 slip surfaces
Exit: (418.5566, 475) ft
Entry: (0, 575) ft
Radius: 281.13949 ft
Center: (251.3262, 700.99426) ft

Slip Slices

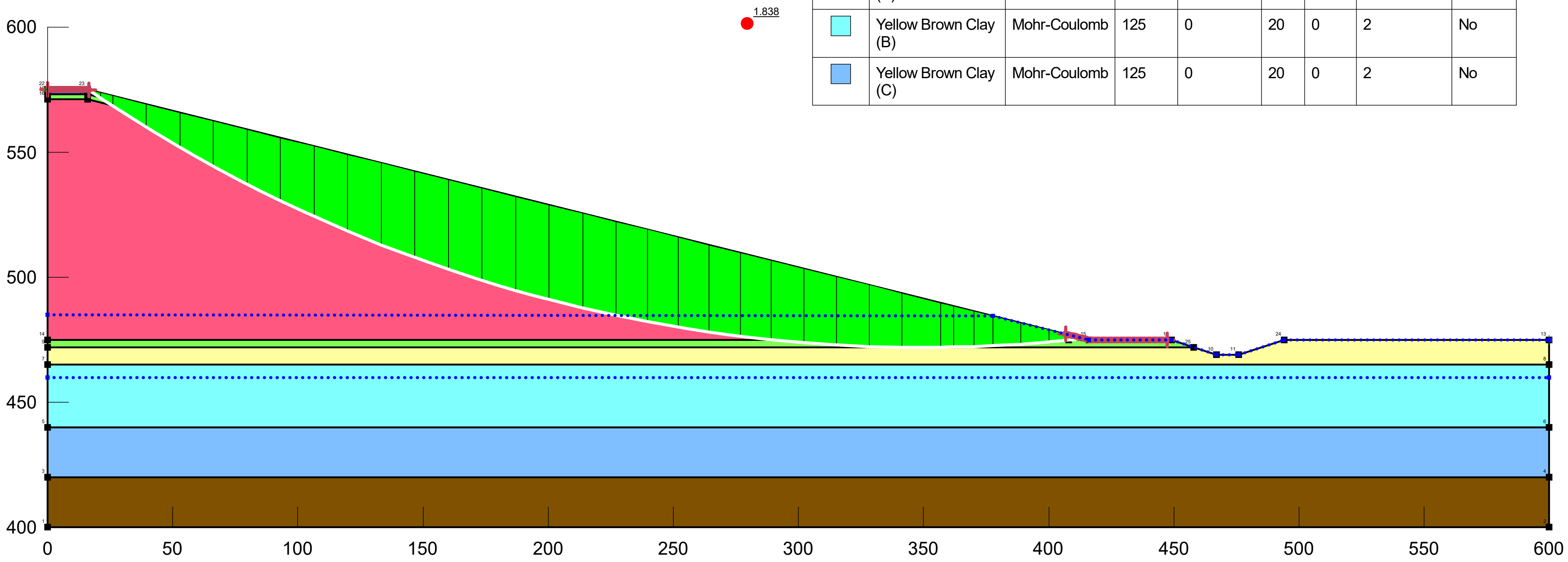
	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	0.50631657	574	-5,553.6418	59.836602	37.390059	0
Slice 2	1.5290291	572	-5,428.9263	-1,508.4309	-0	2,000
Slice 3	9.0227126	559.08648	-4,623.7415	977.15061	497.8831	0
Slice 4	22.934874	537.48619	-3,277.0324	2,341.7584	1,193.1855	0
Slice 5	36.804623	519.59814	-2,161.9635	3,484.6582	1,775.522	0
Slice 6	50.674372	504.32168	-1,209.8574	4,520.384	2,303.2507	0
Slice 7	64.544121	491.07595	-384.46926	5,457.0962	2,780.5294	0
Slice 8	77.787398	479.9527	308.52754	6,317.0334	3,061.4867	0
Slice 9	86.161873	473.5	710.48446	7,256.7665	0	2,000
Slice 10	93.379885	468.5	1,021.8884	7,748.2842	0	2,000
Slice 11	106.57996	460.16285	1,541.0365	8,566.1847	0	2,000
Slice 12	122.67624	451.18103	2,100.1726	9,425.144	0	2,000
Slice 13	138.77252	443.51818	2,577.0051	10,127.412	0	2,000
Slice 14	153.63996	437.47212	2,953.0515	10,652.055	0	2,000
Slice 15	167.27856	432.80713	3,243.0205	11,026.169	0	2,000

Slice 16	180.91715	428.90538	3,485.3638	11,306.618	0	2,000
Slice 17	194.55575	425.7343	3,682.1128	11,496.61	0	2,000
Slice 18	208.19435	423.2688	3,834.8335	11,598.508	0	2,000
Slice 19	221.83295	421.49016	3,944.694	11,613.925	0	2,000
Slice 20	235.47155	420.3853	4,012.5115	11,543.795	0	2,000
Slice 21	251.3262	420	4,035.2446	11,347.273	0	2,000
Slice 22	267.18085	420.3853	4,009.8928	11,050.501	0	2,000
Slice 23	280.81945	421.49016	3,939.8227	10,694.413	0	2,000
Slice 24	294.45805	423.2688	3,827.7095	10,249.325	0	2,000
Slice 25	308.09665	425.7343	3,672.7362	9,712.5337	0	2,000
Slice 26	321.73525	428.90538	3,473.7346	9,080.4412	0	2,000
Slice 27	335.37384	432.80713	3,229.1386	8,348.3879	0	2,000
Slice 28	349.01244	437.47212	2,936.9169	7,510.4201	0	2,000
Slice 29	358.87383	441.25963	2,699.7622	6,845.1777	0	2,000
Slice 30	365.9372	444.31482	2,508.535	6,320.8836	0	2,000
Slice 31	373.87924	448.00971	2,277.318	5,693.5843	0	2,000
Slice 32	383.35	452.86203	1,888.0829	4,880.9356	0	2,000
Slice 33	394.45	459.09882	1,326.6535	3,845.8717	0	2,000
Slice 34	402.06029	463.69131	921.98313	3,077.1138	0	2,000

Slice 35	406.06029	466.27874	698.45444	2,633.4203	0	2,000
Slice 36	411.21223	469.77874	400.10497	2,036.0896	0	2,000
Slice 37	415.21223	472.56519	164.15731	1,563.1885	0	2,000
Slice 38	417.2783	474.06519	58.332401	1,359.1607	0	2,000

File Name: Stage 2-20 deg_2 water surfaces El 460.gsz
F of S: 1.838

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Phi-B (°)	Piezometric Line	Include Ru in PWP
🟥	By Product	Mohr-Coulomb	103	0	27	0	1	No
🟫	Clayshale	Mohr-Coulomb	130	7,000	0	0	2	No
🟩	Compacted Clay	Mohr-Coulomb	120	0	20	0	1	No
🟦	Drainage / Protective Layer	Mohr-Coulomb	120	0	32	0	1	No
🟨	Yellow Brown Clay (A)	Mohr-Coulomb	125	0	20	0		No
🟦	Yellow Brown Clay (B)	Mohr-Coulomb	125	0	20	0	2	No
🟦	Yellow Brown Clay (C)	Mohr-Coulomb	125	0	20	0	2	No



Stage 2

File Information

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Last Edited By: Gilkey, Keith
Revision Number: 19
Date: 9/25/2018
Time: 2:14:45 PM
Tool Version: 8.16.5.15361
File Name: Stage 2-20 deg_2 water surfaces El 460.gsz
Directory: I:\16215106\Calculations\Stability\
Last Solved Date: 9/25/2018
Last Solved Time: 2:15:36 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Stage 2

Kind: SLOPE/W
Method: Spencer
Settings
  PWP Conditions Source: Piezometric Line with Ru
  Apply Phreatic Correction: No
Slip Surface
  Direction of movement: Left to Right
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Resisting Side Maximum Convex Angle: 1 °
  Driving Side Maximum Convex Angle: 5 °
  Optimize Critical Slip Surface Location: No

Tension Crack
    - Tension Crack Option: (none)

F of S Distribution
    - F of S Calculation Option: Constant

Advanced
    - Number of Slices: 30
    - F of S Tolerance: 0.001
    - Minimum Slip Surface Depth: 0.1 ft
    - Search Method: Root Finder
    - Tolerable difference between starting and converged F of S: 3
    - Maximum iterations to calculate converged lambda: 20
    - Max Absolute Lambda: 2

Materials

Compacted Clay

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Drainage / Protective Layer

Model: Mohr-Coulomb
Unit Weight: 120 pcf
Cohesion': 0 psf
Phi': 32 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

By Product

Model: Mohr-Coulomb
Unit Weight: 103 pcf
Cohesion': 0 psf
Phi': 27 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 1
    Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Clayshale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
Piezometric Line: 2
Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0, 575) ft
Left-Zone Right Coordinate: (16.48981, 574.87755) ft
Left-Zone Increment: 50
Right Projection: Range
Right-Zone Left Coordinate: (406.7319, 477.31702) ft

Right-Zone Right Coordinate: (447.35723, 475) ft
Right-Zone Increment: 50
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 575) ft
Right Coordinate: (600, 475) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	485
Coordinate 2	377.8	484.5
Coordinate 3	416	475
Coordinate 4	449	475
Coordinate 5	467	469
Coordinate 6	476	469
Coordinate 7	494	475
Coordinate 8	600	475

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	460
Coordinate 2	600	460

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	600	400
Point 3	0	420
Point 4	600	420

Point 5	0	440
Point 6	600	440
Point 7	0	465
Point 8	600	465
Point 9	0	472
Point 10	467	469
Point 11	476	469
Point 12	449	475
Point 13	600	475
Point 14	0	475
Point 15	416	475
Point 16	0	571
Point 17	16	571
Point 18	400	475
Point 19	0	573
Point 20	16	573
Point 21	408	475
Point 22	0	575
Point 23	16	575
Point 24	494	475
Point 25	458	472

Regions

	Material	Points	Area (ft²)
Region 1	Clayshale	1,3,4,2	12,000
Region 2	Yellow Brown Clay (C)	5,6,4,3	12,000
Region 3	Yellow Brown Clay (B)	7,8,6,5	15,000
Region 4	Yellow Brown Clay (A)	7,9,25,10,11,24,13,8	4,477.5
Region 5	Compacted Clay	9,14,18,21,15,12,25	1,360.5
Region 6	By Product	14,16,17,18	19,968
Region 7	Compacted Clay	16,19,20,21,18,17	808
Region 8	Drainage / Protective Layer	19,22,23,15,21,20	824

Current Slip Surface

Slip Surface: 28,152

F of S: 1.838
Volume: 10,097.481 ft³
Weight: 1,070,412.7 lbs
Resisting Moment: 2.6920364e+008 lbs-ft
Activating Moment: 1.4644683e+008 lbs-ft
Resisting Force: 436,759.14 lbs
Activating Force: 237,562.5 lbs
F of S Rank (Analysis): 1 of 28,611 slip surfaces
F of S Rank (Query): 1 of 28,611 slip surfaces
Exit: (413.87594, 475.53102) ft
Entry: (16.489809, 574.87755) ft
Radius: 588.63612 ft
Center: (349.02785, 1,060.5842) ft

Slip Slices

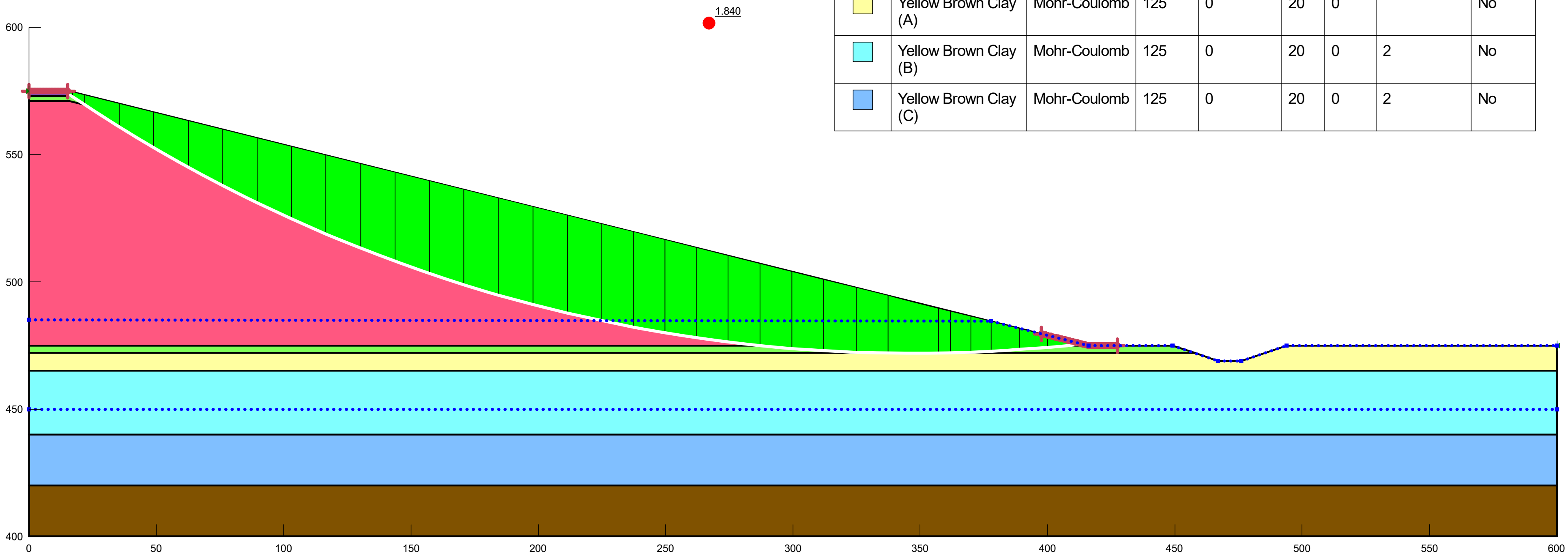
	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	18.828321	573.29292	-5,511.0331	90.860967	56.776233	0
Slice 2	23.585105	570.10372	-5,312.4201	286.65003	104.33208	0
Slice 3	32.708958	564.22583	-4,946.3929	587.16822	299.17715	0
Slice 4	46.120119	555.92764	-4,429.6935	1,003.1773	511.14436	0
Slice 5	59.53128	548.11476	-3,943.2775	1,391.1897	708.84656	0
Slice 6	72.94244	540.76529	-3,485.7779	1,750.9942	892.1761	0
Slice 7	86.353601	533.8598	-3,055.9829	2,082.3748	1,061.023	0
Slice 8	99.764762	527.38103	-2,652.815	2,385.1034	1,215.2709	0
Slice 9	113.17592	521.31358	-2,275.3136	2,658.9333	1,354.7942	0
Slice 10	126.58708	515.6437	-1,922.6207	2,903.5937	1,479.4549	0
Slice 11	139.99824	510.35909	-1,593.9687	3,118.785	1,589.1003	0

Slice 12	153.40941	505.44874	-1,288.6705	3,304.1743	1,683.5609	0
Slice 13	166.82057	500.90279	-1,006.1109	3,459.3907	1,762.6476	0
Slice 14	180.23173	496.71243	-745.73953	3,584.0218	1,826.1503	0
Slice 15	193.64289	492.86976	-507.06483	3,677.6087	1,873.8353	0
Slice 16	207.05405	489.36778	-289.6486	3,739.642	1,905.4428	0
Slice 17	220.46521	486.20024	-93.101766	3,769.5567	1,920.6851	0
Slice 18	233.37014	483.45699	77.011592	3,766.6237	1,879.9513	0
Slice 19	245.76884	481.10993	222.44379	3,731.4219	1,787.9136	0
Slice 20	258.16753	479.03666	350.79176	3,665.7543	1,689.0577	0
Slice 21	270.56623	477.23426	462.23776	3,569.2477	1,583.1006	0
Slice 22	282.96493	475.70022	556.93811	3,441.4672	1,469.741	0
Slice 23	295.6698	474.40782	636.53466	3,249.9327	951.19909	0
Slice 24	308.68086	473.36865	700.3043	3,064.1677	860.37592	0
Slice 25	321.69191	472.6192	745.99524	2,838.6267	761.65557	0
Slice 26	334.70297	472.15837	773.67661	2,572.4766	654.70965	0
Slice 27	349.02785	472	782.3761	2,229.3941	526.6715	0
Slice 28	359.38155	472.04458	778.73896	1,956.4625	428.65629	0
Slice 29	365.9372	472.20474	768.20407	1,764.7506	362.71328	0
Slice 30	373.87924	472.48598	749.99835	1,518.7651	279.80821	0

Slice 31	383.35	472.97584	632.98089	1,207.7242	209.18947	0
Slice 32	394.45	473.72958	413.69403	820.20039	147.95622	0
Slice 33	404	474.53435	215.27633	443.37488	83.021084	0
Slice 34	408.44571	474.95478	120.05176	248.18237	46.635727	0
Slice 35	411.37981	475.26508	55.156629	118.17758	39.379862	0
Slice 36	413.87207	475.53059	-0.086741895	0.19888453	0.12427685	0

File Name: Stage 2-20 deg_2 water surfaces El 450.gsz
F of S: 1.840

Color	Name	Model	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)	Phi-B (°)	Piezometric Line	Include Ru in PWP
🟥	By Product	Mohr-Coulomb	103	0	27	0	1	No
🟫	Clayshale	Mohr-Coulomb	130	7,000	0	0	2	No
🟩	Compacted Clay	Mohr-Coulomb	120	0	20	0	1	No
🟦	Drainage / Protective Layer	Mohr-Coulomb	120	0	32	0	1	No
🟨	Yellow Brown Clay (A)	Mohr-Coulomb	125	0	20	0		No
🟦	Yellow Brown Clay (B)	Mohr-Coulomb	125	0	20	0	2	No
🟦	Yellow Brown Clay (C)	Mohr-Coulomb	125	0	20	0	2	No



Stage 2

File Information

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Last Edited By: Gearing, Phillip
Revision Number: 20
Date: 9/24/2018
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Tool Version: 8.16.5.15361
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Directory: I:\16215106\Calculations\Stability\
Last Solved Date: 9/24/2018
Last Solved Time: 5:54:06 PM

Project Settings

Length(L) Units: Feet
Time(t) Units: Seconds
Force(F) Units: Pounds
Pressure(p) Units: psf
Strength Units: psf
Unit Weight of Water: 62.4 pcf
View: 2D
Element Thickness: 1

Analysis Settings

Stage 2

Kind: SLOPE/W
Method: Spencer
Settings
  PWP Conditions Source: Piezometric Line with Ru
  Apply Phreatic Correction: No
Slip Surface
  Direction of movement: Left to Right
  Use Passive Mode: No
  Slip Surface Option: Entry and Exit
  Critical slip surfaces saved: 1
  Resisting Side Maximum Convex Angle: 1 °
  Driving Side Maximum Convex Angle: 5 °
  Optimize Critical Slip Surface Location: No

- Tension Crack
  - Tension Crack Option: (none)
- F of S Distribution
  - F of S Calculation Option: Constant
- Advanced
  - Number of Slices: 30
  - F of S Tolerance: 0.001
  - Minimum Slip Surface Depth: 0.1 ft
  - Search Method: Root Finder
  - Tolerable difference between starting and converged F of S: 3
  - Maximum iterations to calculate converged lambda: 20
  - Max Absolute Lambda: 2

Materials

Compacted Clay

- Model: Mohr-Coulomb
- Unit Weight: 120 pcf
- Cohesion': 0 psf
- Phi': 20 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1
  - Include Ru in PWP: No

Drainage / Protective Layer

- Model: Mohr-Coulomb
- Unit Weight: 120 pcf
- Cohesion': 0 psf
- Phi': 32 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1
  - Include Ru in PWP: No

By Product

- Model: Mohr-Coulomb
- Unit Weight: 103 pcf
- Cohesion': 0 psf
- Phi': 27 °
- Phi-B: 0 °
- Pore Water Pressure
  - Piezometric Line: 1
  - Include Ru in PWP: No

Yellow Brown Clay (A)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Include Ru in PWP: No

Yellow Brown Clay (B)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 2
    Include Ru in PWP: No

Yellow Brown Clay (C)

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 20 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 2
    Include Ru in PWP: No

Clayshale

Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 7,000 psf
Phi': 0 °
Phi-B: 0 °
Pore Water Pressure
    Piezometric Line: 2
    Include Ru in PWP: No

Slip Surface Entry and Exit

Left Projection: Range
Left-Zone Left Coordinate: (0, 575) ft
Left-Zone Right Coordinate: (15.24856, 575) ft
Left-Zone Increment: 50
Right Projection: Range
Right-Zone Left Coordinate: (397.55248, 479.61188) ft

Right-Zone Right Coordinate: (427.35586, 475) ft
Right-Zone Increment: 50
Radius Increments: 10

Slip Surface Limits

Left Coordinate: (0, 575) ft
Right Coordinate: (600, 475) ft

Piezometric Lines

Piezometric Line 1

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	485
Coordinate 2	377.8	484.5
Coordinate 3	416	475
Coordinate 4	449	475
Coordinate 5	467	469
Coordinate 6	476	469
Coordinate 7	494	475
Coordinate 8	600	475

Piezometric Line 2

Coordinates

	X (ft)	Y (ft)
Coordinate 1	0	450
Coordinate 2	600	450

Points

	X (ft)	Y (ft)
Point 1	0	400
Point 2	600	400
Point 3	0	420
Point 4	600	420

Point 5	0	440
Point 6	600	440
Point 7	0	465
Point 8	600	465
Point 9	0	472
Point 10	467	469
Point 11	476	469
Point 12	449	475
Point 13	600	475
Point 14	0	475
Point 15	416	475
Point 16	0	571
Point 17	16	571
Point 18	400	475
Point 19	0	573
Point 20	16	573
Point 21	408	475
Point 22	0	575
Point 23	16	575
Point 24	494	475
Point 25	458	472

Regions

	Material	Points	Area (ft²)
Region 1	Clayshale	1,3,4,2	12,000
Region 2	Yellow Brown Clay (C)	5,6,4,3	12,000
Region 3	Yellow Brown Clay (B)	7,8,6,5	15,000
Region 4	Yellow Brown Clay (A)	7,9,25,10,11,24,13,8	4,477.5
Region 5	Compacted Clay	9,14,18,21,15,12,25	1,360.5
Region 6	By Product	14,16,17,18	19,968
Region 7	Compacted Clay	16,19,20,21,18,17	808
Region 8	Drainage / Protective Layer	19,22,23,15,21,20	824

Current Slip Surface

Slip Surface: 25,545

F of S: 1.840
Volume: 10,337.538 ft³
Weight: 1,095,453.6 lbs
Resisting Moment: 2.7676765e+008 lbs-ft
Activating Moment: 1.5043275e+008 lbs-ft
Resisting Force: 447,075.32 lbs
Activating Force: 242,964.35 lbs
F of S Rank (Analysis): 1 of 28,611 slip surfaces
F of S Rank (Query): 1 of 28,611 slip surfaces
Exit: (413.46321, 475.6342) ft
Entry: (13.723704, 575) ft
Radius: 591.15831 ft
Center: (347.26728, 1,063.0746) ft

Slip Slices

	X (ft)	Y (ft)	PWP (psf)	Base Normal Stress (psf)	Frictional Strength (psf)	Cohesive Strength (psf)
Slice 1	14.861852	574.22609	-5,568.9351	70.255813	43.900704	0
Slice 2	16.531973	573.09309	-5,498.3743	161.40415	100.85651	0
Slice 3	19.465813	571.13355	-5,376.3409	286.40752	104.24381	0
Slice 4	28.638175	565.20011	-5,006.8517	590.10527	300.67365	0
Slice 5	42.179168	556.78724	-4,483.0071	1,012.626	515.95872	0
Slice 6	55.720161	548.86858	-3,990.0008	1,406.7162	716.75769	0
Slice 7	69.261154	541.42159	-3,526.4268	1,772.163	902.96214	0
Slice 8	82.802146	534.42631	-3,091.04	2,108.7492	1,074.4614	0
Slice 9	96.343139	527.86502	-2,682.7338	2,416.2453	1,231.1385	0
Slice 10	109.88413	521.72193	-2,300.5228	2,694.4028	1,372.8668	0
Slice 11	123.42512	515.98292	-1,943.5271	2,942.9489	1,499.5073	0

Slice 12	136.96612	510.6354	-1,610.9601	3,161.581	1,610.906	0
Slice 13	150.50711	505.66809	-1,302.1184	3,349.9627	1,706.8912	0
Slice 14	164.0481	501.07091	-1,016.3722	3,507.7187	1,787.2719	0
Slice 15	177.5891	496.83482	-753.15871	3,634.4309	1,851.835	0
Slice 16	191.13009	492.95178	-511.97526	3,729.6339	1,900.3434	0
Slice 17	204.67108	489.41461	-292.37422	3,792.8104	1,932.5334	0
Slice 18	218.21207	486.21695	-93.958312	3,823.3863	1,948.1126	0
Slice 19	231.18079	483.46085	76.951161	3,820.7915	1,907.5819	0
Slice 20	243.57723	481.1151	222.30261	3,785.9272	1,815.7574	0
Slice 21	255.97366	479.04185	350.64915	3,720.7458	1,717.15	0
Slice 22	268.3701	477.23823	462.17141	3,624.8791	1,611.4801	0
Slice 23	280.76654	475.70175	557.02445	3,497.8984	1,498.4502	0
Slice 24	293.25918	474.4225	635.81798	3,309.7198	973.22065	0
Slice 25	305.84801	473.40286	698.40343	3,132.3124	885.87041	0
Slice 26	318.43685	472.65338	744.13171	2,917.8916	791.1839	0
Slice 27	331.02568	472.17301	773.06701	2,665.719	688.86898	0
Slice 28	347.26728	472	782.5215	2,277.0729	543.97221	0
Slice 29	359.56519	472.04891	778.4537	1,953.3074	427.61177	0
Slice 30	365.9372	472.22489	766.94635	1,764.1348	362.94689	0

Slice 31	373.87924	472.52864	747.33656	1,514.9754	279.39768	0
Slice 32	383.35	473.04473	628.68222	1,200.2233	208.02393	0
Slice 33	394.45	473.82854	407.51905	808.40919	145.91208	0
Slice 34	403.93732	474.65214	208.89891	430.70387	80.730402	0
Slice 35	410.66433	475.33225	62.068179	133.07964	44.372885	0
Slice 36	413.45862	475.63368	-0.10359649	0.23776018	0.14856905	0

APPENDIX E

Seepage Potential and Karst Condition Assessment

Seepage Potential and Karst Condition Assessment

The disposal facility is designed and constructed to include storm water run-on and run-off management and leachate control systems. The storm water management system consists of drainage ditches, diversion berms, culverts, drop inlets, storm water pipes, and a storm water run-off pond to convey and contain storm water away from the disposal facility. The leachate control system consists of a series of 4-inch diameter perforated pipes spaced approximately 50 feet apart that drain in the direction of the storm water runoff pond to limit leachate head buildup within the waste over the liner. The landfill liner elevation is above the groundwater elevation. There are no concerns that storm water, leachate, or groundwater movement will impact the stability of the landfill.

As noted in **Appendix A**, karst features were not observed in the borings within and adjacent to the disposal facility. Regionally, the site geology is not known for karst features. The site soils are clays overlying clayshale weathered from shale bedrock that are not subject to karst conditions.

References

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Black & Veatch Corp., 2010, Engineering Report, Solid Waste Disposal Facility, Sandy Creek Energy Station, Sandy Creek Services, LLC.

SCS Engineers, 2018, June 2018 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, Texas.

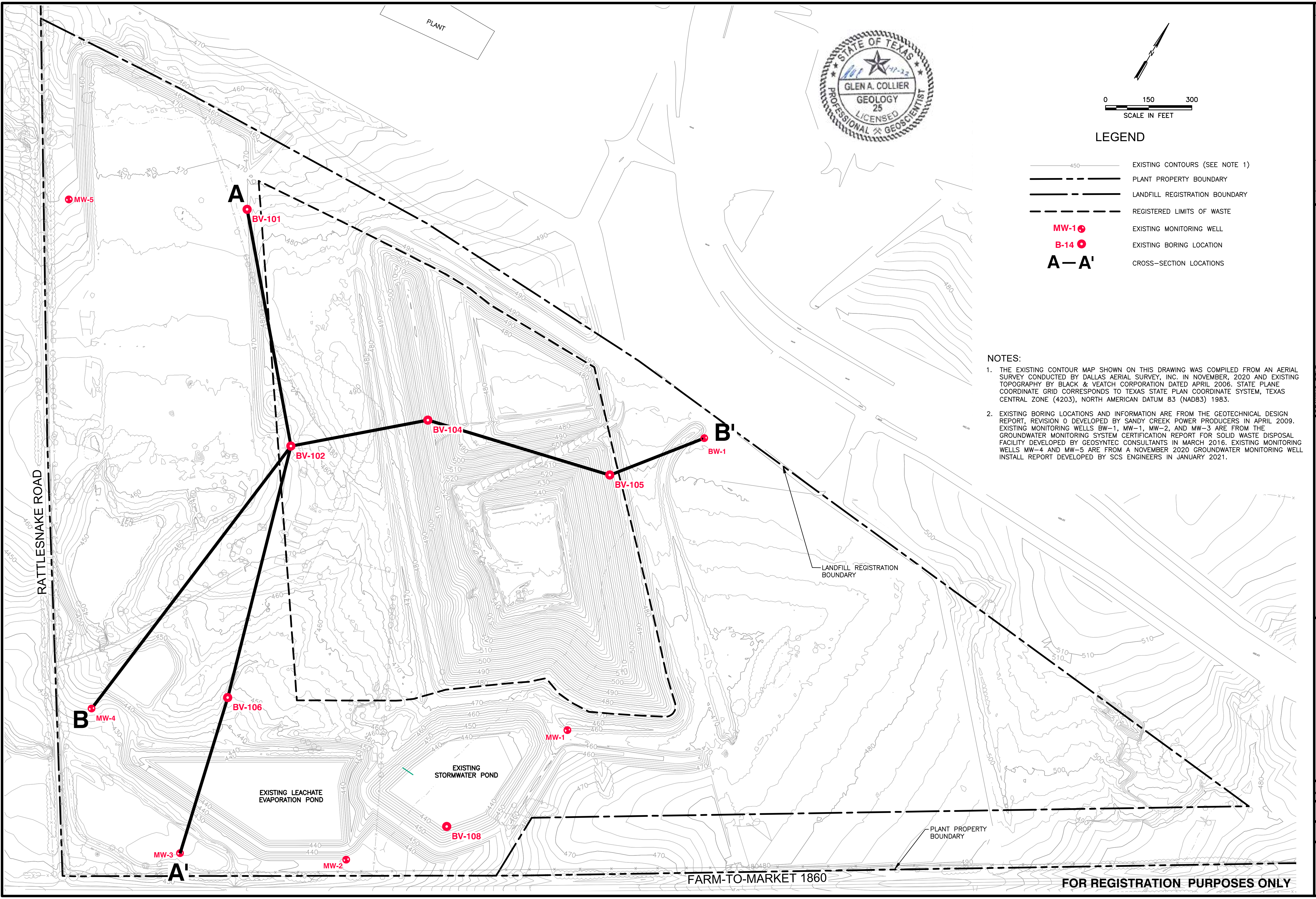
DLN/jsn/MRH

I:\16215106\Deliverables\Appendices\E1_Seepage Potential and Karst Condition Assessment.docx

APPENDIX II.B2

GEOLOGIC CROSS-SECTION LOCATION PLAN, GEOLOGIC CROSS SECTIONS, AND BORING LOGS

11/18/2021 3:19 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\ATT 4\GEOLOGIC - CROSS SECTIONS



GLEN A. COLLIER
GEOLOGY
25
1-17-22

LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
— - —	PLANT PROPERTY BOUNDARY
— - —	LANDFILL REGISTRATION BOUNDARY
— — —	REGISTERED LIMITS OF WASTE
MW-1 ●	EXISTING MONITORING WELL
B-14 ●	EXISTING BORING LOCATION
A — A'	CROSS-SECTION LOCATIONS

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. EXISTING BORING LOCATIONS AND INFORMATION ARE FROM THE GEOTECHNICAL DESIGN REPORT, REVISION 0 DEVELOPED BY SANDY CREEK POWER PRODUCERS IN APRIL 2009. EXISTING MONITORING WELLS BW-1, MW-1, MW-2, AND MW-3 ARE FROM THE GROUNDWATER MONITORING SYSTEM CERTIFICATION REPORT FOR SOLID WASTE DISPOSAL FACILITY DEVELOPED BY GEOSYNTEC CONSULTANTS IN MARCH 2016. EXISTING MONITORING WELLS MW-4 AND MW-5 ARE FROM A NOVEMBER 2020 GROUNDWATER MONITORING WELL INSTALL REPORT DEVELOPED BY SCS ENGINEERS IN JANUARY 2021.

FOR REGISTRATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
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△			

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
GEOLOGIC CROSS-SECTION LOCATION MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

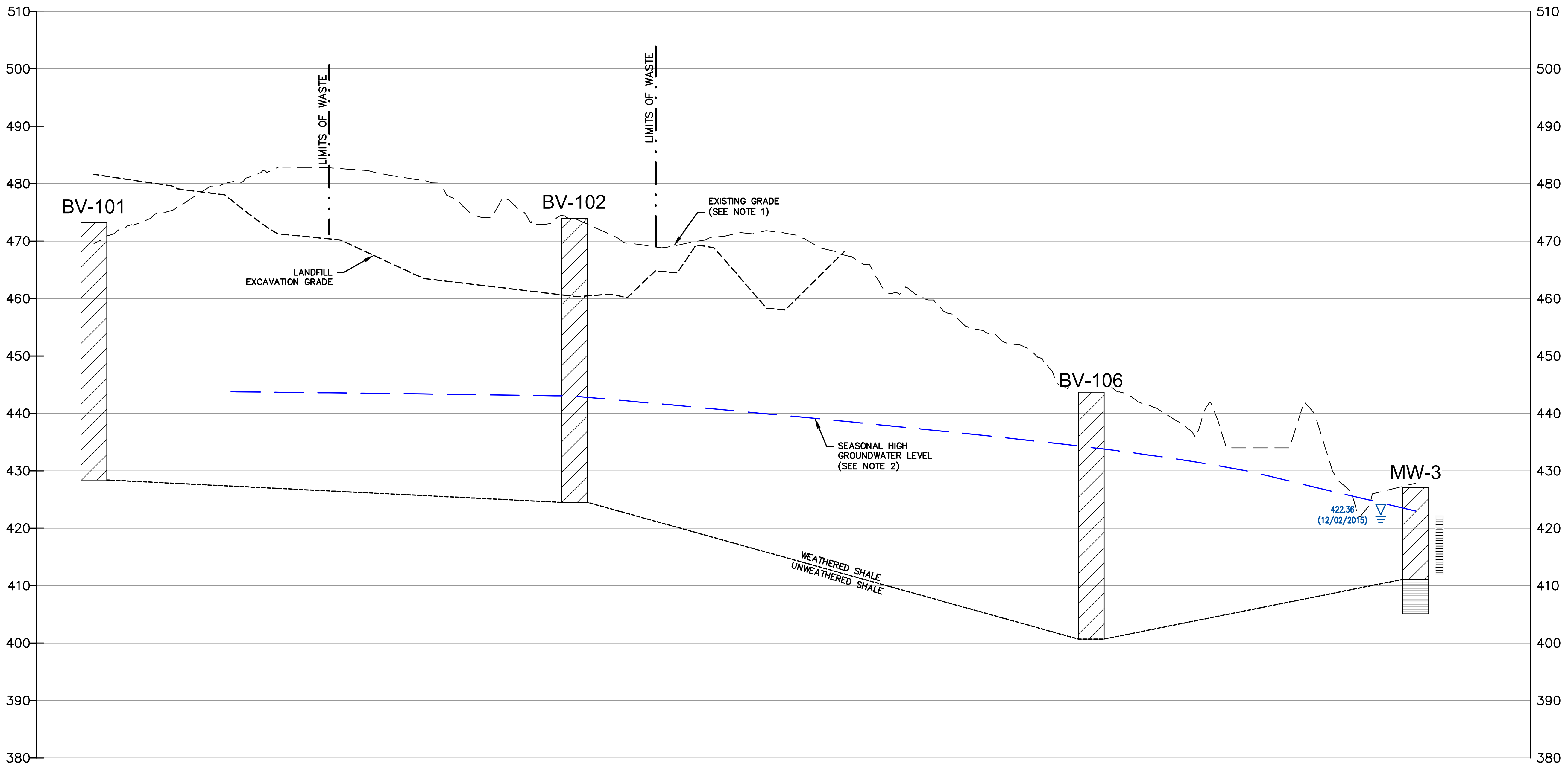
PROJ. NO. 16221059.00
DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

CADD FILE:
GEOLOGIC - CROSS SECTIONS

DATE:
11/2021

SCALE:
AS SHOWN

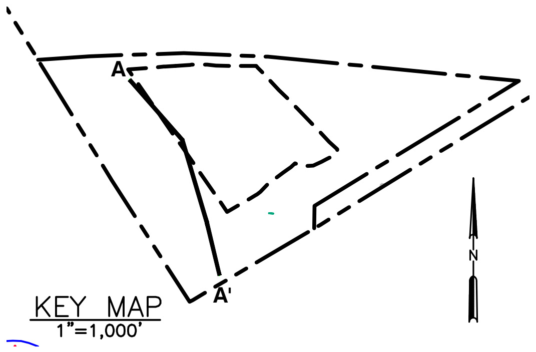
DRAWING NO.
II.B-1



CROSS SECTION A-A'

0 10 20
VERTICAL SCALE IN FEET

0 100 200
HORIZONTAL SCALE IN FEET



KEY MAP
1"=1,000'

GLEN A. COLLIER
GEOLOGY
25

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.

LEGEND:

— — — —	EXISTING GRADE (SEE NOTE 1)
— — — —	SEASONAL HIGH GROUNDWATER
....	WEATHERED/UNWEATHERED SHALE TRANSITIONAL CONTACT
- - - - - - -	PROPOSED LANDFILL EXCAVATION GRADE
510.74 ▽ (7/8/20)	STATIC WATER LEVEL IN MONITORING WELL (DATE OF WATER LEVEL READING)
▨	WEATHERED SHALE
☰	UNWEATHERED SHALE
‖	SCREENED INTERVAL

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
GEOLOGIC CROSS SECTION A-A'

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00	DWN. BY: ORA	Q/A RVW BY: BJD
DSN. BY: BJD	CHK. BY: BJD	APP. BY: BJD

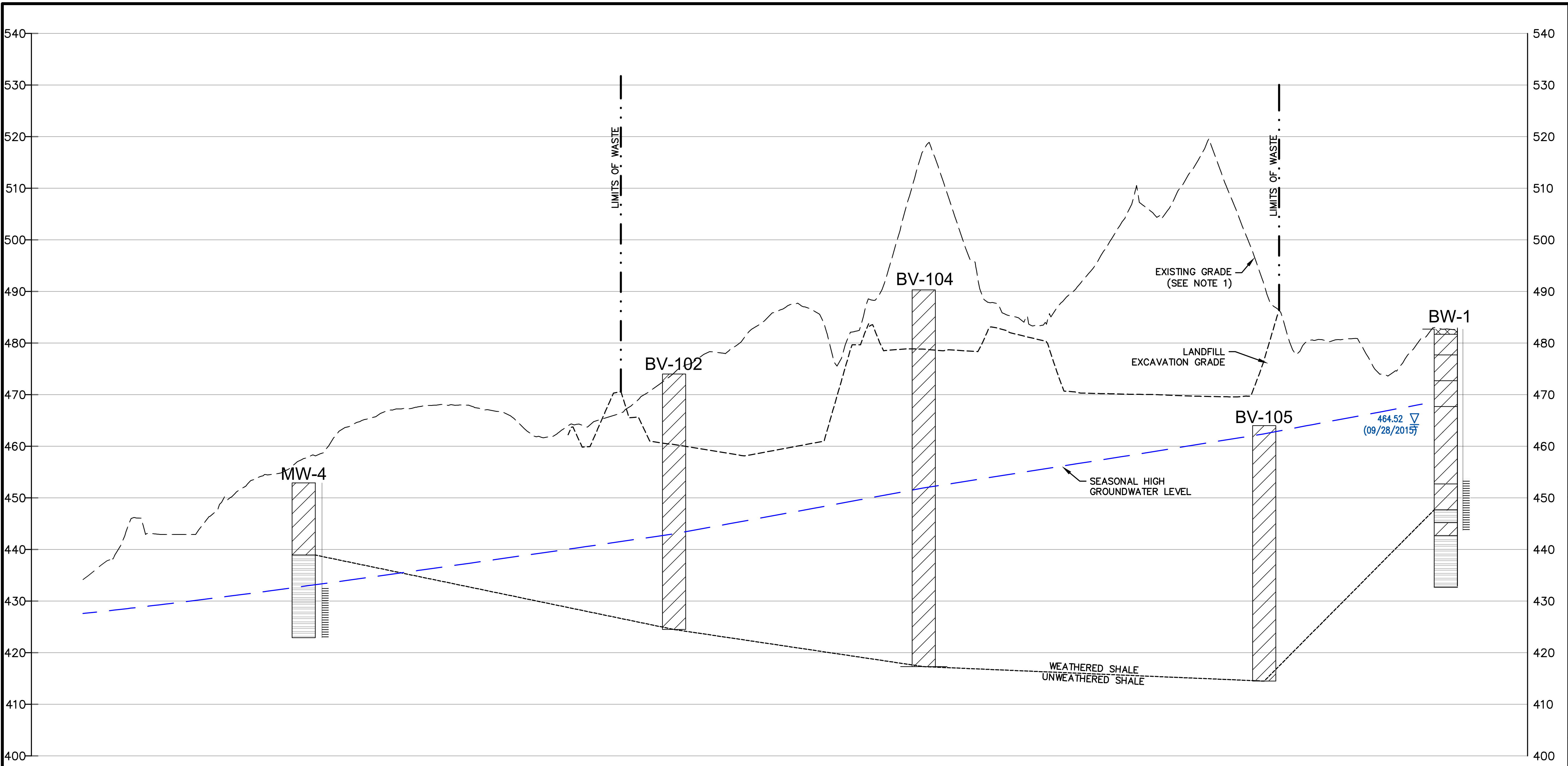
CADD FILE: GEOLOGIC – CROSS SECTIONS

DATE: 11/2021

SCALE: AS SHOWN

DRAWING NO.
II.B-2

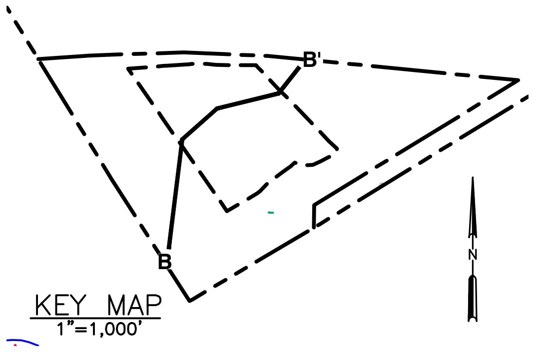
11/21/2021 10:54 AM \\BED-FS02\Data\Civil 3D Projects\CADD\SANDY CREEK\16221059.00 TCEQ Registration\DWG\ATT 4\GEOLOGIC – CROSS SECTIONS



0 10 20
VERTICAL SCALE IN FEET

0 100 200
HORIZONTAL SCALE IN FEET

CROSS SECTION B-B'



KEY MAP
1"=1,000'

GLEN A. COLLIER
GEOLOGY
25
1-17-22

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLANE COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.

LEGEND:

— — — —	EXISTING GRADE (SEE NOTE 1)
— — —	SEASONAL HIGH GROUNDWATER
------------	WEATHERED/UNWEATHERED SHALE TRANSITIONAL CONTACT
– – – – – –	PROPOSED LANDFILL EXCAVATION GRADE
510.74 (7/8/20) ▽	STATIC WATER LEVEL IN MONITORING WELL (DATE OF WATER LEVEL READING)
▨	WEATHERED SHALE
☰	UNWEATHERED SHALE
▥	SCREENED INTERVAL

FOR REGISTRATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
GEOLOGIC CROSS SECTION B-B'

PROJECT TITLE
**SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION**

CLIENT
**SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682**

SCS ENGINEERS
**STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188**

PROJ. NO. 16221059.00	DSN. BY: BJD
DWN. BY: ORA	CHK. BY: BJD
Q/A RVW BY: BJD	APP. BY: BJD

CADD FILE:
GEOLOGIC – CROSS SECTIONS

DATE:
11/2021

SCALE:
AS SHOWN

DRAWING NO.
II.B-3

11/18/2021 3:18 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\ATT 4\GEOLOGIC – CROSS SECTIONS

BLACK & VEATCH

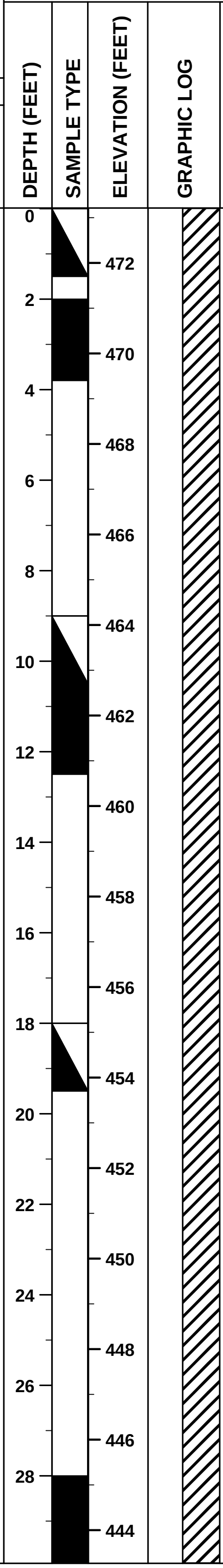
BORING LOG

BORING NO. BV-101
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 4026.0' E 8990.0'	**GROUND ELEVATION (DATUM)** 473.2 ft (MSL)	**TOTAL DEPTH** 44.8 (feet)
SURFACE CONDITIONS Side of hill; weed cover	**COORDINATE SYSTEM** PLANT	**DATE START** 08/08/2007	**DATE FINISHED** 08/08/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	1	2	3	0.2
TW	2	1.8	-	-	-	1.5
SPT	3	6	7	8	15	1.5
TW	4	2.0	-	-	-	2.0
SPT	5	7	11	12	23	1.5
TW	6	2.0	-	-	-	1.4



CLASSIFICATION OF MATERIALS

CLAY; brown; soft; moist; low plasticity; w/some sand & gravel (6" Topsoil)

grading yellow-brown; stiff; w/some gypsum seams; trace cemented clay seams

grading w/1/4" cemented clay nodules

cemented clay nodules grades out

grading w/some cementation

grading mottled gray

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. @4' PP=4.5 tsf

PP=4.25 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-101
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 4026.0' E 8990.0'	**GROUND ELEVATION (DATUM)** 473.2 ft (MSL)	**TOTAL DEPTH** 44.8 (feet)
SURFACE CONDITIONS Side of hill; weed cover	**COORDINATE SYSTEM** PLANT	**DATE START** 08/08/2007	**DATE FINISHED** 08/08/2007

LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD						
SPT	7	10	13	14	27	1.5	38	◣		▨	grading very stiff	
TW	8	1.8	-	-	-	1.8	44	■		▨	grading dark gray; fissile	
												Bottom of boring @ 44.8'. Water level not recorded. Boring backfilled w/ bentonite chips.

DEPTH (FEET): 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58

ELEVATION (FEET): 442 440 438 436 434 432 430 428 426 424 422 420 418 416 414

4/11/2008 1:21 PM SCEA - Sandy Creek Energy Station

BLACK & VEATCH

BORING LOG

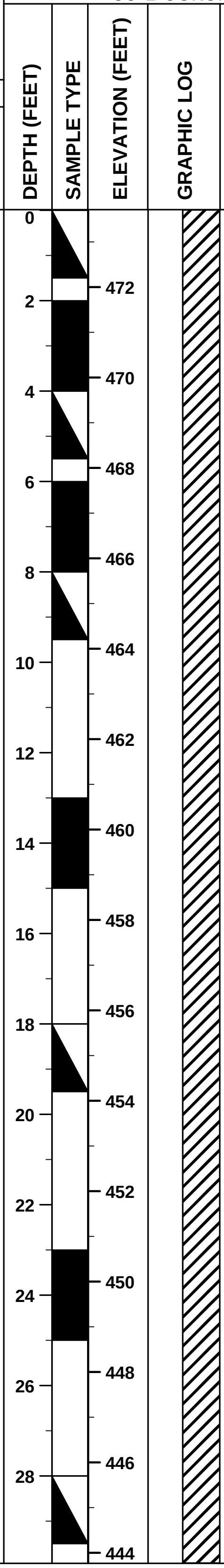
BORING NO. BV-102

SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3335.0' E 9470.0'	**GROUND ELEVATION (DATUM)**
TOTAL DEPTH 49.5 (feet)		
SURFACE CONDITIONS High weeds; boring offset 150' east	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07
DATE FINISHED 8/3/07		
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	3	3	3	6	0.9
TW	2	2.0	-	-	-	2.0
SPT	3	7	8	8	16	1.5
TW	4	2.0	-	-	-	2.0
SPT	5	7	8	8	16	1.3
TW	6	2.0	-	-	-	2.0
SPT	7	7	9	11	20	1.5
TW	8	2.0	-	-	-	2.0
SPT	9	10	12	15	27	1.5



CLASSIFICATION OF MATERIALS

CLAY: brown; firm; moist; high plasticity
(6" Topsoil)

@ 3.0' grading gray-brown; very stiff; w/some sand & 1" subrounded gravel
sand grades out

grading mottled yellow-brown-gray

grading w/occasional white cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@4' PP>4.5 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-102
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3335.0' E 9470.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS High weeds; boring offset 150' east	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07	**DATE FINISHED** 8/3/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	DEPTH (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
TW	10	2.0	-	-	-	2.0	34		
SPT	11	9	11	14	25	1.5			
TW	12	2.0	-	-	-	2.0	44		
							48	grading hard	
SPT	13	15	18	23	41	1.5			
							50		Bottom of boring at 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.

DEPTH (FEET): 30, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56, 58

ELEVATION (FEET): 442, 440, 438, 436, 434, 432, 430, 428, 426, 424, 422, 420, 418, 416, 414

4/11/2008 1:21 PM SCEA - Sandy Creek Energy Station

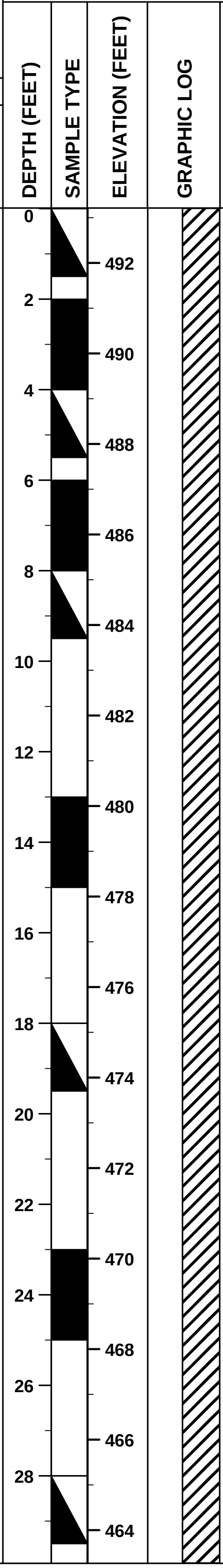
BLACK & VEATCH

BORING LOG

BORING NO. BV-103
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 4056.0' E 10249.0'
GROUND ELEVATION (DATUM) 493.2 ft (MSL)
TOTAL DEPTH 49.5 (feet)
SURFACE CONDITIONS Rolling hills, tall weeds
COORDINATE SYSTEM Plant
DATE START 8/1/07
DATE FINISHED 8/1/07
LOGGED BY JJ Deeken
CHECKED BY JJ Deeken
APPROVED BY BL Christensen

SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	CLASSIFICATION OF MATERIALS	REMARKS
SPT	1	2	2	1	3	0.8	CLAY: brown; soft; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
TW	2	2.0	-	-	-	2.0	grading stiff	
SPT	3	2	5	8	13	1.5	grading yellow-brown & gray seams	@2' PP=2.0 tsf @4' PP=2.5 tsf
TW	4	2.0	-	-	-	1.6		@6' PP=4.5 tsf
SPT	5	5	8	11	19	1.5	grading very stiff	Reacts w/HCL
TW	6	2.0	-	-	-	2.0		PP=4.5 tsf
SPT	7	6	8	10	18	1.5		
TW	8	2.0	-	-	-	2.0		
SPT	9	7	11	12	23	1.5	grading w/quartz seams	



BLACK & VEATCH

BORING LOG

BORING NO. BV-103
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 4056.0' E 10249.0'	**GROUND ELEVATION (DATUM)** 493.2 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Rolling hills, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** JJ Deeken	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE, SAMPLE NUMBER, SET 6 INCHES, 2ND 6 INCHES, 3RD 6 INCHES, N VALUE, SAMPLE RECOVERY

ROCK CORING: CORE SIZE, RUN NUMBER, RUN LENGTH, RUN RECOVERY, RQD RECOVERY, PERCENT RECOVERY, RQD

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	ELEVATION (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
							30			
								462		
							32			
								460	grading iron oxide staining	PP=4.5 tsf
TW	10	2.0	-	-	-	2.0	34			
								458		
							36		@ 36.0' quartz seams grades out	
								456		
							38			
SPT	11	7	12	15	27	1.5				
								454		
							40			
								452		
							42			
								450	grading blue-gray	PP=4.5 tsf
TW	12	2.0	-	-	-	2.0	44			
								448		
							46			
								446		
							48		grading hard	
SPT	13	11	17	20	37	1.5				
								444		
							50			Bottom of boring at 49.5'. Water level not recorded. Boring backfilled with bentonite chips.
								442		
							52			
								440		
							54			
								438		
							56			
								436		
							58			
								434		

BLACK & VEATCH

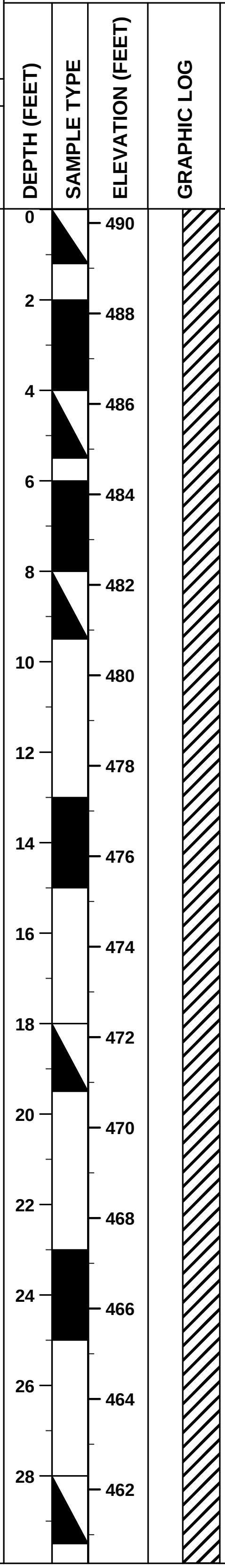
BORING LOG

BORING NO. BV-104

SHEET 1 OF 3

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3609.0' E 9869.0'	**GROUND ELEVATION (DATUM)** 490.3 ft (MSL)	**TOTAL DEPTH** 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju		**APPROVED BY** BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	2	2	4	1.2
TW	2	2.0	-	-	-	1.7
SPT	3	2	4	6	10	1.5
TW	4	2.0	-	-	-	2.0
SPT	5	5	6	9	15	1.5
TW	6	2.0	-	-	-	2.0
SPT	7	6	6	9	15	1.5
TW	8	2.0	-	-	-	2.0
SPT	9	7	10	12	22	1.5



CLASSIFICATION OF MATERIALS

CLAY: brown; soft; moist; high plasticity
(6" Topsoil)

grading stiff

grading yellow-brown & occasional gray clay seams

grading fissile

grading very stiff; w/1/4" quartz seams

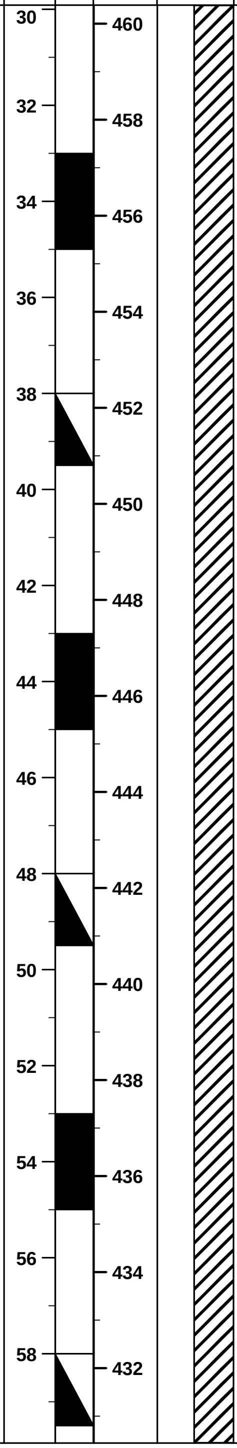
REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@2' PP=1.75 tsf
@4' PP=2.0 tsf

PP>4.5 tsf

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3609.0' E 9869.0'	**GROUND ELEVATION (DATUM)** 490.3 ft (MSL)	**TOTAL DEPTH** 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD			
							33	grading w/some 1/8" quartz grains	PP>4.5 tsf
TW	10	2.0	-	-	-	2.0	33–35		
SPT	11	7	10	12	22	1.5	38–39.5	grading iron oxide staining	
TW	12	2.0	-	-	-	2.0	43–45		PP>4.5 tsf
SPT	13	8	9	12	21	1.5	48–49.5		
TW	14	2.0	-	-	-	2.0	53–55		
SPT	15	10	14	19	33	1.5	58–59.5	grading hard; w/occasional quartz seams	



BLACK & VEATCH

BORING LOG

BORING NO. BV-104
SHEET 3 OF 3

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3609.0' E 9869.0'	**GROUND ELEVATION (DATUM)** 490.3 ft (MSL)	**TOTAL DEPTH** 73.0 (feet)
SURFACE CONDITIONS Top of hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE / ROCK CORING: CORE SIZE	SAMPLE NUMBER / RUN NUMBER	SET 6 INCHES / RUN LENGTH	2ND 6 INCHES / RUN RECOVERY	3RD 6 INCHES / RQD RECOVERY	N VALUE / PERCENT RECOVERY	SAMPLE RECOVERY / RQD	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
							60		430	▨		
							62		428	▨		
TW	16	2.0	-	-	-	2.0	64	■	426	▨	grading blue-gray & yellow-brown seams; quartz seams grades out	PP>4.5 tsf
							66		424	▨		
SPT	17	14	16	20	36	1.5	68	◣	422	▨		
							70		420	▨		
							72		418	▨		Bottom of boring at 73.0'. Water level not recorded. Boring backfilled w/ bentonite chips.
							74		416			
							76		414			
							78		412			
							80		410			
							82		408			
							84		406			
							86		404			
							88		402			

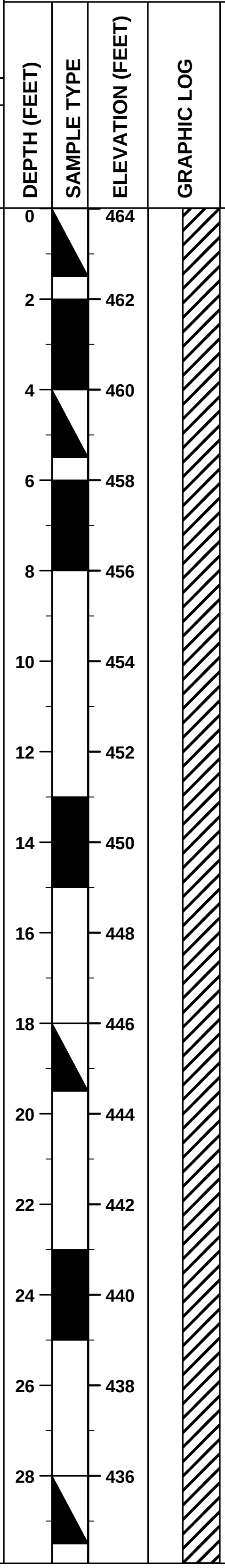
BLACK & VEATCH

BORING LOG

BORING NO. BV-105
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3690.0' E 10524.0'	**GROUND ELEVATION (DATUM)** 464.0 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Side hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING: SAMPLE TYPE ROCK CORING: CORE SIZE	SAMPLE NUMBER RUN NUMBER	SET 6 INCHES RUN LENGTH	2ND 6 INCHES RUN RECOVERY	3RD 6 INCHES RQD RECOVERY	N VALUE PERCENT RECOVERY	SAMPLE RECOVERY RQD	CLASSIFICATION OF MATERIALS	REMARKS
							CLAY: brown; firm; moist; high plasticity (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. @2' PP=2.0 tsf @3.5' PP=2.0 tsf @6' PP=2.8 tsf
SPT	1	2	2	3	5	0.8		
							grading stiff	
TW	2	2.0	-	-	-	1.5		
							grading firm	
SPT	3	3	3	4	7	1.5		
							grading yellow-brown & gray seams; very stiff	
TW	4	2.0	-	-	-	1.7		
							grading fissile	PP>4.5 tsf
TW	5	2.0	-	-	-	2.0		
								PP>4.5 tsf
SPT	6	6	8	10	18	1.5		
							grading w/occasional cemented quartz seams	PP>4.5 tsf
TW	7	2.0	-	-	-	1.8		
							grading blue-gray; hard; gray seams grades out	PP>4.5 tsf
SPT	8	12	15	24	39	1.5		



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BORING LOG

BORING NO. BV-105
SHEET 2 OF 2

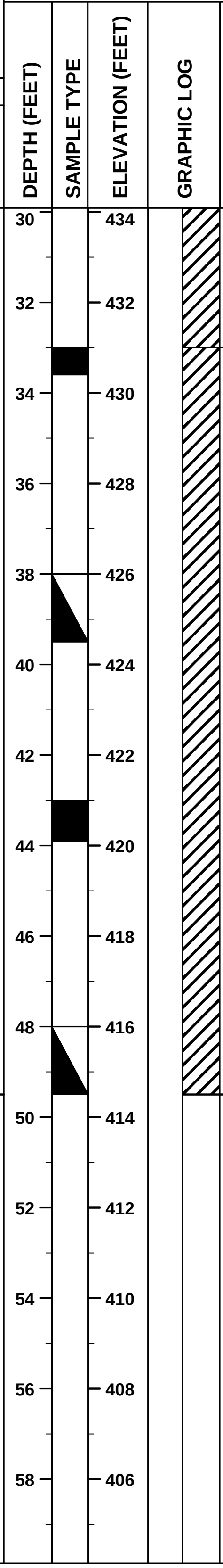
CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3690.0' E 10524.0'	**GROUND ELEVATION (DATUM)** 464.0 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Side hill, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/1/07	**DATE FINISHED** 8/1/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
TW	9	0.6	-	-	-	0.6
SPT	10	21	32	42	74	1.5
TW	11	0.9	-	-	-	0.9
SPT	12	32	42	46	88	1.5

ROCK CORING

CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD



CLASSIFICATION OF MATERIALS

33.0 CLAYSHALE; gray; hard; moist; high plasticity; fissile

grading w/frequent cemetations

REMARKS

TW refusal

Thick walled tube driven 100 blows

Bottom of boring at 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.

BLACK & VEATCH

BORING LOG

BORING NO. BV-106
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2448.0' E 9621.0'	**GROUND ELEVATION (DATUM)**
TOTAL DEPTH 44.2 (feet)	**SURFACE CONDITIONS** Valley, tall weeds	**COORDINATE SYSTEM** Plant
DATE START 8/3/07	**DATE FINISHED** 8/3/07	**LOGGED BY** JJ Deeken
CHECKED BY V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING											
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	ELEVATION (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING										
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD				
SPT	1	2	2	2	4	1.0	0	440	CLAY; brown; soft; moist; high plasticity; w/trace coarse sand & 1" gravel (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
TW	2	2.0	-	-	-	1.1	2	438	grading stiff	
SPT	3	2	5	5	10	0.1	4	436		@4' PP=2.2 tsf Gravel in SPT3
TW	4	2.0	-	-	-	2.0	6	434	grading dark gray; w/some gravel	
SPT	5	4	6	10	16	0.1	8	432	grading very stiff	Gravel in SPT5
							10	430		
							12	428		PP>4.5 tsf
TW	6	2.0	-	-	-	1.8	14	426		
							16	424		
SPT	7	14	26	33	59	1.5	18	422	grading hard; w/frequent light gray partings; occasional cemented clay seams; gravel grades out	
							20	420		
							22	418		
TW	8	0.8	-	-	-	0.8			23.0 CLAYSHALE; gray; hard; moist; high plasticity; fissile	
							24	416		
							26	414		
SPT	9	20	25	32	57	1.5	28	412		

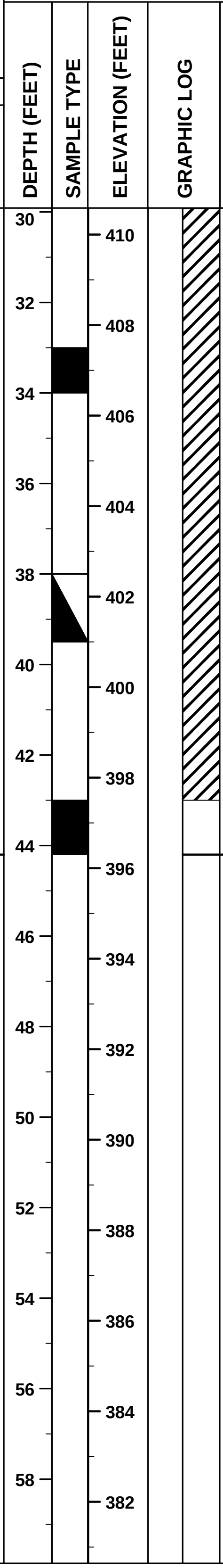
BLACK & VEATCH

BORING LOG

BORING NO. BV-106
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2448.0' E 9621.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 44.2 (feet)
SURFACE CONDITIONS Valley, tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07	**DATE FINISHED** 8/3/07
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
TW	10	1.0	-	-	-	1.0
SPT	11	26	35	43	78	1.5
TW	12	1.2	-	-	-	1.2



CLASSIFICATION OF MATERIALS

REMARKS

Thick walled tube pushed 8", then driven 2".

Thick walled tube pushed 4", then driven 10".

Bottom of boring at 44.2' Water level not recorded. Boring backfilled w/ bentonite chips.

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BORING LOG

BORING NO. BV-107

SHEET 1 OF 1

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 3101.0' E 10663.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 29.5 (feet)
SURFACE CONDITIONS Natural drainage path, brush cover	**COORDINATE SYSTEM** Plant	**DATE START** 08/09/2007	**DATE FINISHED** 08/09/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING													
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING												
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD						
							0		450	▨	CLAY; brown; moist; high plasticity; w/some gravel; trace sand (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
TW	1	2.0	-	-	-	1.2	6	■	444	▨	grading very stiff	PP=2.5 tsf
SPT	2	4	6	7	13	1.5	14	◣	438	▨	grading mottled yellow-brown-gray; stiff	
TW	3	1.2	-	-	-	1.2	18	■	432	▨	grading dark gray; moist; slightly fissile; w/some cemented clay seams & gravel	TW refusal @ 19.2'
SPT	4	16	20	28	48	1.5	23.0	◣	428	▨	CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/some gravel	Harder drilling
SPT	5	19	25	36	61	1.5	28	◣	422	▨		Bottom of boring at 29.5'. Water level not recorded. Piezometer installed on 08/09/07.

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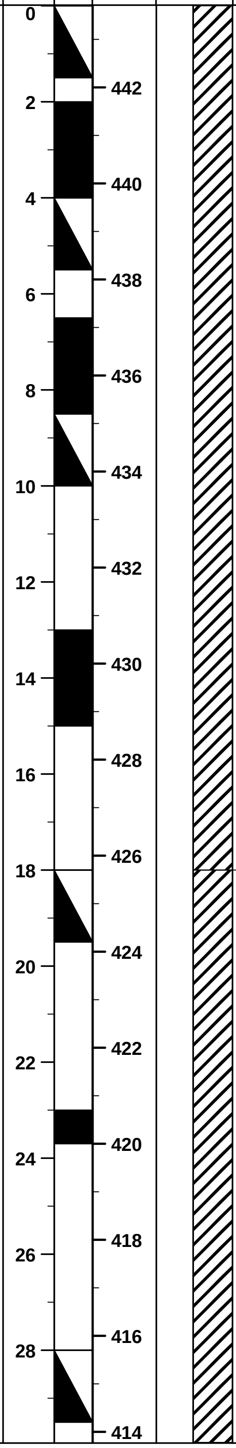
BORING LOG

BORING NO. BV-108
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2345.0' E 10497.0'
GROUND ELEVATION (DATUM) 443.7 ft (MSL)
TOTAL DEPTH 39.0 (feet)
SURFACE CONDITIONS Hill; weeds
COORDINATE SYSTEM Plant
DATE START 08/02/2007
DATE FINISHED 08/02/2007
LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING: SAMPLE TYPE, SAMPLE NUMBER, SET 6 INCHES, 2ND 6 INCHES, 3RD 6 INCHES, N VALUE, SAMPLE RECOVERY
ROCK CORING: CORE SIZE, RUN NUMBER, RUN LENGTH, RUN RECOVERY, RQD RECOVERY, PERCENT RECOVERY, RQD



SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
SPT	1	3	3	3	6	1.2	<u>CLAY</u>; brown; firm; moist; high plasticity; w/some sand & 1" gravel (6" Topsoil)	Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer. TW-2 disturbed @2' PP=3.2 tsf @4' PP=3.2 tsf
TW	2	2.0	-	-	-	2.0	grading yellow-brown	
SPT	3	3	6	7	13	1.5	grading stiff	
TW	4	2.0	-	-	-	2.0		TW4 PP=4.0 tsf
SPT	5	7	9	10	19	1.5	grading very stiff; w/some quartz sand	
TW	6	2.0	-	-	-	2.0	grading mottled dark gray	PP>4.5 tsf
SPT	7	16	26	38	64	1.5	<u>CLAYSHALE</u>; gray; hard; moist; high plasticity; fissile; w/occasional cementation @ 19.5' grading dark gray	PP>4.5 tsf
TW	8	0.7	-	-	-	0.7		PP>4.5 tsf
SPT	9	20	33	46	79	1.5		PP>4.5 tsf

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BORING LOG

BORING NO. BV-108

SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2345.0'	E 10497.0'	**GROUND ELEVATION (DATUM)** 443.7 ft (MSL)	**TOTAL DEPTH** 39.0 (feet)
SURFACE CONDITIONS Hill; weeds		**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007
LOGGED BY JJ Deeken		**CHECKED BY** V Bhadriraju		**APPROVED BY** BL Christensen

SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	DEPTH (FEET)	SAMPLE TYPE	ELEVATION (FEET)	GRAPHIC LOG	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD						
TW	10	0.8	-	-	-	0.8		■		▨		
TW	11	1.0	-	-	-	1.0		■		▨		
												Bottom of boring @ 39.0'. Water level not recorded. Boring backfilled w/ bentonite chips.

BLACK & VEATCH

BORING LOG

BORING NO. BV-109
SHEET 1 OF 2

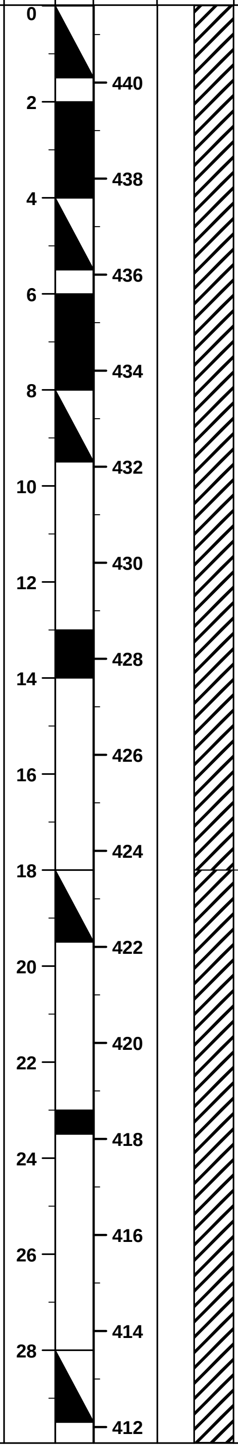
CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station		**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2339.0' E 10190.0'	**GROUND ELEVATION (DATUM)** 441.6 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)
SURFACE CONDITIONS Valley; tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007
LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
SPT	1	3	2	2	4	1.1
TW	2	2.0	-	-	-	1.0
SPT	3	3	6	6	12	1.4
TW	4	2.0	-	-	-	2.0
SPT	5	8	12	15	27	1.5
TW	6	1.0	-	-	-	1.0
SPT	7	17	27	37	64	1.5
TW	8	0.5	-	-	-	0.5
SPT	9	21	32	41	73	1.5

ROCK CORING

CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD



CLASSIFICATION OF MATERIALS

CLAY; brown; soft; moist; high plasticity (6" Topsoil)

grading yellow-brown

grading stiff

grading very stiff

grading dark gray

18.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/frequent cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

PP=2.0 tsf

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BORING LOG

BORING NO. BV-109

SHEET 2 OF 2

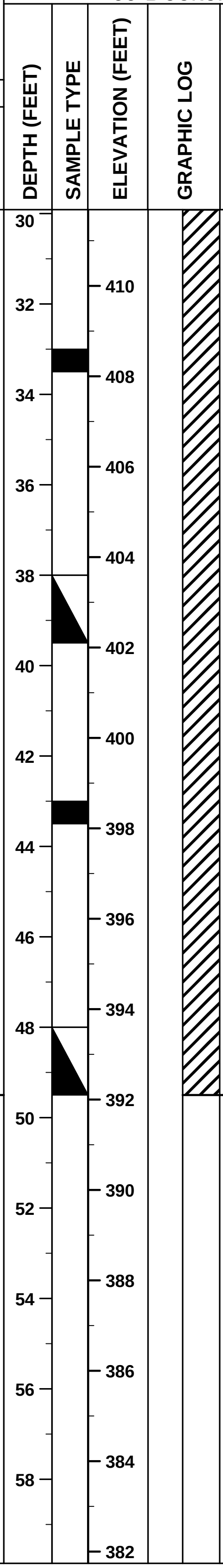
CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060

PROJECT LOCATION Reisel, Texas
COORDINATES N 2339.0' E 10190.0'
GROUND ELEVATION (DATUM) 441.6 ft (MSL)
TOTAL DEPTH 49.5 (feet)

SURFACE CONDITIONS Valley; tall weeds
COORDINATE SYSTEM Plant
DATE START 08/02/2007
DATE FINISHED 08/02/2007

LOGGED BY JJ Deeken
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING									
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING								
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
TW	10	0.5	-	-	-	0.5		Tube end crushed.
SPT	11	22	32	41	73	1.5		
TW	12	0.5	-	-	-	0.5		
SPT	13	27	39	46	85	1.5		Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.



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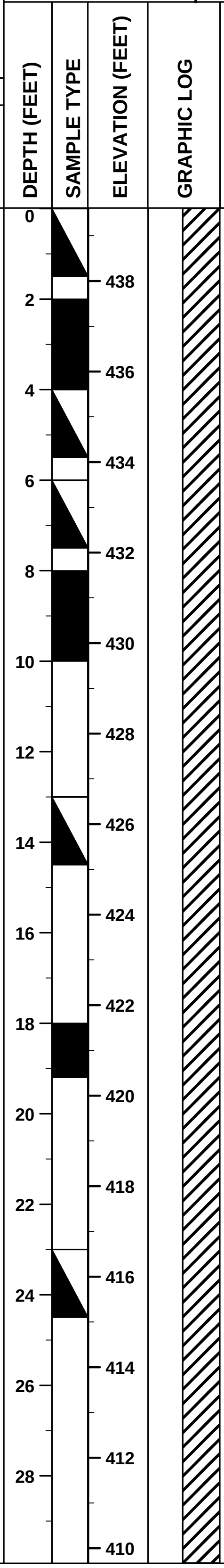
BORING LOG

BORING NO. BV-110
SHEET 1 OF 2

CLIENT Sandy Creek Energy Associates		**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2551.0' E 10393.0'	**GROUND ELEVATION (DATUM)** 439.6 ft (MSL)	**TOTAL DEPTH** 39.5 (feet)
SURFACE CONDITIONS Valley/tall weeds	**COORDINATE SYSTEM** Plant	**DATE START** 8/3/07	**DATE FINISHED** 8/4/07
LOGGED BY DE Campbell	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen	

SOIL SAMPLING / **ROCK CORING**

SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	WOH	2	2	4	1.2
TW	2	2.0	-	-	-	1.1
SPT	3	3	4	7	11	1.0
SPT	4	3	3	3	6	1.3
TW	5	2.0	-	-	-	2.0
SPT	6	3	5	8	13	1.3
TW	7	1.2	-	-	-	1.2
SPT	8	18	26	36	62	1.5



CLASSIFICATION OF MATERIALS

CLAY: brown; soft; moist; high plasticity; w/trace subrounded red fine gravel (6" Topsoil)

grading stiff

grading yellow-brown; firm

@ 10.0' grading mottled gray

grading w/trace cementation; gravel grades out

grading gray

grading hard; w/occasional cemented clay seams

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.
@2' PP=1.5 tsf

PP=2.25 tsf

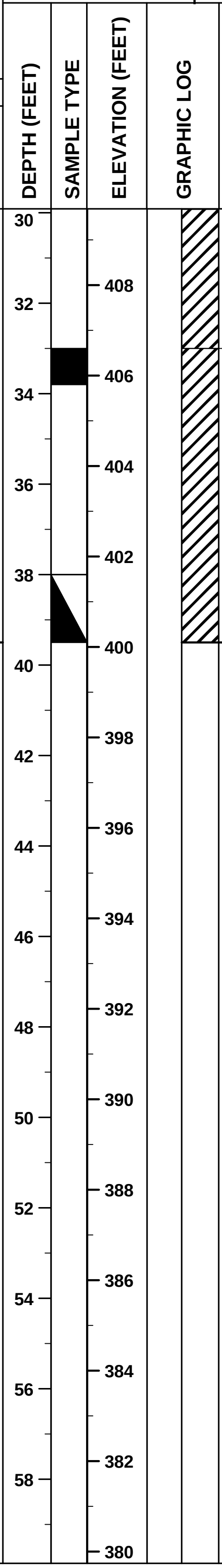
BLACK & VEATCH

BORING LOG

BORING NO. BV-110
SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates
PROJECT Sandy Creek Energy Station
PROJECT NO. 149060
PROJECT LOCATION Reisel, Texas
COORDINATES N 2551.0' E 10393.0'
GROUND ELEVATION (DATUM) 439.6 ft (MSL)
TOTAL DEPTH 39.5 (feet)
SURFACE CONDITIONS Valley/tall weeds
COORDINATE SYSTEM Plant
DATE START 8/3/07
DATE FINISHED 8/4/07
LOGGED BY DE Campbell
CHECKED BY V Bhadriraju
APPROVED BY BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
TW	9	0.8	-	-	-	0.8
SPT	10	22	34	43	76	1.5



CLASSIFICATION OF MATERIALS

33.0

CLAYSHALE: gray; hard; moist; high plasticity; fissile; w/trace cementation

REMARKS

Tube end crushed.

Bottom of boring @ 39.5'. Water level not recorded. Boring backfilled w/ bentonite chips.

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BORING LOG

BORING NO. BV-111
SHEET 1 OF 2

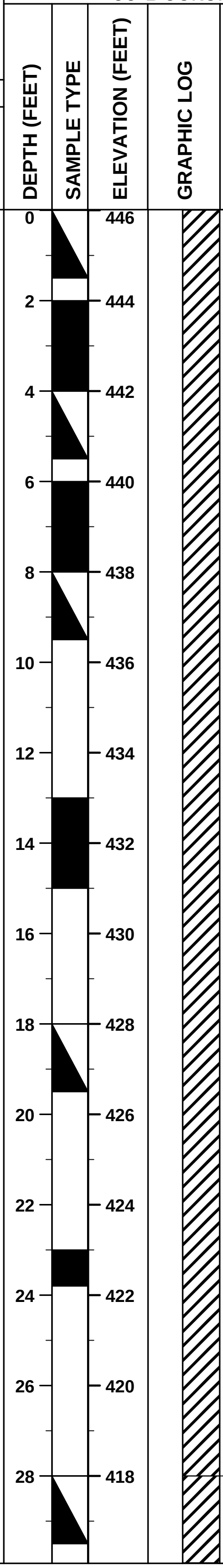
CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2739.0'	E 10465.0'	**GROUND ELEVATION (DATUM)** 446.0 ft (MSL)	**TOTAL DEPTH** 49.5 (feet)

SURFACE CONDITIONS tall weeds in valley, heavy rain	**COORDINATE SYSTEM** Plant	**DATE START** 08/02/2007	**DATE FINISHED** 08/02/2007

LOGGED BY JJ Deeken	**CHECKED BY** V Bhadriraju	**APPROVED BY** BL Christensen

SOIL SAMPLING						
SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY
ROCK CORING						
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	2	2	3	5	1.2
TW	2	2.0	-	-	-	1.5
SPT	3	2	4	5	9	1.4
TW	4	2.0	-	-	-	1.8
SPT	5	2	4	7	11	1.5
TW	6	2.0	-	-	-	2.0
SPT	7	10	15	19	34	1.5
TW	8	0.8	-	-	-	0.8
SPT	9	20	27	38	65	1.5



CLASSIFICATION OF MATERIALS

CLAY; brown; firm; moist; high plasticity
(6" Topsoil)

grading stiff

grading yellow; w/trace sand

@ 9.0' grading yellow-brown

grading hard; w/some sand
@ 18.5' grading w/1" gravel

@ 19.5' grading gray-brown

grading w/occasiional quartz seams

28.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/trace cementation

REMARKS

Boring advanced w/rotary wash using 3-7/8" step bit & bentonite mud as drilling fluid. SPT performed w/ autohammer.

@6' PP=1.5 tsf

@8' PP=3.5 tsf

PP>4.5 tsf

PP>4.5 tsf

BLACK & VEATCH

BORING LOG

BORING NO. BV-111

SHEET 2 OF 2

CLIENT Sandy Creek Energy Associates

PROJECT Sandy Creek Energy Station

PROJECT NO. 149060

PROJECT LOCATION Reisel, Texas

COORDINATES N 2739.0' E 10465.0'

GROUND ELEVATION (DATUM) 446.0 ft (MSL)

TOTAL DEPTH 49.5 (feet)

SURFACE CONDITIONS tall weeds in valley, heavy rain

COORDINATE SYSTEM Plant

DATE START 08/02/2007

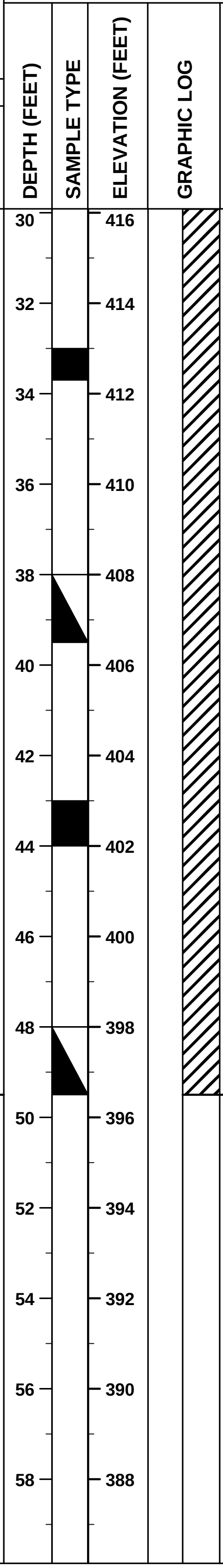
DATE FINISHED 08/02/2007

LOGGED BY JJ Deeken

CHECKED BY V Bhadriraju

APPROVED BY BL Christensen

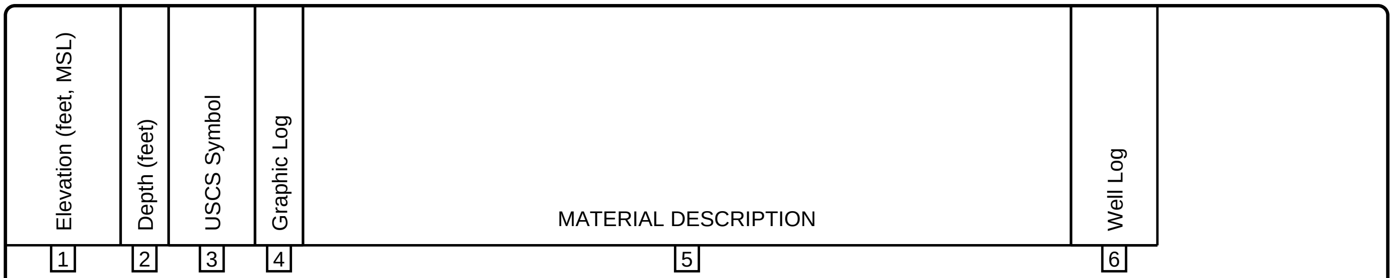
SOIL SAMPLING: SAMPLE TYPE	SAMPLE NUMBER	SET 6 INCHES	2ND 6 INCHES	3RD 6 INCHES	N VALUE	SAMPLE RECOVERY	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
TW	10	0.7	-	-	-	0.7		Thick walled tube driven.
SPT	11	23	44	41	85	1.5	grading dry to moist	
TW	12	1.0	-	-	-	1.0		Thick walled tube driven.
SPT	13	30	40	47	87	1.5		
								Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.



Project: **Sandy Creek Energy Station**
Project Location: **2161 Rattlesnake Road Riesel, TX 76682**
Project Number: **TXL0526 / 02**

Key to Log of Boring

Sheet 1 of 1



COLUMN DESCRIPTIONS

1. Elevation (feet, MSL): Elevation (feet, MSL)
2. Depth (feet): Depth in feet below the ground surface.
3. USCS Symbol: Type of material encountered.
4. Graphic Log: Graphic depiction of the subsurface material encountered.
5. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
6. Well Log: Graphical representation of well installed upon completion of drilling and sampling.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

■ Bentonite plug
🟧 Fat CLAY, CLAY w/SAND, SANDY CLAY (CH)
▤ Claystone
⁘ Portland Cement Concrete
⁘ Gravel
▦ Grout
⁘ Poorly graded SAND (SP)

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

▽ Water level (at time of drilling, ATD)
▼ Water level (after waiting)
Minor change in material properties within a stratum
— — Inferred/gradational contact between strata
—?— Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Figure A-1

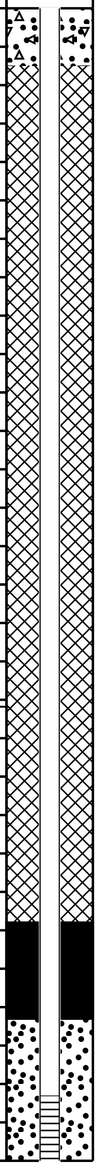
Project: **Sandy Creek Energy Station**
Project Location: **2161 Rattlesnake Road Riesel, TX 76682**
Project Number: **TXL0526 / 02**

Log of Boring BW-1
Sheet 1 of 2

Date(s) Drilled **9/21/2015 and 9/22/2015**	Logged By **Alexander Brewster**	Checked By **Lindsay O'Leary, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **5" and 8.25" HSA (Note 1)**	Total Depth of Borehole **50 ft**
Drill Rig Type **Truck-Mounted CME**	Drilling Contractor **Best Drilling Services, Inc.**	Approximate Surface Elevation **482.70 (ft, MSL)**
Groundwater Level and Date Measured **464.52 (ft, MSL) (9/28/2015)**	Sampling Method(s) **Core Barrel**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **UTM: N 10515061.29', E 3350322.30'. N-NE of Landfill Cell 2; between the warehouse and laydown yard; near the eastern corner of a stormwater swale.**	

Elevation (feet, MSL)	Depth (feet)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION
482.7	0			Fill; gravel
		CH		Fill; light brown CLAY; slightly moist; some localized gypsum crystals and sand pockets
477.7	5	CH		Fill; light brown CLAY with occasional thin strata of dark brown CLAY; slightly moist; bigger localized gypsum crystals;
472.7	10	CH		Light brown CLAY with thin strata of dark brown CLAY containing organic fines; moist; low recovery
467.7	15	CH		Dark brown CLAY with organic fines; moist
				some gravel pieces (9/28/2015) ▼
462.7	20	CH		Light brown / tan CLAY; moist
		CH		Brown CLAY; moist
457.7	25			
				Heavily crystallized calcite pockets; small gypsum / sand seams
452.7	30			

Well Log



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Project: **Sandy Creek Energy Station**
Project Location: **2161 Rattlesnake Road Riesel, TX 76682**
Project Number: **TXL0526 / 02**

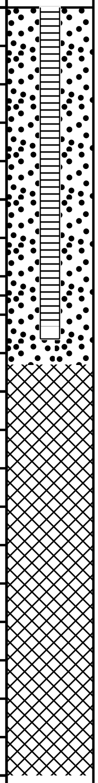
Log of Boring BW-1

Sheet 2 of 2

Elevation (feet, MSL)	Depth (feet)	USCS Symbol	MATERIAL DESCRIPTION
452.7	30	CH	Light brown CLAY interbedded with brown CLAY; moist; pronounced gypsum / sand seams
447.7	35	Claystone	Dark grey CLAYSTONE; slightly moist; hard
		CH	Light brown CLAY interbedded with brown CLAY; slightly moist
442.7	40	Claystone	Dark gray CLAYSTONE; slightly moist; hard
437.7	45		
432.7	50		End of drilling at 50 ft; no initial groundwater encountered.
427.7	55		
422.7	60		
417.7	65		

Note 1: A 5" borehole was drilled on 9/21/2015 for geotechnical logging purposes. On 9/22/2015, an 8.25" auger was used to expand the borehole for well installation purposes.

Well Log



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Project: **Sandy Creek Energy Station**

Project Location: **2161 Rattlesnake Road Riesel, TX 76682**

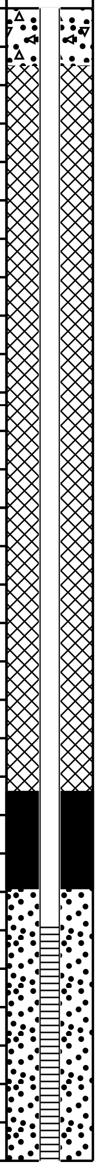
Project Number: **TXL0526 / 02**

Log of Boring MW-1

Sheet 1 of 2

Date(s) Drilled **9/21/2015**	Logged By **Alexander Brewster**	Checked By **Lindsay O'Leary, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8.25" HSA**	Total Depth of Borehole **45 ft**
Drill Rig Type **Truck-Mounted CME**	Drilling Contractor **Best Drilling Services, Inc.**	Approximate Surface Elevation **462.85 (ft, MSL)**
Groundwater Level and Date Measured **452.52 (ft, MSL) (9/28/2015)**	Sampling Method(s) **Core Barrel**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **UTM: N 10513907.71', E 3350439.78'. S of Landfill Cell 2; near northeastern edge of stormwater pond.**	

Elevation (feet, MSL)	Depth (feet)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION	Well Log
462.85	0	CH		Fill; light brown CLAY with gravel; dry	
		CH		Fill; light brown CLAY with some gravel; dry; some dessication	
457.85	5	CH		Light brown CLAY with occasional thin strata of dark brown CLAY containing organic fines; dry; slight dessication	
452.85	10			(9/28/2015) ▼	
		CH		Light brown CLAY; dry; thin sandy gypsum seams and crystals	
447.85	15				
442.85	20				
437.85	25			Low recovery	
432.85	30				



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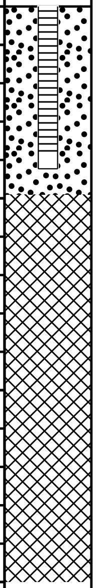
Project: **Sandy Creek Energy Station**
Project Location: **2161 Rattlesnake Road Riesel, TX 76682**
Project Number: **TXL0526 / 02**

Log of Boring MW-1

Sheet 2 of 2

Elevation (feet, MSL)	Depth (feet)	USCS Symbol	Graphic Log	MATERIAL DESCRIPTION
432.85	30		🟧	Low recovery
		Claystone	▤	Dark gray CLAYSTONE with thin strata of light brown CLAY; dry
427.85	35	Claystone	▤	Dark gray CLAYSTONE; dry; low recovery
422.85	40	Claystone	▤	Dark gray CLAYSTONE; moist
417.85	45			End of drilling at 45 ft; initial groundwater encountered at 45 ft.
412.85	50			
407.85	55			
402.85	60			
397.85	65			

Well Log



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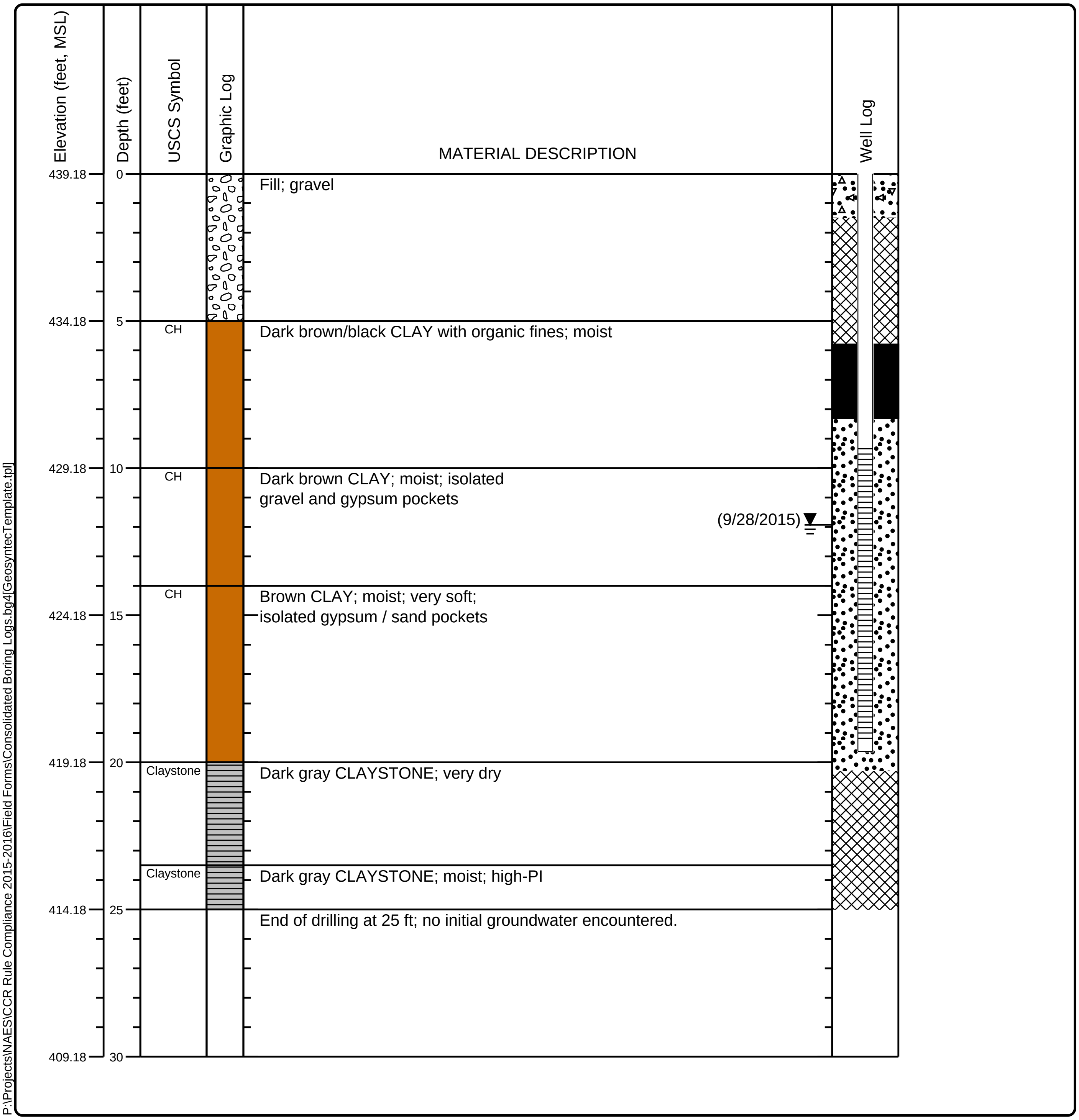
Project: **Sandy Creek Energy Station**
Project Location: **2161 Rattlesnake Road Riesel, TX 76682**
Project Number: **TXL0526 / 02**

Log of Boring MW-2
Sheet 1 of 1

Date(s) Drilled **9/23/2015**	Logged By **Alexander Brewster**	Checked By **Lindsay O'Leary, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8.25" HSA**	Total Depth of Borehole **25 ft**
Drill Rig Type **Truck-Mounted CME**	Drilling Contractor **Best Drilling Services, Inc.**	Approximate Surface Elevation **439.18 (ft, MSL)**
Groundwater Level and Date Measured **427.25 (ft, MSL) (9/28/2015)**	Sampling Method(s) **Core Barrel**	Hammer Data **N/A**
Borehole Backfill **Well Completion**	Location **UTM: N 10513176.91', E 3349982.33'. SE of leachate evaporation pond.**	



Elevation (feet, MSL)	Depth (feet)	USCS Symbol	MATERIAL DESCRIPTION
439.18	0		Fill; gravel
434.18	5	CH	Dark brown/black CLAY with organic fines; moist
429.18	10	CH	Dark brown CLAY; moist; isolated gravel and gypsum pockets
		CH	Brown CLAY; moist; very soft; isolated gypsum / sand pockets
424.18	15		
419.18	20	Claystone	Dark gray CLAYSTONE; very dry
		Claystone	Dark gray CLAYSTONE; moist; high-PI
414.18	25		End of drilling at 25 ft; no initial groundwater encountered.
409.18	30		

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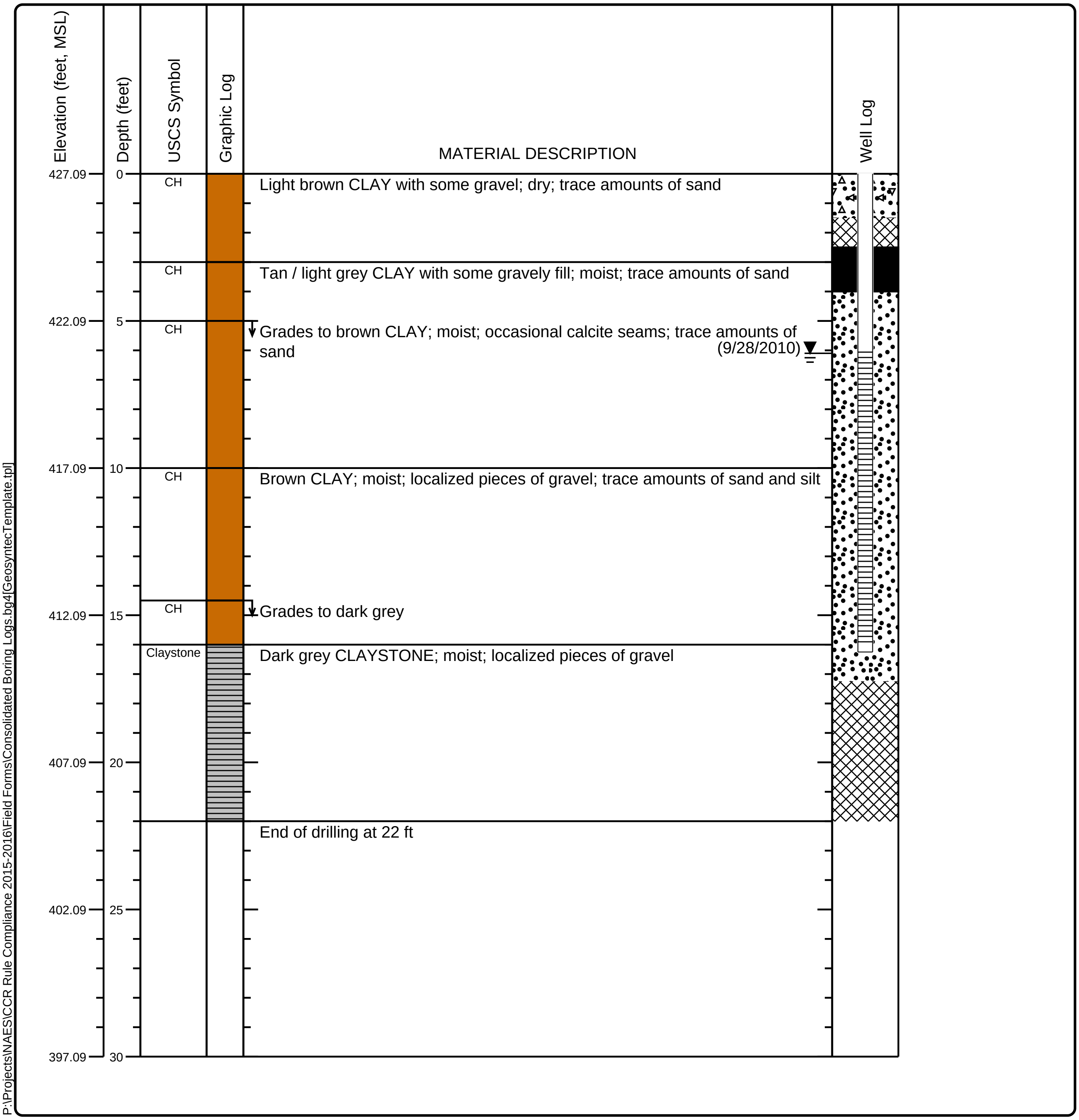
Project: **Sandy Creek Energy Station**
Project Location: **2161 Rattlesnake Road Riesel, TX 76682**
Project Number: **TXL0084 / 03**

Log of Boring MW-3 (GB-3)

Sheet 1 of 1

Date(s) Drilled **9/1/2010**	Logged By **M. Zahirul Islam**	Checked By **Lindsay O'Leary, P.E.**
Drilling Method **Hollow Stem Auger**	Drill Bit Size/Type **8.25" HSA**	Total Depth of Borehole **22 ft**
Drill Rig Type **Truck-Mounted CME**	Drilling Contractor **Total Support Services, Inc.**	Approximate Surface Elevation **427.09 (ft, MSL) (based on Oct 2015 survey)**
Groundwater Level and Date Measured **420.99 (ft, MSL) (9/28/2010)**	Sampling Method(s) **Core Barrel**	Hammer Data **N/A**
Borehole Backfill **Cement Bentonite Grout**	Location **UTM: N 10512867.54', E 3349455.27' (based on Oct 2015 survey). SW of leachate evaporation pond.**	



USCS Symbol	MATERIAL DESCRIPTION
CH	Light brown CLAY with some gravel; dry; trace amounts of sand
CH	Tan / light grey CLAY with some gravely fill; moist; trace amounts of sand
CH	Grades to brown CLAY; moist; occasional calcite seams; trace amounts of sand
CH	Brown CLAY; moist; localized pieces of gravel; trace amounts of sand and silt
CH	Grades to dark grey
Claystone	Dark grey CLAYSTONE; moist; localized pieces of gravel
	End of drilling at 22 ft

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Project: **Sandy Creek Energy Station**

Project Location: **2161 Rattlesnake Road Riesel, TX 76682**

Project Number: **TXL0084 / 03**

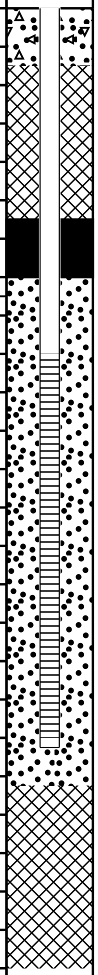
Log of Boring GB-2

Sheet 1 of 1

Date(s) Drilled	**8/31/2010 and 9/1/2010**	Logged By	**M. Zahirul Islam**	Checked By	**Lindsay O'Leary, P.E.**
Drilling Method	**Hollow Stem Auger**	Drill Bit Size/Type	**8.25" HSA**	Total Depth of Borehole	**25 ft**
Drill Rig Type	**Truck-Mounted CME**	Drilling Contractor	**Total Support Services, Inc.**	Approximate Surface Elevation	**444.62 (ft, MSL) (based on Oct 2015 survey)**
Groundwater Level and Date Measured	**437.12 (ft, MSL) (9/22/2010)**	Sampling Method(s)	**Core Barrel**	Hammer Data	**N/A**
Borehole Backfill	**Well Completion**	Location	**UTM: N 10513360.72', E 33494325.82' (based on Oct 2015 survey). Approximately 65 ft N of western corner of leachate evaporation pond.**		

Graphic Log

Well Log



Elevation (feet, MSL)	Depth (feet)	USCS Symbol	MATERIAL DESCRIPTION
444.62	0	CH	Tan / light grey CLAY with some gravel; moist
		CH	Brown CLAY; moist; occasional calcite seams; small amounts of sand and trace amounts of silt
439.62	5	CH	Brown CLAY with some gravel; occasional calcite seams; trace amounts of silt and sand
			(9/28/2010) ▼
434.62	10		
429.62	15	CH	↓ Grades to grey
		CH	Dark gray CLAY intermixed with light brown CLAY
		Claystone	Dark grey CLAYSTONE; dry
424.62	20		
419.62	25		End of drilling at 25 ft
414.62	30		

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SCS ENGINEERS
SCS Engineers
1901 Central Drive, Ste. 550
Bedford, Texas
Telephone: 817-571-2288

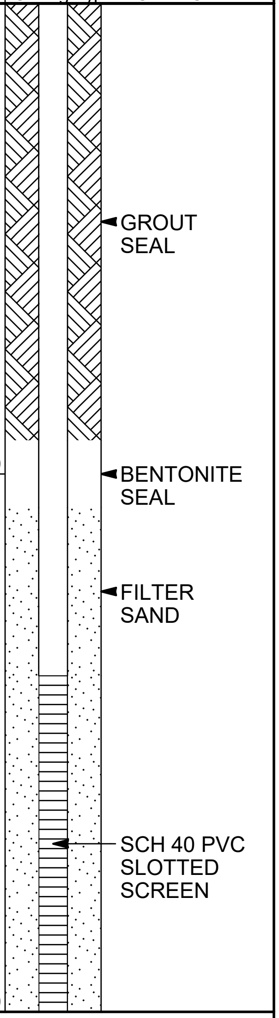
WELL NUMBER MW-4

PAGE 1 OF 1

CLIENT SCES
PROJECT NAME Sandy Creek
PROJECT NUMBER 16220089.00 T80
PROJECT LOCATION 2161 Rattlesnake Rd., Riesel, TX 76682
DATE STARTED 11/2/20 **COMPLETED** 11/2/20
GROUND ELEVATION 433.73 ft **HOLE SIZE** 8.25 inches
DRILLING CONTRACTOR West Drilling
GROUND WATER LEVELS:
DRILLING METHOD Hollow Stem Auger
AT TIME OF DRILLING ---
LOGGED BY AB **CHECKED BY** JL
AT END OF DRILLING ---
NOTES
AFTER DRILLING ---

DEPTH (ft)	NUMBER	GRAPHIC LOG	MATERIAL DESCRIPTION
0		▨	CLAY (CH): Dark brown, moist. light brown/tan to 14 feet, some gravel some gypsum seams, some sand hard sand lenses with increasing depth
14.0		☰	CLAYSTONE: Dark gray, slightly moist, some crystallized gypsum. dry becomes harder with increased depth, some sand lenses
30.0			Bottom of borehole at 30.0 feet.

WELL DIAGRAM
Casing Top Elev: 0 (ft)
Casing Type: SCH PVC



STATE OF TEXAS
James Lawrence
Discipline
License # 541
LICENSED PROFESSIONAL GEOSCIENTIST
James Lawrence
1/22/2021

APPENDIX II.B3

SETTLEMENT CALCULATIONS

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
REGISTRATION APPLICATION
TCEQ REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

APPENDIX II.B3
SETTLEMENT CALCULATIONS

Prepared for:

SANDY CREEK SERVICES, LLC
2161 Rattlesnake Road
Riesel, Texas 76682

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

Prepared by:

SCS ENGINEERS
Texas Board of Professional Engineers, Reg. No. F-3407
Dallas/Fort Worth Office
1901 Central Drive, Suite 550
Bedford, Texas 76021
817/571-2288

Revision 0 – January 2022
SCS Project No. 16221059.00

TABLE OF CONTENTS

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2 SITE SOILS....5
3 METHODOLOGY AND RESULTS....6
  3.1 METHODOLOGY....6
  3.2 RESULTS....7
  3.3 REFERENCES....7

Attachments

II.B3-1 Settlement Analyses
II.B3-2 Settlement Calculations Supplemental Information

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

1 INTRODUCTION

These Settlement Calculations have been prepared for Sandy Creek Services, LLC (Owner and Operator) of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill), located in McLennan County. These calculations have been prepared consistent with Texas Administrative Code (30 TAC) §352.641 and Title 40 of the Code of Federal Regulations (40 CFR) §257.64(b)(1) related to on-site or local soil conditions that may result in significant differential settling for Cell 3. Cells 1 and 2 are considered an existing Landfill (consistent with §257.53); therefore, they are not subject to the requirements of §352.641 [§257.64(b)(1)]. Cell 3 is considered a lateral expansion (consistent with §257.53) and will be constructed consistent with requirements in §352.641 [§257.64(b)(1)].

Settlement, which may induce stresses on the bottom liner system, may occur due to consolidation of the foundation soils resulting from the stress induced by the landfill components (e.g., bottom liner, waste, intermediate cover, and final cover systems). Therefore, settlement and the induced stresses on the bottom liner system were analysed in this Appendix.

Final cover settlement may occur due to consolidation of foundation soils and consolidation (primary) within the waste (mainly consisting of coal combustion residual (CCR)). However, following review of the final cover system as depicted in Drawing IV-3, final cover settlement calculations were not performed because: (1) the landfill final grades do not have a large flat top deck area; (2) the the waste disposed in this Landfill is compacted during placement to minimize future consolidation and settlement consistent with Section 2.3 of the Part V – Site Operating Plan; and (3) the waste disposed does not contain organic matter suseptable to settlement. Therefore, any settlement that may impede water flow and cause grade reversals and ponding is not anticipated.

2 SITE SOILS

As discussed in Part I – General Registration Application Requirements and Part VI – Groundwater Monitoring and Corrective Action Plan, soils at the Landfill are stiff to hard clays overlaying hard clayshale weathered from shale bedrock. For the foundation settlement calculations, the clayshale is assumed to be incompressible, and the clay layer remaining after cell excavation is considered to be the compressible layer. As depicted in the cross-section of Cell 3 in Attachment II.B3-1, the subgrade of the bottom liner system ranges from 31 to 71 feet of the clayshale. To be conservative, the clay overlaying the clayshale foundation soil layers are assumed to be normally consolidated.

3 METHODOLOGY AND RESULTS

3.1 METHODOLOGY

Foundation soils settlements are calculated using the following 1-D consolidation theory settlement equation used in geotechnical engineering for normally consolidated clays (Holtz and Kovacs, 1981).

$$S = C_c \frac{H}{1 + e_0} log\left(\frac{P}{P_0}\right)$$

where:

S = total settlement;
C_c = compression index;
H = initial thickness of compressible layer;
e_0 = initial void ratio;
P_0 = initial effective overburden stress;
P = final effective overburden pressure.

Following the calculation of settlement along the analyzed cross sections, settlement induced strains of the liner system are calculated using the following equation.

$$\varepsilon = \frac{L_0 - L_f}{L_0} \times 100\ (percent)$$

where:

ε = strain in the liner system (+ indicated compression, - indicated tension);
L_f = final length between calculation points based on post-settlement elevations; and
L_i = initial length between calculation points based on pre-settlement elevations.

The estimated tensile strains were compared to the conservative allowable tensile strains of 5% for the liner system geomembrane and 0.5% for the compacted clay liner.

Settlement of the foundation soils was calculated using the EXCEL spreadsheet provided in in Attachment II.B3-1. Material property assumptions are also summarized in this spreadsheet. Unit weight of the Landfill waste is assumed to be 105 pcf for settlement calculations. Compression index (Cc) was conservatively estimated for the compressible soils underlying the Landfill from consolidation tests results (ASTM D2435) conducted by Black and Veach (Geotechnical Design Report Revision 0. Sandy Creek Power Partners, Apr. 2009).

Potential heave (rebound) due to excavation of overburden above the excavation base grades was built into the foundation settlement spreadsheet when calculating the initial overburden stress of the soil layers.

One cross section (Section 1) was analyzed for the Cell 3. This cross section was located along the leachate collection and removal trench of the cell, which has the flattest slope on the cell floor (i.e., 1%). The location of the cross section on the excavation and final cover grading plans are presented in Attachment II.B3-1 along with the geometry of the cross section.

3.2 RESULTS

The minimum calculated post-settlement slope is 0.45% for the cross-section depicted in Attachment II.B3-1, as compared to the original pre-settlement slope of 1%. Therefore, positive drainage of leachate towards the leachate collection and removal sumps will be maintained. Maximum calculated tensile strain in the liner system is less than 0.1%, which is less than the allowable tensile strain for typical liner system geosynthetic components and compacted clay liners. As shown in attachment II.B3-1, the bottom liner system will be relaxing (i.e., no tension) in some of the areas of Cell 3 and therefore not impacted by settlement.

It is therefore concluded that foundation settlement and associated strain will not adversely affect the performance of the bottom liner system.

3.3 REFERENCES

Black & Veatch Corp., 2009, Geotechnical Design Report, Sandy Creek Energy Station, Riesel, Texas, Sandy Creek Power Partners.

Koerner, G. R. and Narejo, D., “Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to Soil Interfaces”, GRI Report #30, June 14, 2005.

ATTACHMENT II.B3 – 1
SETTLEMENT ANALYSES

STATE OF TEXAS
BRETT J. DeVRIES
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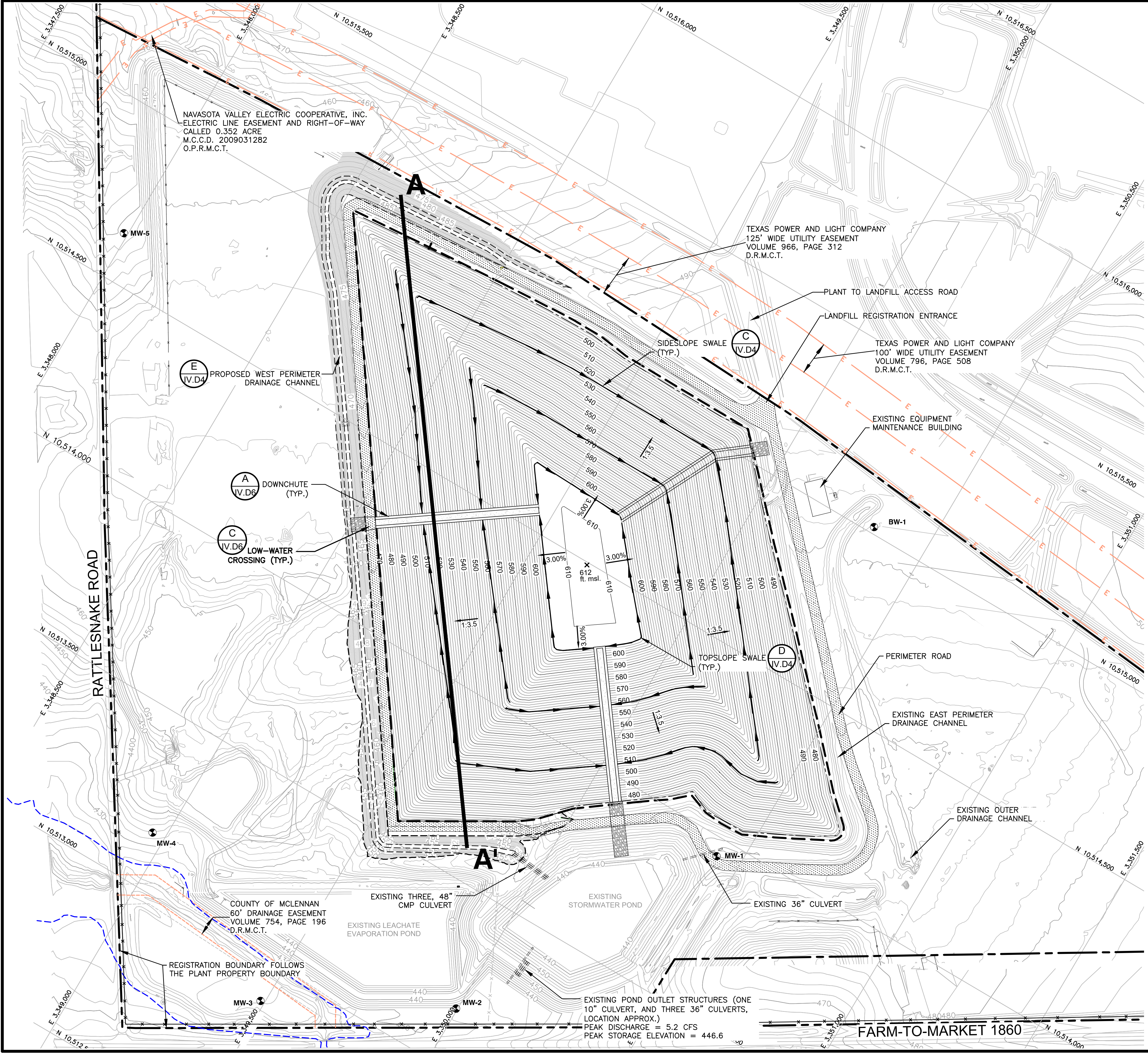
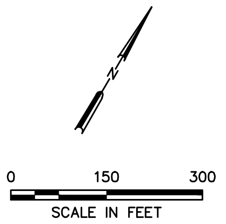
PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of Drawings
III.B3-1 and 2, and page
II.B3-1-2





LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
— - —	PLANT PROPERTY BOUNDARY
— - —	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 3)
— — —	REGISTERED LIMITS OF WASTE
N 10,516,500 E 3,347,000	STATE PLANE COORDINATES
MW-1	EXISTING GROUNDWATER MONITORING WELL
450	PROPOSED FINAL COVER CONTOUR
→ → →	PROPOSED DRAINAGE SWALES
▤	PROPOSED DOWNCHUTES
—×—×—	EXISTING FENCE
- - -	EXISTING DRAINAGE EASEMENT
— E —	EXISTING ELECTRICAL EASEMENT
- - -	100-YEAR FLOOD PLAIN (SEE NOTE 2)
▨	PERIMETER ROAD

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48309C0600D, DATED 10/20/2019.
3. REGISTRATION BOUNDARY IS FROM AN EXHIBIT AND FIELD NOTES FOR A 148.84 ACRES SOLID WASTE DISPOSAL FACILITY TRACT DEVELOPED BY WALKER PARTNERS IN SEPTEMBER 2021.

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
△			
△			
△			
△			
△			

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00	DSN. BY: BJD
DWN. BY: AGA	CHK. BY: SS
Q/A RVW BY: SS	APP. BY: BJD

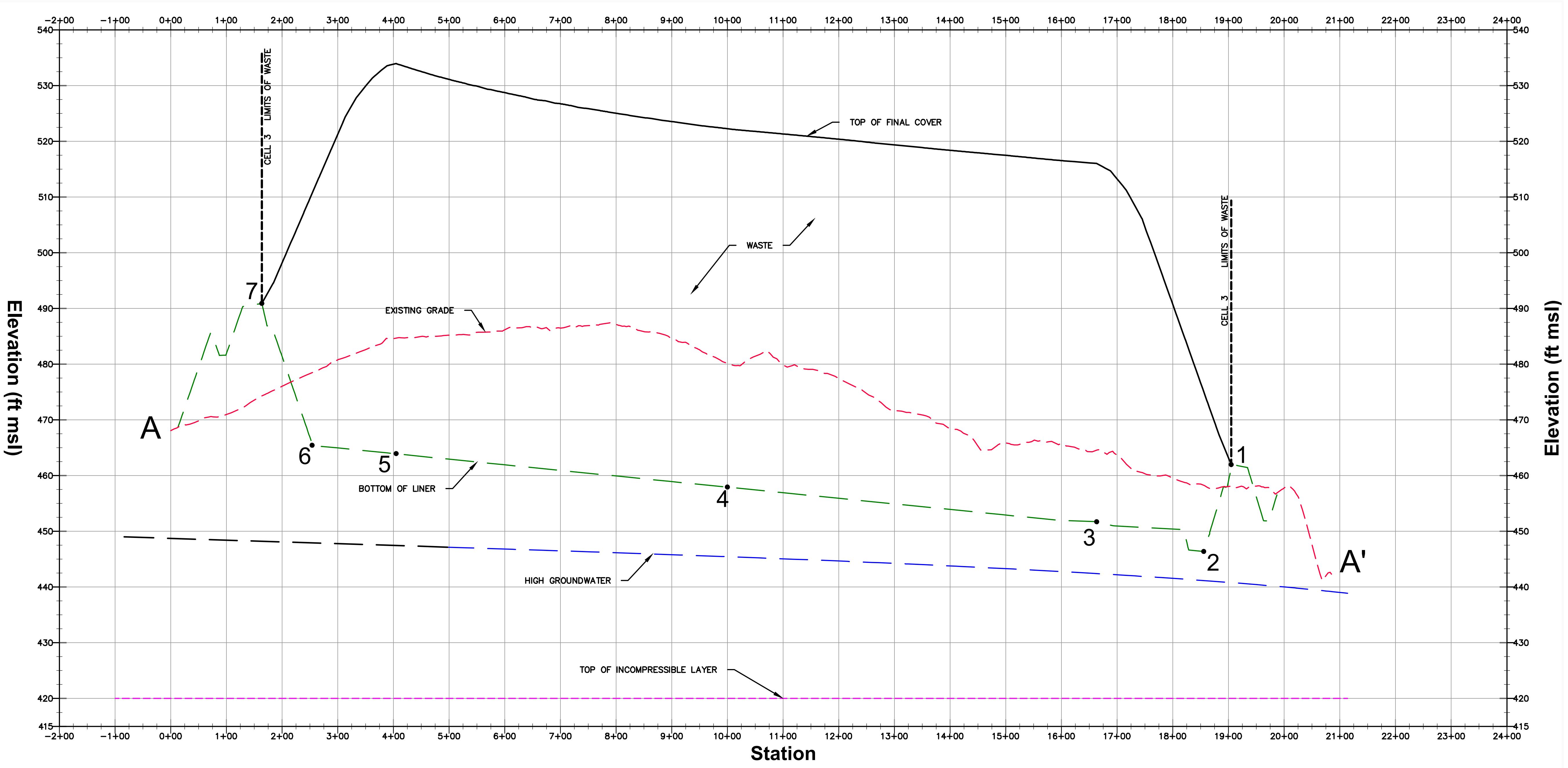
CADD FILE: INTERIM DRAINAGE DESIGN (CELLS 1 – 3)

DATE: 9/2021

SCALE: AS SHOWN

DRAWING NO.
II.B3-1

1/17/2022 11:54 AM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\Interim Drainage Design (Cells 1 - 3)



LEGEND

▬ ▬ ▬	LIMITS OF WASTE/CELL BOUNDARIES
— — —	EXISTING TOPOGRAPHY
— — —	BOTTOM OF LINER
———	TOP OF FINAL COVER GRADES
— — —	HIGH GROUNDWATER
- - - -	INCOMPRESSIBLE LAYER

0 10 20
VERTICAL SCALE IN FEET

0 100 200
HORIZONTAL SCALE IN FEET

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
△			
△			
△			
△			
△			
△			

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CROSS SECTION A-A'

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE: CROSS SECTIONS

DATE: 11/2021

SCALE: AS SHOWN

DRAWING NO.
II.B3-2

ATTACHMENT II.B3 – 1
SETTLEMENT ANALYSES

Date: November 4, 2021
Project: CCR Waste Management Facility, McLennan County, TX
Project No.: 16221059.00

Calc'd by: BD Date: 11/4/2021
Chk'd by: BG Date: 11/5/2021

Spreadsheet to calculate the amount of foundation soils consolidation/settlement.
Cell 3 - Cross Section 1

Equation: $S = C_c * [H/(1+e_o)] * \log(P/P_o)$, where

S = total settlement due to consolidation; feet
C_c = Average compression index;
w = Moisture Content; %
H = thickness of the foundation soil layer; feet
e_o = average initial void ratio of the foundation soil layer before surcharge
P = total pressure acting on mid-height of the foundation soil layer, ($P = P_o + s$);psf.
s = surcharge ($s = (H_s \times \gamma_{CCR}) + (F \times \gamma_{Fill}) - (C \times \gamma_{Foundation\ Soil})$)
H_s = Height of Waste in feet
P_o = present effective overburden pressure at mid-height of the foundation soil layer; psf

ASSUMPTIONS:

1. Average unit wt. of liner/fnl cvr, γ_{Fill} (pcf):	120
2. Average unit wt. of waste, γ_{waste} (pcf):	103
3. Unit weight of foundation soil, $\gamma_{Foundation\ Soil}$ (pcf):	125
4. eo:	0.56
5. C_c:	0.220
6. Thickness of Final Cover System (ft)	3.0

Location of Consideration Point	EG El. feet	GWT El. feet	Top of Bedrock El. feet	Subgrade El. feet	Top of Protective Soil Layer feet	Top of Final Cover feet	Thickness of Found. Soil to Bedrock H feet	Existing Ground to Bedrock H_o feet	Fill F feet	Cut C feet	Height of Waste H_s feet	C_c -	Surcharge (ΔP) s psf	e_o -	P'$_o$ psf	P' (P'$_o$ + ΔP) psf	Settlement S feet
SECTION 2																	
A_1 (x=0)	457.9	440.8	420.0	462.0	466.0	466.0	42.0	37.9	4.1	-4.1	0.0	0.220	521	0.5600	2,126	2,647	0.56
A_2 (x=50.5)	458.3	441.2	420.0	450.0	454.0	475.1	30.0	38.3	0.0	8.3	18.1	0.220	1,117	0.5600	2,527	3,644	0.67
A_3 (x=242.7)	464.6	442.4	420.0	451.9	455.9	516.0	31.9	44.6	0.0	12.6	57.1	0.220	4,545	0.5600	3,173	7,718	1.74
A_4 (x=906.0)	480.3	445.5	420.0	458.6	462.6	522.2	38.6	60.3	0.0	21.7	56.7	0.220	3,149	0.5600	4,736	7,885	1.20
A_5 (x=1,501.0)	484.6	447.4	420.0	464.5	468.5	534.0	44.5	64.6	0.0	20.1	62.5	0.220	3,699	0.5600	4,971	8,670	1.52
A_6 (x=1,651.0)	478.5	447.9	420.0	466.0	470.0	510.5	46.0	58.5	0.0	12.5	37.5	0.220	2,012	0.5600	4,127	6,139	1.12
A_7 (x=1,743.0)	474.8	448.2	420.0	490.9	494.9	494.9	70.9	54.8	16.1	0.0	0.0	0.220	110	0.5600	2,869	2,979	0.16
Max. Settlement (Cell Floor)																	1.74
Max. Settlement (Side Slope)																	0.56

Analysis Location	Point A_1	Point A_2	Point A_3	Point A_4	Point A_5	Point A_6	Point A_7
x-Coordinate	0.0	50.5	242.7	906.0	1501.0	1651.0	1743.0
Pre-settlement Top of Subgrade, ft	462.00	450.00	451.92	458.56	464.51	466.01	490.90
Total Settlement, ft	0.56	0.67	1.74	1.20	1.04	0.00	1.04
Post-settlement Top of Subgrade, ft	461.44	449.33	450.18	457.35	463.47	466.01	489.86

Analysis Location	Point A_1 to Point A_2	Point A_2 to Point A_3	Point A_3 to Point A_4	Point A_4 to Point A_5	Point A_5 to Point A_6	Point A_6 to Point A_7
Pre-settlement Slope, %	23.76	1.00	1.00	1.00	1.00	27.06
Post-settlement Slope, %	23.98	0.45	1.08	1.03	1.69	25.93
Initial Length, ft	51.91	192.21	663.33	595.03	150.01	95.31
Final Length, ft	51.93	192.20	663.34	595.03	150.02	95.04
Strain, % (- values=no tension)	0.049%	-0.004%	0.001%	0.000%	0.009%	-0.279%

ATTACHMENT II.B3 – 2
SETTLEMENT CALCUALATIONS SUPPLEMENTAL INFORMATION

GEOTECHNICAL DESIGN REPORT, SANDY CREEK ENERGY STATION, RIESEL, TEXAS, SCPP, APRIL 2009

Sandy Creek Energy Station
Riesel, Texas

Geotechnical Design Report
Revision 0

SCPP Project 149060
SCPP File No. 52.0106

April 2009

SCPP
Sandy Creek Power Partners

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Related to coefficient of consolidation

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See Groundwater Monitoring System Certification Report for Solid Waste Disposal Facility, Sandy Creek Energy Station, Riesel, McLennan County, Texas, Geosyntec Consultants, March 2016

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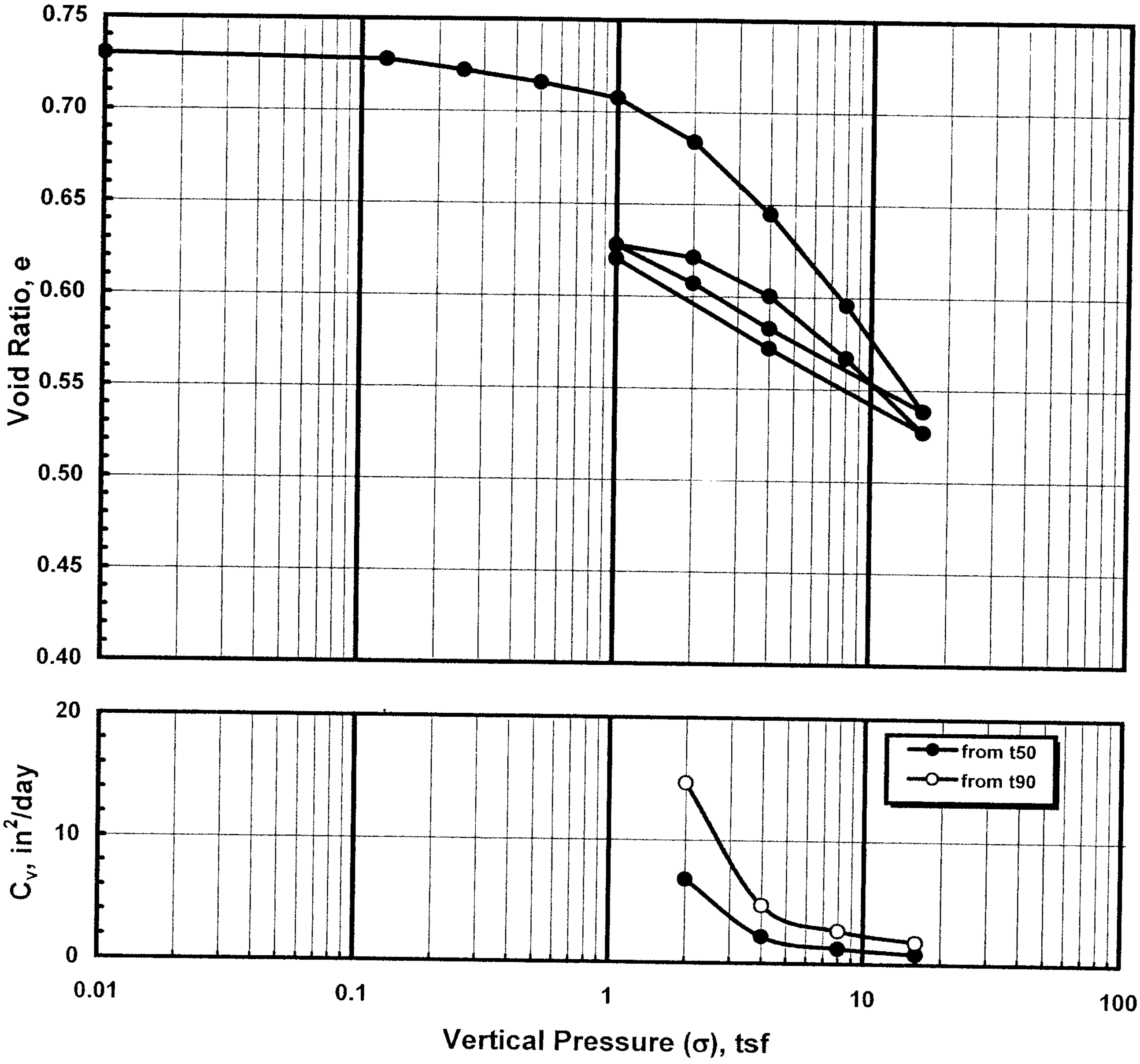
Appendix F
Laboratory Test Results

CONSOLIDATION TEST RESULTS - ASTM D 2435



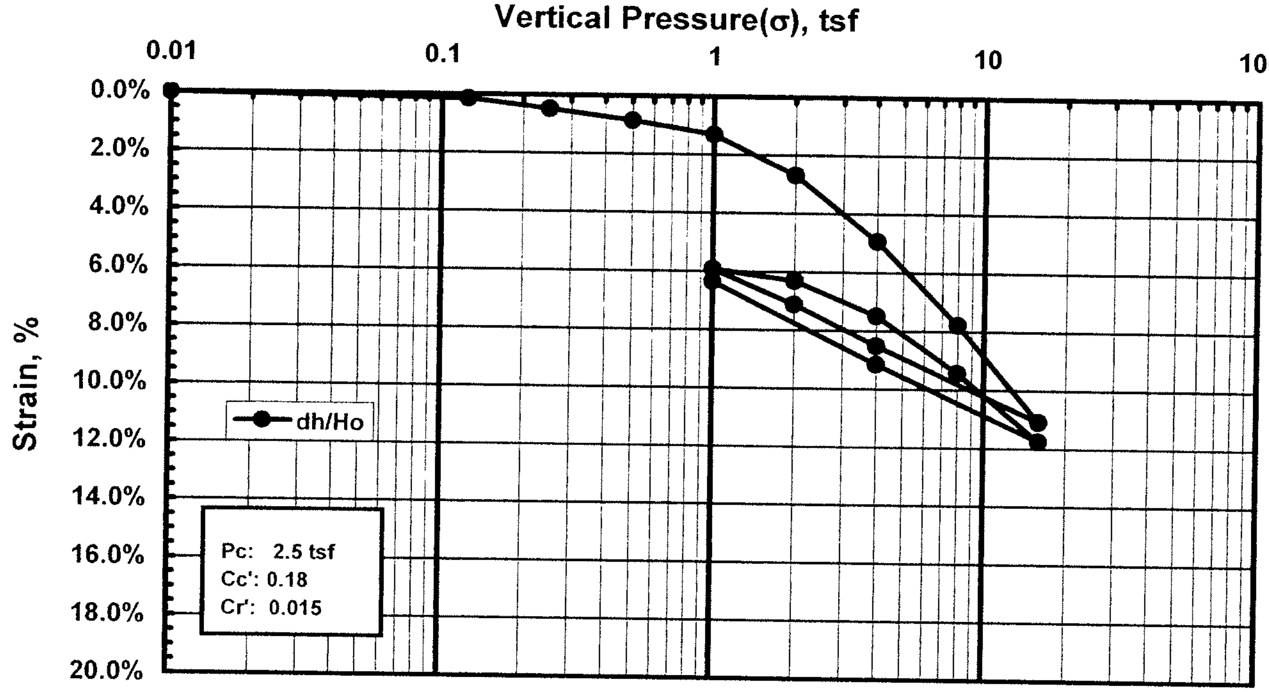
Sample Condition	Before	After
Moisture Content, %:	26.5%	26.9%
Sample Height, in.:	1.0000	0.8826
Void Ratio, e:	0.7302	0.5271
Unit Weight, pcf:	95.6	108.3
Degree of Saturation:	0.96	1.35

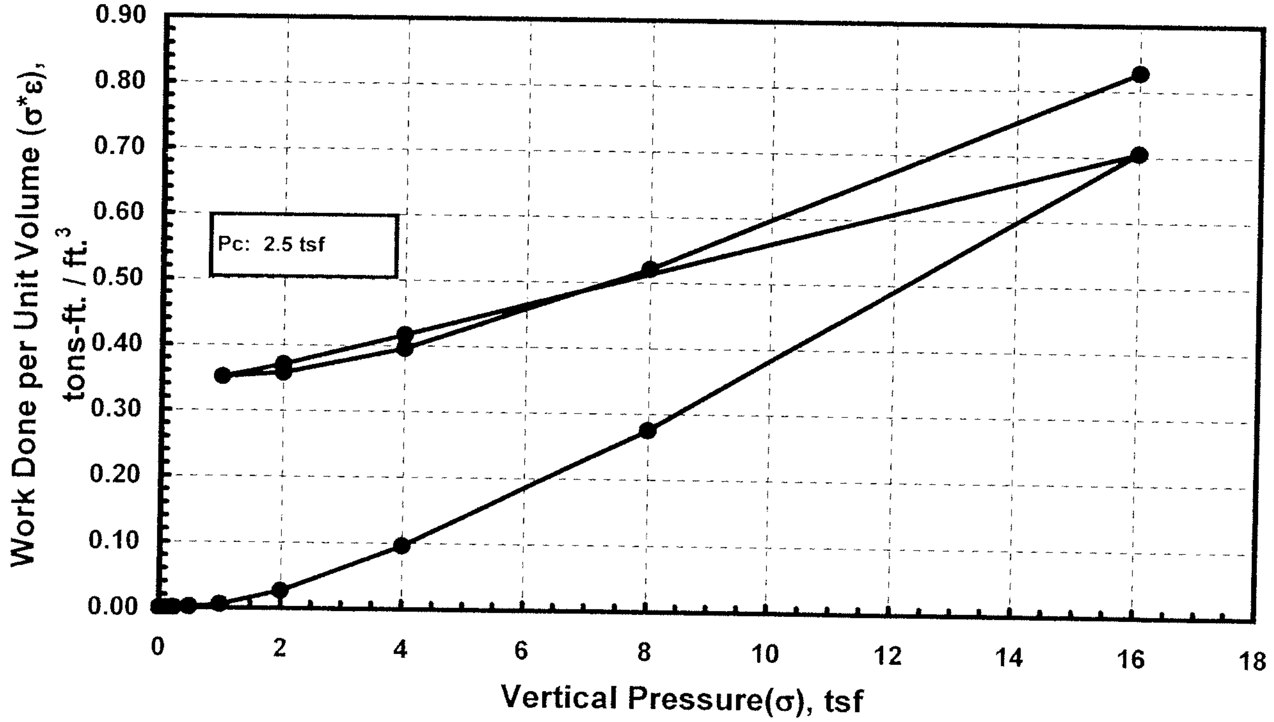
Consolidation Parameters	
Overburden Pressure, tsf:	1.1
Preconsolidation Pressure, tsf:	2.5
Compression Index, Cc:	0.18
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-1
Sample ID, Depth:	TW-6, 18-20 feet

Liquid Limit: - Hand Pen: -
Plastic Limit: -
Plastic Limit: -
Sample Classification: Silty Clay, Brown, Gray

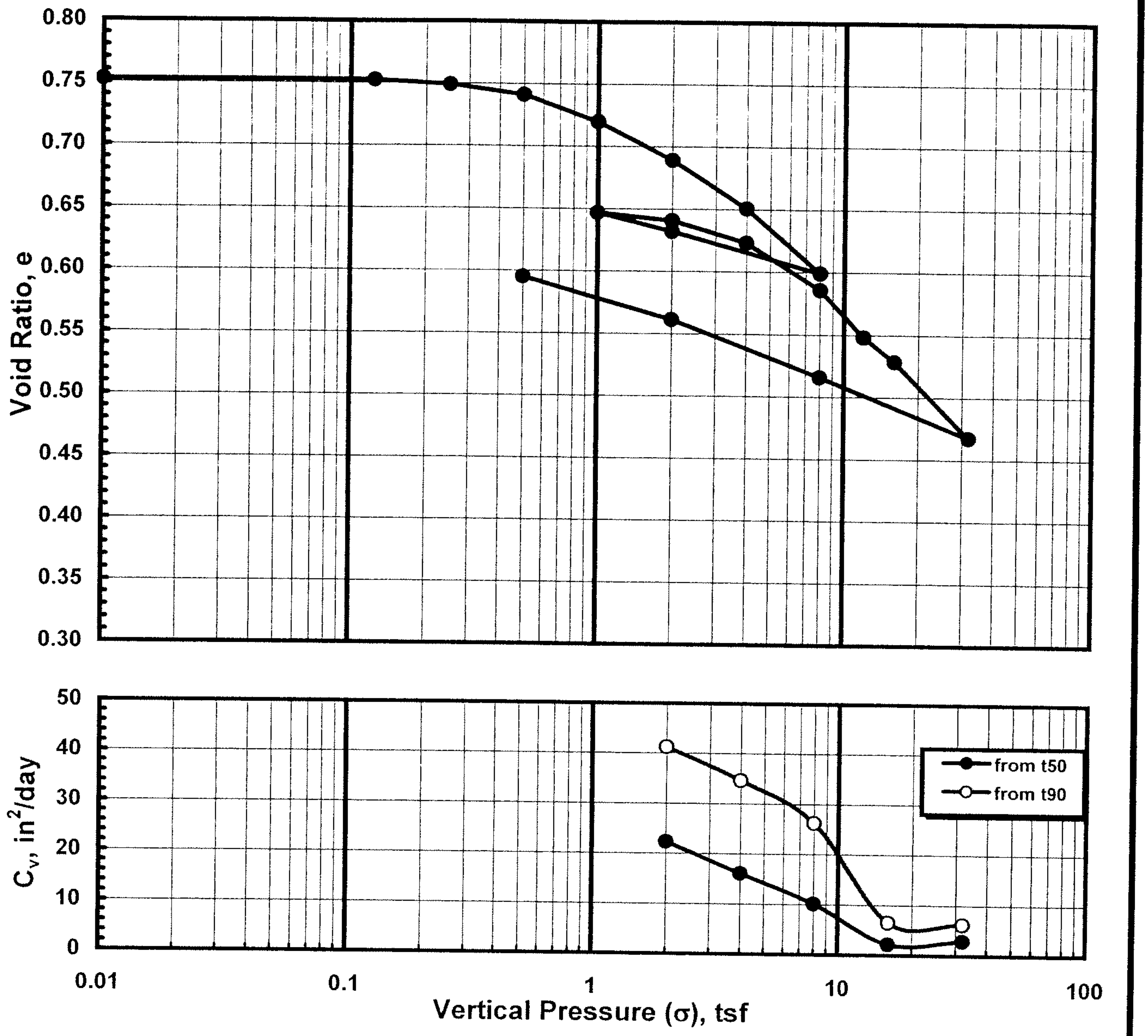
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-1	Plastic Limit:	-		
Sample ID, Depth:	TW-6, 18-20 feet	Sample Classification:	Silty Clay, Brown, Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435

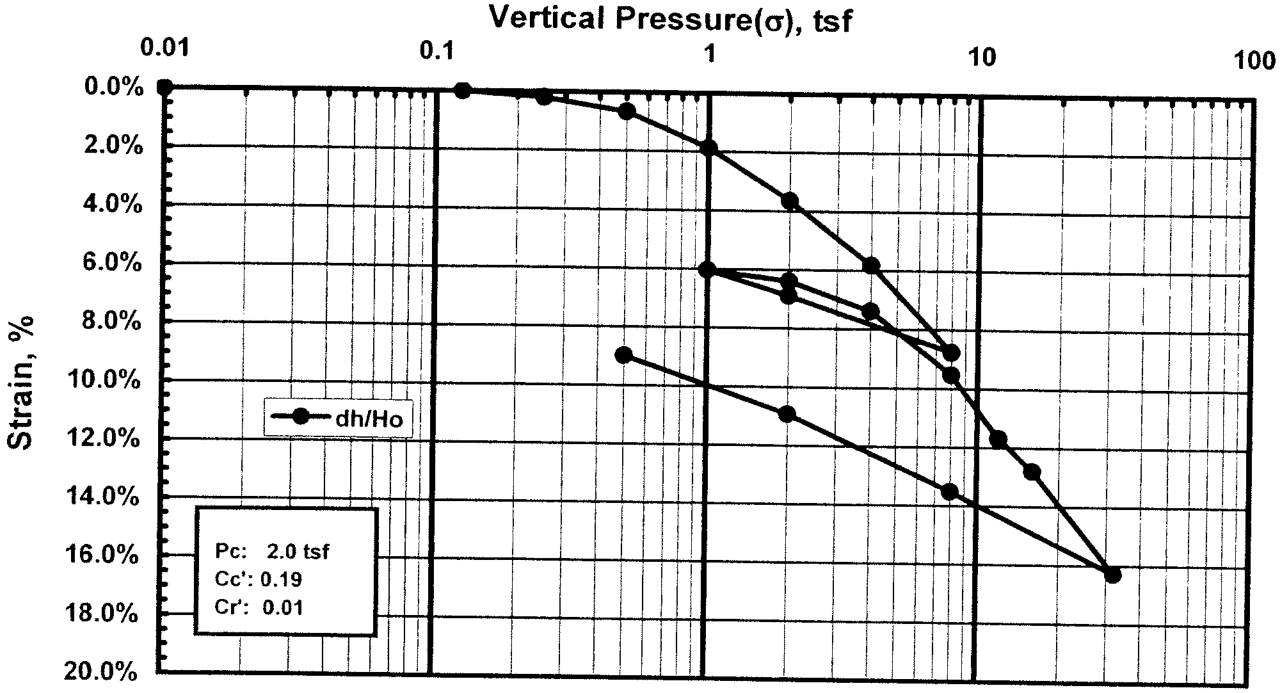


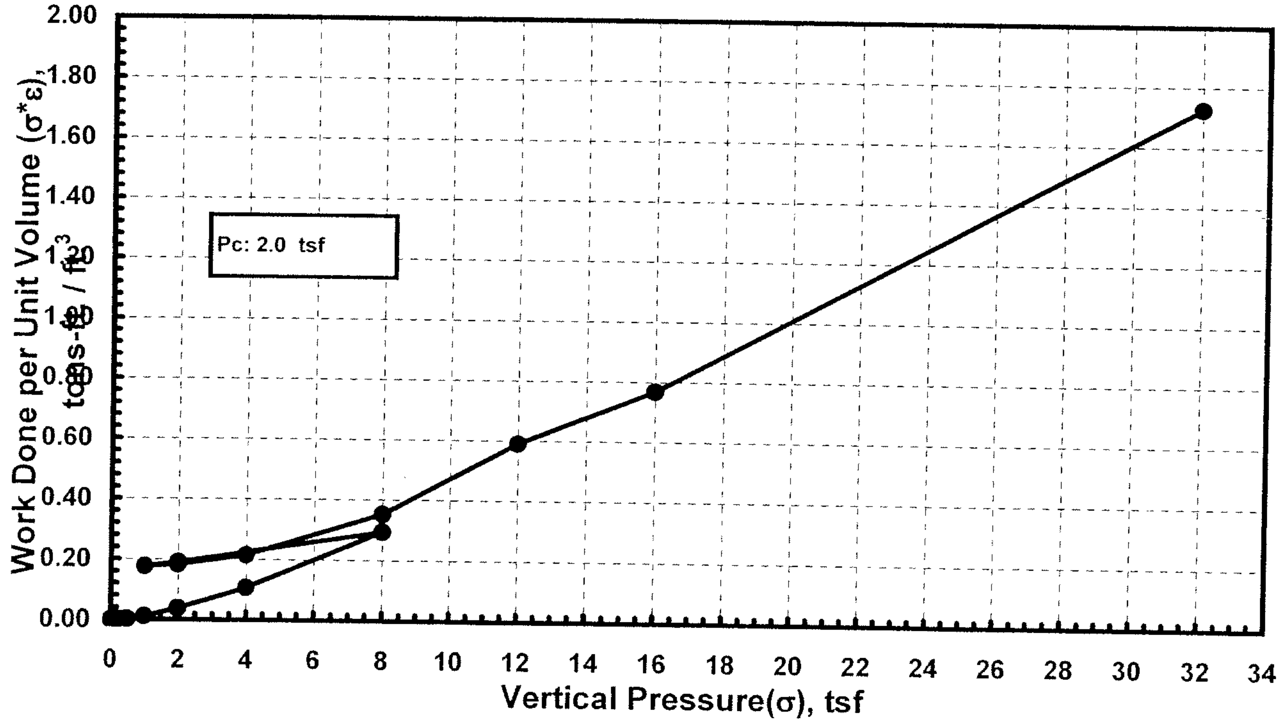
Sample Condition	Before	After
Moisture Content, %:	26.7%	25.6%
Sample Height, in.:	1.0000	0.9102
Void Ratio, e:	0.7526	0.5952
Unit Weight, pcf:	94.4	103.7
Degree of Saturation:	0.94	1.14

Consolidation Parameters	
Overburden Pressure, tsf:	1.7
Preconsolidation Pressure, tsf:	2.0
Compression Index, Cc:	0.19
Re-Compression Index, Cr	0.01

Project Number:	286-75083	Liquid Limit:	66	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	30		
Boring No.:	BV-2	Plastic Limit:	36		
Sample ID, Depth:	TW-7, 28-29.7 feet	Sample Classification:	Lean Clay (CL), Brown, Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435

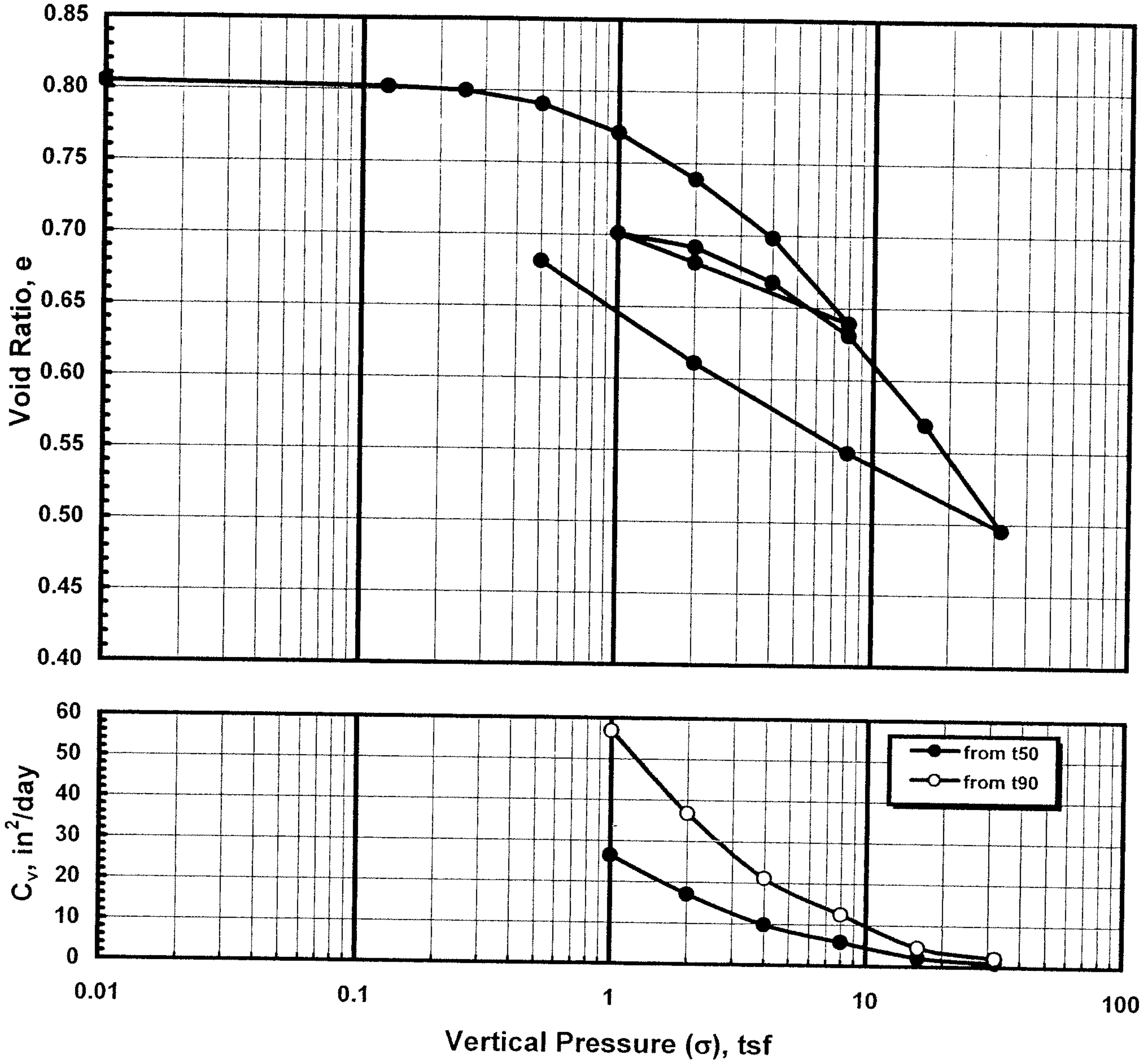




Project Number:	286-75083	Liquid Limit:	66	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	30		
Boring No.:	BV-2	Plastic Limit:	36		
Sample ID, Depth:	TW-7, 28-29.7 feet	Sample Classification:	Lean Clay (CL), Brown, Gray		

BV-2, TW-7, 28-29.7 feet *Page 3 of 11*

CONSOLIDATION TEST RESULTS - ASTM D 2435

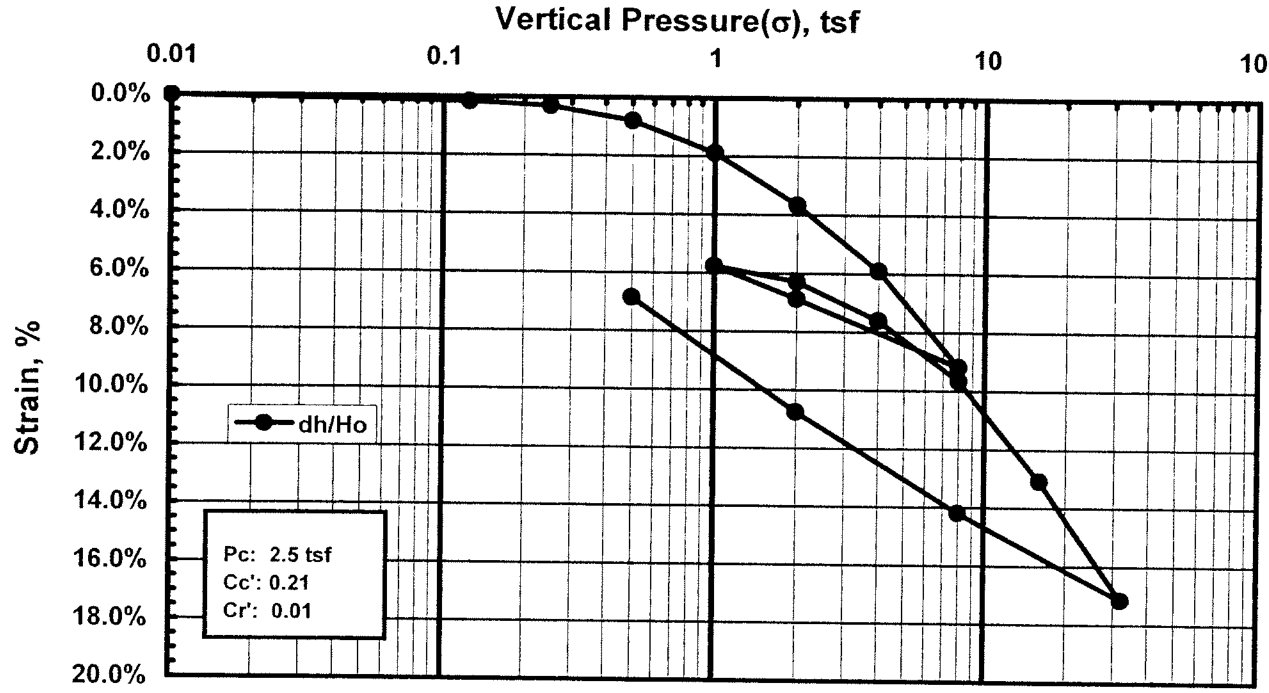


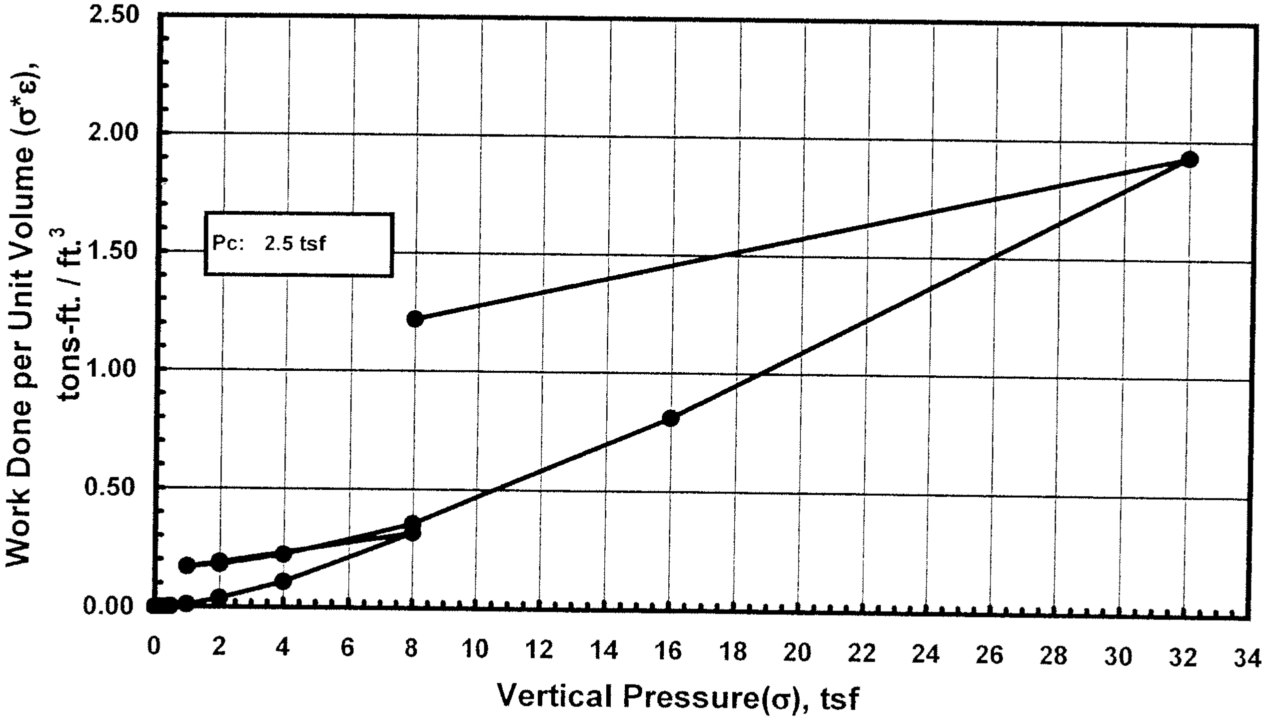
Sample Condition	Before	After
Moisture Content, %:	27.7%	29.5%
Sample Height, in.:	0.8750	0.8151
Void Ratio, e:	0.8049	0.6814
Unit Weight, pcf:	91.6	98.3
Degree of Saturation:	0.91	1.15

Consolidation Parameters	
Overburden Pressure, tsf:	0.8
Preconsolidation Pressure, tsf:	2.5
Compression Index, Cc:	0.21
Re-Compression Index, Cr	0.01

Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-4	Plastic Limit:	-		
Sample ID, Depth:	TW-4, 13-14 feet	Sample Classification:	-		

CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	- Hand Pen: -
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-
Boring No.:	BV-4	Plastic Limit:	-
Sample ID, Depth:	TW-4, 13-14 feet	Sample Classification:	-

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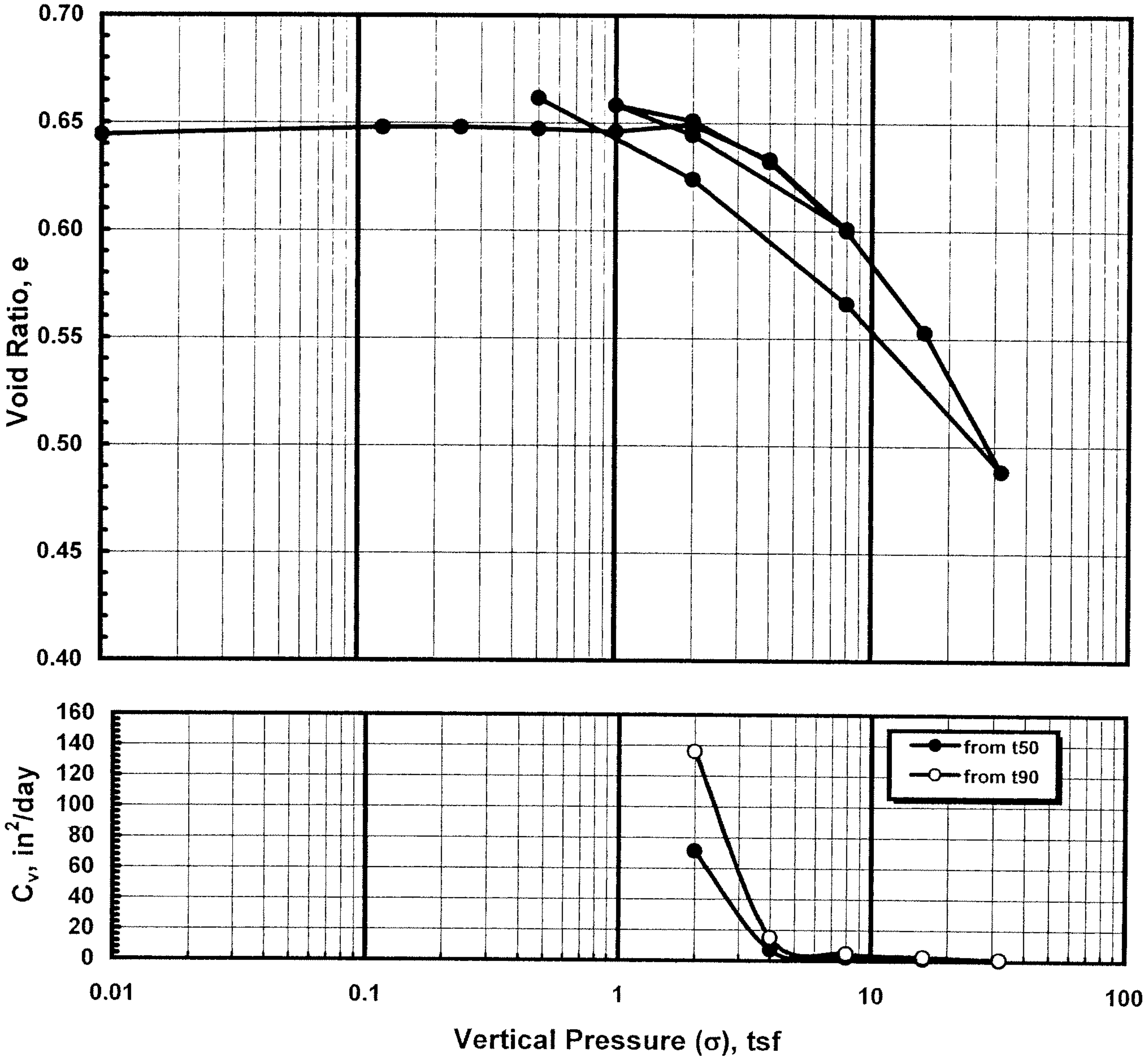
CONSOLIDATION TEST RESULTS - ASTM D 2435

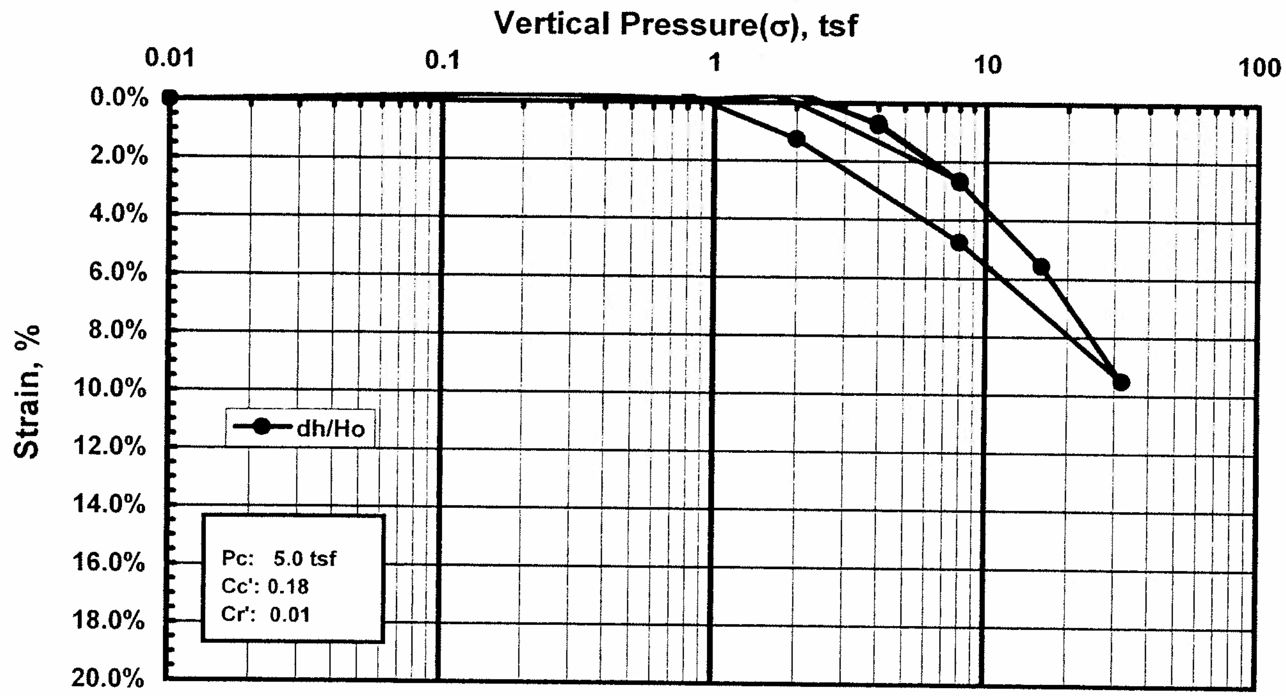


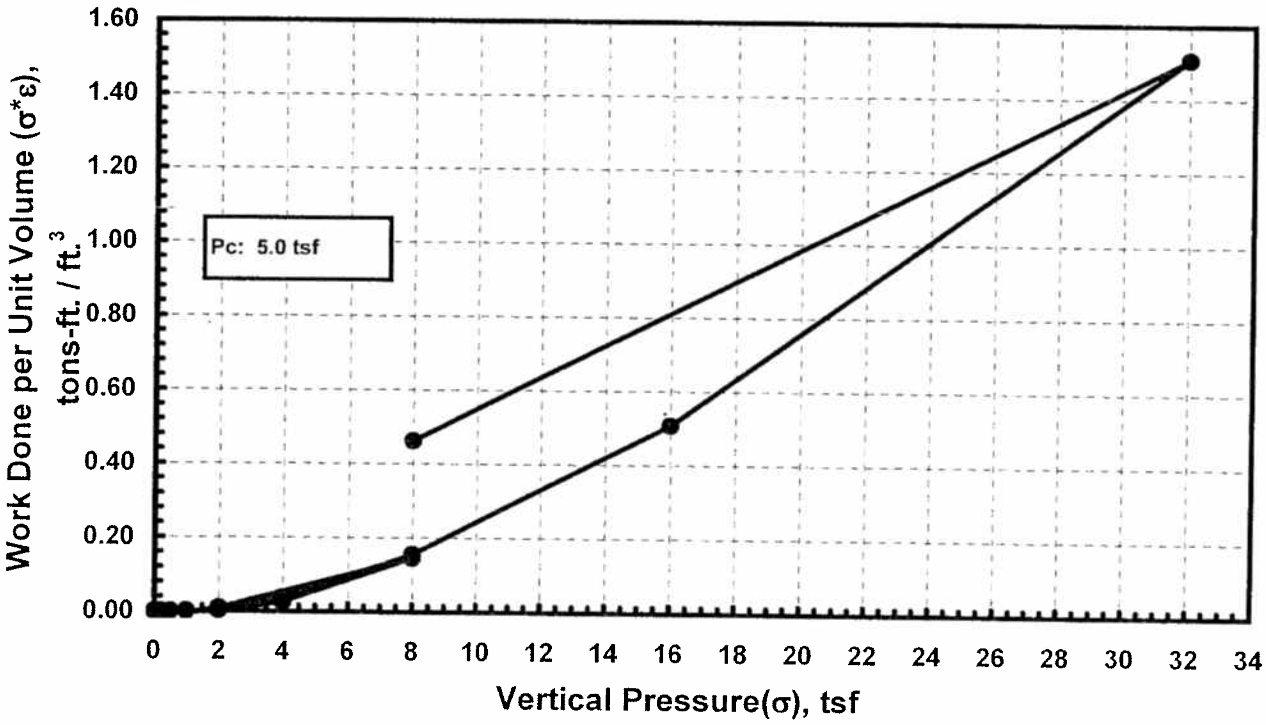
Sample Condition	Before	After
Moisture Content, %:	21.6%	23.8%
Sample Height, in.:	1.0000	1.0105
Void Ratio, e:	0.6443	0.6616
Unit Weight, pcf:	104.4	103.3
Degree of Saturation:	0.92	0.99

Consolidation Parameters	
Overburden Pressure, tsf:	2.1
Preconsolidation Pressure, tsf:	5.0
Compression Index, Cc:	0.18
Re-Compression Index, Cr	0.01

Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-8	Plasticity Index:	-		
Sample ID, Depth:	TW-12, 35-36 feet	Sample Classification:	Fat Clay (CH), Dark Gray		

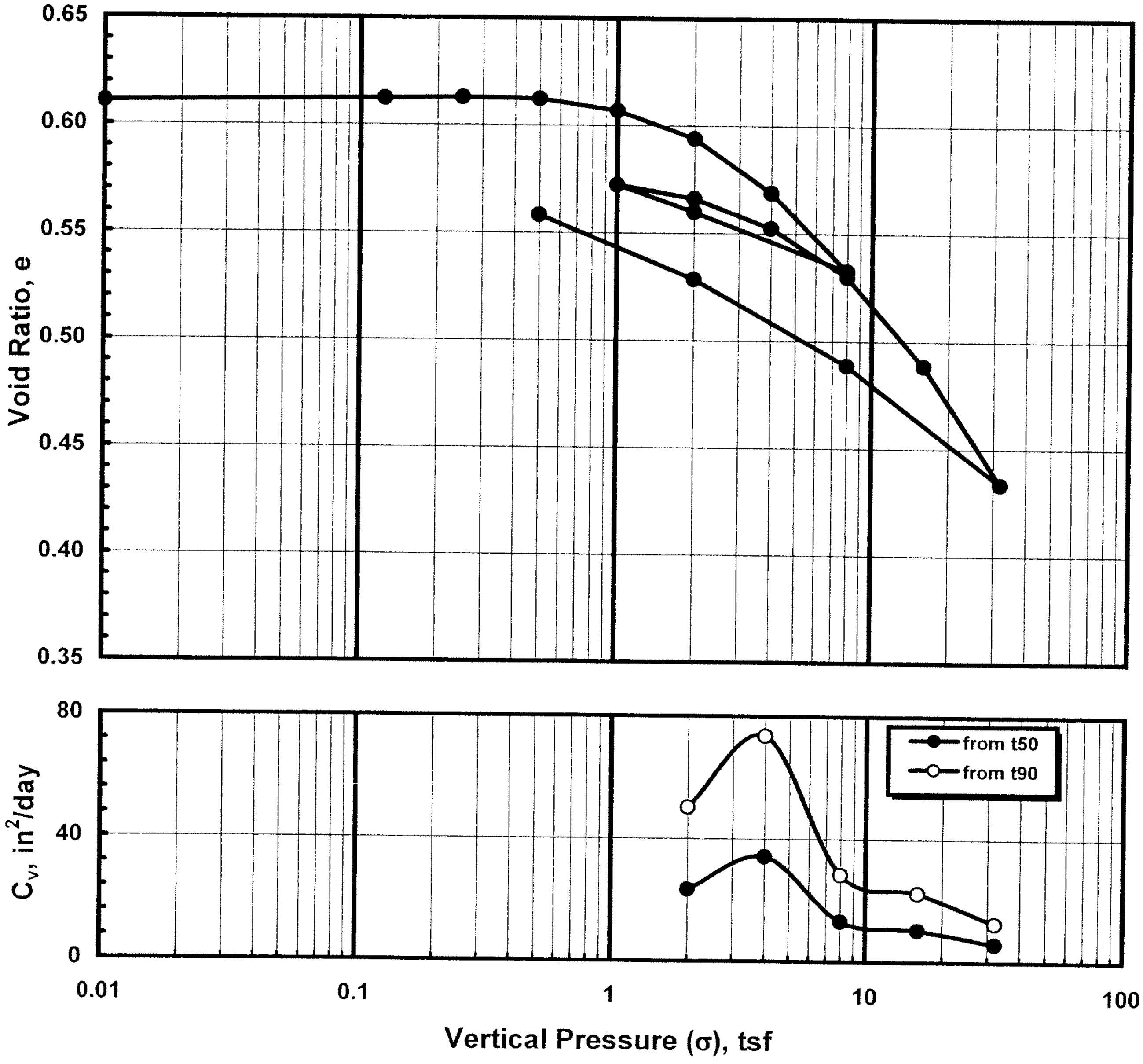
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-8	Plastic Limit:	-		
Sample ID, Depth:	TW-12, 35-36 feet	Sample Classification:	Fat Clay (CH), Dark Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	18.3%	19.3%
Sample Height, in.:	1.0000	0.9674
Void Ratio, e:	0.6108	0.5583
Unit Weight, pcf:	106.5	110.1
Degree of Saturation:	0.82	0.95

Consolidation Parameters	
Overburden Pressure, tsf:	3.2
Preconsolidation Pressure, tsf:	3.5
Compression Index, Cc:	0.16
Re-Compression Index, Cr	0.01

Project Number: 286-75083

Project Name Sandy Creek Energy Station, Riese

Boring No.: BV-6

Sample ID, Depth: TW-11, 53-53.7 feet

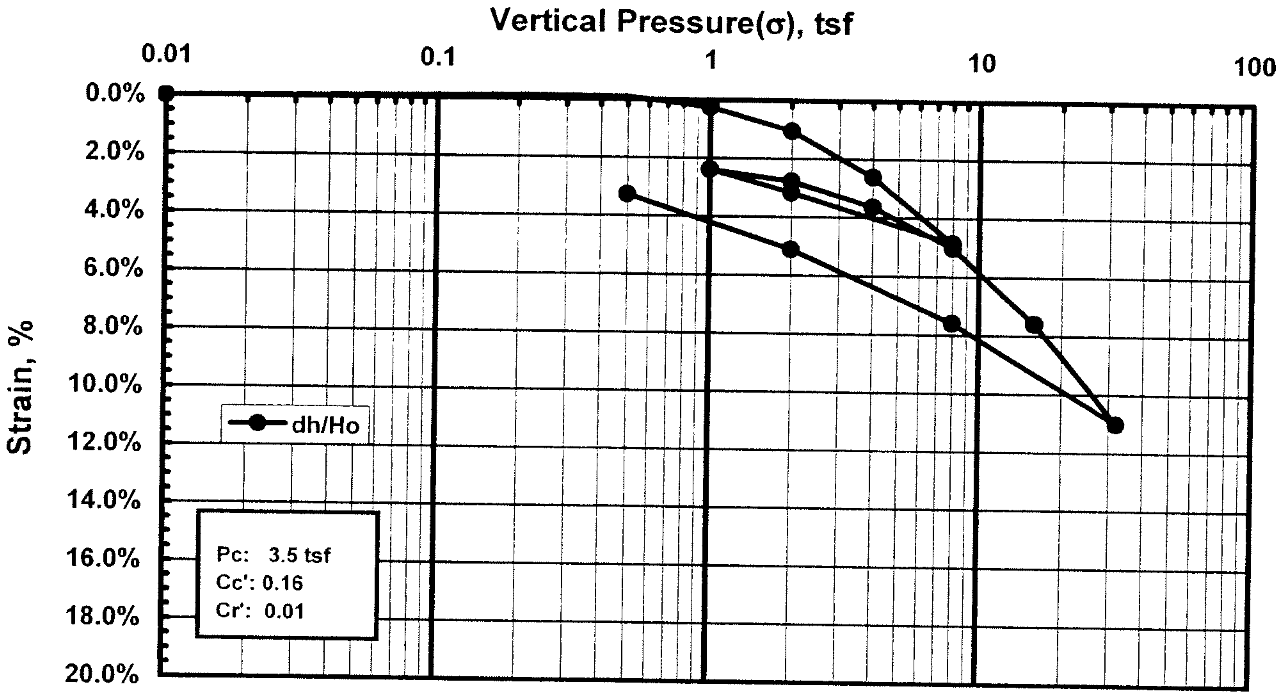
Liquid Limit: - Hand Pen: -

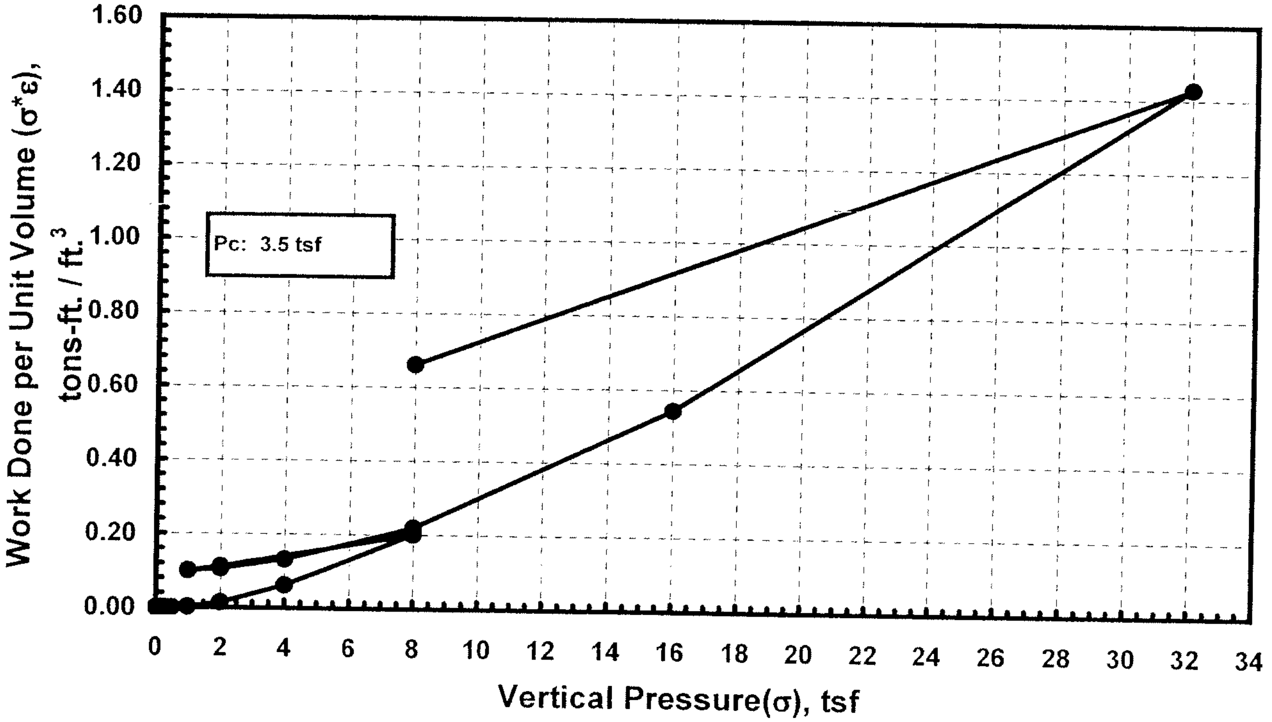
Plastic Limit: -

Plasticity Index: -

Sample Classification: Fat Clay (CH), Dark Gray

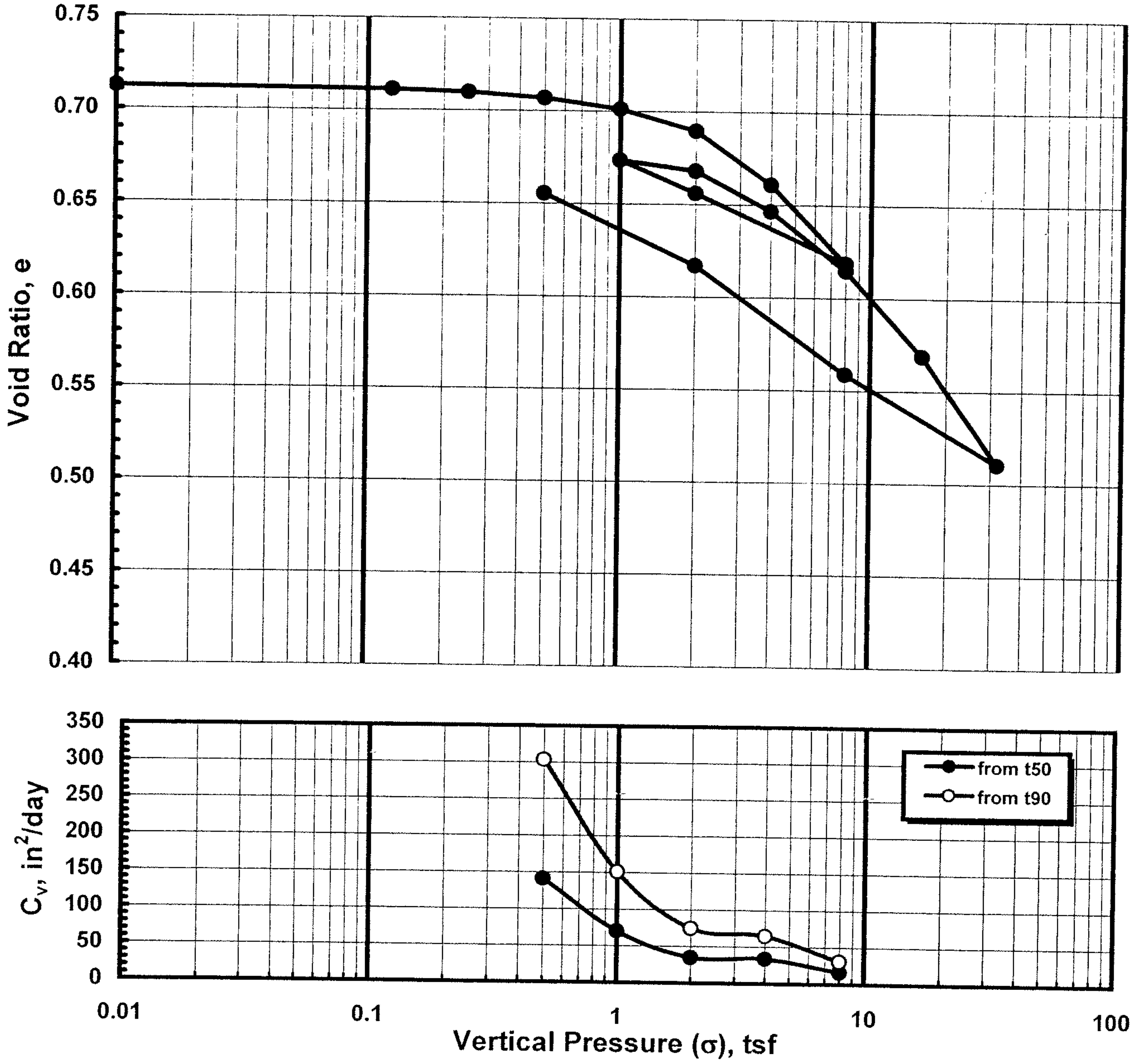
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-6	Plastic Limit:	-		
Sample ID, Depth:	TW-11, 53-53.7 feet	Sample Classification:	Fat Clay (CH), Dark Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	25.2%	26.6%
Sample Height, in.:	1.0000	0.8822
Void Ratio, e:	0.7124	0.5107
Unit Weight, pcf:	96.6	109.5
Degree of Saturation:	0.94	1.38

Consolidation Parameters	
Overburden Pressure, tsf:	1.9
Preconsolidation Pressure, tsf:	2.0
Compression Index, Cc:	0.18
Re-Compression Index, Cr	0.015

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-10
Sample ID, Depth:	TW-10, 30-32 ft

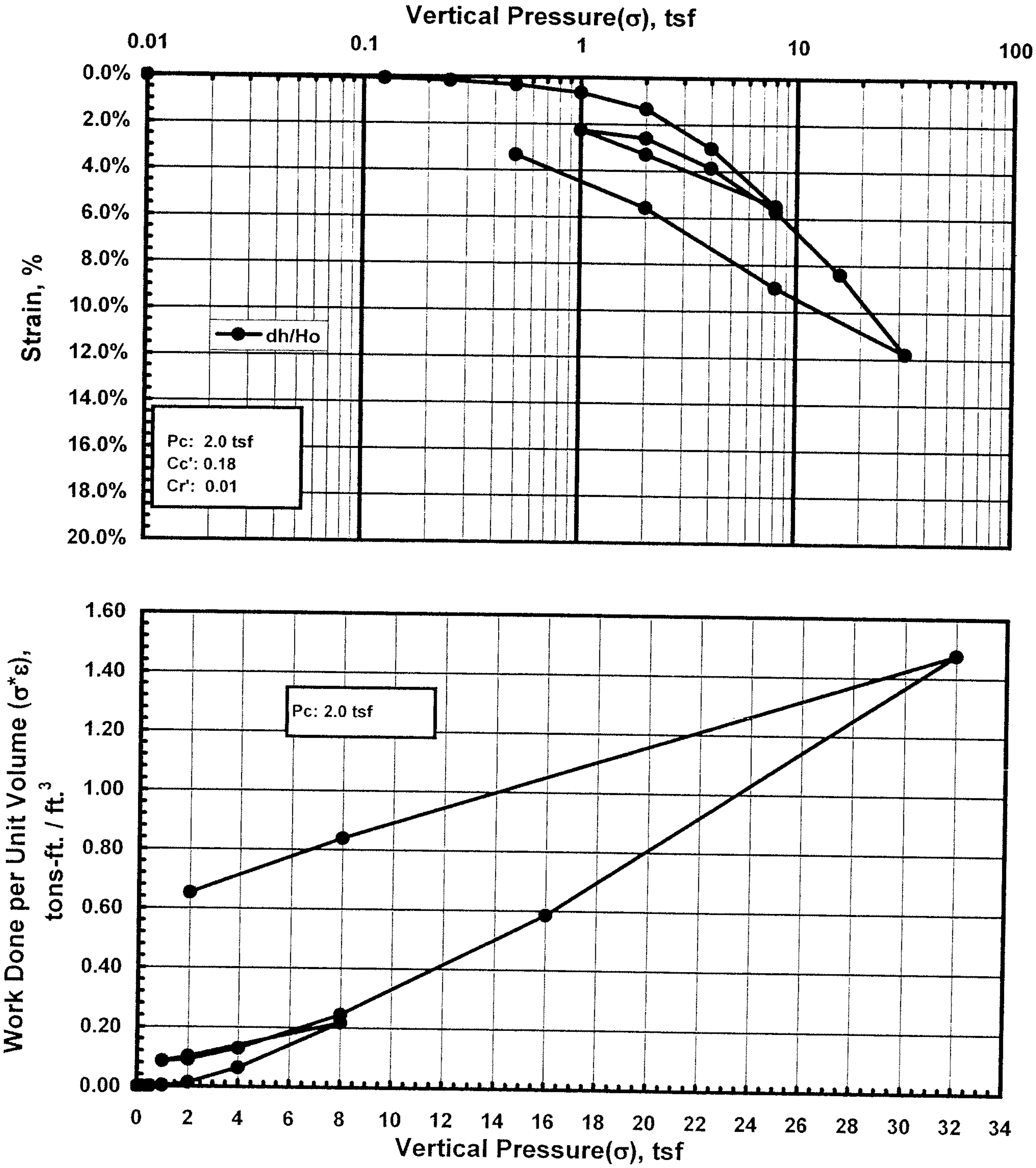
Liquid Limit: Hand Pen:

Plastic Limit:

Plastic Limit:

Sample Classification: Grayish Brown, Fat Clay

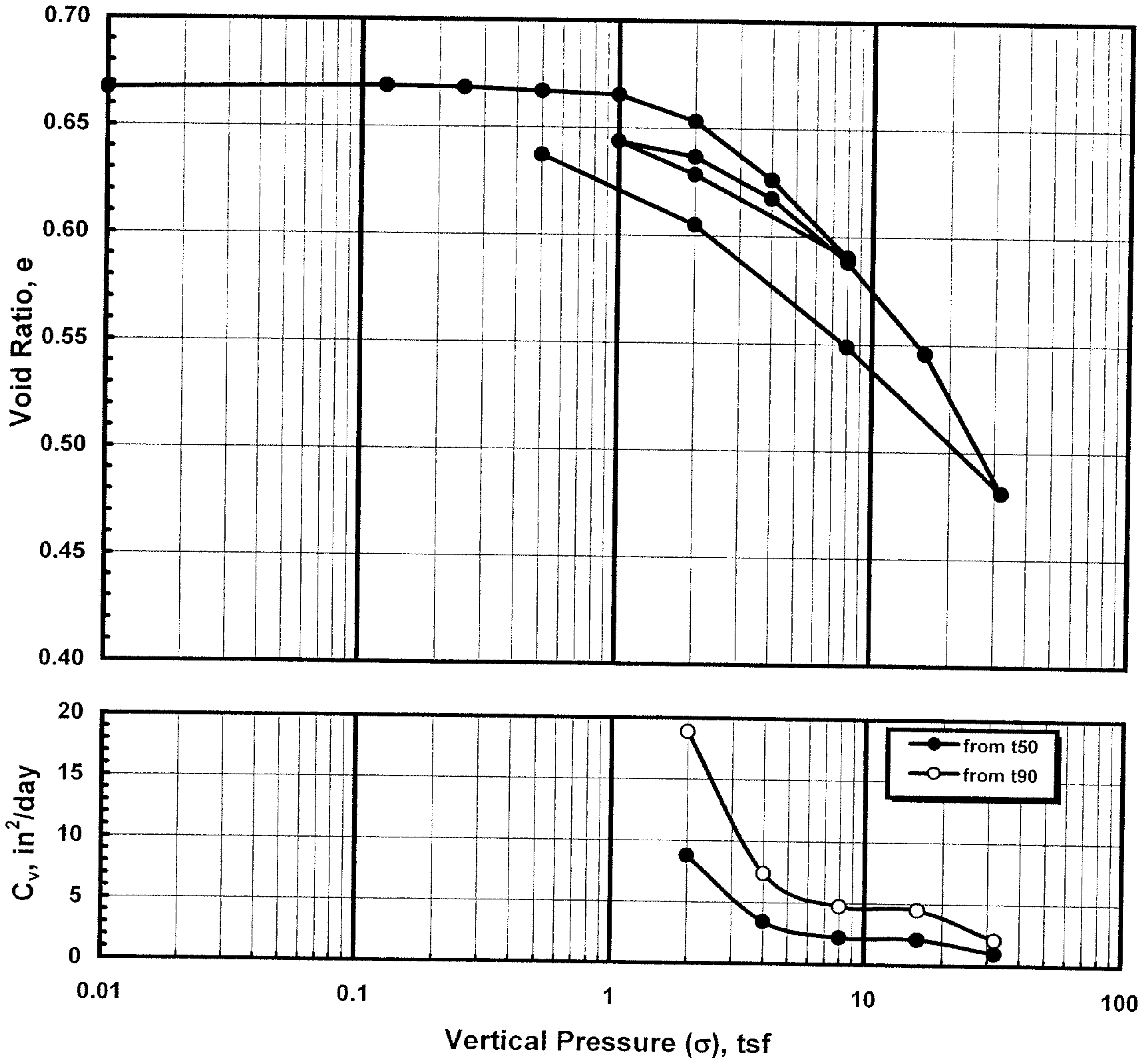
CONSOLIDATION TEST RESULTS - ASTM D 2435



Project Number:	286-75083	Liquid Limit:	Hand Pen:
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	
Boring No.:	BV-10	Plastic Limit:	
Sample ID, Depth:	TW-10, 30-32 ft	Sample Classification: Grayish Brown, Fat Clay	

psi

CONSOLIDATION TEST RESULTS - ASTM D 2435

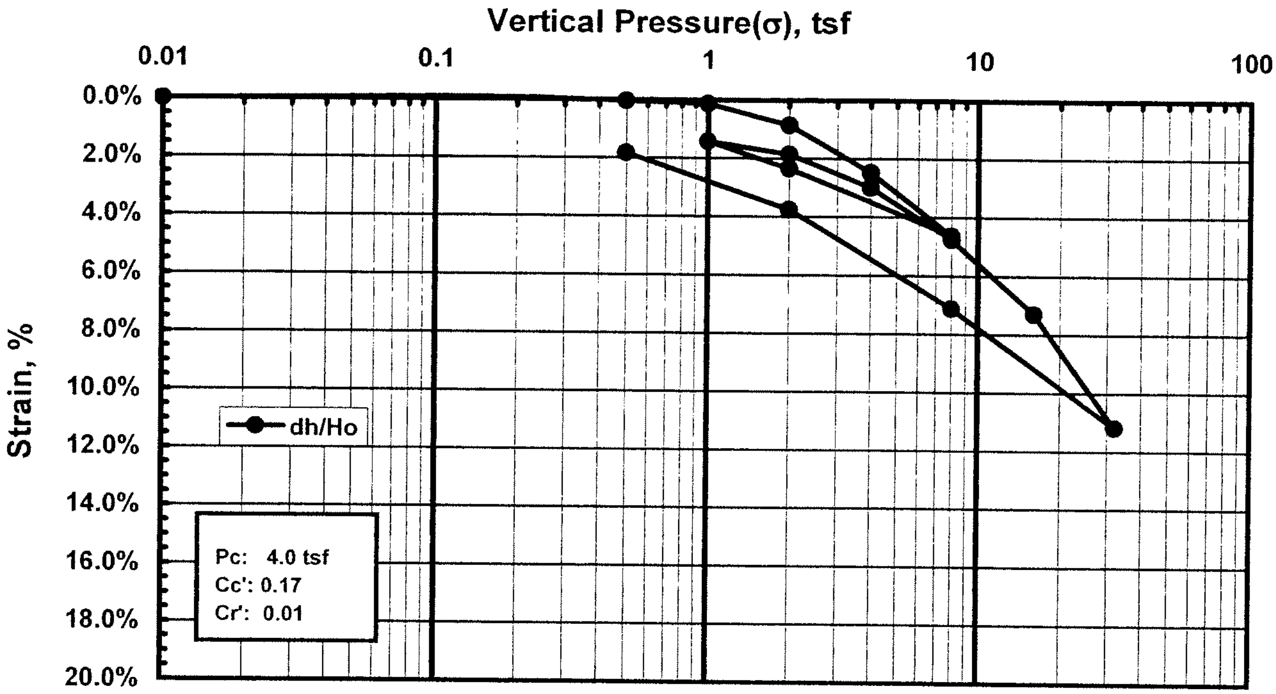


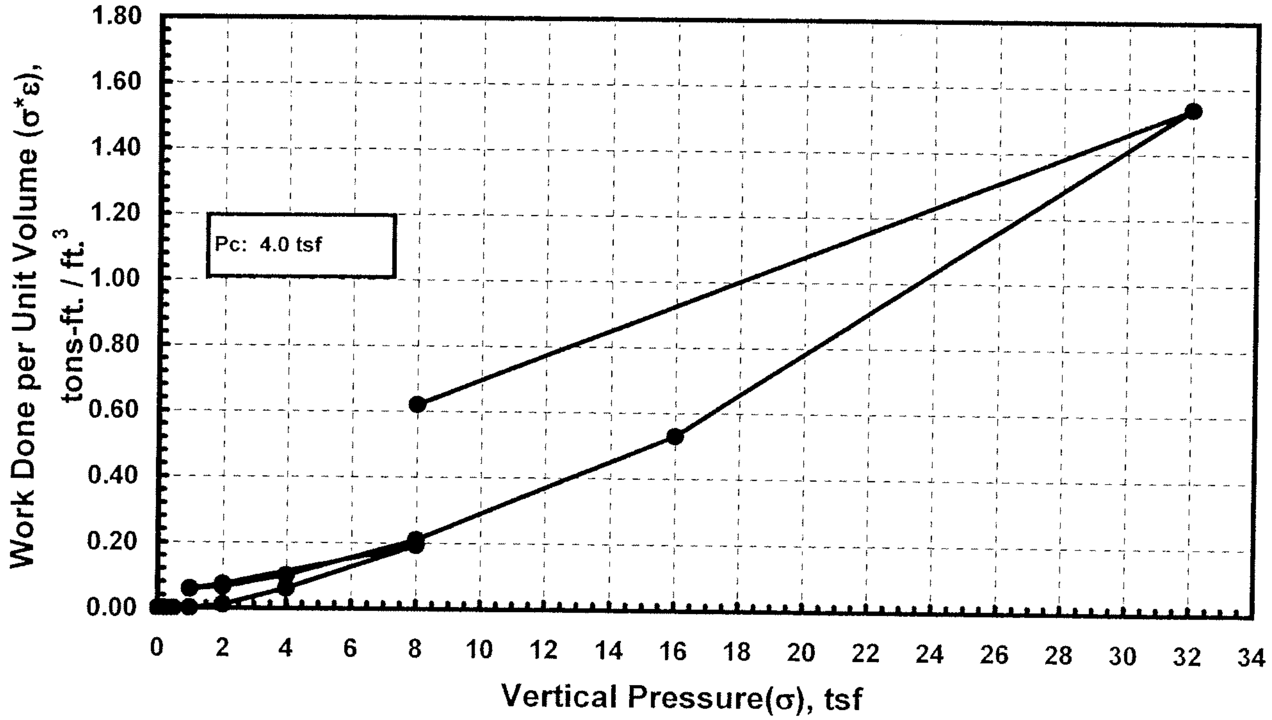
Sample Condition	Before	After
Moisture Content, %:	20.9%	22.1%
Sample Height, in.:	1.0000	0.9818
Void Ratio, e:	0.6675	0.6371
Unit Weight, pcf:	102.9	104.8
Degree of Saturation:	0.86	0.95

Consolidation Parameters	
Overburden Pressure, tsf:	2.3
Preconsolidation Pressure, tsf:	4.0
Compression Index, Cc:	0.17
Re-Compression Index, Cr	0.01

Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	4.5+
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-11	Plasticity Index:	-		
Sample ID, Depth:	TW-9, 38-40 feet	Sample Classification:	Fat Clay (CH), Gray		

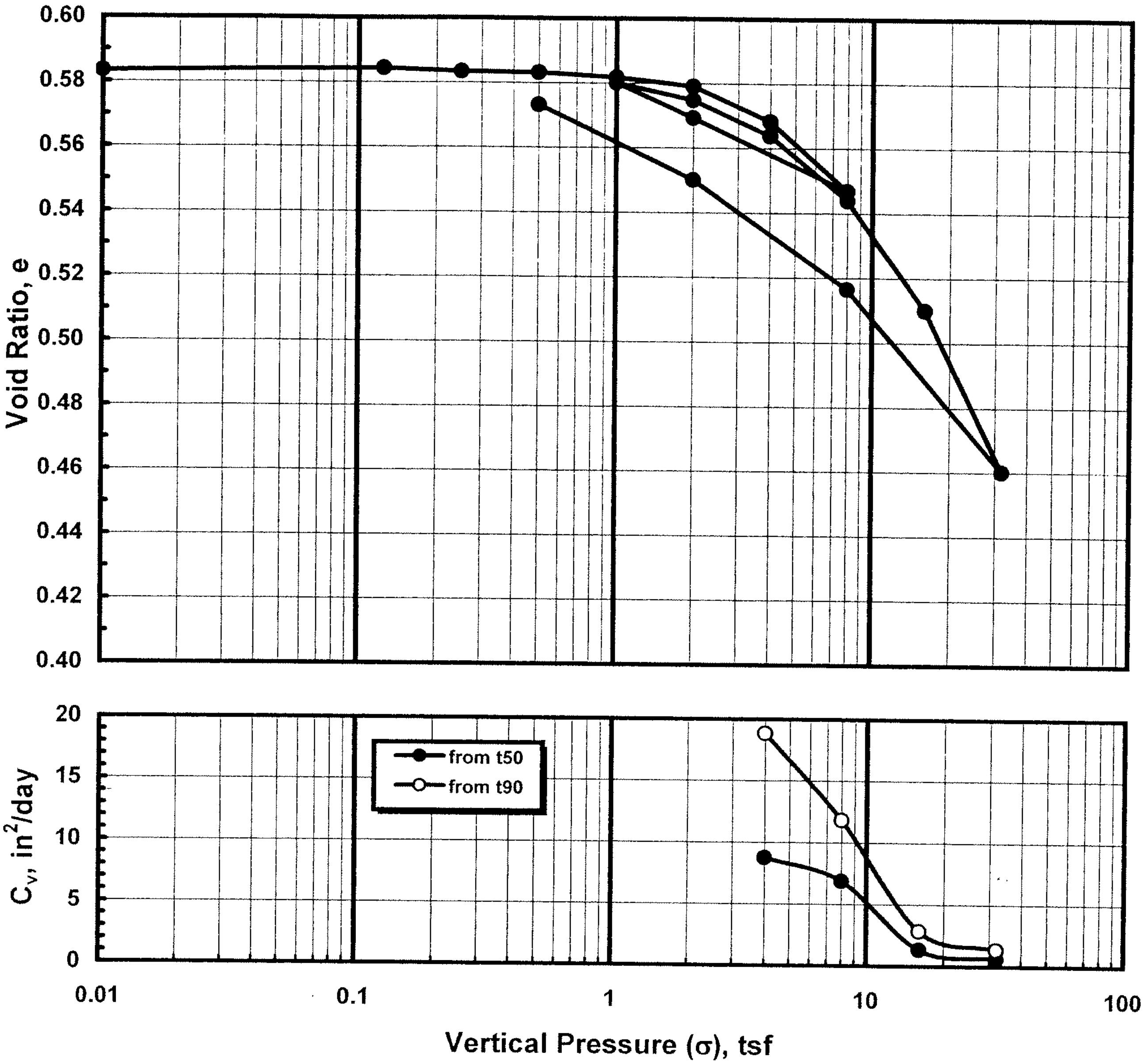
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	4.5+
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-11	Plastic Limit:	-		
Sample ID, Depth:	TW-9, 38-40 feet	Sample Classification:	Fat Clay (CH), Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



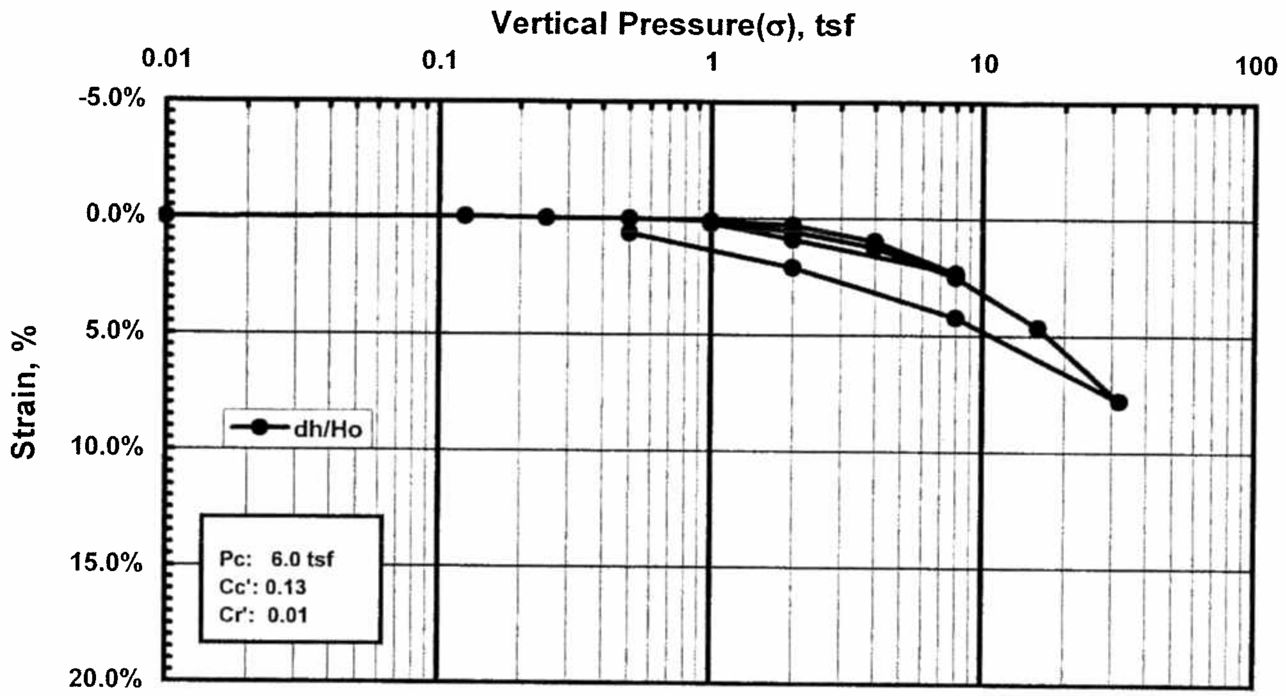
Sample Condition	Before	After
Moisture Content, %:	19.8%	20.7%
Sample Height, in.:	1.0000	0.9936
Void Ratio, e:	0.5833	0.5732
Unit Weight, pcf:	108.4	109.1
Degree of Saturation:	0.93	0.99

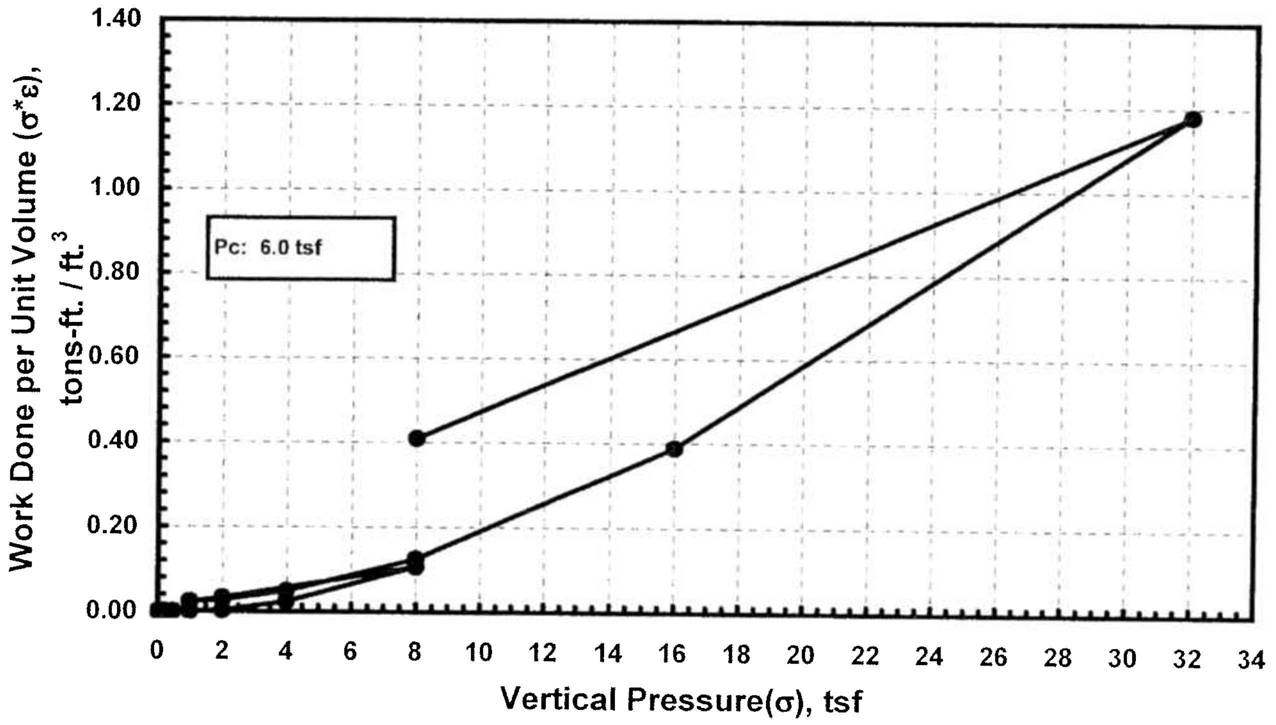
Consolidation Parameters	
Overburden Pressure, tsf:	2.9
Preconsolidation Pressure, tsf:	6.0
Compression Index, Cc:	0.13
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-11
Sample ID, Depth:	TW-11, 48-48.7 feet

Liquid Limit:	-	Hand Pen:	-
Plastic Limit:	-		
Plasticity Index:	-		
Sample Classification:	Fat Clay (CH), Brown, Gray		

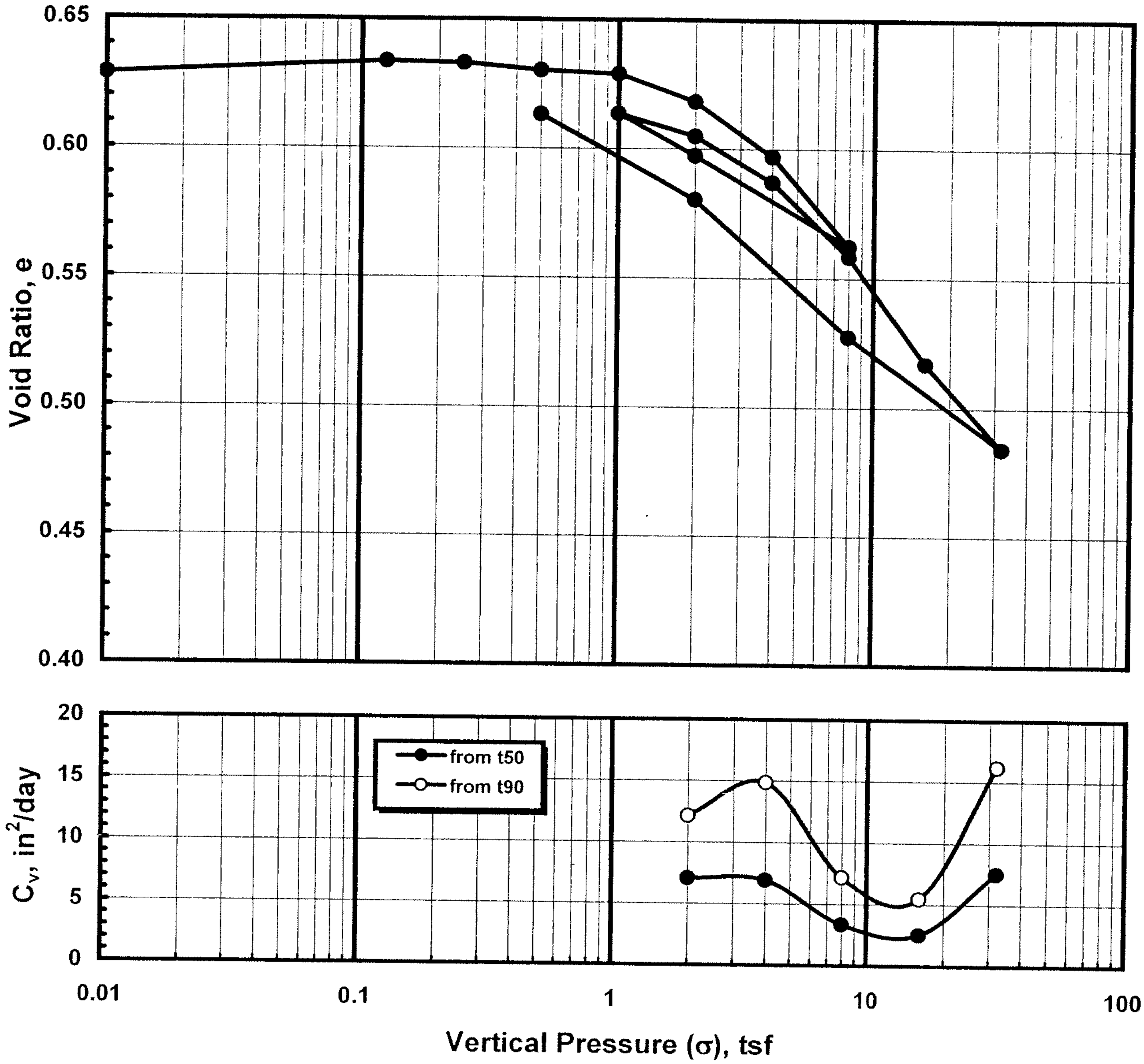
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-11	Plastic Limit:	-		
Sample ID, Depth:	TW-11, 48-48.7 feet	Sample Classification:	Fat Clay (CH), Brown, Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



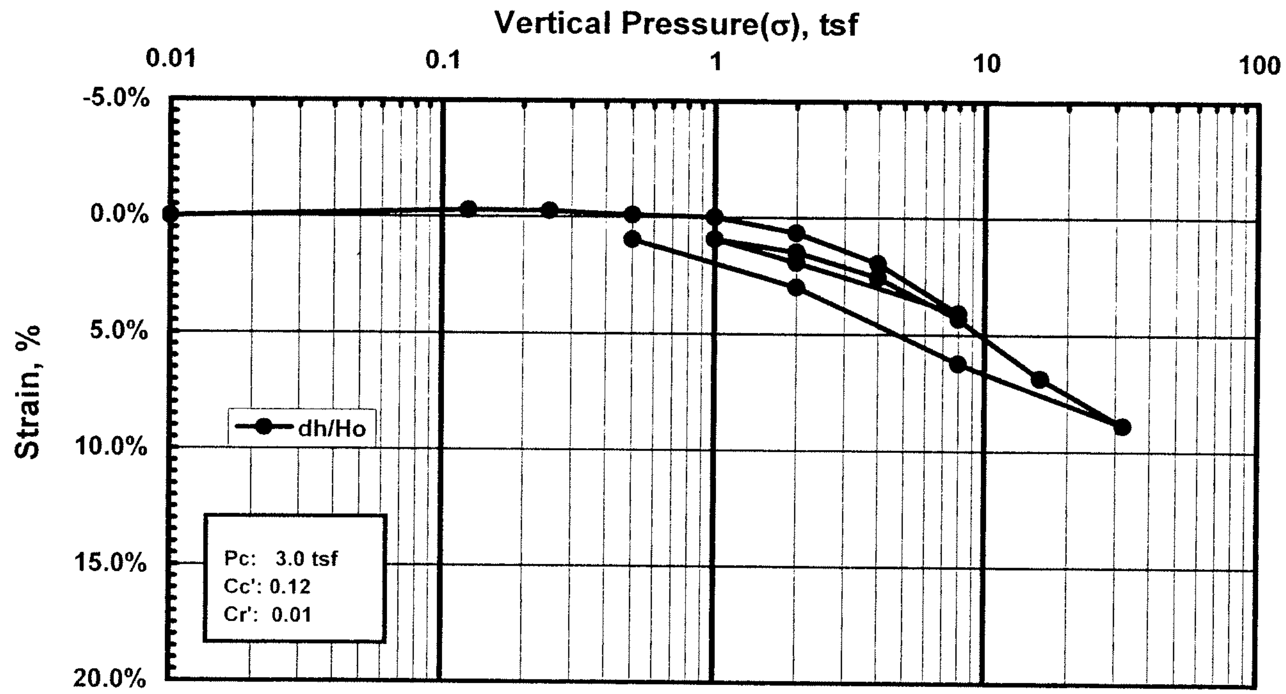
Sample Condition	Before	After
Moisture Content, %:	20.6%	21.8%
Sample Height, in.:	1.0000	0.9905
Void Ratio, e:	0.6287	0.6132
Unit Weight, pcf:	105.4	106.4
Degree of Saturation:	0.90	0.98

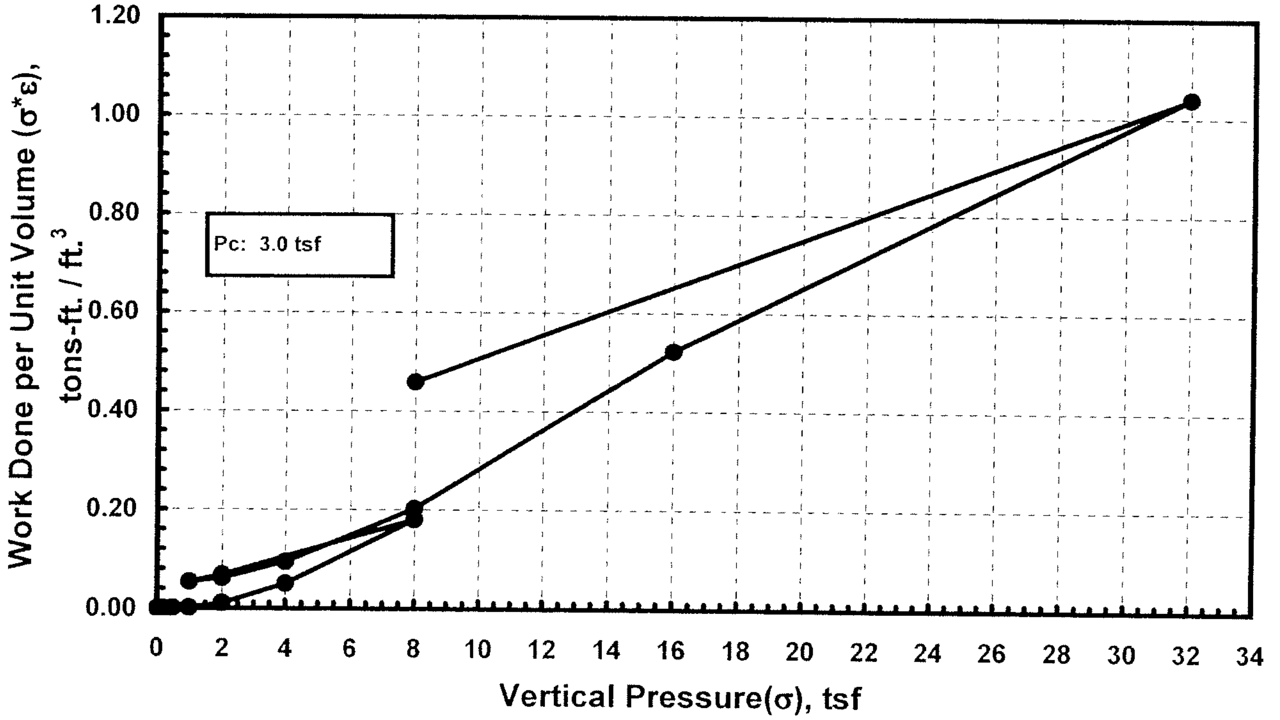
Consolidation Parameters	
Overburden Pressure, tsf:	1.8
Preconsolidation Pressure, tsf:	3.0
Compression Index, Cc:	0.12
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-12
Sample ID, Depth:	TW-8, 29-31 feet

Liquid Limit:	-	Hand Pen:	-
Plastic Limit:	-		
Plasticity Index:	-		
Sample Classification:	Fat Clay (CH), Brown, Gray		

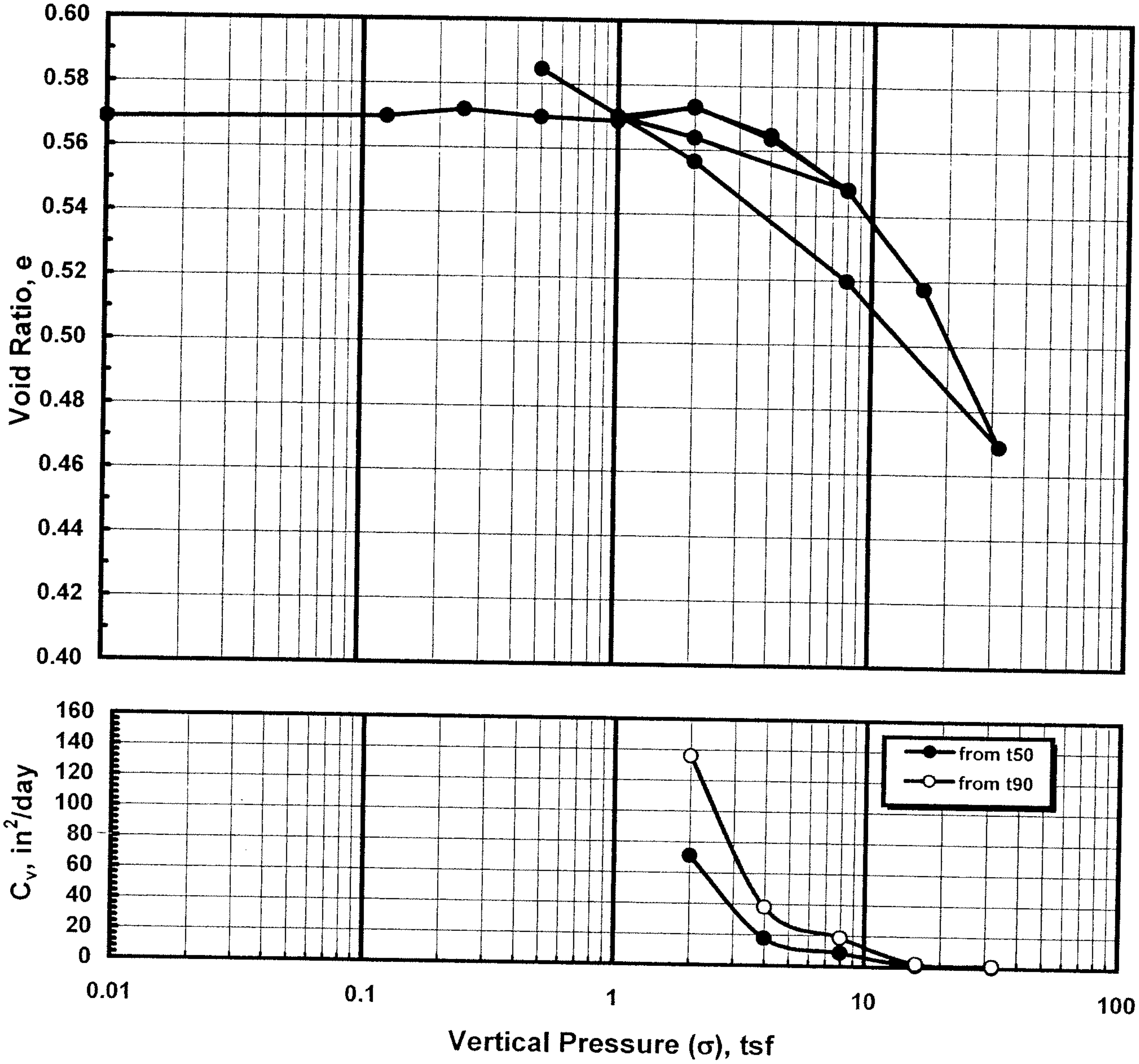
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	- Hand Pen: -
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-
Boring No.:	BV-12	Plastic Limit:	-
Sample ID, Depth:	TW-8, 29-31 feet	Sample Classification:	Fat Clay (CH), Brown, Gray

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	18.7%	20.2%
Sample Height, in.:	1.0000	1.0101
Void Ratio, e:	0.5688	0.5846
Unit Weight, pcf:	109.4	108.3
Degree of Saturation:	0.91	0.95

Consolidation Parameters	
Overburden Pressure, tsf:	2.9
Preconsolidation Pressure, tsf:	7.0
Compression Index, Cc:	0.12
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-12
Sample ID, Depth:	TW-10, 48-48.9 feet

Liquid Limit:	-	Hand Pen:	-
Plastic Limit:	-		
Plasticity Index:	-		
Sample Classification: Fat Clay (CH), Dark Gray			

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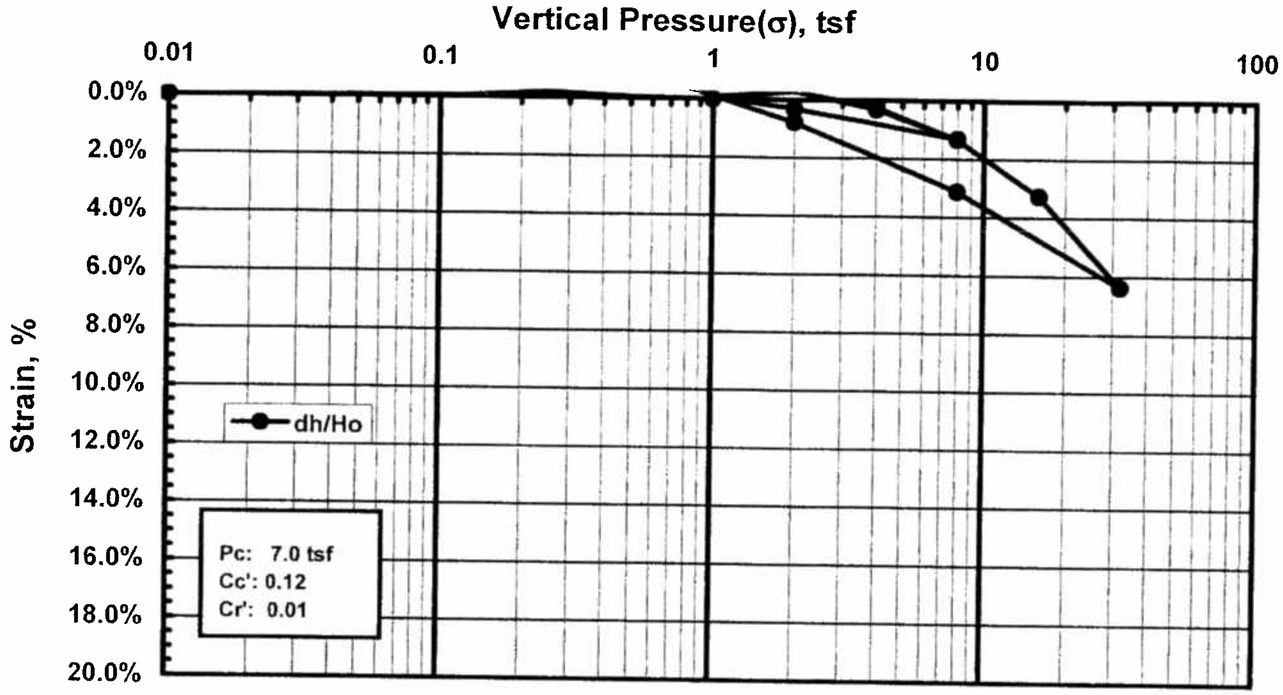
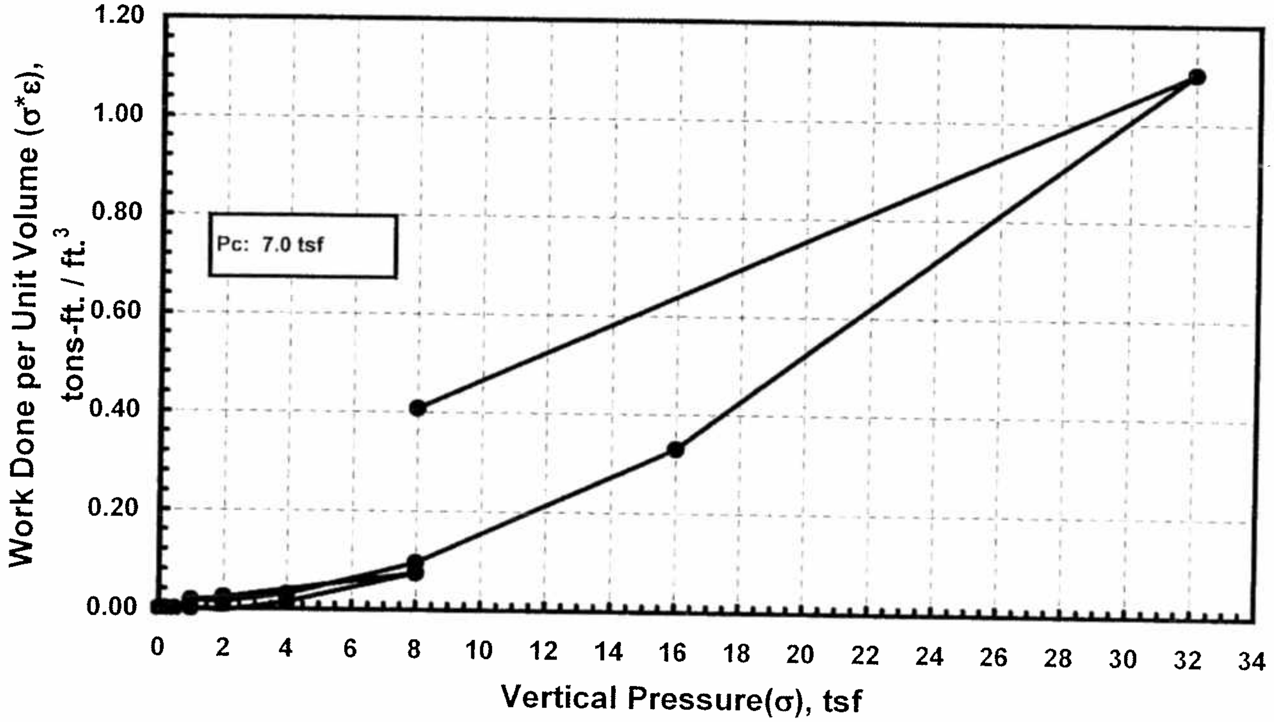
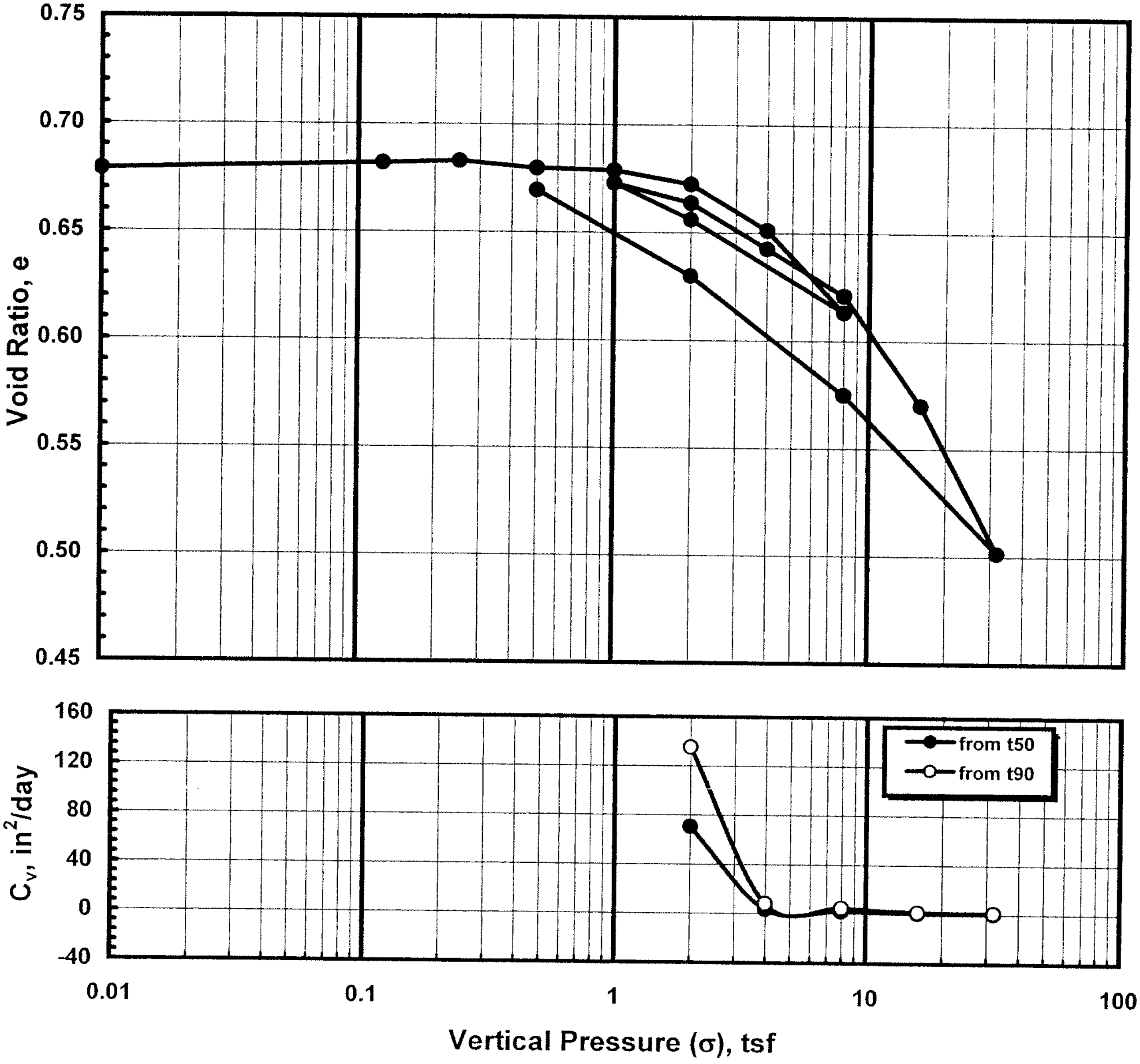
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-12	Plastic Limit:	-		
Sample ID, Depth:	TW-10, 48-48.9 feet	Sample Classification:	Fat Clay (CH), Dark Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	22.6%	23.7%
Sample Height, in.:	1.0000	0.9944
Void Ratio, e:	0.6789	0.6695
Unit Weight, pcf:	102.2	102.8
Degree of Saturation:	0.91	0.97

Consolidation Parameters	
Overburden Pressure, tsf:	2.0
Preconsolidation Pressure, tsf:	6.0
Compression Index, Cc:	0.19
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-17A
Sample ID, Depth:	TW-10, 33-35 feet

Liquid Limit:	65	Hand Pen:	4.5+
Plastic Limit:	24		
Plasticity Index:	41		
Sample Classification:	Fat Clay (CH), Gray		

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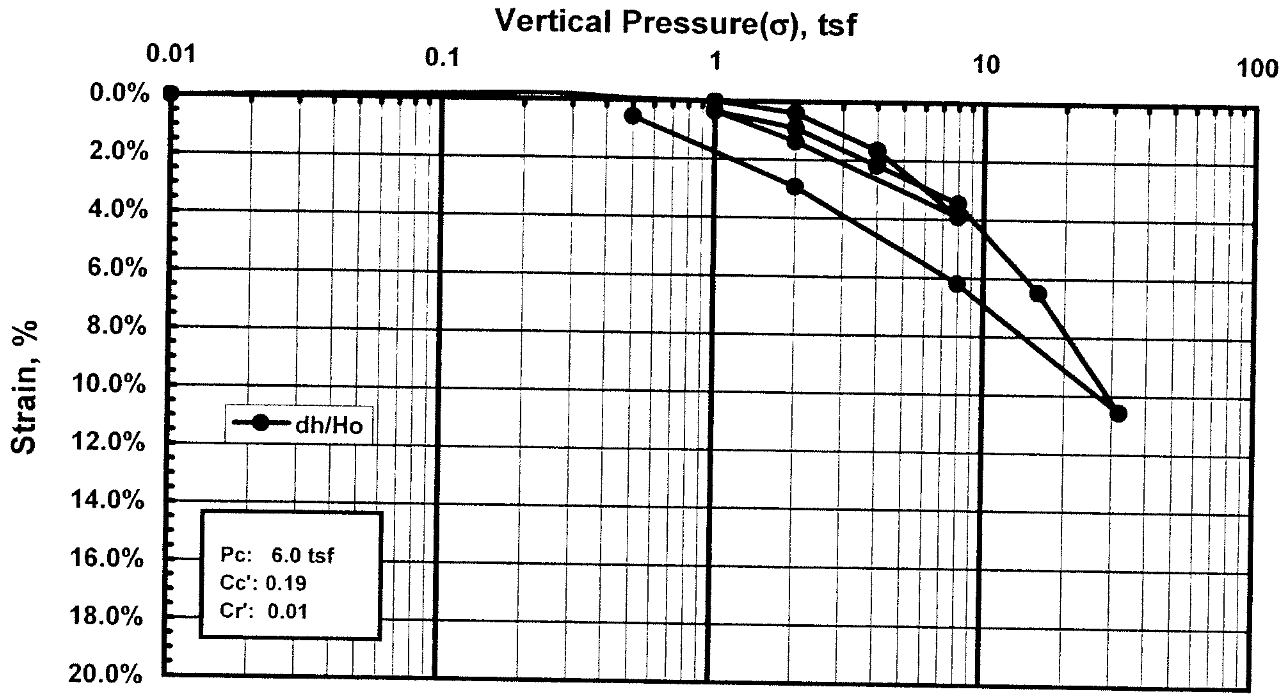
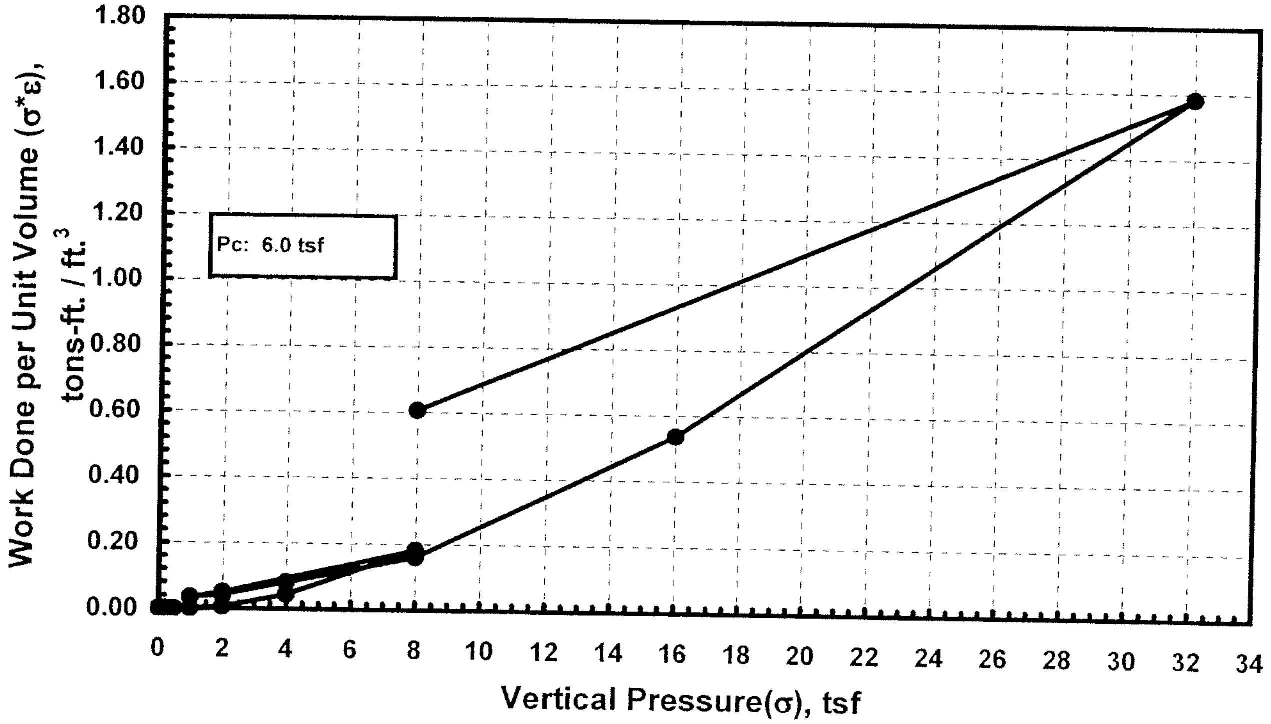
BV-17A, TW-10, 33-35 feet **Page 2 of 12**

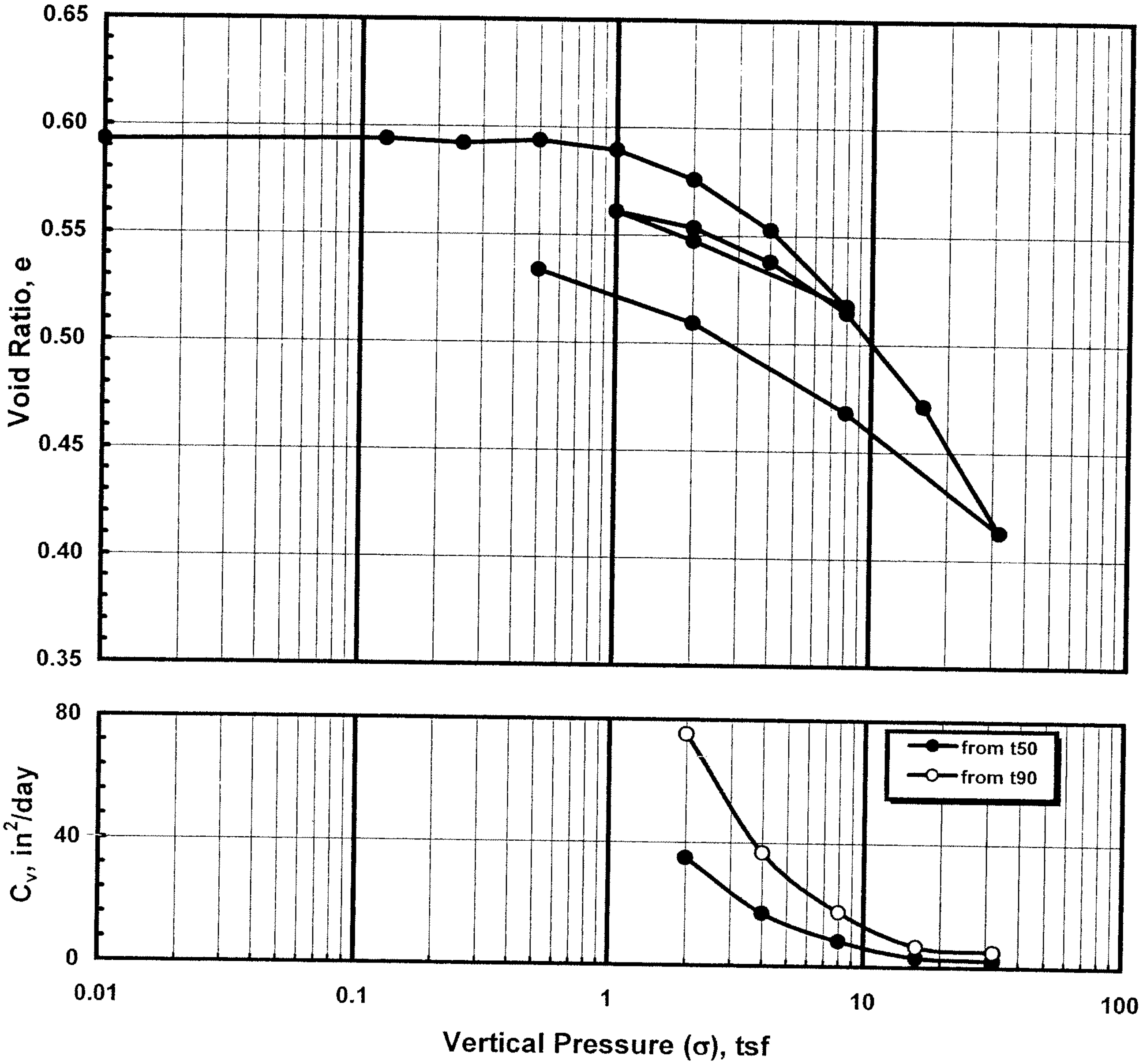
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	65	Hand Pen:	4.5+
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	24		
Boring No.:	BV-17A	Plastic Limit:	41		
Sample ID, Depth:	TW-10, 33-35 feet	Sample Classification:	Fat Clay (CH), Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	17.2%	19.4%
Sample Height, in.:	1.0000	0.9628
Void Ratio, e:	0.5930	0.5338
Unit Weight, pcf:	107.7	111.9
Degree of Saturation:	0.80	1.00

Consolidation Parameters	
Overburden Pressure, tsf:	3.5
Preconsolidation Pressure, tsf:	4.0
Compression Index, Cc:	0.17
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-17A
Sample ID, Depth:	TW-14, 58-58.6 feet

Liquid Limit:	60	Hand Pen:	0
Plastic Limit:	27		
Plasticity Index:	33		
Sample Classification:	Fat Clay (CH), Dark Gray		

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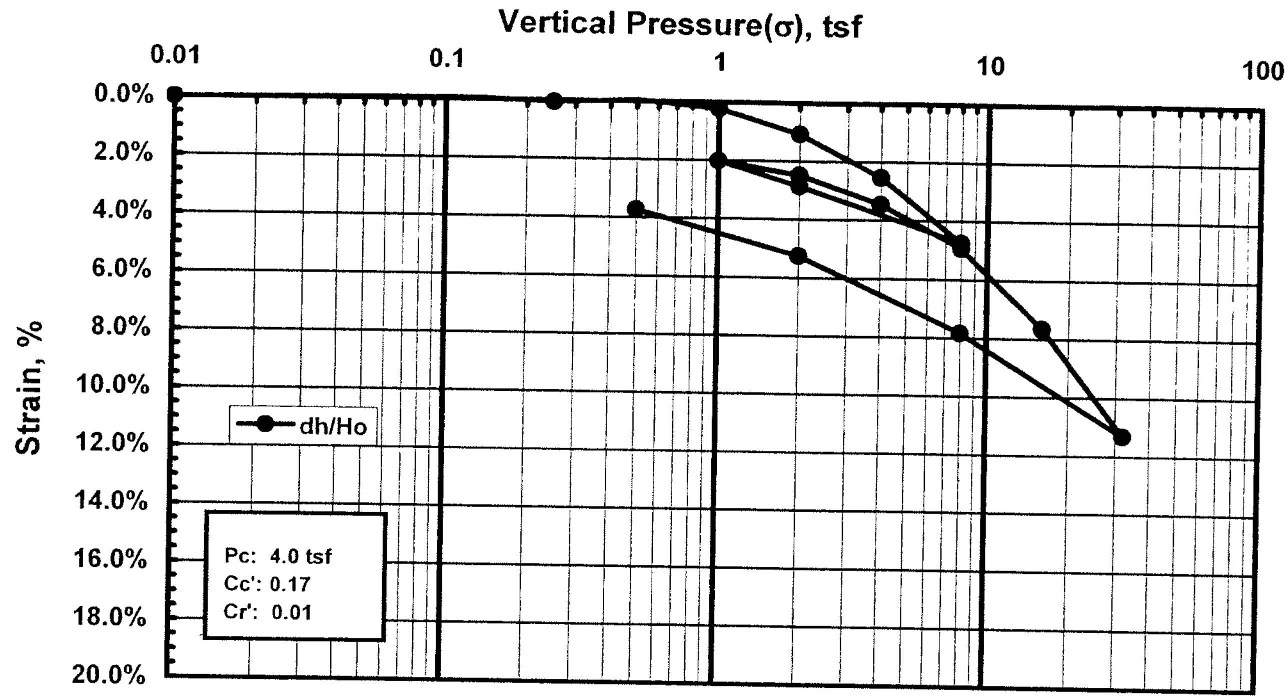
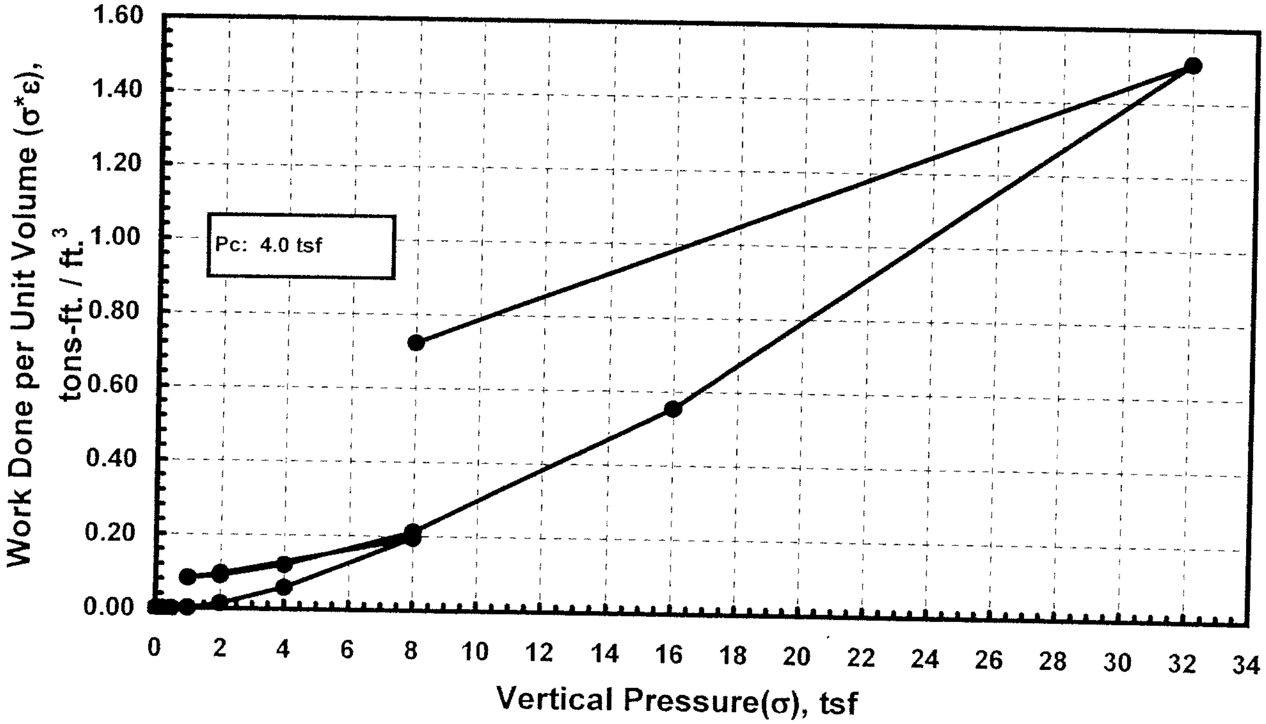
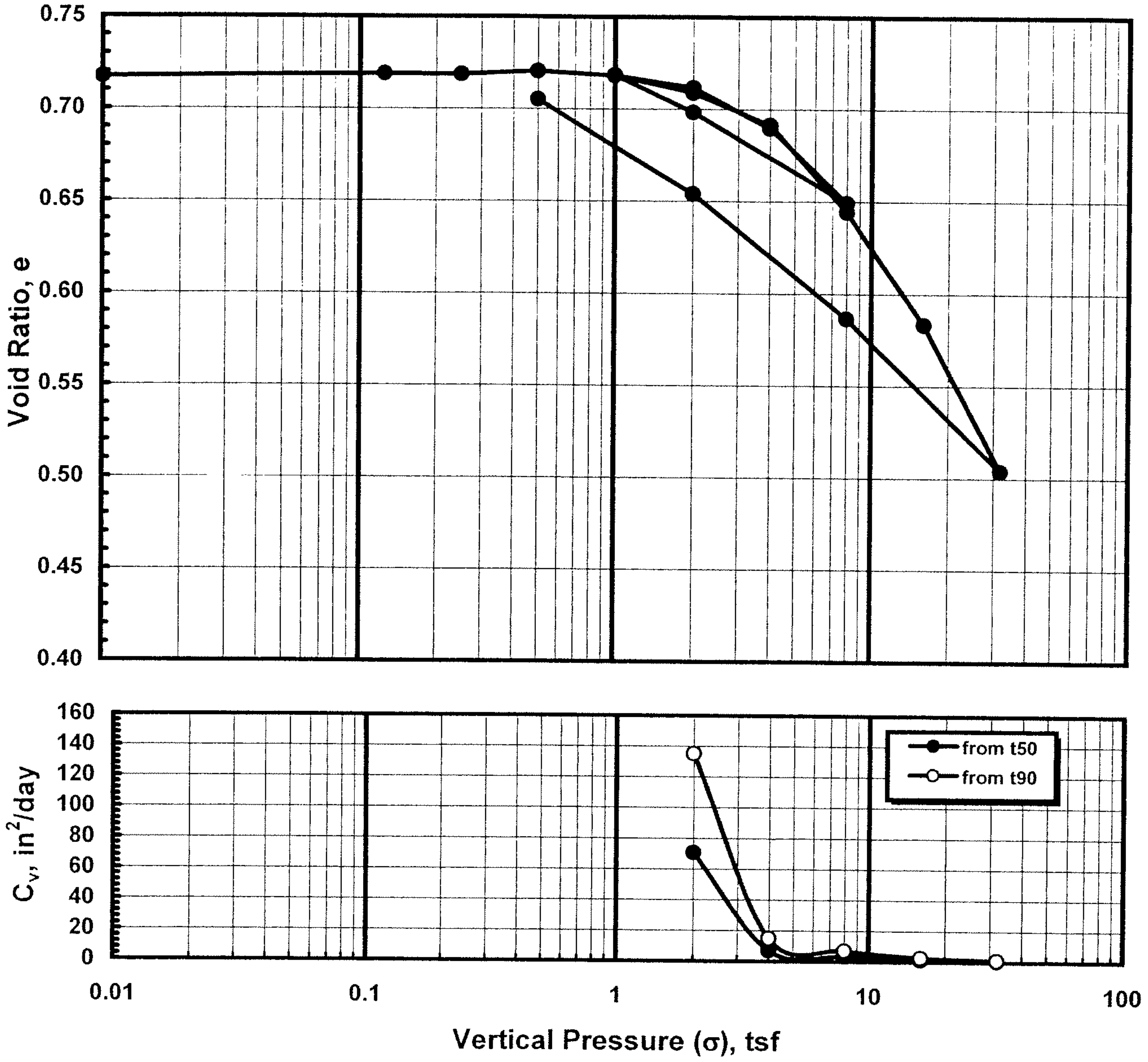
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	60	Hand Pen:	0
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	27		
Boring No.:	BV-17A	Plastic Limit:	33		
Sample ID, Depth:	TW-14, 58-58.6 feet	Sample Classification:	Fat Clay (CH), Dark Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435

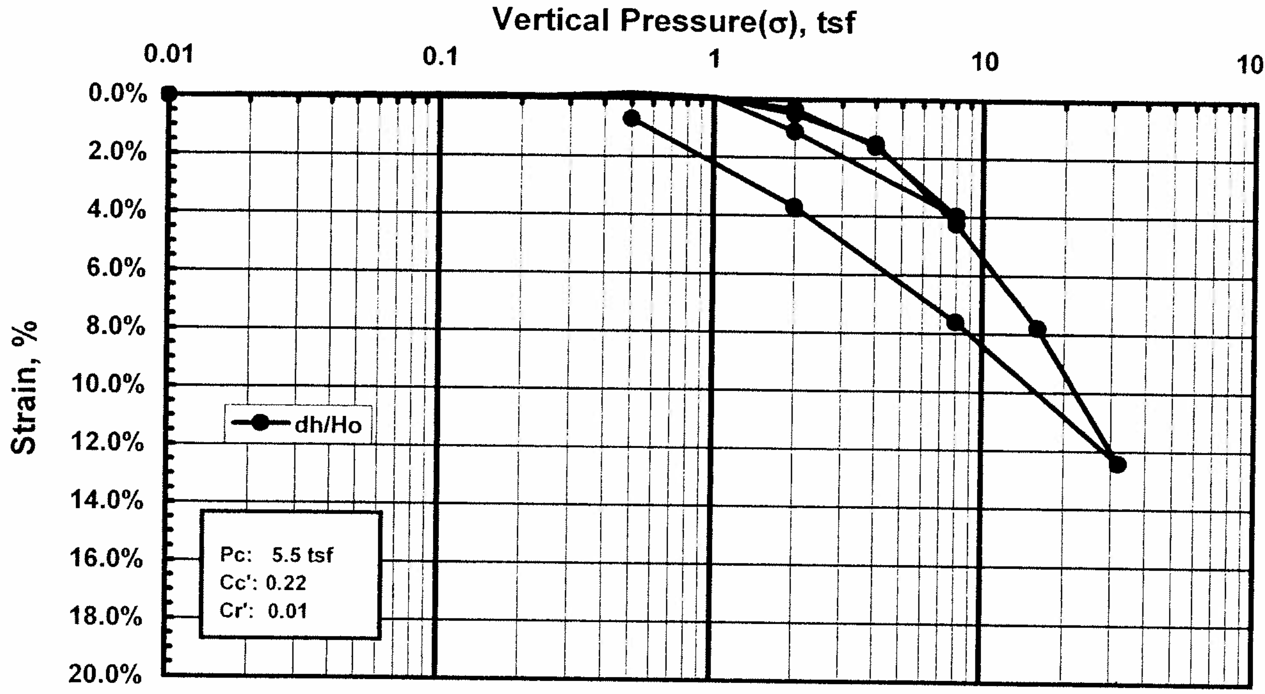


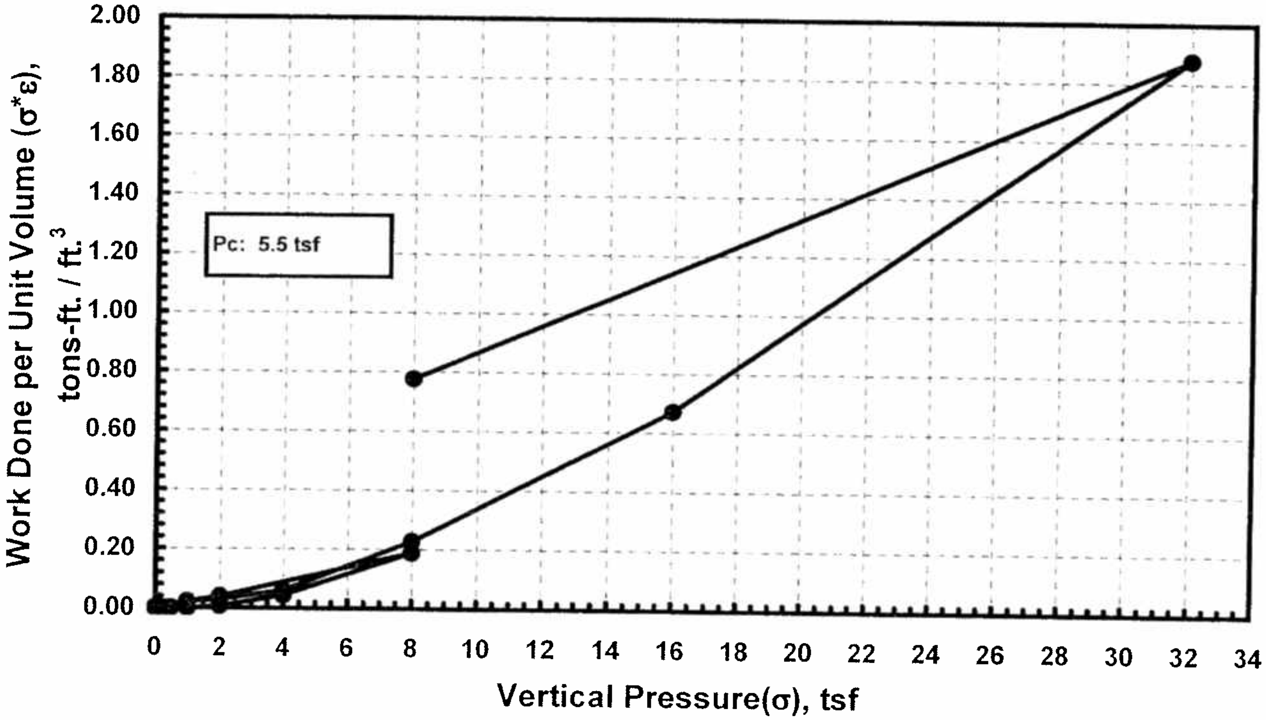
Sample Condition	Before	After
Moisture Content, %:	25.4%	26.5%
Sample Height, in.:	1.0000	0.9930
Void Ratio, e:	0.7172	0.7052
Unit Weight, pcf:	99.9	100.6
Degree of Saturation:	0.97	1.03

Consolidation Parameters	
Overburden Pressure, tsf:	1.7
Preconsolidation Pressure, tsf:	5.5
Compression Index, Cc:	0.22
Re-Compression Index, Cr	0.01

Project Number:	286-75083	Liquid Limit:	-	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-		
Boring No.:	BV-18	Plasticity Index:	-		
Sample ID, Depth:	TW-10, 28-30 feet	Sample Classification:	Fat Clay (CH), Brown, Gray		

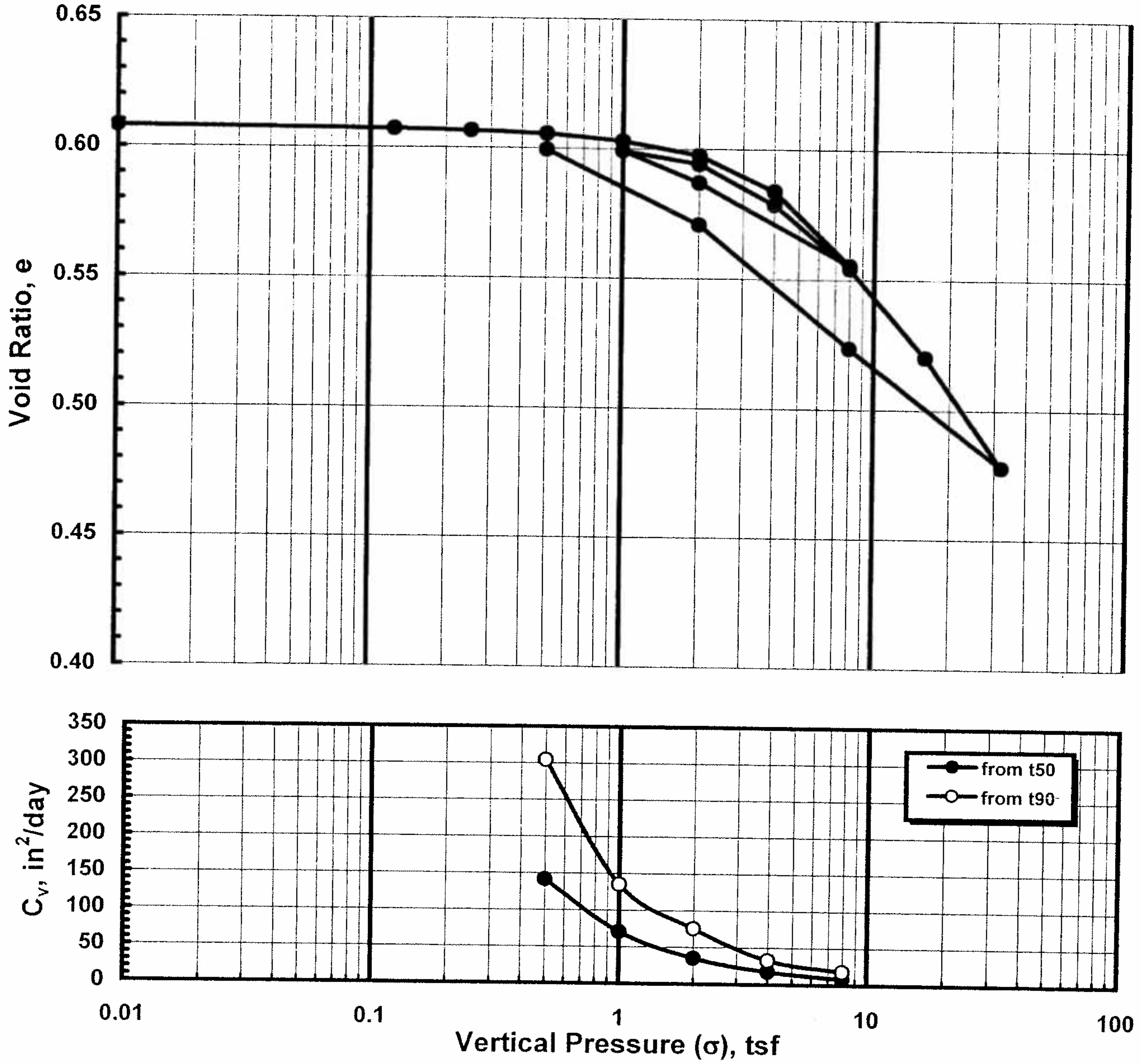
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	- Hand Pen: -
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-
Boring No.:	BV-18	Plastic Limit:	-
Sample ID, Depth:	TW-10, 28-30 feet	Sample Classification:	Fat Clay (CH), Brown, Gray

CONSOLIDATION TEST RESULTS - ASTM D 2435

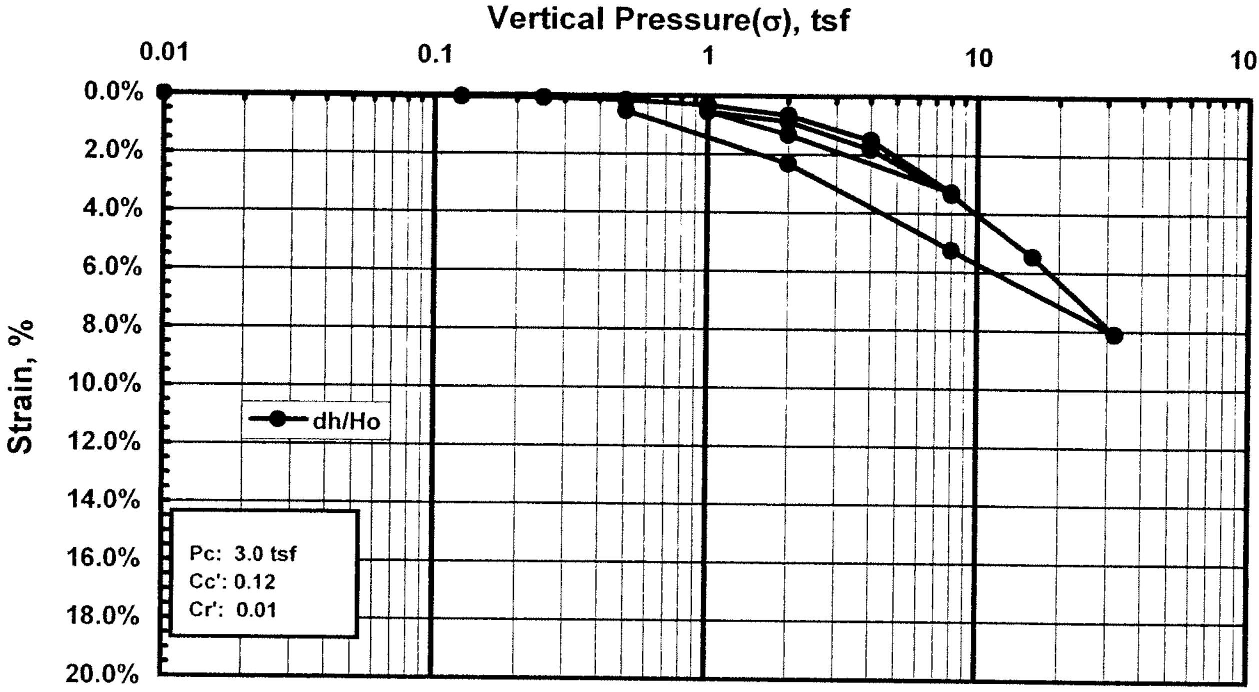


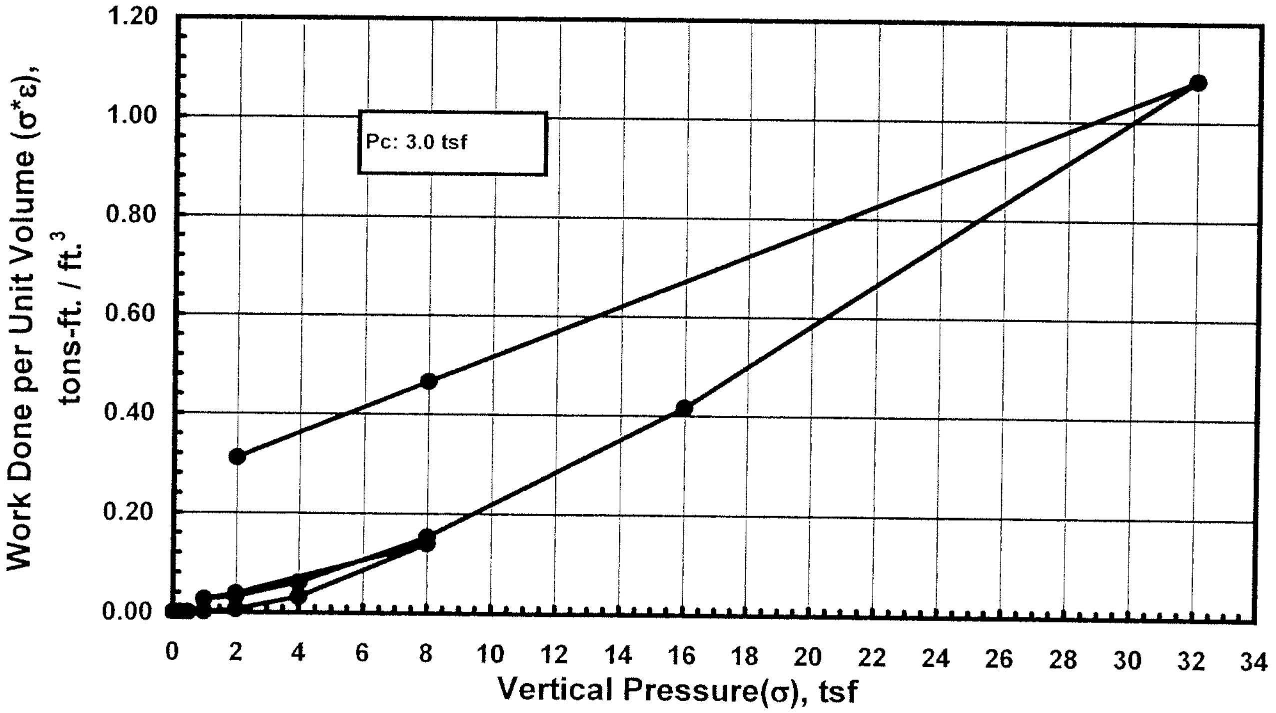
Sample Condition	Before	After
Moisture Content, %:	23.3%	24.4%
Sample Height, in.:	1.0000	0.9947
Void Ratio, e:	0.6081	0.5995
Unit Weight, pcf:	102.8	103.4
Degree of Saturation:	1.02	1.08

Consolidation Parameters	
Overburden Pressure, tsf:	2.3
Preconsolidation Pressure, tsf:	3.0
Compression Index, Cc:	0.12
Re-Compression Index, Cr	0.01

Project Number:	286-75083	Liquid Limit:	Hand Pen:
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	
Boring No.:	BV-18	Plastic Limit:	
Sample ID, Depth:	TW-8, 38-40	Sample Classification: Gry. Brn.,Fat Clay w/Sand Pockets	

CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	Hand Pen:
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	
Boring No.:	BV-18	Plastic Limit:	
Sample ID, Depth:	TW-8, 38-40	Sample Classification: Gry. Brn.,Fat Clay w/Sand Pockets	

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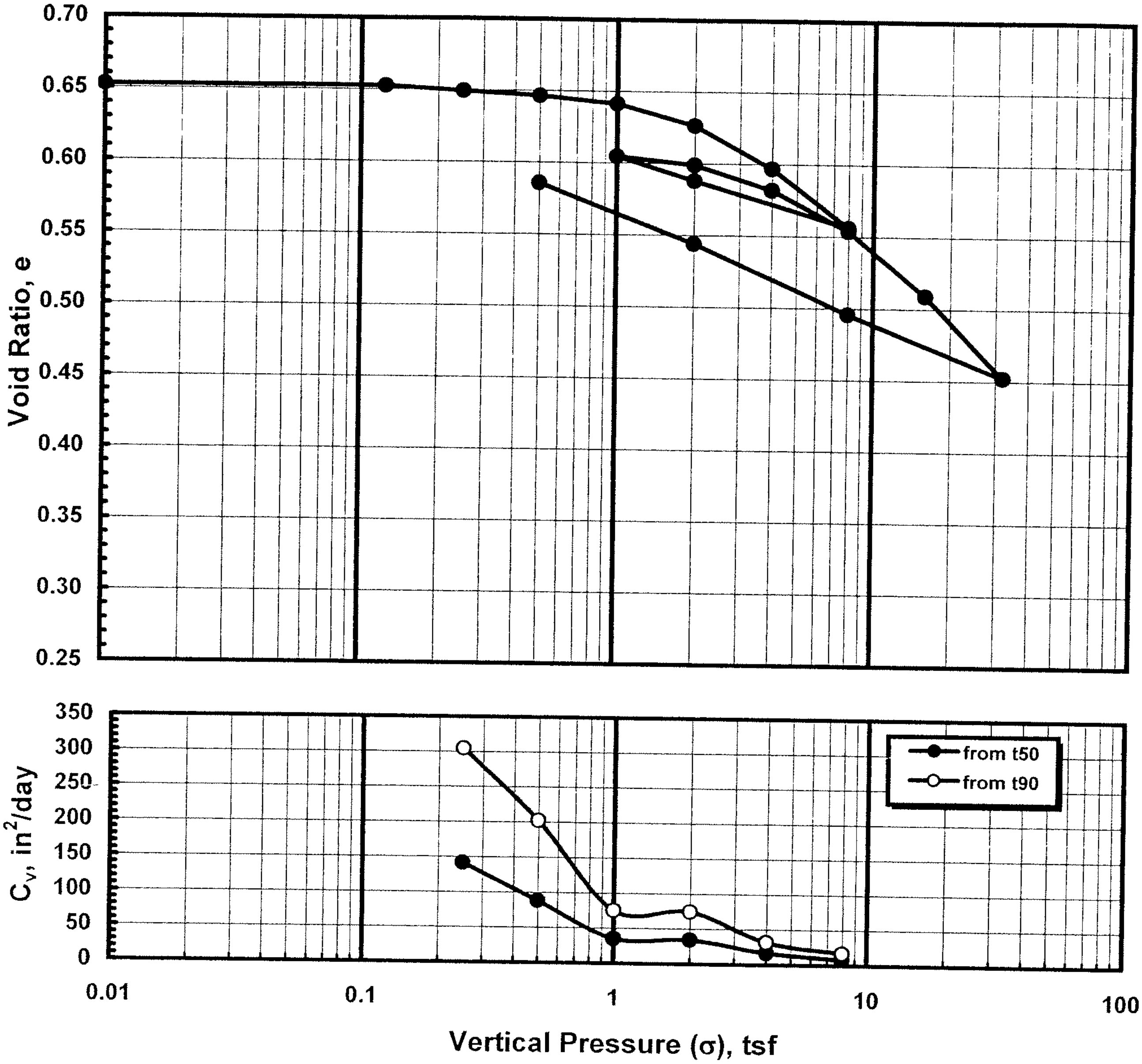
CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	23.6%	24.0%
Sample Height, in.:	1.0000	0.9595
Void Ratio, e:	0.6526	0.5856
Unit Weight, pcf:	100.1	104.3
Degree of Saturation:	0.96	1.08

Consolidation Parameters	
Overburden Pressure, tsf:	2.6
Preconsolidation Pressure, tsf:	3.0
Compression Index, Cc:	0.15
Re-Compression Index, Cr	0.01

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-20
Sample ID, Depth:	TW-11, 43-45 feet

Liquid Limit:	-	Hand Pen:	-
Plastic Limit:	-		
Plastic Limit:	-		
Sample Classification:	Fat Clay (CH), Brown, Gray		

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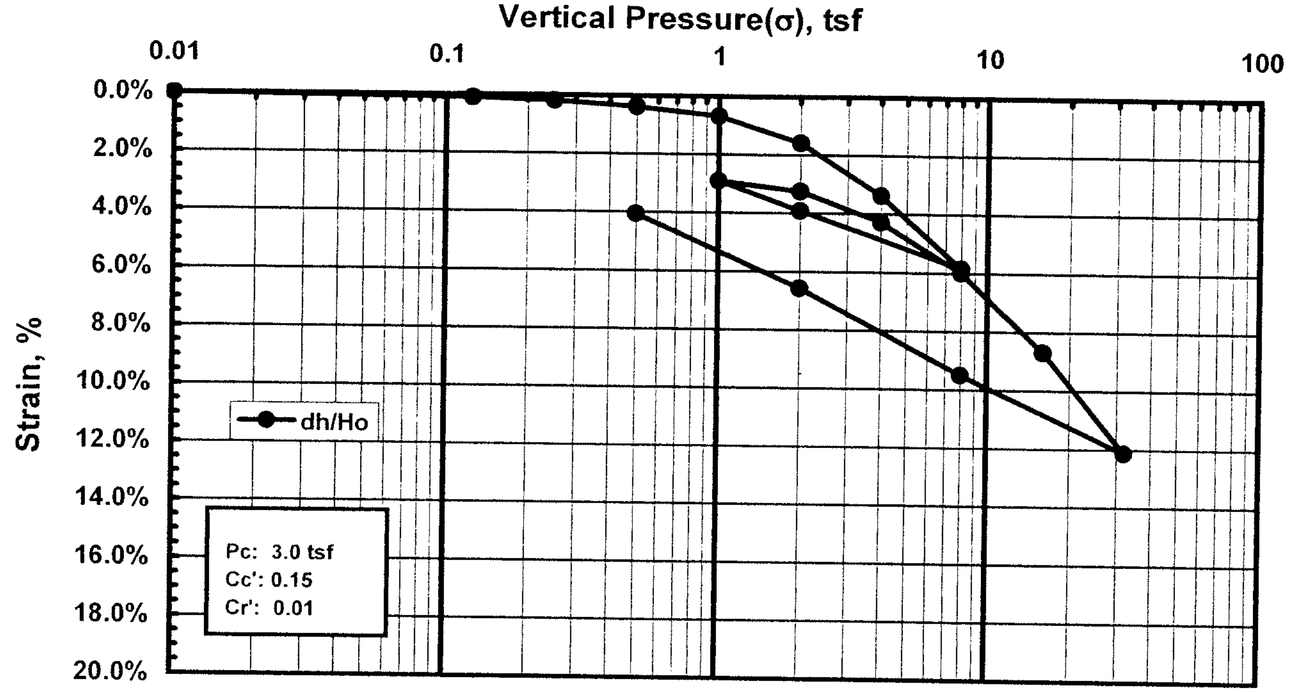
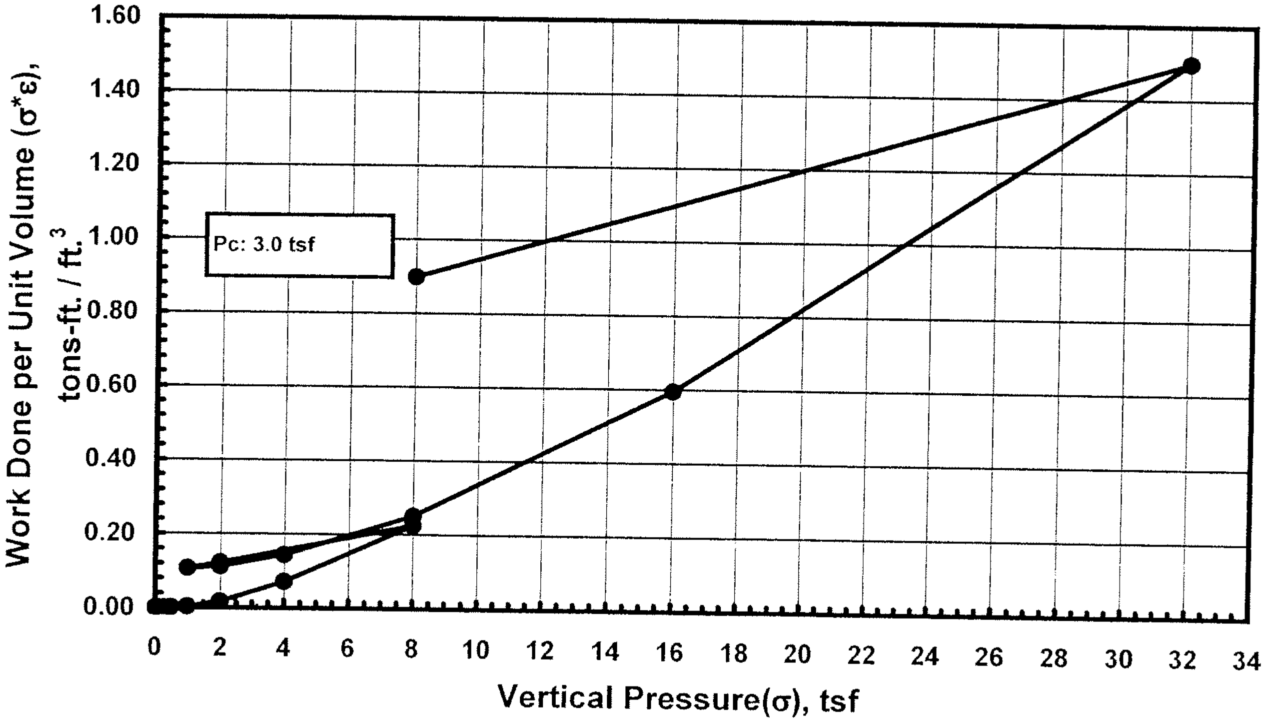
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	- Hand Pen: -
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	-
Boring No.:	BV-20	Plastic Limit:	-
Sample ID, Depth:	TW-11, 43-45 feet	Sample Classification:	Fat Clay (CH), Brown, Gray

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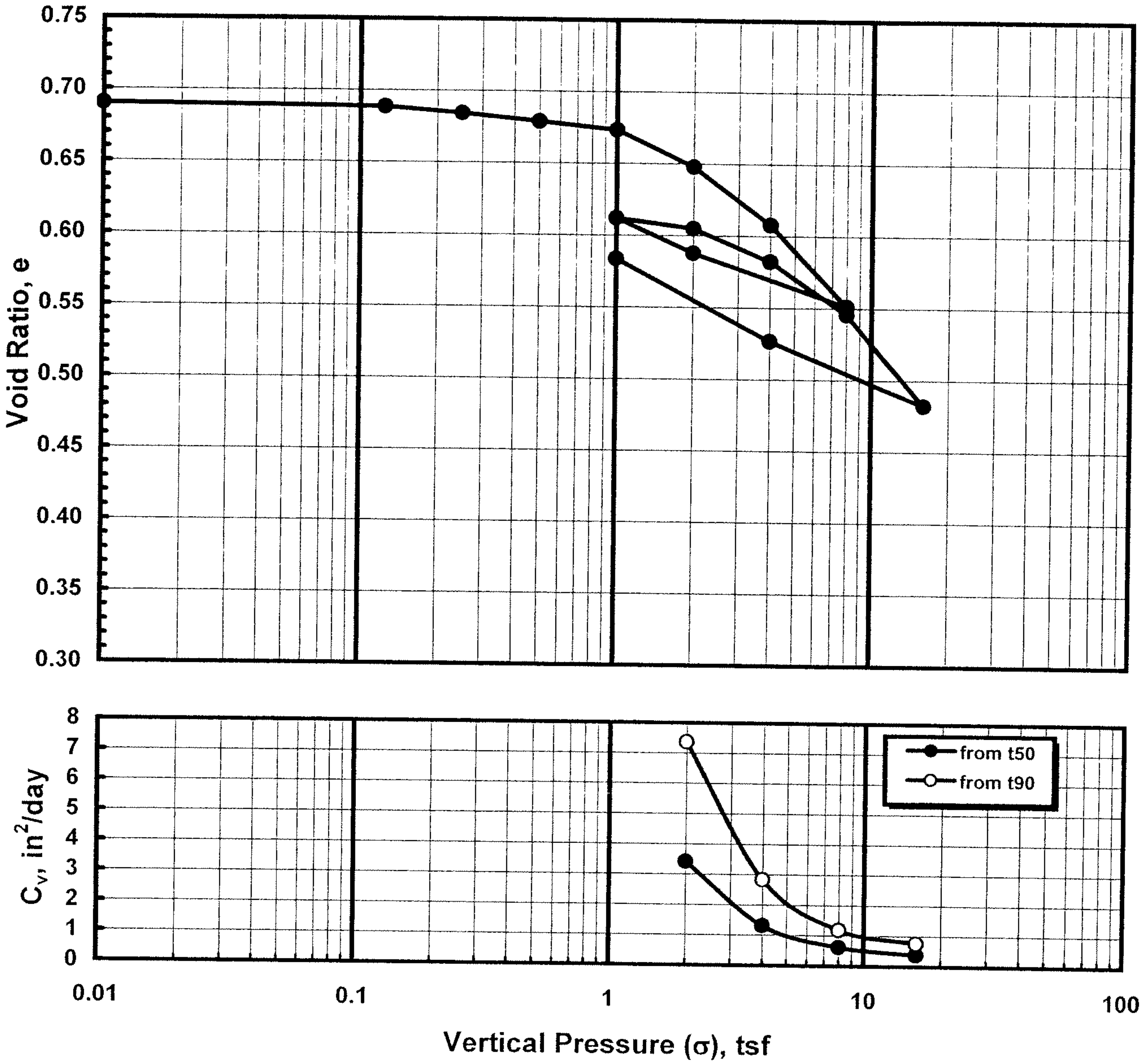
CONSOLIDATION TEST RESULTS - ASTM D 2435

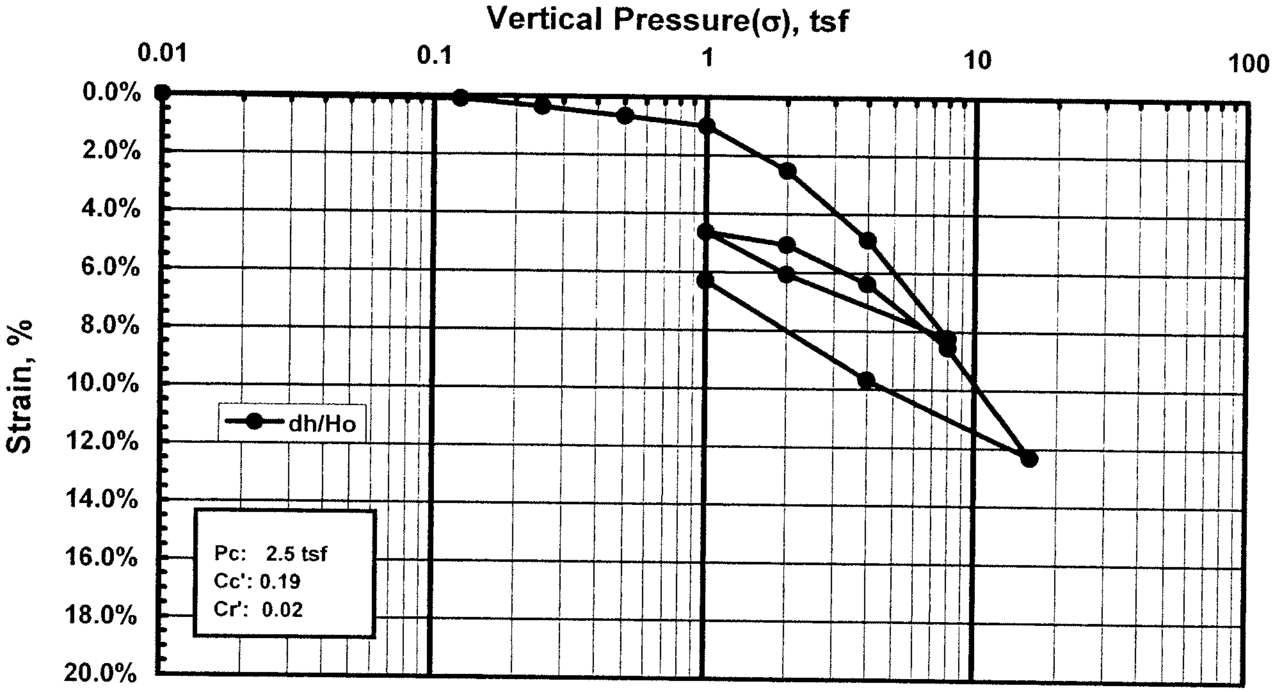


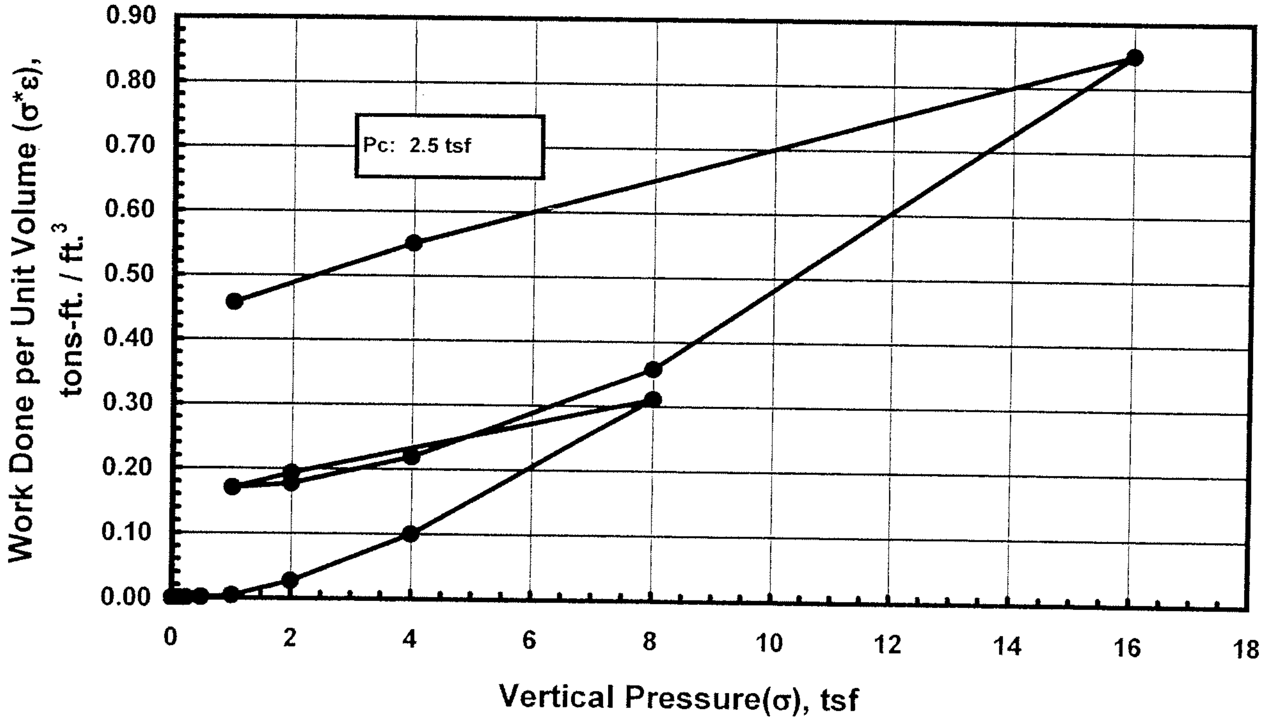
Sample Condition	Before	After
Moisture Content, %:	26.3%	25.2%
Sample Height, in.:	1.0000	0.9370
Void Ratio, e:	0.6902	0.5837
Unit Weight, pcf:	97.8	104.4
Degree of Saturation:	1.01	1.14

Consolidation Parameters	
Overburden Pressure, tsf:	0.8
Preconsolidation Pressure, tsf:	2.5
Compression Index, Cc:	0.19
Re-Compression Index, Cr	0.02

Project Number:	286-75083	Liquid Limit:	68	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	26		
Boring No.:	BV-24	Plastic Limit:	42		
Sample ID, Depth:	TW-4, 13-15 feet	Sample Classification:	Fat Clay (CH), Brown, Gray		

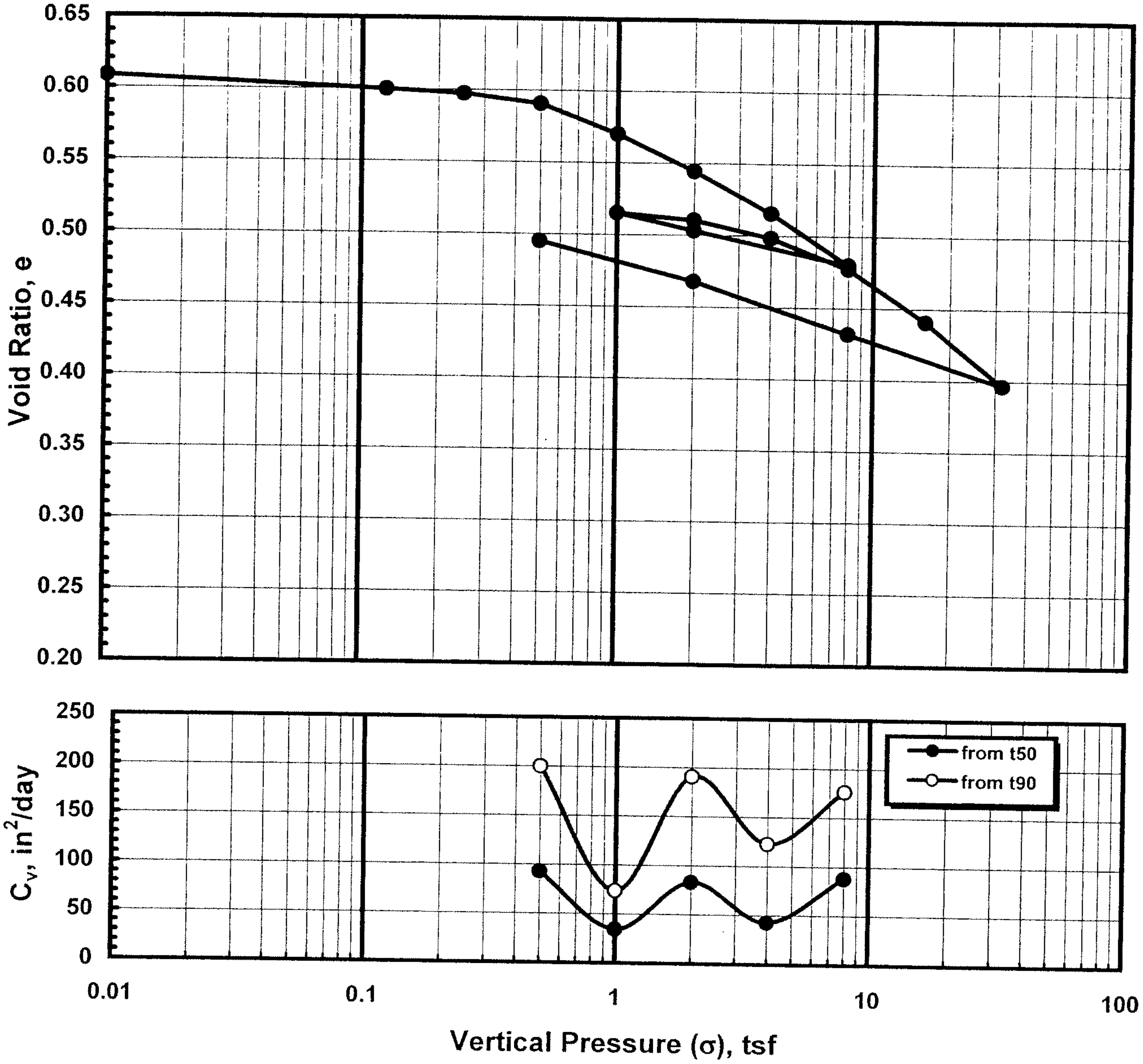
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	68	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	26		
Boring No.:	BV-24	Plastic Limit:	42		
Sample ID, Depth:	TW-4, 13-15 feet	Sample Classification:	Fat Clay (CH), Brown, Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	18.9%	20.4%
Sample Height, in.:	1.0000	0.9295
Void Ratio, e:	0.6084	0.4950
Unit Weight, pcf:	102.8	110.6
Degree of Saturation:	0.82	1.09

Consolidation Parameters	
Overburden Pressure, tsf:	1.4
Preconsolidation Pressure, tsf:	1.5
Compression Index, Cc:	0.13
Re-Compression Index, Cr	0.01
Swell Index, Cs:	

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-24
Sample ID, Depth:	TW-6, 23-23.6 feet

Liquid Limit:	62	Hand Pen:	-
Plastic Limit:	27		
Plastic Limit:	35		
Sample Classification:	Fat Clay (CH), Brown, Gray		

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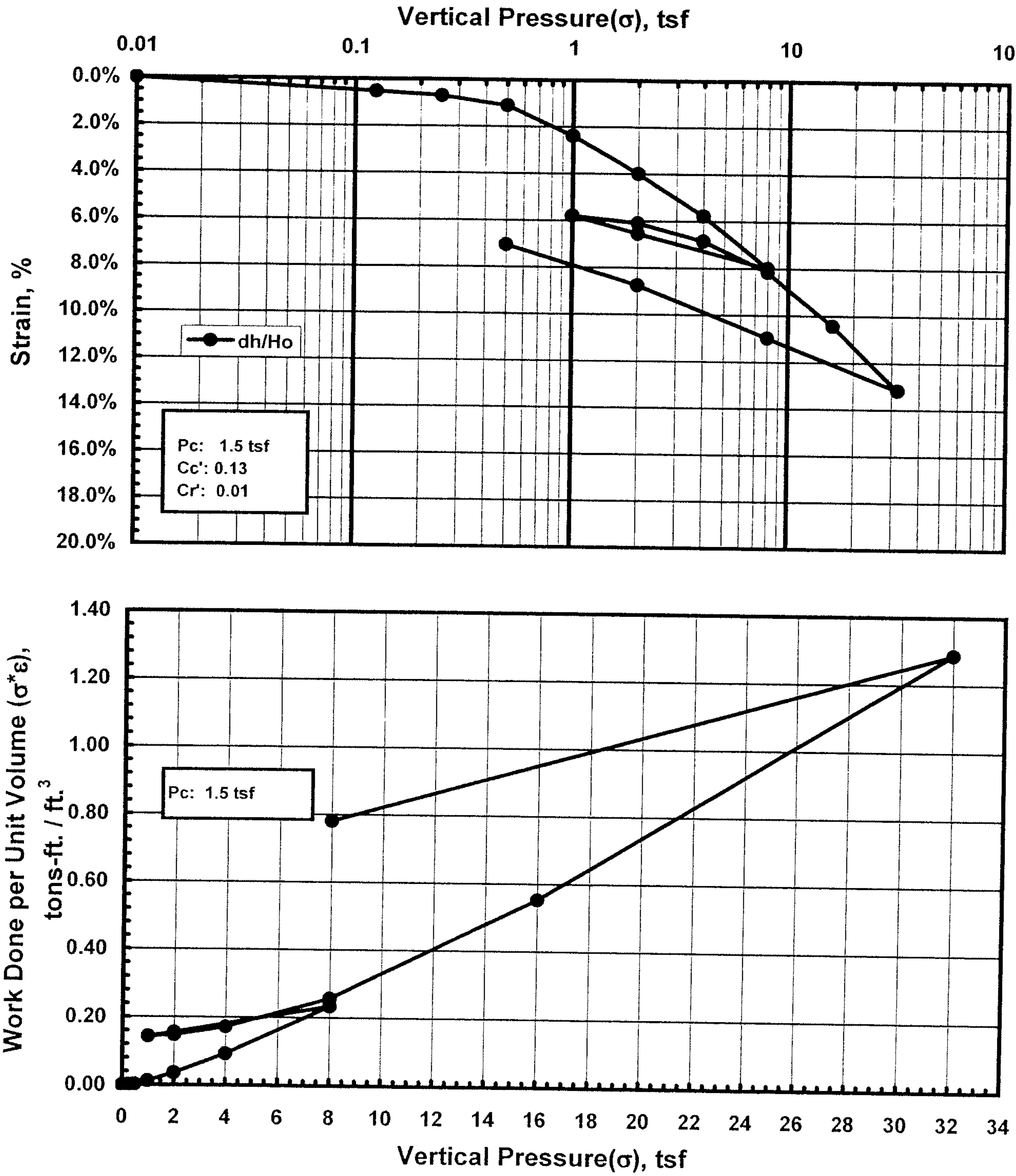
CONSOLIDATION TEST RESULTS - ASTM D 2435



Project Number:	286-75083	Liquid Limit:	62 Hand Pen: -
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	27
Boring No.:	BV-24	Plastic Limit:	35
Sample ID, Depth:	TW-6, 23-23.6 feet	Sample Classification:	Fat Clay (CH), Brown, Gray

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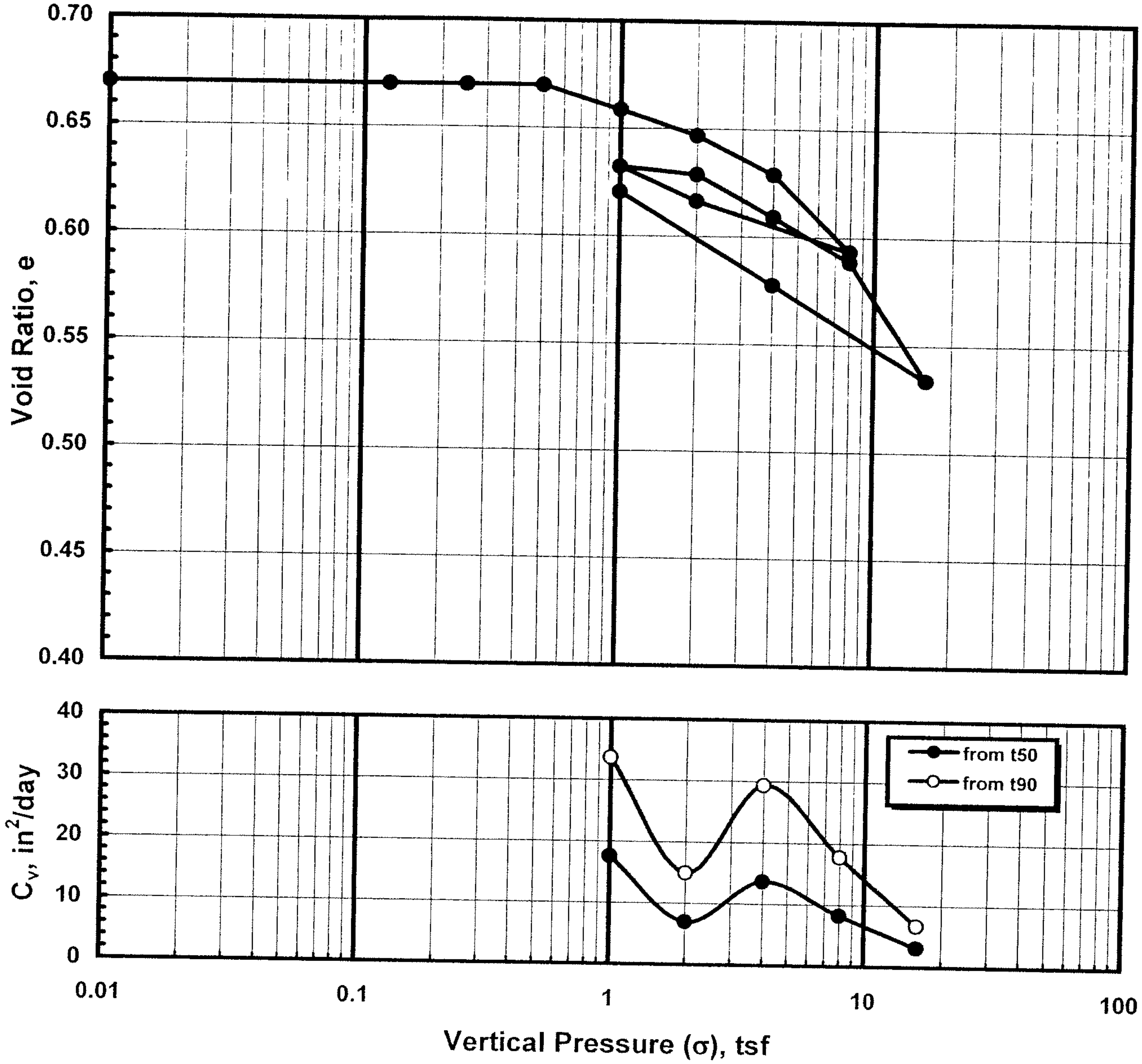
CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	25.6%	26.2%
Sample Height, in.:	1.0000	0.9705
Void Ratio, e:	0.6698	0.6205
Unit Weight, pcf:	99.0	102.0
Degree of Saturation:	1.01	1.12

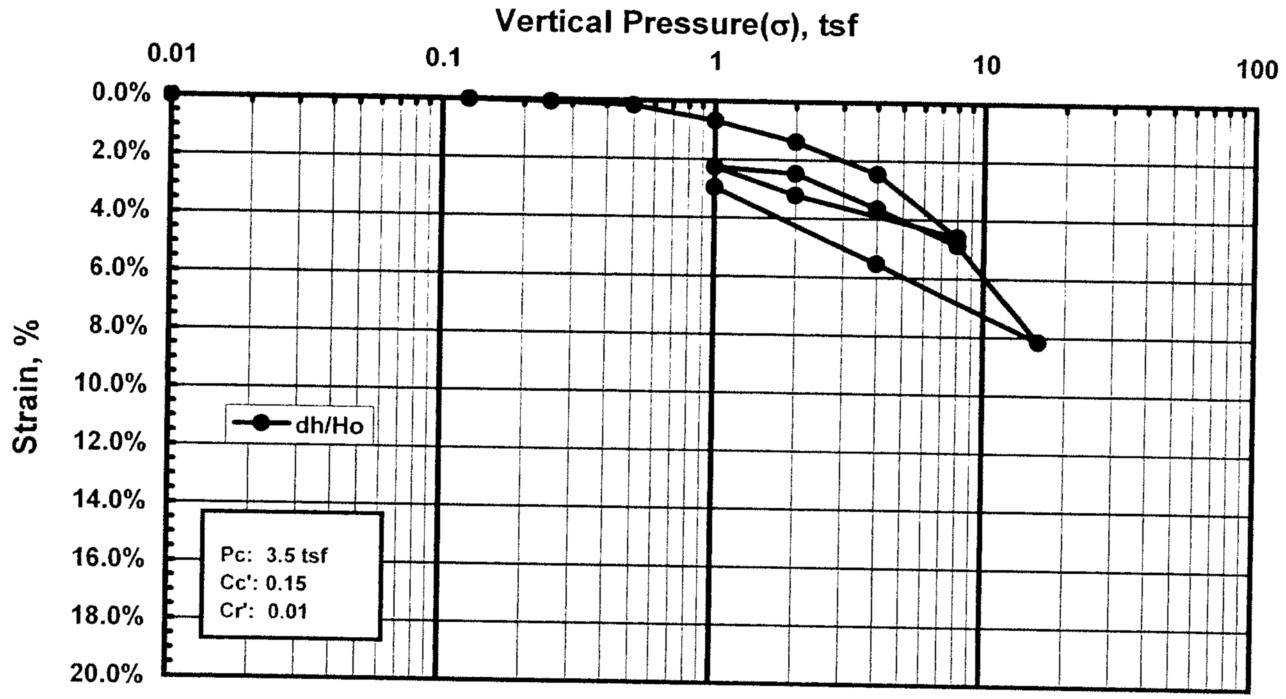
Consolidation Parameters	
Overburden Pressure, tsf:	1.3
Preconsolidation Pressure, tsf:	3.5
Compression Index, Cc:	0.15
Re-Compression Index, Cr	0.01

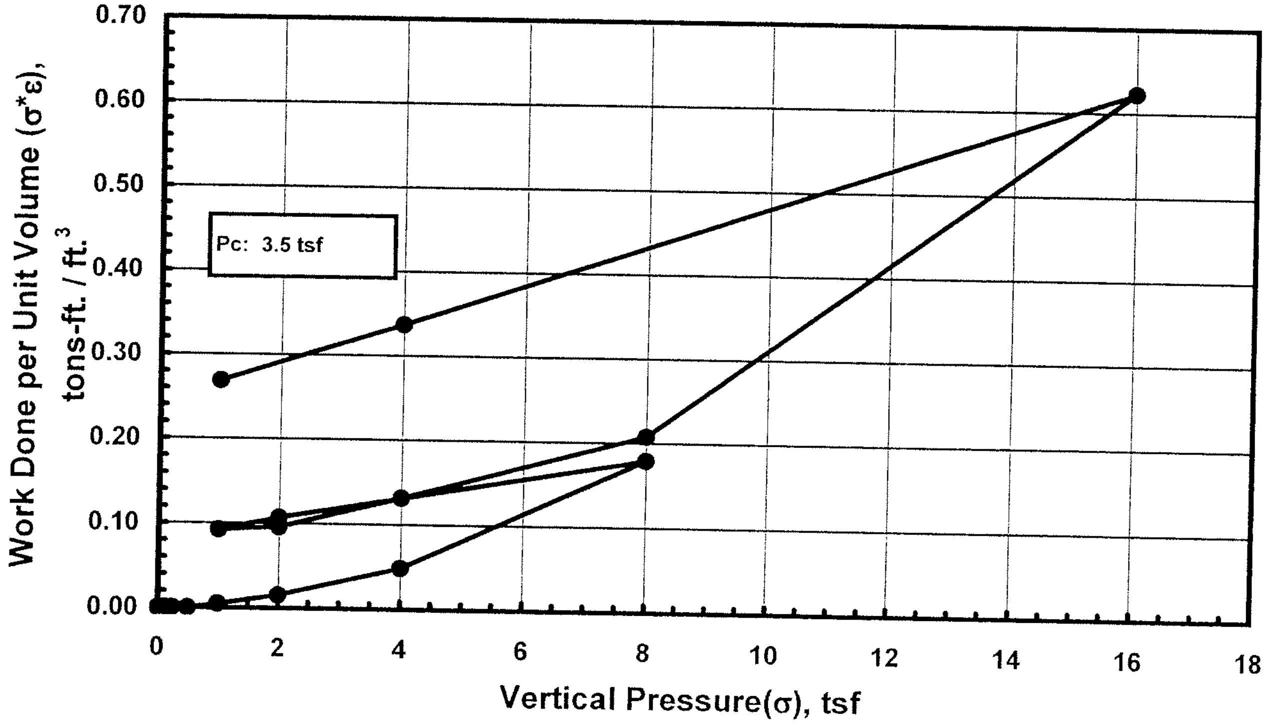
Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-26
Sample ID, Depth:	TW-7, 20-21.8 feet

Liquid Limit:	117	Hand Pen:	-
Plastic Limit:	30		
Plastic Limit:	87		
Sample Classification:	Fat Clay (CH), Brown, Gray, Dry		

psi

CONSOLIDATION TEST RESULTS - ASTM D 2435

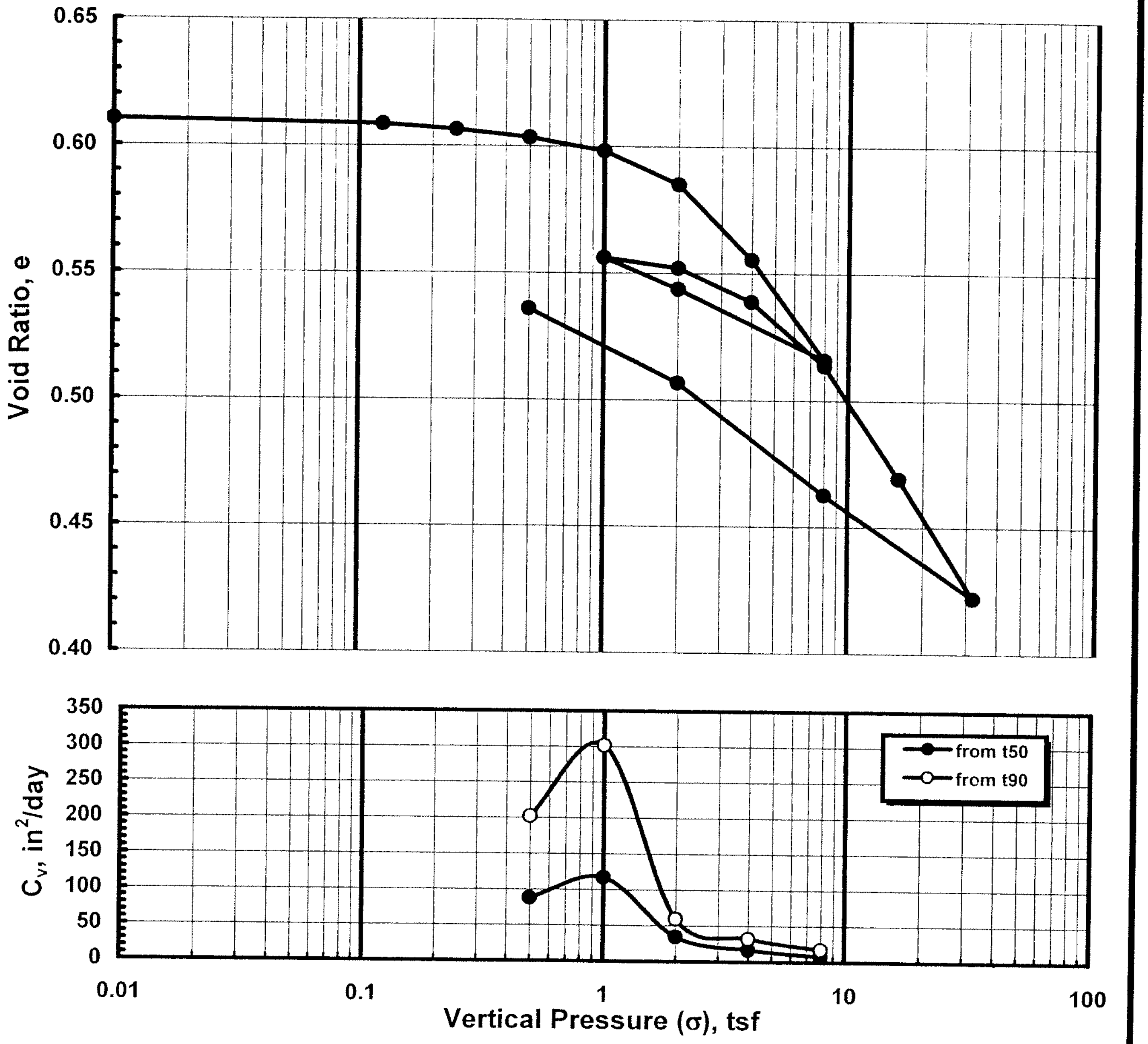




Project Number:	286-75083	Liquid Limit:	117	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	30		
Boring No.:	BV-26	Plastic Limit:	87		
Sample ID, Depth:	TW-7, 20-21.8 feet	Sample Classification:	Fat Clay (CH), Brown, Gray, Dry		

psi

CONSOLIDATION TEST RESULTS - ASTM D 2435



Sample Condition	Before	After
Moisture Content, %:	21.2%	22.4%
Sample Height, in.:	1.0000	0.9538
Void Ratio, e:	0.6103	0.5359
Unit Weight, pcf:	102.7	107.7
Degree of Saturation:	0.92	1.11

Consolidation Parameters	
Overburden Pressure, tsf:	2.0
Preconsolidation Pressure, tsf:	2.0
Compression Index, Cc:	0.14
Re-Compression Index, Cr	0.01
Swell Index, Cs:	

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-31
Sample ID, Depth:	TW-8, 33-34.2

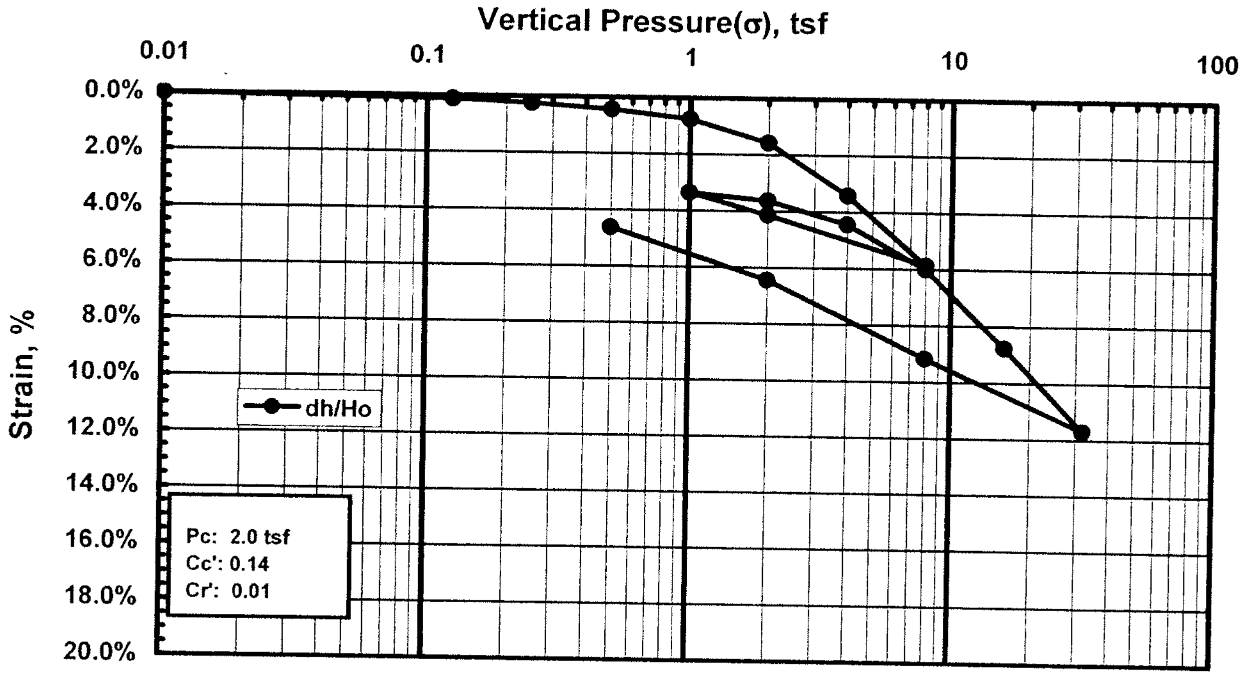
Liquid Limit: Hand Pen:

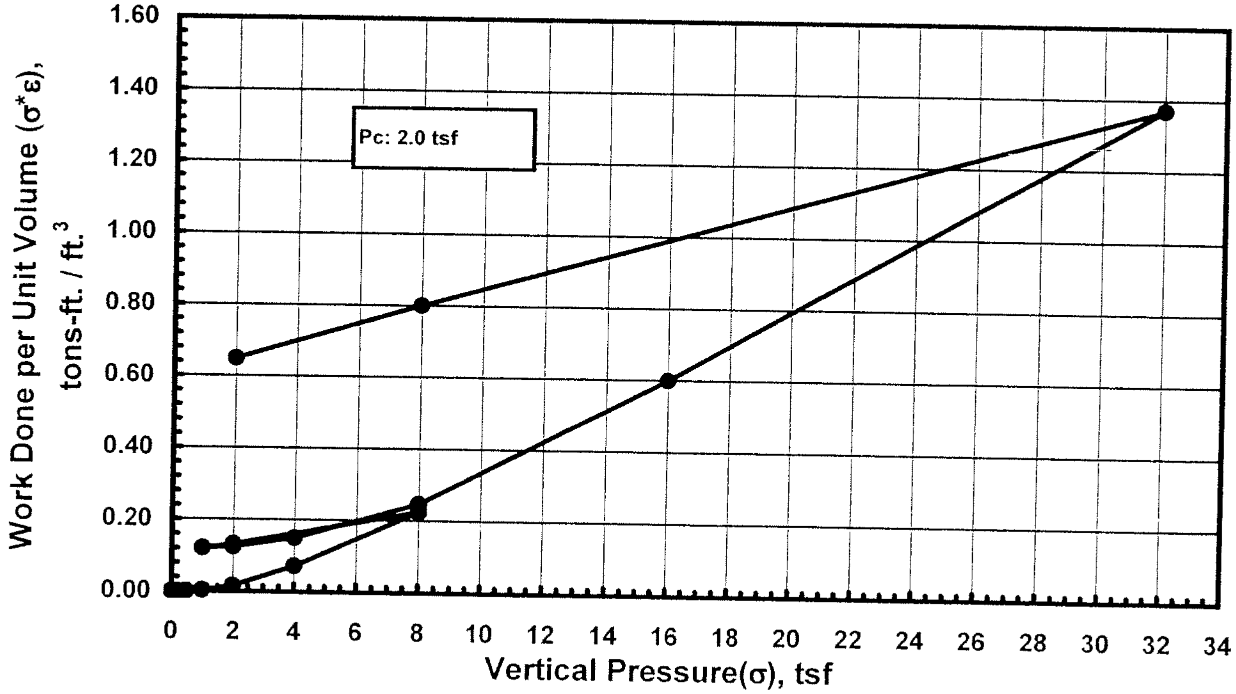
Plastic Limit:

Plastic Limit:

Sample Classification: Dk Gry. Brn, Fat Clay w/silt pockets

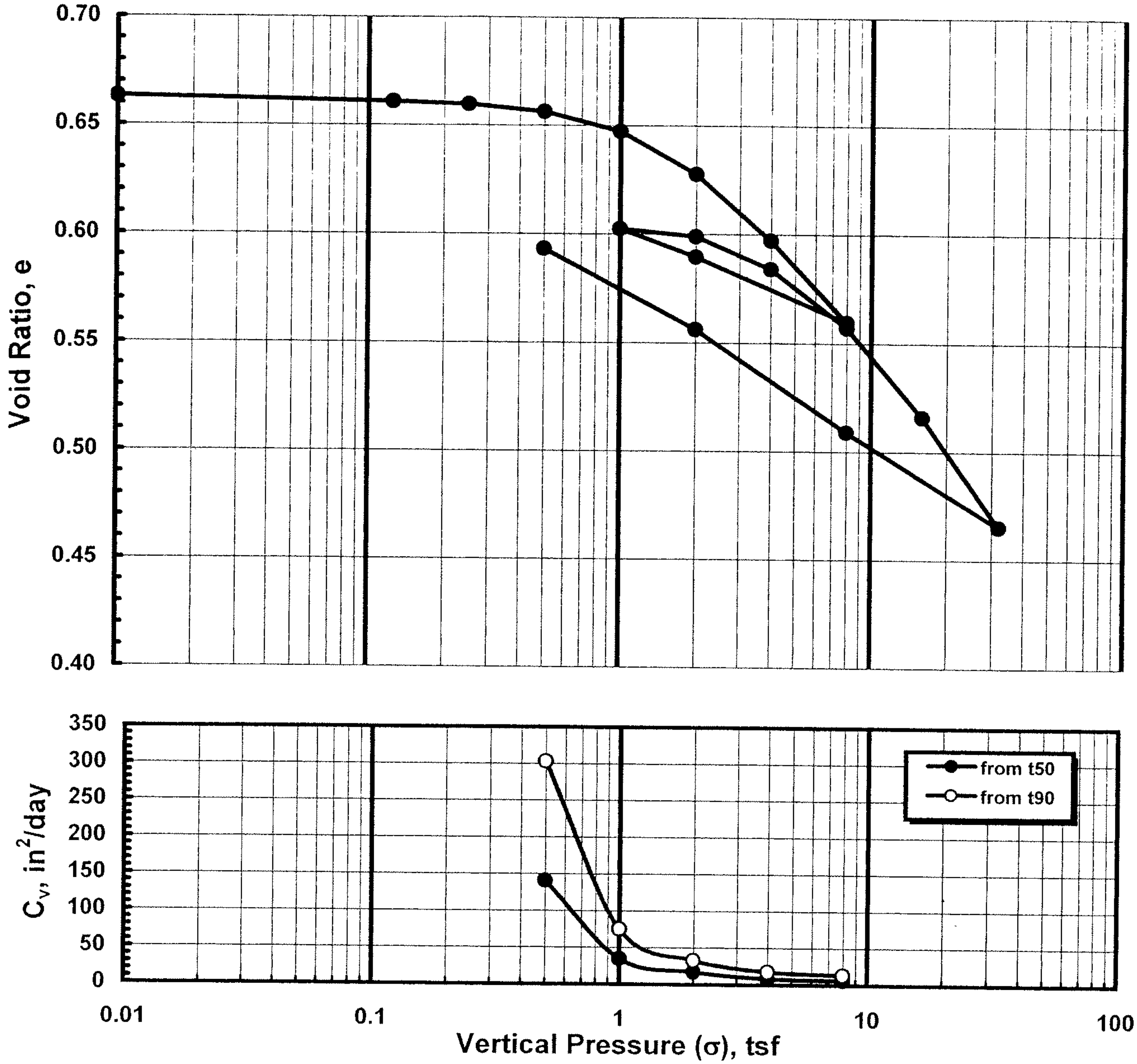
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	**Liquid Limit:**	**Hand Pen:**
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	
Boring No.:	BV-31	**Plastic Limit:**	
Sample ID, Depth:	TW-8, 33-34.2	**Sample Classification:** Dk Gry. Brn, Fat Clay w/silt pockets	

CONSOLIDATION TEST RESULTS - ASTM D 2435



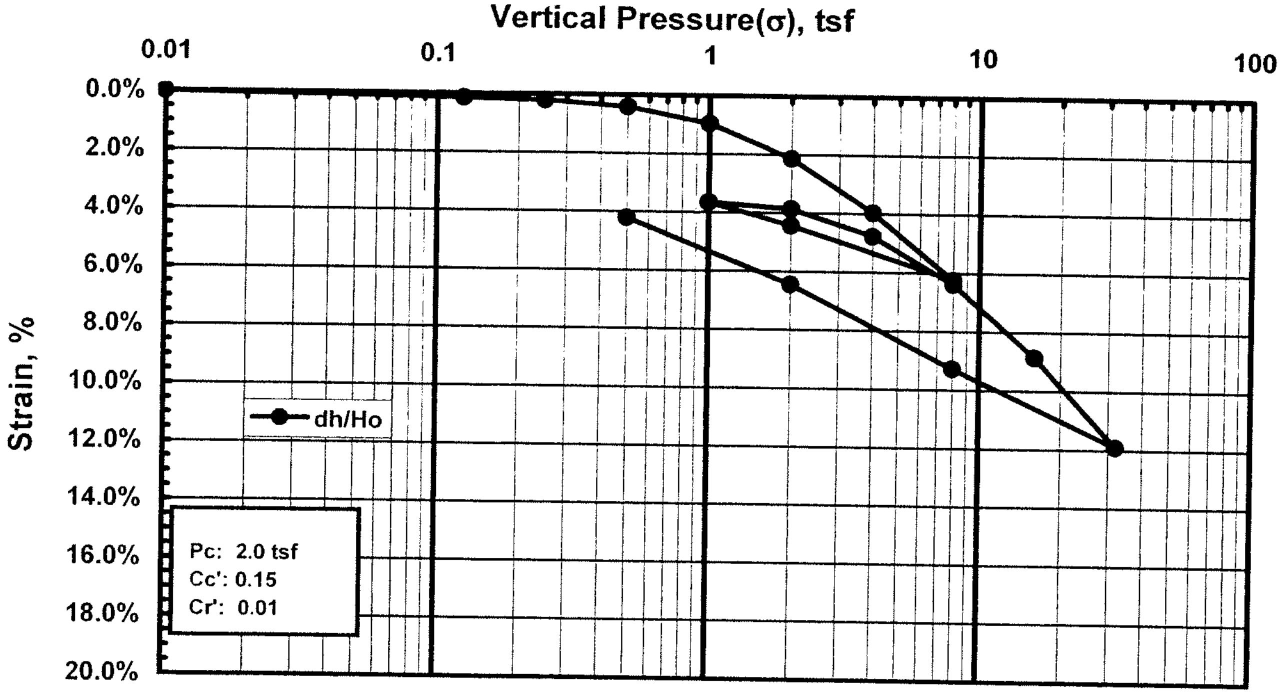
Sample Condition	Before	After
Moisture Content, %:	23.3%	24.2%
Sample Height, in.:	1.0000	0.9579
Void Ratio, e:	0.6632	0.5932
Unit Weight, pcf:	99.4	103.8
Degree of Saturation:	0.93	1.08

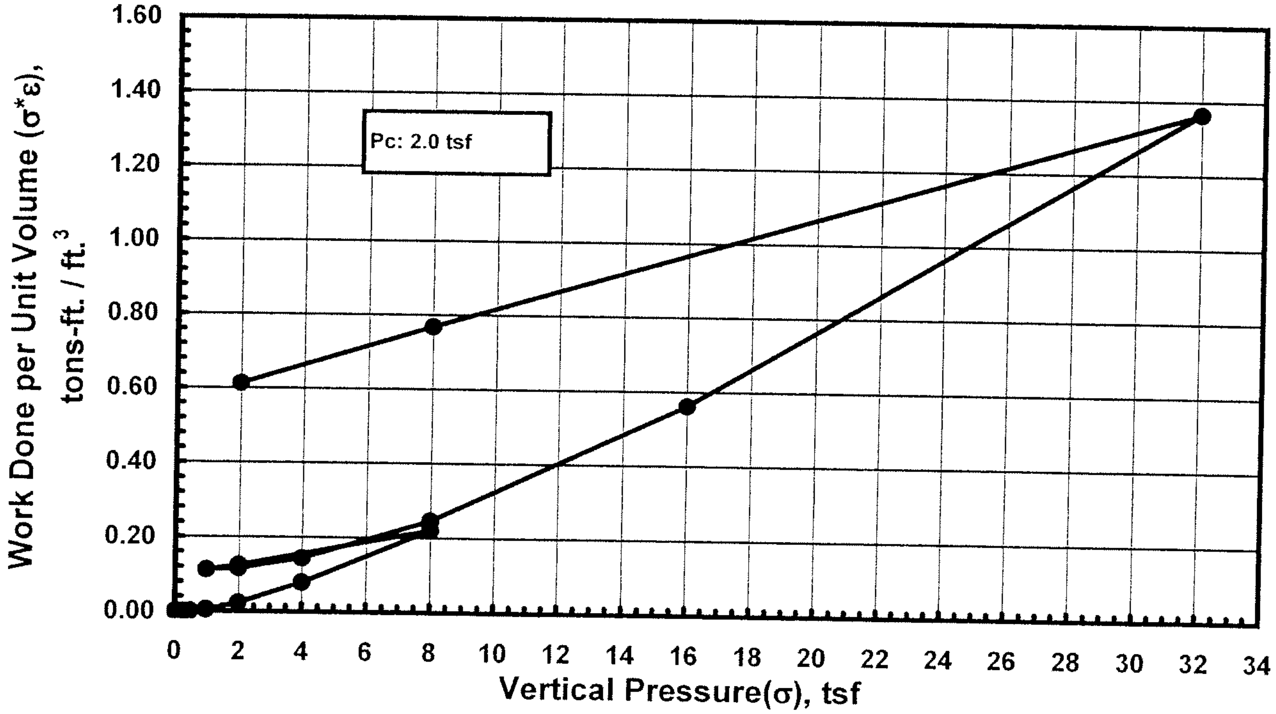
Consolidation Parameters	
Overburden Pressure, tsf:	1.7
Preconsolidation Pressure, tsf:	2.0
Compression Index, Cc:	0.15
Re-Compression Index, Cr	0.01
Swell Index, Cs:	

Project Number:	286-75083
Project Name	Sandy Creek Energy Station, Riese
Boring No.:	BV-34
Sample ID, Depth:	TW-8, 28-30

Liquid Limit:	69	Hand Pen:	-
Plastic Limit:	23		
Plastic Limit:	46		
Sample Classification:	Grayish Brown, Fat Clay		

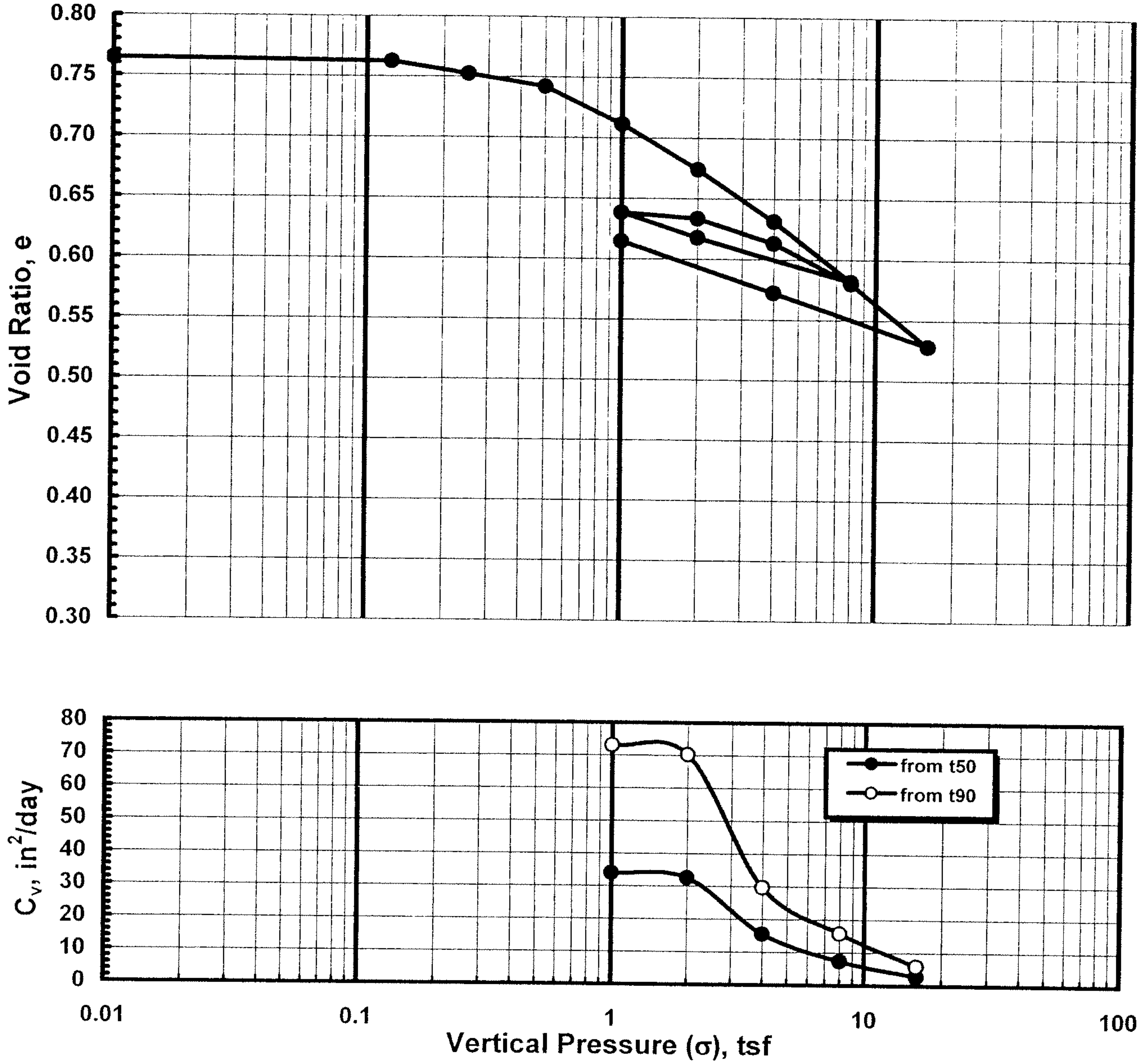
CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	69	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	23		
Boring No.:	BV-34	Plastic Limit:	46		
Sample ID, Depth:	TW-8, 28-30	Sample Classification:	Grayish Brown, Fat Clay		

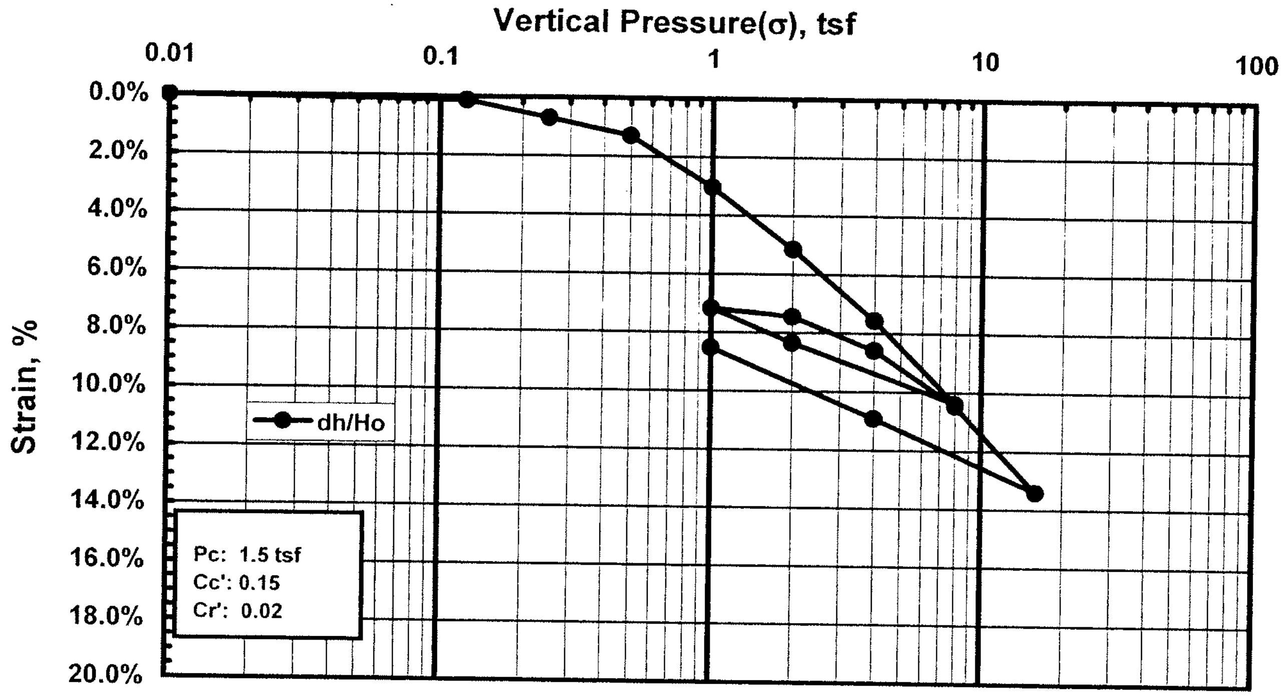
CONSOLIDATION TEST RESULTS - ASTM D 2435

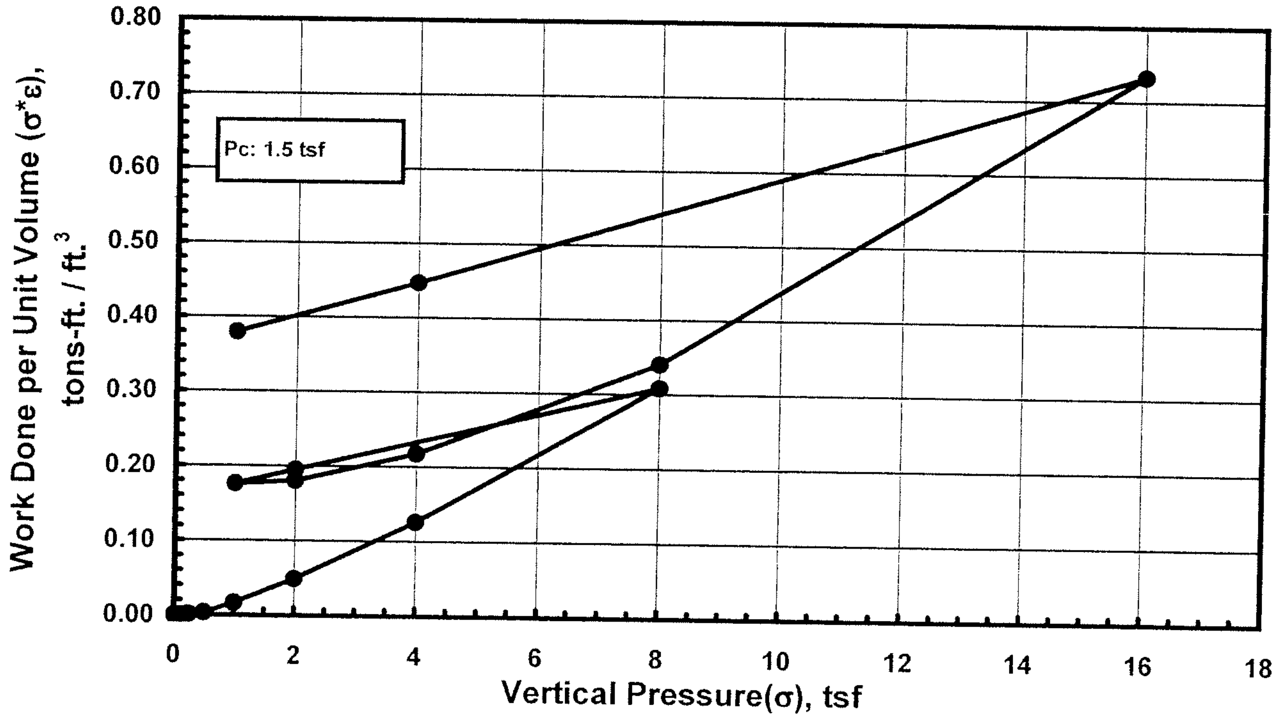


Sample Condition	Before	After	Consolidation Parameters	
Moisture Content, %:	26.1%	26.1%	Overburden Pressure, tsf:	1.4
Sample Height, in.:	1.0000	0.9149	Preconsolidation Pressure, tsf:	1.5
Void Ratio, e:	0.7648	0.6146	Compression Index, Cc:	0.15
Unit Weight, pcf:	93.7	102.4	Re-Compression Index, Cr	0.02
Degree of Saturation:	0.90	1.12	Swell Index, Cs:	

Project Number:	286-75083	Liquid Limit:	67	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	31		
Boring No.:	BV-35	Plastic Limit:	36		
Sample ID, Depth:	TW-7, 23-25 feet	Sample Classification:	Silty Clay, Brown, Gray		

CONSOLIDATION TEST RESULTS - ASTM D 2435





Project Number:	286-75083	Liquid Limit:	67	Hand Pen:	-
Project Name	Sandy Creek Energy Station, Riese	Plastic Limit:	31		
Boring No.:	BV-35	Plastic Limit:	36		
Sample ID, Depth:	TW-7, 23-25 feet	Sample Classification:	Silty Clay, Brown, Gray		

APPENDIX II.C

PROTECTED SPECIES HABITAT ASSESSMENT

ies
integrated environmental solutions

03 November 2021

Ms. Dana L. Perry
Business Manager
Sandy Creek Energy Station
P.O. Box 370
Riesel, Texas 76682

Re: Sandy Creek Energy Station - Protected Species Habitat Assessment
Approximately 132 acres associated with the landfill serving Sandy Creek Energy Station, near Riesel, McLennan County, Texas

Dear Ms. Perry,

Integrated Environmental Solutions, LLC (IES) performed a protected species habitat assessment on approximately 132 acres associated with the landfill serving Sandy Creek Energy Station, near Riesel, McLennan County, Texas (**Attachment A, Figure 1**). This habitat assessment was performed to satisfy the requirements regarding the Endangered Species Act (ESA). The following report is a list of the federal and state-listed protected species for McLennan County and their preferred vegetation assemblages, a summary of the vegetation communities identified on the site, an evaluation of whether or not the communities present on the site could support a protected species, and whether or not future proposed actions would affect listed species.

INTRODUCTION

<u>*Protected Species*</u>

Federal

The ESA of 1973 (Public Law [P.L.] 93-205) and the amendments of 1988 (P.L. 100-578) were enacted to provide a program of preservation for endangered and threatened species and to provide protection for ecosystems upon which these species depend for their survival. The ESA requires all federal agencies to implement protection programs for designated species and to use their authorities to further the purposes of the Act. Responsibility for the listing of an endangered or threatened species and for the development of recovery plans lies with the Secretary of Interior and Secretary of Commerce. The U.S. Fish and Wildlife Service (USFWS) is responsible for implementing the ESA within the United States.

An endangered species is a species, which is in danger of extinction throughout all or a significant portion of its range. A threatened species is a species likely to become endangered within the near future throughout all or a significant portion of its range. Proposed species are those, which have been formally submitted to Congress for official listing as endangered or threatened.

In addition, the USFWS has identified species, which are candidates for possible addition to the list of Endangered and Threatened Wildlife and Plants (50 Code of Federal Regulations [CFR] 17.11 and 17.12) under the ESA. The USFWS maintains a candidate list to: (1) provide advance knowledge of potential listings that could affect land planning decisions, (2) solicit input to identify candidates not requiring protection or additional species that may require protection under the ESA, and (3) solicit information needed to prioritize the order in which species will be proposed for listing. Candidate species have no legal protection under the ESA.

The Migratory Bird Treaty Act of 1918 states that it is unlawful to kill, capture, collect, possess, buy, sell, trade, or transport any migratory bird, nest, young, feather, or egg in part or in whole, without a federal permit issued in accordance with the Act's policies and regulations. However, in a recent decision the U.S. Court of Appeals for the Fifth Circuit found that for an unlawful "taking" to occur, a "deliberate act done directly and intentionally to migratory birds" would need to occur. (United States v. CITGO Petroleum Corp., No. 14-40128 [5th Cir. Sept. 4, 2015]).

State

The Texas Parks and Wildlife Department (TPWD) Wildlife Diversity Program (WDP) maintains computerized records of state-listed threatened and endangered species by county. The State of Texas does not list threatened and endangered species using the same criteria as the federal government. When the USFWS lists a plant species, the State of Texas then lists that plant. Thus, the list of threatened and endangered plants in Texas is the same as the Federal list. The state has separate laws governing the listing of animal species as threatened or endangered. Threatened and endangered animal species in Texas are those species so designated according to Chapters 67 and 68 of the Texas Parks and Wildlife Code and Section 65.171 - 65.184 of Title 31 of the Texas Administrative Code. Species that are not currently listed by the Federal government may be listed as threatened or endangered by the TPWD.

METHODOLOGY

Prior to conducting fieldwork, the list of Endangered and Threatened Wildlife and Plants under the ESA was obtained through the USFWS Information, Planning, and Conservation System (IPaC) and from the TPWD WDP. The vegetation communities used by each species was obtained and is detailed below. During the field survey, vegetation composition within and adjacent to the project site were noted to determine whether there was any potential for protected species habitat. This survey was not designed to identify the presence of protected species; however, if any species were observed, they were recorded. Photographs were taken at representative points, illustrating common vegetation communities within the survey area (**Attachment B**).

RESULTS

Literature Review

According to the USFWS, four species; the Golden-cheeked Warbler (*Setophaga chrysoparia*), Piping Plover (*Charadrius melodus*), Red Knot (*Calidris canutus rufa*), and Whooping Crane (*Grus americana*) are listed as federally protected (i.e., threatened or endangered) with the potential to occur within McLennan County. The Texas Fawnsfoot (*Truncilla macrodon*) is listed as a candidate species with the potential to occur within McLennan County. The Piping Plover and Red Knot are conditionally listed as threatened within McLennan County on the basis that the proposed project is for wind energy production. No federally listed critical habitat for these species is located within the vicinity of the survey area. The TPWD lists 14 state protected species that could occur within McLennan County, four of which are also federally listed for McLennan County.

Attachment C identifies the state and federally protected species that could potentially occur within McLennan County from the IPAC and Rare and Threatened Endangered Species of Texas (RTEST) lists.

Site Survey

Mr. Rudi Reinecke of IES evaluated the survey area on 20 October 2020. This survey was designed to provide a habitat evaluation of the overall survey area with the primary focus on the plant community.

The property was undeveloped and was historically used for agriculture practices. Recently, Sandy Creek Energy Station developed the property for a power generating station with attendant features. The site has had varying degrees of improvements to facilitate the construction and operation of the power generating station (i.e., the land fill in the center; a temporary construction parking lot on the west; a construction staging area on the east side; and settling/retention ponds in the south). There were three general plant communities identified in the site – **grassland**, **broadleaf woods,** and **open water**. The grassland was characterized as a rangeland with the majority of the community disturbed from nearby operations. The temporary parking lot and construction staging areas were gravel but have grasses and forbs colonizing the abandoned lots. The closed portions of the landfill were inactive and vegetated with grasses. The **grassland** was comprised of forbs and grasses such as Bermudagrass (*Cynodon dactylon*), King Ranch bluestem (*Bothriochloa ischaemum*), meadow dropseed (*Sporobolus asper*), Missouri goldenrod (*Solidago missouriensis*), silver bluestem (*Bothriochloa laguroides*), giant ragweed (*Ambrosia trifida*), sumpweed (*Iva annua*), snow-the-prairie (*Euphorbia bicolor*), heath aster (*Symphyotrichum ericoides*), annual sunflower (*Helianthus annuus*), Johnsongrass (*Sorghum halepense*), sideoats grama (*Bouteloua curtipendula*), oldfield threeawn (*Aristita oligantha*), lemon beebalm (*Monarda citriodora*), annual broomweed (*Amphiachyris dracunculoides*), white tridens (*Tridens albescens*), and balloon vine (*Cardiospermum halicacabum*). There were scattered honey mesquite (*Prosopis glandulosa*) and willow baccharis (*Baccharis salicina*) shrubs colonizing the grassland.

The **broadleaf woods** community was located in the west-central portion of the project site that had numerous structures that were in various stages of deterioration. This community was likely a result of the old farmstead in the area. The community was dominated by sugarberry (*Celtis laevigata*), honey mesquite, and honey locust (*Gleditsia triacanthos*) trees and shrubs.

The **open water** community was associated with various ponds throughout the survey area.

CONCLUSIONS

<u>*Preferred Habitat for Federally Protected Species*</u>

Table 1 provides a summary of the federally and state-listed species that could potentially occur within McLennan County, as well as a brief description of their habitat, whether this habitat is present within the survey area, and whether the proposed project would potentially affect the listed species.

Regarding federally listed threatened and endangered species, Golden-cheeked Warbler, Piping Plover, Red Knot, and Whooping Crane were listed for McLennan County. The Texas Fawnsfoot was listed as a candidate species with the potential to occur within McLennan County. As these projects will not be related to wind energy, the Piping Plover and Red Knot will not be affected. Open water was observed within the survey area; however, the water was much too deep to be preferred by the whooping crane. No mature stands of Ashe juniper and various oaks was observed within the survey area; therefore, no habitat preferred by the Golden-cheeked Warbler was observed.

- Whooping Cranes utilize estuaries, prairie marshes, moist grasslands, croplands, and will use large shallow wetland areas associated with lakes for roosting and feeding. The survey area was observed with open water; however, the water was much too deep to be preferred by the Whooping Crane.

- The Golden-cheeked Warbler utilizes mature stands of mixed Ashe juniper, various oaks (*Quercus* spp.), and other broadleaf deciduous hardwood trees with a dense overstory as nesting and foraging habitat. This unique vegetation community is not present within the survey area.

Habitats were not suitable for any of the federally listed threatened or endangered species. Nor were the habitats suitable for nesting, feeding, or stopover migration habitat for the remaining species.

<u>*Preferred Habitat for State Protected Species*</u>

There were 14 state-listed threatened and endangered species for McLennan County, which includes the above federally listed species. There was no habitat for any state-listed species within the project site:

- Red Knot, Piping Plover, White-faced Ibis (*Plegadis chihi*), and Whooping Crane occurrences would be in relation to stopover during migration; however, no suitable stopover habitat was observed within the survey area.
- Interior Least Tern (*Sterna antillarum athalassos*) follow the flyways of the large river systems, such as the Trinity River and Brazos River; the Brazos River is more than 2 miles to the west of this project site and the ponds on this site are too small for the Interior Least Tern to feed on.
- Black Rails (*Laterallus jamaicensis*) and Wood Storks (*Mycteria americana*) utilize freshwater marsh habitats, of which were not identified within the project site.

Table 1. Federally- and State- listed Threatened and Endangered Species Occurring or Potentially Occurring in McLennan County, Texas

Species	State Status	Federal Status	Description of Habitat	Habitat Present[1]	Species Effect[2]
Black Rail (*Laterallus jamaicensis*)	T	LT	Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous years dead grasses; nest usually hidden in marsh grass or at base of Salicornia.	**No**	**No**
Golden-cheeked Warbler (*Setophaga chrysoparia*)	E	LE	Ashe juniper in mixed stands with various oaks (*Quercus* spp.). Edges of cedar brakes. Dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer.	**No**	**No**
Interior Least Tern (*Sterna antillarum athalassos*)	E	DL	Sand beaches, flats, bays, inlets, lagoons, islands. Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony.	**No**	**No**
Piping Plover (*Charadrius melodus*)	T	LT	Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands. Also spoil islands in the Intracoastal Waterway. Based on the November 30, 1992 Section 6 Job No. 9.1, Piping Plover and Snowy Plover Winter Habitat Status Survey, algal flats appear to be the highest quality habitat. Some of the most important aspects of algal flats are their relative inaccessibility and their continuous availability throughout all tidal conditions. Sand flats often appear to be preferred over algal flats when both are available, but large portions of sand flats along the Texas coast are available only during low-very low tides and are often completely unavailable during extreme high tides or strong north winds. Beaches appear to serve as a secondary habitat to the flats associated with the primary bays, lagoons, and inter-island passes. Beaches are rarely used on the southern Texas coast, where bayside habitat is always available, and are abandoned as bayside habitats become available on the central and northern coast. However, beaches are probably a vital habitat along the central and northern coast (i.e. north of Padre Island) during periods of extreme high tides that cover the flats. Optimal site characteristics appear to be large in area, sparsely vegetated, continuously available or in close proximity to secondary habitat, and with limited human disturbance.	**No**	**No**
Red Knot (*Calidris canutus rufa*)	T	LT	The Red Knot prefers the shoreline of coast and bays and uses mudflats during rare inland encounters. Primary prey items include coquina clam (*Donax* spp.) on beaches and dwarf surf clam (*Mulinia lateralis*) in bays, at least in the Laguna Madre. Wintering Range includes- Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.	**No**	**No**
Whooping Crane (*Grus americana*)	E	LE	Small ponds, marshes, and flooded grain fields for both roosting and foraging. Potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties.	**Yes**	**No**
White-faced Ibis (*Plegadis chihi*)	T	---	Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.	**No**	**No**
Wood Stork (*Mycteria americana*)	T	---	Prefers to nest in large tracts of baldcypress (*Taxodium distichum*) or red mangrove (*Rhizophora mangle*); forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags,	**No**	**No**

Species	State Status	Federal Status	Description of Habitat	Habitat Present[1]	Species Effect[2]
			sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960.		
Club shiner (*Notropis potteri*)	T	---	Occurs in the Brazos, Colorado, San Jacinto, and Trinity river basins. It occurs within these river basins if flowing water with silt or sand substrate is present.	**No**	**No**
Sharpnose shiner (*Notropis oxyrhynchus*)	E	LE	Range is now restricted to upper Brazos River upstream of Possum Kingdom Lake. May be native to Red River and Colorado River basins. Typically found in turbid water over mostly silt and shifting sand substrates.	**No**	**No**
Smalleye shiner (*Notropis buccula*)	E	LE	Endemic to the Brazos River drainage; presumed to have been introduced into the Colorado River. Historically found in lower Brazos River as far south as Hempstead, Texas but appears to now be restricted to upper Brazos River system upstream of Possum Kingdom Lake. Typically found in turbid waters of broad, sandy channels of mainstream, over substrate consisting mostly of shifting sand.	**No**	**No**
Brazos Heelsplitter (*Potamilus streckersoni*)	T	---	Occurs from streams, but not far into the headwaters, to large rivers, and some reservoirs. In riverine systems occurs most often in nearshore habitats such as banks and backwater pools but occasionally in main channel habitats such as riffles. Typically found in standing to slow-flowing water in soft substrates consisting of silt, mud, or sand but occasionally in moderate flows with gravel and cobble substrates.	**No**	**No**
Texas Fawnsfoot (*Truncilla macrodon*)	T	C	Occurs in large rivers but may also be found in medium-sized streams. Occurs in shore areas such as banks and backwaters but also riffles and point bar habitats with low to moderate water velocities. Typically occurs in substrates of mud, sandy mud, gravel and cobble.	**No**	**No**
Texas horned lizard (*Phrynosoma cornutum*)	T	---	Terrestrial: Open habitats with sparse vegetation, including grass, prairie, cactus, scattered brush, or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive. Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area.	**No**	**No**

LE – Federally Listed Endangered, LT – Federally Listed Threatened, DL – Federally Delisted, PT – Federally Proposed Threatened, C – Federal Candidate, E – State Listed Endangered, T - State Listed Threatened

[1] *Habitat Present? – Does the habitat located within the survey area match the habitat requirements for that particular protected species?*

[2] *Species Effect? – Will the proposed project potentially affect a protected species?*

Data Sources: USFWS IPaC (published and accessed 07 January 2021), TPWD (published 25 August 2020, accessed 07 January 2021), and field survey of the project site

- Wood Storks (*Mycteria americana*) can occur east of the Dallas-San Antonio-Zapata line in Texas between July and September. The inland habitat is primarily based on their feeding habitat around prairie ponds that other shorebirds typically utilize. These types of prairie ponds are typically large ponds with shallow water habitats for foraging. The ponds located on the site are either lined with plastic or do not have any shallow water fringes. Therefore, the Wood Stork is unlikely to utilize these ponds.
- The Golden-cheeked Warbler utilizes mature stands of mixed Ashe juniper, various oaks, and other broadleaf deciduous hardwood trees with a dense overstory as nesting and foraging habitat; therefore, no suitable habitat is present.
- The club shiner (*Notropis potteri*) is present within flowing water streams in the Brazos, Colorado, San Jacinto, and Trinity River basins; there were no streams within the project site.
- The sharpnose shiner (*Notropis oxyrhynchus*) and smalleye shiner (*Notropis buccula*) are restricted to the Brazos River watershed upstream of Possum Kingdom Lake; as there are no streams within the project site, these species would not be present.
- The Texas horned lizard (*Phrynosoma cornutum*) prefers bare ground with scattered clumps of vegetation which does not occur within the survey area.

Vegetation Communities

None of the vegetation observed within the survey areas would be considered unique or compose a unique vegetation type for the region. The vegetation communities described were composed of species that are not only common to grassland and forested areas, but to the Cross-Timber eco-region of Central Texas. It is IES' professional opinion that the proposed project will not have any effect on any unique vegetation, vegetation communities, or habitat types.

Potential to Affect Protected Species

As previously noted, no preferred habitat for any of the federally or state-listed species was present within the survey area.

IES appreciates the opportunity to work with you, Sandy Creek Energy Station, and SCS Engineers on this project and hope we may be of assistance to you in the future. If you have any comments, questions, or concerns, please do not hesitate to contact me at 972-562-7672 (rreinecke@intenvsol.com).

Sincerely,

Integrated Environmental Solutions, LLC.

Rudi Reinecke
Vice President

File ref: 04.306.005

ATTACHMENT A

Figures

Figure 1.
General Location Map

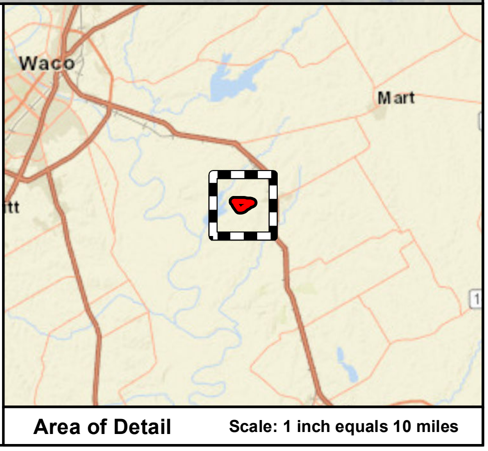
Sandy Creek
City of Riesel
McLennan County, Texas

1 in = 2,000 feet
Feet
0 2,000

N
W E
S

File Ref. 04.306.005
Date: 8/19/2021

□ Survey Area



Area of Detail Scale: 1 inch equals 10 miles

Figure 2.
Vegetation Communities Identified within the Survey Area

Sandy Creek
City of Riesel
McLennan County, Texas

1 in = 500 feet

Feet
0 500

N
W E
S

File Ref. 04.306.005
Date: 8/19/2021

🟥 Survey Area

Vegetation Communties

🟫 Grassland

🟩 Broadleaf Woods

🟦 Open Water

ATTACHMENT B

Site Photographs

Photograph Location Map

Sandy Creek
City of Riesel
McLennan County, Texas

1 in = 500 feet

Feet
0 500

File Ref. 04.306.005
Date: 8/19/2021

N
W E
S

🟥 Survey Area
○ Photograph Location

Vegetation Communties

🟫 Grassland
🟩 Broadleaf Woods
🟦 Open Water


Photograph 1


Photograph 2


Photograph 3


Photograph 4


Photograph 5


Photograph 6


Photograph 7


Photograph 8


Photograph 9


Photograph 10


Photograph 11


Photograph 12


Photograph 13


Photograph 14


Photograph 15


Photograph 16


Photograph 17


Photograph 18


Photograph 19


Photograph 20


Photograph 21


Photograph 22

ATTACHMENT C

Protected Species Lists

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Austin Ecological Services Field Office
10711 Burnet Road, Suite 200
Austin, TX 78758-4460
Phone: (512) 490-0057 Fax: (512) 490-0974
http://www.fws.gov/southwest/es/AustinTexas/
http://www.fws.gov/southwest/es/EndangeredSpecies/lists/

In Reply Refer To:
Consultation Code: 02ETAU00-2021-SLI-1966
Event Code: 02ETAU00-2021-E-04030
Project Name: Sandy Creek PSHA

August 19, 2021

Subject: List of threatened and endangered species that may occur in your proposed project location or may be affected by your proposed project

To Whom It May Concern:

The enclosed species list identifies threatened, endangered, proposed and candidate species, as well as proposed and final designated critical habitat, that *may* occur within the county of your proposed project and/or may be affected by your proposed project. The species list fulfills the requirements of the U.S. Fish and Wildlife Service (Service) under section 7(c) of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.).

Please note that new information based on updated surveys, changes in the abundance and distribution of species, changed habitat conditions, or other factors could change this list. Feel free to contact us if you need more current information or assistance regarding the potential impacts to federally proposed, listed, and candidate species and federally designated and proposed critical habitat. Also note that under 50 CFR 402.12(e) of the regulations implementing section 7 of the Act, the accuracy of this species list should be verified after 90 days. This verification can be completed formally or informally as desired. The Service recommends that verification be completed by visiting the ECOS-IPaC website at regular intervals during project planning and implementation for updates to species lists and information. An updated list may be requested through the ECOS-IPaC system by completing the same process used to receive the enclosed list.

The purpose of the Act is to provide a means whereby threatened and endangered species and the ecosystems upon which they depend may be conserved. Under sections 7(a)(1) and 7(a)(2) of the Act and its implementing regulations (50 CFR 402 *et seq*.), Federal agencies are required to utilize their authorities to carry out programs for the conservation of federally listed as threatened or endangered species and to determine whether projects may affect these species and/or designated critical habitat.

A Biological Assessment is required for construction projects (or other undertakings having similar physical impacts) that are major Federal actions significantly affecting the quality of the human environment as defined in the National Environmental Policy Act (42 U.S.C. 4332(2)(c)). For projects other than major construction activities, the Service suggests that a biological evaluation similar to a Biological Assessment be prepared to determine whether the project may affect listed or proposed species and/or designated or proposed critical habitat. Recommended contents of a Biological Assessment are described at 50 CFR 402.12.

While a Federal agency may designate a non-Federal representative to conduct informal consultation or prepare a biological assessment, the Federal Agency must notify the Service in writing of any such designation. The Federal agency shall also independently review and evaluate the scope and content of a biological assessment prepared by their designated non-Federal representative before that document is submitted to the Service.

If a Federal agency determines, based on the Biological Assessment or biological evaluation, that listed species and/or designated critical habitat may be affected by a federally funded, permitted or authorized activity, the agency is required to consult with the Service pursuant to 50 CFR 402. The following definitions are provided to assist you in reaching a determination:

- *No effect* - the proposed action will not affect federally listed species or critical habitat. A “no effect” determination does not require section 7 consultation and no coordination or contact with the Service is necessary. However, if the project changes or additional information on the distribution of listed or proposed species becomes available, the project should be reanalyzed for effects not previously considered.
- *May affect, but is not likely to adversely affect* - the project may affect listed species and/or critical habitat; however, the effects are expected to be discountable, insignificant, or completely beneficial. Certain avoidance and minimization measures may need to be implemented in order to reach this level of effect. The Federal agency or the designated non-Federal representative should consult with the Service to seek written concurrence that adverse effects are not likely. Be sure to include all of the information and documentation used to reach your decision with your request for concurrence. The Service must have this documentation before issuing a concurrence.
- *Is likely to adversely affect* - adverse effects to listed species may occur as a direct or indirect result of the proposed action. For this determination, the effect of the action is neither discountable nor insignificant. If the overall effect of the proposed action is beneficial to the listed species but the action is also likely to cause some adverse effects to individuals of that species, then the proposed action “is likely to adversely affect” the listed species. The analysis should consider all interrelated and interdependent actions. An “is likely to adversely affect” determination requires the Federal action agency to initiate formal section 7 consultation with our office.

Regardless of the determination, the Service recommends that the Federal agency maintain a complete record of the evaluation, including steps leading to the determination of effect, the qualified personnel conducting the evaluation, habitat conditions, site photographs, and any other related information. More information on the regulations and procedures for section 7 consultation, including the role of permit or license applicants, can be found in the "Endangered

Species Consultation Handbook" at: http://www.fws.gov/endangered/esa-library/pdf/TOC-GLOS.PDF.

Migratory Birds

For projects that may affect migratory birds, the Migratory Bird Treaty Act (MBTA) implements various treaties and conventions for the protection of these species. Under the MBTA, taking, killing, or possessing migratory birds is unlawful. Migratory birds may nest in trees, brushy areas, or other areas of suitable habitat. The Service recommends activities requiring vegetation removal or disturbance avoid the peak nesting period of March through August to avoid destruction of individuals, nests, or eggs. If project activities must be conducted during this time, we recommend surveying for nests prior to conducting work. If a nest is found, and if possible, the Service recommends a buffer of vegetation remain around the nest until the young have fledged or the nest is abandoned.

For additional information concerning the MBTA and recommendations to reduce impacts to migratory birds please contact the U.S. Fish and Wildlife Service Migratory Birds Office, 500 Gold Ave. SW, Albuquerque, NM 87102. A list of migratory birds may be viewed at https://www.fws.gov/birds/management/managed-species/migratory-bird-treaty-act-protected-species.php. Guidance for minimizing impacts to migratory birds for projects including communications towers can be found at: https://www.fws.gov/birds/management/project-assessment-tools-and-guidance/guidance-documents/communication-towers.php. Additionally, wind energy projects should follow the wind energy guidelines

https://www.fws.gov/birds/management/project-assessment-tools-and-guidance/guidance-documents/wind-energy.php) for minimizing impacts to migratory birds and bats.

Finally, please be aware that bald and golden eagles are protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668 et seq.), and projects affecting these species may require development of an eagle conservation plan https://www.fws.gov/birds/management/project-assessment-tools-and-guidance/guidance-documents/eagles.php.

We appreciate your concern for threatened and endangered species. The Service encourages Federal agencies to include conservation of threatened and endangered species into their project planning to further the purposes of the Act. Please include the Consultation Tracking Number in the header of this letter with any request for consultation or correspondence about your project that you submit to our office.

Attachment(s):

- Official Species List

Official Species List

This list is provided pursuant to Section 7 of the Endangered Species Act, and fulfills the requirement for Federal agencies to "request of the Secretary of the Interior information whether any species which is listed or proposed to be listed may be present in the area of a proposed action".

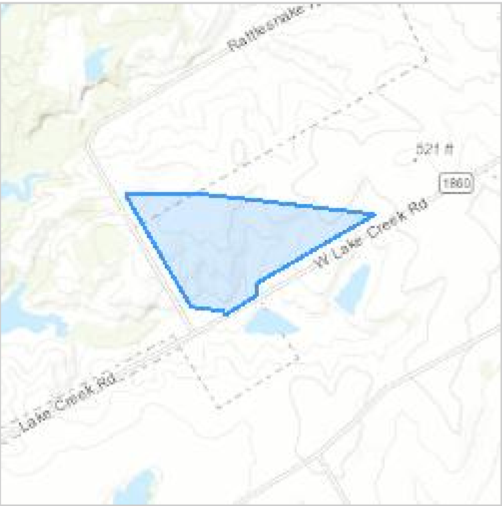
This species list is provided by:

Austin Ecological Services Field Office
10711 Burnet Road, Suite 200
Austin, TX 78758-4460
(512) 490-0057

Project Summary

Consultation Code: 02ETAU00-2021-SLI-1966
Event Code: 02ETAU00-2021-E-04030
Project Name: Sandy Creek PSHA
Project Type: ** OTHER **
Project Description: 04.306.005
Project Location:

Approximate location of the project can be viewed in Google Maps: https://www.google.com/maps/@31.4692489,-96.95418342315735,14z



Counties: McLennan County, Texas

Endangered Species Act Species

There is a total of 5 threatened, endangered, or candidate species on this species list.

Species on this list should be considered in an effects analysis for your project and could include species that exist in another geographic area. For example, certain fish may appear on the species list because a project could affect downstream species. Note that 2 of these species should be considered only under certain conditions.

IPaC does not display listed species or critical habitats under the sole jurisdiction of NOAA Fisheries[1], as USFWS does not have the authority to speak on behalf of NOAA and the Department of Commerce.

See the "Critical habitats" section below for those critical habitats that lie wholly or partially within your project area under this office's jurisdiction. Please contact the designated FWS office if you have questions.

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1. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

Birds

NAME	STATUS
Golden-cheeked Warbler (=wood) *Dendroica chrysoparia* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/33	Endangered
Piping Plover *Charadrius melodus* Population: [Atlantic Coast and Northern Great Plains populations] - Wherever found, except those areas where listed as endangered. There is **final** critical habitat for this species. The location of the critical habitat is not available. This species only needs to be considered under the following conditions: ▪ Wind Energy Projects Species profile: https://ecos.fws.gov/ecp/species/6039	Threatened
Red Knot *Calidris canutus rufa* There is **proposed** critical habitat for this species. The location of the critical habitat is not available. This species only needs to be considered under the following conditions: ▪ Wind Energy Projects Species profile: https://ecos.fws.gov/ecp/species/1864	Threatened
Whooping Crane *Grus americana* Population: Wherever found, except where listed as an experimental population There is **final** critical habitat for this species. The location of the critical habitat is not available. Species profile: https://ecos.fws.gov/ecp/species/758	Endangered

Clams

NAME	STATUS
Texas Fawnsfoot *Truncilla macrodon* No critical habitat has been designated for this species. Species profile: https://ecos.fws.gov/ecp/species/8965	Candidate

Critical habitats

THERE ARE NO CRITICAL HABITATS WITHIN YOUR PROJECT AREA UNDER THIS OFFICE'S JURISDICTION.

Last Update: 6/22/2021

MCLENNAN COUNTY

BIRDS

black rail *Laterallus jamaicensis*

Salt, brackish, and freshwater marshes, pond borders, wet meadows, and grassy swamps; nests in or along edge of marsh, sometimes on damp ground, but usually on mat of previous years dead grasses; nest usually hidden in marsh grass or at base of Salicornia

Federal Status: LT
State Status: T
SGCN: Y
Endemic: N
Global Rank: G3
State Rank: S2

golden-cheeked warbler *Setophaga chrysoparia*

Ashe juniper in mixed stands with various oaks (Quercus spp.). Edges of cedar brakes. Dependent on Ashe juniper (also known as cedar) for long fine bark strips, only available from mature trees, used in nest construction; nests are placed in various trees other than Ashe juniper; only a few mature junipers or nearby cedar brakes can provide the necessary nest material; forage for insects in broad-leaved trees and shrubs; nesting late March-early summer.

Federal Status: LE
State Status: E
SGCN: Y
Endemic: N
Global Rank: G2
State Rank: S2S3B

interior least tern *Sternula antillarum athalassos*

Sand beaches, flats, bays, inlets, lagoons, islands. Subspecies is listed only when inland (more than 50 miles from a coastline); nests along sand and gravel bars within braided streams, rivers; also know to nest on man-made structures (inland beaches, wastewater treatment plants, gravel mines, etc); eats small fish and crustaceans, when breeding forages within a few hundred feet of colony

Federal Status: DL: Delisted
State Status: E
SGCN: N
Endemic: N
Global Rank: G4T3Q
State Rank: S1B

piping plover *Charadrius melodus*

Beaches, sandflats, and dunes along Gulf Coast beaches and adjacent offshore islands. Also spoil islands in the Intracoastal Waterway. Based on the November 30, 1992 Section 6 Job No. 9.1, Piping Plover and Snowy Plover Winter Habitat Status Survey, algal flats appear to be the highest quality habitat. Some of the most important aspects of algal flats are their relative inaccessibility and their continuous availability throughout all tidal conditions. Sand flats often appear to be preferred over algal flats when both are available, but large portions of sand flats along the Texas coast are available only during low-very low tides and are often completely unavailable during extreme high tides or strong north winds. Beaches appear to serve as a secondary habitat to the flats associated with the primary bays, lagoons, and inter-island passes. Beaches are rarely used on the southern Texas coast, where bayside habitat is always available, and are abandoned as bayside habitats become available on the central and northern coast. However, beaches are probably a vital habitat along the central and northern coast (i.e. north of Padre Island) during periods of extreme high tides that cover the flats. Optimal site characteristics appear to be large in area, sparsely vegetated, continuously available or in close proximity to secondary habitat, and with limited human disturbance.

Federal Status: LT
State Status: T
SGCN: Y
Endemic: N
Global Rank: G3
State Rank: S2N

rufa red knot *Calidris canutus rufa*

Red knots migrate long distances in flocks northward through the contiguous United States mainly April-June, southward July-October. A small plump-bodied, short-necked shorebird that in breeding plumage, typically held from May through August, is a distinctive and unique pottery orange color. Its bill is dark, straight and, relative to other shorebirds, short-to-medium in length. After molting in late summer, this species is in a drab gray-and-white non-breeding plumage, typically held from September through April. In the non-breeding plumage, the knot might be confused with the omnipresent Sanderling. During this plumage, look for the knot’s prominent pale eyebrow and whitish flanks with dark barring. The Red Knot prefers the shoreline of coast and bays and also uses mudflats during rare inland encounters. Primary prey items include coquina clam (Donax spp.) on beaches and dwarf surf clam (Mulinia lateralis) in bays, at least in the Laguna Madre. Wintering Range includes-Aransas, Brazoria, Calhoun, Cameron, Chambers, Galveston, Jefferson, Kennedy, Kleberg, Matagorda, Nueces, San Patricio, and Willacy. Habitat: Primarily seacoasts on tidal flats and beaches, herbaceous wetland, and Tidal flat/shore.

Federal Status: LT
State Status: T
SGCN: Y
Endemic: N
Global Rank: G4T2
State Rank: S2N

white-faced ibis *Plegadis chihi*

Prefers freshwater marshes, sloughs, and irrigated rice fields, but will attend brackish and saltwater habitats; currently confined to near-coastal rookeries in so-called hog-wallow prairies. Nests in marshes, in low trees, on the ground in bulrushes or reeds, or on floating mats.

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G5 State Rank: S4B

whooping crane *Grus americana*

Small ponds, marshes, and flooded grain fields for both roosting and foraging. Potential migrant via plains throughout most of state to coast; winters in coastal marshes of Aransas, Calhoun, and Refugio counties.

Federal Status: LE State Status: E SGCN: Y
Endemic: N Global Rank: G1 State Rank: S1N

wood stork *Mycteria americana*

Prefers to nest in large tracts of baldcypress (Taxodium distichum) or red mangrove (Rhizophora mangle); forages in prairie ponds, flooded pastures or fields, ditches, and other shallow standing water, including salt-water; usually roosts communally in tall snags, sometimes in association with other wading birds (i.e. active heronries); breeds in Mexico and birds move into Gulf States in search of mud flats and other wetlands, even those associated with forested areas; formerly nested in Texas, but no breeding records since 1960

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G4 State Rank: SHB,S2N

FISH

chub shiner *Notropis potteri*

Brazos, Colorado, San Jacinto, and Trinity river basins. Flowing water with silt or sand substrate

Federal Status: State Status: T SGCN: Y
Endemic: N Global Rank: G4 State Rank: S2

Notropis oxyrhynchus
sharpnose shiner

Range is now restricted to upper Brazos River upstream of Possum Kingdom Lake. May be native to Red River and Colorado River basins. Typically found in turbid water over mostly silt and shifting sand substrates.

Federal Status: LE State Status: E SGCN: Y
Endemic: Y Global Rank: G3 State Rank: S1S2

smalleye shiner *Notropis buccula*

Endemic to the Brazos River drainage; presumed to have been introduced into the Colorado River. Historically found in lower Brazos River as far south as Hempstead, Texas but appears to now be restricted to upper Brazos River system upstream of Possum Kingdom Lake. Typically found in turbid waters of broad, sandy channels of main stream, over substrate consisting mostly of shifting sand.

Federal Status: LE State Status: E SGCN: Y
Endemic: Y Global Rank: G2 State Rank: S1S2

MOLLUSKS

Brazos Heelsplitter *Potamilus streckersoni*

Reported from streams, but not far into the headwaters, to large rivers, and some reservoirs. In riverine systems occurs most often in nearshore habitats such as banks and backwater pools but occasionally in mainchannel habitats such as riffles. Typically found in standing to slow-flowing water in soft substrates consisting of silt, mud or sand but occasionally in moderate flows with gravel and cobble substrates (Randklev et al. 2014b,c; Tsakiris and Randklev 2016b; Smith et al. 2019) [Mussels of Texas 2020]

Federal Status: State Status: T SGCN: Y
Endemic: Y Global Rank: GNR State Rank: SNR

Texas Fawnsfoot *Truncilla macrodon*

Occurs in large rivers but may also be found in medium-sized streams. Is found in protected near shore areas such as banks and backwaters but also riffles and point bar habitats with low to moderate water velocities. Typically occurs in substrates of mud, sandy mud, gravel and cobble. Considered intolerant of reservoirs (Randklev et al. 2010; Howells 2010o; Randklev et al. 2014b,c; Randklev et al. 2017a,b). [Mussels of Texas 2019]

Federal Status: C	State Status: T	SGCN: Y
Endemic: Y	Global Rank: G1	State Rank: S2

REPTILES

Texas horned lizard *Phrynosoma cornutum*

Terrestrial: Open habitats with sparse vegetation, including grass, prairie, cactus, scattered brush or scrubby trees; soil may vary in texture from sandy to rocky; burrows into soil, enters rodent burrows, or hides under rock when inactive. Occurs to 6000 feet, but largely limited below the pinyon-juniper zone on mountains in the Big Bend area.

Federal Status:	State Status: T	SGCN: Y
Endemic: N	Global Rank: G4G5	State Rank: S3

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
REGISTRATION APPLICATION
TCEQ REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

PART III
FUGITIVE DUST CONTROL PLAN

Prepared for:

SANDY CREEK SERVICES, LLC
2161 Rattlesnake Road
Riesel, Texas 76682

BRETT J. DeVRIES
128061

Brett 1/13/22

Prepared by:

SCS ENGINEERS
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Dallas/Fort Worth Office
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817/571-2288

Revision 0 – January 2022
SCS Project No. 16221059.00

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III.A 2020 Annual Fugitive Dust Control Report

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

1 PE CERTIFICATION (40 CFR §257.80(b)(7))

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

I, Brett DeVries, Ph.D., P.E., hereby certify that this Fugitive Dust Control Plan for the Sandy Creek Energy Station Coal Combustion Residual Waste Management Facility meets the requirements in 30 TAC §352.801 (40 CFR §257.80). This Plan was prepared by or under my supervision. I am a duly licensed Professional Engineer under the laws of the State of Texas.

Brett DeVries, Ph.D., P.E.
(printed or typed name)

License number __128061______________________

My license renewal date is __9/30/2022______

2 INTRODUCTION

This Fugitive Dust Control Plan has been prepared for the Sandy Creek Services, LLC (Owner and Operator) of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill), located in McLennan County. The Plan has been prepared consistent with Title 30 of the Texas Administrative Code (30 TAC), Chapter 352.801 (Title 40 of the Code of Federal Regulations (40 CFR), Part 257.80) and the Plant's air permit (TCEQ Permit No. 70861, Special Condition 25).

Specifically, consistent with 30 TAC §352.801 [40 CFR §257.80(b)(1) through (7)], the Landfill Owner/Operator will implement measures that will effectively minimize coal combustion residual (CCR) from becoming airborne at the Landfill, including CCR fugitive dust originating from the CCR Landfill, roads, and other CCR management and material handling activities within the Landfill Registration Boundary.

This Plan is applicable to the Landfill, which is comprised of Cells 1 through 3. At the time of preparing this Registration Application, Cells 1 and 2 and a portion of Cell 3 (inclusive of Subcells 3A through 3D) that was constructed in 2021 are existing active cells. Future subcells within Cell 3 will be operated consistent with this Plan.

This Plan describes the measures taken by the Landfill Owner/Operator to control CCR fugitive dust within the Landfill Registration Boundary, and is divided into the following two operations:

- CCR Transport Fugitive Dust Control Measures – CCR conveyance from the Landfill Registration Boundary to the active area of the Landfill; and
- CCR Landfill Fugitive Dust Control Measures - CCR disposal at the Landfill, including the landfilling process and wind erosion impacts from the landfill.

3 CCR FUGITIVE DUST CONTROL MEASURES (§257.80(b)(1))

This section of the Plan describes the CCR fugitive dust control measures the Landfill Owner/Operator will use to minimize CCR from becoming airborne at the Landfill, as required by §257.80(b)(1). The two main operations at the Landfill, related to CCR fugitive dust control measures, are identified in Section 2 of this Plan below.

3.1 FUGITIVE DUST CONTROL MEASURES DURING CCR TRANSPORT

Dump trucks (on or off-road), roll-off containers, or similar waste hauling equipment (referred to herein as "hauling equipment") will be used to haul CCR material from the Plant or other locations within the Plant Property Boundary to the Landfill for disposal. This section of the Plan encompasses CCR fugitive dust control measures that will be implemented during the transportation of CCR from the Landfill Registration Boundary to the Landfill. These measures are as follows:

- CCR (specifically fly and bottom ash) may be placed into hauling equipment while still wet;
- CCR will be placed in open hauling equipment to prevent overfilling;
- The size and moisture content of the bottom ash particles will reduce the potential for creating fugitive dust;
- Onsite access roads (perimeter and internal haul roads) will be sprayed with a water truck or other appropriate equipment as-needed during periods of significantly dry weather.

3.2 CCR LANDFILL FUGITIVE DUST CONTROL MEASURES

This section of the Plan encompasses CCR fugitive dust control measures that will be implemented during CCR placement within the Landfill. These measures are as follows:

- CCR material may be pre-conditioned during placement as discussed in Section 4 of this Plan;
- The CCR will be compacted during placement in accordance with the Site Operating Plan (SOP, Part V);
- Onsite internal haul roads will be sprayed with a water truck or other appropriate equipment as-needed during periods of significantly dry weather.
- In accordance with the Plant's air permit (TCEQ Permit No. 70861, Special Condition 25), the maximum working face size (active area) of the Landfill will not exceed one

(1) acre and the maximum area of exposed waste (active areas) will not exceed five (5) acres total;

- The nature of the fly ash is such that adding moisture may develop a harder top layer. This procedure may be utilized as-needed to decrease CCR dust generation; and
- Inactive areas will be covered with intermediate cover (12-inch soil layer or alternate intermediate cover) to limit dust emissions in accordance with the SOP (Part V).

4 LANDFILLING CCR AS CONDITIONED (§257.80(B)(2))

This section of the Plan describes the measures the Landfill Owner/Operator will use to emplace CCR into the Landfill as "conditioned CCR" consistent with §257.80(b)(2). For the purposes of this Plan, conditioned CCR means wetting the CCR with water, to a moisture content that will prevent wind dispersal but not result in the generation of free liquids.

CCR generated at the Plant may be pre-conditioned with moisture to enable transportation and landfilling in its as-generated state. Dust will be controlled during waste placement by periodic spraying from a water truck or other appropriate equipment as-needed during periods of significantly dry weather and to prevent dust from becoming a nuisance to surrounding areas. Care will be taken to utilize only the minimum amount of water needed for dust suppression within the lined area of the Landfill to avoid over-saturating the waste.

5 TRACKING CITIZEN COMPLAINTS (§257.80(b)(3))

If the Landfill Owner/Operator receives a citizen complaint involving CCR fugitive dust events; the complaint will be logged and the log maintained by the Landfill Owner/Operator in accordance with §257.80(b)(3). The information documented will include the following:

- Date and time of complaint;
- Date and time of alleged CCR fugitive dust-related issue being noted;
- Description of alleged event; and
- Name of person logging the complaint.

The information listed above will be used to periodically assess the effectiveness of this Plan as described in Section 6 of this Plan, and will be included in the annual reports as described in Section 7.1 of this Plan.

6 ASSESSMENT OF EFFECTIVENESS (§257.80)(b)(4))

The Landfill Owner/Operator will periodically assess this Plan's effectiveness in accordance with §257.80(b)(4), which will include the following measures:

- On-site incidents of CCR airborne dust, including frequency of occurrence, as recorded by the Landfill Owner/Operator. This will include date, time, description of the incident and the related corrective measures;
- The number and character of citizen complaints received related to CCR fugitive dust, as described in Section 5 of this Plan; and
- The results of any regulatory inspections related to CCR fugitive dust.

The required annual reports (see Section 7.1 of this Plan) will be used to evaluate the effectiveness of this Plan, the measures included in it, and personnel implementation of these measures.

7 RECORDKEEPING, NOTIFICATION, AND POSTING OF INFORMATION TO THE INTERNET (§257.80(D))

The Landfill Owner/Operator will maintain a copy of this Plan in the Site Operating Record and on the Landfill's publicly accessible website consistent with §257.105(g) and §257.107(g) as specified in Section 4 of the SOP.

Consistent with §257.80(b)(6), this Plan will be amended whenever there is material changes in the site operating conditions that would substantially affect this Plan. Additionally, this Plan may be amended at any time provided the revised Plan is signed/sealed by a qualified professional engineer in the state of Texas in accordance with §305.62, related to a minor registration amendment, and the new Plan is placed in the Site Operating Record, and the new Plan is placed on the Landfill's publicly accessible website as outlined in the SOP (Part V).

7.1 ANNUAL CCR FUGITIVE DUST CONTROL REPORT (§257.80(c))

Consistent with §257.80(c), an annual fugitive dust control report will be prepared by a qualified person, including the Landfill Owner/Operator, that includes the following:

- A description of the actions taken by the Landfill Owner/Operator to control CCR fugitive emissions;
- A record of all citizen complaints; and
- A summary of any corrective measures taken during the year.

The initial annual CCR fugitive dust control report will be completed within 14 months of the date that this Plan is placed into the Site Operating Record, as required by §257.105(g). Subsequent annual reports will be completed one year following completion of the previous report.

APPENDIX III.A

2020 ANNUAL FUGITIVE DUST CONTROL REPORT

2020 Fugitive Dust Report
Sandy Creek Energy Station
Riesel, Texas

Facility Background

Sandy Creek is a nominal 900-megawatt (MW) super-critical electrical generating unit (EGU) that burns low sulfur sub-bituminous coal brought in by train from the Powder River Basin. The unit is equipped with one pulverized coal (PC) boiler, one multiple shell condensing steam turbine generator, multiple steam surface condensers, one multiple cell mechanical draft cooling tower, one auxiliary boiler, and various auxiliary equipment. Emissions control equipment includes a selective catalytic reduction (SCR) to control nitrogen oxides (NOx), a dry flue-gas desulfurization (FGD) system, a baghouse and activated carbon injection (ACI) system.

During the combustion of coal in the boiler non-combustible residues (bottom ash) fall from the PC boiler into quench water and are continuously removed using an enclosed conveyor system and conveyed from a chute onto a concrete pad surrounded on three sides with a concrete enclosure. Ash from the PC boiler's economizer is transported from the economizer area by screw conveyor and dropped onto the bottom ash conveying system and mixed with this bottom ash.

Combustible residues from the boiler, as well as residues from emissions control equipment, are referred to as fly ash in the Facility Plan. The fly ash is conveyed via a closed system to a silo. For on-site disposal, a pug mill adds moisture, and the moistened ash is dropped from one of two silo chutes and loaded into open-topped trucks which transfer the fly ash to the Facility's on-site Coal Combustion Residuals (CCR) landfill. For off-site sales, the fly ash is loaded dry from the silo via an enclosed, telescoping system, into enclosed tank trucks for transport off the facility property. A small portion of pre-conditioned fly ash also drops out through the FGD onto a concrete pad and is loaded into trucks via a front-end loader for disposal at the CCR landfill.

Bottom ash and unsold fly ash, as well as other Facility-generated waste types (including cooling water screenings, waste coal, coal mill rejects, water treatment cake material, and waste lime residues) are deposited at the CCR landfill. An unpaved road approximately 0.15 miles in length leads from the Facility to the CCR landfill. At this landfill, the fly ash and bottom ash are compacted for storage.

SCES uses a water truck equipped with pressurized directional sprays to suppress dust on the paved and unpaved roads as well as the active areas of the landfill.

Introduction:

In accordance with the requirements of Title 40 of the Code of Federal Regulations (40 CFR) Part 257, subpart §257.80(c). The 2020 fugitive dust inspection and report include actions taken to control Coal Combustion Residual fugitive dust, citizens' complaints, and any corrective measures taken during the year. For the control of fugitive dust, the report is broken into four main operational areas as outlined in the Fugitive Dust Control Plan (Rev2 – December 2018).

General Fugitive Dust Control Measures:

The boiler and a large portion of the equipment used to combust coal to generate electricity are located inside a structure that encloses nine floors of the boiler. This structure reduces fugitive emissions generated through the transfer of economizer ash as well as bottom ash. The portions of the facility that are not enclosed utilize barriers, wind fence, drop chutes, and water to reduce the possible production of fugitive dust from the four operational areas. Housekeeping is also an important component in reducing the amount of ash that can produce fugitive dust. The Fugitive Dust Control Plan is broken up into the following four areas:

- **Inspection of Bottom Ash Fugitive Dust Control Measures**
- **Inspection of Fly Ash Fugitive Dust Control Measures**
- **Inspection of Ash Transport Fugitive Dust Control Measures**
- **Inspection of CCR Landfill Fugitive Dust Control Measures**

Inspection of Bottom Ash Fugitive Dust Control Measures

The bottom ash generated from the combustion of sub-bituminous coal in the boiler at Sandy Creek consists of the heavy ash materials that accumulate in the economizer area of the boiler and the bottom ash conveyance quench water system at the base of the boiler. The economizer ash is moved to the bottom ash collection area by a series of screws and dropped onto the wet ash of the ash quench system before being conveyed to the outside storage area. Both ash types will be referred to as bottom ash for this report. The management practices used by Sandy Creek to mitigate the accumulation of bottom ash to reduce the production of fugitive dust are as follows:

- Bottom ash residues are generated inside the structure that encloses most of the boiler.
- The bottom ash is wetted prior to deposition onto the outside storage area.
- The bottom ash consists of larger particle sizes that are less prone to the creation of fugitive dust.
- The outside storage area has a concrete floor with three concreate walls that are approximately twenty feet high. The floor of the area has grating that routes stormwater collected in the deposition area to the low flow wastewater treatment pond.
- The bottom ash is removed and transported to the on-site landfill before the moisture is allowed to dissipate.

- The outside storage area is cleaned on a regular basis to further mitigate the formation of fugitive ash.

Assessment of Effectiveness

During the 2020 year, no third-party complaints were received regarding the generation of fugitive dust originating from the bottom ash collection area. On-site personnel working in the area did not report any fugitive dust problems. The annual inspection conducted by a third-party engineer noted no fugitive dust emissions coming from the bottom ash area. The Texas Commission on Environmental Quality (TCEQ) Waco Region Waste Section did conduct a regulatory audit of the rule requirements and required documentation as well as an inspection of the facilities at Sandy Creek on July 30, 2020. No violations were documented during the audit and inspection.

Inspection of Fly Ash Fugitive Dust Control Measures

The fly ash generated from the combustion of sub-bituminous coal in the boiler at Sandy Creek consists of the light ash materials that are collected by the baghouse and transported utilizing supplied air through an enclosed system to the fly ash storage silo. A small portion, consisting of less than 5% of the total ash production, is deposited onto a concrete floor at the base of the FGD used for the removal of Sulfur Dioxide emissions.

The management practices used by Sandy Creek to mitigate the accumulation of fly ash to reduce the production of fugitive dust are as follows:

- The transport system for fly ash is entirely enclosed apart from the FGD system. The gas path takes the fly ash through the baghouse which captures approximately 99% of the fly ash in the gas stream. The baghouse is monitored continuously using an opacity monitor as well as broken bag indicators. Failures of the baghouse are rare, but when a failure occurs the problem area or baghouse compartment is shut down. The fly ash is cleaned up and repairs are made as soon as possible to mitigate fugitive dust. During cleanup, when possible, water sprays are used to wet the ash.
- The fly ash collected in the baghouse is then transported by an enclosed system using supplied air to the fly ash silo. The silo is equipped with a dual filter system that utilizes differential pressure as a warning that the filter system may be failing. Failures of the filter system are rare, but the system is designed so each side can be repaired with the other still in operation so the silo should never be without filtration. Any spilled fly ash is cleaned up as soon as possible to mitigate fugitive dust. During cleanup, when possible, water sprays are used to wet the ash.

- The drop point at the base of the FGD is under negative pressure. As chunks of fly ash drop to the concrete floor, the lighter fly ash is re-entrained and transported to the baghouse for removal.
- The fly ash that does accumulate at the base of the FGD is removed on a regular basis by a front-end loader and open top dump truck. Water sprays are utilized to wet the fly ash during the loading process.
- The FGD drop point area is cleaned at a regular interval to reduce the chance of wind picking up any spilled fly ash.
- A wind fence has also been installed around the FGD drop points to reduce the wind turbulence through the area and the chances of wind picking up fugitive dust.
- The fly ash in the silo is transferred by two separate methods:
  - The transfer of fly ash for transport to the on-site landfill is wetted in a pug mill prior to drop into an open top truck. The wetting of the fly ash reduces the formation of fugitive dust emissions while the ash is dropped or transported. An observer watches the filling process to ensure the trucks are not over-filled during the transfer of fly ash from the pug mill to the open trucks.
  - The transfer of fly ash for transport off-site is achieved with a drop chute that forms a seal with a closed tank truck. The fly ash is dry and is not routed through the pug mill. Fugitive fly ash is re-entrained in the chute system and routed to the dust collection system at the top of the silo.
- Fly ash that accumulates at the base of the fly ash silo is required to be cleaned up after the loading of each truck (tank and open top). This requirement is found in the site Multisector General Permit TXR050000, Section O.

Assessment of Effectiveness

No formal complaints were received regarding the area below the FGD drop point or Fly Ash silo during 2020. Windscreens were installed in late 2019 to reduce wind turbulence through the SDA area. The windscreens have reduced the wind turbulence through the area as well as fugitive dust. The annual third-party inspection was completed and found the control measures currently in place were effective. The TCEQ Waco Region Waste Section did conduct a regulatory audit of the rule requirements and required documentation as well as an inspection of the facilities at Sandy Creek on July 30, 2020. No violations were documented during the audit and inspection.

Inspection of Ash Transport Fugitive Dust Control

Bottom ash and fly ash continue to be transported to the on-site landfill by a 35-yard, high walled, open top dump truck. Fly ash is also transported off-site in a closed tank truck. The management practices used by Sandy Creek to mitigate the accumulation of bottom ash and fly ash to reduce the production of fugitive dust are as follows:

- Bottom ash is moved to the open top trucks utilizing a front-end loader. The ash is transferred while the ash still has moisture to reduce the formation of fugitive dust. The particle size of the bottom ash is also large and reduces the formation of fugitive dust. The bottom ash is also located behind three large retaining walls that are approximately 20 feet high and act to reduce wind turbulence through the area.
- As discussed above, the transfer of fly ash from the FGD area utilizes a front-end loader to move the fly ash accumulated below the FGD to the open top truck. Water is utilized to reduce the formation of fugitive dust during loading operations. The wind fence has also helped to reduce the spread of fugitive dust when the ash is transferred from the drop area onto a waiting truck.
- From the fly ash silo, ash transported to the landfill is wetted utilizing a pug mill before being dropped into a waiting open top truck. The pug mill reduces the formation of fugitive dust formation and transport. A spotter also ensures the trucks are not overfilled during the transfer process.
- From the fly ash silo, ash transported off-site is transferred dry through a drop chute system that forms a seal with a closed tank truck. The chute is equipped with a system that transports fugitive fly ash back into the silo.
    - Operators work to ensure the tank trucks are not overfilled by timing the drop of ash.
    - If a small amount of fly ash does accumulate at the point where the seal is made with the tank opening, this is cleaned via vacuum air back to the silo. Following the completion of the fill cycle the tank trucks then move to the scales to be weighed and then move to a gantry platform to close the tank opening and wash the residue ash from the top of the tank truck into a small pit collection area.
        - The water in the small pit is cleaned out as needed but is often cleaned daily due to the accumulation of contact water. The pit is not allowed the dry out and is not allowed to overflow the sides.
    - If a tank truck is overfilled the truck will back into a designated area and hook into a hose that removes the excess ash to the gas stream leading into the unit baghouse. Small spills associated with disengaging the hose are cleaned up immediately as required by the multisector stormwater permit. The area where tank trucks are permitted to back up and off-load excess ash is permanently paved with concrete and is easier to clean up small deposits of ash caused when decoupling.
- The road to the landfill continues to be periodically graded and a speed limit of 10 mph is enforced.
- During dry conditions, a water truck is utilized to water the landfill road and active working face of the landfill to reduce the formation of fugitive emissions.

Assessment of Effectiveness

No formal complaints were received regarding the transport of ash during 2020. The annual third-party inspection was completed and found the control measure currently in place were effective. The TCEQ Waco Region Waste Section did conduct a regulatory audit of the rule requirements and required documentation as well as an inspection of the facilities at Sandy Creek on July 30, 2020. No violations were documented during the audit and inspection.

Inspection of CCR Landfill Fugitive Dust Control

The management practices used by Sandy Creek to mitigate the production of fugitive dust in the landfill are as follows:

- Prior to placement of the ash in the landfill it is conditioned with water as explained through the above processes.
- After the ash has been deposited into the working face of the landfill, a compactor is used to compact the ash.
- The active area of the landfill is also closely controlled due to New Source Review Permit 70861, Condition 25. This requirement restricts the landfill to only have five acres of the landfill open at any time. The active working area of the landfill is restricted to one acre.
- A water truck is also utilized to water the compacted areas of the landfill. Once the wetted fly ash dries, the ash forms a hard crust that further minimizes the potential for the formation of fugitive dust.
- Temporary cover is utilized on inactive portions of the landfill to reduce wind erosion.
- A berm surrounds the outside of the open, inactive area and active ash placement areas. The ash is graded to direct contact stormwater to the chimney drains which are a part of the leachate management system.
- All plant roads are watered on a regular basis during dry periods.

Assessment of Effectiveness

No formal complaints were received regarding the transport of ash during 2020. The annual third-party inspection was completed and found the control measures currently in place were effective. The TCEQ Waco Region Waste Section did conduct a regulatory audit of the rule requirements and required documentation as well as an inspection of the facilities at Sandy Creek on July 30, 2020. No violations were documented during the audit and inspection.

Summary of Citizen Complaints

There were no citizen complaints associated with or related to Coal Combustion Residual dust during 2020. The last complaint related to dust was received on October 2, 2018, regarding dust coming from the off-site transport of ash in the tank trucks. A wash station with collection pit was installed and is utilized by each individual tank truck driver before leaving the site.

Corrective Actions

During the 2019 year several site personnel had been reporting dusting originating from the FGD drop point during high wind conditions. In late 2019 a project was initiated to install wind fence to reduce turbulence through the FGD area. The project was completed in early 2020 and has reduced the amount of fugitive dust coming from the FGD area. Concrete was also added to two small areas at the entrance of the FGD's. The concrete surfaces have aided the movement of heavy equipment into and out of the areas under the FGD. The concrete surface is also much easier to clean and maintain.

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
RESGISTRATION APPLICATION
TCEQ REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

PART IV
LANDFILL CRITERIA AND DESIGN DRAWINGS

Prepared for:

SANDY CREEK SERVICES, LLC
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Riesel, Texas 76682

BRETT J. DeVRIES
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Brett DeVries 1/13/22

Prepared by:

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Dallas/Fort Worth Office
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Revision 0 – January 2022
SCS Project No. 16221059.00

Drawings

IV–1 Existing Conditions Map
IV–2 Excavation Plan
IV–3 Leachate Collection and Removal System Plan
IV–4 Landfill Completion Plan
IV–5 Cross Section Location Plan
IV–6 Cross Section A-A’
IV–7 Cross Section B-B’
IV–8 Liner Details
IV–9 Leachate Collection and Removal System Details
IV–10 Final Cover Details
IV–11 Perimeter Berm Details – 1
IV–12 Perimeter Berm Details – 2

Appendices

IV.A Leachate Collection and Removal System Plan
IV.B Liner Construction Quality Assurance Plan
IV.C Run-on and Run-off Control Plan

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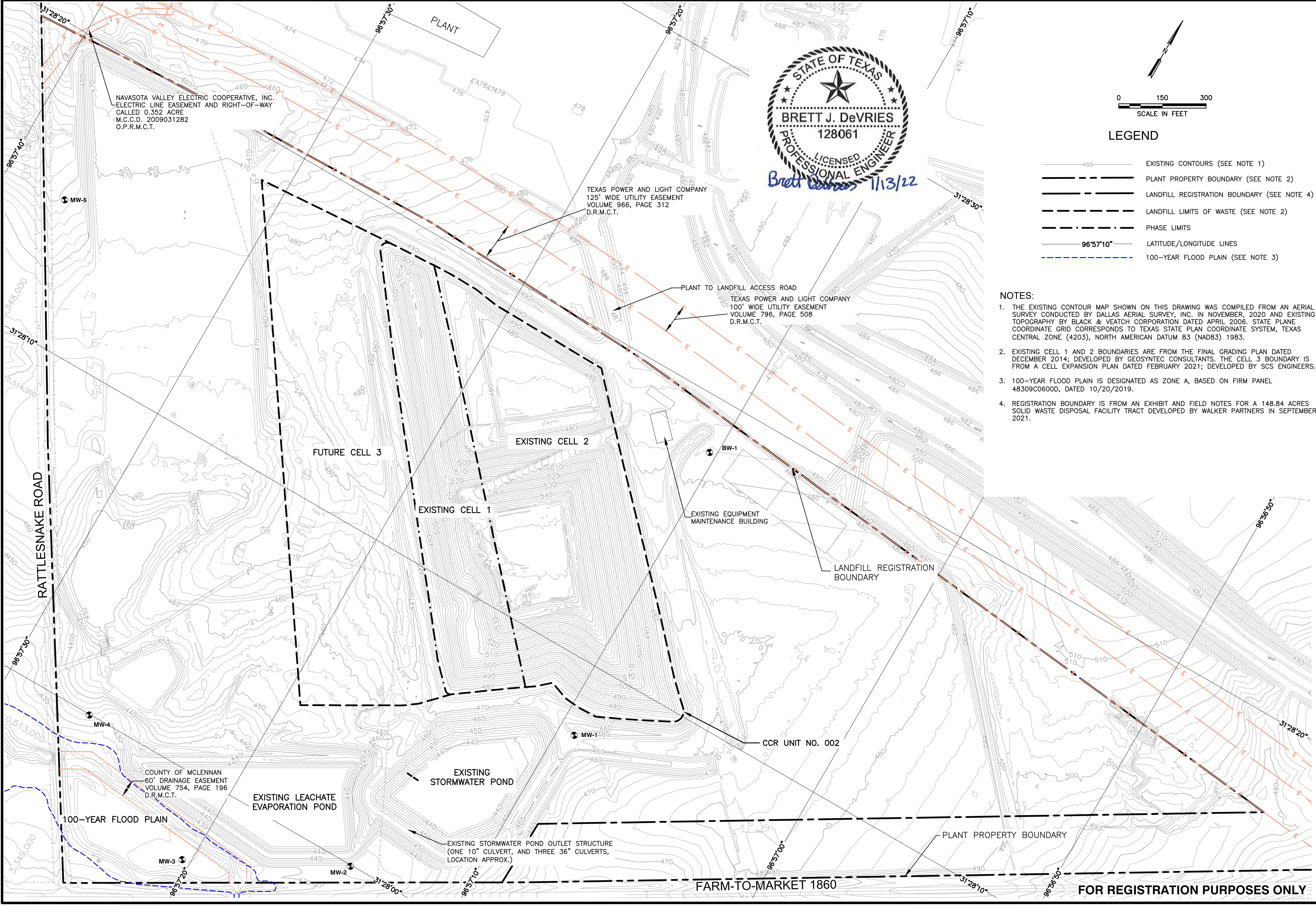
TBPE Reg. # F-3407



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LEGEND

- ——450—— EXISTING CONTOURS (SEE NOTE 1)
- —— - —— PLANT PROPERTY BOUNDARY (SEE NOTE 2)
- —— - —— LANDFILL REGISTRATION BOUNDARY (SEE NOTE 4)
- — — — — LANDFILL LIMITS OF WASTE (SEE NOTE 2)
- — - — - — PHASE LIMITS
- ——96°57'10"—— LATITUDE/LONGITUDE LINES
- - - - - - - 100-YEAR FLOOD PLAIN (SEE NOTE 3)

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
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3. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48309C0600D, DATED 10/20/2019.
4. REGISTRATION BOUNDARY IS FROM AN EXHIBIT AND FIELD NOTES FOR A 148.84 ACRES SOLID WASTE DISPOSAL FACILITY TRACT DEVELOPED BY WALKER PARTNERS IN SEPTEMBER 2021.

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EXISTING CONDITIONS MAP

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
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2161 RATTLESNAKE ROAD
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DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

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IV-1 – EXISTING CONDITIONS MAP

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11/2021

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IV-1

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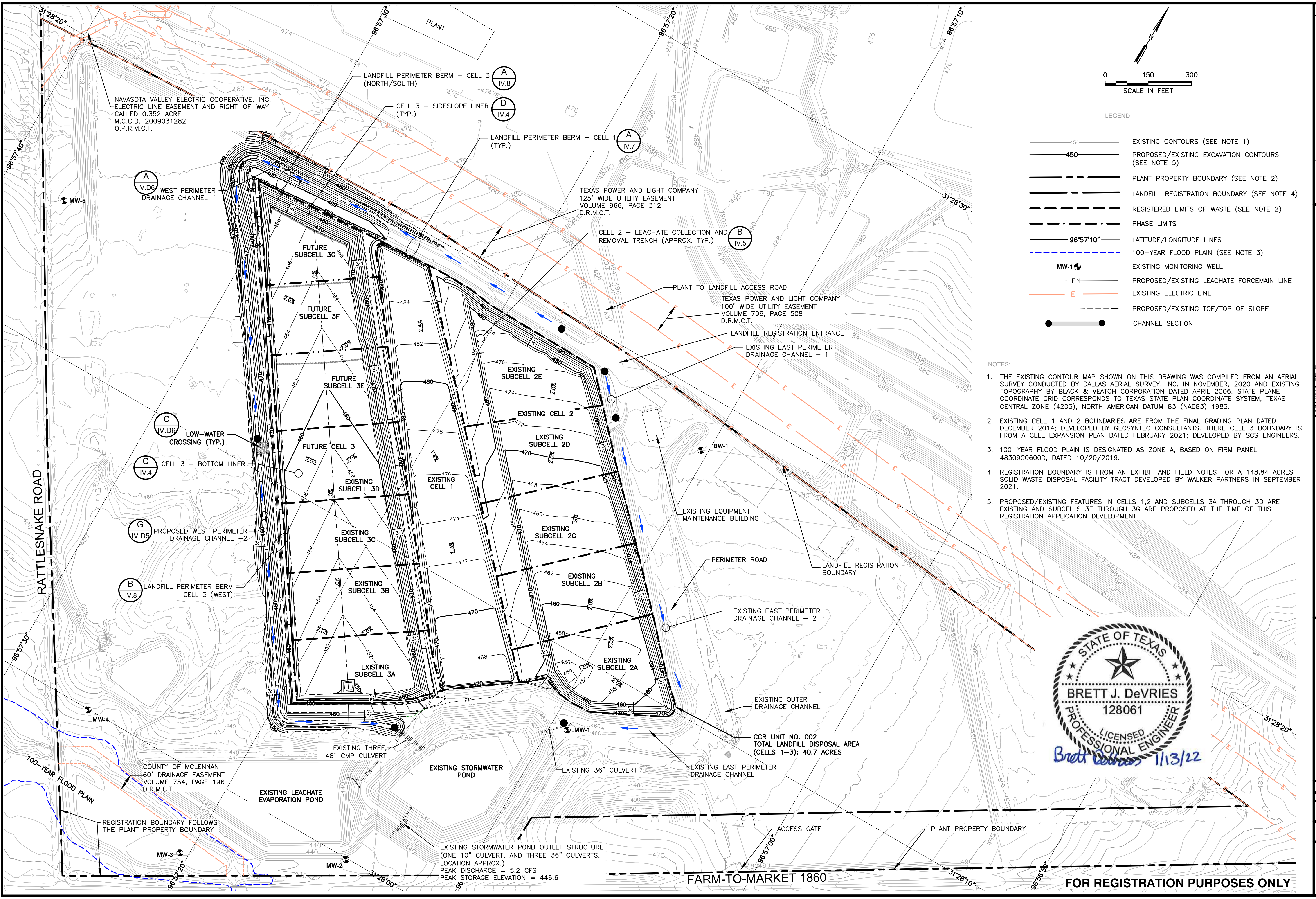

LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
450	PROPOSED/EXISTING EXCAVATION CONTOURS (SEE NOTE 5)
— - —	PLANT PROPERTY BOUNDARY (SEE NOTE 2)
— - - —	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 4)
— — —	REGISTERED LIMITS OF WASTE (SEE NOTE 2)
— · —	PHASE LIMITS
96°57'10"	LATITUDE/LONGITUDE LINES
- - -	100–YEAR FLOOD PLAIN (SEE NOTE 3)
MW-1	EXISTING MONITORING WELL
FM	PROPOSED/EXISTING LEACHATE FORCEMAIN LINE
E	EXISTING ELECTRIC LINE
- - -	PROPOSED/EXISTING TOE/TOP OF SLOPE
●—●	CHANNEL SECTION

NOTES:

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3. 100–YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48309C0600D, DATED 10/20/2019.
4. REGISTRATION BOUNDARY IS FROM AN EXHIBIT AND FIELD NOTES FOR A 148.84 ACRES SOLID WASTE DISPOSAL FACILITY TRACT DEVELOPED BY WALKER PARTNERS IN SEPTEMBER 2021.
5. PROPOSED/EXISTING FEATURES IN CELLS 1,2 AND SUBCELLS 3A THROUGH 3D ARE EXISTING AND SUBCELLS 3E THROUGH 3G ARE PROPOSED AT THE TIME OF THIS REGISTRATION APPLICATION DEVELOPMENT.

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EXCAVATION PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
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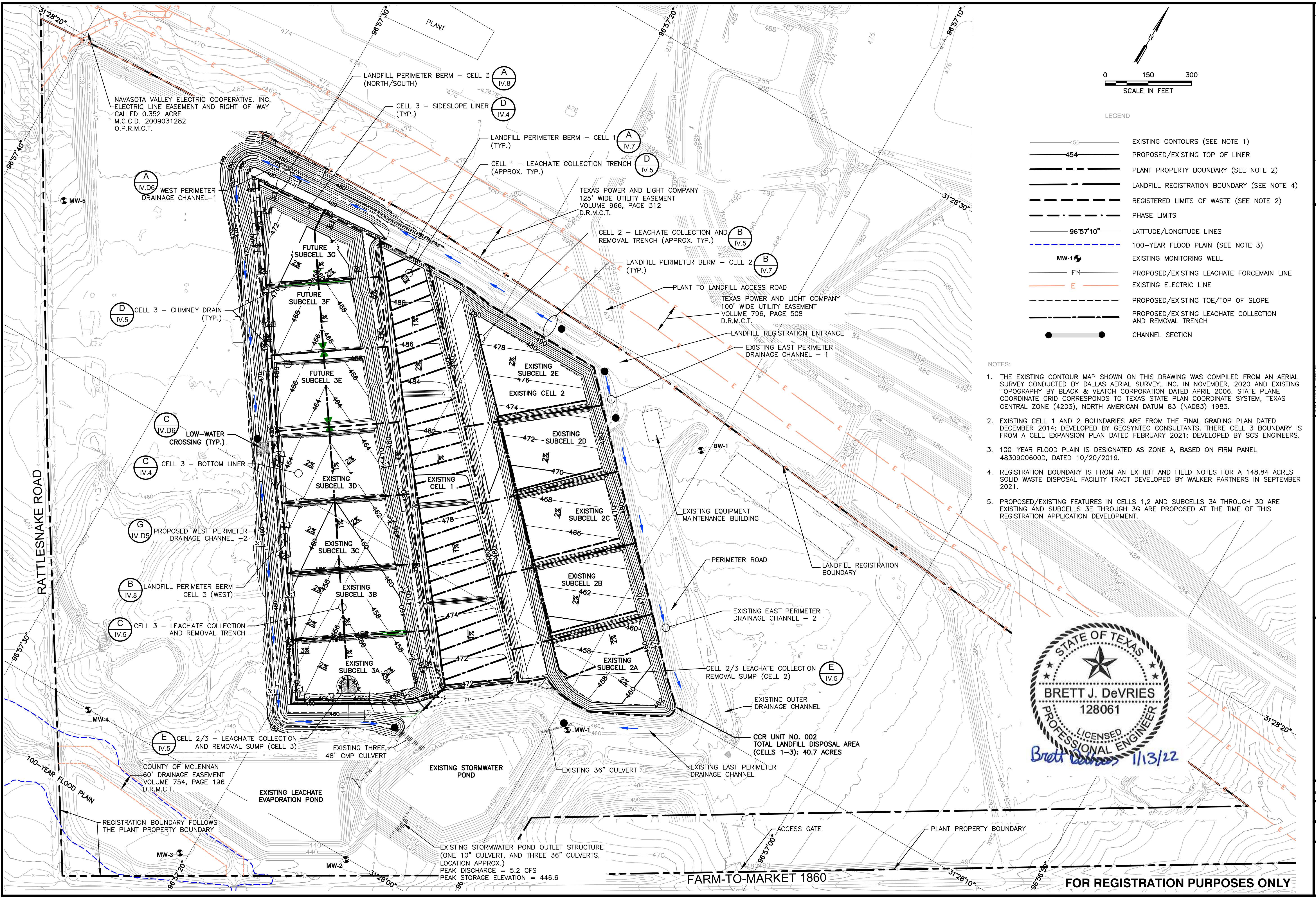

LEGEND

450 EXISTING CONTOURS (SEE NOTE 1)

454 PROPOSED/EXISTING TOP OF LINER

PLANT PROPERTY BOUNDARY (SEE NOTE 2)

LANDFILL REGISTRATION BOUNDARY (SEE NOTE 4)

REGISTERED LIMITS OF WASTE (SEE NOTE 2)

PHASE LIMITS

96°57'10" LATITUDE/LONGITUDE LINES

100–YEAR FLOOD PLAIN (SEE NOTE 3)

MW-1 EXISTING MONITORING WELL

FM PROPOSED/EXISTING LEACHATE FORCEMAIN LINE

E EXISTING ELECTRIC LINE

PROPOSED/EXISTING TOE/TOP OF SLOPE

PROPOSED/EXISTING LEACHATE COLLECTION AND REMOVAL TRENCH

CHANNEL SECTION

NOTES:

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LEACHATE COLLECTION AND REMOVAL SYSTEM PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
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DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

CADD FILE: IV–3 – LCRS

DATE: 11/2021

SCALE: AS SHOWN

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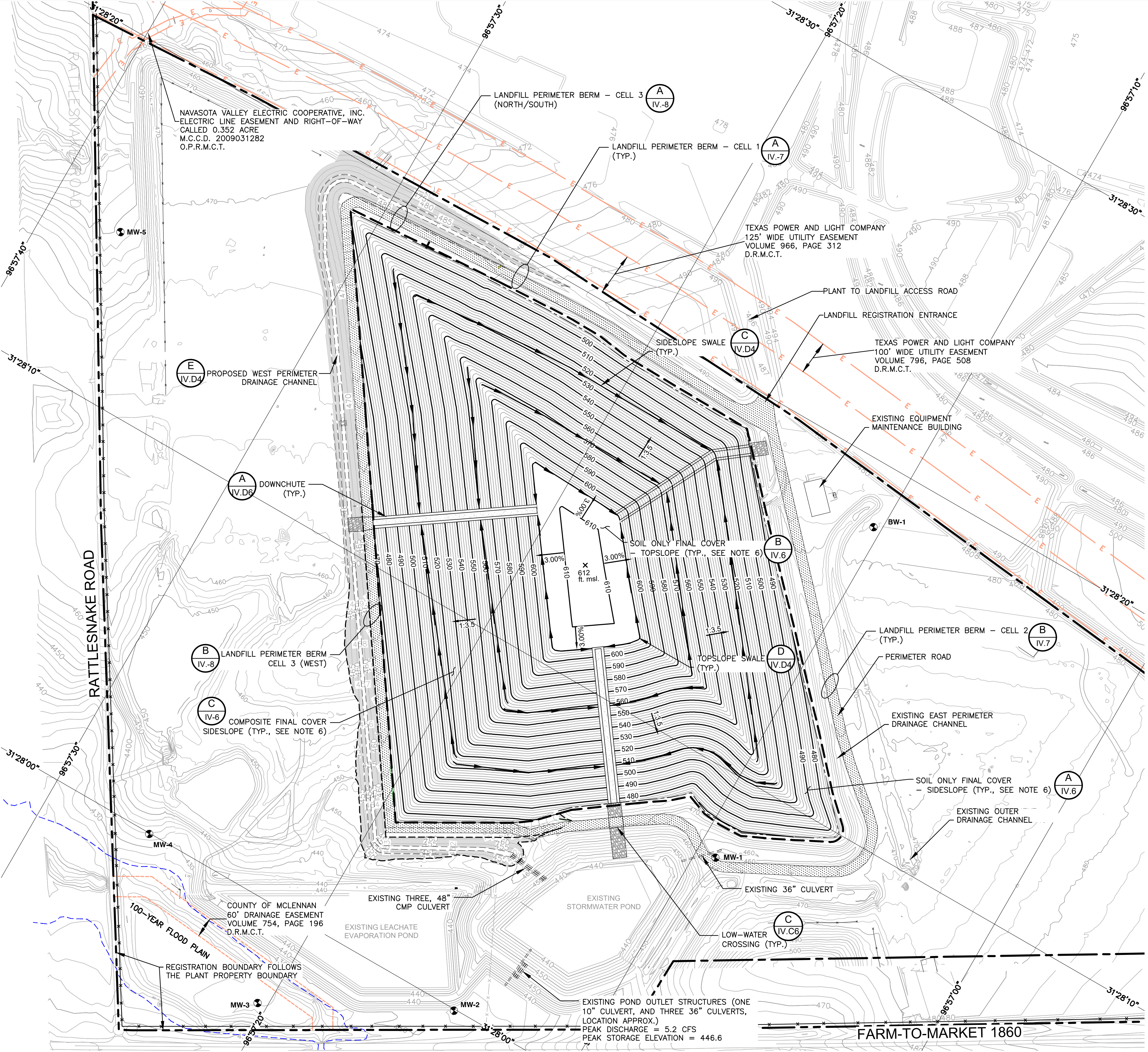

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SCALE IN FEET

LEGEND

——454——	EXISTING CONTOURS (SEE NOTE 1)
━━ ‒ ‒ ━━	PLANT PROPERTY BOUNDARY
━━ ‒ ━━	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 3)
━ ━ ━ ━	REGISTERED LIMITS OF WASTE (SEE NOTE 4)
—— 96°57'10" ——	LATITUDE/LONGITUDE LINES
MW-1 ◐	EXISTING GROUNDWATER MONITORING WELL
——454——	PROPOSED FINAL COVER CONTOUR (SEE NOTE 5)
—►—►—►	PROPOSED DRAINAGE SWALES
≡	PROPOSED DOWNCHUTES
—×—×—×—	EXISTING FENCE
- - - -	EXISTING DRAINAGE EASEMENT
—— E ——	EXISTING ELECTRICAL EASEMENT
– – – –	100–YEAR FLOOD PLAIN (SEE NOTE 2)
▨	PERIMETER ROAD

NOTES:

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5. ELEVATIONS SHOWN ON THIS DRAWING WITHIN REGISTERED LIMITS OF WASTE ARE TOP OF FINAL COVER ELEVATIONS IN FT MEAN SEA LEVEL (FT MSL).
6. SOIL ONLY FINAL COVER WILL BE INSTALLED OVERLAYING CELL 1 AND 2, COMPOSITE FINAL COVER WILL BE INSTALLED OVERLAYING CELL 3 AND UP TO THE TOPSLOPE. TEXTURED GEOMEMBRANE AND DOUBLE–SIDED GEOCOMPOSITE WILL EXTEND A MINIMUM OF 5 FEET ON TO THE LANDFILL TOPDECK.

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LANDFILL COMPLETION PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00	DWN. BY: AGA	Q/A RVW BY: SS
DSN. BY: BJD	CHK. BY: SS	APP. BY: BJD

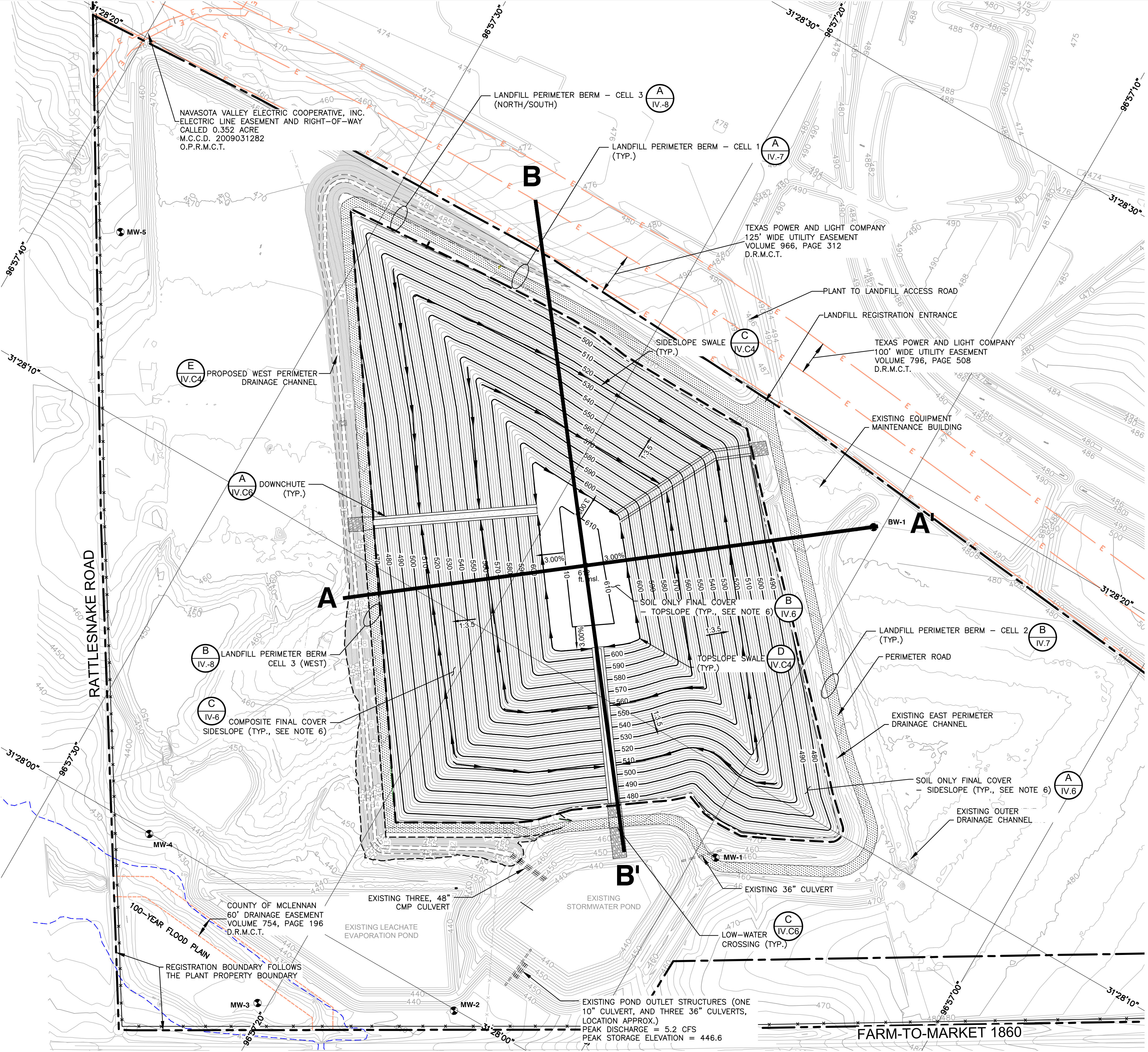
CADD FILE:
IV–4 – LANDFILL COMPLETION PLAN

DATE:
9/2021

SCALE:
AS SHOWN

DRAWING NO.
IV-4

1/14/2022 4:20 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\IV-4 – Landfill Completion Plan



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0 150 300
SCALE IN FEET

LEGEND

- EXISTING CONTOURS (SEE NOTE 1)
- PLANT PROPERTY BOUNDARY
- LANDFILL REGISTRATION BOUNDARY
- REGISTERED LIMITS OF WASTE
- 96°57'10" LATITUDE/LONGITUDE LINES
- MW-1 EXISTING GROUNDWATER MONITORING WELL
- 454 PROPOSED FINAL COVER CONTOUR
- PROPOSED DRAINAGE SWALES
- PROPOSED DOWNCHUTES
- EXISTING FENCE
- EXISTING DRAINAGE EASEMENT
- E EXISTING ELECTRICAL EASEMENT
- 100-YEAR FLOOD PLAIN (SEE NOTE 2)
- PERIMETER ROAD

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CROSS SECTION LAYOUT PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

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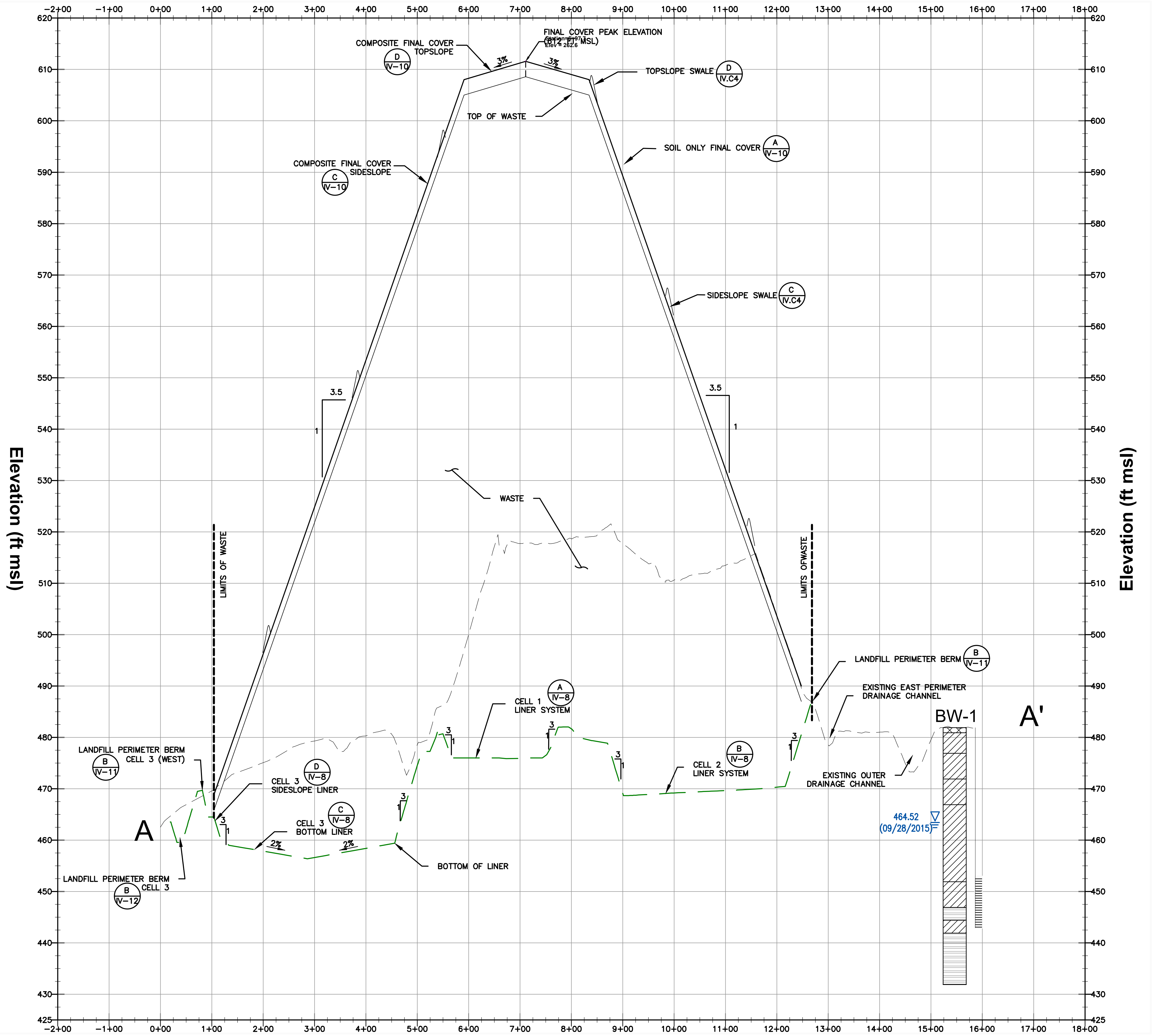
PROJ. NO. 16221059.00
DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

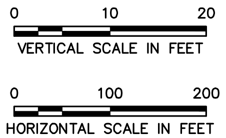
CADD FILE:
IV-5 – CROSS SECTIONS LAYOUT

DATE:
11/2021

SCALE:
AS SHOWN

DRAWING NO.
IV-5





LEGEND

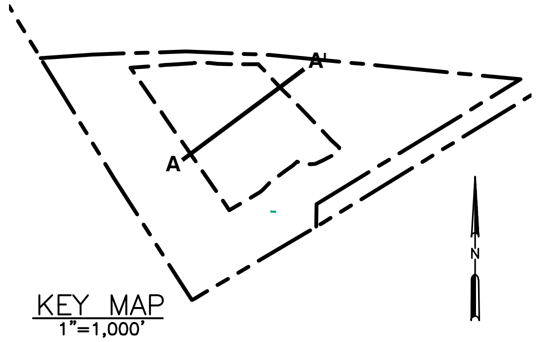
- - - - LIMITS OF WASTE/CELL BOUNDARIES
- - - - EXISTING TOPOGRAPHY
- - - - BOTTOM OF LINER
—— TOP OF WASTE
— — SEASONAL HIGH GROUNDWATER
☒ SOIL (BROWN/BLACK CLAY)
▨ WEATHERED SHALE
▤ UNWEATHERED SHALE
SCREENED INTERVAL
510.74 (7/8/20) ▽ STATIC WATER LEVEL IN MONITORING WELL (DATE OF WATER LEVEL READING)

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

NOTE:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.



KEY MAP
1"=1,000'

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REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CROSS SECTION A-A'

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00
DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

CADD FILE: IV-6' IV-7 – CROSS SECTIONS
DATE: 11/2021
SCALE: AS SHOWN
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IV-6

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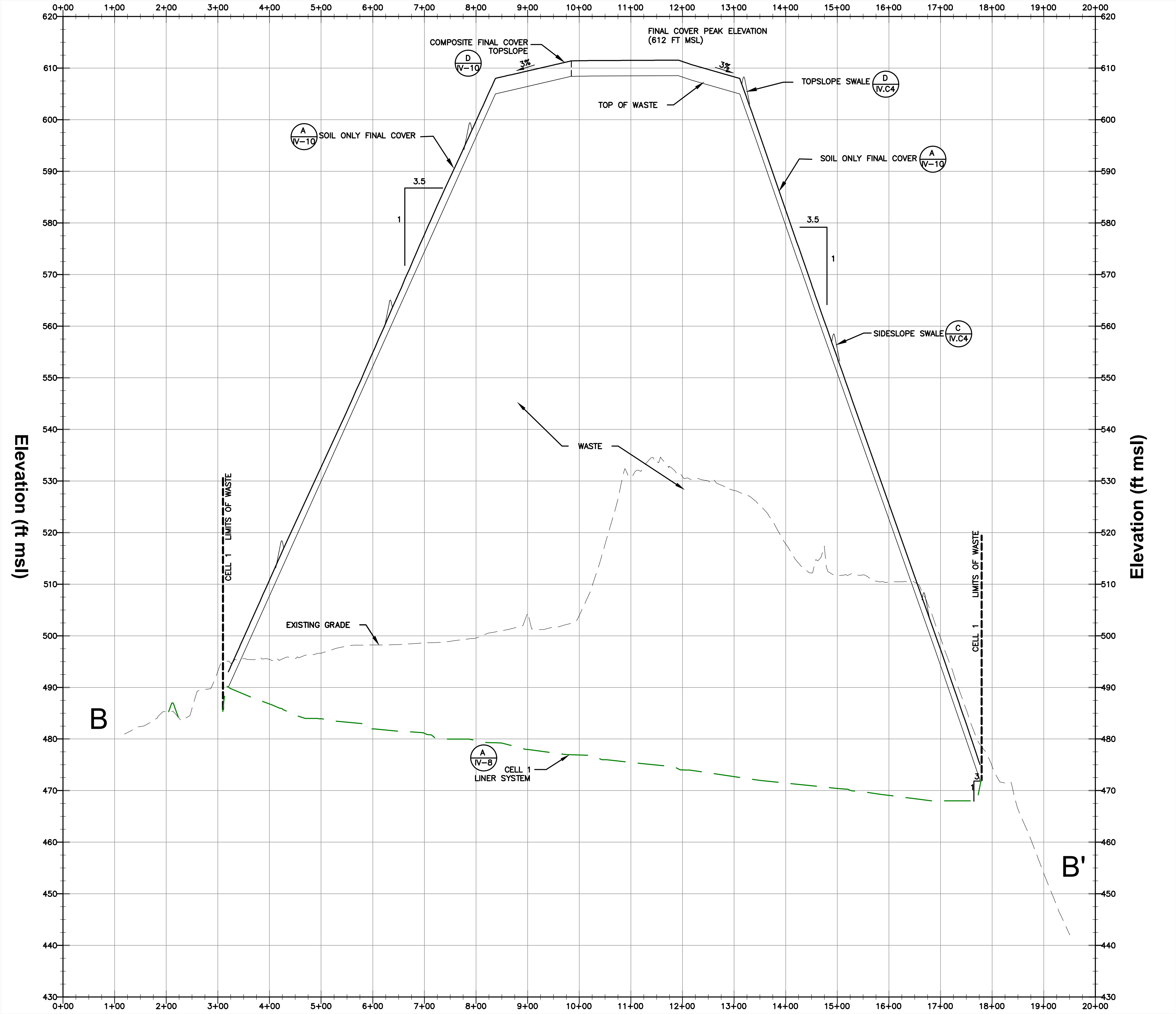
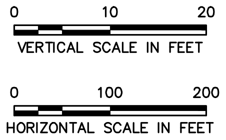




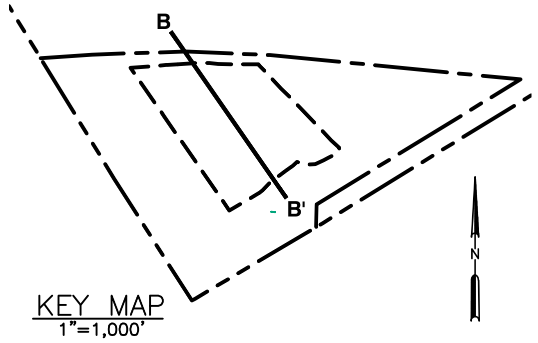
LEGEND

━ ━ ━	LIMITS OF WASTE/CELL BOUNDARIES
— — —	EXISTING TOPOGRAPHY
- - - -	BOTTOM OF LINER
———	TOP OF WASTE
— — —	SEASONAL HIGH GROUNDWATER
▩	SOIL (BROWN/BLACK CLAY)
▨	WEATHERED SHALE
▤	UNWEATHERED SHALE

BRETT J. DeVRIES
128061
Brett DeVries 1/13/22

NOTE:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.



KEY MAP
1"=1,000'

FOR REGISTRATION PURPOSES ONLY

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CROSS SECTION B-B'

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

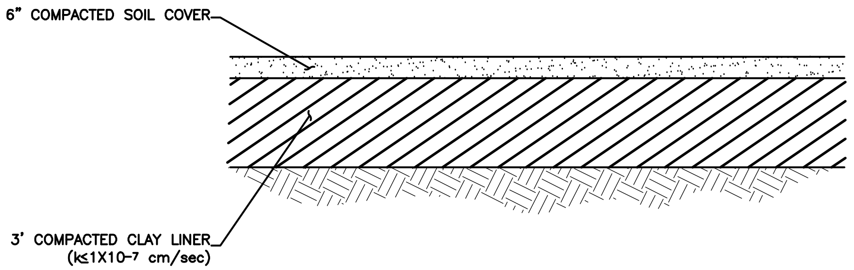
PROJ. NO. 16221059.00
DSN. BY: BJD
DWN. BY: ORA
CHK. BY: BJD
Q/A RVW BY: BJD
APP. BY: BJD

CADD FILE: IV-6' IV-7 - CROSS SECTIONS

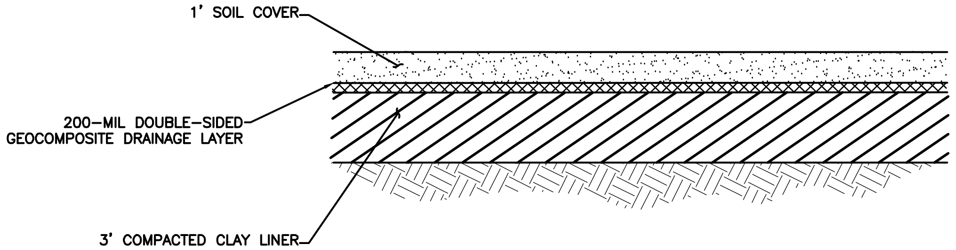
DATE: 11/2021

SCALE: AS SHOWN

DRAWING NO.
IV-7



CELL 1 – LINER SYSTEM (A / IV-8)
NTS



CELL 2 – LINER SYSTEM (B / IV-8)
NTS

NOTES:

1. LINER SYSTEM FOR CELL 1 WAS OBTAINED FROM PLANS DEVELOPED BY SANDY CREEK POWER PARTNERS IN 2010 AND THE LINER SYSTEM FOR CELL 2 WAS OBTAINED FROM PLANS DEVELOPED BY GEOSYTECH CONSULTANTS IN 2013. LINER SYSTEMS ARE REPRESENTATIVE OF BOTH BOTTOM AND SIDESLOPES.

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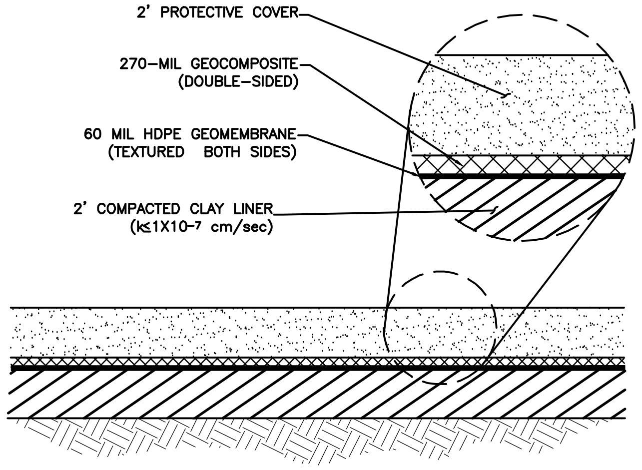
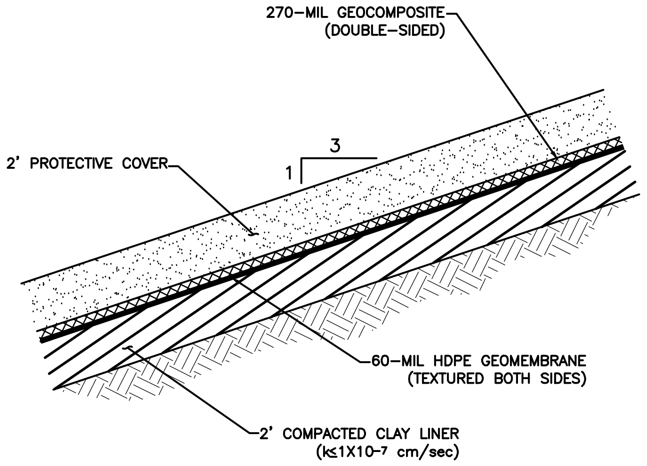


CELL 3 – BOTTOM LINER (C / IV-8)
NTS



CELL 3 – SIDESLOPE LINER (D / IV-8)
NTS

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LINER DETAILS

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
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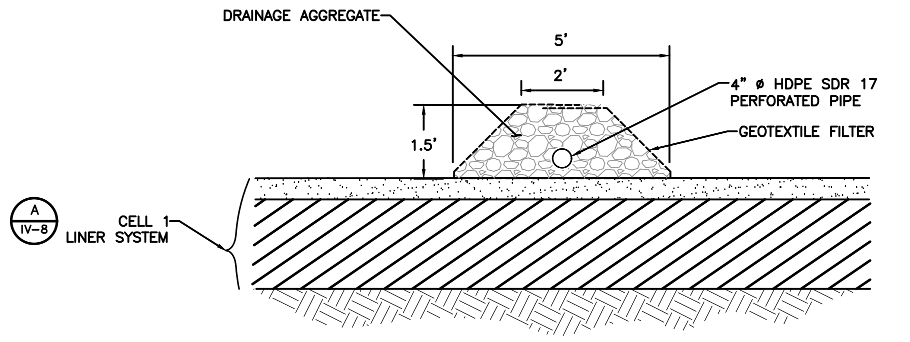
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO.: 16221059.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE: IV-8 – DETAILS
DATE: 11/2021
SCALE: AS SHOWN
DRAWING NO.: IV-8



CELL 1 – LEACHATE COLLECTION AND REMOVAL TRENCH (SEE NOTE 5) A IV-9
NTS

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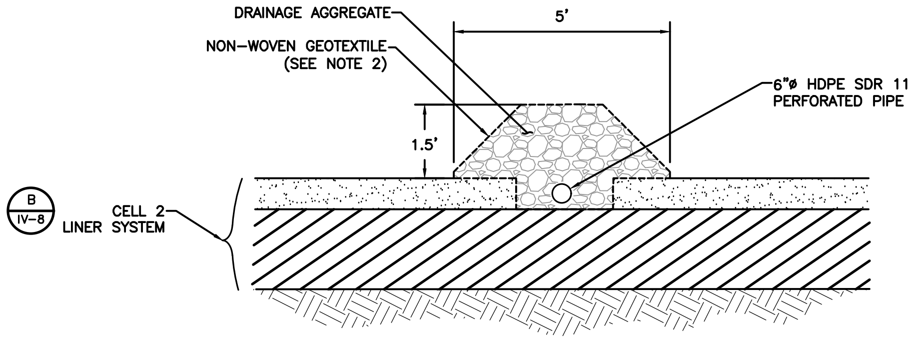
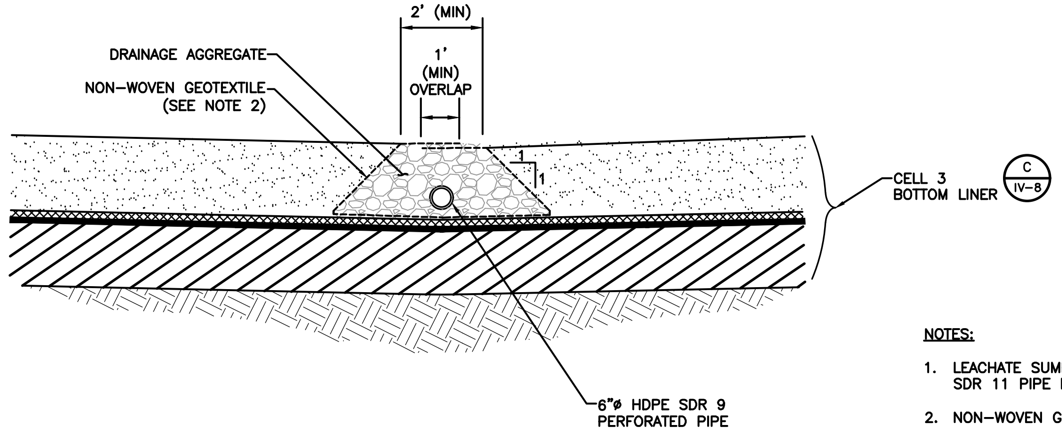
128061

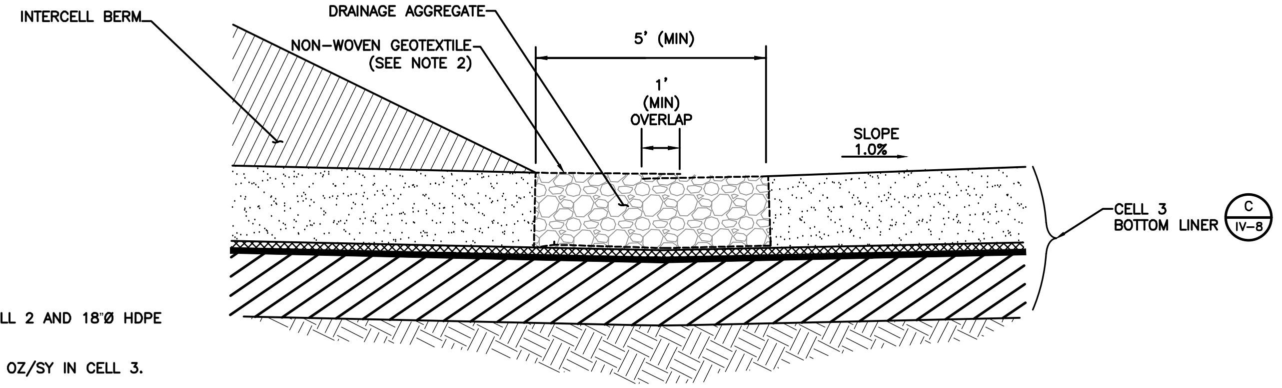
Brett DeVries 1/13/22



CELL 2 – LEACHATE COLLECTION AND REMOVAL TRENCH (SEE NOTE 5) B IV–9
NTS



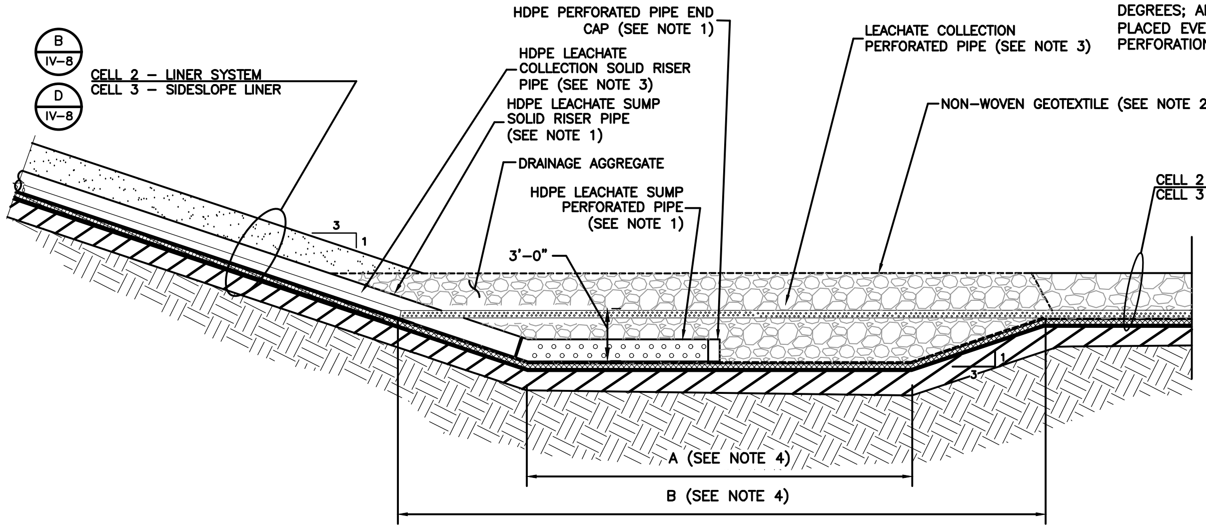
CELL 3 – LEACHATE COLLECTION AND REMOVAL TRENCH C IV–9
NTS



CELL 3 – CHIMNEY DRAIN D IV–9
NTS

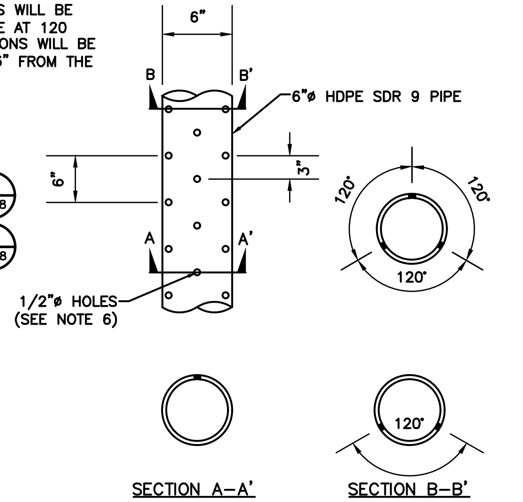
NOTES:

1. LEACHATE SUMP PIPE IS 24"Ø HDPE SDR 11 PIPE IN CELL 2 AND 18"Ø HDPE SDR 11 PIPE IN CELL 3.
2. NON–WOVEN GEOTEXTILE IS 8 OZ/SY IN CELL 2 AND 12 OZ/SY IN CELL 3.
3. LEACHATE COLLECTION PIPE IS 6"Ø HDPE SDR 11 IN CELL 2 AND 6"Ø HDPE SDR 9 IN CELL 3.
4. DIMENSION "A" IS 20'X20' IN CELL 2 AND 27'X27' IN CELL 3; AND DIMENSION "B" IS 38'X38' IN CELL 2 45'X45' IN CELL 3.
5. LEACHATE COLLECTION AND REMOVAL TRENCH FOR CELL 1 WAS OBTAINED FROM PLANS DEVELOPED BY SANDY CREEK POWER PARTNERS IN 2010 AND THE LEACHATE COLLECTION AND REMOVAL TRENCH FOR CELL 2 WAS OBTAINED FROM PLANS DEVELOPED BY GEOSYTECH CONSULTANTS IN 2013.
3. HDPE PIPE PERFORATIONS FOR CELL 3 WILL BE 1/2"ø. THREE ROWS OF PERFORATIONS WILL BE INSTALLED: ONE ROW OF PERFORATIONS WILL BE LOCATED AT THE TOP OF THE PIPE (0 DEGREE LOCATION); ONE AT 120 DEGREES; AND ONE AT THE 240 DEGREE LOCATION. PERFORATIONS WILL BE PLACED EVERY 6" IN A ROW WITH THE TOP ROW STAGGERED 3" FROM THE PERFORATIONS IN THE ADJACENT ROWS.

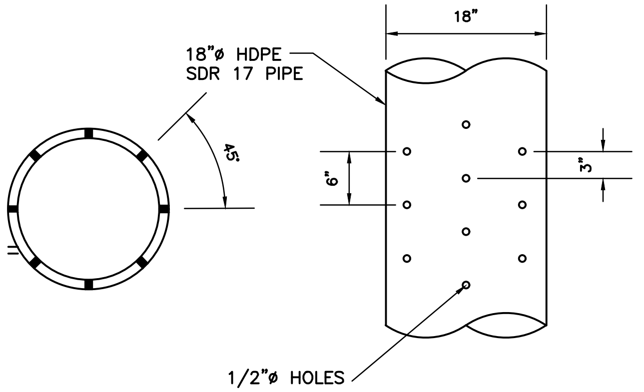


CELL 2 – LEACHATE COLLECTION AND REMOVAL TRENCH B IV–8
CELL 3 – LEACHATE COLLECTION AND REMOVAL TRENCH C IV–8

CELL 2/3 LEACHATE COLLECTION SUMP E IV–9
NTS



6" ø HDPE SDR 9 PERFORATED PIPE F IV–9
NTS



18"ø HDPE SDR 17 PERFORATED PIPE G IV–9
NTS

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1/17/2022 10:46 AM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\IV-9 - Details

REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
LEACHATE COLLECTION AND REMOVAL SYSTEM DETAILS

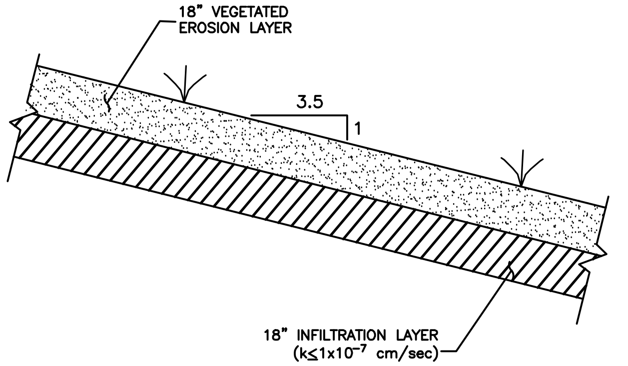
PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

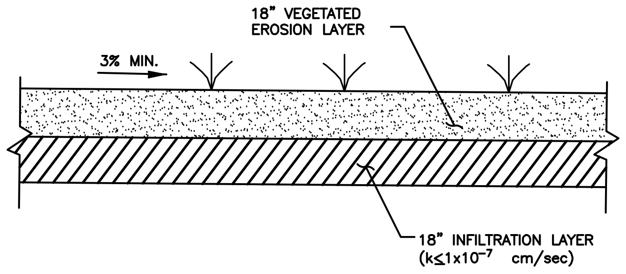
PROJ. NO. 16221059.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE: IV–9 – DETAILS
DATE: 11/2021
SCALE: AS SHOWN
DRAWING NO. IV-9



SOIL ONLY FINAL COVER – SIDESLOPE (A / IV–10)

NTS

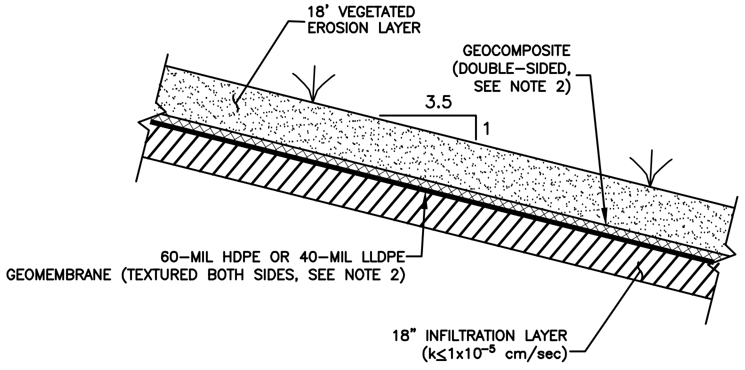


SOIL ONLY FINAL COVER – TOPSLOPE (B / IV–10)

NTS

NOTE:

1. SOIL ONLY FINAL COVER WILL BE INSTALLED OVERLAYING CELL 1 AND 2, COMPOSITE FINAL COVER WILL BE INSTALLED OVERLAYING CELL 3 AND UP TO THE TOP OF DECK (CONSISTENT WITH NOTE 2).
2. TEXTURED GEOMEMBRANE AND DOUBLE–SIDED GEOCOMPOSITE WILL EXTEND A MINIMUM OF 5 FEET ONTO THE LANDFILL TOPSLOPE.
3. AT THE DISCRETION OF THE LANDFILL OWNER/OPERATOR IN AREAS OVERLAYING CELLS 1 AND 2, THE COMPOSITE FINAL COVER (SEE THIS DRAWING, DETAILS C AND D) MAY BE INSTALLED OVER CELLS 1 AND 2.



COMPOSITE FINAL COVER – SIDESLOPE (C / IV–10)

NTS

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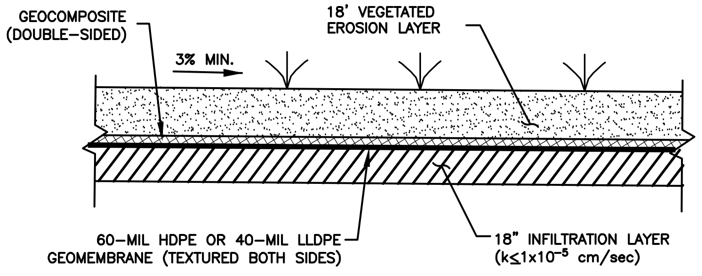
128061

Brett DeVries 1/13/22



COMPOSITE FINAL COVER – TOPSLOPE (OPTIONAL) (D / IV–10)

NTS

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
FINAL COVER DETAILS

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
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PROJ. NO. 16221059.00
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Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

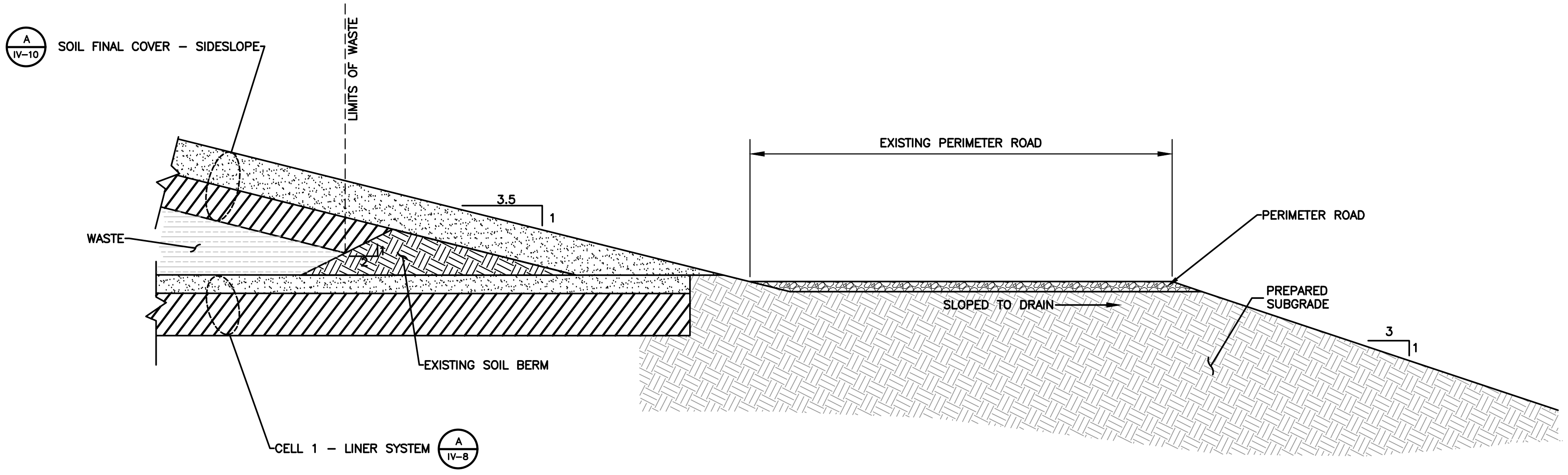
CADD FILE: IV–10 – FINAL COVER DETAIL–1

DATE: 11/2021

SCALE: AS SHOWN

DRAWING NO.
IV-10

1/15/2022 12:32 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\IV–10 – Final Cover Detail–1



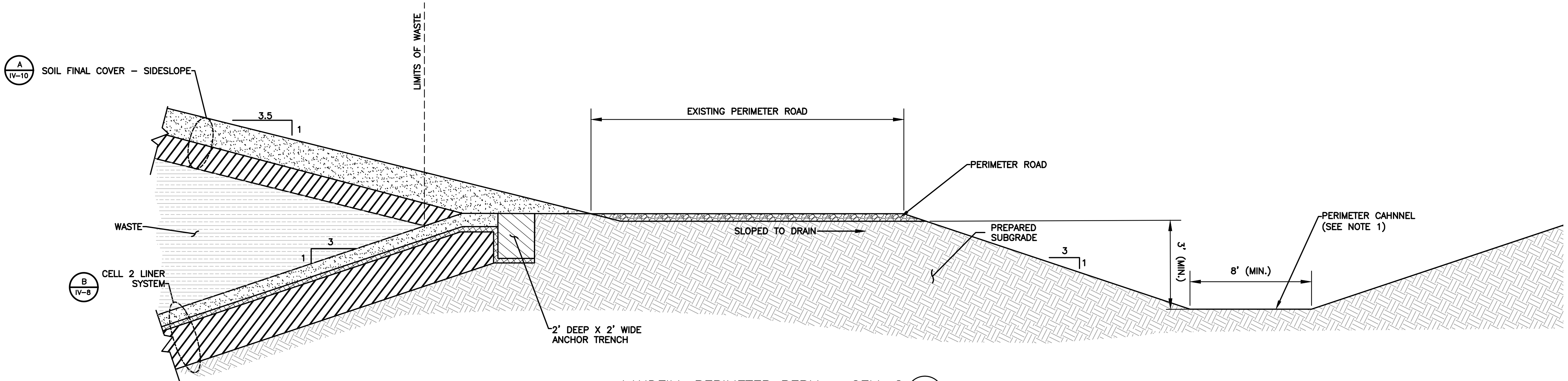
LANDFILL PERIMETER BERM – CELL 1 (A IV-11)
NTS

NOTE:

1. PERIMETER CHANNEL MAY BE LOCATED AT THE LANDFILL SIDE OF THE PERIMETER ROAD.

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22



LANDFILL PERIMETER BERM – CELL 2 (B IV-11)
NTS

FOR REGISTRATION PURPOSES ONLY

1/15/2022 12:33 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\IV-11 – Perimeter Berm –1

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
PERIMETER BERM DETAILS - 1

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
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RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

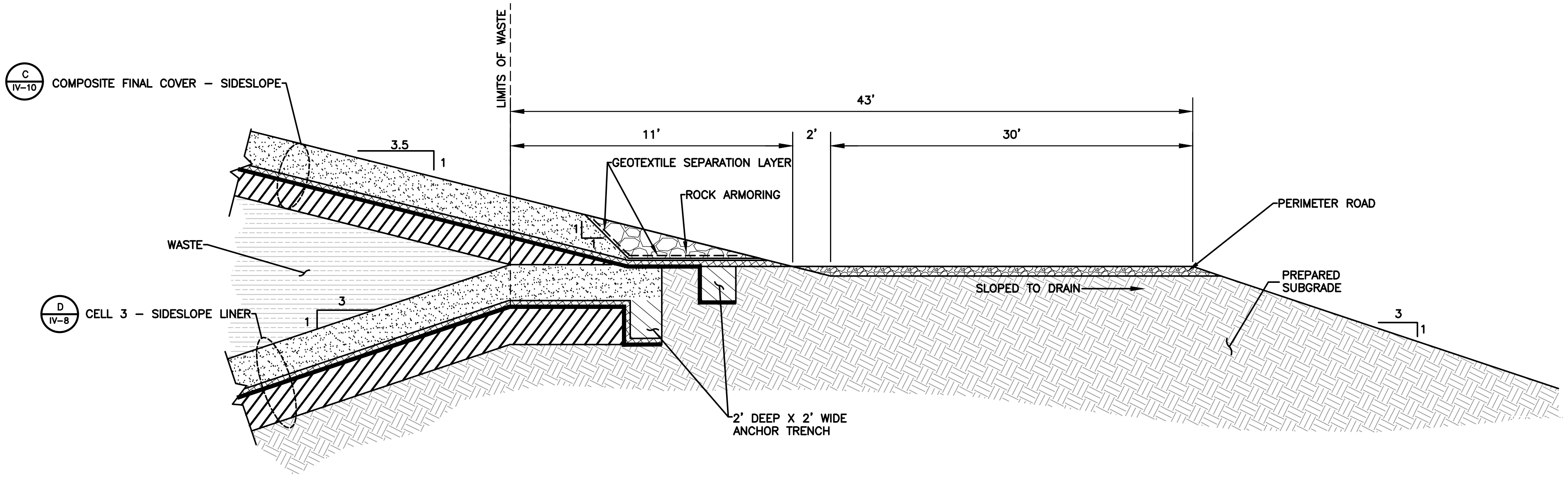
PROJ. NO. 16221059.00
DWN. BY: ORA
Q/A RVW BY: BJD
DSN. BY: BJD
CHK. BY: BJD
APP. BY: BJD

CADD FILE: IV-11 – PERIMETER BERM –1

DATE: 11/2021

SCALE: AS SHOWN

DRAWING NO.
IV-11

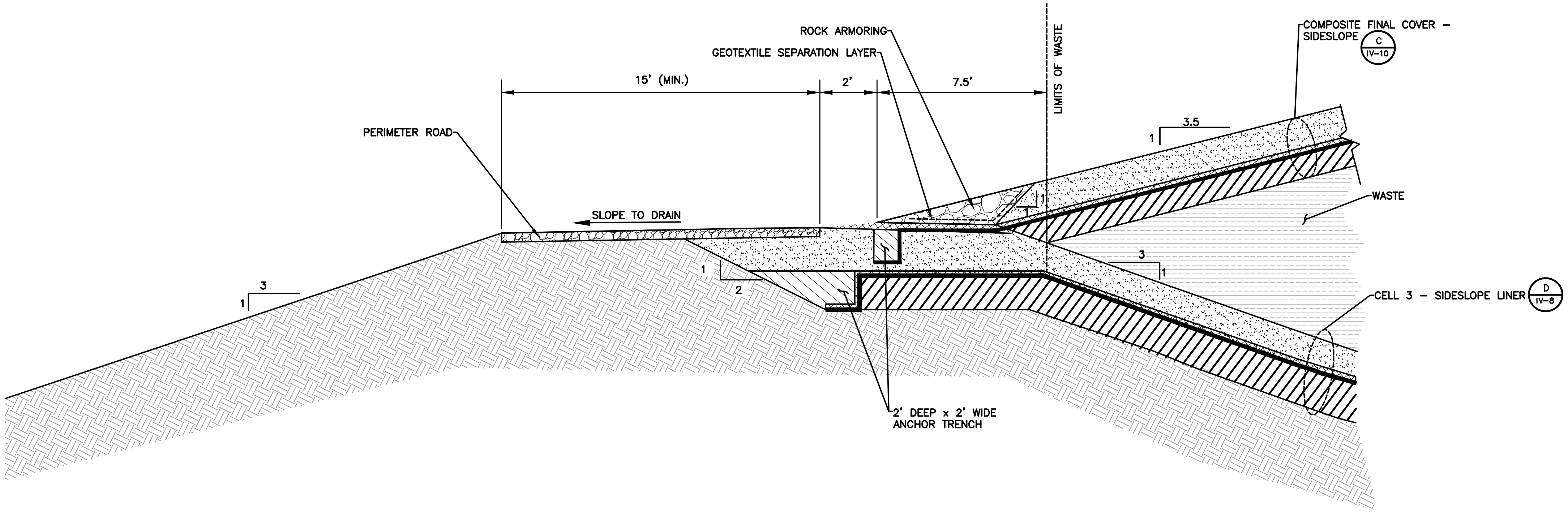


LANDFILL PERIMETER BERM – CELL 3 (NORTH/SOUTH) A IV-12

NTS

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22



LANDFILL PERIMETER BERM – CELL 3 (WEST) B IV-12

NTS

FOR REGISTRATION PURPOSES ONLY

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
PERIMETER BERM DETAILS - 2

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

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SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
REGISTRATION APPLICATION
TCEQ REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

APPENDIX IV.A
LEACHATE COLLECTION AND REMOVAL SYSTEM PLAN

Prepared for:

SANDY CREEK SERVICES, LLC
2161 Rattlesnake Road
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BRETT J. DeVRIES
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Brett DeVries 1/13/22

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IV.A1 Leachate Generation Model
IV.A2 Leachate Collection System Design Calculations
IV.A3 HDPE Pipe Corrosion Durability Literature

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

1 PE CERTIFICATION (40 CFR §257.70(e))

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

I, Brett DeVries, Ph.D., P.E., hereby certify that the composite liner system and leachate collection and removal system for Cell 3 at the Sandy Creek Energy Station Coal Combustion Residual Waste Management Facility meets the requirements in 30 TAC §352.701 [40 CFR §257.70(b) and (d)]. This certification is based on this Registration Application and was prepared by or under my supervision. I am a duly licensed Professional Engineer under the laws of the State of Texas.

Brett DeVries, Ph.D., P.E.
(printed or typed name)

License number __128061_________________

My license renewal date is __9/30/2022______

2 PURPOSE AND SCOPE

This Leachate Collection and Removal System (LCRS) Plan has been prepared for Sandy Creek Services, LLC (Owner and Operator) of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill), located in McLennan County. The Plan has been prepared consistent with Title 30 of the Texas Administrative Code (30 TAC), Chapter 352, Subchapter F (Title 40 of the Code of Federal Regulations (40 CFR), Part 257, Subpart D).

The Landfill and associated support facilities are located on the southwest corner of the Plant Property Boundary, as shown on Drawings I.B-1 and I.B-4 in Part I, Appendix I.B. As currently designed, the Landfill is one unit (Unit 002) that will ultimately occupy approximately 40.7 acres and consist of three cells referred to as Cells 1 through 3 (Part I, Appendix I.B, Drawing I.B-4). Cells 1 and 2 are existing active cells that were constructed in 2010 and 2014, respectively, with ongoing waste placement operations. A portion of Cell 3 (inclusive of Subcells 3A through 3D, encompassing approximately 10.3 acres) was constructed in 2021 prior to and during the time of preparing this Registration Application. Cells 1 and 2 were constructed in accordance with rules and regulations for CCR Landfill construction at the time of construction (prior to promulgation of 30 TAC 352 and 40 CFR Part 257); therefore, are not subject to the requirements of §352.701 and §257.70. Cell 3 (including subcells) is considered a lateral expansion (consistent with §257.53) and will be constructed and operated consistent with this Registration Application. Additionally, Subcells 3A through 3D that were constructed in 2021 will be operated consistent with this Registration Application.

This Plan provides the details of the collection, storage, removal, and disposal systems for leachate generated during the active and post-closure care periods of the Landfill. Calculations and analysis required to comply with §352.701 (§257.70) are only provided for Cell 3 since Cells 1 and 2 were constructed prior to promulgation of these rules and are considered existing Landfills. Specifically, this Plan addresses the following:

1. Leachate and contact water (i.e., water that has come in contact with waste or leachate) generation. This includes an estimation of leachate generation, performed using the Hydrologic Evaluation of Landfill Performance (HELP) model, and the management of contact water;

2. Description of the LCRS; including the following:

    - Geocomposite performance and material specifications.

    - Layout, capacity, and strength/stability of leachate collection piping.

    - Layout and capacity of leachate collection sumps.

    - Drainage stone specifications.

    In accordance with §257.70(d)(2) and (3), the materials specified for the LCRS will be chemically resistant to CCR and any non-CCR waste (hereby referred to as "waste") managed at the Landfill and the leachate expected to be generated; have sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment; and to minimize clogging during the active life and post-closure care period. These calculations are provided in Attachment IV.A2 of this Plan, and are representative of the Landfill Completion Plan (see Part IV, Drawing IV-4) presented in this Application.

However, it should be noted that similar calculations are provided in Part II, Appendix II.A – Cell 3 Compliance Demonstration and Notification Letter. The calculations provided in Part II, Appendix II.A are based on the assumption that the Landfill will be laterally expanded into a future Cell 4, resulting in a higher final waste placement elevation. As such, should this scenario be pursued in the future, a major amendment to this Registration Application will be submitted for TCEQ approval consistent with 30 TAC §305.62.

3. Leachate storage;

4. Leachate disposal; and

5. Requirements for recordkeeping, notification, and posting of information on the Landfill's publically accessible website.

Drawings provided in Part IV – Landfill Criteria and Design Drawings depicts the layout and details of the LCRS components, liner systems (existing and proposed), and final cover systems. Consistent with §257.70(d)(1), the LCRS for Cell 3 has been designed to maintain less than 30 centimeters (approximately 12 inches) of leachate over the bottom liner system.

3 LEACHATE AND CONTACT WATER GENERATION

3.1 GENERAL PROCESS

Leachate is generated as water infiltrates into the waste and Landfill cover (i.e., intermediate and final cover) and percolates through the layers of waste, and as moisture is released from high moisture content waste. The quantity of leachate produced will depend upon the climate, site topography, type of cover, construction and landfilling procedures, and waste characteristics.

Contact water is defined as liquid that has come into contact with waste or leachate. Contact water is generated when stormwater runoff contacts waste at the active area (also known as "working face") of the Landfill, and will be handled and disposed in the same manner as leachate, as described in this Plan.

3.2 LEACHATE GENERATION

The HELP model, Version 4.0 (Beta), was used to estimate the amount of leachate that will be generated by the Landfill and the response of the leachate collection system components to maintain the leachate head on the liner below 30 centimeters. The HELP model is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of Landfills. The model uses climate, soil, and Landfill design data in its calculations. It uses solution techniques that account for key factors affecting water movement in a Landfill, including: surface storage; snowmelt; runoff; infiltration; evapotranspiration; vegetative growth; soil moisture storage; lateral subsurface drainage; unsaturated vertical drainage; and leakage through soil, geomembrane, and composite liners (EPA, 2020).

Leachate generation was evaluated for active, interim, and closed Landfill conditions. Attachment IV.A1 describes the HELP model demonstration, which was designed to be representative of Landfill development. In addition, Attachment IV.A1 describes the Landfill profile input parameters and assumptions that were utilized in the HELP model simulations.

As presented in Attachment IV.A1 "Help Model Summary Sheets," the HELP model results demonstrate that the LCRS will maintain less than the 30 centimeters of leachate head over the bottom liner for all conditions modeled in Cell 3.

LCRS design calculations are presented in Attachment IV.A2.

3.3 STORMWATER MANAGEMENT

Surface water (i.e., stormwater and contact water) will be managed throughout the active life of the Landfill to minimize the amount of stormwater that will come into contact with waste or leachate. Surface water run-on onto the working face or areas of exposed waste (i.e., contact water) will be controlled using temporary diversion berms. Diversion berms will be constructed on the up-hill side of the working face to divert stormwater away from the working face and into the stormwater management system thus reducing the volume of contact water and leachate generated. Cells 2 and 3 will utilize interim cell berms to minimize the amount of leachate generated during Landfill operation. Stormwater collected in subcells that have not been in contact with waste will be discharged as uncontaminated water into the stormwater pond. Additionally, to promote run-off and prevent ponding, the Landfill cover will be graded and maintained to divert surface water away from the working face of the Landfill.

Surface water run-off from the working face (i.e., contact water) will be contained within the exposed waste areas, including working face, by using temporary containment berms. Water that infiltrates into the underlying waste will be managed as leachate. Contact water at the working face will be kept to a minimum and directed to the leachate collection and removal system, which discharges into the leachate evaporation pond in accordance with Section 5 of this Plan. Additionally, at no time will contact water be allowed to discharge into the stormwater management system, offsite into waters of the United States, or onto adjacent properties.

Methodologies described in the Texas Department of Transportation's Hydraulic Design Manual (revised September 2019) were used to estimate the volume of water that will be diverted around the working face or contained at the working face. These methodologies were also used to develop an approach for estimating the height of temporary diversion and containment berms required to contain and divert stormwater from coming into contact with waste. The design calculations and sizing of the diversion and containment berms for a 25 year, 24-hour storm event are provided in Appendix IV.C – Run-on and Run-off Control System Plan.

Uncontaminated stormwater runoff will be discharged from the Landfill consistent with the site's Texas Pollutant Discharge Elimination System (TPDES), 40 CFR §257.81(b), and Section 3 of Appendix IV.C. Surface water will be managed throughout the active life of the Landfill to minimize infiltration into the filled areas and to minimize contact with waste. In addition, intermediate and final cover will be graded and maintained to promote runoff and prevent ponding, thereby reducing leachate generation.

Water that does not come in contact with waste, contact water, or leachate (including run-off generated from fill areas covered with intact intermediate soil or alternative cover) will be managed as stormwater (i.e. non-contact water). This stormwater runoff from the Landfill will be conveyed to the perimeter stormwater management system, comprised of perimeter channels and existing stormwater pond, by drainage swales/downchutes and overland flow before being discharged from the Landfill Registration Boundary.

4 LEACHATE COLLECTION AND REMOVAL SYSTEM

4.1 SYSTEM LAYOUT

The primary component providing leachate and contact water management in the Landfill is the LCRS. The LCRS is designed to control the accumulation of leachate within the waste disposal area during the active periods of landfilling, and after Landfill closure. The LCRS consists of LCRS piping in Cell 1; and a primary leachate drainage layer (i.e., geocomposite) placed over the bottom and sideslope liner system, LCRS piping, and LCRS sumps and pumps in Cells 2 and 3. Layout of the LCRS piping and sumps for the Landfill is shown on Drawing IV-3 in Part IV. Liner details are shown on Drawing IV-8 and LCRS details are shown on Drawing IV-9.

4.2 LEACHATE DRAINAGE LAYER

The leachate drainage layer in Cells 2 and 3 consists of a geonet-geotextile composite (referred to as geocomposite) placed directly over the bottom and sideslope liner systems. The geocomposite is utilized to collect and transfer leachate to the LCRS pipes and sumps. The geocomposite consists of a high density polyethylene (HDPE) geonet with a non-woven geotextile heat bonded to one or both sides of the geonet, where double-sided geocomposite will be placed on the bottom and sideslopes of the Landfill. The geocomposite installed in Cell 3 will have hydraulic properties that will provide adequate drainage of leachate to the leachate collection and removal piping and sump, thereby maintaining less than 30 centimeter leachate head above the bottom liner system in Cell 3. Additionally, the non-woven geotextile will provide adequate filtration of sediment and protection of the underlying geosynthetics during development of the Landfill. Calculations demonstrating the minimum required material properties for the geocomposite and non-woven geotextile for Cell 3 are presented in Attachment IV.A2 of this Plan.

A 0.5-foot thick (in Cell 1) and 1-foot thick (in Cell 2) protective soil cover was placed over the liner system (in Cell 1) or geocomposite (in Cells 2) prior to waste placement. A 2-foot-thick protective soil cover will be placed over the liner system geocomposite in Cell 3. Onsite soils were or will be used for protective cover, which have a hydraulic conductivity (k) less than 1.0 x 10^{-4} cm/sec. Therefore, to facilitate drainage into the LCRS, chimney drains (also referred to as leachate collection and removal trenches), comprised of aggregate wrapped in a non-woven geotextile, were and will be constructed over the leachate collection and removal piping in all cells. Additional discussion regarding the aggregate around the LCRS piping is provided in Section 4.6 of this Plan.

4.3 LEACHATE COLLECTION AND REMOVAL PIPING

The bottom liner system of each cell is designed to drain toward a perforated leachate collection and removal pipe(s) located in each cell, as shown on Drawing IV-3 in Part IV. The LCRS piping is sloped to gravity drain leachate to the leachate evaporation pond in Cell 1 and into LCRS sumps located at the perimeter of Cells 2 and 3.

The LCRS pipes are 4-inch diameter HDPE pipe with a Dimensional Ratio (DR) value of 17 in Cell 1, 6-inch diameter HDPE pipe with a DR value of 11 in Cell 2, and a 6-inch diameter HDPE pipe and a DR value of 9 or less in Cell 3. Solid 6-inch diameter HDPE cleanout risers are located on the sideslopes at the down-gradient end of the leachate collection pipes in Cell 2 and the down- and up=gradient ends for Cell 3 to allow clean-out of the respective pipes. Solid 18-inch (Cell 3) or 24-inch (Cell 2) diameter HDPE (DR 11 or less) sump risers are located on the sideslopes at the down-gradient end of Cells 2 and 3 for pump installation and removal of leachate from the leachate collection and removal sumps. Design calculations for the LCRS pipe and sump riser pipe for Cell 3 are provided in Attachment IV.A2 of this Plan. These calculations demonstrate the adequacy of the pipe to convey leachate to the sump, the structural stability of the pipe, and the satisfaction of the perforation requirements.

Due to overburden pressures in deeper portions of the Landfill, it is necessary to construct chimney drains over the leachate collection piping using aggregate backfill, meeting the specifications described in Section 4.6. In addition to facilitating drainage through the protective cover, the chimney drains are necessary for pipe structural stability and provide redundant flow capacity for leachate drainage to the sumps in the event the pipes become damaged or clogged. The aggregate backfill will be separated from the adjacent protective cover and waste layers by wrapping the chimney drain in a non-woven geotextile fabric. Details of the piping and chimney drains is provided on Drawing IV-9 in Part IV.

4.4 LCRS DURABILITY AND LONG-TERM PERFORMANCE

In accordance with §257.70(d)(2) and (3), the LCRS for Cell 3 has been designed with materials that are chemically resistant to CCR and any non-CCR waste managed at the Landfill and the leachate expected to be generated, have sufficient strength and thickness to prevent collapse under the pressures exerted by overlying waste, waste cover materials, and equipment; and to minimize clogging during the active life and post-closure care period. High density polyethylene (HDPE) will be used, because it is the material of choice for LCRS geocomposite geonet and piping, as well as the bottom liner systems, due to its durability, flexibility, and chemical resistance in aggressive chemical environments (see Attachment IV.A3). Polypropylenes incorporated into geotextiles have been demonstrated to provide similar performance and minimize clogging in Landfill applications.

Furthermore, the drainage stone incorporated into the LCRS for Cell 3 will have a low calcium carbonate content so as to avoid negative impacts by contact with leachate. Lastly, the analysis of pipe strength under the construction and fill conditions at the Landfill is presented in Attachment IV.A2 of this Plan. These calculations demonstrate the pipe has been designed to perform adequately under both construction and waste loading conditions.

In conclusion, the LCRS for Cell 3 has been designed with components of sufficient chemical resistance, durability, strength, and thickness to provide adequate performance through the active life as well as the closure and post-closure periods of the Landfill.

4.5 LEACHATE COLLECTION AND REMOVAL SUMPS AND PUMPS

The LCRS sump and pump in Cell 3 have been designed and sized to limit maximum head above the bottom liner system at the outside edge of the sumps to within the thickness of the geocomposite (i.e., less than 30 centimeters above the bottom liner, see Attachment IV.A1). The sump in both Cells 2 and 3 will be at least 3 feet deep with minimum dimensions shown on Drawing IV-9 (see Detail E). The sump in Cell 3 has been designed to provide storage of approximately 7,911 gallons of leachate (Note, this capacity excludes approximately 6 inches of lost storage required for the pump head volume). The Cell 3 sump will provide in excess of one-day of leachate storage for the maximum calculated leachate generation rate, as provided in the sump design calculations provided in Attachment IV.A2. The sump in Cell 3 will be backfilled with drainage stone meeting the gradation requirements specified in Section 4.6 of this Plan.

Leachate will be removed from the sump using a submersible pump located in an 18-inch diameter sideslope sump riser pipe. Leachate will be transferred to the leachate evaporation pond as described in Section 5 of this Plan. As described in Section 5 of this Plan, the primary method of leachate management will be through evaporation in the leachate evaporation pond. Occasionally, leachate maybe used by the Landfill Owner/Operator for dust control within the Landfill or sent offsite by the Landfill Owner/Operator for disposal at a permitted wastewater treatment facility or other authorized disposal facility.

The sumps in Cells 2 and 3 will be equipped with a permanent submersible pump and controls. Each pump will be equipped with sensors (i.e., pressure transducers) to turn the pump on and off based on leachate levels within the respective sump. The pump-on liquid level will be set at a maximum elevation of 30 inches above the bottom of the sump. The pump-off liquid level will be set at a maximum elevation of 6 inches above the bottom of the sump or the manufacturer’s recommended minimum depth to protect the pump from damage during low-level pumping. Using the pump’s level controls, leachate levels will be maintained within the sumps at a depth ranging from 6 to 30 inches, thereby preventing the sumps from overtopping. Additionally, each sump pump will be equipped with a pressure transducer that will allow monitoring of leachate levels within the sump. Plant personnel or other qualified person will inspect the leachate levels in the sumps at the control panel on a weekly basis during the weekly inspections to verify that the pumps are operating correctly and leachate levels are being maintained within the sumps consistent with Section 3 of the Site Operating Plan (Part V). The pump control panel will also be equipped with a high-level indicator light, which will indicate when leachate levels within the sump reach a depth that may result in leachate levels above the bottom liner system greater than 30 centimeters.

In the unlikely event of a pump failure, the leachate storage capacity of the sump will provide adequate storage capacity to prevent accumulation of leachate on the liner outside the sump for a period of at least one-day. Sump design calculations for Cell 3 are presented in Attachment IV.A2. The LCRS sump configuration for Cells 2 and 3 are provided on Drawing IV-9 in Part IV.

4.6 DRAINAGE AGGREGATE

Granular drainage material around the leachate collection and removal pipes (i.e., chimney drains) and in the sumps will consist of durable particles of aggregate. Drainage aggregate requirements specified in the remainder of this section will be applicable to Cell 3 only. The aggregate will be tested (in accordance with JLT-S-105-89 or ASTM D3042 modified to use a solution of hydrochloric acid having a pH of 5) to demonstrate that the loss of mass will be less than 15 percent.

The drainage aggregate will meet the following gradation:

Sieve Size Square Opening	Percent Passing
2 inches	100
½ inch	0 – 5

Drainage aggregate of this gradation will have a permeability greater than or equal to 1×10^{-2} cm/sec, therefore no permeability testing is required.

The drainage aggregate will be covered by a 12 oz/sy or greater weight non-woven geotextile to maintain separation of drainage aggregate from the overlying operational layers and surrounding protective cover. The geotextile used to protect the drainage aggregate will be chemically resistant to waste managed at the Landfill.

5 LEACHATE AND CONTACT WATER STORAGE AND DISPOSAL

As discussed in Section 4.5, leachate storage will be provided in the LCRS sumps and leachate evaporation pond. Initial leachate storage will be provided in the sumps. Leachate that is generated during operations is collected at the bottom of the Landfill and conveyed to the leachate evaporation pond as follows:

- Leachate from Cell 1 is directed to the leachate evaporation pond via a leachate gravity drain pipe;
- Leachate from Cell 2 is pumped from a leachate sump, located at the low end of the cell (Subcell 2A), to the leachate gravity drain pipe and directed to the leachate evaporation pond; and
- Leachate from Cell 3 is pumped from the leachate sump, located at the low end of the cell (Subcell 3A), to a leachate forcemain and directed to the leachate evaporation pond.

Contact water will be contained at the working face using temporary diversion berms, as described in Section 3.3 of this Plan. Water that infiltrates into the underlying waste will be managed as leachate. Contact water at the working face will be kept to a minimum and directed to the LCRS, which discharges into the leachate evaporation pond.

Leachate and contact water will be stored in the leachate evaporation pond until it evaporates, may be used for dust control, or disposed of at a permitted wastewater treatment facility or other authorized disposal facility. Actual leachate generation and evaporation rate in the leachate evaporation pond will govern the need for expanding the evaporation pond, other leachate storage devices (e.g., storage tanks), or disposal disposed of at a permitted wastewater treatment facility or other authorized disposal facility.

Leachate and contact water will be stored in the leachate evaporation pond, which is designed with a 2 foot compacted clay liner (hydraulic conductivity (k) $\leq 1 \times 10^{-7}$ cm/sec), a 60-mil high density polyethylene (HDPE) geomembrane (textured both sides), and a maximum operating depth of 6 feet and maximum storage capacity of 6.2 million gallons. This evaporation pond is a no-discharge pond and has a freeboard of 2 feet which will be maintained at all times. The liquid level indicator in the evaporation pond is placed in the southeast corner of the pond. If there is no available storage in the leachate evaporation pond, leachate will be used by the Landfill Owner/Operator for dust control within the Landfill consistent with Section 2.5 of Part V – Site Operating Plan (SOP) and the Part III – Fugitive Dust Control Plan. Otherwise, the excess leachate will be sent offsite by the Landfill Owner/Operator for disposal at a permitted wastewater treatment facility or other authorized disposal facility.

Plant personnel and/or other qualified person will inspect the leachate evaporation pond for damage and document amount of freeboard on a weekly and annual basis consistent with Section 3 of the SOP. Records of these inspections and any maintenance as a result of the inspections will be maintained in the Site Operating Record in accordance with Section 3 of the SOP.

In the event of a leachate or contact water spill, these liquids will be treated as contact water and contained by either construction of earthen berms or placement of sorbent pads/socks, etc. surrounding the spill, and Landfill Owner/Operator will implement the following spill response procedures:

1. Immediately remove the leachate or contact water upon detection of the spill or leak by pumping the leachate or contact water to the leachate evaporation pond or working face.

2. The area subjected to the spill or leak will also be cleaned up by removing all soil or material showing any sign of contamination and disposed of at the working face of the Landfill.

3. The resulting clean-up procedures will be documented in the Site Operating Record.

6 RECORDKEEPING, NOTIFICATION, AND POSTING OF INFORMATION TO THE INTERNET (40 CFR §257.70(g))

The Landfill Owner/Operator will maintain a copy of this Plan in the Site Operating Record and on the Landfill's publicly accessible website consistent with §257.105(f), §257.106(f), §257.107(f), and Section 4 of the SOP (Part V).

In accordance with 257.70(e) and prior to construction of a lateral expansion associated with this Application (i.e., future Cell 3 subcells), the Landfill Owner/Operator will obtain a certification from a registered professional engineer in the State of Texas, stating that the design the composite liner and LCRS meets the requirements in §257.70(b) and (d). Consistent with 257.70(e), a Compliance Demonstration for Cell 3 (see Attachment II.A1) was developed prior to construction of Cell 3, Subcells 3A through 3D. This Compliance Demonstration contained a certification from a registered professional engineering in the State of Texas stating that the design of the Cell 3 composite liner and LCRS meets the requirements in §257.70(b) and (d).

All liner evaluation reports will be placed in the Site Operating Record, in accordance with §257.105(f)(1) and Section 4 of the SOP (Part V). In accordance with §352.851(1) and (2) and §257.70(f), a certification letter signed by the Responsible Official for the Plant and a registered professional engineer in the State of Texas, stating that the cell (including the composite liner and LCRS) has been constructed in compliance with conditions of this Registration Application and §257.70(b) and (d).

The Landfill Owner/Operator will place the above mentioned certifications in Site Operating Record and on the Landfill's publicly accessible website, and provide notification to the TCEQ consistent with Section 4 of the SOP.

ATTACHMENT IV.A1

LEACHATE GENERATION MODEL

(HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE (HELP) OUTPUT FILES)

- Leachate Generation Model Narrative
- Help Model Summary Sheets
- HELP Output Files

LEACHATE GENERATION MODEL NARRATIVE

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITYTCEQ
REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

ATTACHMENT IV.A1
LEACHATE GENERATION MODEL

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1 LEACHATE GENERATION

1.1 INTRODUCTION AND OBJECTIVE

This Leachate Generation Model has been prepared for the Sandy Creek Services, LLC (Owner and Operator of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill), located in McLennan County. This document has been prepared for Cell 3 at the Landfill as required by Title 40, Code of Federal Regulation (CFR) §257.70(d)(1); as well as the requirements of Title 30 Texas Administrative Code (TAC) §352.701, specifically related to maintaining less than 30 centimeters (approximately 12 inches) depth of leachate over the composite liner.

Cells 1 and 2 are existing active cells that were constructed in 2010 and 2014, respectively, with ongoing waste placement operations, and considered as existing Landfills as defined under §257.53. A portion of Cell 3 (inclusive of Subcells 3A through 3D encompassing approximately 10.3 acres) was constructed in 2021 prior to and during the time of preparing this Registration Application (Application). Cells 1 and 2 were constructed in accordance with rules and regulations for CCR Landfill construction at the time of construction (prior to propagation of 30 TAC 352 and 40 CFR Part 257); therefore, do not necessary need to comply §352.701 and §257.70(d)(1). All future subcells in Cell 3 and any future cells are considered lateral expansions and will be constructed and operated consistent with this Application.

This document addresses leachate generated from Cell 3.

1.2 LEACHATE COLLECTION SYSTEM

The barrier components of the bottom/sideslope liner system will be comprised of a 24-inch thick compacted clay liner overlain by a 60-mil high density polyethylene (HDPE) geomembrane liner. Above these barrier layers, the leachate collection and removal system (LCRS) will include a 270-mil lateral drainage layer (geocomposite, consisting of high density polyethylene (HDPE) geonet with a non-woven geotextile head bonded to both sides of the geonet) that will convey leachate to the leachate collection piping and sump, and overlain by a 24-inch-thick protective soil cover (onsite soils, which will have a hydraulic conductivity (k) less than 1.0 x 10^{-4} cm/sec). The leachate collection and removal piping will be covered by drainage stone encapsulated in non-woven filter fabric. The bottom liner system of Cell 3 will slope to drain at a minimum 2 percent toward a perforated leachate collection pipe located in the center of each cell. This leachate generation model is based on a maximum flow length to the LCRS pipe of 210 feet at a 2 percent slope within Cell 3.

Leachate generated at the Landfill will enter the LCRS piping by either: (1) infiltrating through the protective soil cover and into underlying geocomposite, which drains to the leachate collection piping; or (2) infiltrating through the gravel chimney drains installed over the LCRS piping. The LCRS piping will be sloped at a minimum 1 percent to drain leachate into a leachate collection sump located at the perimeter of Cell 3. Furthermore, the active interim, and final conditions were analyzed for Landfill operations during periods of no leachate recirculation.

The layout and design details of the LCRS are depicted on the Drawings IV-3 and IV-9 in Part IV – Landfill Criteria.

1.3 METHOD OF ANALYSIS

The HELP model Version 4.0 (Beta) is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of the disposal facility. The model accepts weather, soil, and design data. It uses solution techniques that account for key factors affecting water movement in a Landfill, including: surface storage; snowmelt; runoff; infiltration; evapotranspiration; vegetative growth; soil moisture storage; lateral subsurface drainage; leachate recirculation; unsaturated vertical drainage; and leakage through soil, geomembrane, and composite liners (EPA, 2020). Output includes peak daily, monthly and annual leachate generation and peak leachate depth over the liner for the respective periods.

1.4 MODEL SETUP

1.4.1 Phases

The Landfill was modeled as a one-acre unit area for the following conditions of Landfill development:

- Case 1 - Active condition with 10 feet of waste, daily cover, and 0% runoff potential;
- Case 2 - Interim condition with 110 feet of waste, intermediate cover, and 90% runoff potential;
- Case 3 – Final condition with 110 feet of waste, final cover, and 100% runoff potential.

In the HELP model, runoff is represented by two terms, “Runoff Potential” and “Curve Number (CN)”, each of which is used differently by the model. Runoff Potential (i.e., Runoff Area) represents the percentage of the area being modeled that is sloped such that it is possible for runoff to occur.

The Curve Number (CN) is similar to the Runoff Potential in that it is used by the HELP model to estimate the volume of runoff from the Landfill cover for a given storm event. The HELP model uses the CN value within a subroutine based on the Curve Number Method to calculate runoff. Unlike the Runoff Potential, the CN value incorporates the effects of soil characteristics (hydraulic conductivity), vegetative cover, and antecedent moisture content in the soil (i.e., initial soil moisture content).

The Runoff Potential was user-selected as zero percent for the active condition, since precipitation contacting these areas will be contained at the working face by containment berms. For the interim conditions, the runoff potential was user-selected as 90 percent as this represents areas of the Landfill that are well-graded and have temporary drainage features in place allowing most of the stormwater to runoff. The remaining 10 percent of the area is assumed to retain runoff through incidental surface storage, thus allowing some amount of infiltration into the underlying waste. For the final condition, the runoff potential was user-selected as 100 percent as this represents areas of the Landfill that are well-graded and have permanent drainage features in place allowing most of the stormwater to runoff.

The HELP model results for the above conditions were reviewed in terms of peak daily leachate depth to confirm compliance with the regulatory requirement of maintaining less than 30 centimeters of leachate over the bottom liner system.

1.4.2 Climatological Data

The climatological data required by the HELP model is dependent on the geographical location, leaf area index, evaporative zone depth, and the number of years to be modeled. From these user inputs, the HELP model generates synthetic precipitation, temperature, and solar radiation data.

For the HELP model presented in this demonstration, the leaf area index (LAI) was assumed zero for the active condition (representing bare soil cover) and 1.0 for the interim condition with 110 feet of waste (representing poor vegetative cover), and 3.5 for the closed condition (representing good vegetative cover). The LAI values correspond to the anticipated vegetative cover at each development condition. The evaporative zone depth was assumed to be 6 inches for the active condition,12 inches for the interim condition, and 18 inches for the final condition.

The precipitation data was modeled using the HELP program's synthetic weather daily generation option for Waco, Texas, for 30 year modeling periods. Monthly precipitation data (from 1941 to 2020) was obtained for Waco Regional Airport Station (USW00013959) from National Oceanic and Atmospheric Administration (NOAA), National Climatic Data Center's (NCDC) Climate Data Online (CDO) service. Mean monthly precipitation data used in the modeling is presented in this Attachment.

The temperature, relative humidity, and solar radiation data were modeled for Waco, Texas using the synthetic daily weather generation for the modeling periods.

Output from the HELP model includes the peak daily, monthly and annual precipitation, temperature, and solar radiation.

1.4.3 Landfill Profiles

The Landfill profile or layer characteristics for each condition of Landfill development are presented in the HELP Model Summary Sheets included in this Attachment. Information provided in the table includes the layer thickness, porosity, field capacity, wilting point, and hydraulic conductivity used by the model for each layer. Default soil and waste characteristics (i.e., hydraulic conductivity, porosity, field capacity, and wilting point) in the HELP model were used for the Landfill profiles for the active condition. However, as described below, the hydraulic conductivity was adjusted based on confining pressure for the interim and final conditions. These assumptions are considered representative of onsite soils or waste to be disposed at the site.

1.4.3.1 Compacted Clay Liner and Flexible Membrane Liner

The 24-inch-thick compacted clay liner was modeled as a barrier layer using default values from the HELP model table of soil characteristics (HELP default texture 16). The flexible geomembrane liner (60 mil HDPE), which is placed directly over the compacted clay liner, was also modeled using default values from the HELP model table of soil, waste, and geosynthetics characteristics (HELP default texture 35). The geomembrane liner was modeled for good installation quality which is represented by four defects per acre and a pinhole density of one hole/acre (Berger and Schroeder, 2013).

1.4.3.2 Leachate Drainage System Layer

The LCRS drainage layer is a geonet drainage layer with a geotextile adhered to both sides (referred to as a geocomposite). The manufactured thickness of the geocomposite is 270-mil (approximately 0.27 inches), which was reduced for compression depending on the amount of waste and soil cover for each condition modeled in HELP.

1.4.3.3 Protective Soil Cover

The protective soil cover was assumed to be a 24-inch-thick clayey soil with a hydraulic conductivity of 1.7 x 10^{-5} cm/sec. HELP default texture 15, high plasticity clay (CH) was selected to reflect soils available on site. Re-compacted soil samples of onsite soils may indicate permeability values less than the values assumed in the HELP model. Therefore, a more permeable clay was selected to simulate higher percolation through protective cover. Default soil characteristics were used for the protective soil cover (HELP default texture 15).

1.4.3.4 Waste

The waste layers described in Section 1.4.1 were utilized for the various Landfill conditions in the HELP model. The waste material was modeled using default HELP model properties for high-density electric plant fly ash (HELP default texture 30). For active condition and interim conditions with 110 ft., which correspond to recently placed waste in relatively loose state, the HELP default hydraulic conductivity (5.0 x 10^{-5} cm/s) was used.

1.4.3.5 Intermediate Cover

CCR Landfills are not required to have daily cover, therefore, the active condition was modeled with no daily cover, and interim conditions were modeled with a 12-inch layer of intermediate soil. The intermediate cover were assumed to be clayey soil, with a hydraulic conductivity of 1.7 x 10^{-5} cm/sec. Default soil characteristics were used for the intermediate cover soils (HELP default texture 15).

1.4.3.6 Final Cover

Final cover on the Landfill topslope and sideslopes from top to bottom will consist of an 18-inch thick erosion layer, a geocomposite drainage layer, a 40-mil geomembrane, and an 18-inch thick barrier layer (compacted clay infiltration layer). The geocomposite will be installed to drain infiltrating water from the final cover. The topslope cover system was evaluated in the HELP modeling. The minimum manufactured thickness of the geocomposite will be 200-mil (approximately 0.20 inches). To evaluate the hydraulic performance of the geocomposite layer, the hydraulic conductivity value used in the HELP model was adjusted until the maximum depth of stormwater percolating through the erosion layer to the geocomposite (for peak daily flow) was less than or approximately equal to the thickness of the geocomposite (i.e., less than 0.20 inches). In this manner water flow above the geomembrane was confined in the geocomposite layer only. Based on this evaluation the minimum allowable transmissivity was calculated based on the hydraulic conductivity to be 5.78x10^{-4} m2/sec (i.e., T_{min} = k x t x 2.54 cm/in x 0.0001 m^2/cm^2, where Tmin = Transmissivity [minimum, m^2/sec], k = hydraulic conductivity [cm/sec], and t = Geocomposite Thickness [inches]) at a gradient of 0.03 for topslope.

For the purposes of this model, it has been assumed that the erosion layer will consist of a clay soil with a hydraulic conductivity of 1.7 x 10^{-5} cm/s or less, consistent with the protective soil (compacted clay). The geomembrane was modeled for good installation quality, 4 defect per acre, and a pinhole density of 1 hole/acre (Tolaymat, and Krause, 2020). The barrier layer will consist of compacted clayey soil with a hydraulic conductivity of 1.0 x 10^{-5} cm/s or less. Default soil characteristics from the HELP model were selected to represent the layers within the final cover system.

1.5 HELP MODEL RESULTS

The HELP model results are presented in the attached HELP model summary sheets. Additionally, the HELP model output files are also provided in this Attachment. As presented in the HELP model output, the depth of leachate over the bottom liner is predicted to be confined to the geocomposite lateral drainage layer, which is below the 30 centimeter regulatory requirement.

1.6 REFERENCES

Tolaymat, T. and Kruase, M. “Hydrologic Evaluation of Landfill Performance 4.0, User Manual”, Version 4.0 (Beta), Environmental Protection Agency/Center for Environmental Solutions and Emergency Management, 2020.

HELP MODEL SUMMARY SHEETS

STATE OF TEXAS
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PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.A1-11
and 12

Prep'd By: SDS
Date: January 2022

SANDY CREEK ENERGY STATION
HELP MODEL SUMMARY SHEET

HELP MODEL INPUT PARAMETERS		ACTIVE (10' CCR)	INTERIM (110' CCR)	CLOSED (110' CCR)
		CASE 1	CASE 2	CASE 3
COMPACTED	Thickness (in)	24	24	24
CLAY LINER	Porosity (vol/vol)	0.4270	0.4270	0.4270
(Texture =16)	Field Capacity (vol/vol)	0.4180	0.4180	0.4180
	Wilting Point (vol/vol)	0.3670	0.3670	0.3670
	Hyd. Conductivity (cm/s)	1.0E-07	1.0E-07	1.0E-07
PRECIPITATION	Average Annual (in)	33.780	31.200	31.260
RUNOFF	Average Annual (in)	0.000	7.975	3.700
EVAPOTRANSPIRATION	Average Annual (in)	24.430	21.652	24.874
LATERAL DRAINAGE (LCS)	Average Annual (cf/year)	34,157	12,468	0.140
LATERAL DRAINAGE (LCS)	Average Annual (cf/day)	93.582	34.159	0.000
LATERAL DRAINAGE (LCS)	Peak daily (cf/day)	406	103	0.023
HEAD ON LINER	Average daily (in)	0.005	0.025	0.000
HEAD ON LINER	Peak daily (in)	0.021	0.008	0.000

SANDY CREEK ENERGY STATION
HELP MODEL SUMMARY SHEET

HELP MODEL INPUT PARAMETERS		ACTIVE (10' CCR)	INTERIM (110' CCR)	CLOSED (110' CCR)
		CASE 1	CASE 2	CASE 3
GENERAL INFORMATION	No. of Years	10	20	30
	Ground Cover	BARE	POOR	GOOD
	Model Area (acre)	1	1	1
	Runoff Area (%)	0	90	100
	Maximum Leaf Area Index	0.0	1.0	3.5
	Evaporative Zone Depth (inch)	6	12	18
PROTECTIVE COVER (Texture = 15)	Thickness (in)		12	18
	Porosity (vol/vol)		0.4750	0.4750
	Field Capacity (vol/vol)		0.378	0.378
	Wilting Point (vol/vol)		0.265	0.265
	Hyd. Conductivity (cm/s)		1.7E-05	1.7E-05
LATERAL DRAINAGE LAYER (Texture = 20)	Thickness (in)			0.2
	Porosity (vol/vol)			0.8500
	Field Capacity (vol/vol)			0.0100
	Wilting Point (vol/vol)			0.0050
	Hyd. Conductivity (cm/s)			1.0E+01
	Slope (%)			3.0
	Slope Length (ft)			130
FLEXIBLE MEMBRANE LINER (Texture = 36)	Thickness (in)			0.04
	Hyd. Conductivity (cm/s)			4.0E-13
	Pinhole Density (holes/acre)			1
	Install. Defects (holes/acre)			4
	Placement Quality			GOOD
BARRIER SOIL LINER (Texture = 15)	Thickness (in)			18.00
	Porosity (vol/vol)			0.4750
	Field Capacity (vol/vol)			0.3780
	Wilting Point (vol/vol)			0.2650
	Hyd. Conductivity (cm/s)			1.7E-05
High-Density Coal Fly Ash (Texture = 30)	Thickness (in)	120	1320	1320
	Porosity (vol/vol)	0.5410	0.5410	0.5410
	Field Capacity (vol/vol)	0.1870	0.1870	0.1870
	Wilting Point (vol/vol)	0.0470	0.0470	0.0470
	Hyd. Conductivity (cm/s)	5.0E-05	5.0E-05	5.0E-05
VERTICAL PERCOLATION LAYER (Texture = 15)	Thickness (in)	24	24	24
	Porosity (vol/vol)	0.4750	0.4750	0.4750
	Field Capacity (vol/vol)	0.3780	0.3780	0.3780
	Wilting Point (vol/vol)	0.2650	0.2650	0.2650
	Hyd. Conductivity (cm/s)	1.7E-05	1.7E-05	1.7E-05
LATERAL DRAINAGE LAYER (Texture = 20)	Thickness (in)	0.25		
	Porosity (vol/vol)	0.8500		
	Field Capacity (vol/vol)	0.0100		
	Wilting Point (vol/vol)	0.0050		
	Hyd. Conductivity (cm/s)	1.0E+01		
	Slope (%)	2.0		
	Slope Length (ft)	210		
LEACHATE COLLECTION (Texture = 123)	Thickness (in)		0.23	0.23
	Porosity (vol/vol)		0.8500	0.8500
	Field Capacity (vol/vol)		0.0100	0.0100
	Wilting Point (vol/vol)		0.0050	0.0050
	Hyd. Conductivity (cm/s)		7.00	7.00
	Slope (%)		2.0	2.0
	Slope Length (ft)		210	210
FLEXIBLE MEMBRANE LINER (Texture = 35)	Thickness (in)	0.06	0.06	0.06
	Hyd. Conductivity (cm/s)	2.0E-13	2.0E-13	2.0E-13
	Pinhole Density (holes/acre)	1	1	1
	Install. Defects (holes/acre)	4	4	4
	Placement Quality	GOOD	GOOD	GOOD

HELP OUTPUT FILES

STATE OF TEXAS
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PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.A1-13
through IV.A1-30

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**                       HELP Version 4.0 Beta (2019)                       **
**                               developed by                               **
**        Environmental Protection Agency (EPA)/Center for Environmental    **
**                    Solutions and Emergency Management                    **
**                                                                          **
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******************************************************************************
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TIME:  13.25     DATE:  11.6.2021

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                 TITLE:  Sandy Creek - Active Case – 10’ waste

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

                           WEATHER DATA SOURCES   1

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        NOTE:  PRECIPITATION DATA WAS SIMULATED USING NOAA

                  DATA FILES FOR    RIESEL    TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.05        2.40        2.73        3.42        4.55        3.11
       1.85        1.86        3.07        3.57        2.44        2.32

         NOTE:  TEMPERATURE DATA WAS SIMULATED USING NOAA

                  DATA FILES FOR    RIESEL    TEXAS


              NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      46.8        50.9        58.1        66.6        74.2        81.6
      85.5        85.4        78.9        68.9        57.4        49.2

        NOTE:  SOLAR RADIATION DATA WAS SIMULATED USING HELP V3.07
                  DATA FILES FOR    RIESEL    TEXAS
                     AND STATION LATITUDE  =  31.54 DEGREES
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                              LAYER DATA   2
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                           VALID FOR 10 YEARS


    NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                 LAYER 1
                                 --------

               TYPE 1 - VERTICAL PERCOLATION LAYER (COVER SOIL)
                          MATERIAL TEXTURE NUMBER 30
          THICKNESS                   =    120.00   INCHES
          POROSITY                    =      0.5410 VOL/VOL
          FIELD CAPACITY              =      0.1870 VOL/VOL
          WILTING POINT               =      0.0470 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.2675 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      5.0000E-05 CM/SEC


                                 LAYER  2
                                 --------

                  TYPE 1 - VERTICAL PERCOLATION LAYER (WASTE)
                          MATERIAL TEXTURE NUMBER 15
          THICKNESS                   =     24.00   INCHES
          POROSITY                    =      0.4750 VOL/VOL
          FIELD CAPACITY              =      0.3780 VOL/VOL
          WILTING POINT               =      0.2650 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.4009 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      1.7000E-05 CM/SEC


                                  LAYER 3
                                 --------

                       TYPE 2 - LATERAL DRAINAGE LAYER
                          MATERIAL TEXTURE NUMBER   20
          THICKNESS                   =      0.25   INCHES
          POROSITY                    =      0.8500 VOL/VOL
          FIELD CAPACITY              =      0.0100 VOL/VOL
          WILTING POINT               =      0.0050 VOL/VOL
          INITIAL SOIL WATER CONTENT  =      0.0341 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=     10.000      CM/SEC
          SLOPE                       =      2.00   PERCENT
          DRAINAGE LENGTH             =    210.0    FEET
```

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                          LAYER 4
                          --------

              TYPE 4 - FLEXIBLE MEMBRANE LINER
                MATERIAL TEXTURE NUMBER 35
      THICKNESS                   =       0.06    INCHES
      EFFECTIVE SAT. HYD. CONDUCT.=       2.0000E-13 CM/SEC
      FML PINHOLE DENSITY         =       1.00    HOLES/ACRE
      FML INSTALLATION DEFECTS    =       4.00    HOLES/ACRE
      FML PLACEMENT QUALITY       =    3 - GOOD

                          LAYER 5
                          --------

                TYPE 3 - BARRIER SOIL LINER
                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  =       0.4270 VOL/VOL
      EFFECTIVE SAT. HYD. CONDUCT.=       1.0000E-07 CM/SEC

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

            GENERAL DESIGN AND EVAPORATIVE ZONE DATA   3
------------------------------------------------------------------------------

                       VALID FOR 10 YEARS


         NOTE:  SCS RUNOFF CURVE NUMBER WAS CALCULATED BY HELP.

        SCS RUNOFF CURVE NUMBER            =      97.1
        FRACTION OF AREA ALLOWING RUNOFF   =       0.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE =       1.000  ACRES
        EVAPORATIVE ZONE DEPTH             =       6.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE  =       1.605  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE =       3.246  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE =       0.282  INCHES
        INITIAL SNOW WATER                 =       0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS   =      51.98   INCHES
        TOTAL INITIAL WATER                =      51.98   INCHES
        TOTAL SUBSURFACE INFLOW            =       0.000   INCHES/YEAR




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                     EVAPOTRANSPIRATION DATA   4
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                          VALID FOR 10 YEARS


         NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                  RIESEL                         TEXAS

             STATION LATITUDE                      =  31.54 DEGREES
             MAXIMUM LEAF AREA INDEX               =   0.00
             START OF GROWING SEASON (JULIAN DATE) =     55 DAYS
             END OF GROWING SEASON (JULIAN DATE)   =    336 DAYS
             AVERAGE ANNUAL WIND SPEED             =  11.00 MPH
             AVERAGE 1ST QUARTER RELATIVE HUMIDITY =  74.0  %
             AVERAGE 2ND QUARTER RELATIVE HUMIDITY =  69.0  %
             AVERAGE 3RD QUARTER RELATIVE HUMIDITY =  65.0  %
             AVERAGE 4TH QUARTER RELATIVE HUMIDITY =  70.0  %

 ******************************************************************************
 ******************************************************************************
                  FINAL WATER STORAGE AT END OF YEAR   10
 ------------------------------------------------------------------------------

                   LAYER         (INCHES)        (VOL/VOL)
                   -----         --------        ---------
                     1           31.2564           0.2605

                     2            9.8248           0.4094

                     3            0.0050           0.0201

                     4            0.0000           0.0000

                     5           10.2480           0.4270


     TOTAL WATER IN LAYERS       51.3342

     SNOW WATER                   0.0000

     INTERCEPTION WATER           0.000

     TOTAL FINAL WATER           51.334

 ******************************************************************************
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                PEAK DAILY VALUES FOR YEARS     1 THROUGH   10
------------------------------------------------------------------------------
                                                   (INCHES)      (CU. FT.)
                                                  ----------    -------------
      PRECIPITATION                                 4.200         15246.00

      RUNOFF                                        0.000             0.00

      DRAINAGE COLLECTED FROM LAYER  3              0.1119          406.40

      PERCOLATION/LEAKAGE THROUGH LAYER  5          0.000000          0.0003

      AVERAGE HEAD ON TOP OF LAYER  4               0.0207

      MAXIMUM HEAD ON TOP OF LAYER 4                0.0413

      LOCATION OF MAXIMUM HEAD IN LAYER  3
            (DISTANCE FROM DRAIN)                   0.97 FEET

      SNOW WATER                                    0.6003          2179.1

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                     0.5264

      MINIMUM VEG. SOIL WATER (VOL/VOL)                     0.0470

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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   10
-------------------------------------------------------------------------------

                                 INCHES              CU. FEET        PERCENT
                             -------------------   -------------    ---------
 PRECIPITATION                33.78     (  6.730)     122603.3      100.00

 RUNOFF                        0.000    (  0.000)          0.0        0.00

 EVAPOTRANSPIRATION           24.430    (  3.521)      88679.5       72.33

 LATERAL DRAINAGE COLLECTED    9.4098   (  2.7177)     34157.4       27.86
   FROM LAYER  3

 PERCOLATION/LEAKAGE THROUGH   0.00001 (  0.00000)         0.0366     0.00
   LAYER  5

 AVERAGE HEAD ON TOP           0.0048   (  0.0014)
   OF LAYER  4

 CHANGE IN WATER STORAGE      -0.0644   (  2.3425)       -233.7       -0.19

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**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**                       HELP Version 4.0 Beta (2019)                       **
**                               developed by                               **
**        Environmental Protection Agency (EPA)/Center for Environmental    **
**                    Solutions and Emergency Management                    **
**                                                                          **
**                                                                          **
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TIME:  11.35     DATE:  11.6.2021

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

              TITLE:  Sandy Creek - Intermediate Case – 110’ CCR

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                            WEATHER DATA SOURCES   1

------------------------------------------------------------------------------


       NOTE:  PRECIPITATION DATA WAS OBTAINED FROM NOAA FOR RIESEL TEXAS


                  DATA FILES FOR    RIESEL    TEXAS

                  NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
       2.05        2.40        2.73        3.42        4.55        3.11
       1.85        1.86        3.07        3.57        2.44        2.32

         NOTE:  TEMPERATURE DATA WAS OBTAINED FROM NOAA FOR RIESEL TEXAS

                  DATA FILES FOR    RIESEL    TEXAS


             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      46.8        50.9        58.1        66.6        74.2        81.6
      85.5        85.4        78.9        68.9        57.4        49.2

         NOTE:  SOLAR RADIATION DATA WAS OBTAINED FROM NOAA FOR RIESEL TEXAS
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                              LAYER DATA   2
------------------------------------------------------------------------------

                           VALID FOR 20 YEARS


     NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
              COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                LAYER 1
                                --------

              TYPE 1 - VERTICAL PERCOLATION LAYER (COVER SOIL)
                        MATERIAL TEXTURE NUMBER 15
           THICKNESS                    =     18.00   INCHES
           POROSITY                     =      0.4750 VOL/VOL
           FIELD CAPACITY               =      0.3780 VOL/VOL
           WILTING POINT                =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.3493 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      1.7000E-05 CM/SEC


                                LAYER 2
                                --------

              TYPE 1 - VERTICAL PERCOLATION LAYER (WASTE)
                        MATERIAL TEXTURE NUMBER 30
           THICKNESS                    =   1320.00   INCHES
           POROSITY                     =      0.5410 VOL/VOL
           FIELD CAPACITY               =      0.1870 VOL/VOL
           WILTING POINT                =      0.0470 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.2675 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      5.0000E-05 CM/SEC


                                LAYER 3
                                --------

                TYPE 1 - VERTICAL PERCOLATION LAYER (WASTE)
                        MATERIAL TEXTURE NUMBER 15
           THICKNESS                    =     24.00   INCHES
           POROSITY                     =      0.4750 VOL/VOL
           FIELD CAPACITY               =      0.3780 VOL/VOL
           WILTING POINT                =      0.2650 VOL/VOL
           INITIAL SOIL WATER CONTENT   =      0.4009 VOL/VOL
           EFFECTIVE SAT. HYD. CONDUCT.=      1.7000E-05 CM/SEC
```

```
                              LAYER 4
                              --------

                  TYPE 3 - LATERAL DRAINAGE LAYER
                    MATERIAL TEXTURE NUMBER 123
         THICKNESS                    =     0.23    INCHES
         POROSITY                     =     0.8500 VOL/VOL
         FIELD CAPACITY               =     0.0100 VOL/VOL
         WILTING POINT                =     0.0050 VOL/VOL
         INITIAL SOIL WATER CONTENT   =     0.0341 VOL/VOL
         EFFECTIVE SAT. HYD. CONDUCT.=      7.000      CM/SEC
         SLOPE                        =     2.00    PERCENT
         DRAINAGE LENGTH              =   210.0     FEET

                             LAYER  5
                             --------

                  TYPE 4 - FLEXIBLE MEMBRANE LINER
                    MATERIAL TEXTURE NUMBER 35
         THICKNESS                    =     0.06    INCHES
         EFFECTIVE SAT. HYD. CONDUCT.=      2.0000E-13 CM/SEC
         FML PINHOLE DENSITY          =     1.00    HOLES/ACRE
         FML INSTALLATION DEFECTS     =     4.00    HOLES/ACRE
         FML PLACEMENT QUALITY        =     3 - GOOD

                             LAYER 6
                             --------

                    TYPE 3 - BARRIER SOIL LINER
                    MATERIAL TEXTURE NUMBER 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   =     0.4270 VOL/VOL
         EFFECTIVE SAT. HYD. CONDUCT.=      1.0000E-07 CM/SEC

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

               GENERAL DESIGN AND EVAPORATIVE ZONE DATA    3
 ------------------------------------------------------------------------------

                          VALID FOR 20 YEARS


       NOTE:  SCS RUNOFF CURVE NUMBER WAS CALCULATED BY HELP.

       SCS RUNOFF CURVE NUMBER              =     93.6
       FRACTION OF AREA ALLOWING RUNOFF     =     90.0    PERCENT
       AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
       EVAPORATIVE ZONE DEPTH               =     12.0    INCHES
       INITIAL WATER IN EVAPORATIVE ZONE    =      4.192  INCHES
       UPPER LIMIT OF EVAPORATIVE STORAGE   =      5.700  INCHES
       LOWER LIMIT OF EVAPORATIVE STORAGE   =      3.180  INCHES
```

```
        INITIAL SNOW WATER                   =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS     =    377.169   INCHES
        TOTAL INITIAL WATER                  =    377.169   INCHES
        TOTAL SUBSURFACE INFLOW              =      0.000   INCHES/YEAR

 ******************************************************************************
                         EVAPOTRANSPIRATION DATA   4
 ------------------------------------------------------------------------------

                             VALID FOR 20 YEARS


          NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                   RIESEL                         TEXAS

              STATION LATITUDE                        =  31.54 DEGREES
              MAXIMUM LEAF AREA INDEX                 =   1.00
              START OF GROWING SEASON (JULIAN DATE)   =     55 DAYS
              END OF GROWING SEASON (JULIAN DATE)     =    336 DAYS
              AVERAGE ANNUAL WIND SPEED               =  11.00 MPH
              AVERAGE 1ST QUARTER RELATIVE HUMIDITY   =  74.0  %
              AVERAGE 2ND QUARTER RELATIVE HUMIDITY   =  69.0  %
              AVERAGE 3RD QUARTER RELATIVE HUMIDITY   =  65.0  %
              AVERAGE 4TH QUARTER RELATIVE HUMIDITY   =  70.0  %

 ******************************************************************************
 ******************************************************************************
                     FINAL WATER STORAGE AT END OF YEAR 20
 ------------------------------------------------------------------------------

                      LAYER        (INCHES)       (VOL/VOL)
                      -----        --------       ---------
                        1            3.1856         0.2655

                        2          328.1599         0.2486

                        3            9.5989         0.4000

                        4            0.0045         0.0196

                        5            0.0000         0.0000

                        6           10.2480         0.4270


    TOTAL WATER IN LAYERS          351.1969

    SNOW WATER                       0.0000

    INTERCEPTION WATER               0.000

    TOTAL FINAL WATER              351.197
```

```
******************************************************************************
******************************************************************************
                PEAK DAILY VALUES FOR YEARS     1 THROUGH 20
------------------------------------------------------------------------------
                                                    (INCHES)      (CU. FT.)
                                                   ----------    -------------
      PRECIPITATION                                   4.200        15246.00

      RUNOFF                                          2.998        10881.20

      DRAINAGE COLLECTED FROM LAYER 4               0.0283          102.80

      PERCOLATION/LEAKAGE THROUGH LAYER 6           0.000000        0.0001

      AVERAGE HEAD ON TOP OF LAYER 5                0.0075

      MAXIMUM HEAD ON TOP OF LAYER 5                 0.0150

      LOCATION OF MAXIMUM HEAD IN LAYER 4
            (DISTANCE FROM DRAIN)                    0.36 FEET

      SNOW WATER                                     0.6003          2179.1

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                      0.4484

      MINIMUM VEG. SOIL WATER (VOL/VOL)                      0.2650

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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   10
-------------------------------------------------------------------------------

                                  INCHES              CU. FEET        PERCENT
                            -------------------    -------------     ---------
 PRECIPITATION               33.78     (  6.730)      122603.3       100.00

 RUNOFF                       8.359    (  2.989)       30342.2        24.75

 EVAPOTRANSPIRATION          23.862    (  3.614)       86619.8        70.65

 LATERAL DRAINAGE COLLECTED   4.1513   (  0.7556)      15069.1        12.29
   FROM LAYER   4

 PERCOLATION/LEAKAGE THROUGH  0.00001 (  0.00000)         0.0276     0.00
   LAYER   6

 AVERAGE HEAD ON TOP          0.0030   (  0.0005)
   OF LAYER   5

 CHANGE IN WATER STORAGE     -2.5972   (  1.5588)      -9427.9       -7.69

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******************************************************************************
**                                                                          **
**                                                                          **
**              HYDROLOGIC EVALUATION OF LANDFILL PERFORMANCE               **
**                                                                          **
**                        HELP Version 4.0 Beta (2019)                      **
**                               developed by                               **
**         Environmental Protection Agency (EPA)/Center for Environmental   **
**                    Solutions and Emergency Management                    **
**                                                                          **
**                                                                          **
******************************************************************************
******************************************************************************

TIME:  11.39     DATE:  11.9.2021

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

                    TITLE:  Sandy Creek - Final Case – 110’ CCR

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

                            WEATHER DATA SOURCES   1

 ------------------------------------------------------------------------------


        NOTE:  PRECIPITATION DATA WAS OBTAINED FROM NOAA FOR RIESEL TEXAS

                   DATA FILES FOR    RIESEL    TEXAS

                 NORMAL MEAN MONTHLY PRECIPITATION (INCHES)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      2.05        2.40        2.73        3.42        4.55        3.11
      1.85        1.86        3.07        3.57        2.44        2.32

     NOTE:  TEMPERATURE DATA WAS OBTAINED FROM NOAA FOR RIESEL TEXAS

                   DATA FILES FOR    RIESEL    TEXAS


             NORMAL MEAN MONTHLY TEMPERATURE (DEGREES FAHRENHEIT)

     JAN/JUL     FEB/AUG     MAR/SEP     APR/OCT     MAY/NOV     JUN/DEC
     -------     -------     -------     -------     -------     -------
      46.8        50.9        58.1        66.6        74.2        81.6
      85.5        85.4        78.9        68.9        57.4        49.2

          NOTE:  SOLAR RADIATION DATA WAS SIMULATED USING HELP V4.0
        FOR STATION LATITUDE  =  31.54 DEGREES LONGITUDE = -97.2 DEGREES
```

```
******************************************************************************

                                LAYER DATA   2
------------------------------------------------------------------------------

                              VALID FOR 30 YEARS


      NOTE:  INITIAL MOISTURE CONTENT OF THE LAYERS AND SNOW WATER WERE
           COMPUTED AS NEARLY STEADY-STATE VALUES BY THE PROGRAM.


                                   LAYER  1
                                   --------

               TYPE 1 - VERTICAL PERCOLATION LAYER (COVER SOIL)
                          MATERIAL TEXTURE NUMBER 15
              THICKNESS                   =     18.00    INCHES
              POROSITY                    =      0.4750 VOL/VOL
              FIELD CAPACITY              =      0.3780 VOL/VOL
              WILTING POINT               =      0.2650 VOL/VOL
              INITIAL SOIL WATER CONTENT  =      0.3536 VOL/VOL
              EFFECTIVE SAT. HYD. CONDUCT.=      1.7000E-05 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  =      0.0100 VOL/VOL
              EFFECTIVE SAT. HYD. CONDUCT.=     10.000   CM/SEC
              SLOPE                       =      3.00    PERCENT
              DRAINAGE LENGTH             =    130.0     FEET


                                   LAYER  3
                                   --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                          MATERIAL TEXTURE NUMBER 36
              THICKNESS                   =      0.04    INCHES
              EFFECTIVE SAT. HYD. CONDUCT.=      4.0000E-13 CM/SEC
              FML PINHOLE DENSITY         =      1.00    HOLES/ACRE
              FML INSTALLATION DEFECTS    =      4.00    HOLES/ACRE
              FML PLACEMENT QUALITY       =      3 - GOOD
```

```
                     LAYER 4
                     --------

           TYPE 3 - BARRIER SOIL LINER
            MATERIAL TEXTURE NUMBER 15
THICKNESS                   =     18.00   INCHES
POROSITY                    =      0.4750 VOL/VOL
FIELD CAPACITY              =      0.3780 VOL/VOL
WILTING POINT               =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.4750 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      1.7000E-05 CM/SEC


                     LAYER 5
                     --------

   TYPE 1 - VERTICAL PERCOLATION LAYER (WASTE)
     HIGH-DENSITY ELECTRIC PLANT COAL FLY ASH
            MATERIAL TEXTURE NUMBER 0
THICKNESS                   =   1320.00   INCHES
POROSITY                    =      0.5410 VOL/VOL
FIELD CAPACITY              =      0.1870 VOL/VOL
WILTING POINT               =      0.0470 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.1870 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      5.0000E-05 CM/SEC


                     LAYER 6
                     --------

   TYPE 1 - VERTICAL PERCOLATION LAYER (WASTE)
            MATERIAL TEXTURE NUMBER 15
THICKNESS                   =     24.00   INCHES
POROSITY                    =      0.4750 VOL/VOL
FIELD CAPACITY              =      0.3780 VOL/VOL
WILTING POINT               =      0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.3780 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      1.7000E-05 CM/SEC


                     LAYER 7
                     --------

         TYPE 2 - LATERAL DRAINAGE LAYER
           MATERIAL TEXTURE NUMBER 123
THICKNESS                   =      0.23    INCHES
POROSITY                    =      0.8500 VOL/VOL
FIELD CAPACITY              =      0.0100 VOL/VOL
WILTING POINT               =      0.0050 VOL/VOL
INITIAL SOIL WATER CONTENT  =      0.0100 VOL/VOL
EFFECTIVE SAT. HYD. CONDUCT.=      7.000  CM/SEC
SLOPE                       =      2.00   PERCENT
DRAINAGE LENGTH             =    210.0    FEET
```

```
                                LAYER 8
                                --------

                       TYPE 4 - FLEXIBLE MEMBRANE LINER
                         MATERIAL TEXTURE NUMBER 35
          THICKNESS                        =      0.06   INCHES
          EFFECTIVE SAT. HYD. CONDUCT.=      2.0000E-13 CM/SEC
          FML PINHOLE DENSITY              =      1.00   HOLES/ACRE
          FML INSTALLATION DEFECTS         =      4.00   HOLES/ACRE
          FML PLACEMENT QUALITY            =      3 - GOOD

                                LAYER 9
                                --------

                         TYPE 3 - BARRIER SOIL LINER
                         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       =      0.4270 VOL/VOL
          EFFECTIVE SAT. HYD. CONDUCT.=      1.0000E-07 CM/SEC

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

                GENERAL DESIGN AND EVAPORATIVE ZONE DATA   3
------------------------------------------------------------------------------

                            VALID FOR 30 YEARS


        NOTE:  SCS RUNOFF CURVE NUMBER WAS CALCULATED BY HELP.

        SCS RUNOFF CURVE NUMBER              =     87.1
        FRACTION OF AREA ALLOWING RUNOFF     =    100.0    PERCENT
        AREA PROJECTED ON HORIZONTAL PLANE   =      1.000  ACRES
        EVAPORATIVE ZONE DEPTH               =     18.0    INCHES
        INITIAL WATER IN EVAPORATIVE ZONE    =      6.364  INCHES
        UPPER LIMIT OF EVAPORATIVE STORAGE   =      8.550  INCHES
        LOWER LIMIT OF EVAPORATIVE STORAGE   =      4.770  INCHES
        INITIAL SNOW WATER                   =      0.000  INCHES
        INITIAL WATER IN LAYER MATERIALS     =    280.769   INCHES
        TOTAL INITIAL WATER                  =    280.769   INCHES
        TOTAL SUBSURFACE INFLOW              =      0.000   INCHES/YEAR

******************************************************************************
                      EVAPOTRANSPIRATION DATA   4
------------------------------------------------------------------------------

                           VALID FOR 30 YEARS


        NOTE:  EVAPOTRANSPIRATION DATA WAS OBTAINED FROM
                 RIESEL                        TEXAS
```

```
           STATION LATITUDE                          =  31.54 DEGREES
           MAXIMUM LEAF AREA INDEX                   =   3.50
           START OF GROWING SEASON (JULIAN DATE)     =     55 DAYS
           END OF GROWING SEASON (JULIAN DATE)       =    336 DAYS
           AVERAGE ANNUAL WIND SPEED                 =  11.00 MPH
           AVERAGE 1ST QUARTER RELATIVE HUMIDITY     =  74.0  %
           AVERAGE 2ND QUARTER RELATIVE HUMIDITY     =  69.0  %
           AVERAGE 3RD QUARTER RELATIVE HUMIDITY     =  65.0  %
           AVERAGE 4TH QUARTER RELATIVE HUMIDITY     =  70.0  %

******************************************************************************
******************************************************************************
                   FINAL WATER STORAGE AT END OF YEAR   30
------------------------------------------------------------------------------

                    LAYER         (INCHES)        (VOL/VOL)
                    -----         --------        ---------
                      1            5.3848           0.2992

                      2            0.0020           0.0100

                      3            0.0000           0.0000

                      4            8.5500           0.4750

                      5          246.8400           0.1870

                      6            9.0720           0.3780

                      7            0.0023           0.0100

                      8            0.0000           0.0000

                      9           10.2480           0.4270


    TOTAL WATER IN LAYERS        280.769

    SNOW WATER                     0.0000

    INTERCEPTION WATER             0.000

    TOTAL FINAL WATER            280.769

******************************************************************************
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******************************************************************************
                  PEAK DAILY VALUES FOR YEARS     1 THROUGH   30
------------------------------------------------------------------------------
                                                  (INCHES)      (CU. FT.)
                                                 ----------   -------------
      PRECIPITATION                                4.640         16843.20

      RUNOFF                                       3.404         12356.80

      DRAINAGE COLLECTED FROM LAYER  2             0.5725         2078.30

      PERCOLATION/LEAKAGE THROUGH LAYER  4         0.000007          0.0257

      AVERAGE HEAD ON TOP OF LAYER  3              0.0438

      MAXIMUM HEAD ON TOP OF LAYER 3               0.0867

      LOCATION OF MAXIMUM HEAD IN LAYER  2
            (DISTANCE FROM DRAIN)                  1.17 FEET

      DRAINAGE COLLECTED FROM LAYER  7             0.0000            0.0232

      PERCOLATION/LEAKAGE THROUGH LAYER  9         0.000000          0.0000

      AVERAGE HEAD ON TOP OF LAYER  8              0.0000

      MAXIMUM HEAD ON TOP OF LAYER 8               0.0000

      LOCATION OF MAXIMUM HEAD IN LAYER  7
            (DISTANCE FROM DRAIN)                  0.00 FEET

      SNOW WATER                                   1.2103            4393.4

      MAXIMUM VEG. SOIL WATER (VOL/VOL)                    0.4725

      MINIMUM VEG. SOIL WATER (VOL/VOL)                    0.2650

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

     AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS    1 THROUGH   30
-------------------------------------------------------------------------------

                                     INCHES             CU. FEET       PERCENT
                               ------------------     ------------   ---------
 PRECIPITATION                  31.26     (  8.300)     113455.7     100.00

 RUNOFF                          3.699    (  2.593)      13426.1      11.83

 EVAPOTRANSPIRATION             24.879    (  4.769)      90311.9      79.60

 LATERAL DRAINAGE COLLECTED      2.6993   (  2.1562)      9798.5       8.64
   FROM LAYER  2
```

```
 PERCOLATION/LEAKAGE THROUGH      0.00004 (   0.00003)          0.1445    0.00
   LAYER  4

 AVERAGE HEAD ON TOP              0.0006  (   0.0005)
   OF LAYER  3

 LATERAL DRAINAGE COLLECTED       0.0000  (   0.0000)           0.1430    0.00
   FROM LAYER  7

 PERCOLATION/LEAKAGE THROUGH      0.00000 (   0.00000)          0.0015    0.00
   LAYER  9

 AVERAGE HEAD ON TOP              0.0000  (   0.0000)
   OF LAYER  8

 CHANGE IN WATER STORAGE         -0.0223  (   1.0018)           -81.1   -0.07

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ATTACHMENT IV.A2

LEACHATE COLLECTION SYSTEM DESIGN CALCULATIONS

- **Pipe Strength Calculations**
- **Geotextile Filter Calculations**
- **Geocomposite Calculations**
- **Pipe Capacity Calculations**
- **Leachate Sump Design Calculations**

STATE OF TEXAS
BRETT J. DeVRIES
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LICENSED
PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.A2-2
through IV.A2-34

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
6-INCH DIAMETER HDPE PIPE
CELL 3

Required:

Analyze the structural stability of the Cell 3 6-inch diameter high density polyethylene leachate collection pipes related to wall crushing, deflection, and wall buckling failures associated with the worst case loading conditions.

Method:

A. Determine the critical load under the following two conditions:

1. Construction loading
2. Overburden loading

B. Use the critical loading pressure to analyze pipe stability under the following three possible

1. Wall crushing
2. Deflection
3. Wall buckling

References:

1. Bass, J., *Avoiding Failure of Leachate Collection and Cap Drainage Systems* , Pollution Technology Review No. 138, Noyes Data Corporation, 1986.
2. Texas Natural Resource Conservation Commission, *Leachate Collection System Handbook* , 30 TAC 330.201, 1993.
3. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, Draft Design Document titled *Technical Note XXX - Considerations for HDPE Pipe Section for Deep Fill Applications, 2002.*
4. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, *The Performance Pipe Engineering Manual* , Vol. 2, 2002.
5. Caterpillar Tractor Company, C*aterpillar Product Brochure: 836H Landfill Compactor (www.cat.com),* 2007.

Solution:

A. Determine critical loading for construction versus overburden conditions.

1. Construction Loading:

Assume: CAT 836H Landfill Compactor with an even load distribution (Ref. 5)

Loaded weight =	130,000	lb
Tire pressure =	40	psi
Number of tires =	4	

For a circular tire imprint:

$$F = \frac{\text{Loaded Weight}}{\text{Number of Tires}}$$

Where: F= Force exerted by one tire (lb)

F =	32,500	lb

Determine radius of contact for circular tire imprint:

$$r = \left(F / \pi p\right)^{1/2}$$

Where:
r = Radius of contact (in)
F = Force exerted by one tire (lb)
p = Tire pressure (psi)

r =	16.1	in

Use Boussinesq's solution to find the stress at a point below a uniformly loaded circular area:

$$y = p(1-((r/z)^2+1)^{-3/2})$$

Where:
y = Change in vertical stress (psi)
p = Tire pressure (psi)
r = Radius of contact (in)
z = Protective cover thickness (in)

z = 24 in

y =	17.1	psi

Assume only one wheel load on pipe and add 50% for impact loading:

$P_L = 1.5y$

Where: $P_L =$ Maximum live load (psi)

$P_L =$ 25.6 psi

$P_D = zw$

Where: $P_D =$ Maximum dead load (psi)
$z =$ Protective cover thickness
$w =$ Unit weight of protective cover

$z =$ 24 in
$w =$ 120 pcf

$P_D =$ 1.7 psi

$P_{Tconst} = P_L + P_D$

Where: $P_{T,\,const} =$ Maximum construction load (psi)

$P_{T,\,const} =$ 27.3 psi

2. Overburden loading (postclosure load):

For maximum overburden load on pipe:

2.0	ft gravel & cover @	120	pcf =	240	psf
3.5	ft final & interim cover @	120	pcf =	420	psf
110.0	ft CCR @	103	pcf =	11,330	psf
			Σ =	11,990	psf

Daily cover is not placed on exposed ash. Interim cover is placed in areas not receiving ash. Operator will scrape off interim cover in those areas prior to placing additional ash.

$P_{Toverburd} =$ 11,990 psf

$P_{Toverburd} =$ 83 psi

Determine critical loading condition:

Construction loading: $P_{Tconst} =$ 27.3 psi
Overburden loading: $P_{Toverburd} =$ 83 psi

Conclusion: Overburden loading is most critical to the structural stability of the pipe and will be used to determine the design overburden pipe stress.

3. Determine design overburden stress:

Adjust critical stress to account for loss of strength in the pipe due to perforations:

$P_{DES} = 12P_T / (12\text{-}1_p)$ (Ref. 1)

Where:

1_p = Cumulative length of perforations per foot of pipe
P_T = Critical pipe stress (psi)
P_{DES} = Pipe stress adjusted for loss of strength (psi), used as design pressure

6 holes/foot
0.5 in/hole

1_p =	3.0	in/ft

From determination of critical loading:

P_T = 83.0 psi

P_{DES} =	111	psi

Note: Soil arching is incorporated into the following calculations, using methods proposed by CPChem for HDPE solid wall pipe. The calculations are applicable to any solid wall HDPE pipe meeting industry standards for composition and manufacture.

B. Pipe Stability Analyses

1. Wall crushing (ring compressive stress) (Ref. 3)

Vertical Arching Factor (VAF) $= 0.88 - 0.71 (S_A-1) / (S_A+2.5)$
Hoop thrust stiffness ratio (S_A) $= 1.43 (M_s r_m/Et)$

Where:

M_s = One dimensional modulus of soil (psi) (Ref. 3)
r_m = Mean pipe radius, = $(D_o+D_i)/4$
D_o = Pipe outside diameter (in)
D_i = Pipe inside diameter (in)
E = Pipe modulus of elasticity (psi)
t = Pipe wall thickness (in)
DR = Dimension Ratio, D_o/t
σ_{yield}= HDPE compressive strength at yield (psi) = 1,600 psi (Ref. 4)

Assumed overburden stress (psi) : 111
Backfill type : Gravel, 95% Std. Proctor
Ms (from Table 1, below) (psi) : 6,775

Table 1. Typical Design Values for Constrained Modulus, M_s (Ref. 3)

Vertical Soil Stress (psi)	Gravelly Sand/Gravels at 95% SPD (psi)	Gravelly Sand/Gravels @ 90% SPD (psi)	Gravelly Sand/Gravels @ 85% SPD (psi)
10	3000	1500	500
20	3500	1700	650
40	4500	2100	900
60	5500	2500	1150
80	6000	2900	1300
100	6500	3200	1450
150	7750	-	-
200	9000	-	-

SPD = Standard Proctor Density

* Based on the linear relationship generated between Vertical Soil Stress (150 and 200 psi) and respective M_s (psi), linear interpolation was used to calculate a MS value of 8,400 psi at a Vertical Soil Stress of 176 psi.

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
6-INCH DIAMETER HDPE PIPE
CELL 3

$P_{RD} = (VAF)\ P_{DES}$ (Ref. 3)

$\sigma_{actual} = P_{RD}(DR) / 2$ (Ref. 3)

Where:

P_{RD} = Radial-directed earth pressure

σ_{actual} = Actual sidewall crushing (compressive) stress

D_o (in) = 6

E (psi) = 28,200 (Ref. 4)

M_s (psi) = 6,775 (Ref. 3, Table 1 above)

σ_{yield}= 1,600 (Ref. 4)

Factor of Safety (FS) = $\sigma_{yield}/\sigma_{actual}$

DR	**P_{DES}**	**t**	**r_m**	**S_A**	**VAF**	**P_{RD} (psf)**	**σ_{actual} (psi)**	**FS**
9	111	0.67	2.67	1.37	0.81	12,931	404	4.0
11	111	0.55	2.73	1.72	0.76	12,098	462	3.5
13.5	111	0.44	2.78	2.15	0.70	11,231	526	3.0
15.5	111	0.39	2.81	2.49	0.67	10,644	573	2.8
17	111	0.35	2.82	2.75	0.64	10,254	605	2.6
19	111	0.32	2.84	3.09	0.61	9,791	646	2.5
21	**111**	**0.29**	**2.86**	**3.44**	**0.59**	**9,381**	**684**	**2.3**
26	111	0.23	2.88	4.29	0.54	9,381	847	1.9

For pipe wall crushing, a minimum FS of 2.0 is desired. From above, a DR of 21 is required for the deepest portions of the landfill. However, higher DR pipe may be used for shallower portions of landfill provided calculations are performed during final design to confirm pipe crushing resistance for selected pipe.

2. Pipe Deflection

Rigidity Factor (R_F) = $12E_s(DR-1)^3 / E$
Secant Modulus of Soil (E_S) = $M_s\ (1+\mu)(1-2\mu)/(1-\mu)$
Soil Strain (ε_s) = $wH_c(100) / (0.75E_s)$
Deflection (%) = $D_F\varepsilon_S$
Dimension Ratio (DR) = D_o/t
Where:

Hc = height of fill (ft) =	see below
w = average weight of fill (pcf) =	see below
μ = soil Poisson ratio =	0.4
P_{DES} substituted for HcW (psi) =	111
M_s (psi) =	6,775
E_s (psi) =	3,162

DR	**E_s**	**E**	**R_F**	**D_F**	**ε_S (%)**	**Deflection (%)**
9	3,162	28,200	689	1.15	4.67	5.37
11	3,162	28,200	1,345	1.32	4.67	6.16
13.5	**3,162**	**28,200**	**2,628**	**1.49**	**4.67**	**6.95**
15.5	3,162	28,200	4,102	1.64	4.67	7.65
17	3,162	28,200	5,511	1.72	4.67	8.03
19	3,162	28,200	7,846	1.81	4.67	8.45

D_F = Deformation Factor obtained from table, attached.

For pipe deflection under the design loading, a target maximum deflection of 7.5 percent is desired. A pipe with DR value of **13.5** exhibits calculated deflection of less than 7.5 percent.

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
6-INCH DIAMETER HDPE PIPE
CELL 3

3. Pipe wall buckling (Ref. 3)

$P_{cr} = 1.63\ ((RB'M_sE) / (DR-1)^3)^{0.5}$ (Ref. 3)

$H(ft) = P_{DES}/w$

$B' = 1 / (1+4e^{(-0.065H)})$ (Ref. 3)

$FS = P_{cr} / P_{DES}$

Where:

P_{cr} = Critical buckling pressure (psi)
B' = Elastic support coefficient
R = Groundwater buoyancy factor (=1)
H = Height of fill (ft)
E = Modulus of Elasticity of pipe (psi)
P_{DES} = Design pipe external loading (psi)
FS = Factor of safety against wall buckling

Assumptions:
H (ft) = 116
B' = 1.00 (calculated using above equation)
E (psi) = 28,200

DR	R	B'	M_s	P_{cr}	P_{DES}	FS
9	1	1.00	6,775	995	111	8.99
11	1	1.00	6,775	712	111	6.43
13.5	1	1.00	6,775	509	111	4.60
15.5	1	1.00	6,775	408	111	3.68
17	1	1.00	6,775	352	111	3.18
19	1	1.00	6,775	295	111	2.66
21	**1**	**1.00**	**6,775**	**252**	**111**	**2.27**
26	1	1.00	6,775	180	111	1.63

For pipe buckling, a minimum FS value of 2.0 is desired. Pipe with DR value of 15.5 or less is acceptable.

Conclusion:

Based on the analysis presented above, in consideration of wall crushing, buckling, and allowable pipe deflection, Cell 3 6-inch diameter HDPE pipe with a maximum DR value of **9** (wall thickness of 0.39 inches) is conservatively selected for deeper portions of landfill.

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE
CELL 3

Required:

Analyze the structural stability of the Cell 3 -18-inch diameter high density polyethylene sump riser pipes related to wall crushing, deflection, and wall buckling failures associated with the worst case loading conditions.

Method:

A. Determine the critical load under the following two conditions:

1. Construction loading
2. Overburden loading

B. Use the critical loading pressure to analyze pipe stability under the following three possible failure conditions:

1. Wall crushing
2. Wall buckling
3. Deflection

References:

1. Bass, J., *Avoiding Failure of Leachate Collection and Cap Drainage Systems* , Pollution Technology Review No. 138, Noyes Data Corporation, 1986.
2. Texas Natural Resource Conservation Commission, *Leachate Collection System Handbook* , 30 TAC 330.201, 1993.
3. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, Draft Design Document titled *Technical Note XXX - Considerations for HDPE Pipe Section for Deep Fill Applications, 2002.*
4. CPChem Performance Pipe, a Division of Chevron Phillips Chemical Company LP, *The Performance Pipe Engineering Manual* , Vol. 2, 2002.
5. Caterpillar Tractor Company, C*aterpillar Product Brochure: 836H Landfill Compactor (www.cat.com),* 2007.

Solution:

A. Determine critical loading for construction versus overburden conditions.

1. Construction Loading:

Assume: CAT 836H Landfill Compactor with an even load distribution (Ref. 5)

Loaded weight = 130,000 lb
Tire pressure = 40 psi
Number of tires = 4

For a circular tire imprint:

$$F = \frac{\text{Loaded Weight}}{\text{Number of Tires}}$$

Where: F= Force exerted by one tire (lb)

F =	32,500	lb

Determine radius of contact for circular tire imprint:

$$r = (F / \pi p)^{1/2}$$

Where:
r = Radius of contact (in)
F = Force exerted by one tire (lb)
p = Tire pressure (psi)

r =	16.1	in

Use Boussinesq's solution to find the stress at a point below a uniformly loaded circular area:

$$y = p(1-((r/z)^2+1)^{-3/2})$$

Where:
y = Change in vertical stress (psi)
p = Tire pressure (psi)
r = Radius of contact (in)
z = Protective cover thickness (in)

z = 24 in

y =	17.1	psi

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE
CELL 3

Assume only one wheel load on pipe and add 50% for impact loading:

$P_L = 1.5y$

Where: $P_L =$ Maximum live load (psi)

$P_L =$	25.6	psi

$P_D = zw$

Where:
$P_D =$ Maximum dead load (psi)
$z =$ Protective cover thickness
$w =$ Unit weight of protective cover

$z =$	24	in
$w =$	120	pcf

$P_D =$	1.7	psi

$P_{Tconst} = P_L + P_D$

Where: $P_{T,\ const} =$ Maximum construction load (psi)

$P_{T,\ const} =$	27.3	psi

2. Overburden loading (postclosure load):

For maximum overburden load on pipe:

2.0	ft gravel & cover @	120	pcf =	240	psf
3.5	ft final & interim cover @	120	pcf =	420	psf
110.0	ft CCR @	103	pcf =	11,330	psf
			Σ =	11,990	psf

Daily cover is not placed on exposed ash. Interim cover is placed in areas not receiving ash. Operator will scrape off interim cover in those areas prior to placing additional ash.

$P_{Toverburd} =$ 11,990 psf

$P_{Toverburd} =$	83	psi

Determine critical loading condition:

Construction loading:	$P_{Tconst} =$	27.3	psi
Overburden loading:	$P_{Toverburd} =$	83	psi
Design loading = Construction loading:	$P_{DES} =$	27.3	psi

Conclusion: Construction loading is most critical to the structural stability of the pipe and will be used to determine the design overburden pipe stress.

B. Pipe Stability Analyses

1. Wall crushing (ring compressive stress) (Ref. 3)

Vertical Arching Factor (VAF) $= 0.88 - 0.71 (S_A-1) / (S_A+2.5)$

Hoop Thrust Stiffness Ratio (S_A) $= 1.43 (M_s r_m/Et)$

Where:

M_s = One dimensional modulus of soil (psi) (Ref. 3)
r_m = Mean pipe radius, $= (D_o+D_i)/4$
D_o = Pipe outside diameter (in)
D_i = Pipe inside diameter (in)
E = Pipe modulus of elasticity (psi)
t = Pipe wall thickness (in)
DR = Dimension Ratio, D_o/t
σ_{yield}= HDPE compressive strength at yield (psi) = 1,600 psi (Ref. 4)

Assumed overburden stress (psi) : 27.3
Backfill type : Gravel, 95% Std. Proctor
Ms (from Table 1, below) (psi) : 3,646 (Ref. 3)

Table 1. Typical Design Values for Constrained Modulus, M_s (Ref. 3)

Vertical Soil Stress (psi)	Gravelly Sand/Gravels at 95% SPD (psi)	Gravelly Sand/Gravels @ 90% SPD (psi)	Gravelly Sand/Gravels @ 85% SPD (psi)
10	3000	1500	500
20	3500	1700	650
40	4500	2100	900
60	5500	2500	1150
80	6000	2900	1300
100	6500	3200	1450

SPD = Standard Proctor Density

* Based on the linear relationship generated between Vertical Soil Stress (20 and 40 psi) and respective Ms (psi), linear interpolation was used to calculate a MS value of 3,646 psi at a Vertical Soil Stress of 27.3 psi.

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE
CELL 3

$P_{RD} = (VAF)\ P_{DES}$ (Ref. 3)

$\sigma_{actual} = P_{RD}(DR) / 2$ (Ref. 3)

Where:

P_{RD} = Radial-directed earth pressure

σ_{actual} = Actual sidewall crushing (compressive) stress

D_o (in) = 18

E (psi) = 28,200 (Ref. 4)

M_s (psi) = 3,646 (Ref. 3)

σ_{yield}= 1,600 (Ref. 4)

Factor of Safety (FS) = $\sigma_{yield}/\sigma_{actual}$

DR	**P_{DES}**	**t**	**r_m**	**S_A**	**VAF**	**P_{RD} (psf)**	**σ_{actual} (psi)**	**FS**
15.5	27	1.16	8.42	1.34	0.82	3,212	173	9.3
17	27	1.06	8.47	1.48	0.79	3,123	184	8.7
19	27	0.95	8.53	1.66	0.77	3,014	199	8.0
21	27	0.86	8.57	1.85	0.74	2,915	213	7.5
26	27	0.69	8.65	2.31	0.69	2,699	244	6.6
32.5	**27**	**0.55**	**8.72**	**2.91**	**0.63**	**2,473**	**279**	**5.7**

For pipe wall crushing, a minimum FS of 2.0 desired. From above, a DR of **32.5** or less is acceptable for use in the leachate sumps and as sideslope riser piping.

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE
CELL 3

2. Pipe Deflection

Rigidity Factor (R_F) = $12E_s(DR-1)^3 / E$
Secant Modulus of Soil (E_S) = $M_s\ (1+\mu)(1-2\mu)/(1-\mu)$
Soil Strain (ε_s) = $wH_c(100) / (0.75E_s)$
Deflection (%) = $D_F\varepsilon_S$
Dimension Ratio (DR) = D_o/t

Where:

Hc = height of fill (ft) = see below
w = average weight of fill (pcf) = see below
μ = soil Poisson ratio = 0.4
P_{DES} substituted for HcW (psi) = 27.3
M_s (psi) = 3,646
E_s (psi) = 1,701

DR	E_s	E	R_F	D_F	ε_s (%)	Deflection (%)
15.5	1,701	28,200	2,207	1.42	2.14	3.04
17	1,701	28,200	2,966	1.52	2.14	3.25
19	1,701	28,200	4,223	1.68	2.14	3.59
21	1,701	28,200	5,792	1.75	2.14	3.74
26	1,701	28,200	11,313	2	2.14	4.28
32.5	**1,701**	**28,200**	**22,630**	**2**	**2.14**	**4.28**

D_F = Deformation Factor obtained from table, attached.

For pipe deflection under the design loading, a maximum deflection of 7.5 percent is desired. From above, a DR of **32.5** or less is acceptable for use in the leachate sumps and as sideslope riser piping.

SANDY CREEK ENERGY STATION
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE
CELL 3

3. Pipe wall buckling (Ref. 3)

$P_{cr} = 1.63\ ((RB'M_sE) / (DR-1)^3)^{0.5}$ (Ref. 3)
$H\ (ft) = P_{DES}/w$
$B' = 1 / (1+4e^{(-0.065H)})$ (Ref. 3)
$FS = P_{cr} / P_{DES}$

Where:

P_{cr} =	Critical buckling pressure (psi)
B' =	Elastic support coefficient
R =	Groundwater buoyancy factor (=1)
H =	Height of fill (ft)
E =	Modulus of Elasticity of pipe (psi)
P_{DES} =	Design pipe external loading (psi)
FS =	Factor of safety against wall buckling

Assumptions:
H (ft) = 116
B' = 1.00 (calculated using above equation)
E (psi) = 28,200

DR	R	B'	Ms	P_{cr}	P_{DES}	FS
9	1	1.00	3,646	730	43.4	16.81
11	1	1.00	3,646	522	43.4	12.03
13.5	1	1.00	3,646	374	43.4	8.61
15.5	1	1.00	3,646	299	43.4	6.89
17	1	1.00	3,646	258	43.4	5.94
19	1	1.00	3,646	216	43.4	4.98
21	1	1.00	3,646	185	43.4	4.25
26	1	1.00	3,646	132	43.4	3.04
32.5	**1**	**1.00**	**3,646**	**93**	**43.4**	**2.15**

For pipe buckling, a minimum FS value of 2.0 is desired. From above, a DR of **32.5** or less is acceptable for use in the leachate sumps and as sideslope riser piping.

Conclusion:
Based on the analysis presented above, in consideration of wall crushing, buckling, and allowable pipe deflection, Cell 3 18-inch diameter HDPE pipe with a maximum DR value of **32.5** (wall thickness of 0.55 inches) is required in landfill sumps and for sidewall risers. Pipe with lower DR values may be used to provide additional stability.

SANDY CREEK DISPOSAL FACILITY
NON-WOVEN GEOTEXTILE DESIGN
CELL 3

Required:

Evaluate that the following non-woven geotextiles meet or exceed the required properties for retention, hydraulic conductivity, porosity, puncture resistance, and survivability for the specified design conditions:

A. Non-Woven Geotextile (12 oz/sy) to be installed around granular drainage aggregate located in the chimney drain and leachate collection sump within Cell 3.

B. Non-Woven Geotextile (8 oz/sy) located on the top/bottom of the drainage geocomposite

Although it is anticipated that the protective cover soil installed at the landfill will have a hydraulic conductivity less than 1 x 10^{-4} cm/s, the geotextile design calculations were performed conservatively assuming a protective cover soil with a hydraulic conductivity of greater than and less than 1 x 10^{-4} cm/s. Therefore, these calculations were performed for the following cases:

Case 1: Hydraulic conductivity greater than or equal to 1 x 10^{-4} cm/s.

Case 2: Hydraulic conductivity less than 1 x 10^{-4} cm/s.

Method:

Evaluate the geotextile properties for retention, hydraulic conductivity, porosity, puncture resistance, and survivability in accordance to Reference 2, as described herein.

Reference:

1. GSE Lining Technology Inc., Product Data Sheet "GSE Nonwoven Geotextiles", 2007
2. Koerner, R.M., Designing With Geosynthetics, third edition, 1994

Solution:

A. Non-Woven Geotextile (12 oz/sy) to be installed around granular drainage aggregate located in the chimney drain and leachate collection sump within Cell 3.

Retention (Case 1 and Case 2):

The apparent opening size (O_{95}) was determined ; **(Ref. 1)**

O_{95} < 0.15 mm

AASHTO's Task Force # 25 report as referenced on pp. 101 of Reference 2 recommends that the following criteria be used to check the geotextile retention properties:

- For soil ≤ 50% passing the No. 200 sieve: $O_{95} < 0.59$mm (i.e., AOS of the fabric ≥ No. 30 sieve); and
- For soil > 50% passing the No. 200 sieve: $O_{95} < 0.30$mm (i.e., AOS of the fabric ≥ the No. 50 sieve).

Since the O_{95} or AOS of the 12 oz/sy geotextile is less than 0.30 mm, it meets the retention criteria for any soil.

Hydraulic Conductivity (k):

For Case 1:

$q_{allow} = q_{ult}$ [(1/FS_{SCB} x FS_{CR} x FS_{IN} x FS_{CC} x FS_{BC})] **(Ref. 2, pp. 159)**

Where:
$q_{allow=}$ allowable flow rate
$q_{ult=}$ ultimate flow rate
FS_{SCB} = factor-of-safety for soil clogging and binding
FS_{CR} = factor-of-safety for creep reduction of void space
FS_{IN} = factor-of-safety for adjacent materials intruding into the geotextile's void space
FS_{CC} = factor-of-safety for chemical clogging
FS_{BC} = factor-of-safety for biological clogging

$q_{ult=}$	0.232	cm/sec	**(Ref. 1)**
FS_{SCB} =	7.5	(Long-term, fine soil)	**(Ref. 2, pp. 160)**
FS_{CR} =	1.65	(Long-term installation)	
FS_{IN} =	1.2	(Moderate normal stresses)	
FS_{CC} =	2.00	(Leachate unknown)	
FS_{BC} =	26.0	(Leachate unknown)	

Calculated factor-of-safety = 772.20

$q_{allow=}$	3.00E-04	cm/s

3.00E-04 > 1.00E-04 cm/s

Global F.S.$_{8oz/sy}$ = [q_{allow}/q_{soil}] = 3.00

After applying average partial factors-of-safety for the geotextile, a global factor of safety for clogging of 3 is determined and is acceptable.

For Case 2:

For protective cover material that has a hydraulic conductivity less than 1 x 10^{-4} cm/s, it is assumed that the hydraulic conductivity of the geotextile will be much greater than the hydraulic conductivity of the protective cover material. Therefore, the minimum hydraulic conductivity is not calculated for this case (i.e., the hydraulic conductivity of the nor woven geotextile will be sufficient to prevent head from developing in the protective cover).

Porosity (Case 1 and Case 2):

The selected non-woven geotextile should have enough openings, that the performance of the non-woven geotextile will not be significantly impaired in the event of blockage of some openings. Giroud recommends a non-woven geotextile porosity of greater than 30%. As per Giroud, the porosity of a non-woven geotextile can be calculated using the following equation.

$n = 1-[m/\rho t] \times 100$ **(Ref. 2, pp. 128)**

Where:
n = geotextile porosity, %
m = geotextile mass per unit area, lb/sf
t = geotextile thickness, ft
ρ = density of filaments, lb/cf

m = 0.083
t = 0.01
ρ = 182
n = 95.4 ***> 30%, therefore, ok***

Puncture Resistance (Case 1 and Case 2):

The selected geotextile must protect the underlying geonet and geomembrane components from damage due to the drainage aggregate. This component can be evaluated based on the puncture resistance of the geotextile. The manufacturer's values for puncture resistance are based on a point load puncture failure (ASTM D4833). The steel rod used to puncture the geotextile is 0.31 in. in diameter. The puncture value of 190 lbs can be converted to 2,520 psi for the 12 oz/sy geotextile.

Assuming a compacted CCR density of approximately 115 lb/cf (CCR and soil), the height of fill would need to be over 3,500 ft high to exert a pressure approaching 2,520 psi. Since the maximum above ground and below ground fill height is significantly below 3,500 ft, the geotextile is adequate to protect the underlying liner components from damage due to static weights of the final waste body.

Survivability (Case 1 and Case 2):

Depending on the severity of an application a geotextile will be used for, the required strength parameters may vary. This assessment is also referred to as a " Survivability" analysis.

Based on Reference 2 pp. 303, geotextile properties are selected based on the subgrade conditions and the operating equipment used during the cell construction. A "Low" rating (see table below) is assumed for the 12 oz/sy geotextile.

Subgrade Conditions	**Construction Equipment Ground Pressure, 6 to 12 in. of Cover: Initial Lift Thickness**		
	Low Pressure (4 psi)	**Med. Pressure (> 4 psi)**	**High Pressure (>8 psi)**
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level such that any shallow depressions and humps do not exceed 6 in. in depth or height. All larger depressions are filled. Alternatively a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 1 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very High
Minimal site preparation is required. Trees may be felled, de-limbed, and left in place. Stumps should be cut to project not more than 6 in. ± above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders, Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very High	Not Recommended

Notes regarding the above table:

Recommendations given above are for 6 to 12 in. initial lift thickness. The recommended pressure for other initial lift thicknesses is listed below:

1. 12 to 18 in. - Reduce survivability requirement by one level
2. 18 to 24 in. - Reduce survivability requirement by two levels
3. >24 in. - Reduce survivability requirement by three levels

Survivability levels are in increasing order: low, moderate, high and very high. For special construction techniques such as pre-rutting, increase survivability requirement one level. Placement of excessive initial cover material thickness may cause bearing failure of soft subgrade. *Source* After Christopher and Holtz [146]

Using the table above, a rating of "High" was initially chosen based on optimum subgrade condition (which will be provided by the liner) and a high ground pressure of > 8 psi. However, since the soil protective cover will be 24 inches (all placed in one lift), the survivability requirement may be reduced by two levels (see Note #2) from "High to Low". Additionally, "Low" ground pressure equipment will be used on all sideslope areas to protect the liner components and a minimum of 24 inches of initial soil thickness will be maintained beneath equipment over the liner.

Based on Reference 2 pp.304, the physical property requirements for the evaluated geotextile are provided below.

PHYSICAL PROPERTY REQUIREMENTS[a]
GEOTEXTILES<50% ELONGATION/GEOTEXTILES>50% ELONGATION[b,c]

Survivability Level	**Grab Strength ASTM D4632 (lb.)**	**Puncture Resistance ASTM D4833 (lb.)**	**Trapezoidal Tear Strength ASTM D4533 (lb.)**
Medium	180/115	70/40	70/40
High	270/180	100/75	100/75

[a] Values shown are minimum average roll values. Strength values are in the weaker principal direction.

[b] Elongation (strain) at failure as determined by ASTM D4632, Grab Tensile.

[c] The values of geotextile elongation do not imply the allowable consolidation properties of the subgrade soil. These must be determined by a separate investigation.

Survivability (Case 1 and Case 2):

Since the table "Physical Property Requirements" provided on Pg. 4.3-4 does not provide physical property requirements for a "low" survivability level, the "medium" survivability level values were used for comparison. Given below are the manufacturer's specifications in comparison for the evaluated 12 oz/sy non-woven geotextile ***(Reference 1, w/ >50% elongation)*** .

Grab Strength (ASTM D4632) = 320 lbs >115 lbs, therefore ok
Puncture Resistance (ASTM D4833) = 190 lbs > 40 lbs, therefore ok
Trapezoid Tear Strength (ASTM D4533) = 125 lbs > 40 lbs, therefore ok

Therefore, the evaluated 12 oz/sy geotextile meets the "LOW" survivability criteria

Summary of required properties for non-woven geotextile installed around the drainage aggregate located in chimney drains and leachate collection sump for both Case 1 & Case 2: (Reference 1)

Apparent opening size	<	0.30	mm
Hydraulic conductivity	>	1×10^{-4}	cm/sec
Porosity	>	30.0	%
Grab tensile strength	≥	115	lbs
Puncture resistance	≥	40	lbs
Trapezoid tear strength	≥	40	lbs

Overall Conclusion:

The evaluated 12 oz/sy non-woven geotextile filter fabric is sufficient to allow proper flow of the leachate without clogging based on the 3 criteria analyzed: retention, hydraulic conductivity, and porosity and is adequate to provide protection to the underlying liner components based on the 2 criteria analyzed: puncture resistance and survivability.

B. Non-Woven Geotextile (8 oz/sy) located on the top/bottom of the drainage geocomposite.

Retention (Case 1 and Case 2):

The apparent opening size (O_{95}) was determined; **(Ref. 1)**

$O_{95} <$ 0.18 mm

AASHTO's Task Force # 25 report as referenced on pp. 101 of Reference 2 recommends that the following criteria be used to check the geotextile retention properties:

- For soil ≤ 50% passing the No. 200 sieve: $O_{95} < 0.59$mm (i.e., AOS of the fabric ≥ No. 30 sieve); and
- For soil > 50% passing the No. 200 sieve: $O_{95} < 0.30$mm (i.e., AOS of the fabric ≥ the No. 50 sieve).

Since the O_{95} or AOS of the 8 oz/sy geotextile is less than 0.30 mm, it meets the retention criteria for any soil.

Hydraulic Conductivity (k):

For Case 1:

$q_{allow} = q_{ult}\,[(1/FS_{SCB} \times FS_{CR} \times FS_{IN} \times FS_{CC} \times FS_{BC})]$ **(Ref. 2, pp. 159)**

Where:
$q_{allow=}$ the allowable flow rate
$q_{ult=}$ the ultimate flowrate
$FS_{SCB} =$ the factor of safety for soil clogging and binding
$FS_{CR} =$ the factor of safety for creep reduction of void space

$FS_{IN} =$ the factor of safety for adjacent materials intruding into the geotextile's void space
$FS_{CC} =$ the factor of safety for chemical clogging
$FS_{BC} =$ the factor of safety for biological clogging

$q_{ult=}$	0.3	cm/sec	**(Ref. 1)**
$FS_{SCB} =$	7.5	(Long-term, fine soil)	**(Ref. 2, pp. 160)**
$FS_{CR} =$	1.65	(Long-term installation)	
$FS_{IN} =$	1.2	(Moderate normal stresses)	
$FS_{CC} =$	2.00	(Leachate unknown)	
$FS_{BC} =$	26.0	(Leachate unknown)	

Calculated factor-of-safety = 772.20

$q_{allow=}$	3.89E-04	cm/s

3.89E-04 > 1.00E-04 therefore, ok

Global F.S.$_{8oz/sy}$ = [q_{allow}/q_{soil}] = 3.89

After applying average partial factors-of-safety for the geotextile, a global factor of safety for clogging of 3.9 is determined and is acceptable.

For Case 2:

For protective cover material that has a hydraulic conductivity less than 1 x 10^{-4} cm/s, it is assumed that the hydraulic conductivity of the geotextile will be much greater than the hydraulic conductivity of the protective cover material. Therefore, the minimum hydraulic conductivity is not calculated for this case (i.e., the hydraulic conductivity of the nor woven geotextile will be sufficient to prevent head from developing in the protective cover).

Porosity (Case 1 and Case 2):

The selected geotextile should have enough openings to ensure that blocking of a few of them will not significantly impair the performance of the geotextile filter. Giroud recommends a non-woven porosity of greater than 30%. As per Giroud, the porosity of a non-woven geotextile can be calculated using the following equation

$n = 1\text{-}[m/\rho t] \times 100$ **(Ref. 2, pp. 128)**

Where:
n = geotextile porosity, %
m = geotextile mass per unit area, lb/sf
t = geotextile thickness, ft
ρ = density of filaments, lb/cf

m = 0.056
t = 0.0075
ρ = 91
n = 91.8 ***> 30%, therefore, ok***

Puncture Resistance (Case 1 and Case 2):

The selected geotextile must protect the underlying geonet and geomembrane components from damage due to the protective cover. This component can be evaluated based on the puncture resistance of the geotextile. The manufacturer's values for puncture resistance are based on a point load puncture failure (ASTM D4833). The steel rod used to puncture the geotextile is 0.31 in. in diameter. The puncture value of 120 lbs can be converted to 1,589 psi for the 8 oz/sy geotextile.

Now, assuming a compacted waste density of approximately 115 lb/cf, the height of fill would need to be over 2,200 ft high to exert a pressure approaching 1,589 psi. Since our maximum above ground and below ground fill height is significantly below 2,200 ft, the geotextile is adequate to protect the underlying liner components from damage due to static weights of the final waste body.

Survivability (Case 1 and Case 2):

Depending on the severity of an application a geotextile will be used for, the required strength parameters may vary. This assessment is also referred to as a " Survivability" analysis.

Based on Reference 2 pp. 303, geotextile properties are selected based on the subgrade conditions and the operating equipment used during the cell construction. A "Low" rating (see table below) is assumed for the 8 oz/sy geotextile.

Subgrade Conditions	**Construction Equipment Ground Pressure, 6 to 12 in. of Cover: Initial Lift Thickness**		
	Low Pressure (4 psi)	**Med. Pressure (> 4 psi)**	**High Pressure (>8 psi)**
Subgrade has been cleared of all obstacles except grass, weeds, leaves, and fine wood debris. Surface is smooth and level such that any shallow depressions and humps do not exceed 6 in. in depth or height. All larger depressions are filled. Alternatively a smooth working table may be placed.	Low	Moderate	High
Subgrade has been cleared of obstacles larger than small to moderate-sized tree limbs and rocks. Tree trunks and stumps should be removed or covered with a partial working table. Depressions and humps should not exceed 1 in. in depth or height. Larger depressions should be filled.	Moderate	High	Very High
Minimal site preparation is required. Trees may be felled, de-limbed, and left in place. Stumps should be cut to project not more than 6 in. ± above subgrade. Fabric may be draped directly over the tree trunks, stumps, large depressions and humps, holes, stream channels, and large boulders, Items should be removed only if placing the fabric and cover material over them will distort the finished road surface.	High	Very High	Not Recommended

Notes regarding the above table:

Recommendations given above are for 6 to 12 in. initial lift thickness. The recommended pressure for other initial lift thicknesses is listed below:

1. 12 to 18 in. - Reduce survivability requirement by one level
2. 18 to 24 in. - Reduce survivability requirement by two levels
3. >24 in. - Reduce survivability requirement by three levels

Survivability levels are in increasing order: low, moderate, high and very high. For special construction techniques such as pre-rutting, increase survivability requirement one level. Placement of excessive initial cover material thickness may cause bearing failure of soft subgrade. *Source* After Christopher and Holtz [146]

Using the table above, a rating of "High" was initially chosen based on optimum subgrade condition (which will be provided by the liner) and a high ground pressure of > 8 psi. However, since the soil protective cover will be 24 inches (all placed in one lift), the survivability requirement may be reduced by two levels (see Note #2) from "High to Low". Additionally, "Low" ground pressure equipment will be used on all sideslope areas to protect the liner components and a minimum of 24 inches of initial soil thickness will be maintained beneath equipment over the liner.

Based on Reference 2 pp.304, the physical property requirements for the evaluated geotextile are provided below.

PHYSICAL PROPERTY REQUIREMENTS[a]
GEOTEXTILES<50% ELONGATION/GEOTEXTILES>50% ELONGATION[b,c]

Survivability Level	**Grab Strength ASTM D4632 (lb.)**	**Puncture Resistance ASTM D4833 (lb.)**	**Trapezoidal Tear Strength ASTM D4533 (lb.)**
Medium	180/115	70/40	70/40
High	270/180	100/75	100/75

[a] Values shown are minimum average roll values. Strength values are in the weaker principal direction.

[b] Elongation (strain) at failure as determined by ASTM D4632, Grab Tensile.

[c] The values of geotextile elongation do not imply the allowable consolidation properties of the subgrade soil. These must be determined by a separate investigation.

Survivability (Case 1 and Case 2):

Since the table "Physical Property Requirements" provided on Pg. 4.3-8 does not provide physical property requirements for a "low" survivability level, the "medium" survivability level values were used for comparison. Given below are the manufacturer's specifications in comparison for the evaluated 8 oz/sy non-woven geotextile ***(Reference 1, w/ >50% elongation)*** .

Grab Strength (ASTM D4632) = 220 lbs >115 lbs, therefore ok
Puncture Resistance (ASTM D4833) = 120 lbs > 40 lbs, therefore ok
Trapezoid Tear Strength (ASTM D4533) = 95 lbs > 40 lbs, therefore ok

Therefore, the evaluated 8 oz/sy geotextile meets the "LOW" survivability criteria

Summary of required properties for non-woven geotextile adhered to the geocomposite for both Case 1 & Case 2: (Reference 1)

Apparent opening size	=	0.30	mm
Hydraulic conductivity	=	1×10^{-4}	cm/sec
Porosity	=	30.0	%
Grab tensile strength	=	115	lbs
Puncture resistance	=	40	lbs
Trapezoid tear strength	=	40	lbs

Overall Conclusion:

The evaluated 8 oz/sy geotextile filter fabric is sufficient to allow proper flow of the leachate without clogging based on the 3 criteria analyzed: retention, hydraulic conductivity, and porosity and is adequate to provide protection to the underlying liner components based on the 2 criteria analyzed: puncture resistance and survivability.

SANDY CREEK DISPOSAL FACILITY
GEOCOMPOSITE FLOW CAPACITY DEMONSTRATION
CELL 3

Prep'd By: SDS
Chkd By: BJD
Date: January 2022

Required:

Determine the hydraulic conductivity of the geocomposite drainage layer in the leachate collection system for use in the HELP model. This demonstration is based on the worst case conditions for leachate generation (active 10-foot of waste) and loading (intermediate 110-foot for Cell 3 only)

Method:

1. Determine the geocomposite thickness under the expected loading conditions.
2. Determine reduction factors for strength and environmental conditions based on expected duration in each stage of landfill development.
3. Compute the required minimum hydraulic conductivity of the geocomposite using the calculated reduction factors. The minimum hydraulic conductivity for the HELP modeling is designated as the minimum value that keeps the depth of leachate over the liner confined to the geocomposite drainage layer.
4. Using the hydraulic conductivity values from Method No. 3. (above), calculate minimum transmissivity values for the geocomposite.
5. Obtain values for geocomposite transmissivity from manufacturer's data, and compare with the transmissivity values developed in Method Nos. 3. and 4. (above) to confirm that geocomposite properties used in the HELP model are respresentative of available geocomposites. The minimum transmissivity for the geocomposite shall exhibit a minimum factor-of-safety of 1.5 when compared to the manufacturer's data

References:

1. Koerner, R.M., *Designing With Geosynthetics, Second Edition* , 1990.
2. Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers", Geosynthetics International, Vol. 7, Nos. 4-6, pp. 285-380
3. GSE, PermaNet HL (bi-planar) Double-sided Geocomposite Transmissivity Data.

SANDY CREEK DISPOSAL FACILITY
GEOCOMPOSITE FLOW CAPACITY DEMONSTRATION
CELL 3

Solution:

1. Estimate geocomposite thickness for the worst case leachate generation and loading conditions, based on an initial thickness of 270 mils:

   Assume the geocomposite will undergo linear compression due to weight of soil (i.e., daily cover or intermediate cover and protective cover) and waste.

Unloaded Geocomposite Thickness =	0.27	in
Compressibility at 15,000 psf =	65	%, as provided by manufacturers
Unit Weight of Soil Only =	120	pcf
Composite Unit Weight of CCR =	103	pcf

Table 1 - Geocomposite Thickness

Fill Condition	d_{CCR}[1] (ft)	d_S[2] (ft)	P[3] (psf)	t[4] (in)
Active, 0%	10	2.0	1,270	0.27
Interim, 90%	110	3.0	11,690	0.23

[1] d_{CCR} is the depth of CCR above the geocomposite.

[2] d_S is the depth of soil (i.e., protective and intermediate) above the geocomposite.

[3] P is the pressure on the geocomposite due to the weight of the waste and soil

[4] t is the thickness of the geocomposite after being subjected to linear compression.
t is calculated by equation (Initial Thickness) - (Max. Compression) x P/30,000.

2. Reduction Factors for Strength and Environmental Conditions

Table 2 - Reduction Factors

Environmental Condition	Range	Fill Condition	
		Active (10' Waste)	Interim (110' Waste)
Geotextile Intrusion [1]	1.0 - 1.2	1.00	1.10
Creep Deformation [1,2]	1.1 - 2.0	1.10	1.20
Chemical Clogging [1,3]	1.5 - 2.0	1.50	1.80
Biological Clogging [3]	1.1 - 1.3	1.10	1.10
Composite Reduction Factor[4]	1.7 - 7.5	1.82	2.61

Notes:

[1] Range values for geotextile intrusion, creep deformation, and chemical clogging were obtained from Giroud, J.P., Zornberg, J.G., and Zhao, A., 2000, "Hydraulic Design of Geosynthetic and Granular Liquid Collection Layers",*Geosynthetics International* , Vol. 7, Nos. 4-6, pp. 285-380.

[2] Based on product literature, geocomposites/geonets will exhibit creep deformation reduction of 1.2 at 15,000 psf.

[3] Range values for biological clogging were obtained from GRI Standard GC8, Geosynthetic Institute, 2013, "Determination of the Allowable Flow Rate of a Drainage Geocomposite".

[4] The Composite Reduction Factor is the product of all of the factors for the respective fill condition.

3. Develop and confirm assumptions for hydraulic conductivity (k) of the geocomposite for HELP model.

Table 3 - Assumed Hydraulic Conductivity

Fill Condition	d_W[1] (ft)	P[2] (psf)	t[3] (in)	Reduction Factor	k_{min}[5] (cm/s)	Peak Leachate Head (in)[6]
Active, 0%	10	1,270	0.27	1.82	10.00	0.04
Interim, 90%	110	11,690	0.23	2.61	7.00	0.02

[1] d_W is the depth of waste above the geocomposite from Table 1.

[2] P is the pressure on the geocomposite due to the weight of the waste and soil from Table 1.

[3] t is the calculated geocomposite thickness from Table 1.

[4] Reduction Factors from Table 2.

[5] k is the assumed hydraulic conductivity value for HELP model. Reduction Factors will be applied to determine required minimum manufacturer transmissivity values, below.

[6] As calculated by HELP model, assuming no leachate recirulation.

4. Using the hydraulic conductivity values from Table 3 (above), calculate minimum transmissivity values for use during design and specifying geocomposites.

$$T_{min} = ((t * 2.54 \text{ cm/in}) * k_{min}) * \text{Reduction Factor}$$

Table 4 - Minimum Required Transmissivity for Geocomposite Design

Fill Condition	P (psf)	t (in)	k_{min} (cm/s)	Reduction Factor	T_{min} (cm^2/sec)	**$T_{min\ Required}$ (m^3/sec/m)**
Active, 0%	1,270	0.27	10.00	1.82	1.24E+01	**1.24E-03**
Interim, 90%	11,690	0.23	7.00	2.61	1.07E+01	**1.07E-03**

5. Compare T_{min} values from Method No. 4 (above) with published manufacturer transmissivity values.

Table 5 - Comparison of Manufacturer's Reported Transmissivity to the Minimum Required Transmissivity

			GSE PermaNet HL (bi-planar) Double-Sided		
Fill Condition	P (psf)	Minimum Required T Value[3] (m^2/sec)	P (psf)	T_{min}[1] (m^3/sec/m)	**Factor of Safety**
Active, 0%	1,270	1.24E-03	1,270	7.20E-02	**57.8**
Interim, 90%	11,690	1.07E-03	11,690	8.50E-03	**8.0**

[1] Geocomposite Transmissivity values determined from tests with hydraulic gradient of 0.02. If higher gradient used by manufacturer to determine transmissivity, manufacturer will be required to certify that geocomposite will provide comparable drainage as described in Table 4, above.

[2] The product shown in the table is provided to demonstrate the availability of products that will meet or exceed the required drainage characteristics. Other manufactured products, either bi-planar or tri-planar geocomposites are acceptable if confirmed to meet the minimum required transmissivity values indicated in Table 5 (above), while providing a minimum factor-of-safety of 1.5.

SANDY CREEK ENERGY STATION
LEACHATE COLLECTION AND REMOVAL
PIPING FLOW CAPACITY
CELL 3

Required:

Demonstrate that the Cell 3 6-inch diameter (SDR 9) leachate collection piping has sufficient capacity to convey leachate during the worst case leachate generation conditions. Due to pipe availability, SDR 9 is expected to be the thickest wall pipe installed at landfill. The critcal case was analyzed:
Case 1: Pipe in the central leachate trench (1% slope)

Method:

A. Use leachate production rates determined from the HELP model analysis (see Attachment IV.B1) as comparison to capacity of 6-inch diameter DR 9 leachate collection piping.
B. Determine required hole size (perforations) based on characteristics of the surrounding drainage media.

References:

1. Bass, J., *Avoiding failure of Leachate Collection and Cap Drainage Systems* , Pollution Technology Review No. 138, Noyles Data Corporation, 1986.
2. Texas Natural Resource Conservation Commission, Leachate Collection System Handbook, 30 TAC 330.201, 1993

SANDY CREEK ENERGY STATION
LEACHATE COLLECTION AND REMOVAL
PIPING FLOW CAPACITY
CELL 3

Solution - Flow Capacity of Pipe (A - Case 1 - Central Pipe):

Determine the average and peak daily flow rate estimate:

The following table summarizes the fill conditions that are likely to be present and have the greatest contribution of leachate into the LCS. The average and peak flow rate (lateral drainage in the LCS layer) is shown for each condition. All flow rates are per acre.

From the HELP model (Attachment 3):

CONDITION	AVERAGE ANNUAL		PEAK DAILY	
	cf/y/ac	g/d/ac	cf/d/ac	g/d/ac
Active, 10' Waste	34,158	700	406	3,040
Interim, 110' Waste	12,468	256	103	769

Cell 3 drains to a single leachate collection sump.

Maximum leachate production (and drainage) expected in the collection pipe is predicted to occur assuming the following scenario:

1.	Active, 10' Waste	5.0	ac
2.	Interim, 110' Waste	12.0	ac
	Total =	17.0	ac

CONDITION	AREA ac	AVERAGE g/d/ac	AVERAGE gpd	AVERAGE cfs
Active, 10' Waste	5.0	700	3,500	0.0054
Interim, 110' Waste	12.0	256	3,068	0.0047
		Total =	6,568	0.0102
With applied Factor of Safety of 1.5:		Total =	9,852	0.0152

CONDITION	AREA ac	PEAK g/d/ac	PEAK gpd	PEAK cfs
Active, 10' Waste	5.0	3,040	15,199	0.0235
Interim, 110' Waste	12.0	769	9,227	0.0143
		Total =	24,427	0.0378
With applied Factor of Safety of 1.5:		Total =	36,640	0.0567

SANDY CREEK ENERGY STATION
LEACHATE COLLECTION AND REMOVAL
PIPING FLOW CAPACITY
CELL 3

Determination of flow capacity (Q_{full}) for a 6-inch diameter perforated pipe:

$$Q_{full} = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

Where: A = Cross-sectional area of pipe, with d representing the inside diameter in feet

R = Hydraulic radius of pipe in feet under full flow conditions

From Pipe Structural Stability Calculations:

Outside Diameter (in) =	6.625	
Dimension Ratio (DR) =	9.0	
Wall Thickness (t) =	0.736	
ID =	5.153	in
=	0.429	ft

$$A = \frac{\Pi \times d^2}{4}$$

A = 0.145 sq ft

$$R = \frac{d}{4}$$

R = 0.107 ft

S = Design slope of pipe S = 0.010 ft / ft

n = Manning's number n = 0.009 for HDPE smooth pipe

Q_{full} = 0.541 cfs

Compare Q_{max} and Q_{full} (Average Flow Rate):

Q_{full} = 0.541 cfs >> Q_{max} = 0.0152 cfs

Compare Q_{max} and Q_{full} (Peak Flow Rate):

Q_{full} = 0.541 cfs >> Q_{max} = 0.0567 cfs

Conclusion:
6-inch diameter HDPE pipe with a DR of 9 exceeds the required flow capacity for both average and peak flow rates.

SANDY CREEK ENERGY STATION
LEACHATE COLLECTION AND REMOVAL
PIPING FLOW CAPACITY
CELL 3

Solution - Perforations Configuration (B):

Pipe perforations must allow free passage of leachate and also prevent migration of drainage media into collection pipes. Therefore, size of perforations depends on media particle size.

$$\frac{D_{85}\text{ of Filter}}{\text{Hole Diameter (d)}} \geq 1.7$$

Where: D_{85} = Particle size for which 85% of all particles are smaller than the following:

For the drainage media with gradation having 100 percent passing 2-inch sieve and 0 to 5 percent the 1/2-inch sieve, the D_{85} will be greater than 1-inch, therefore 1-inch was used in this calculation for conservatism.

D_{85} = 25 mm

= 0.985 in

Standard hole diameter: d = 0.5 in

Check values to find that:

$$\frac{D_{85}\text{ of Filter}}{\text{Hole Diameter}} = 2.0 \geq 1.7 \quad \text{(acceptable)}$$

In Addition:

A minimum open area of 1 square inch per foot of drainage pipe is recommended by the U.S. Soil Conservation Service and the U.S. Bureau of Reclamation, as represented by the 6 perforations per foot required for leachate collection pipe, see Figure 6.

Conclusion:

Perforations will consist of 0.5-inch diameter holes with a minimum ope area of 1 square inch per foot of drainage pipe, as analyzed above.

SANDY CREEK DISPOSAL FACILITY
LEACHATE COLLECTION SUMP DESIGN
CELL 3

Required:

Determine the required size of the leachate collection sump, based on the conditions of landfill development when it is anticipated that the leachate collected in an individual sump will be the greatest. **These calculations are for a leachate collection sump with a maximum contributing Cell 3 area of 17 acres.**

Method:

A. Evaluate the average leachate flow rate into the leachate collection sump, based on the greatest leachate generation potential.
B. Evaluate the storage capacity and minimum storage time of the leachate sump, based on the specified sump geometry.
C. Calculate the average daily pump cycle time, based on a specified pump size.

References:

1. Texas Natural Resource Conservation Commission, *Leachate Collection System Handbook* , 30 TAC 330.201, 1993.

Solution:

A. Evaluate the average leachate flow rate into the leachate collection sump, based on the greatest leachate generation potential.

The following table summarizes the fill conditions that are likely to be present and have the greatest contribution of leachate into the LCS and sump system. The average generation rates (lateral drainage in the LCS layer) are shown for each condition. All flow rates are per acre.

Average annual leachate generation rates are from the HELP model output, as provided in Attachment 3:

CONDITION	Average Leachate Generation		Assumed Area	Leachate Collection
	(cf/y/ac)	(cf/d/ac)	(ac) [1]	(cfd)
Active, 10' Waste	34,157	93.6	5	468
Interim, 110' Waste	12,468	34.2	12	410
Total	46,625	127.7	17	878

[1] Assumes an active area of 5 acres and the remaining of the 12 acres are at interim grades

B. Evaluate the storage capacity and minimum storage time of the leachate sump, based on the specified sump geometry.

$$V_{REQ} = V_C / P$$

V_C = Volume, Leachate collection rate, (cfd)
P = Porosity

Assumed porosity of drainage stone: $P = 0.35$

Condition	V_C (cfd) [1]	V_{REQ} (cfd)
Active, 10' Waste	468	1,337
Interim, 110' Waste	410	1,171
Total	**878**	**2,508**

[1] The leachate collection rates shown are consistent with those calculated in Method A, above.

SANDY CREEK DISPOSAL FACILITY
LEACHATE COLLECTION SUMP DESIGN
CELL 3

Prep'd By: BG
Chkd By: SDS
Date:January 2022

Selection of Sump Geometry:

Assumed sideslope of sump = (X)H : 1V = 3 ft

Assumed depth of sump = 3 ft

$$V_{TOT} = \frac{X_T^{\,2} h_T}{3} - \frac{X_B^{\,2} h_B}{3} - B$$

Where:
X_T = Length of top side
X_B = Length of bottom side
h_T = Height of pyramid with (X)H:1V sideslope and width X_T
h_B = Height of pyramid with (X)H:1V sideslope and width X_B

X_T = 40 ft
X_B = 22 ft
h_T = 6.67 ft
h_B = 3.67 ft
B = 277 cu ft (Pump head vol. of 6" in bottom of sump)

V_{TOT} = 2,687 cu ft total sump volume
= 940 cu ft leachate capacity
= 7,034 gallons leachate capacity

Number of days storage for conditions:

$$\text{STORAGE} = \frac{V_{TOT}}{V_{REQ}}$$

V_{REQ} = 2,508 cu. ft.
V_{TOT} = 2,687 cfd

Storage = 1.07 days

C. Calculate the average daily pump cycle time, based on a specified pump size.

Specified Submersible Pump Capacity (gpm) : 15

Total Leachate Collection: 878 cfd
Total Leachate Collection: 6,566 gal/day
Maximum Pump Time: 7 hours/day

Notes:

[1] Pump cycles will be determined at time of pump selection, based on manufacturer's operational recommendations. Although there may be periods of landfill development (i.e., active, 10-foot waste) when the pump will operate continuously throughout the day, as waste elevations increase and the leachate collection rates decrease, the pump time will also decrease.

[2] A lower or higher capacity pump may be substituted for the 15 gpm pump, provided the sump drawdown criteria maintains less than the required 30-centimeter depth of the bottom liner.

Conclusion:

Based on above calculations, the leachate collection sumps will have sufficient capacity for storage of leachate during the time period of greatest leachate generation and subsequent contribution to the LCS. As such, the sump will have the following minimum dimensions. The sump design will provide for at least 1 day of leachate storage within the sump, without exceeding the 30 centimeters of leachate head over the bottom liner system.

Sump Top Dimension (X_T) = **40** ft
Sump Bottom Dimension ($X_{B)}$ = **22** ft
Sump Sideslopes = **3** (X)H:1V
Sump Design Depth = **3** ft

ATTACHMENT IV.A3

CELL 3 HDPE PIPE CORROSION DURABILITY LITERATURE

Chemical & Abrasion Resistance

Revision 0

Chemical & Abrasion Resistance of Corrugated Polyethylene Pipe

Brought to you by the CPPA, a non-profit industry trade association dedicated to providing unbiased, non-branded information about the use and installation of corrugated polyethylene pipe.

Your Information Resource

CORRUGATED POLYETHYLENE PIPE ASSOCIATION
CPPA ™

A division of the Plastics Pipe Institute, Inc.

Preface

The material presented in this technical booklet has been prepared in accordance with recognized principles and practices, and is for general information only. The information should not be used without first securing competent advice with respect to its suitability for any general or specific application.

While the material is believed to be technically correct, the Corrugated Polyethylene Pipe Association makes no representation or warranty of any kind, and assumes no liability therefore. Inquiries on specific products, their attributes, and the manufacturer's warranty should be directed to member companies. An up-to-date directory of the membership of the Corrugated Polyethylene Pipe Association is available on request.

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Introduction

Pipe environments are determined by the chemical and physical characteristics of the effluent and soil, vary from site to site and are not always predictable. Materials that can withstand some environments may not be as tolerant of others, and so may not perform as expected.

Aggressive pipe environments that include effluent and soil can result in pipe corrosion or abrasion. These factors, alone or in combination, can lead to a shortened product life or loss of structural integrity. It is very important to select durable materials to ensure long term performance in adverse environments.

Corrugated polyethylene pipe has a documented performance record of almost 30 years. Existing installations have provided the industry with a tremendous amount of information. Research has added to that knowledge base through material analysis and by comparison with other pipe materials. Available data indicates that specifiers can confidently expect a minimum service life of 50 years in typical drainage applications, and in all likelihood even more.

Through research and testing, corrugated polyethylene pipe has demonstrated that it can last longer than many other pipe materials. Specifically, because of corrugated polyethylene pipe's material properties, it withstands corrosion and abrasion better than traditional drainage pipe materials.

Resistance to Chemically Aggressive Environments

Chemical corrosion is the deterioration of the pipe that can result from the chemical action of the effluent or soil on the pipe material. In storm sewers, evidence of chemical corrosion usually shows as deterioration of the pipe invert. Highly corrosive conditions can eventually lead to a total loss of the invert, and a corresponding loss of structural integrity.

Corrugated polyethylene pipe is the preferred choice for installations that are subjected to acidic mine runoff, aggressive landfill leachate or strong acids with a pH as low as 2.0. Plastics withstand the effects of most basic and acidic chemicals, and polyethylene is one of the most chemically stable plastics used in drainage pipe applications.

pH

In fact, acidic or alkaline-based industrial solutions; hydrocarbon-based fluids such as gasoline, motor oil, diesel fuel and kerosene; and detergents, bleaches and other cleaning solutions are often stored, shipped and sold in high density polyethylene packaging. Sometimes polyethylene is even used for rehabilitating concrete pipe to extend its life in a corrosive environment. And protective coatings are often times used to prolong the life of concrete and steel pipe, but always with added cost.

INDUSTRIAL SOLUTIONS

Traditional drainage pipe materials such as concrete, steel and aluminum have varying levels of resistance to chemicals. Acidic chemicals and saline conditions, from road salts or sea water can often cause deterioration in these materials.

Most corrugated polyethylene pipe systems include some type of gasket, usually made of a natural rubber or ethylene propylene (EPDM) compound. In terms of the success of the overall installation, gaskets are a critical link in the drainage system. As such, the effects of caustic solutions and chemicals on the gasket material have also been thoroughly investigated and tested. Detailed information on gasket chemical resistance can be obtained by contacting individual CPPA manufacturing members.

Potentially aggressive chemicals commonly found in storm sewers include road salts, fuels, and motor oils. In some parts of the country, acidic runoff from mines creates very severe conditions. Contaminated soils, such as those with high levels of certain hydrocarbons, can also factor into the overall picture of chemical impact.

HYDROCARBON

A sampling of chemicals that have been tested for compatibility with polyethylene pipe of various materials is shown in Table 1.

Table 1
Chemical Resistance of Polyethylene Pipe to Selected Substances*

Chemical or Substance	**Polyethylene Pipe (73°F/23°C)**
Alcohol, ethyl	R
Antifreeze agents, vehicle	R
Bleaching solution, 12.5% active chlorine	R
Bleaching solution, 5.5% active chlorine	R
Brake fluid	R
Diesel fuel	R
Diesel fuel/oil	R
Ethane	R
Fertilizer salts, aqueous	R
Fuel oil	R
Gasoline	R to C
Hydraulic fluid/oil	R
Hydrogen peroxide, aqueous 10% - 90%	R
Jet fuels	R
Methanol, pure	R
Motor oil	R
Nitric acid, 0% - 30%	R
Nitric acid, >30% - 50%	R to C
Petroleum, sour, refined	R
Sea water	R
Sewage, residential	R
Soap solutions, aqueous	R
Sulfuric acid, 70% - 90%	R
Two-stroke engine oil	R

R = Plastic pipe is generally resistant (Specimen swells <3% or has weight loss of <0.5% and elongation at break is not significantly changed)

C = Plastic pipe has limited resistance only and may be suitable for some conditions (Specimen swells 3% - 8% at weight and loss of 0.5% - 5% and/or elongation at break decreased by <50%)

*A more complete listing of polyethylene's chemical resistance can be obtained by contacting the CPPA.

Chemicals and abrasion are the most common durability concerns for drainage pipes, especially when the effluent flows at high velocities. But in test after test, results show that it takes longer to abrade through polyethylene than concrete.

Abrasives, such as stones or debris, can result in a mechanical wearing away of the pipe. The extent of the problem depends on the type of abrasive, frequency that the material is in the pipe, velocity of the flow, and the type of pipe material. The effect of abrasives may be seen in the pipe invert where exposure is most severe. Over time, abrasives can result in a loss of pipe strength or reduction in hydraulic quality as they gradually remove wall material.

Abrasion Resistance Testing

Pipe materials vary in their resistance to abrasives. Laboratory tests have been conducted to obtain wear rates of materials under controlled conditions. One of the most widely recognized projects[1] was conducted in 1990 under the direction of Dr. Lester Gabriel at California State University. This project evaluated the wear rates of 12" and 24" (300 and 600 mm) concrete pipe and smooth interior corrugated polyethylene pipe, among other materials, under laboratory conditions.

Sections of pipe were charged with an abrasive slurry consisting of crushed quartz aggregate and water. The pipe ends were then capped. The pipe was attached to a rocker apparatus and rotated such that the average velocity of the slurry was about 3 fps (0.9 m/s). Aggregate and pH were monitored throughout the test and adjusted as necessary to keep them as close as possible to their original conditions. The test was completed after a specified number of rotations. Then the effect of the slurry was determined by measuring the loss of wall thickness.

Interpreting the test results requires an understanding of the wall sections and what constitutes a "failure" for each product. According to ASTM C76, 12" (300 mm) concrete pipe must have a minimum of 0.5" (13 mm) of concrete cover over the circumferential steel reinforcement. The failure point for concrete is typically assumed to be when the reinforcement is exposed; at this point some of the structural integrity has been lost and the reinforcement is vulnerable to corrosion.

Smooth interior corrugated polyethylene pipe in 12" (300 mm) diameter has a minimum liner thickness of 0.035" (0.9 mm), although manufacturers typically use much heavier liners. The failure point of this product is assumed to be when the liner wears away. At this point, the strength of the pipe, supplied by the corrugated outer wall, remains intact.

Table 2 presents the maximum amount of wear that occurred during the test and the "expendable" wall thickness (e.g., the thickness of the wall that can abrade before reaching failure). The remaining wall thickness is presented as a percentage of the expendable wall thickness, and is an indication of the amount of service life remaining.

Table 2
Abrasion Test Results Under Neutral Conditions (pH 7.0)

	Initial Wall Thickness in. (mm)	Max. Loss of Wall Thickness in. (mm)	Expendable Wall Thickness in. (mm)	Remaining Wall Thickness %	Visual Results
12" (300 mm) Smooth Interior Polyethylene Pipe	.110 (2.8)	0.021 (0.53)	0.035 (0.89)	40	Liner showed some evidence of wear; liner perforation did not occur.
12" (300 mm) Concrete Pipe	2.15 (54.6)	0.79 (20)	0.5 (13)	<0	Steel reinforcement would have been exposed.*

*It was the intent of the project to test Class III reinforced concrete pipe. It was not realized until the tests had been completed that the pipe was not reinforced. This booklet discusses the results of the project as if reinforcement was present, because it is commonly used in construction applications.

Abrasion Test Results on 12" (300 mm) Concrete and Smooth Interior Polyethylene Pipe Under Neutral Conditions (pH 7.0)

The test results show that polyethylene pipe had significantly more service life remaining after the test, as evidenced by the amount of wall thickness that was still present.

Wall thickness alone, without regard to wear rate, is sometimes used to estimate service life. This test proved that evaluating just the wall thickness can be deceiving. The heavier wall of the concrete pipe failed at some point prior to completion of the test, whereas 40% of the relatively thin liner on the corrugated polyethylene pipe remained intact even after the experiment was completed. The wear rate of the material can - and in this case does - take precedence over the wall thickness.

Combined Abrasion and Chemical Corrosion Testing

Another phase of the research described above was to conduct the same test but with a moderately acidic effluent. The objective was to determine what might be expected from the combined effects of a chemically aggressive environment and abrasives. The setup of the pipe and abrasives was the same as before, although the effluent pH was maintained at 4.0. Table 3 shows the results of this trial.

Table 3

Abrasion Test Results Under Moderately Acidic Conditions (pH 4.0)

	Initial Wall Thickness in. (mm)	Max. Loss of Wall Thickness in. (mm)	Expendable Wall Thickness in. (mm)	Remaining Wall Thickness %	Visual Results
12" (300 mm) Smooth Interior Polyethylene Pipe	0.110 (2.8)	0.024 (0.61)	0.035 (0.89)	31	Liner showed some evidence of wear; liner perforation did not occur.
12" (300 mm) Concrete Pipe	2.15 (54.6)	1.20 (30.5)	0.5 (13)	<0	Loss of wall thickness was much higher than in neutral conditions. Significant amounts of reinforcement would have been exposed.

Abrasion Test Results on 12" (300 mm) Concrete and Smooth Interior Polyethylene Pipe Under Moderately Acidic Conditions (pH 4.0)

Moderately acidic conditions, similar to what could easily be expected in a dilute mine drainage application or perhaps in concentrated acid rain areas, caused dramatically different results for the pipe. The wear rate nearly doubled for concrete pipe compared to the neutral environment, whereas it increased about 15% for the smooth interior corrugated polyethylene pipe.

The time at which the failure point was reached becomes even more obvious under this test condition. Reinforcement on the concrete pipe would have been exposed, thereby failing the pipe, long before it had in the chemically neutral environment. By contrast, the polyethylene pipe did not experience significantly more wear in a chemically aggressive environment, and over 30% of the liner thickness, or service life, remained at the completion of this test.

As in the previous trial, the larger diameter pipe wore at a noticeably lower rate than the smaller diameter material.

Laboratory tests, like the one described previously, are usually conducted under a set of rigorous conditions designed to produce results in a reasonable length of time. Test conditions may somewhat resemble field conditions in the selection of abrasives and pH conditions, but deviate in the quantity of abrasives and the constancy of their application. Thus, laboratory tests are very important for providing information on *relative* wear rates and *relative* product lives, but will likely provide misleading results if extrapolated directly into actual service life values.

Actual polyethylene pipe installations have demonstrated superior durability. In 1981, the Ohio Department of Transportation installed a corrugated polyethylene pipe in a culvert application near an abandoned strip mine in southeast Ohio. Acidic (pH 2.5-4.0) and abrasive effluent had limited the lives of previously used pipe materials to two to five years, at which time either the invert wore through or the pipe collapsed. The polyethylene pipe replaced a polymer-coated steel pipe which had reached the end of its service life.

In 1990, a report[2] was published summarizing nine years of periodic inspections. The pipe remained nearly unaffected by the abrasive and acidic conditions. A high bedload was noted during the inspection made in 1985; rocks, coal and sand had been piled on the bank in an area 35' long by 15' wide by 1' deep (10.5 m x 4.5 m x 0.3 m) on the downstream end of the pipe providing an indication of the type and velocity of the abrasives.

An update[3] was published in 1996; after 14 years of service, or nearly three times that of any other material used in that application, the pipe was in excellent condition and ready for many more years of dependable service.

Summary

Nonpressure polyethylene pipe used in drainage applications has nearly 30 years of successful applications in the United States. A tremendous amount of information has been obtained from its application and from laboratory investigations which indicate a 50 year minimum service life for typical storm drainage applications.

Polyethylene has demonstrated very high resistance to environmentally aggressive applications where other materials' performance falls short. Tests conducted at California State University to determine the effects of abrasives in neutral and acidic environments showed the service life of polyethylene to far exceed that of concrete.

Additional tests are in progress that will support these long term performance behaviors. CPPA will report on those tests as the results become available.

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SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
REGISTRATION APPLICATION
TCEQ REGISTRATION NO. -----
McLENNAN COUNTY, TEXAS

APPENDIX IV.B
LINER CONSTRUCTION QUALITY ASSURANCE PLAN

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1 INTRODUCTION

1.1 PURPOSE AND SCOPE

The following Liner Construction Quality Assurance (CQA) Plan has been prepared for Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill) to provide the Landfill Owner/Operator, Design Engineer, CQA Professional of Record, Contractor, and Geosynthetics Contractor the needed guidance regarding CQA/control during construction of bottom liner system at the Landfill. This CQA Plan also will provide the CQA Professional of Record the needed guidance for preparing the Liner Evaluation Report (LER) for each Landfill cell to be constructed at the Landfill.

This CQA Plan addresses the testing methods and other requirements for Cell 3 and future expansions of the Landfill set forth in 30 Texas Administrative Code (TAC) §352.701, 40 Code of Federal Regulations (CFR) §257.70, and current TCEQ guidance document, RG-534 (2017 version). The scope of this CQA Plan includes general requirements concerning roles, responsibilities, and qualifications of the parties involved; and instructions for these parties to implement the CQA program.

The proposed bottom and sideslope composite liner system is comprised of the following (from top to bottom):

- 2-foot-thick soil protective cover;
- Double-sided geocomposite (non-woven geotextile on both sides of geonet);
- 60-mil textured HDPE geomembrane (textured on both sides);
- 2-foot-thick low permeability soil liner (hydraulic conductivity, $k < 1x10^{-7}$ cm/sec); and
- Prepared subgrade (excavation grade).

These bottom and sideslope liner systems are depicted on Drawing IV-8 (Appendix IV.A – Landfill Design Drawings). The design of the leachate collection system components are described in Appendix IV.A – Leachate Collection and Removal System Plan. Additional guidance and technical requirements for the liner, leachate collection system, and related construction will also be presented in the construction plans and technical specifications prepared prior to construction of waste disposal cell.

This CQA Plan includes the requirements for the following:

- Subgrade;
- Compacted Clay Layer;
- Geosynthetics (geomembrane, drainage geocomposite, and geotextiles);
- Leachate Collection Piping;

- Drainage Aggregate; and
- Protective Cover.

This CQA Plan, which will be followed during liner construction, outlines materials selection and evaluation, laboratory test requirements, field test requirements, and corrective action needed for mitigation of issues that may arise during performance of work for the above describe components. This CQA Plan also includes documentation and reporting requirements included for the LER. Additional guidance and technical requirements for the liner, leachate collection system, and related construction will also be presented in the construction plans and technical specifications prepared prior to construction of the cell.

1.2 DEFINITIONS

Whenever the terms listed below are used, the intent and meaning shall be interpreted as indicated.

1.2.1 ASTM

This means the American Society for Testing and Materials.

1.2.2 CCR

This means Coal Combustion Residuals.

1.2.3 Construction Plans

Plans or drawings depicting the liner design and cell construction. The drawings will include, at a minimum, existing conditions plan, site layout plan, excavation/backfill plan, top of clay liner plan, top of protective cover plan, leachate collection sump and riser details, leachate collection system details, and sufficient cross-sectional details depicting the liner layers, tie-in to existing liner, and termination of the liner layers. If necessary, the drawings will also depict the stormwater management features and materials for control of stormwater and erosion of the liner components. The terms "Construction Plans," "Construction Drawings," "plans" and "drawings" shall be interpreted to be the same when referring to the bottom liner design.

1.2.4 Construction Quality Assurance (CQA)

A planned system of activities that provides the Landfill Owner/Operator and registration agency assurance that the cell liner will be constructed as specified in the design, construction plans and technical specifications (collectively referred to as the Contract Documents) prepared for the cell construction. CQA includes observations and evaluations of materials and workmanship necessary to assess and document that construction has been performed consistent with the Contract Documents. CQA also refers to measures taken by the CQA geotechnical professional and/or CQA Monitor to assess if the bottom and sideslope liner systems construction has been in compliance with the Contract Documents and this CQA Plan for the Landfill.

1.2.5 Construction Quality Control (CQC)

These actions provide a means to measure the characteristics of an item, material, or service to comply with the requirements of the contract or registration documents. CQC actions will be performed by the Contractor or manufacturer of materials. All quality control testing shall be performed prior to or during construction of the liner. In no instance shall quality control field or laboratory testing be undertaken after completion of liner construction.

1.2.6 Contract Documents

These are the official set of documents provided by the Landfill Owner/Operator. These documents include bidding requirements, contract forms, contract conditions, technical specifications, construction plans, addenda, and contract modifications, related to the respective cell construction project.

1.2.7 Composite Liner System

A composite liner consists of two components; the upper component consisting of, at a minimum, a 30-mil geomembrane liner (GM), and the lower component consisting of at least a two-foot layer of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second (cm/sec). GM components consisting of high density polyethylene (HDPE) must be at least 60-mil thick.

1.2.8 Technical Specifications (or Specifications)

These are the qualitative requirements for products, materials, and workmanship upon which the construction contract is based.

1.2.9 Earthwork

This is a construction activity involving the use of soil materials as defined in the technical specifications.

1.2.10 Geomembrane Liner

This is a very low permeability synthetic membrane liner or barrier used with any geotechnical engineering related material so as to control fluid migration in a man-made project, structure or system. For this Landfill, the geomembrane liner shall be a 60-mil high-density polyethylene (HDPE) and shall be textured on both sides. The geomembrane liner is also referred to as geomembrane, membrane, liner, or sheet.

1.2.11 Liner Evaluation Report (LER)

This is a construction certification report prepared and sealed by the Professional of Record that is submitted to the Landfill Owner/Operator for recordkeeping in the Site Operating Record consistent with Section 4 of the Site Operating Plan (SOP, Part V).

1.2.12 Nonconformance

This is a deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of nonconformance include, but are not limited to, physical defects, test failures, and inadequate documentation.

1.2.13 Panel

This is a unit area of geomembrane, which will be seamed in the field.

1.3 ROLES, RESPONSIBILITIES, AND QUALIFICATIONS

1.3.1 CQA Geotechnical Professional (GP)

The GP is an authorized representative of the Landfill Owner/Operator and has overall responsibility for CQA and confirming that the bottom and sideslope liner systems have been constructed in general accordance with the construction plans and technical specifications. The GP must be a Professional Engineer licensed in Texas with experience in either solid waste engineering and/or geotechnical engineering.

The GP must show competency and experience in certifying similar installations and be presently employed by or practicing as a solid waste engineer or geotechnical engineer in a geotechnical and/or environmental engineering organization. The credentials of the GP must meet or exceed the minimum requirements required by Rule §257.53 of the CFR. The GP will be the professional of record, who signs the Liner Evaluation Report.

1.3.2 CQA Monitor

These are representatives of the GP who work under direct supervision of the GP. The CQA Monitor is responsible for quality assurance monitoring and performing on-site tests and observations. A qualified Lead CQA Monitor shall have a minimum of two years of directly related experience; or be a graduate engineer or geologist with one year of directly related experience. A junior CQA Monitor may work under the direct supervision of the Lead CQA Monitor or the GP and may have less than one year of directly related experience. The CQA Monitor is onsite full-time during subgrade preparation, liner system construction and leachate collection system construction and reports directly to the GP. Any references to monitoring, testing, or observations to be performed by the GP should be interpreted to mean the GP or CQA Monitor working under the GP's direction.

1.3.3 Contractor

This is the person or persons, firm, partnership, corporation, or any combination, who as an independent Contractor, has entered into a contract with the Landfill Owner/Operator. The Contractor's role will be to furnish materials, earthwork, construction, and to provide overall construction responsibility for the completion of the Landfill liner system. The Contractor will be experienced in similar liner construction for Landfills, surface impoundments, etc. to the satisfaction of the Landfill Owner/Operator.

1.3.4 Design Engineer

These individual(s) or firm(s) are responsible for the design and preparation of the project construction plans and technical specifications; also referred to as "Designer" or "Engineer."

1.3.5 Geosynthetics Contractor

This is the person or persons, firm, partnership, corporation, or any combination, who as an independent Contractor, has entered into a contract with the Landfill Owner/Operator. The Contractor's role will be to furnish geosynthetic materials, earthwork, construction, and to provide overall construction responsibility for the completion of the Landfill liner system. The Contractor will be experienced in similar geosynthetic liner construction for Landfills, surface impoundments, etc. to the satisfaction of the Landfill Owner/Operator.

1.3.6 Operator

The organization that will operate the Landfill disposal unit.

1.3.7 Owner

The organization that owns the Landfill disposal unit.

1.3.8 Owner's Representative

This is the person or persons that is an official representative of the Landfill Owner/Operator responsible for environmental compliance, planning, organizing, operations, and controlling the construction activities.

1.3.9 Quality Assurance Laboratory

The firm(s) responsible for conducting tests on borrow and clay liner samples taken from the site, as well as testing of geomembrane index properties and field seams obtained during destructive field sampling. Multiple laboratories can be used. The laboratory reports directly to the CQA Monitor. Laboratory test results will be incorporated into the LER.

1.3.10 CQA Surveyor

A third-party firm responsible for conducting certification surveys of the subgrade, top of soil liner layer, leachate collection system, and top of protective cover during liner construction for confirmation the respective layer has been constructed in accordance with the required tolerances and minimum thickness, if applicable. The CQA surveyor reports directly to the Engineer, GP, CQA Monitor, or Landfill Owner/Operator, and shall be a registered professional land surveyor (RPLS) in the State of Texas. Record drawing(s) developed from the Certifications surveys will be incorporated into the LER.

2 SUBGRADE AND ENGINEERED FILL

2.1 SUBGRADE

Subgrade refers to a surface that is exposed after stripping topsoil or excavating to establish the grade directly beneath the bottom liner system. Grading of the prepared subgrade should generally conform to Part IV, Drawing IV-2.

Prior to beginning liner construction, the subgrade area will be stripped to a depth sufficient to remove loose surface soils or soft zones within the exposed excavation. The subgrade will be proof-rolled with heavy, rubber-tired construction equipment to detect areas subject to pumping caused by excessively wet soils, or surface water. If soils subject to pumping cannot be disked, dried, or stabilized, these areas will be undercut to firm material and refilled with engineered fill, as defined in Section 2.2. The contractor should notify the CQA Monitor if groundwater is encountered during construction. If measurable quantities of groundwater are encountered during excavation or during installation of the soil liner, the GP will evaluate the need for groundwater or dewatering controls.

Based on visual evaluations, the GP or the CQA Monitor will determine whether additional physical testing methods are necessary to evaluate the excavated or prepared subgrade or subgrade areas where fill is placed. Testing might include shallow test holes, test trenches, density, and moisture testing. Additional proof-rolling may also be required.

The GP will approve the prepared subgrade prior to the placement of the soil liner. Approval will be based on a review of test information, if applicable, and CQA monitoring of the subgrade preparation.

Prior to soil liner construction, visual examination of the subgrade preparation and documentation by the GP must be obtained to confirm that the subgrade is suitable as a foundation for the soil liner. Criteria that may be used for this visual evaluation include, but are not limited to, the following:

- No groundwater seepage observed from the subgrade surface;
- No softening of the subgrade surface;
- No softness or sheen within secondary features; and
- No water accumulation in low areas of subgrade surface.

2.2 ENGINEERED FILL

Engineered Fill material (which may also be referred to as structural or general fill) will be used in the establishment of proper subgrade elevations and in the construction of earthen embankments.

Engineered fill shall be soil free from chemical contamination, construction material, organics, debris, frozen material, or other deleterious materials. Engineered Fill shall be obtained from on-site borrow areas, when possible, and shall have a plasticity index (PI) between 5 to 50 percent, at least 10 percent passing the No. 200 sieve, at least 90 percent passing the No. 4 sieve, and no rock greater than 1-inch in size. For quality control purposes, pre-construction testing will be performed as described in Table 2-1, and more often as necessary based on a visual change in soil type or classification (as judged by the GP or CQA Monitor based on visual observation).

Table 2-1 Engineered Fill Testing Schedule

TEST	METHOD USED	FREQUENCY
Unified Soil Classification	ASTM D2487	1 per soil type/minimum 1 per borrow source
Sieve Analysis	ASTM D422 or D1140	
Atterberg Limits	ASTM D4318	
Moisture/Density Relationship	ASTM D698	
Field Moisture/Density Test	ASTM D1556, D2167, or D6938	1 per 10,000 ft^2 per 6-inch lift. A minimum of 3 compaction tests will be required per compacted lift regardless of area.

All Engineered Fill shall be compacted to 95 percent (standard Proctor) of the maximum dry density in accordance with ASTM D698 at a moisture content ranging from -2% to +4% of optimum (as determined by ASTM D698), unless otherwise allowed by the Design Engineer. Engineered Fill will be spread in relatively uniform lifts, no greater than 8 inches in thickness (uncompacted). Each lift will be compacted with sufficient passes (back and forth) of compaction equipment, to achieve a minimum 95 percent of the maximum dry density. Additional passes may be required if CQA testing does not verify that adequate compaction is being achieved.

The contractor shall be responsible for coordinating all testing, and confirming that all tests are passing prior to placing successive lifts of soil. The CQA Monitor shall document field density testing results on a field density log and locations on a general location map for inclusion into the LER.

Prior to placement of successive lifts, the surface of previously compacted lifts or subgrade will be scarified using tracks of dozer, a disk, or other methods acceptable to the CQA Monitor. Placement methods shall be such that smooth interfaces between successive lifts are not created. Surface will be moisture conditioned if dried prior to placement of successive lifts.

2.3 SURVEYING

Field surveying will be conducted to verify the lines and grades of the liner subgrade. A 50-foot by 50-foot survey grid will be established with additional coverage to confirm compliance with the design grades, including top and toe of slopes and other grade changes. The survey will be used to establish as-built construction information and verify soil liner and protective cover thickness, as described in Section 3.5 and Section 10.3, respectively. Field surveying will be conducted to verify the lines and grades of the liner subgrade at a tolerance of 0 feet to +0.2 feet.

2.4 CONTROL OF SURFACE WATER

The excavation may be subject to ponded water from storm events. The excavation area will therefore have a down-gradient low area or temporary sump area to collect water entering the excavation, and be graded to allow drainage to this area. Portable pumps will be on-site to dewater the low areas or temporary sump(s). Temporary internal and external diversion berms also will be constructed to divert surface water away from the excavation.

Management of surface water and contact water is Contractor's responsibility. Contractor shall provide and maintain proper equipment and facilities (pumps, sumps, suction, and discharge lines, and other dewatering system components) to remove surface water. Contractor shall keep excavations and subgrade soils and draining to extent possible so as to obtain a satisfactory foundation condition for the cell construction.

Soft, excessively wet, or otherwise deleterious subgrade areas identified by CQA Monitor shall be removed (over-excavated) and replaced with Engineered Fill meeting the material and compaction requirements described above, to achieve the design elevations and to provide sufficient foundation support to the overlying compacted soil layer. The extent of over-excavation shall be identified by the CQA Monitor so that the affected area provides a firm foundation and ties in to surrounding areas with acceptable proof-roll results or properly placed Engineered Fill.

The subgrade shall be firm and without standing water prior to placement of overlying compacted soil layer. Contractor shall establish and maintain temporary drainage ditches and other diversions outside limits of subgrade to convey surface water away from the subgrade to natural drainage pathways. Any ponded water that accumulates on newly constructed subgrade surface shall be promptly removed.

3 LOW PERMEABILITY SOIL LINER

3.1 INTRODUCTION

Construction of the low permeability soil liner will begin after excavation, embankment construction, subgrade preparation, and grading to excavation grades has been completed. For this Landfill, the soil liner constructed for all Cell 3 and future expansions will be a 2-foot thick compacted soil (clay) liner, as described in Section 1.1.

Soil for the soil liner must achieve an installed hydraulic conductivity of $1x10^{-7}$ cm/s or less; a liquid limit (LL) of 30 or greater; a plasticity index (PI) of 15 or greater; percent passing the No. 200 sieve of 30 percent or greater; and 100 percent passing the 1-inch sieve (i.e., no particles greater than 1 inch in size) with no more than 10 percent rocks by weight. The final lift of the soil liner shall not contain rock or other deleterious materials that can cause damage to the overlying geomembrane.

3.2 QUALITY ASSURANCE TESTING

3.2.1 Pre-Construction Testing

Pre-construction testing will be performed for each liner material borrow source and for each identifiable change in material from an individual borrow source (i.e., change in color and plasticity or gradation based on visual observation by the GP or CQA Monitor). A change in color only (with same gradation and plasticity characteristics) will not be considered a change of material. Density test results will be reported as a percentage of the maximum dry density at a corresponding optimum moisture content. Testing will be performed according in the laboratory according to the testing schedule set forth in Table 3-1.

For each borrow source, correlations will be developed based on moisture/density tests and hydraulic conductivity tests (performed on soil samples at a calculated density) of representative soil samples demonstrating that the soils will have the required permeability at the specified level of compaction. Field moisture/density test results will be reported as a percentage of the maximum dry density at the corresponding optimum moisture content. Correlation testing will be provided to GP and CQA Monitor for use in the field during soil liner construction.

Table 3-1 Soil Liner Pre-Construction Testing Schedule

TEST	METHOD USED	FREQUENCY
Unified Soil Classification	ASTM D2487	1 per soil type / minimum 1 per borrow source
Sieve Analysis	ASTM D422 or D1140	
Atterberg Limits	ASTM D4318	
Moisture/Density Relationship	ASTM D698	
Hydraulic Conductivity	ASTM D5084 or D5093 (1)(2)(3)	1 per Moisture-Density Relationship

1. Field testing of permeability (in accordance with ASTM D5093) is optional, and may be replaced by laboratory testing.
2. Testing procedures in Appendix VII of the Corps of Engineers Manual EM 1110-2-1906, November 30, 1970, Laboratory Soils Testing, may be used as an alternative method.
3. Permeability tests will be conducted with tap water or 0.05N solution of CaSO4. Distilled water will not be allowed.

3.3 CONSTRUCTION TESTING

Construction quality assurance for the soil liner will consist of both laboratory and field testing. The minimum frequencies and test methods for testing soil liner during construction are presented on Table 3-2. The CQA Monitor will be on-site during clay liner construction activities. Laboratory testing will be performed by a quality assurance laboratory.

Quality assurance testing of soil liner will be performed during the construction of the liner. In no instance will any quality assurance field or laboratory testing be undertaken after completion of liner construction, except for that testing which is required of the final constructed lift or confirmation of layer thickness. All soil testing and evaluation of the clay liner will be complete prior to installing the geomembrane and leachate collection system on the area under construction.

Table 3-2 Soil Liner Construction Testing Schedule

TEST	METHOD	MINIMUM FREQUENCY
Field Moisture/Density Test	ASTM D1556, D2167, or D6938	1 per 8,000 ft^2 per 6-inch lift (1)
Sieve Analysis	ASTM D422 or D1140	1 per 100,000 ft^2 per 6-inch lift (2)
Atterberg Limits	ASTM D4318	
Hydraulic Conductivity (3) (4)	ASTM D5084 or CoE EM 1110-2-1906 or ASTM D5093 (5)	
Thickness	Survey	1 per 5,000 ft^2

1. A minimum of three tests must be conducted for each 6-inch lift, regardless of area.
2. A minimum of one test must be conducted for each lift, regardless of area.
3. Testing will be conducted on undisturbed samples collected by Shelby tubes in accordance with ASTM D1587.
4. Permeability tests will be run using tap water or a 0.05N solution of $CaSO_4$. Distilled water will not be allowed.
5. Field testing of permeability (in accordance with ASTM D5093) is optional, and may be replaced by laboratory testing.

3.4 CONSTRUCTION PROCEDURES

3.4.1 General Construction Procedures

During placement of the soil liner, the following guidelines apply:

- The subgrade surface should be scarified (roughened) prior to placing the first lift of the soil liner, thus providing adequate bonding between the liner and underlying foundation soils.

- Bottom and sideslope soil liners will be constructed in compacted lifts not exceeding 6 inches (or 8-inches uncompacted). The top of each subsequent lift should be scarified (roughened) to a shallow depth prior to the spreading and compaction of successive lifts, thereby providing bonding between the lifts.

- The maximum clod size of the compacted liner soils shall be approximately one inch in diameter. In all cases soil clods shall be reduced to the smallest size necessary to achieve the coefficient of permeability reported by the testing laboratory and to destroy any macrostructure evidenced after the compaction of the clods under density-controlled conditions.

- No loose lift should be thicker than the pads of the compactor so that complete bonding with the top of the previous lift is achieved. The soil liner lifts will be compacted with a minimum 3 passes (back and forth) of the compaction equipment to achieve the target compaction.

- At a minimum, soil liner will be compacted to 95 percent of the maximum dry density and at a moisture content of 0 to +4% above optimum, as determined by ASTM D698. Soil liner density/moisture test results will be reported as a percentage of the maximum dry density at the corresponding moisture content percentage. The CQA Monitor will inspect the adequacy of the scarification and compaction effort in providing good lift bonding (i.e., no smooth interface between lifts) during the initial stages of layer installation.

- The soil liner will be compacted to meet a hydraulic conductivity less than or equal to 1×10^{-7} cm/sec.

- Although not anticipated since design grades are not this steep, equipment and safety limitations prohibit finished grades with slopes greater than 3H:1V if the liner is constructed parallel to the surface. Compaction equipment placing sideslope liners on slopes steeper than 3H: 1V results in reduced stability of compaction equipment, and reduction in compaction efficiency.

- The top surface of the completed soil liner must be sealed with a smooth-drummed roller prior to final liner thickness surveying and placement of the geomembrane liner.

- The surface of the soil liner will be sealed by smooth drumming when construction is to be shut down for more than 24 hours to mitigate the effects of desiccation and wetting from rainfall events. Additionally, smooth drum rolling to seal the surface will be required on a routine basis during the summer months at the end of each day’s liner construction to reduce desiccation.

- Any liner perforations required for obtaining laboratory samples will be repaired by backfilling the hole with bentonite chips or 50/50 powdered/granulated bentonite/soil/sand mixture hand-tamped into place. If the hole is in the upper lift of soil liner, the upper 2 inches will be backfilled by clayey liner soil which will be hand-tamped sufficiently to blend the backfill into the adjacent soil liner lift.

- Soil liner construction shall be conducted in a systematic and timely manner, such that the soil liner is not left exposed for an extended period of time. The Contractor will be required to maintain any exposed soil liner in a condition acceptable to the CQA Monitor through the completion and approval of the soil liner, and during placement of the geomembrane over the soil liner.

3.4.2 Liner Tie-ins and Terminations

The leading 10 to 20 feet of the liner will not be covered with CCR waste, but instead will be protected to facilitate tie-in with subsequent cell liners. Soil liner tie-ins will be performed using the following procedures:

- Soil liner tie-ins to Cell 1 Liner:
    - Liner tie-ins will be constructed by “butting” the entire thickness of a new liner segment next to the previously constructed section of liner.
    - The surface of the existing liner will be scarified (roughened) prior to subsequent soil placement, to further reduce the possibility of construction joints.
- Soil liner tie-ins to previously constructed Cell 3 and future composite liners systems:
    - The edge of the previously installed liner will be uncovered, exposed, and cut back on a slope so that the entire existing liner edge is tied to new construction without superimposed construction joints.
    - The surface of the existing liner will be scarified (roughened) prior to subsequent soil placement, to further reduce the possibility of construction joints.
    - The length of the tie-in area should be at least 5 feet per foot thickness of liner.
    - Liners will not be constructed by “butting” the entire thickness of a new liner segment next to the previously constructed section of liner.

3.4.3 Hydrating Soil Liner

Prior to attempting to hydrate (moisture condition by wetting) clayey soils, clod sizes will be reduced by disking, pulverizing, or other method of breaking clods as acceptable to the GP or CQA Monitor. The number of passes required for adequate clod size reduction will be determined in the field between the Contractor and GP (minimum of 3 passes back and forth), based on soil condition, equipment used, and equipment operation. After applying water, the soil will be mixed and stockpiled, if necessary, to allow adequate time for hydration to occur. The amount of moisture conditioning and time of hydration will be determined in the field by the GP. Water used in hydrating liner soils must be clean and will not have come into contact with waste, CCR, or any objectionable material.

3.5 PROCEDURES FOR ADDRESSING FAILING TESTS

3.5.1 Failing Field Density Tests

As described in Table 3-2, field density tests will be performed at a frequency of 1 test per 8,000 square feet, per lift. In the event a test indicates field density less than specified, the Contractor will be required to moisture condition (either dry or moisten, if needed) the soil, and then re-compact and retest the soil. The entire 8,000 square foot area represented by the failing test will be required to be reworked.

Alternately, the Contractor may perform a minimum of 3 additional field density tests spaced no less than 20 feet in a circular pattern surrounding the original failed test, and, if all tests pass field density, the rework area will be limited to the area inside of the circle formed by the passing tests. If one or more of the additional field tests fail, the entire 8,000 square foot area represented by the failed test will require reworking.

In the event of a second failed field density test, the GP will be immediately notified, and a field decision made by the GP regarding conducting a second rework of the area (as described above) or alternately, requiring that an additional Proctor test be performed on the soils comprising the failed test area. If an additional Proctor test is required, the GP will direct the Contractor to either obtain soil samples from the failed area, or alternately, from the borrow source from which the failing soils were obtained. Reworking and retesting of the soils will not occur until after the additional laboratory testing has been completed, and the new Proctor test information submitted to the GP or CQA Monitor.

The results of both passing and failing tests will be recorded and reported within the LER.

3.5.2 Failing Gradation or Atterberg Limits Tests

As described in Table 3-2, gradation and Atterberg limits tests will be performed at a frequency of 1 test per 100,000 square feet, per lift of soil liner (concurrent with permeability tests). In the event of a failing test, the GP will immediately be notified, and the failing laboratory results provided to the GP. If either the LL or the PI varies by 10 or more points when compared against the appropriate moisture/density curve developed for that borrow source, the soil is considered as a separate soil borrow source and a new test series, including moisture/density, compaction relationship, sieve analysis, and coefficient of permeability should be determined and these results used for field construction control.

Additional test samples will be obtained at a minimum of 3 locations, spaced no less than 20 feet in a circular pattern surrounding the original failed test. If passing results are obtained for the additional test samples, the area defined by the passing tests will be removed, replaced, and retested. If one or more of the additional tests fail, a new sample will be obtained 30 feet (minimum) from the original failed test (along a line radiating from the original failed test through the failing additional test(s)), and in 10-foot (minimum) increments thereafter, until passing test results are obtained. The area requiring removal and replacement ultimately will be defined by passing test results. After removal and replacement, one additional passing test in the approximate center of the reworked area will be required.

3.5.3 Failing Permeability Tests

As described in Table 3-2, permeability tests will be performed at a frequency of 1 test per 100,000 square feet, per lift of soil liner (concurrent with gradation and Atterberg limits tests). In the event of a failing permeability test, the GP will immediately be notified, and the failing laboratory results provided to the GP.

Prior to requiring additional permeability sampling and testing, a field density test will be performed at the location of the failed test. If a failing field density test is obtained, the failed area will be defined as described in Section 3.4.1, except that additional field density testing will be performed until passing tests are obtained. After reworking and achieving passing field density tests, a new permeability sample will be obtained for testing.

If passing field density tests are obtained at the location of the failed permeability test location, additional Atterberg limits and gradation test samples will be obtained at a minimum of 3 locations, spaced no less than 20 feet in a circular pattern surrounding the original failed test. If passing results are obtained for the additional test samples (Atterberg limits and gradation tests), the area defined by the passing tests will be removed and replaced. If one or more of the additional tests fail, a new sample will be obtained 30 feet (minimum) from the original failed test (along a line radiating from the original failed test through the failing additional test(s)), and in 10-foot (minimum) increments thereafter, until passing test results are obtained. Passing Atterberg limits and gradation test results will be used to define the area requiring removal and replacement. After removal and replacement, a new permeability sample will be obtained and tested, and a passing test obtained prior to approval of the reworked area.

3.6 THICKNESS VERIFICATION

The thickness of constructed soil liners will be verified by surveying methods. As described in Table 3-2, at a minimum, one thickness verification will be performed for every 5,000 square feet of constructed soil liner. Survey locations will be based on pre-established survey grid in accordance with Section 2.3. A minimum of three (3) survey points shall be used for all constructed soil liners regardless of size. All elevation calculations necessary for thickness verification will be included in the LER submittal. The compacted clay liner shall have a minimum thickness of 2 feet and the thickness tolerance shall be 0 to 0.2 feet.

4 GEOMEMBRANE

4.1 INTRODUCTION

This section describes CQA procedures for the installation of 60-mil high-density polyethylene (HDPE) geomembrane. CQA procedures for drainage geocomposite, geotextiles, and leachate collection piping are discussed in Sections 5 through 8. The overall goal of the CQA procedures is to confirm (1) that proper materials, construction techniques and procedures are used; (2) that the Geosynthetic Contractor implements a quality control plan in accordance with this CQA Plan; and (3) that the project is built in accordance with this CQA Plan and the project construction plans and technical specifications. The quality assurance program is intended to identify and define problems that may occur during construction and to observe that these problems are avoided and/or corrected before construction is complete.

The LER, prepared after completion of construction, will document that the constructed facility meets the design intent and technical specifications.

4.2 QUALITY CONTROL AND QUALITY ASSURANCE TESTING

CQC during installation of the geomembrane will be performed by the Geosynthetics Contractor. CQA during installation of geomembrane will be performed by the GP or CQA Monitor to assure that the geomembrane is installed in accordance with this CQA Plan and the project construction plans and technical specifications. To monitor compliance, a quality assurance program will include the following:

- A review of the geomembrane manufacturer’s quality control submittals.
- Material conformance testing.
- CQA testing, both destructive and non-destructive.
- Construction monitoring and documentation.

Conformance testing refers to activities that take place prior to material installation. Construction testing includes activities that occur during geosynthetic installation. Quality control/assurance monitoring and testing will be conducted in accordance with this CQA Plan and the project construction plans and technical specifications. The GP or CQA Monitor will be on-site, and observe geomembrane installation and testing activities.

4.2.1 Manufacturer’s Quality Control

Prior to the installation of the geomembrane, the manufacturer or installer will provide the GP with quality control certificates signed by a responsible party employed by the manufacturer. Each quality control certificate will include roll identification numbers, testing procedures, and results of quality control tests. The manufacturer’s quality control tests will be performed in accordance with the test methods and frequencies provided in the most recent version of Geosynthetic

Research Institute (GRI) standard GM-13. Additionally, testing for the geomembrane resin will be performed in accordance with the following:

- Specific Gravity/Density (ASTM D792 or D1505): 1 per batch and every resin lot; and
- Melt Flow Index (ASTM D1238): 1 per batch and every resin lot.

All geomembrane properties must meet the minimum values set forth in the most recent version of GRI standard GM-13. UV Resistance testing not required for geomembrane that will be immediately covered. A copy of the current version of GRI-GM13 is included in Attachment IV.B1.

4.2.2 Conformance Testing

Conformance testing refers to testing (by a third-party independent laboratory) performed after manufacture of the geomembrane to verify it meets the required specifications. Conformance testing methods and required frequencies are presented in Table -4-1.

Table 4-1 Geomembrane Conformance Testing Schedule

TEST	METHOD	MINIMUM FREQUENCY
Thickness (laboratory)	ASTM D5994	1 per 50,000 ft^2 and every resin lot
Density	ASTM D1505 or D792	1 per 100,000 ft^2 and every resin lot
Carbon black content	ASTM D1603	
Carbon black dispersion	ASTM D5596	
Tensile properties (2)	ASTM D638 or D6693	

1. No single measurement will be less than ten percent below the required nominal thickness in order for the panel to be acceptable. A minimum of 5 measurements will be made per panel.
2. 2-inch initial gauge length assumed for elongation at break at 2.0 in/min.

4.3 INSTALLATION

4.3.1 Delivery

Upon delivery of the geomembrane, the CQA Monitor will observe that:

- The geomembrane is delivered in rolls and is not folded. Any evidence of folding (other than from the manufacturing process) or other shipping damage is cause for rejection of the material.
- Equipment used to unload and store the rolls does not damage the geomembrane.
- The geomembrane is stored in an acceptable location and in accordance with the manufacturer's recommendations and specifications. The geomembrane must not be

stored more than five (5) rolls high. During delivery and storage, the geomembrane must be protected from puncture, dirt, grease, water, mud, mechanical abrasions, excessive heat, or other potentially damaging elements. During storage, the geomembrane shall be raised off the floor/ground to minimize damage.

- All manufacturing documentation required by this CQA Plan, as set forth in the technical specifications, has been received and reviewed for compliance with the specifications. This documentation will be included in the LER.
- The geosynthetics receipt log form has been completed for all materials received.

Damaged geomembrane will be rejected and removed from the site or stored at a location separate from accepted geomembrane. Geomembrane that does not have proper identification or manufacturer's documentation must be stored at a separate location until all documentation has been received, reviewed, and accepted, and will not be incorporated into work until all required documentation is received and reviewed by the CQA Monitor for completeness.

4.3.2 Panel Placement

During panel placement, the CQA Monitor must perform the following:

- Record panel and roll numbers and lengths on the panel placement and/or panel seaming log. Develop field notes documenting panel deployment that depicts the locations of panels, seams, destructive test locations and repairs. These field notes will be used to produce a record drawing of the panel placement to be included in the LER. Alternatively, the panel placement drawing may be developed from field surveying methods.
- Observe the geomembrane surface as it is deployed and record all panel defects and repair of the defects (panel rejected, patch installed) on the repair sheet. All repairs will be made in accordance with this CQA Plan, supplemental technical specifications, and located on the record drawing of panel placement.
- Observe that heavy vehicular equipment is not allowed on the geomembrane during handling (low ground-pressure support equipment, such as generators, may be allowed with rub sheet protection, as applicable).
- Observe that there are no angular stones greater than 1 inch in size, construction debris, or other deleterious items immediately beneath the geomembrane within the soil liner, which could cause damage to the geomembrane.
- Observe that the geomembrane is placed in a manner that provides good contact with the underlying materials, and that no bridging or stretching over surface features occurs. The subgrade (soil liner) under the geomembrane must be smooth-rolled, and maintained in a smooth, uniform, and compacted condition during geomembrane installation. Geomembrane placement methods must be conducted as not to rut or damage underlying soil liner.

- Observe that the geomembrane is not dragged across a surface that would damage the material. If the geomembrane is dragged across an unprotected surface, the geomembrane must be inspected for damages and repaired or rejected, as necessary. Record weather conditions including temperature. The geomembrane must not be deployed in the presence of excess moisture (fog, dew, mist, etc.), rain, or high wind. In addition, the geomembrane should not be placed when the air temperature is less than 40°F unless this requirement is waived by the Design Engineer in writing. Excessive wind is that which can lift and move the geomembrane panels.

- Observe that people working on the geomembrane do not smoke, wear shoes that could damage the geomembrane, or engage in activities that could damage the geomembrane.

- Observe that the method used to deploy the geomembrane minimizes wrinkles and that the geomembrane is anchored to prevent movement by the wind. Wrinkles should be walked-out or removed at the discretion of the CQA personnel. Confirm that the geomembrane is placed in a manner that provides good contact with the underlying soil liner materials, and that no bridging or stretching over surface features occurs.

- Observe that no more panels are deployed than can be seamed on that same day.

- Observe that there are no horizontal seams on sideslopes and that the textured material extends a minimum length beyond the toe of the slope as shown on the construction plans.

The CQA Monitor must inform both the Contractor and the GP of any observed variances or unacceptable conditions from above. Note, however, that the CQA Monitor’s failure to identify one or more of the above conditions does not relieve the Contractor of responsibility for installing and protecting the geomembrane installation in accordance with the CQA Plan, construction plans, and technical specifications.

4.3.3 Field Seaming

A seam numbering system must be agreed to by the GP and Contractor prior to the start of seaming operations. One procedure is to identify the seam by adjacent panels. For example, the seam located between Panels 306 and 401 would be Seam No. 306/401.

Trial seam testing will be performed for each of the following events:

- At the beginning of each seaming period per workday and for each seaming apparatus, including in the morning and immediately after each extended break throughout the day.

- After any major change in environmental condition, i.e., temperature, humidity, dust, etc.

- Any time the seaming apparatus is turned off for longer than 30 minutes.

- When seaming different geomembranes, i.e., smooth to textured.

Both the welder and the welding apparatus must be tested for extrusion welding. Only the apparatus must be tested according to the above schedule for fusion welding. Each welder or seamer, whether extrusion or fusion welding, must be tested at least once daily.

Each trial seam shall be at least three (3) feet in length, and 1 foot wide. A minimum of four (4) adjoining 1-inch wide coupons will be die-cut from the test seam. Two (2) field samples will be tested for shear, and two (2) samples tested for peel. The apparatus used for field testing must have a current certificate of calibration issued by the appropriate state or federal agency.

If one (1) of the test seams fails, the trial seam will be repeated and testing performed on the trial seam samples. If the second trial seam fails, two additional trial seams will be performed and tested. Trial seaming and retesting will continue until two (2) consecutive passing test series (i.e., two (2) consecutive trial seams) are achieved for the apparatus, and welder, if applicable (extrusion welding only).

The CQA Monitor must observe trial welding operations, quantitative testing of each trial weld for peel and shear, and recording of the results on the trial weld form. It is important that the trial welds or seams be completed under conditions similar to those under which the panels will be welded.

CQA documentation of trial seam procedures shall include, at a minimum, the following:

- Documentation that trial seams are performed by each welder and welding apparatus prior to commencement of welding and prior to commencement of the second half of the workday, or after extended break periods throughout the day.
- The welder, the welding apparatus number, time, date, ambient air temperature, welding machine temperatures and trial seam number for each trial seam.

During geomembrane welding operations, the CQA Monitor must observe the following:

- The Contractor has the number of welding apparatuses and spare parts necessary to perform the work.
- Equipment used for welding will not damage the geomembrane.
- The extrusion welder is purged prior to beginning a weld until all the heat-degraded extrudate is removed.
- Seam grinding has been completed less than one hour before seam welding, and the upper geomembrane is beveled (extrusion welding only).
- The end of welds more than five (5) minutes old are ground to expose new material before restarting a weld (extrusion welding only).
- The ambient temperature, measured six (6) inches above the geomembrane surface, is between 41° and 104° Fahrenheit.

- The contact surfaces of the geomembrane are clean, free of dust, grease, dirt, debris, and moisture prior to welding.
- The seams are overlapped a minimum of three (3) inches for extrusion and hot wedge welding, or in accordance with manufacturer's recommendations, whichever is more stringent. Panels should be overlapped (shingled) in the down-grade direction.
- No solvents or adhesives are present in the seam area.
- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude CQA testing.
- The panels are being welded in accordance with the plans and specifications. Seams should be oriented parallel to the line of maximum slope. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- There is no free moisture in the weld area.

Observe that at the end of each day or installation segment, all unseamed panel edges are anchored with sandbags or other approved devices. Penetration anchors shall not be used to secure the geomembrane. If seaming operations are carried out at night, adequate illumination shall be provided and must be approved by the GP.

4.4 SEAM TESTING

During seam testing, the CQA Monitor will perform the following tasks:

- Review technical specifications regarding test procedures.
- Observe that equipment operators are properly trained and qualified to perform their work.
- Observe that test equipment meets project technical specifications.
- Observe that the entire length of each seam is tested in accordance with the specifications.
- Observe continuity testing and record results on the appropriate test log.
- Observe that testing is completed in accordance with the technical specifications.
- Identify the failed areas by marking the area with a waterproof marker compatible with the geomembrane, and inform the Contractor of any required repairs, then record the repair area on the repair log.
- Observe that all repairs are completed and tested in accordance with the project specifications.

- Record all completed and tested repairs on the repair log.

For destructive samples, the CQA Monitor will select locations where seam samples will be cut for laboratory testing. Sample locations should not be disclosed to the Contractor prior to completion of the seam.

Destructive samples must be shipped to the third-party laboratory for seam testing. Test methods and required frequencies are presented in Section 4.4.1. The third-party laboratory will provide test results in writing or via telephone, to the GP. Certified test results are to be provided within 5 days. The CQA Monitor must immediately notify the GP in the event of a calibration discrepancy or failed test results.

4.4.1 Non-Destructive Testing

Continuous, non-destructive testing will be performed on all seams by the installer. Air pressure testing on dual-track fusion welds and vacuum-box testing for extrusion welds are the only acceptable methods. Leaks must be isolated and repaired by the following procedures:

1. Air-Pressure Testing (GRI GM6) - The ends of the air channel of the dual-track fusion weld must be sealed and pressured to approximately 30 psi, if possible. The air pump must then be shut off and the air pressure observed after five (5) minutes. A loss of less than 4 psi is acceptable if it is determined that the air channel is not blocked between the sealed ends. A loss of 4 psi or more indicates the presence of a seam leak that must then be isolated and repaired by following the procedures described under "Seam Failure Repairs and Retesting." The GP or his/her qualified representatives must observe and record all pressure gauge readings.

2. Vacuum-Box Testing (ASTM D4437) - A suction value of approximately 3 to 5 inches of gauge vacuum must be applied to all extrusion welded seams that can be tested in this manner. Examples of extrusion welded seams that do not easily lend themselves to vacuum testing would be around boots, appurtenances, etc. The seam must be observed for leaks at least ten seconds while subjected to this vacuum. The GP or his/her qualified representative must observe 100 percent of this testing.

4.4.2 Destructive Testing

Destructive seam testing will be performed in accordance with ASTM D6392. Destructive samples shall be taken at a minimum of one (1) location for every 500 linear feet of field seam. The total footage of individual repairs of leaks of more than 10 feet and individual repairs of more than 10 feet for failed seams must also be counted and destructively tested using the same frequency of testing described above. At a minimum, a destructive test must be done for each welding machine used for seaming or repairs. A sufficient amount of the seam must be removed in order to conduct field testing, independent laboratory testing, and archiving of enough material in order to retest the seam when necessary.

Field testing shall include at least two (2) peel test specimens (four (4) when possible for testing both tracks on dual-track fusion welded seams). Independent laboratory testing shall consist of five (5) shear test specimens and five (5) peel test specimens (10 when possible for both tracks of dual-track fusion welded seams). Destructive seam-testing locations shall be cap-stripped and the cap completely seamed by extrusion welding to the parent geomembrane. Capped sections shall be nondestructively tested. Additional destructive test samples may be taken if deemed necessary by the GP or CQA Monitor.

All field-tested specimens from a destructive test location must be passing in both shear and peel for the seam to be considered as passing. Field-tested specimens are determined as passing if the specimen tested in peel fails in film tear bond (FTB) and all test specimens meet the criteria listed in Table 4-2. Independent laboratory testing must confirm these field results. The minimum passing criteria for independent laboratory testing are all three of the following:

- 5 of 5 specimens tested in the peel mode must fail in FTB.
- 5 of 5 specimens from each peel and shear determination must meet the minimum specified values in Table 4-2.
- All 5 specimens for shear determination should meet the minimum percent elongation at break value in Table 4-2.

The above criteria must be met by both tracks from each dual-track fusion welded seam before it is considered as passing.

Table 4-2 Geomembrane Seam Strength Schedule

Property	Qualifier	Unit	Value
Shear Strength	Min.	lb/in	120
Shear elongation at break	Min.	%	50
Peel Strength:			
Fusion	Min	lb/in	91
Extrusion	Min.	lb/in	78

4.4.3 Seam Failure Delineation

In the event failing tests are obtained at a destructive test location, new destructive test samples will be obtained, a minimum of 10 feet in either direction of the failing test. If one, but not both, of the additional tests fail, further additional destructive testing will be required until passing tests are obtained at both ends of the original destructive test location. A cap will be required for the areas subject to destructive testing, and testing of the cap will be required as set forth in this CQA Plan. If more than two failing destructive test locations are observed for a single seam, the CQA Monitor will have the alternative of requiring the entire seam be removed, and a new seam welded.

In the event more than one (1) failing destructive test are observed for a single welding apparatus, new (passing) trial welds will be required prior to resuming geomembrane welding or seaming with the apparatus.

4.5 REPAIRS AND RETESTING

All seam leaks and destructive test locations shall be repaired for a distance of at least six (6) inches on each side of the leak or destructive test location. At a minimum, these repairs shall be non-destructively retested in accordance with Section 4.4.1. Destructive testing shall be performed in accordance with Section 4.4.2, or at the discretion of the CQA Monitor.

4.5.1 Repairs

Any portion of the geomembrane with a detected flaw, or which fails a non-destructive or destructive test, or where destructive tests were cut, or where non-destructive tests left cuts or holes, must be repaired in accordance with the specifications. The CQA Monitor must locate and record all repairs on the repair sheet. Repair techniques include the following:

- Patching - used to repair holes, tears, large panel defects, undispersed raw materials, contamination by foreign matter, and destructive sample locations.
- Extrusion - used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than 3/8-inch in the largest dimension.
- Topping – used to repair inadequate seam areas, which have an exposed edge, for lengths of seams under five (5) feet. An extruded weld shall be permitted along the outside edge.
- Capping - used to repair failed welds or to cover seams, less than five (5) feet in length, where welds or bonded sections cannot be non-destructively tested. An extrusion weld or fusion weld shall be allowed.
- Spot welding and seaming – used to repair small tears, pinholes, or other minor, localized flaws.
- Removal - used to replace areas with large defects, greater than five (5) feet in length, where the preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal shall be patched or capped.

Repair procedures will include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one (1) hour prior to the repair.
- Clean and dry all surfaces at the time of repair.
- Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of patches to a radius of at least 3 inches. Bevel the top edges of patches prior to extrusion welding.
- Geomembrane below large caps should be approximately cut to avoid water or gas collection between the two sheets.

4.5.2 Wrinkles

During placement of cover materials over the geomembrane, temperature changes or creep can cause wrinkles to develop in the geomembrane. Wrinkles which can fold over must be repaired either by cutting out the excess material or, if possible, by allowing the liner to contract by temperature reduction. In no case can material be placed over the geomembrane which could result in the membrane folding. The CQA Monitor must monitor the geomembrane for wrinkles and notify the Contractor if wrinkles are being covered by soil. The CQA Monitor is then responsible for documenting corrective action to remove the wrinkles.

4.5.3 Folded Material

All folded geomembrane must be removed. Remnant folds evident after deployment of the roll which are due to manufacturing process are acceptable.

4.5.4 Bridging or Induced Tension

Bridging or Induced Tension: Bridging is defined as areas where the geomembrane is not in contact with the subgrade due to a void in the subgrade or the sheet is pulled in tension so as to span over depressions in the subgrade. Areas likely to promote bridging, i.e. trenches, toe of slopes, etc., shall be loaded with sandbags after deployment and after seaming. Induced tension is stress introduced into the geomembrane during installation or covering. These areas will likely result in bridging. Areas with excessive bridging shall be identified and repaired by either of the following methods:

1. The geomembrane shall be cut by the Contractor, so the tension is relieved and the geomembrane conforms to the subgrade contours. The cut geomembrane shall be repaired and tested according to the Contract Documents regarding repairs and testing.

2. The geomembrane shall be cut by the Contractor, and subgrade material shall be added and placed, in accordance with the contract specifications, so as bring the geomembrane in contact with the subgrade. The cut geomembrane shall be repaired and tested according to the Contract Documents regarding repairs and testing.

4.5.5 Anchor Trench

An anchor trench will be constructed around all portions of the geomembrane where the leading edge(s) of the geomembrane will not be needed for future tie-in for expansion into the next lined cell. The anchor trench backfill material will be placed as outlined in the technical specifications. Care will be taken when backfilling and compaction to prevent damage to the underlying geomembrane. Slightly rounded corners will be provided in anchor trenches where the geomembrane enters the trench as to avoid sharp bends in the geomembrane.

The geomembrane anchor trench will be left open until seaming is completed. Expansion and contraction of the geomembrane should be accounted for in the liner placement. The anchor trench will be filled in the morning when temperatures are coolest to reduce bridging of the geomembrane.

The anchor trench backfill material will be placed in uniform lifts compacted to at least 90 percent of standard Proctor (ASTM D 698) density at a moisture content ranging from -2 to +4 percent of optimum. Compaction density and moisture of the anchor trench backfill will be visually verified by the CQA Monitor. Specific density and moisture testing of in-place anchor trench backfill will be at the discretion of the CQA Monitor.

4.6 GEOMEMBRANE ACCEPTANCE

The Contractor retains all ownership and responsibility for the geomembrane until acceptance by the Landfill Owner/Operator. In the event the Contractor is responsible for placing cover over the geomembrane, the Contractor retains all ownership and responsibility for the geomembrane until all required documentation is complete, and the cover material is placed. After panels are placed, seamed, tested successfully, and any repairs are made, the completed installation will be inspected by the Landfill Owner/Operator's and Contractor's representatives. Any damage or defect found during this inspection will be repaired by the installer. The installation will not be accepted until it meets the requirements of both representatives. In addition, the geomembrane will be accepted by the GP only when the following has been completed:

- The installation is finished.
- All seams have been inspected and verified to be acceptable.
- All required laboratory and field tests have been completed and reviewed.
- All required Contractor-supplied documentation has been received and reviewed.
- Record drawings of the panel placement, testing, and repairs have been completed and verified by the GP. The record drawings show the panel dimensions, the location of all panels, seams, destructive tests, and repairs.
- Acceptance of the LER by the Landfill Owner/Operator, certification letter submitted to the TCEQ, and TCEQ inspection (if applicable).

5 DRAINAGE GEOCOMPOSITE

5.1 INTRODUCTION

This section describes CQA procedures for the installation of drainage geocomposite in the liner. All quality control testing will be conducted in accordance with this CQA Plan, construction plans, and technical specifications. The GP or CQA Monitor will be on-site, and observe all geocomposite installation.

5.2 DELIVERY

Upon delivery, the CQA Monitor must observe the following:

- Unloading equipment will not damage the drainage geocomposite rolls.
- Drainage geocomposite rolls are wrapped in impermeable and opaque protection covers.
- Care is used when unloading the rolls.
- All documentation required by the CQA Plan and technical specifications has been received and reviewed for compliance.
- Each roll is marked or tagged with the manufacturer's name, lot number, roll number, and roll dimensions.
- Materials are stored in a location that will protect the rolls from precipitation, mud, dirt, dust, puncture, cutting, impact forces, or any other damaging or deleterious conditions.

Any damaged rolls shall be rejected and removed from the site or stored at a location, separate from accepted rolls, designated by the Landfill Owner/Operator. All rolls which do not have proper manufacturer's documentation shall also be stored at a separate location until all documentation has been received and approved.

5.3 QUALITY CONTROL TESTING

The drainage geocomposite manufacturer (or supplier), will conduct quality control testing in accordance with the manufacturer’s quality control program and certify that all materials delivered comply with technical specifications. The minimum frequencies and test methods for manufacturer’s quality control testing for geocomposites are presented in Table 5-1. The material certifications shall be reviewed by the GP and approved for the project prior to acceptance of any of the material.

The geocomposite manufacturer also shall certify that geocomposite transmissivity meets or exceeds the transmissivity requirements set forth in the construction plans and technical specifications (see Appendix IV.A – Leachate Collection and Removal System Plan for transmissivity requirements). The manufacturer shall further certify that transmissivity results meet or exceed all requirements for the gradient and confining pressures listed in the technical specifications. If alternate gradient or confining pressures are used for the certification, the geocomposite manufacturer shall certify that the material meets or exceeds the contract documents. However, even with the manufacturer's certification, the GP reserves the right to reject any materials not meeting the transmissivity requirements, including gradient and confining pressure requirements.

Table 5-1 Manufacturer's Testing Schedule for Geocomposite

PRODUCT	TEST	METHOD	MINIMUM FREQUENCY
Resin	Density	ASTM D1505 or D792	1 per batch and once per resin lot
	Carbon Black	ASTM D1603/4218	
Geonet	Density	ASTM D1505 or D792	1 per 100,000 ft^2 and once per resin lot
	Mass/Area	ASTM D1603	
	Tensile Strength	ASTM D5035	
	Thickness	ASTM D5199	
Geotextile	Mass/Area	ASTM D5261	1 per 100,000 ft^2 and once per resin lot
	Grab Tensile Strength	ASTM D4632	
	Puncture Strength	ASTM D4632	
	Apparent Opening Size	ASTM D4751	
	Water Flow Rate	ASTM D4491	
	UV Resistance	ASTM D4355	
Geocomposite	Ply Adhesion	ASTM F904	One test per product type
	Transmissivity(1)	ASTM D4716	

1. In accordance with ASTM D4716 with a normal stress of 20,000 PSF for the leachate collection with a gradient of 0.02; a profile of upper load plate, non-woven geotextile/HDPE drainage net/non-woven geotextile composite (if applicable), and lower plate; and a time period of 15 minutes.

5.4 INSTALLATION

5.4.1 Surface Preparation

Prior to geocomposite installation, the CQA Monitor must observe the following:

- All lines and grades have been verified by the Contractor.
- All debris, soil, dust and other materials shall be removed from the geomembrane surface being prepared prior to deployment of the overlying geocomposite.
- When placed over a geomembrane, the geomembrane installation, including all required documentation, has been completed.
- The supporting surface does not contain stones that could damage the geocomposite or the geomembrane.

5.4.2 Placement

During placement, the CQA Monitor must perform the following:

- Observe the geocomposite as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used to deploy the geocomposite does not damage the geocomposite or underlying geomembrane by handling, trafficking, leakage of hydrocarbons, or by other means.
- Verify that people working on the geocomposite do not smoke, wear shoes that could damage the geocomposite, or engage in activities that could damage the geocomposite or underlying geomembrane.
- Verify that the geocomposite is anchored to prevent movement by the wind (the Contractor is responsible for any damage resulting to or from wind-blown geocomposite. Use sandbags, or equivalent, to prevent bridging).
- Verify that the geocomposite remains free of contaminants such as soil, grease, fuel, etc.
- Observe that the geocomposite is laid smooth and free of tension, stress, folds, wrinkles, or creases.
- Observe that on slopes the geocomposite is secured in the anchor trench and then rolled or lowered down the slope in a controlled fashion.
- Observe that adjacent rolls of geocomposite are overlapped, tied, and seamed in accordance with the manufacturer’s recommendations and the specifications.
- Observe that the geonet components are tied at the specified interval with plastic fasteners. In the absence of other specifications, the adjoining geonet panels will be tied approximately every 5 feet along the roll length (edges) and every 1 foot along the roll width (ends).
- Observe that geotextile component is overlapped and either thermal bonded or sewn together.
- All seams shall run parallel to the line of the slope. Seams shall be overlapped a minimum of four (4) inches. Typing material shall be white or yellow for easy inspection. Metallic material shall not be allowed. The geotextile shall then be overlapped and sewn.

5.5 REPAIRS

Repair procedures include the following:

- Holes or tears in the drainage geocomposite will be repaired by placing a geocomposite patch extending 2 feet beyond the edges of the hole or tear.
- Secure patch to the originally installed geocomposite by tying every 6 inches.
- Where the hole or tear width across the roll is more than 50 percent of the roll width, the damaged area will be removed and replaced across the entire roll width.

6 NON-WOVEN GEOTEXTILE

6.1 INTRODUCTION

This section describes CQA procedures for the installation of non-woven for liner construction. Non-woven geotextile material requirements incorporated into geocomposite are discussed in Section 5. All quality control testing will be conducted in accordance with this CQA Plan and the project construction plans and technical specifications. The GP or CQA Monitor will be on-site, and observe all geotextile installation.

6.2 DELIVERY

During delivery the CQA Monitor must observe the following:

- Unloading equipment will not damage the geotextile rolls.
- Geotextile rolls are wrapped in impermeable and opaque protection covers.
- Care is used when unloading the rolls.
- All documentation required by the CQA Plan and technical specifications has been received and reviewed for compliance.
- Each roll is marked or tagged with the manufacturer's name, lot number, roll number, and roll dimensions.
- Materials are stored in a location that will protect the rolls from precipitation, mud, dirt, dust, puncture, cutting, impact forces, or any other damaging or deleterious conditions.

Any damaged rolls must be rejected and removed from the site or stored at a location separate from accepted rolls, designated by the Landfill Owner/Operator. All rolls which do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

6.3 QUALITY CONTROL TESTING

The geotextile manufacturer (or supplier), will conduct quality control testing in accordance with the manufacturer’s quality control program and certify that all materials delivered comply with technical specifications. The minimum frequencies and test methods for manufacturer’s quality control testing for the non-woven geotextile is presented in Table 6-1. The material certifications will be reviewed by the GP and approved for the project prior to acceptance of any of the material.

Table 6-1 Manufacturer's Testing Schedule for Non-Woven Geotextile

TEST	METHOD	MINIMUM FREQUENCY
Mass/Area	ASTM D5261	1 per 100,000 ft^2 and once per resin lot
Grab Tensile Strength	ASTM D4632	
CBR Puncture Strength	ASTM D6241	
Apparent OpeningUV Size	ASTM D4751	
UV Resistance	ASTM D4355	
Water Flow Rate	ASTM D4491	

6.4 INSTALLATION

6.4.1 Surface Preparation

Prior to geotextile installation, the CQA Monitor must observe the following:

- All lines and grades have been verified by the Contractor.
- Except where a geotextile is used as wrap around gravel (such as around chimney drains), all debris, soil, dust and other materials shall be removed from the surface being prepared for geotextile deployment.
- When placed over a geomembrane or geocomposite, the underlying material installation, including all required documentation, has been completed.

6.4.2 Placement

During placement, the CQA Monitor must observe the following:

- Observe the geotextile as it is deployed, and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Observe that equipment used does not damage the geotextile by handling, equipment transit, leakage of hydrocarbons, or other means.
- Observe that people working on the geotextile do not smoke, wear shoes that could damage the material, or engage in activities that could damage the material.

- Observe that the geotextile is securely anchored as applicable.
- Observe that the geotextiles are temporarily anchored as necessary to prevent movement by the wind.
- Observe that the panels are overlapped in accordance with the construction plans, technical specifications and manufacturer's recommendations.
- Examine the geotextile after installation to confirm that no potentially harmful foreign objects are present.
- Observe that seams (where required) are continuously sewn or thermal bonded in accordance with the manufacturer's recommendations and project specifications.

The CQA Monitor must inform both the Contractor and GP if the above conditions are not met.

6.5 REPAIRS

Repair procedures include the following:

- Patching - used to repair holes, tears and large defects.
- Removal - used to replace areas with large defects where the preceding method is not appropriate.

Holes, tears, and defects must be repaired in the following manner. Soil or other material which may have penetrated the defect must be removed completely prior to repair. If located on a slope, the defect must be patched using the same type of material. On a sideslope, should any tear, hole, or defect exceed 10 percent of the width of the panel, the panel must be removed and replaced. If the defect is not located on a slope, the patch must be made using the same type of material and placed with a minimum of 24 inches overlap in all directions. All geotextile patches should be thermal bonded in place.

7 EQUIPMENT ON GEOSYNTHETIC MATERIALS

Use of equipment on the liner system under construction will be minimized to reduce the potential for geomembrane puncture or damage to the other geosynthetic components. Spinning of tires or sharp turns will be prohibited when working directly above the geomembrane protective cover. The CQA Monitor will verify that small equipment such as generators are placed on scrap geomembrane material (rub sheets) above geosynthetic materials being installed for the liner system. Drainage aggregate and/or protective cover will be placed using low ground pressure equipment, using procedures that do not shove, fold, or displace the geosynthetics. The CQA Monitor will verify that the geosynthetics are not shoved, folded, or displaced while overlying drainage aggregate or protective cover layers are being placed.

Unless otherwise specified by the GP, all lifts of drainage aggregate or protective soil material placed over geosynthetics shall be placed by equipment based on the following guidelines:

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in.)
< 5	12
5 - 8	18
8 - 16	24
> 16	36

No equipment will be left running and unattended over the liner system area under construction.

8 LEACHATE COLLECTION PIPING

8.1 INTRODUCTION

This section describes CQA procedures for the installation of pipe for the leachate collection system. The objective of the following requirements are (1) to assure that proper construction techniques and procedures are used, and (2) that the project is built in accordance with the construction plans and technical specifications. To monitor compliance, a quality assurance program will be implemented that includes (1) a review of the Contractor's quality control submittals and (2) construction monitoring.

8.2 DELIVERY

The CQA Monitor will observe the following:

- That upon delivery, the pipe and pipe fittings are in compliance with the requirements of the technical specifications.
- That a pipe laydown area is designated in which the pipe and pipe fittings are protected from excessive heat, cold, construction traffic, hazardous chemicals, and solvents. If the pipe and pipe fittings are stored at a location where other construction materials are present, the CQA Monitor will observe that stacking or insertion of the other construction materials onto or into the pipe and pipe fitting is prohibited. The CQA Monitor will periodically examine the storage area to observe that the pipe fittings are undamaged, and have been adequately protected.
- That upon transporting pipe and fittings from the storage location to the construction site, the Contractor will use pliable straps, slings, or rope to lift the pipe. Steel cables or chains will not be used to transport or lift the pipe.
- That the Contractor will provide that pipe greater than 20 feet in length will be lifted with at least two support points. The Contractor will not drop, impact, or bump into the pipe, particularly at the pipe ends. Pipe and fitting ends must be cleaned of all dirt, debris, oil, or any other contaminant which may prohibit making a sound joint. Prior to making a sound joint, Contractor should cleaned pipes of dirt, debris, oil, or other contaminants on the inside.

The CQA Monitor will document all activities associated with the handling and storage of this material in order to maintain compliance with this portion of the CQA Plan.

8.3 QUALITY CONTROL TESTING

Prior to the acceptance of the pipe, the pipe manufacturer will provide the GP with product data sheets and/or shop drawings documenting the design specifications for pipe materials provided for the project. The product data sheets shall document the following:

- A description of the pipe to be delivered to the project, including but not limited to the strength classification, diameter, and dimensional ratio

- Shop drawings depicting the perforation pattern for each pipe size supplied for the project.

- Property data sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications or equivalent.

- A certification by the supplier that the pipe delivered for the project meets the material properties of the product data sheets and/or shop drawings.

The GP will observe that the property values certified by the pipe manufacturer meet all of the technical specifications and that measurements of properties by the pipe manufacturer are properly documented and that the test methods used are acceptable.

8.4 INSTALLATION

8.4.1 Surface Preparation

Prior to pipe installation, the CQA Monitor must observe the following:

- All lines and grades have been verified by the Contractor.

- The area where pipe is to be installed is free of deleterious material which may damage the pipe or underlying geosynthetics or might clog the pipe.

- Pipe perforations for leachate collection system are drilled in the pipe prior to delivery to the site, or while in the staging or laydown area, outside of the area where the pipe is to be installed. Drilling will not be allowed over the geosynthetics. The pipe shall be cleaned of drill cuttings (inside and out) prior to being placed.

- Pipe perforations are drilled at the correct size and spacing according to the construction plans and technical specifications. Perforations can be either factory-predrilled or field-drilled.

8.4.2 Placement

During pipe and fitting installation, the CQA Monitor will perform the following:

- Observe all pipe, pipe fittings, and joints as the pipe is being laid. The CQA Monitor will observe that pipes and fittings are not broken, cracked, or otherwise damaged or unsatisfactory. Prior to fusing (if required), the pipe installer will provide for a fusion surface area which is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.

- Observe that the pipe and fittings are being constructed in accordance with technical specifications, manufacturer's recommendations and accepted practices.

- Observe that the people and equipment utilized to install the pipe do not damage the pipe or any other component of the liner system. No butt fusion welding equipment shall be allowed directly on the geosynthetics, and no primer or glue shall be used directly over the geosynthetics. If butt fusion welding is performed within the cell, a protective piece of geosynthetics will be placed beneath welder.

- Observe placement of aggregate chimney drains or protective cover over pipe.

9 DRAINAGE AGGREGATE

9.1 MATERIALS

Granular drainage material around the leachate collection pipes (i.e., chimney drains), and within and above the leachate collection sumps will consist of durable particles of crushed stone, natural gravel, or lightweight aggregate free of silt, clay, or other unsuitable materials. River rock or rounded particles are not suitable as leachate pipe bedding. The aggregate shall be free of organics, foreign objects, or other deleterious materials. The aggregate shall have a loss of mass due to calcium carbonate of less than 15 percent (in accordance with J&L Test Designation S-105-89 or ASTM D3042 modified to use a solution of hydrochloric acid having a pH of 5).

Drainage aggregate will be placed using low ground pressure equipment, as specified in Section 7 of this CQA Plan. Drainage aggregate will be placed by spreading in front of the placement equipment with a minimum lift thickness of 12 inches separating the equipment and the underlying geosynthetics.

The drainage aggregate will meet the following gradation:

Sieve Size Square Opening	**Percent Passing**
2 inches	100
½ inch	0 – 5

Drainage aggregate of this gradation will meet a minimum permeability requirement of $1x10^{-2}$ cm/s, therefore no permeability testing is required.

9.2 TESTING

The drainage aggregate shall be tested for gradation and calcium carbonate, in accordance with ASTM C136 and J&L Test Designation S-105-89 or ASTM D3042 modified, respectively, at the supply source or third party testing laboratory at a minimum of 1 test per 3,000 cubic yards or 1 test per lined area or cell (if less than 3,000 cubic yards required). The physical characteristics of the aggregate shall be evaluated through visual inspection and laboratory classification testing before construction and visual inspection by the CQA Monitor during construction. The drainage aggregate may be tested during construction at the discretion of the CQA Monitor. The test results for the drainage aggregate used in the leachate collection system will be included in the LER.

10 PROTECTIVE COVER

10.1 MATERIALS

Protective cover will be placed over the drainage geocomposite in accordance with the construction plans and technical specifications. The drainage geocomposite will be covered with a minimum of two (2) feet of protective cover, with exception to the chimney drains and leachate collection sumps. The protective cover shall be free of organics, angular rocks, foreign objects, or other deleterious materials which might damage the geocomposite or underlying geomembrane. The lower 12 inches of protective cover shall be free of rock particles greater than 2 inches in size, and the upper 12 inches of protective cover shall be free of rock particles greater than 4 inches in size.

Chimney drains will be installed within the protective cover to provide leachate drainage access to the underlying leachate collection system. Typical chimney drain details are provided in the Part IV Drawings. Material requirements for the chimney drain aggregate are described in Section 9 of this CQA Plan.

10.2 INSTALLATION

The protective cover layer will be placed using low ground pressure equipment, as specified in Section 7 of this CQA Plan. The protective cover shall be placed by spreading in front of the placement equipment with a minimum lift thickness of 12 inches of soil separating the equipment and the underlying geosynthetics. Placement methods will be monitored that excessive shoving or stretching of the geosynthetics does not occur. Under no circumstance shall the construction equipment come in direct contact with the installed geosynthetics.

During construction, the GP or CQA Monitor will:

- Provide full-time inspection during all periods when protective cover is being installed.
- Verify that survey control staking is performed prior to work. Care will be required of the surveyor and Contractor that survey stakes are not left in the protective cover after placement and confirmation surveying, or that survey stakes are not broken off and left in the protective cover, or that survey stakes do not perforate the underlying liner system.
- Verify that underlying installed geosynthetics are not damaged during placement operations.
- If damage to geosynthetics occurs, mark damaged geosynthetics and verify that damage is repaired consistent with this CQA Plan.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and material placement meet equipment specifications.

10.3 THICKNESS VERIFICATION

The thickness of constructed soil liners and protective cover will be verified by surveying methods. As described in Table 3-2, at a minimum, one thickness verification will be performed for every 5,000 square feet of constructed soil liner. Survey locations will be based on pre-established survey grid in accordance with Section 2.3. A minimum of three (3) survey points shall be used for all constructed soil liners regardless of size. All elevation calculations necessary for thickness verification will be included in the LER submittal. The compacted clay liner shall have a minimum thickness of 2 feet and the thickness tolerance shall be 0 to 0.2 feet.

11 DOCUMENTATION

11.1 INTRODUCTION

The quality assurance plan depends on thorough monitoring and documentation of construction activities. Therefore, the GP and CQA Monitor will document that quality assurance requirements have been addressed and satisfied. Documentation will consist of the following:

- Daily progress reports;
- Laboratory test results;
- Field testing results, logs and location maps;
- Nonconformance and corrective action reports (if necessary);
- Photographic documentation; and
- Summary of design and field adjustment, if any.

Standard report forms will be provided by the GP prior to construction.

11.2 LINER EVALUATION REPORT (LER)

After construction of the bottom and sideslope liner system, a LER will be prepared and placed in the Site Operating Record, in accordance with §257.105(f)(1) and Section 4 of the SOP (Part V). The LER will certified by a qualified professional engineer in the state of Texas that the composite liner and leachate collection and removal system has been constructed in accordance with §257.70 and this registration application.

In accordance with §352.851(1) and (2), a certification letter signed by the Responsible Official for the Plant and a registered professional engineer in the State of Texas, stating that the expansion has been constructed in compliance with conditions of this registration, and the TCEQ has inspected the newly constructed expansion and finds it is in compliance with the conditions of this registration, will be submitted to the TCEQ. If within 15 days of submission of the certification letter to the TCEQ, the TCEQ has not notified the Landfill Owner/Operator of their intent to inspect, then it is understood that the TCEQ has waived the opportunity for this inspection and the Landfill Owner/Operator can commence disposal of waste in the lateral expansion.

11.3 LINER EVALUATION REPORT (LER) FORMAT

Each LER submittal must include a clearly legible site map, which depicts the grid system on site, graphic scale, north arrow, sectorized fill layout plan, filled area, present active area, and area covered by the current submittal. It may be a printed drawing from a master drawing, which is annotated and updated with each new submittal. In addition, each LER must include all or part of the following items as appropriate and depending on the constructed elements of the liner:

- All field and laboratory test documentation for liner soils, borrow source test results, and installation test and sample locations plotted on a location plan;
- All test documentation for leachate collection and protective cover layers;
- For geomembrane, include manufacturer's certifications, documentation of all manufacturer's and independent testing, seam tests (non-destructive and destructive seam testing), and seaming and repair records;
- Manufacturer's certification and testing documentation for all geosynthetics; and
- Survey documentation of the thickness of the soil liner, a geomembrane drawing showing locations of panels, repairs, and destructive tests, leachate collection, and protective cover layers.

ATTACHMENT IV.B1

GEOSYNTHETIC RESEARCH INSTITUTE, TEST METHOD GM13 (GRI-GM13)

Geosynthetic Institute
475 Kedron Avenue
Folsom, PA 19033-1208 USA
TEL (610) 522-8440
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Revision 15: September 9, 2019
Revision schedule on pg. 11

GRI - GM13 Standard Specification*

Standard Specification for

"Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes" SM

This specification was developed by the Geosynthetic Research Institute (GRI), with the cooperation of the member organizations for general use by the public. It is completely optional in this regard and can be superseded by other existing or new specifications on the subject matter in whole or in part. Neither GRI, the Geosynthetic Institute, nor any of its related institutes, warrant or indemnifies any materials produced according to this specification either at this time or in the future.

1. Scope

1.1 This specification covers high density polyethylene (HDPE) geomembranes with a formulated sheet density of 0.940 g/ml, or higher, in the thickness range of 0.75 mm (30 mils) to 3.0 mm (120 mils). Both smooth and textured geomembrane surfaces are included.

1.2 This specification sets forth a set of minimum, physical, mechanical and chemical properties that must be met, or exceeded by the geomembrane being manufactured. In a few cases a range is specified.

1.3 In the context of quality systems and management, this specification represents manufacturing quality control (MQC).

> Note 1: Manufacturing quality control represents those actions taken by a manufacturer to ensure that the product represents the stated objective and properties set forth in this specification.

1.4 This standard specification is intended to ensure good quality and performance of HDPE geomembranes in general applications, but is possibly not adequate for the complete specification in a specific situation. Additional tests, or more restrictive

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*This GRI standard specification is developed by the Geosynthetic Research Institute through consultation and review by the member organizations. This specification will be reviewed at least every 2-years, or on an as-required basis. In this regard it is subject to change at any time. The most recent revision date is the effective version and it is kept current on the Institute's Website <<geosynthetic-institute.org>>.

values for test indicated, may be necessary under conditions of a particular application.

> Note 2: For information on installation techniques, users of this standard are referred to the geosynthetics literature, which is abundant on the subject.

2. Referenced Documents

2.1 ASTM Standards

D 792	Specific Gravity (Relative Density) and Density of Plastics by Displacement
D 1004	Test Method for Initial Tear Resistance of Plastics Film and Sheeting
D 1238	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
D 1603	Test Method for Carbon Black in Olefin Plastics
D 3895	Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
D 4218	Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
D 4833	Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
D 5199	Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
D 5397	Procedure to Perform a Single Point Notched Constant Tensile Load – (SP-NCTL) Test: Appendix
D 5596	Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
D 5721	Practice for Air-Oven Aging of Polyolefin Geomembranes
D 5885	Test method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
D 5994	Test Method for Measuring the Core Thickness of Textured Geomembranes
D 6370	Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
D 6693	Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
D 7238	Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
D 7466	Test Method for Measuring the Asperity Height of Textured Geomembranes

2.2 GRI Standards

GM10	Specification for the Stress Crack Resistance of Geomembrane Sheet

2.3 U. S. Environmental Protection Agency Technical Guidance Document "Quality Control Assurance and Quality Control for Waste Containment Facilities," EPA/600/R-93/182, September 1993, 305 pgs.

3. Definitions

Manufacturing Quality Control (MQC) - A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for materials and workmanship as stated in certification documents and contract specifications.
ref. EPA/600/R-93/182

Manufacturing Quality Assurance (MQA) - A planned system of activities that provides assurance that the materials were constructed as specified in the certification documents and contract specifications. MQA includes manufacturing facility inspections, verifications, audits and evaluation of the raw materials (resins and additives) and geosynthetic products to assess the quality of the manufactured materials. MQA refers to measures taken by the MQA organization to determine if the manufacturer is in compliance with the product certification and contract specifications for the project.
ref. EPA/600/R-93/182

Formulation - The mixture of a unique combination of ingredients identified by type, properties and quantity. For HDPE polyethylene geomembranes, a formulation is defined as the exact percentages and types of resin(s), additives and carbon black.

Nominal - Representative value of a measurable property determined under a set of conditions, by which a product may be described. Abbreviated as nom. in Tables 1 and 2.

4. Material Classification and Formulation

4.1 This specification covers high density polyethylene geomembranes with a formulated sheet density of 0.940 g/ml, or higher. Density can be measured by ASTM D1505 or ASTM D792. If the latter, Method B is recommended.

4.2 The polyethylene resin from which the geomembrane is made will generally be in the density range of 0.932 g/ml or higher, and have a melt index value per ASTM D1238 of less than 1.0 g/10 min.

4.3 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.

4.4 No post consumer resin (PCR) of any type shall be added to the formulation.

5. Physical, Mechanical and Chemical Property Requirements

5.1 The geomembrane shall conform to the test property requirements prescribed in Tables 1 and 2. Table 1 is for smooth HDPE geomembranes and Table 2 is for single and double sided textured HDPE geomembranes. Each of the tables are given in English and SI (metric) units. The conversion from English to SI (metric) is soft.

Note 3: The tensile strength properties in this specification were originally based on ASTM D 638 which uses a laboratory testing temperature of 23°C ± 2°C. Since ASTM Committee D35 on Geosynthetics adopted ASTM D 6693 (in place of D 638), this GRI Specification followed accordingly. The difference is that D 6693 uses a testing temperature of 21°C ± 2°C. The numeric values of strength and elongation were not changed in this specification. If a dispute arises in this regard, the original temperature of 23°C ± 2°C should be utilized for testing purposes.

Note 4: There are several tests often included in other HDPE specifications which are omitted from this standard because they are outdated, irrelevant or generate information that is not necessary to evaluate on a routine MQC basis. The following tests have been purposely omitted:

- Volatile Loss
- Dimensional Stability
- Coeff. of Linear Expansion
- Resistance to Soil Burial
- Low Temperature Impact
- ESCR Test (D 1693)
- Wide Width Tensile
- Water Vapor Transmission
- Water Absorption
- Ozone Resistance
- Modulus of Elasticity
- Hydrostatic Resistance
- Tensile Impact
- Field Seam Strength
- Multi-Axial Burst
- Various Toxicity Tests

Note 5: There are several tests which are included in this standard (that are not customarily required in other HDPE specifications) because they are relevant and important in the context of current manufacturing processes. The following tests have been purposely added:

- Oxidative Induction Time
- Oven Aging
- Ultraviolet Resistance
- Asperity Height of Textured Sheet (see Note 6)

Note 6: The minimum average value of asperity height does not represent an expected value of interface shear strength. Shear strength associated with geomembranes is both site-specific and product-specific and should be determined by direct shear testing using ASTM D5321/ASTM D6243 as prescribed. This testing should be included in the particular site's CQA conformance testing protocol for the geosynthetic materials involved, or formally waived by the Design Engineer, with concurrence from the Owner prior to the deployment of the geosynthetic materials.

Note 7: There are other tests in this standard, focused on a particular property, which are updated to current standards. The following are in this category:

- Thickness of Textured Sheet
- Puncture Resistance
- Stress Crack Resistance
- Carbon Black Dispersion (In the viewing and subsequent quantitative interpretation of ASTM D 5596 only near spherical agglomerates shall be included in the assessment).

5.2 The values listed in the tables of this specification are to be interpreted according to the designated test method. In this respect they are neither minimum average roll values (MARV) nor maximum average roll values (MaxARV).

5.3 The properties of the HDPE geomembrane shall be tested at the minimum frequencies shown in Tables 1 and 2. If the specific manufacturer's quality control guide is more stringent and is certified accordingly, it must be followed in like manner.

Note 8: This specification is focused on manufacturing quality control (MQC). Conformance testing and manufacturing quality assurance (MQA) testing are at the discretion of the purchaser and/or quality assurance engineer, respectively.

6. Workmanship and Appearance

6.1 Smooth geomembrane shall have good appearance qualities. It shall be free from such defects that would affect the specified properties of the geomembrane.

6.2 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.

6.3 General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

7. MQC Sampling

7.1 Sampling shall be in accordance with the specific test methods listed in Tables 1 and 2. If no sampling protocol is stipulated in the particular test method, then test specimens shall be taken evenly spaced across the entire roll width.

7.2 The number of tests shall be in accordance with the appropriate test methods listed in Tables 1 and 2.

7.3 The average of the test results should be calculated per the particular standard cited and compared to the minimum value listed in these tables, hence the values listed are the minimum average values and are designated as "min. ave."

8. MQC Retest and Rejection

8.1 If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

9. Packaging and Marketing

9.1 The geomembrane shall be rolled onto a substantial core or core segments and held firm by dedicated straps/slings, or other suitable means. The rolls must be adequate for safe transportation to the point of delivery, unless otherwise specified in the contract or order.

10. Certification

10.1 Upon request of the purchaser in the contract or order, a manufacturer's certification that the material was manufactured and tested in accordance with this specification, together with a report of the test results, shall be furnished at the time of shipment.

ENGLISH UNITS

Table 1(a) – High Density Polyethylene (HDPE) Geomembrane -Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness (min. ave.) - mils	D5199	nom.	nom.	nom.	nom.	nom.	nom.	nom.	per roll
• lowest individual of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties *(1)* (min. ave.)	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		114	152	190	228	304	380	456	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	54	72	90	108	144	180	216	45,000 lb
Stress Crack Resistance *(2)* - hr.	D5397 (App.)	500	500	500	500	500	500	500	per GRI-GM10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(5)*									200,000 lb
(a) Standard OIT - min.	D 3895	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 in.

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Table 1(b) – High Density Polyethylene (HPDE) Geomembrane - Smooth

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness - (min. ave.) - mm • lowest individual of 10 values - %	D5199	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	nom. -10	per roll
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties *(1)* (min. ave.)	D 6693 Type IV								9,000 kg
• yield strength - kN/m		11	15	18	22	29	37	44	
• break strength - kN/m		20	27	33	40	53	67	80	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		700	700	700	700	700	700	700	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	240	320	400	480	640	800	960	20,000 kg
Stress Crack Resistance *(2)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM-10
Carbon Black Content (range) - %	D 4218 *(3)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	note *(4)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(5)*									90,000 kg
(a) Standard OIT - min.	D 3895	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(5), (6)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(7)*	D 7238								
(a) Standard OIT (min. ave.)	D 3895	N. R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	N.R. *(8)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(9)*	D 5885	50	50	50	50	50	50	50	

(1) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(2) The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(3) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(4) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(5) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(6) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(7) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(8) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(9) UV resistance is based on percent retained value regardless of the original HP-OIT value.

ENGLISH UNITS

Table 2(a) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		30 mils	40 mils	50 mils	60 mils	80 mils	100 mils	120 mils	
Thickness mils (min. ave.) - mils	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mils	D 7466	16	16	16	16	16	16	16	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	200,000 lb
Tensile Properties (min. ave.) *(2)*	D 6693								20,000 lb
• yield strength - lb/in.	Type IV	63	84	105	126	168	210	252	
• break strength - lb/in.		45	60	75	90	120	150	180	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - lb	D 1004	21	28	35	42	56	70	84	45,000 lb
Puncture Resistance (min. ave.) - lb	D 4833	45	60	75	90	120	150	180	45,000 lb
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	20,000 lb
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	45,000 lb
Oxidative Induction Time (OIT) (min. ave.) *(6)*									200,000 lb
(a) Standard OIT - min.	D 3895	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 1.3 inches
Break elongation is calculated using a gage length of 2.0 inches

(3) SP-NCTL per ASTM D5397 Appendix, is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

SI (METRIC UNITS)

Table 2(b) – High Density Polyethylene (HDPE) Geomembrane - Textured

Properties	Test Method	Test Value							Testing Frequency (minimum)
		0.75 mm	1.00 mm	1.25 mm	1.50 mm	2.00 mm	2.50 mm	3.00 mm	
Thickness (min. ave.) - mm	D 5994	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	nom. -5%	per roll
• lowest individual for 8 out of 10 values - %		-10	-10	-10	-10	-10	-10	-10	
• lowest individual for any of the 10 values - %		-15	-15	-15	-15	-15	-15	-15	
Asperity Height mils (min. ave.) - mm	D 7466	0.40	0.40	0.40	0.40	0.40	0.40	0.40	every 2nd roll *(1)*
Formulated Density (min. ave.) - g/cc	D 1505/D 792	0.940	0.940	0.940	0.940	0.940	0.940	0.940	90,000 kg
Tensile Properties (min. ave.) *(2)*	D 6693								9,000 kg
• yield strength - kN/m	Type IV	11	15	18	22	29	37	44	
• break strength - kN/m		8	10	13	16	21	26	32	
• yield elongation - %		12	12	12	12	12	12	12	
• break elongation - %		100	100	100	100	100	100	100	
Tear Resistance (min. ave.) - N	D 1004	93	125	156	187	249	311	374	20,000 kg
Puncture Resistance (min. ave.) - N	D 4833	200	267	333	400	534	667	800	20,000 kg
Stress Crack Resistance *(3)* - hr.	D 5397 (App.)	500	500	500	500	500	500	500	per GRI GM10
Carbon Black Content (range) - %	D 4218 *(4)*	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	2.0-3.0	9,000 kg
Carbon Black Dispersion	D 5596	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	note *(5)*	20,000 kg
Oxidative Induction Time (OIT) (min. ave.) *(6)*									90,000 kg
(a) Standard OIT - min.	D 3895	100	100	100	100	100	100	100	
— or —									
(b) High Pressure OIT - min.	D 5885	400	400	400	400	400	400	400	
Oven Aging at 85°C *(6), (7)*	D 5721								
(a) Standard OIT (min. ave.) - % retained after 90 days	D 3895	55	55	55	55	55	55	55	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 90 days	D 5885	80	80	80	80	80	80	80	
UV Resistance *(8)*	D 7238								
(a) Standard OIT (min. ave.)	D 3895	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	N.R. *(9)*	per each formulation
— or —									
(b) High Pressure OIT (min. ave.) - % retained after 1600 hrs *(10)*	D 5885	50	50	50	50	50	50	50	

(1) Alternate the measurement side for double sided textured sheet

(2) Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction.
Yield elongation is calculated using a gage length of 33 mm
Break elongation is calculated using a gage length of 50 mm

(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.

(4) Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views:
9 in Categories 1 or 2 and 1 in Category 3

(6) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.

(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

(8) The condition of the test should be 20 hr. UV cycle at 75°C followed by 4 hr. condensation at 60°C.

(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.

(10) UV resistance is based on percent retained value regardless of the original HP-OIT value.

Adoption and Revision Schedule
for
HDPE Specification per GRI-GM13

"Test Methods, Test Properties, Testing Frequency for
High Density Polyethylene (HDPE) Smooth and Textured Geomembranes"

Adopted: June 17, 1997

Revision 1: November 20, 1998; changed CB dispersion from allowing 2 views to be in Category 3 to requiring all 10 views to be in Category 1 or 2. Also reduced UV percent retained from 60% to 50%.

Revision 2: April 29, 1999: added to Note 5 after the listing of Carbon Black Dispersion the following: "(In the viewing and subsequent quantitative interpretation of ASTM D5596 only near spherical agglomerates shall be included in the assessment)" and to Note (4) in the property tables.

Revision 3: June 28, 2000: added a new Section 5.2 that the numeric table values are neither MARV or MaxARV. They are to be interpreted per the the designated test method.

Revision 4: December 13, 2000: added one Category 3 is allowed for carbon black dispersion. Also, unified terminology to "strength" and "elongation".

Revision 5: May 15, 2003: Increased minimum acceptable stress crack resistance time from 200 hrs to 300 hrs.

Revision 6: June 23, 2003: Adopted ASTM D 6693, in place of ASTM D 638, for tensile strength testing. Also, added Note 2.

Revision 7: February 20, 2006: Added Note 6 on Asperity Height clarification with respect to shear strength.

Revision 8: Removed recommended warranty from specification.

Revision 9: June 1, 2009: Replaced GRI-GM12 test for asperity height of textured geomembranes with ASTM D 7466.

Revision 10 April 11, 2011: Added alternative carbon black content test methods

Revision 11 December 13, 2012: Replaced GRI-GM11 with the equivalent ASTM D 7238.

Revision 12 November 14, 2014: Increased minimum acceptable stress crack resistance time from 300 to 500 hours. Also, increased asperity height of textured sheet from 10 to 16 mils (0.25 to 0.40 mm).

Revision 13 November 4, 2015: Removed Footnote (1) on asperity height from tables.

Revision 14 January 6, 2016: Removed Trouser Tear from Note 5.

Revision 15: September 9, 2019: Editorial update to harmonize tables.

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION NO. -----
REGISTRATION APPLICATION
McLENNAN COUNTY, TEXAS

PART IV, APPENDIX IV.C
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN

Prepared for:

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Brett DeVries 1/13/22

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1 PE CERTIFICATION (40 CFR §257.81(a))

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

I, Brett DeVries, Ph.D., P.E., hereby certify that this enclosed Run-on and Run-off Control System Plan for the Sandy Creek Energy Station Coal Combustion Residual Waste Management Facility meets the requirements in 30 TAC §352.811 and 40 CFR §257.81(a) and (b). This Plan was prepared by or under my supervision. I am a duly licensed Professional Engineer under the laws of the State of Texas.

Brett DeVries, Ph.D., P.E.
(printed or typed name)

License number __128061____________________

My license renewal date is __9/30/2022______

2 INTRODUCTION

This Run-on and Run-off Control Plan has been prepared for the Sandy Creek Services, LLC (Owner and Operator) of the Sandy Creek Energy Station (Plant) Coal Combustion Residual (CCR) Waste Management Facility (Landfill) located in Riesel, McLennan County, Texas. This Plan has been prepared consistent with Title 30 of the Texas Administrative Code (30 TAC), Chapter 352.811 and Title 40 of the Code of Federal Regulations (40 CFR), Part 257.81.

Specifically, consistent with 30 TAC §352.811 and 40 CFR §257.81(a), the run-on and run-off control systems have been designed to prevent stormwater flow onto the working face of the Landfill, and collect and control flow from the active portion (i.e., contact water) of the Landfill during peak discharge from a 25-year, 24-hour storm event. Run-on and run-off from the working face of the Landfill will be handled in a manner that complies with the Texas Pollutant Discharge Elimination System (TPDES) consistent with 40 CFR §257.81(b) and Section 3 of this Plan. Additionally, run-on and run-off control systems are designed to convey post-closure (following final cover installation) run-on and runoff from a 25-year, 24-hour storm event. This includes the design of downchutes, drainage swales, and perimeter drainage channels conveying the discharge from the Landfill area to the existing stormwater pond.

This Plan is applicable for Landfill, which is comprised of Cells 1, 2, and 3. At the time of preparing this Plan, Cells 1 and 2 are existing active cells. A portion of Cell 3 (inclusive of Subcells 3A through 3D) will be operational after construction is completed in 2021. Future Subcells within Cell 3 will be operated consistent with this Plan.

Consistent with 40 CFR §257.81(c)(4), this Plan will be revised every five (5) years from the completion date of the last Plan. Additionally, the Plan will be amended whenever there is a change in conditions that would substantially affect the existing Plan, in accordance with 30 TAC §352.131. The Landfill Owner/Operator will comply with recordkeeping, notification, and internet requirements outlined in the Site Operating Plan (SOP, see Part V).

3 STORMWATER, LEACHATE, AND CONTACT WATER MANAGEMENT

Surface water (i.e., stormwater and contact water) will be managed in accordance with this Plan throughout the active life of the Landfill to minimize the amount of stormwater that comes into contact with waste, contact water, or leachate. Water that does not come in contact with waste or leachate will be managed as stormwater (i.e. non-contact water). This stormwater runoff from the Landfill will be conveyed to the perimeter stormwater management system, comprised of perimeter channels and existing stormwater pond, by drainage swales/downchutes and overland flow before being discharged from the Landfill Registration Boundary.

Surface water run-on onto the working face or areas of exposed waste will be controlled using temporary diversion berms. Diversion berms will be constructed on the up-hill side of the working face to divert stormwater away from the working face and into the stormwater management system (evaporative leachate pond), thus reducing the volume of contact water and leachate generated. Cells 2 and 3 utilize interim cell berms to minimize the amount of leachate generated during Landfill operation. Stormwater collected in subcells that have not been in contact with waste will be discharged as uncontaminated water into the stormwater pond.

Contact water will be contained within the exposed waste areas, including working face, by using temporary containment berms and directed to the leachate collection and removal system, which discharges into the leachate evaporation pond. Site grading of the exposed waste areas will be regularly conducted to provide drainage, promote run-off, and minimize ponding of water over areas containing waste in accordance with the Site Operating Plan (Part V). Additionally, at no time will contact water be allowed to discharge into the stormwater management system, offsite into waters of the United States, or onto adjacent properties. Surface water that infiltrates into the underlying waste will be managed as leachate in accordance with Part IV, Appendix IV.A, related to the Leachate Collection and Removal System Plan and Part V, SOP.

Methodologies described in the Texas Department of Transportation's Hydraulic Design Manual (revised September 2019) were used to estimate the volume of water that will be diverted around the working face or contained at the working face. These methodologies were also used to develop an approach for estimating the height of temporary diversion and containment berms required to contain and divert stormwater from coming into contact with waste. The design calculations and sizing of the diversion and containment berms for a 25 year, 24-hour storm event are provided in Attachment IV.C3 of this Plan.

4 POST-CLOSURE STORMWATER MANAGEMENT

4.1 ANALYSIS METHODOLOGY

4.1.1 HYDROLOGIC ANALYSIS METHODS

Surface water discharges were estimated for a 25-year, 24-hour storm event using AutoCAD Civil 3D Hydraflow Hydrographs Extension. Hydraflow Hydrographs was also used to develop hydrographs for the post-closure conditions for computation of the peak flow rates from individual drainage areas of the Landfill into the perimeter stormwater management system. These peak flows were used in the design of the major surface water drainage features proposed for the Landfill (i.e. perimeter drainage channels, downchutes, and drainage swales).

Hydraflow Hydrographs for Autodesk Civil 3D (2020) is an application for urban hydrologic and hydraulic systems engineering, which can be used for analyzing the hydrologic properties of watersheds, determining runoff from synthetic storms, and planning or modeling stormwater control measures, such as detention ponds. The Hydraflow Hydrographs model represents a watershed as a network of hydrologic and hydraulic components. The modeling process results in the computation of hydrographs for surface water runoff, channel-flow, and detention basin storage within the watershed. The program then combines and routes the hydrographs through user-defined up- and down-gradient drainage features to defined watershed outlets.

4.1.1.1 Major Calculation Parameters

Input parameters for the Hydraflow Hydrographs model are described below and presented in Attachment IV.C1 of this Plan. Attachment IV.C1 includes precipitation data, SCS Curve Numbers, Manning’s coefficients, and drainage channel information used in the model.

Watershed Drainage Areas

Drainage areas are generally assumed to be areas that share similar run-on and run-off characteristics, surface features, and typically discharge to a single reach (i.e., channel), detention basin, or off-site discharge location. The on-site watershed drainage areas and surrounding drainage features modeled using Hydraflow Hydrographs are presented on Drawing IV.C2. Due to the existing topography and existing outer drainage channels located to the east of the Landfill, no watershed drainage areas have stormwater run-on onto the Landfill Registration Boundary. As such, generally all drainage areas outside the perimeter stormwater management system either generates stormwater run-off away from the Landfill (i.e., west side of the Landfill) or is intercepted by the existing outer drainage channels and is directed around the Landfill.

Hypothetical Precipitation Distribution

The hypothetical precipitation distribution was derived from the NOAA Atlas 14, Precipitation Frequency Data Server (consistent with the September 2019 memo developed by the Texas Commission on Environmental Quality [TCEQ]). A Type III storm event with a return period of 25-years and duration of 24-hours was used for the hydrologic modeling. This storm event is associated with approximately 7.42 inches of precipitation, which was assumed to be evenly distributed across the entire Landfill watershed for the return period. Input parameters discussed above are provided in Attachment IV.C1.

Curve Numbers (CN)

Curve number (CN) values for the final cover and surrounding areas were selected based on the cover type. A CN value of 80 was used for post-closure conditions for final cover. Reference tables for these CN values are provided in Attachment IV.C1. Based on the soil survey map of the Landfill area (as shown in Attachment IV-C3), on-site soils are predominantly clay, silty clay, and sandy loam. Therefore, Hydrologic Soil Group (HSG) C and D are appropriate for the final cover and surrounding drainage area. CN of 80 is a representative assumption for HSG C/D (i.e., open space, fair to good drainage conditions).

Routing and Hydrograph Methods

The routing and hydrograph method represents the methodology used by the model to develop hydrographs for each drainage area, channel, and detention basin; which are then combined by the program to represent the watershed being analyzed. Hydraflow Hydrographs uses the SCS hydrograph method for calculating runoff hydrographs. Time of concentrations for SCS hydrographs were estimated using the Technical Release 55 (TR-55) method. The TR-55 method was developed by the Natural Resources Conservation Service (formerly the Soil Conservation Service), method as shown in the Hydraflow Hydrographs Model Input Parameters, which are related to Post-Closure Drainage Area Conditions provided in Attachment IV.C1.

Perimeter channel routing from the Landfill drainage areas to an existing stormwater pond was completed as shown in Attachment IV.C2. Hydraflow Hydrographs uses the Modified Att-Kin routing method for calculating channel hydrographs. The input parameters for the model are based on the length, channel geometry, slope, and surface roughness of the channel. Input parameters for post-closure drainage channels are summarized in Attachment IV.C1. Channel capacity, velocity, and peak flow depths were estimated using Manning’s equation, as described in 4.1.2.2 of this Plan.

As part of this Plan, the existing stormwater pond will be used at the detention basin for the Landfill. This detention basin (stormwater pond) was constructed to reduce the combined peak flow rates from the post-closure subbasins to a level that will not adversely impact down-gradient properties. Input parameters for the stormwater pond are included in the Hydraflow Hydrographs Model output file (i.e., Pond Report) provided in Attachment IV.C2.

4.1.2 HYDRAULIC ANALYSIS METHOD

This section describes the methodology used for evaluating hydraulic parameters, including geometry and peak flow velocities, for the stormwater conveyance structures, such as drainage swales (topslope and sideslope), downchutes, drainage channels, and detention basin outlet structure that are or will be constructed at the Landfill. This section also describes the methodology for evaluating the overland flow velocity on the final cover slopes.

4.1.2.1 Permissible Non-Erosive Flow Velocities

The peak flow velocities were calculated using the methodologies described herein, and were compared to the permissible non-erosive flow velocity for vegetated Landfill slopes or drainage features. Landfill cover or drainage features experiencing erosive velocities (i.e., in excess of the defined non-erosive velocity) will be armored or protected using structural controls.

In accordance with published literature, as provided with calculations in Attachment IV.C3 of this Plan, permissible non-erosive flow velocities are defined as velocities less than or equal to 5 to 7 feet per second (fps) depending on the slope for vegetated perimeter channels, drainage swales, and final cover slopes.

4.1.2.2 Analysis of Drainage Swales and Downchutes

Drainage swales (i.e., final cover topslope and sideslope swales) and downchutes are structural controls used to convey runoff from the Landfill cover to the perimeter drainage system and to reduce cover erosion by limiting uninterrupted flow lengths. These structures will be installed on final cover as depicted on Drawings IV.C1 and IV.C2-A, and as needed on immediate cover to control erosion of the intermediate as the Landfill is developed, as described in the SOP (see Part V).

Drainage swales will be installed following construction and placement of final cover and as needed on intermediate cover to the representative grades coinciding with the elevations and/or maximum spacing between swales. The maximum horizontal spacing between drainage swales will be 175 horizontal feet on a 3.5:1 slope, as discussed in Section 4.2. Drainage swales and downchutes on final cover will be installed at the general locations depicted on Drawings IV.C1 and IV.C2-A.

The methodology for sizing drainage swales and downchutes is described below and Section 4.2. Drainage swale and downchute details are depicted on Drawings IV.C5 and IV.C6.

Rational Method

The Rational Method was used to estimate peak runoff from typical contributing areas for design of the drainage swales and downchutes installed on final cover. Contributing areas at this Landfill are less than 200 acres, therefore the Rational Method is applicable. The Rational Method estimates the peak rate of runoff at any location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time-of-concentration (the time required for water to flow from the most remote point of the drainage area to the location being analyzed).

The Rational Method is expressed as the following:

$$Q = CIA$$

Where, Q = maximum rate of runoff, cfs
C = runoff coefficient representing a ratio of runoff to rainfall

I = average rainfall intensity for a duration equal to the time-of-concentration, inches per hour
A = drainage area contributing to the discharge location, acres

The runoff coefficient (C) used for the drainage swale and downchute analysis is described in the calculations provided in Attachment IV.C3. The 25-year, 24-hour rainfall intensity (I) was determined for McLennan County using Atlas of Depth-Duration Frequency (DDF) of Precipitation of Annual Maxima for Texas spreadsheet by Texas Department of Transportation (TXDOT), assuming a minimum time-of-concentration (tc) of 10 minutes for sizing Landfill drainage swales and downchutes. A depiction of the contributing areas (A) used for the analysis of swales and downchutes is provided on Drawing IV.C2-B.

Manning's Equation for Uniform Flow

Hydraulic analysis of the drainage swale and downchute geometry was performed using Manning's uniform flow equation. The uniform flow assumption used by Manning's equation is applicable to long prismatic channels of uniform slope, such as those proposed for the drainage swales or downchutes.

The general form of Manning's equation is:

$$V = \frac{1.49R^{0.667}S^{0.5}}{n}$$

Where, V = Velocity of flow, fps
n = Manning's "n"
R = Hydraulic Radius, ft, or

$$R = \frac{A}{P}$$

S = Friction slope for non-uniform flow or channel slope for uniform flow, ft/ft
A = Area of water perpendicular to direction of flow, sf
P = Wetted perimeter, ft

Using the relationship Q = VA, Manning's equation can be written as:

$$Q = \frac{1.49AR^{0.667}S^{0.5}}{n}$$

The uniform flow assumption equates the slope of the structure to the friction slope. Therefore, the slope of the channel can be used for "S" in Manning's equation for computation of uniform flow. Using the peak flow rate for a 25-year, 24-hour storm event calculated using the Rational Method (described above), the velocity and peak flow depth within drainage swales and downchutes was calculated using Manning's equation.

The following assumptions were used when evaluating the peak velocity with drainage swales and downchutes:

- Drainage swales will be grass-lined for velocities less than or equal to 5 fps. These structures were designed assuming a Manning's "n" of 0.027.
- When velocities exceed 5 fps, typically downchutes, the structure will be lined with armoring materials, as described below.
- Armoring materials will include: rip rap or turf reinforcement mats (TRM) for intermediate cover drainage swales; gabions, rip rap, TRM, or flexible membrane liner for intermediate cover downchutes; and gabions for final cover downchutes. In any case, these structures were designed assuming a Manning's "n" of 0.033, as this surface roughness provides the greatest flow depth within the respective structure for the referenced armoring materials.
- Energy dissipation in the form of gabions, rip rap, or dissipation blocks will be installed at the confluence of downchutes and the Landfill toe of slope and/or perimeter drainage channels.

Both the drainage swale and downchute cross-sections will be capable of retaining the peak flow rate, as calculated using the Rational Method described above. A peak flow analysis was performed for drainage swales and downchutes installed on final cover. Calculations using Manning's equation for the hydraulic properties of the drainage swales and downchutes were performed using the AutoCAD Civil 3D Hydraflow Express Extension (2020). This flow analysis and the Hydraflow Express output summary sheets for these calculations are presented in Attachment IV.C3.

4.1.2.3 Flow Capacity of Drainage Channels

The existing east perimeter channel and proposed west perimeter channel are designed to convey run-off from the developed Landfill to the existing stormwater pond. The peak flow rates obtained from Hydraflow Hydrographs for contributing subbasins were used to evaluate the flow capacity of the perimeter drainage channels. Hydraflow Express was used to confirm that the designed channel geometry, depth, and invert slope will provide sufficient capacity to discharge the 25-year, 24-hour storm event. The following assumptions were incorporated into the channel modeling:

- Manning's coefficient values of 0.027 for grass-lined channels or 0.033 for rip rap/TRM-lined channels was used for the analysis.
- Channels were designed with trapezoidal cross-sections with 3H:1V sideslopes (see Drawing IV.C5).
- Each channel was analyzed for peak flow for the 25-year, 24-hour storm event with freeboard above the flow depth associated with the peak flow rate was added to the channel design.

Information derived from the Hydraflow Express output files includes channel flow depth and peak velocity at the peak flow conditions. The respective Hydraflow Express output files for each of the perimeter channels are included in Attachment IV.C3.

4.1.2.4 Stormwater Pond Outlet Structure

The stormwater pond, which will be used as a detention basin for the Landfill, has two existing outlet structures, including a 10-inch diameter bleed pipe at an invert elevation of 439 ft. and a set of three, 36-inch diameter pipes at an invert elevation of 450 ft[1]. Each of these outlet structures are located on the south end of the pond.

An elevation-area-discharge relationship was developed for the pond based on the constructed pond elevations, and utilized in the Hydraflow Hydrographs for routing run-off through the detention basin. The discharge relationships for the stormwater pond are provided in Attachment IV.C2 of this Plan as part of the Hydraflow Hydrographs output file (i.e., Pond Report).

4.1.2.5 Overland Flow Velocity

An analysis was performed to evaluate overland flow velocities on final cover slopes. Overland flow is defined as the combination of sheet flow and shallow concentrated flow conditions. Sheet flow velocity is defined as the ratio of the sheet flow length to the sheet flow time of concentration. Calculated overland flow velocities were compared to the permissible non-erosive flow velocities, as defined in Section 4.1.2.1 of this Plan.

In accordance with TR-55, sheet flow occurs on slopes at lengths less than 100 feet, whereas shallow concentrated flow begins at lengths greater than 100 feet. The time-of-concentration (tc) for sheet flow on the Landfill slopes was analyzed using Kinematic Wave procedures, which are referenced in TR-55.

The shallow concentrated flow velocity was analyzed by calculating the shallow concentrated flow depth, which was derived using Manning’s Equation. Based on the shallow concentrated flow depth, the peak flow rate and velocity were calculated using the Rational Method and the Continuity Equation (Q=VA) assuming a unit width of flow (w = 1-foot).

These methods were performed to demonstrate that the overland flow velocity on final cover slopes will be below 5 fps at the designed swale spacing of 175 feet. The greatest potential slopes and flow lengths for final cover slopes, as described in Attachment IV.C3, Hydraulic Analysis – Overland Flow Velocity Analysis, were evaluated. The flow lengths provided were selected to maintain velocities less than permissible non-erosive flow velocities (see Section 4.1.2.1 of this Plan) and maintain soil loss less than the permissible soil loss limits (see Section 4.2 of this Plan).

Sample calculations for overland flow velocity on typical final cover areas are presented in Attachment IV.C3, Hydraulic Analysis – Overland Flow Velocity Analysis. As presented in the calculations, flow velocities will be maintained at less than the maximum permissible non-erosive velocities for the respective vegetated cover.

4.2 SOIL LOSS ANALYSIS METHOD

The Universal Soil Loss Equation (USLE)/Revised Universal Soil Loss Equation (RUSLE) was used to calculate the soil loss resulting from precipitation contacting the final cover. The estimated

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[1] Based on the Run-on and Run-off Control System Plan prepared by Geosyntec Consultants in 2016.

soil loss was compared to the permissible soil loss for intermediate and final cover, as defined by the TCEQ. Consistent with TCEQ guidelines ("Surface Water Drainage and Erosional Stability Guidelines for a Municipal Solid Waste Landfill", TCEQ, Revised May 2018), the soil loss demonstration should pertain to the top dome surfaces and external embankment sideslopes for final cover phases of Landfill operation.

The USLE/RUSLE is an empirical equation which estimates soil losses from rainfall and runoff. The USLE was developed by statistical analysis of many plot-years of rainfall, runoff, and sediment loss data from many small plots located around the country. The USLE is supported by the National Resource Conservation Service (NRCS).

The Universal Soil Loss Equation is:

$$A=RKLSCP$$

Where
A = average annual soil loss (tons/acre/ year)
R = rainfall and runoff erosivity index for a given location
K = soil erodibility factor
L = slope length factor
S = slope steepness factor
C = cover and management factor
P = erosion control practice factor

The input parameters into the USLE/RUSLE and soil loss calculations for final cover are presented in Attachment IV.C4 of this Plan.

4.2.1 Final Cover Soil Loss

The purpose of calculating the soil loss from final cover is to evaluate the frequency (i.e., spacing between drainage swales) at which the drainage swales must be installed to maintain soil loss at less than or equal to 3 tons/acre/year (maximum permissible soil loss recommended by the TCEQ for final cover slopes). Soil loss on final cover was calculated for the sideslopes and topslopes. The analysis for the topslope is based on the greatest flow length of 125 ft on the 3 percent topslope. Drainage swales on final cover sideslopes will be installed at a maximum spacing of 175 horizontal feet or 50 vertical feet, assuming a 3.5H:1V sideslope. Soil loss calculations for final cover were based on the assumption that vegetation would be established following application of final cover, and that the vegetation would provide approximately 90 percent ground coverage.

Based on the results, the maximum erosion potential of the final cover was estimated to be 0.30 tons/acre/year and 2.6 tons/acre/year on the topslope and sideslope, respectively, as shown in Attachment IV.C4.

5 POST-CLOSURE CONDITIONS

Post-closure conditions with delineated drainage areas and direction of surface water flow to the existing stormwater pond are depicted on Drawings IV.C1 and IV.C2-A. Additionally, a general layout of the post-closure drainage system, including perimeter drainage channels, is also presented on Drawings IV.C1 and IV.C2-A. As shown on the drawings, rainfall coming into contact with the Landfill final cover slopes will be collected as run-off in drainage swales located at set intervals on the final cover slopes, as described in Section 4.1.2.2 of this Plan. Run-off will flow within the drainage swales, roughly parallel to the slope, into gabion-lined downchutes, from which it will be conveyed to the toe of the Landfill and into the drainage channels or discharge directly into the existing stormwater pond. The stormwater discharged into the pond will evaporate or discharge through the previously discussed set of outlet structures.

5.1 DRAINAGE FEATURE MODELING

5.1.1 DRAINAGE SWALES AND DOWNCHUTES

The drainage swales were designed to have peak flow velocities of less than 7 feet per second with only vegetation proposed for the channel lining. Downchutes were designed with gabion lining. As described in this section, the peak flow rates in the drainage swales and downchutes were determined from the Hydraflow Hydrograph output for the respective contributing drainage areas. The peak velocity and flow depth within each channel were calculated using Hydraflow Express, based on the proposed geometry. The Hydraflow Hydrograph output files for each channel are included in Attachment IV.C3. Cross-sections for a typical drainage swale and downchute are presented on the Drawings IV.C5 and IV.C6, respectively.

5.1.2 DRAINAGE CHANNEL DESIGN

The channels were designed to have peak flow velocities of less than 7 feet per second where only vegetation is proposed for the channel lining. For velocities greater than approximately 7 feet per second, the channels were designed with either rip rap lining, gabions, or TRM. The hydraulic analysis of the perimeter drainage channels is described in Section 4.1.2.3. As described in this section, the peak flow rates in the channels were determined from the Hydraflow Hydrograph output for the respective contributing drainage areas. The peak velocity and flow depth within each channel were calculated using Hydraflow Express, based on the proposed channel geometry. A summary of the channel design parameters, which were incorporated into Hydraflow Hydrograph and Hydraflow Express, are included in Attachment IV.C1. Additionally, the Hydraflow Express output files for each channel are included in Attachment IV.C3. A typical channel cross-section is presented on Drawing IV.C5.

5.1.3 EXISTING STORMWATER POND

The existing stormwater pond was modeled consistent with the constructed elevations and outlet structures, as described in Section 4.1.2.4. The stormwater from the Landfill will be detained in the stormwater pond until the depth of water within the pond reaches an elevation of 439 ft. and will then continuously discharge. Under a 25-year, 24-hour storm event, the 36-inch diameter outlet pipes will not be necessary for discharge. As such, the pond will provide sufficient capacity for the 25-year, 24-hour storm event.

5.2 SUMMARY OF POST-CLOSURE MODELING RESULTS

This Run-on and Run-off Control Plan has been prepared consistent with 30 TAC Chapter 352.811 and Title 40 of the Code of Federal Regulations (40 CFR), Part 257.81 for run-on and run-off controls for coal combustion residual (CCR) Landfills. Specifically, consistent with 30 TAC §352.811 and 40 CFR §257.81(a), the run-on and run-off control systems were designed to prevent stormwater flow onto exposed waste areas, including the working face, of the Landfill, and collect and control contact water from the active portion of the Landfill during peak discharge from a 25-year, 24-hour storm event. Run-on and run-off from the working face of the Landfill will be handled in manner that complies with the Texas Pollutant Discharge Elimination System (TPDES) consistent with 40 CFR §257.81(b) and Section 3 of this Plan. Additionally, run-on and run-off control systems are designed to convey post-closure (following final cover installation) run-on and runoff from a 25-year, 24-hour storm event. This includes the design of downchutes, drainage swales, and drainage channels conveying the discharge from the Landfill area to the existing stormwater pond.

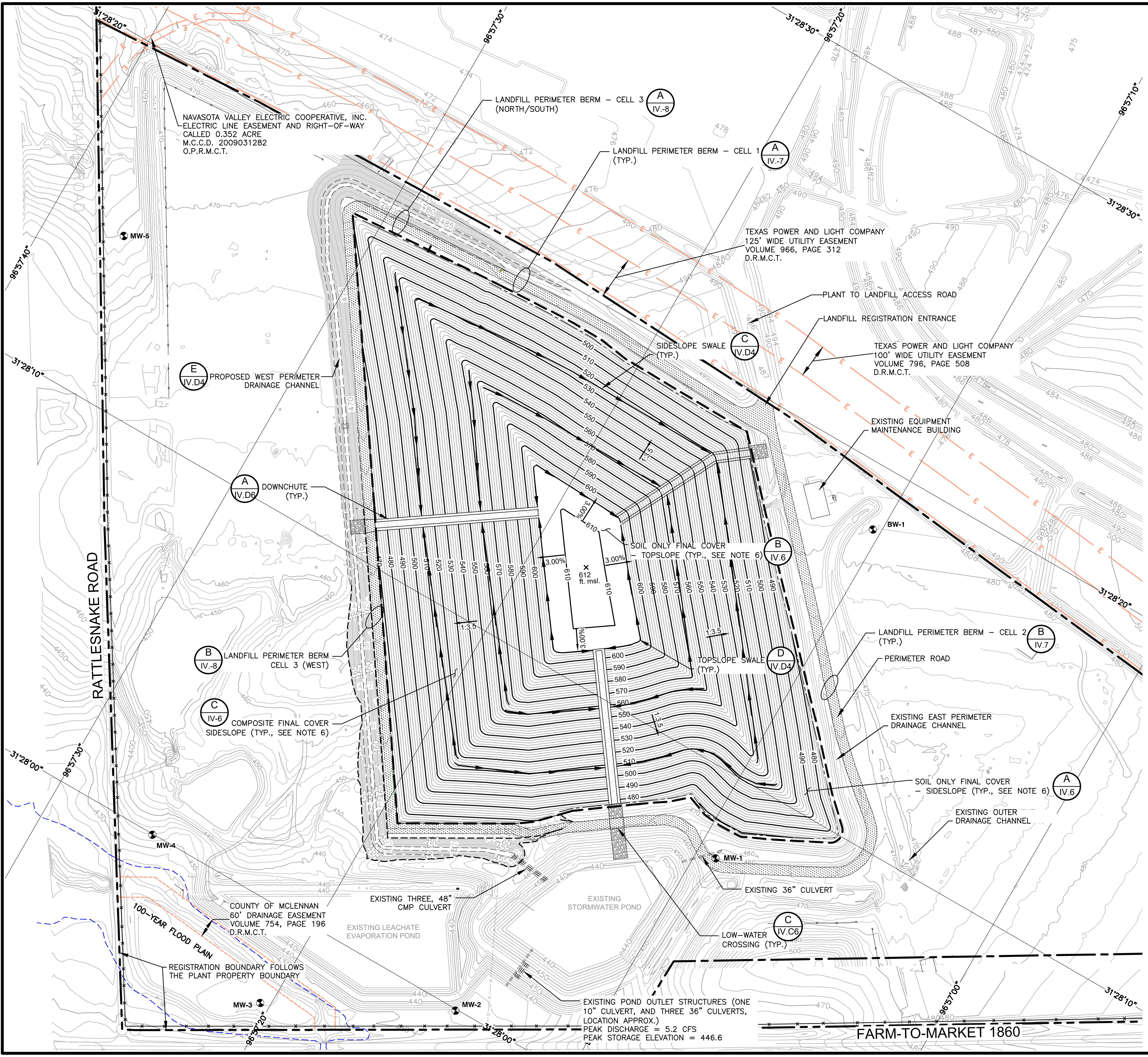
Post-closure conditions are represented by the fully developed Landfill, with final closure having been completed, and all drainage features in-place and operational, as described in Section 5 and presented on Drawings IV.C1 and IV.C2-A. Input parameters for the Hydraflow Hydrograph modeling performed for post-closure conditions are presented in Attachment IV.C1. The results of Hydraflow Hydrograph modeling of the post-closure conditions are included in Attachment IV.C2.

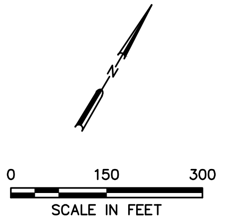
As shown in the Pond Report, which is included in Attachment IV.C2, there will be minimal discharge from the existing 10-inch outlet pipe for the design event (i.e., 25-year 24-hour event). The peak water elevation in the existing pond for this event is anticipated to be at 446.6 ft. No discharge is anticipated from the three 36-inch outlet pipes that are installed at an invert elevation of 450 ft.; however, these pipes are designed in an effort to prevent overtopping of the pond in an unlikely event that the pond peak water elevation exceeds the invert elevation of the outlet pipes.

Discharge velocities from the drainage features will be below the 7 feet per second threshold, which typically is considered the threshold for erosion damage. This will be accomplished by dissipating discharge velocities where needed.

DRAWINGS

- Drawing IV.C1: Run-on and Run-off Control System Plan
- Drawing IV.C2-A: Run-on and Run-off Control System Plan Schematic
- Drawing IV.C2-B: Drainage Swale Areas and Downchute Areas Schematic
- Drawing IV.C3: Example Interim Stormwater/Contact Water Management Plan
- Drawing IV.C4: Existing Stormwater Pond Plan
- Drawing IV.C5: Surface Water Management Details-1
- Drawing IV.C6: Surface Water Management Details-2
- Drawing IV.C7: Contact Water Management Details





LEGEND

——454——	EXISTING CONTOURS (SEE NOTE 1)
—— – ——	PLANT PROPERTY BOUNDARY
—— - ——	LANDFILL REGISTRATION BOUNDARY (SEE NOTE 3)
— — —	REGISTERED LIMITS OF WASTE (SEE NOTE 4)
——96°57'10"——	LATITUDE/LONGITUDE LINES
MW-1 ●	EXISTING GROUNDWATER MONITORING WELL
——454——	PROPOSED FINAL COVER CONTOUR (SEE NOTE 5)
—▶——▶—	PROPOSED DRAINAGE SWALES
═══	PROPOSED DOWNCHUTES
—×—×—×—	EXISTING FENCE
- - - -	EXISTING DRAINAGE EASEMENT
—— E ——	EXISTING ELECTRICAL EASEMENT
- - - -	100-YEAR FLOOD PLAIN (SEE NOTE 2)
▨	PERIMETER ROAD

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. 100-YEAR FLOOD PLAIN IS DESIGNATED AS ZONE A, BASED ON FIRM PANEL 48309C0600D, DATED 10/20/2019.
3. REGISTRATION BOUNDARY IS FROM AN EXHIBIT AND FIELD NOTES FOR A 148.84 ACRES SOLID WASTE DISPOSAL FACILITY TRACT DEVELOPED BY WALKER PARTNERS IN SEPTEMBER 2021.
4. EXISTING CELL 1 AND 2 BOUNDARIES ARE FROM THE FINAL GRADING PLAN DATED DECEMBER 2014; DEVELOPED BY GEOSYNTEC CONSULTANTS. THERE CELL 3 BOUNDARY IS FROM A CELL EXPANSION PLAN DATED FEBRUARY 2021; DEVELOPED BY SCS ENGINEERS.
5. ELEVATIONS SHOWN ON THIS DRAWING WITHIN REGISTERED LIMITS OF WASTE ARE TOP OF FINAL COVER ELEVATIONS IN FT MEAN SEA LEVEL (FT MSL).
6. SOIL ONLY FINAL COVER WILL BE INSTALLED OVERLAYING CELL 1 AND 2, COMPOSITE FINAL COVER WILL BE INSTALLED OVERLAYING CELL 3 AND UP TO THE TOPSLOPE. TEXTURED GEOMEMBRANE AND DOUBLE-SIDED GEOCOMPOSITE WILL EXTEND A MINIMUM OF 5 FEET ON TO THE LANDFILL TOPDECK.

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

FOR REGISTRATION PURPOSES ONLY

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
RUN-ON AND RUN OFF CONTROL SYSTEM PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

PROJ. NO. 16221059.00	DWN. BY: AGA	Q/A RVW BY: SS	
DSN. BY: BJD	CHK. BY: SS	APP. BY: BJD	

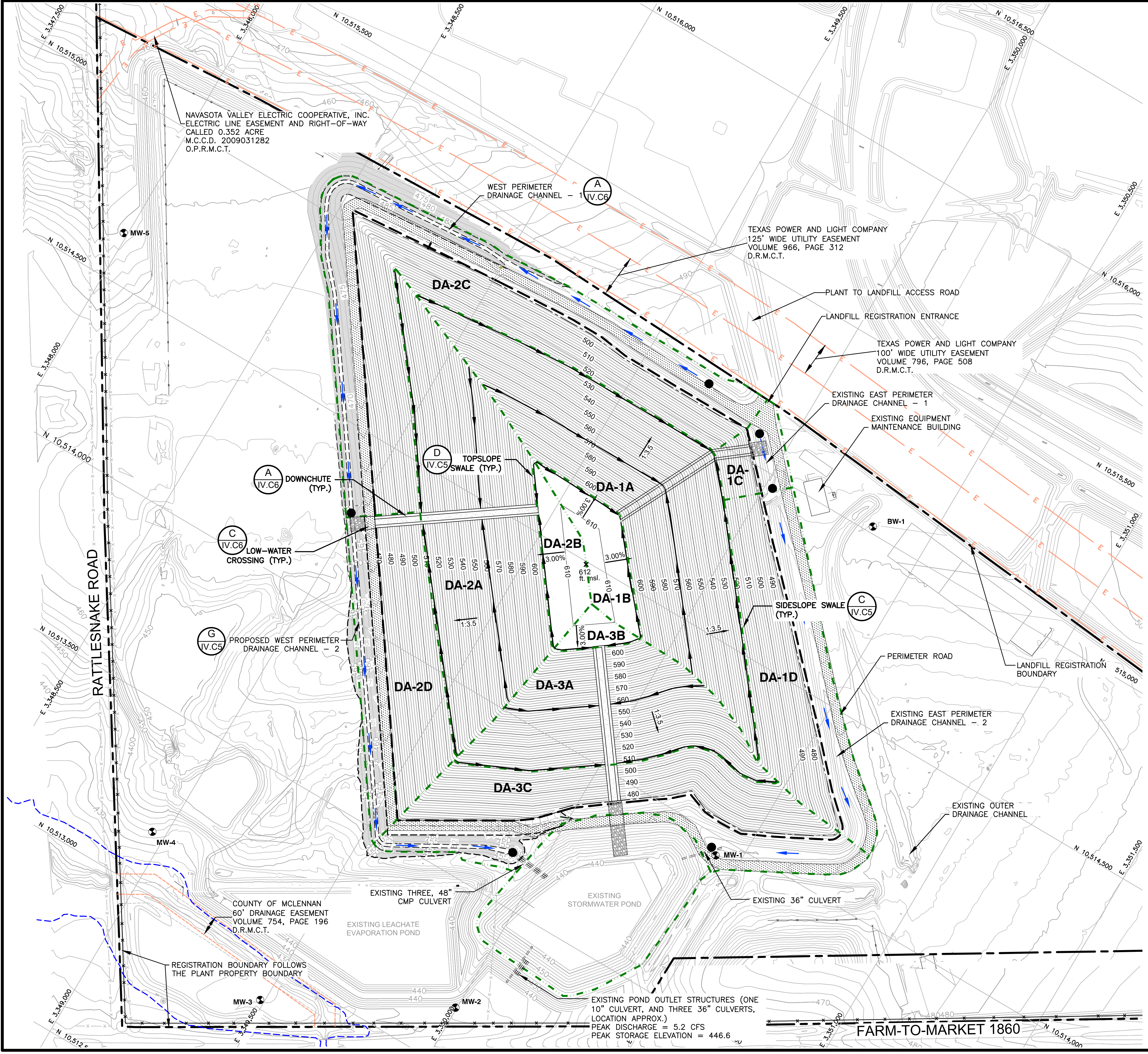
CADD FILE:
IV-4 – LANDFILL COMPLETION PLAN

DATE:
9/2021

SCALE:
AS SHOWN

DRAWING NO.
IV.C1

1/14/2022 4:22 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\IV-4 – Landfill Completion Plan



LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
	PLANT PROPERTY BOUNDARY
	LANDFILL REGISTRATION BOUNDARY
	REGISTERED LIMITS OF WASTE
N 10,516,500 E 3,347,000	STATE PLANE COORDINATES
MW-1	EXISTING GROUNDWATER MONITORING WELL
450	PROPOSED FINAL COVER CONTOUR
	PROPOSED TOP/TOE OF SLOPE
	PROPOSED DRAINAGE AREA
	PROPOSED DRAINAGE SWALES
	PROPOSED DOWNCHUTES
	CHANNEL SECTION
	CHANNEL FLOW DIRECTION
	EXISTING FENCE
	EXISTING DRAINAGE EASEMENT
E	EXISTING ELECTRICAL EASEMENT
	100-YEAR FLOOD PLAIN
	PERIMETER ROAD

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.

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Brett DeVries 1/13/22

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REV	DATE	DESCRIPTION	BY

TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
RUN-ON AND RUN-OFF CONTROL SYSTEM PLAN SCHEMATIC

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
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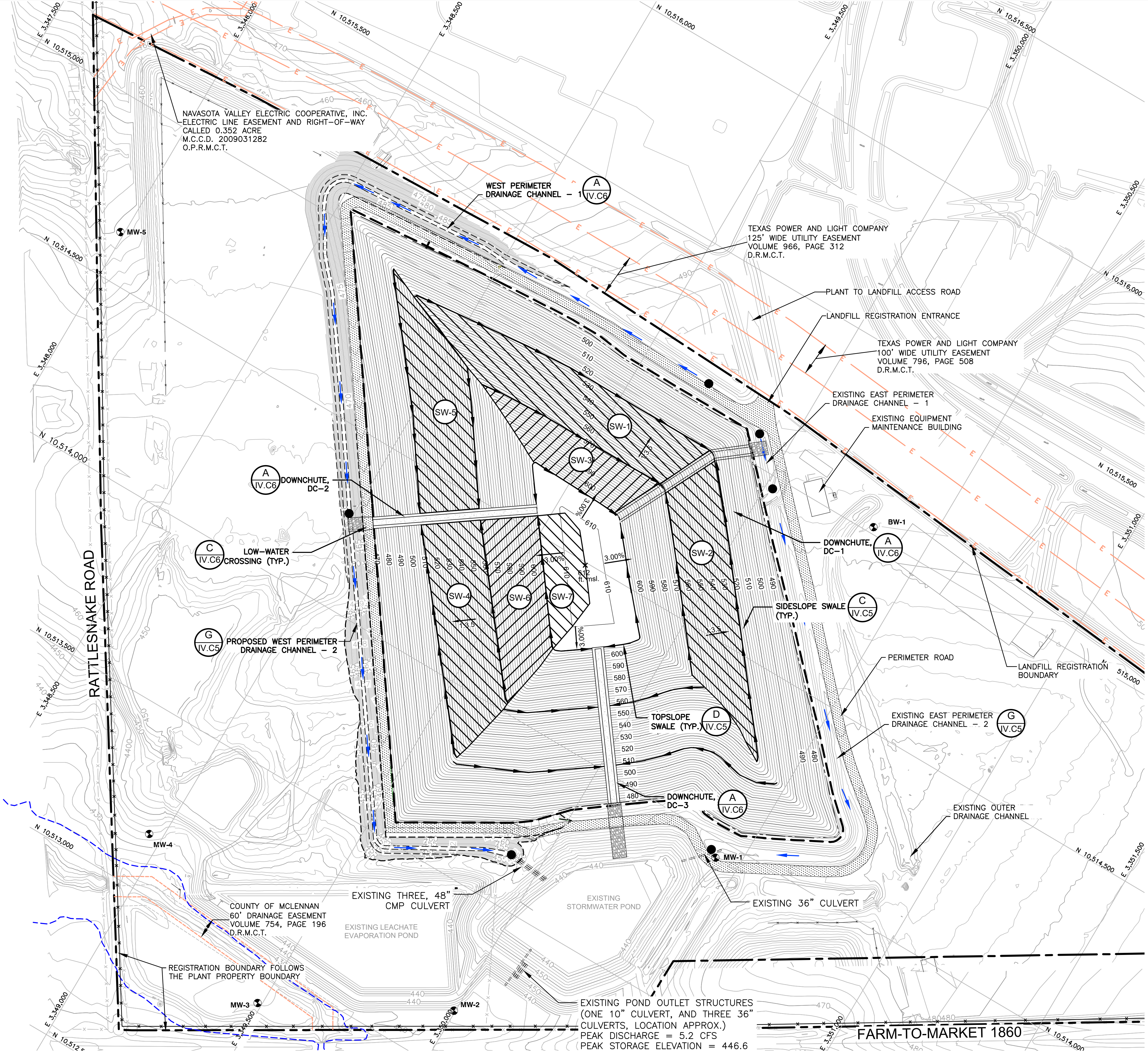
PROJ. NO. 16221059.00
DWN. BY: AGA
Q/A RVW BY: SS
DSN. BY: BJD
CHK. BY: SS
APP. BY: BJD

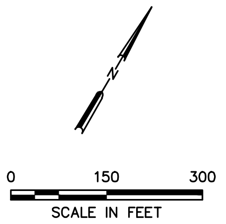
CADD FILE: INTERIM DRAINAGE DESIGN (CELLS 1 – 3)

DATE: 9/2021

SCALE: AS SHOWN

DRAWING NO.
IV.C2-A





LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
— - —	PLANT PROPERTY BOUNDARY
— - —	LANDFILL REGISTRATION BOUNDARY
— — —	REGISTERED LIMITS OF WASTE
N 10,516,500 E 3,347,000	STATE PLANE COORDINATES
MW-1	EXISTING GROUNDWATER MONITORING WELL
450	PROPOSED FINAL COVER CONTOUR
- - -	PROPOSED TOP/TOE OF SLOPE
— · —	PROPOSED DRAINAGE AREA
→	PROPOSED DRAINAGE SWALES
═	PROPOSED DOWNCHUTES
●—●	CHANNEL SECTION
→	CHANNEL FLOW DIRECTION
—×—	EXISTING FENCE
- - -	EXISTING DRAINAGE EASEMENT
— E —	EXISTING ELECTRICAL EASEMENT
- - -	100–YEAR FLOOD PLAIN
▒	PERIMETER ROAD
▨	DRAINAGE SWALE AREA

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.

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1/15/2022 1:19 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\Interim Drainage Design (Cells 1 - 3)

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
DRAINAGE SWALE AND DOWNCHUTE AREA SCHEMATIC

PROJECT TITLE
SANDY CREEK ENERGY STATION CCR WASTE MANAGEMENT FACILITY TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

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STEARNS, CONRAD AND SCHMIDT
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PH (817) 571-2288 FAX NO. (817) 571-2188

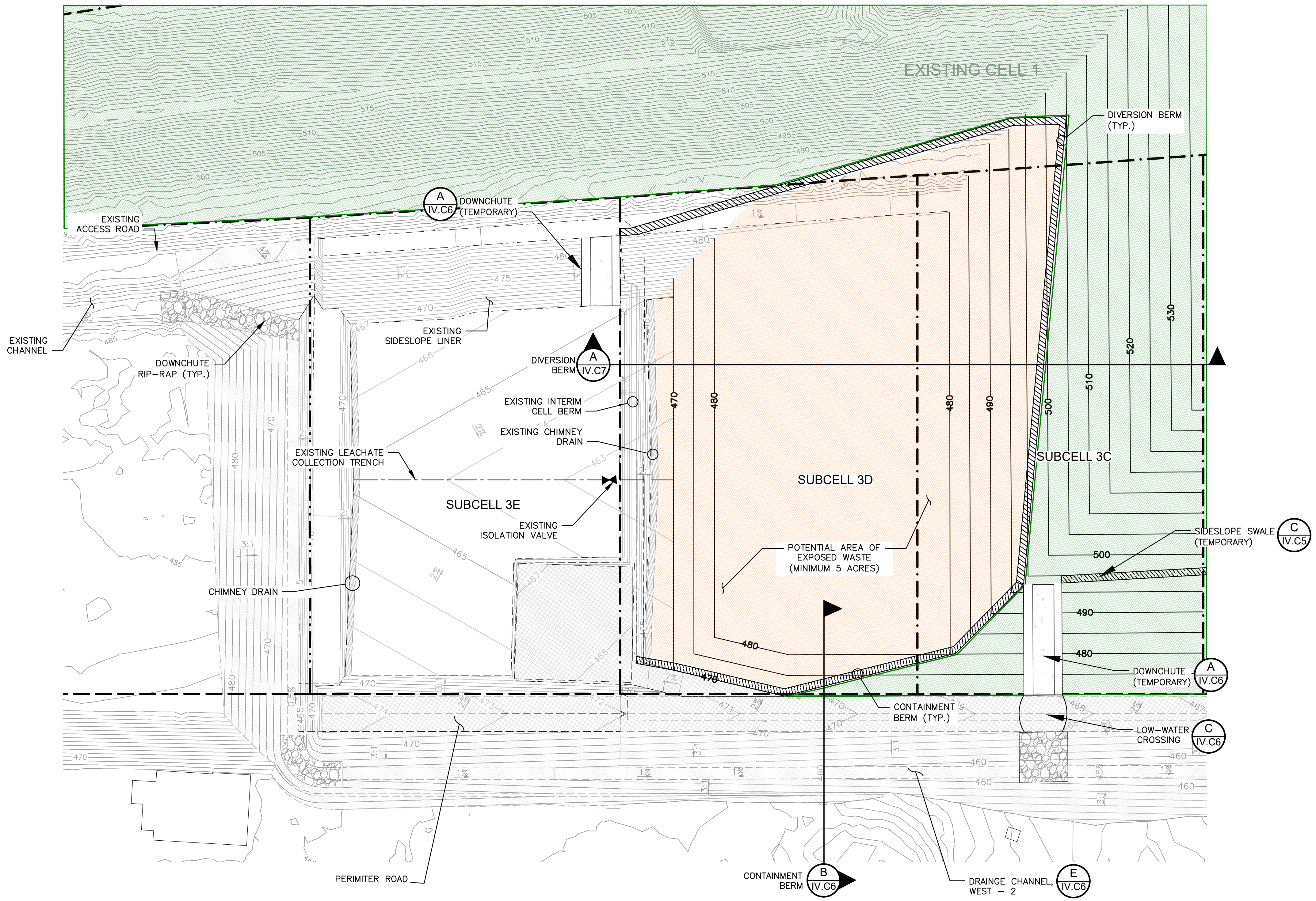
PROJ. NO. 16221059.00
DWN. BY: AGA
Q/A RVW BY: SS
DSN. BY: BJD
CHK. BY: SS
APP. BY: BJD

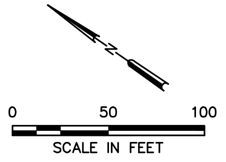
CADD FILE: INTERIM DRAINAGE DESIGN (CELLS 1 – 3)

DATE: 9/2021

SCALE: AS SHOWN

DRAWING NO.
IV.C2-B





LEGEND

450	EXISTING CONTOURS (SEE NOTE 1)
— — —	REGISTERED LIMITS OF WASTE
— · —	EXISTING CELL BOUNDARY
— · · —	PROPOSED SUBCELL BOUNDARY
- - -	EXISTING TOE/TOP OF SLOPE
— - —	EXISTING LEACHATE COLLECTION TRENCH
⋈	EXISTING ISOLATION VALVE
▨	EXISTING CHIMNEY DRAIN
▨	EXISTING ACCESS ROAD
🟧	AREA OF EXPOSED WASTE
🟩	AREA OF INTERIMEDIATE/FINAL COVER
▨	PROPOSED DIVERSION BERM
▨	PROPOSED CONTAINMENT BERM
▨	PROPOSED TEMPORARY SWALE
☰	PROPOSED DOWNCHUTES

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.
2. THIS DRAWING DEPICTS A HYPOTHETICAL SCNEARIO DURING FILLING FOR MANAGEMENT OF CONTACT WATER AND DIVERSION OF STORMWATER AWAY FROM EXPOSED ASH AREAS. CALCULATIONS FOR DIVERSION BERMS ARE SHOWN IN APPENDIX IV.D3.

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128061

Brett DeVries 1/13/22

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DRAWING TITLE
EXAMPLE INTERIM STORMWATER/
CONTACT WATER MANAGEMENT PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
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PROJ. NO. 16221059.00	DWN. BY: AGA	Q/A RVW BY: SS
DSN. BY: BJD	CHK. BY: SS	APP. BY: BJD

CADD FILE:
INTERIM CELL 3 – PHASE 2 – CONTACT WATER PLAN

DATE:
9/2021

SCALE:
AS SHOWN

DRAWING NO.
IV.C3

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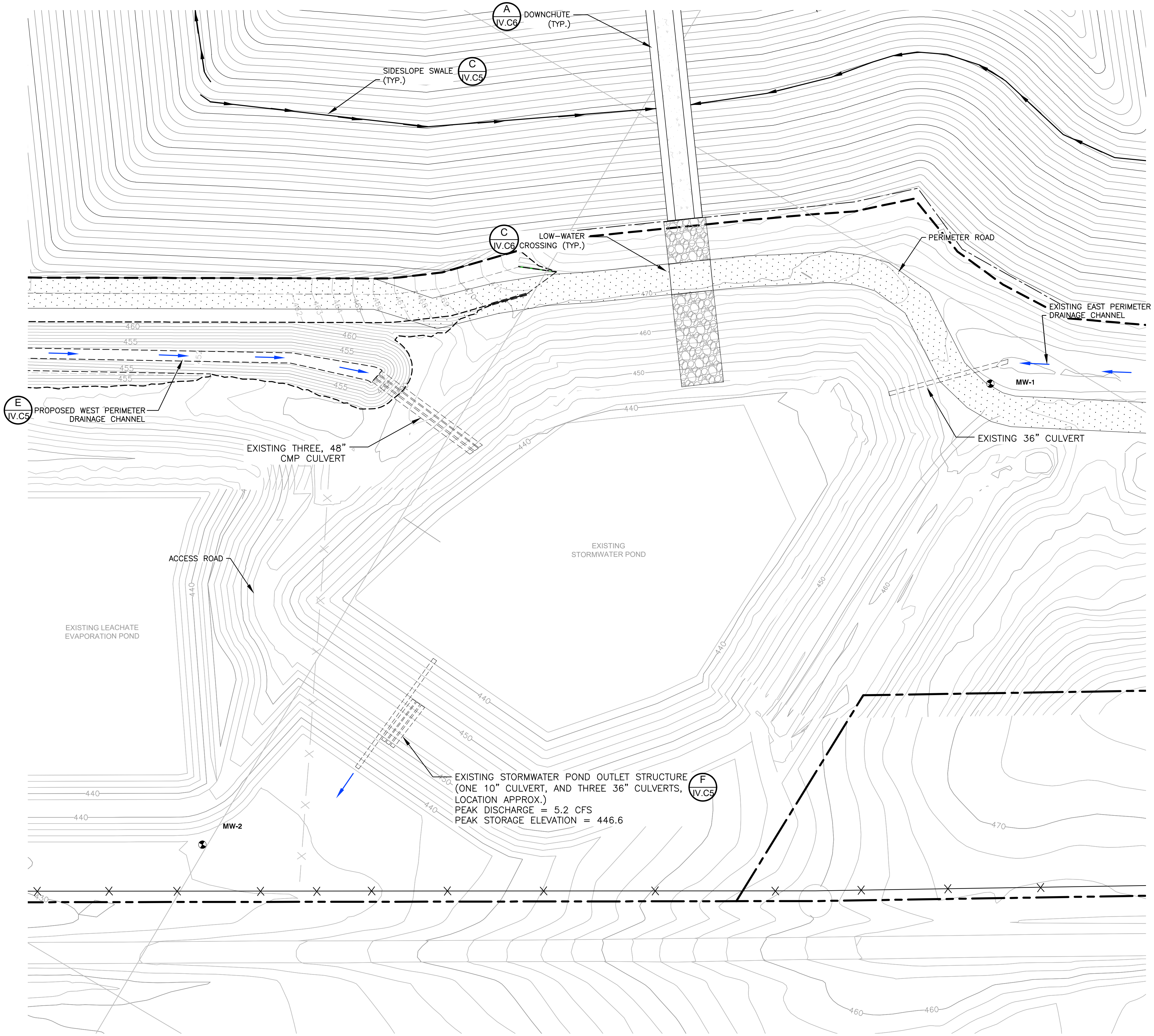

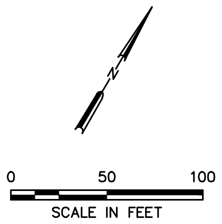

LEGEND

—450—	EXISTING CONTOURS (SEE NOTE 1)
— - —	PLANT PROPERTY BOUNDARY
— - —	LANDFILL REGISTRATION BOUNDARY
— — —	REGISTERED LIMITS OF WASTE
MW-1 ●	EXISTING GROUNDWATER MONITORING WELL
—450—	PROPOSED FINAL COVER CONTOUR
—►—►—	PROPOSED DRAINAGE SWALES
═══	PROPOSED DOWNCHUTES
→	CHANNEL FLOW DIRECTION
—×—×—	EXISTING FENCE
▨	PERIMETER ROAD

NOTES:

1. THE EXISTING CONTOUR MAP SHOWN ON THIS DRAWING WAS COMPILED FROM AN AERIAL SURVEY CONDUCTED BY DALLAS AERIAL SURVEY, INC. IN NOVEMBER, 2020 AND EXISTING TOPOGRAPHY BY BLACK & VEATCH CORPORATION DATED APRIL 2006. STATE PLANE COORDINATE GRID CORRESPONDS TO TEXAS STATE PLAN COORDINATE SYSTEM, TEXAS CENTRAL ZONE (4203), NORTH AMERICAN DATUM 83 (NAD83) 1983.

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Brett DeVries 1/13/22

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
EXISTING STORMWATER
POND PLAN

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
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PROJ. NO. 16221059.00
DSN. BY: BJD
DWN. BY: AGA
CHK. BY: SS
Q/A RVW BY: SS
APP. BY: BJD

CADD FILE: INTERIM DRAINAGE DESIGN (CELLS 1 – 3)

DATE: 9/2021

SCALE: AS SHOWN

DRAWING NO.
IV.C4

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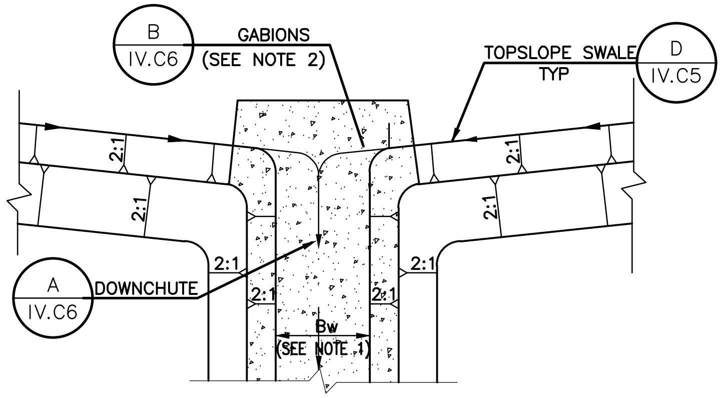
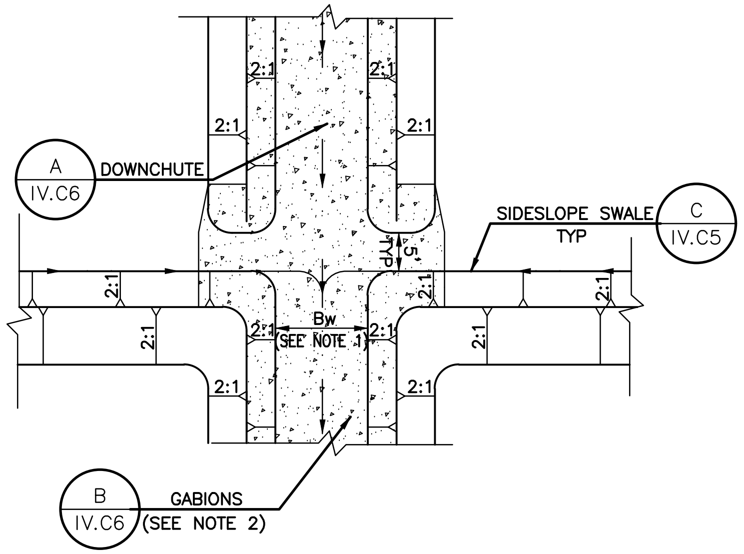


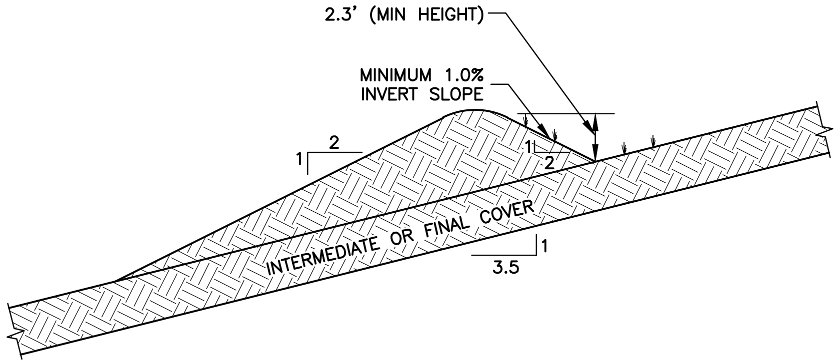
SWALE/DOWNCHUTE CONFLUENCE (A / IV.C5)

NTS



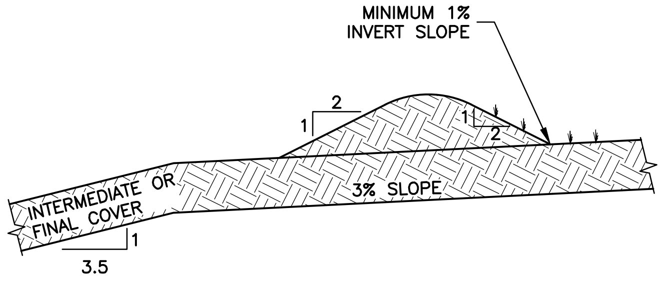
SWALE/DOWNCHUTE CONFLUENCE (B / IV.C5)

NTS



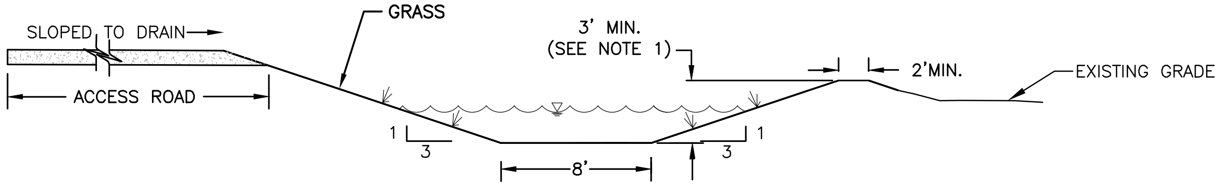
SIDESLOPE SWALE (C / IV.C5)

NTS



TOPSLOPE SWALE (D / IV.C5)

NTS

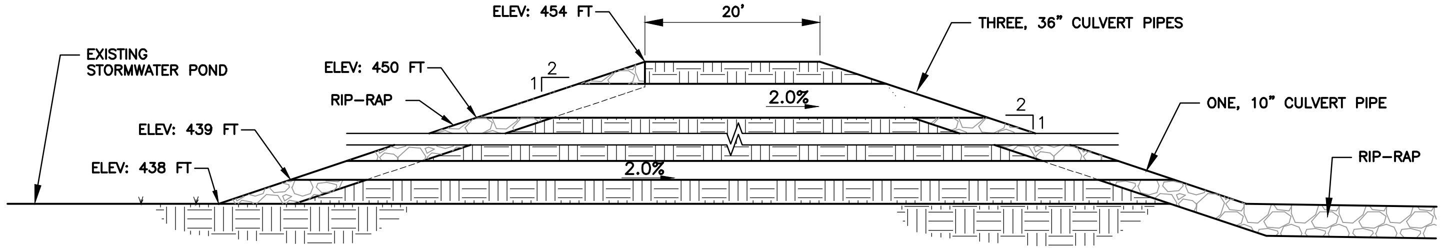


NOTE:

1. DESIGNED DRAINAGE CHANNEL DEPTH WILL INCLUDE MINIMUM 1-FOOT FREEBOARD ABOVE D_{25} (DEPTH AT 25-YEAR, 24 HOUR STORM EVENT), AS PRESENTED IN APPENDIX IV.D1.

DRAINAGE CHANNEL (E / IV.C5)

NTS



EXISTING STORMWATER POND OUTLET STRUCTURE (F / IV.C5)

NTS

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Brett DeVries 1/13/22

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE

SURFACE WATER
DRAINAGE DETAILS - 1

PROJECT TITLE

SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT

SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
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1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

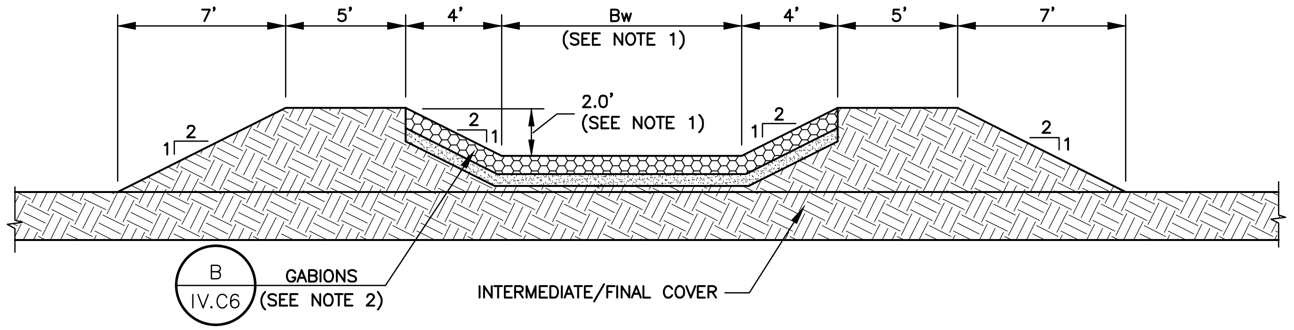
PROJ. NO. 16221059.00
DSN. BY: BJD
DWN. BY: AGA
CHK. BY: SS
Q/A RVW BY: SS
APP. BY: BJD

CADD FILE:
DRAINAGE – LEACH AND CONT WATER PLAN

DATE:
9/2021

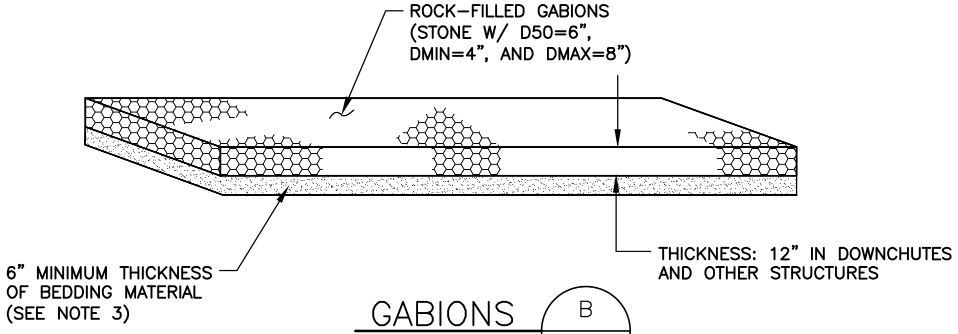
SCALE:
AS SHOWN

DRAWING NO.
IV.C5



DOWNCHUTE (A, IV.C6)

NTS



GABIONS (B, IV.C6)

NTS

NOTES, DETAILS A – C:

1. DESIGN OF DOWNCHUTES IS PRESENTED IN APPENDIX IV.D3. DOWNCHUTES WILL BE CONSTRUCTED WITH A MINIMUM BOTTOM WIDTH, Bw, OF 15' FOR FINAL COVER. TYPICAL DOWNCHUTE DEPTH IS 2 FEET FOR INDIVIDUAL DOWNCHUTES ON FINAL COVER. FINAL DEPTHS TO BE DETERMINED DURING CLOSURE DESIGN.
2. DOWNCHUTES INSTALLED ON INTERMEDIATE COVER WILL BE LINED WITH GABIONS, RIP RAP, TRM OR FLEXIBLE MEMBRANE LINER; DOWNCHUTES INSTALLED ON FINAL COVER WILL BE LINED WITH GABIONS.
3. BEDDING MATERIAL WILL CONSIST OF A COARSE SAND OR FINE CRUSHED STONE.
4. LOW WATER CROSSINGS ONLY WILL BE INSTALLED AT LOCATIONS WHERE VEHICLE CROSSING OF DOWNCHUTE IS NECESSARY.

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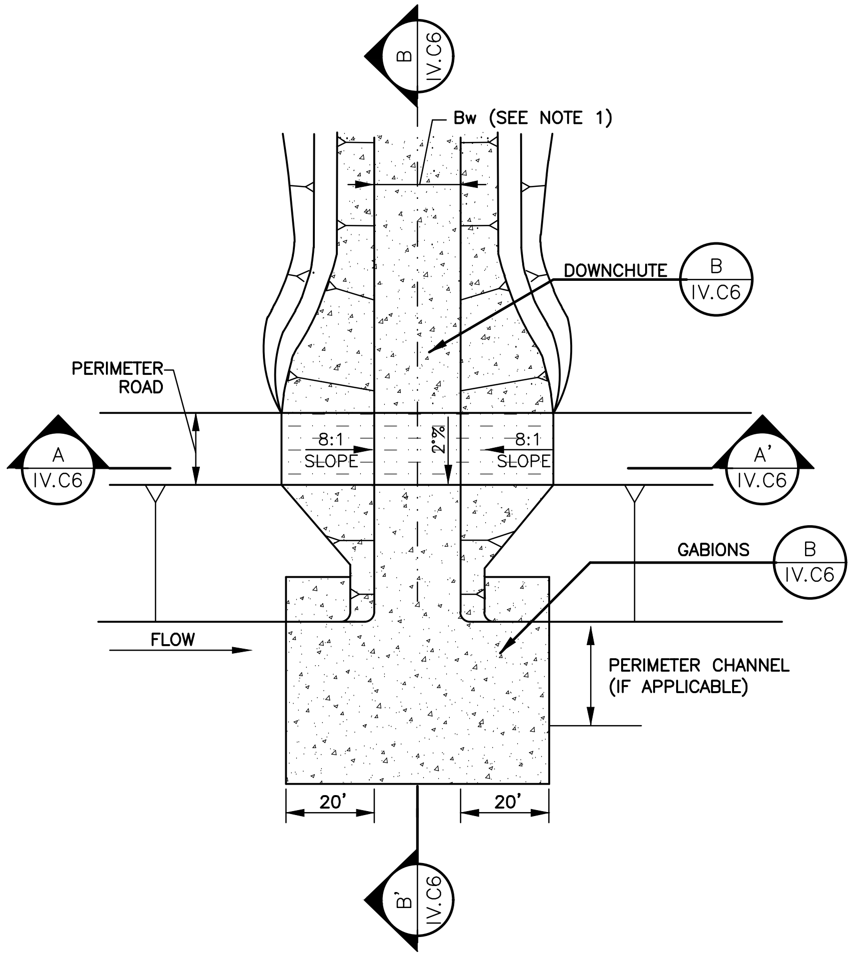
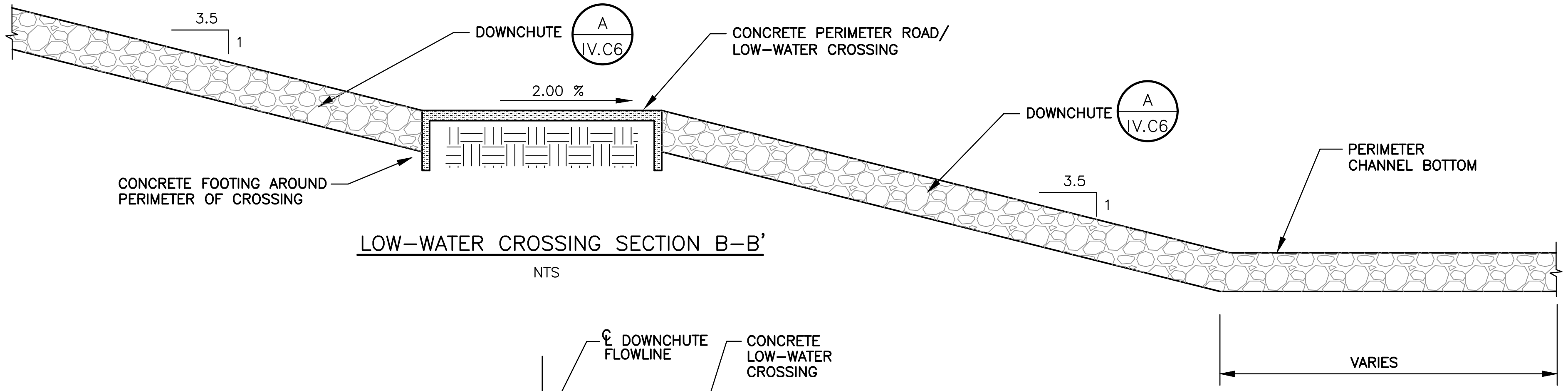
Brett DeVries 1/13/22



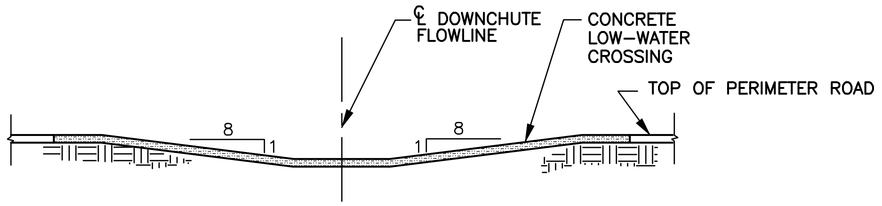
LOW-WATER CROSSING (C, IV.C6)

NTS



LOW-WATER CROSSING SECTION B-B'

NTS



LOW-WATER CROSSING SECTION A-A'

NTS

FOR REGISTRATION PURPOSES ONLY

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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
SURFACE WATER
DRAINAGE DETAILS - 2

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

CLIENT
SANDY CREEK SERVICES, LLC
2161 RATTLESNAKE ROAD
RIESEL, TEXAS 76682

SCS ENGINEERS
STEARNS, CONRAD AND SCHMIDT
CONSULTING ENGINEERS
1901 CENTRAL DRIVE, SUITE 550, BEDFORD, TX 76021
PH (817) 571-2288 FAX NO. (817) 571-2188

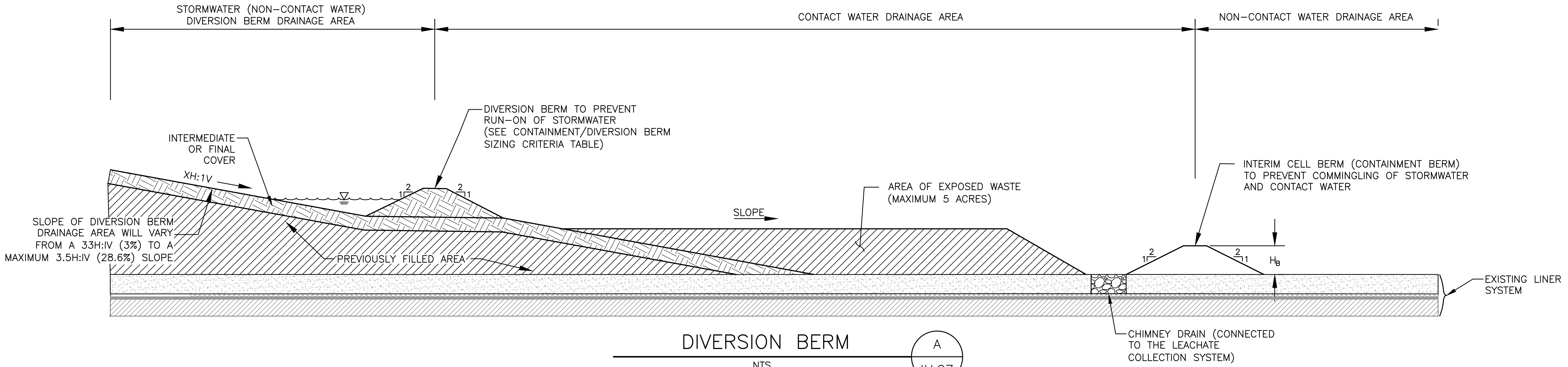
PROJ. NO. 16221059.00
DWN. BY: AGA
Q/A RVW BY: SS
DSN. BY: BJD
CHK. BY: SS
APP. BY: BJD

CADD FILE:
DRAINAGE – LEACH AND CONT WATER PLAN

DATE:
9/2021

SCALE:
AS SHOWN

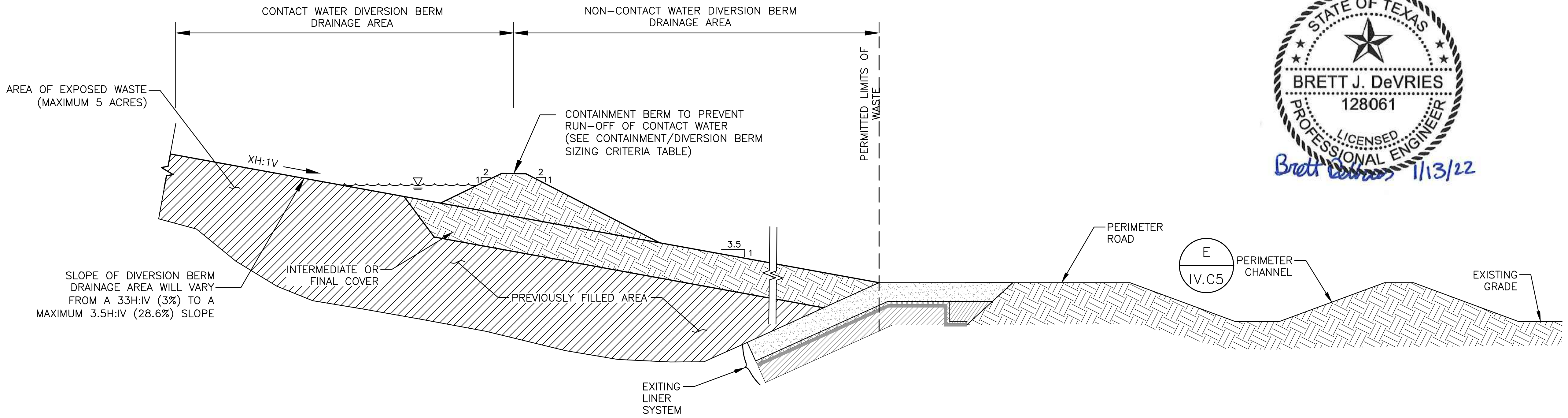
DRAWING NO.
IV.C6



DIVERSION BERM

NTS

A
IV.C7



CONTAINMENT BERM

NTS

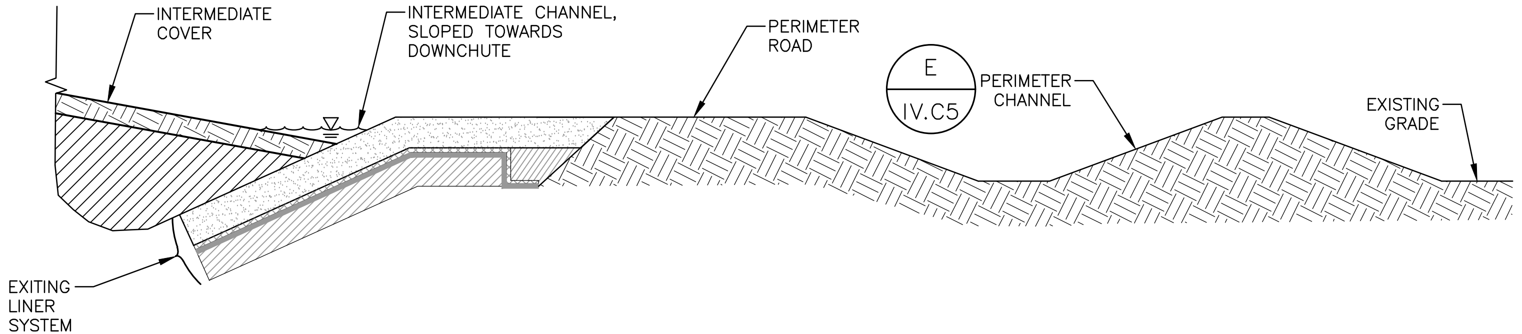
B
IV.C7

BRETT J. DeVRIES
128061

Brett DeVries 1/13/22

CONTAINMENT/DIVERSION BERM SIZING CRITERIA *						
DIVERSION BERM DRAINAGE AREA (ACRES)	MINIMUM 3%			MAXIMUM 28.6%		
	FLOW RATE (CFS)	FLOW DEPTH (FT)	REQUIRED MINIMUM DIVERSION BERM HEIGHT (FT)	FLOW RATE (CFS)	FLOW DEPTH (FT)	REQUIRED MINIMUM DIVERSION BERM HEIGHT (FT)
0.5	1.9	0.3	1.3	1.9	0.5	1.5
1.0	3.9	0.4	1.4	3.9	0.7	1.7
2.0	7.7	0.5	1.5	7.7	0.9	1.9
5.0	19.4	0.6	1.6	19.4	1.3	2.3
8.0	31.0	0.8	1.8	31.0	1.5	2.5

* CONTAINMENT/DIVERSION BERM WILL BE SIZED USING THE ABOVE TABLE AS A GUIDELINE TO PREVENT RUN-ON OF STORMWATER FROM THE 25 YEAR, 24 HOUR STORM EVENT. SUPPORTING CALCULATIONS ARE INCLUDED ON THE CONTAINMENT AND DIVERSION BERM SUMMARY SHEET IN APPENDIX IV.D3 (TABLE 2).



PERIMETER STORMWATER MANAGEMENT DETAIL

NTS

C
IV.C7

FOR REGISTRATION PURPOSES ONLY

1/15/2022 1:45 PM G:\SANDY CREEK\16221059.00 TCEQ Registration\DWG\Drainage - Leach and Cont Water Plan

REV	DATE	DESCRIPTION	BY
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TEXAS BOARD OF PROFESSIONAL ENGINEERS REG. NO. F-3407

DRAWING TITLE
CONTACT WATER MANAGEMENT DETAILS

PROJECT TITLE
SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
TCEQ REGISTRATION APPLICATION

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PROJ. NO. 16221059.00	DWN. BY: AGA	Q/A RVW BY: SS
DSN. BY: BJD	CHK. BY: SS	APP. BY: BJD

CADD FILE:
DRAINAGE – LEACH AND CONT WATER PLAN

DATE:
9/2021

SCALE:
AS SHOWN

DRAWING NO.
IV.C7

ATTACHMENT IV.C1

HYDRAFLOW HYDROGRAPHS INPUT PARAMETERS

- Precipitation Data
- SCS Curve Numbers
- Manning's Coefficients
- Post-Closure Drainage Area Conditions
- Post-Closure Drainage Channels

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED
PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.C1-2
through IV.C1-21

PRECIPITATION DATA

NOAA Atlas 14, Volume 11, Version 2
Location name: Riesel, Texas, USA*
Latitude: 31.4743°, Longitude: -96.9592°
Elevation: 480.95 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	**2**	**5**	**10**	**25**	**50**	**100**	**200**	**500**	**1000**
5-min	**0.428** (0.324-0.565)	**0.501** (0.383-0.655)	**0.621** (0.473-0.816)	**0.721** (0.541-0.960)	**0.859** (0.624-1.18)	**0.966** (0.684-1.36)	**1.08** (0.742-1.55)	**1.19** (0.801-1.76)	**1.35** (0.876-2.06)	**1.47** (0.932-2.31)
10-min	**0.682** (0.516-0.901)	**0.800** (0.610-1.05)	**0.992** (0.755-1.30)	**1.15** (0.865-1.53)	**1.38** (1.00-1.89)	**1.55** (1.10-2.18)	**1.72** (1.19-2.49)	**1.90** (1.28-2.82)	**2.14** (1.39-3.28)	**2.33** (1.47-3.65)
15-min	**0.861** (0.652-1.14)	**1.01** (0.768-1.32)	**1.24** (0.946-1.63)	**1.44** (1.08-1.92)	**1.71** (1.25-2.35)	**1.92** (1.36-2.71)	**2.14** (1.48-3.09)	**2.37** (1.59-3.50)	**2.68** (1.74-4.09)	**2.92** (1.85-4.57)
30-min	**1.21** (0.915-1.60)	**1.41** (1.08-1.85)	**1.74** (1.32-2.28)	**2.01** (1.51-2.68)	**2.39** (1.73-3.27)	**2.68** (1.89-3.76)	**2.97** (2.05-4.29)	**3.29** (2.21-4.87)	**3.73** (2.42-5.70)	**4.07** (2.58-6.38)
60-min	**1.57** (1.19-2.07)	**1.84** (1.40-2.40)	**2.27** (1.73-2.99)	**2.64** (1.98-3.51)	**3.15** (2.28-4.30)	**3.53** (2.50-4.97)	**3.94** (2.72-5.68)	**4.38** (2.94-6.48)	**4.99** (3.24-7.64)	**5.49** (3.47-8.59)
2-hr	**1.90** (1.45-2.48)	**2.26** (1.73-2.91)	**2.83** (2.17-3.67)	**3.31** (2.51-4.37)	**4.01** (2.93-5.43)	**4.55** (3.24-6.33)	**5.12** (3.56-7.31)	**5.76** (3.89-8.41)	**6.65** (4.34-10.0)	**7.37** (4.68-11.4)
3-hr	**2.08** (1.60-2.71)	**2.50** (1.92-3.19)	**3.16** (2.43-4.08)	**3.73** (2.84-4.89)	**4.55** (3.35-6.13)	**5.20** (3.72-7.20)	**5.90** (4.11-8.36)	**6.68** (4.52-9.68)	**7.77** (5.08-11.7)	**8.66** (5.52-13.3)
6-hr	**2.41** (1.86-3.10)	**2.94** (2.27-3.69)	**3.74** (2.90-4.77)	**4.45** (3.41-5.78)	**5.49** (4.07-7.33)	**6.34** (4.57-8.68)	**7.26** (5.08-10.2)	**8.28** (5.64-11.9)	**9.75** (6.40-14.4)	**11.0** (7.00-16.6)
12-hr	**2.74** (2.13-3.49)	**3.37** (2.61-4.17)	**4.32** (3.38-5.45)	**5.17** (4.00-6.64)	**6.43** (4.81-8.49)	**7.47** (5.42-10.1)	**8.62** (6.07-11.9)	**9.91** (6.78-14.0)	**11.8** (7.78-17.2)	**13.4** (8.58-20.0)
24-hr	**3.09** (2.43-3.90)	**3.83** (2.99-4.69)	**4.94** (3.90-6.17)	**5.94** (4.63-7.55)	7.42 (5.58-9.68)	**8.63** (6.30-11.5)	**9.99** (7.08-13.6)	**11.5** (7.93-16.1)	**13.8** (9.16-19.9)	**15.8** (10.1-23.2)
2-day	**3.47** (2.76-4.34)	**4.33** (3.44-5.28)	**5.65** (4.51-7.00)	**6.81** (5.35-8.57)	**8.49** (6.42-10.9)	**9.82** (7.20-13.0)	**11.3** (8.06-15.3)	**13.0** (9.02-18.0)	**15.6** (10.4-22.3)	**17.9** (11.5-25.9)
3-day	**3.77** (3.01-4.68)	**4.69** (3.75-5.71)	**6.13** (4.92-7.55)	**7.38** (5.83-9.23)	**9.16** (6.95-11.7)	**10.6** (7.77-13.8)	**12.1** (8.65-16.2)	**13.9** (9.65-19.0)	**16.6** (11.1-23.5)	**18.9** (12.2-27.2)
4-day	**4.03** (3.23-4.99)	**4.99** (4.02-6.06)	**6.50** (5.24-7.98)	**7.80** (6.18-9.71)	**9.64** (7.34-12.3)	**11.1** (8.18-14.4)	**12.7** (9.07-16.9)	**14.5** (10.1-19.7)	**17.2** (11.5-24.1)	**19.5** (12.6-27.9)
7-day	**4.71** (3.80-5.77)	**5.72** (4.64-6.90)	**7.32** (5.94-8.91)	**8.68** (6.93-10.7)	**10.6** (8.14-13.4)	**12.1** (9.01-15.7)	**13.8** (9.92-18.2)	**15.6** (10.9-21.0)	**18.3** (12.3-25.3)	**20.5** (13.3-28.9)
10-day	**5.26** (4.27-6.42)	**6.32** (5.16-7.60)	**7.99** (6.52-9.69)	**9.42** (7.55-11.6)	**11.4** (8.80-14.3)	**13.0** (9.69-16.7)	**14.7** (10.6-19.2)	**16.5** (11.6-22.1)	**19.1** (12.9-26.3)	**21.3** (13.9-29.8)
20-day	**6.86** (5.61-8.28)	**8.05** (6.67-9.65)	**10.0** (8.25-12.0)	**11.6** (9.41-14.1)	**13.9** (10.7-17.2)	**15.5** (11.7-19.7)	**17.3** (12.6-22.3)	**19.1** (13.5-25.2)	**21.6** (14.6-29.3)	**23.6** (15.4-32.6)
30-day	**8.18** (6.73-9.81)	**9.48** (7.92-11.3)	**11.7** (9.69-13.9)	**13.4** (10.9-16.2)	**15.8** (12.3-19.5)	**17.6** (13.2-22.1)	**19.3** (14.1-24.8)	**21.2** (15.0-27.7)	**23.6** (16.0-31.7)	**25.4** (16.7-34.8)
45-day	**10.1** (8.36-12.0)	**11.5** (9.73-13.8)	**14.0** (11.7-16.7)	**16.0** (13.0-19.1)	**18.5** (14.5-22.6)	**20.4** (15.4-25.4)	**22.1** (16.2-28.2)	**23.9** (17.0-31.1)	**26.3** (17.9-35.0)	**28.0** (18.4-38.1)
60-day	**11.8** (9.84-14.1)	**13.4** (11.4-16.0)	**16.1** (13.5-19.1)	**18.2** (14.9-21.7)	**20.9** (16.4-25.4)	**22.8** (17.3-28.3)	**24.6** (18.1-31.2)	**26.4** (18.7-34.1)	**28.7** (19.5-38.0)	**30.3** (20.0-40.9)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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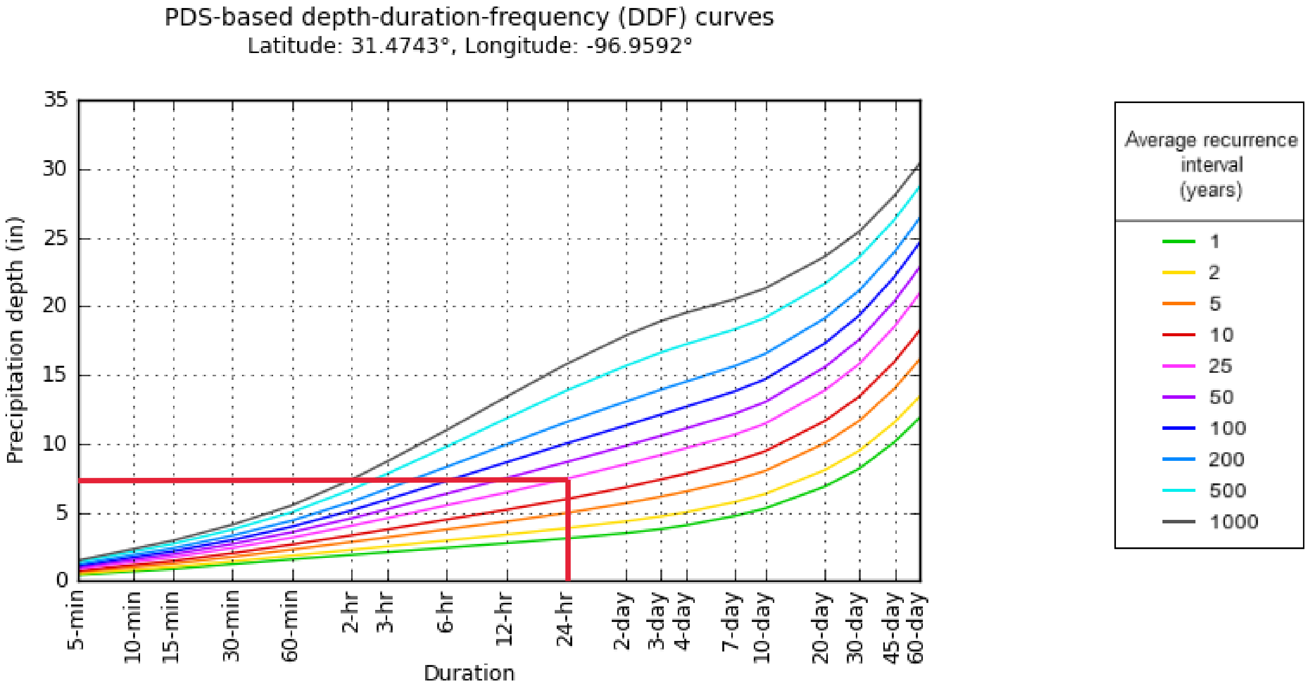
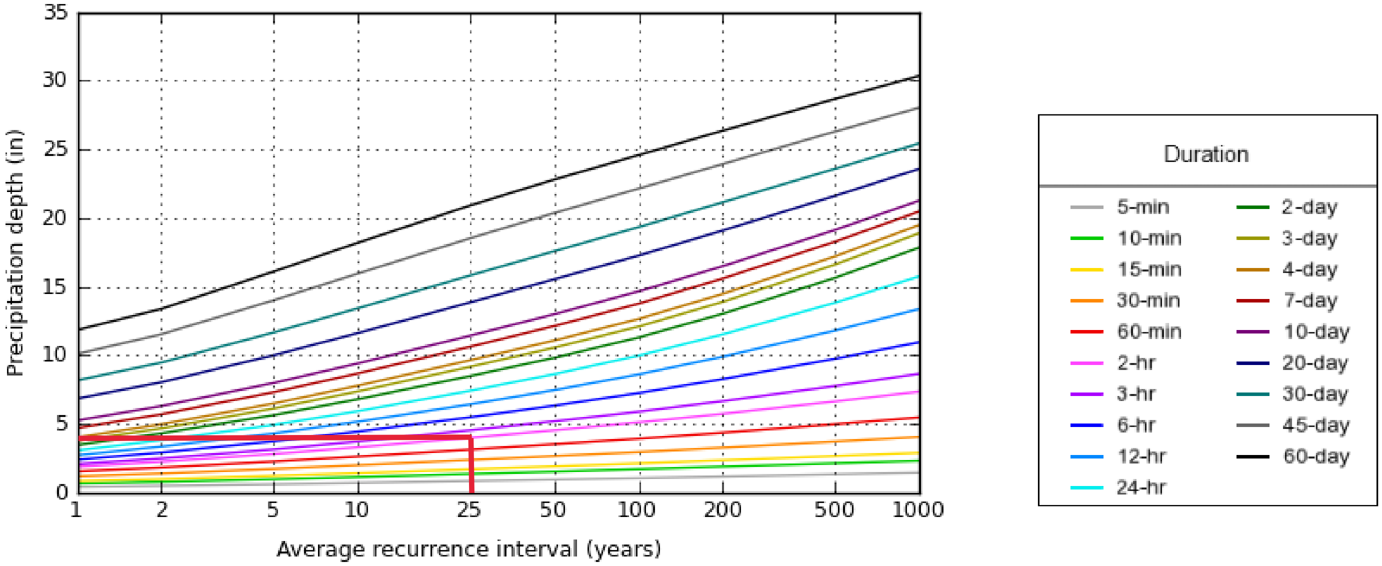
PF graphical





NOAA Atlas 14, Volume 11, Version 2

Created (GMT): Fri Sep 10 20:22:08 2021

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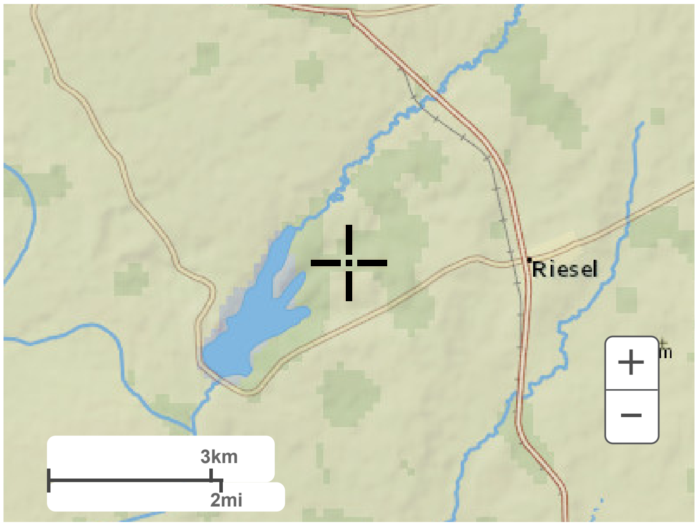
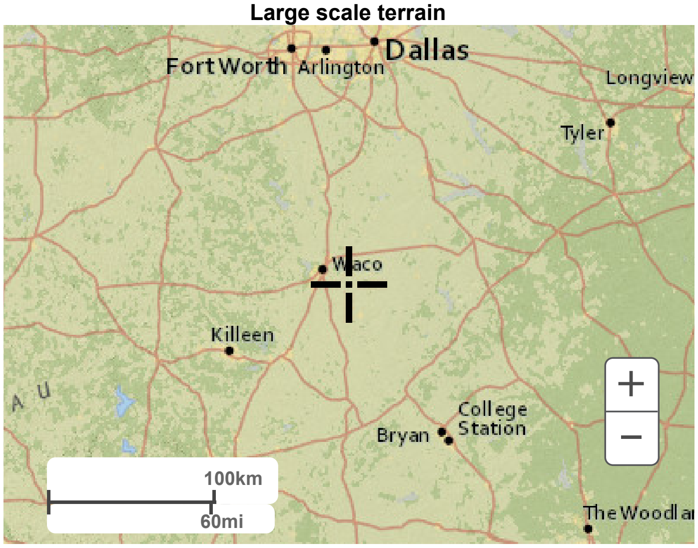
Maps & aerials

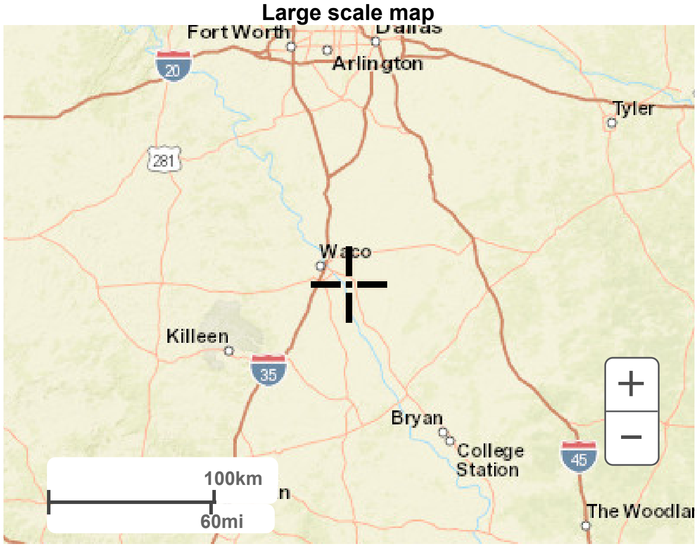
Small scale terrain



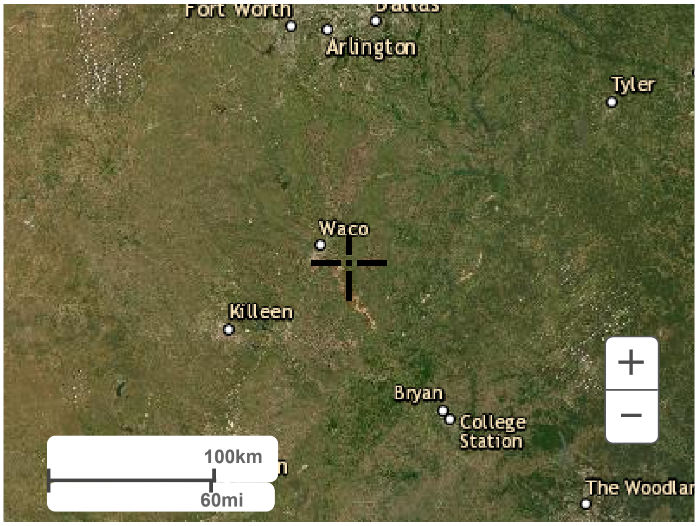
Large scale terrain



Large scale map



Large scale aerial

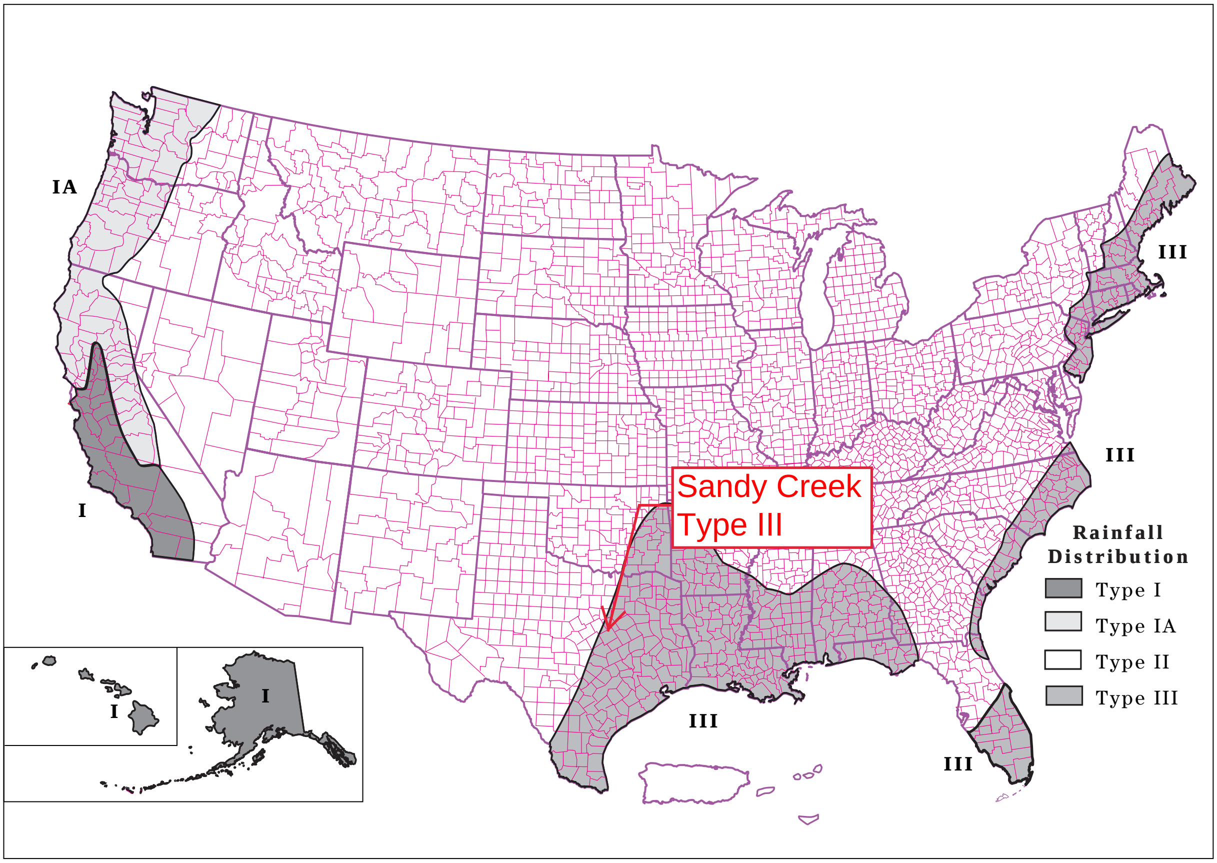


Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

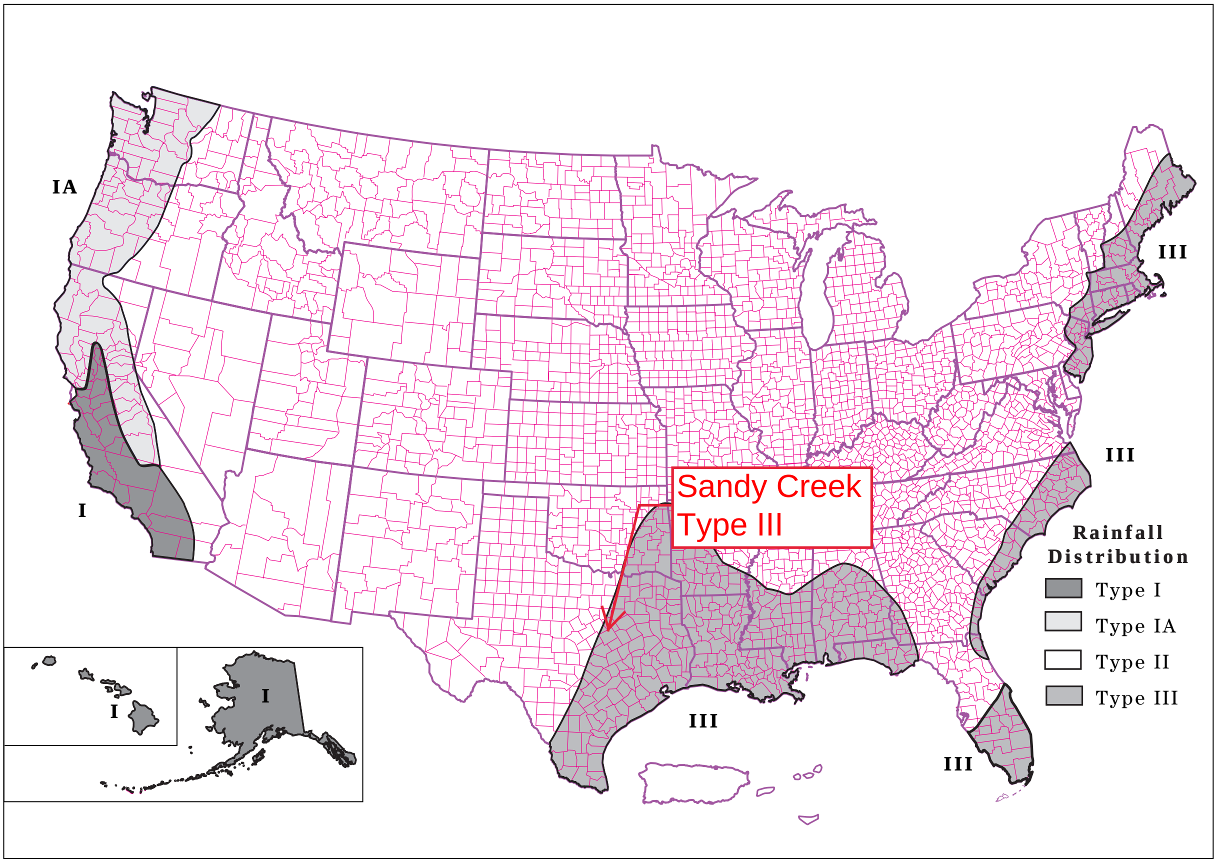
Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

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East of 105th meridian

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West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

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Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

SCS CURVE NUMBERS

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

Table 2-2a Runoff curve numbers for urban areas [1]

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		[illegible]	[illegible]	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

Final Cover and Surrounding
Drainage Areas
CN = 80

---

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

MANNING'S COEFFICIENTS

Sandy Creek Energy Station
Coal Combustion Residual Waste Management Facility
Hydraulic Analysis Manning's "n" References

Post-closure Conditions

Description	Use	Reference	Mannings "n"
Drainage swales, short grass and some weeds, established channels.	Hydraflow Hydrographs Extension model for swales	See Item 3, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.027
Downchutes, gabion or rip rap lined, established channels.	Hydraflow Hydrographs Extension model for downchutes	See Item 4, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.033
Drainage Channels, short grass and some weeds, established channels	Hydraflow Hydrographs Extension model for routing reaches.	See Item 3, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.027
Drainage Channels, rip rap or TRM lined, established channels.	N/A	See Item 4, Table 4.1, "Design Hydrology and Sedimentology for Small Catchments", Haan et al.	0.033

Note: Manning's "n" used for drainage swales, downchutes, and channels were incorporated into Hydraflow Hydrographs Extension for Autodesk Civil 3D, as well as the Hydraulic Analysis using Hydraflow Express Extension for Autodesk Civil 3D.
Reference: C.T. Haan, B.J. Barfield, J.C. Hayes. *Design Hydrology and Sedimentology for Small Catchments*. Academic Press. 1994.

Design Hydrology and Sedimentology for Small Catchments

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An Irish engineer named Manning found that the equation

$$v = KR^{2/3}S^{1/2}$$

fit experimental data quite nicely. This equation is known as Manning's equation and differs from Chezy's equation only in the exponent on R. So that the factor related to the channel roughness would increase as roughness increased, Manning's equation is generally written as

$$v = (1/n)R^{2/3}S^{1/2}$$

in the metric system with v in meters per second and R in meters. The coefficient n is known as Manning's n. In the English system of units, Manning's equation is

$$v = \frac{1.49}{n}R^{2/3}S^{1/2}, \tag{4.23}$$

where v is in fps, R is in feet, and S is in feet per foot. Tables of Manning's n are widely available. Table 4.1 is such a table taken from several sources, drawing heavily on Schwab *et al.* (1966, 1971). Manning's n is influenced by many factors, including the physical roughness of the channel surface, the irregularity of the channel cross section, channel alignment and bends, vegetation, silting and scouring, and obstruction within the channel. Chow (1959) displays some photographs of typical channels and the associated values for Manning's n.

Figure 4.9 contains some useful relationships for calculating the hydraulic properties of A, P, R, and top width, T, for three common channels. For natural channels, these properties are best determined from measurements based on the actual cross sections of the channel.

Table 4.1 Typical Values for Manning's n

Type and description of conduits	n Values[a]		
	Min.	Design	Max.
Channels, lined			
Asphaltic concrete, machine placed		0.014	
Asphalt, exposed prefabricated		0.015	
Concrete	0.012	0.015	0.018
Concrete, rubble	0.016		0.029
Metal, smooth (flumes)	0.011		0.015
Metal, corrugated	0.021	0.024	0.026
Plastic	0.012		0.014
Shotcrete	0.016		0.017
Wood, planed (flumes)	0.009	0.012	0.016
Wood, unplaned (flumes)	0.011	0.013	0.015
Channels, earth			
Earth bottom, rubble sides	0.028	0.032	0.035
Drainage ditches, large, no vegetation			
(a) < 2.5 hydraulic radius	0.040		0.045
(b) 2.5–4.0 hydraulic radius	0.035		0.040
(c) 4.0–5.0 hydraulic radius	0.030		0.035
(d) > 5.0 hydraulic radius	0.025		0.030
Small drainage ditches	0.035	0.040	0.040
Stony bed, weeds on bank	0.025	0.035	0.040
Straight and uniform	0.017	0.0225	0.025
Winding, sluggish	0.0225	0.025	0.030
Channels, vegetated			
(See subsequent discussion)			

Type and description of conduits	n Values[a]		
	Min.	Design	Max.
Natural Streams			
③ (a) Clean, straight bank, full stage, no rifts or deep pools	0.025	0.027	0.033
② (b) Same as (a) but some weeds and stones	0.030		0.040
① (c) Winding, some pools and shoals, clean	0.035	0.040	0.050
(d) Same as (c), lower stages, more ineffective slopes and sections	0.040		0.055
(e) Same as (c), some weeds and stones	0.033		0.045
(f) Same as (d), stony sections	0.045		0.060
(g) Sluggish river reaches, rather weedy or with very deep pools	0.050		0.080
(h) Very weedy reaches	0.075		0.150
Pipe			
Asbestos cement		0.009	
Cast iron, coated	0.011	0.013	0.014
Cast iron, uncoated	0.012		0.015
Clay or concrete drain tile (4–12 in.)	0.010	0.0108	0.020
Concrete	0.010	0.014	0.017
Metal, corrugated	0.021	0.025	0.0255
Steel, riveted and spiral	0.013	0.016	0.017
Vitrified sewer pipe	0.010	0.014	0.017
Wood stave	0.010	0.013	
Wrought iron, black	0.012		0.015
Wrought iron, galvanized	0.013	0.016	0.017

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[a] Selected from numerous sources.

United States Department of Agriculture

Natural Resources Conservation Service

Conservation Engineering Division

Technical Release 55

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Urban Hydrology for Small Watersheds

TR-55

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).

[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[3] When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Post-Closure, landfill final cover
Grass: Short grass prairie n = 0.15 Post-Development, landfill final cover.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

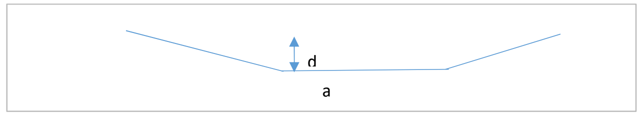
POST-CLOSURE DRAINAGE AREA CONDITIONS

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
POST-CLOSURE DRAINAGE AREA

2-yr, 24-hr Rainfall Depth = 3.83 inches

				Sheet Flow				Shallow Concentrated Flow (Swales)				Open Channel Flow								Time of Concentration (Tc)			
Hyd. No.	**Contributing Drainage Areas**	**Area (acres)**	**Curve Number (CN)**	**Surface Description**	**Length**	**Slope**	**Manning n**	**Surface Description**	**Length**	**Slope**	**Avg. Velocity**	**Surface Description**	**Length**	**Slope (ft/ft)**	**Manning n**	**Cross-sectional Area**	**Wetted Perimeter**	**Hydraulic Radius**	**Avg. Velocity**	**Sheet Flow T_c**	**Shallow Concentrated Flow T_c**	**Channel Flow T_c**	**Total T_c**
					(feet)	**(ft/ft)**			**(feet)**	**(ft/ft)**	**(ft/s)**		**(feet)**	**(ft/ft)**		**(ft2)**	**(ft)**	**(ft)**	**(ft/s)**	**(min)**	**(min)**	**(min)**	**(min)**
1	DA-1A	8.5	80.0	Grass	160	0.286	0.15	Grass	860	0.010	4.0	Grass	430	0.286	0.033	4.8	16.4	0.3	10.7	5	4	1	9
2	DA-1B	1.2	80.0	Grass	125	0.030	0.15	Grass	240	0.010	4.0	-	-	-	-	-	-	-	-	9	1	-	10
3	DA-1C	1.2	80.0	Grass	140	0.286	0.15	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	4
5	DA-1D	5.4	80.0	Grass	175	0.286	0.15	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	5
8	DA-2A	7.9	80.0	Grass	175	0.286	0.15	Grass	570	0.010	4.0	Grass	550	0.286	0.033	4.8	16.4	0.3	10.7	5	2	1	8
9	DA-2B	1.1	80.0	Grass	125	0.030	0.15	Grass	295	0.010	4.0	-	-	-	-	-	-	-	-	9	1	-	10
10	DA-2C	10.3	80.0	Grass	150	0.286	0.15	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	4
12	DA-2D	4.7	80.0	Grass	175	0.286	0.15	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	5
15	DA-3A	4.9	80.0	Grass	175	0.286	0.15	Grass	330	0.010	4.0	Grass	290	0.286	0.033	3.2	15.9	0.2	8.3	5	1	1	7
16	DA-3B	0.4	80.0	Grass	125	0.030	0.15	Grass	150	0.010	4.0	-	-	-	-	-	-	-	-	9	1	-	10
17	DA-3C	6.7	80.0	Grass	175	0.286	0.15	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	5
18	Stormwater Pond	5.5	98.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Channel Section:



Total Area = **58 acres**

	a (ft)	d (ft)	water depth (ft)	left slope (%)	right slope (%)	Area (ft2)	Wetted P (ft)
DA-1A Downchute	15	2.0	0.31	50.0	50.0	4.8	16.4
DA-2A Downchute	15	2.0	0.30	50.0	50.0	4.8	16.4
DA-3A Downchute	15	2.0	0.21	50.0	50.0	3.2	15.9

Methodology:

Reference: United States Department of Agriculture. Hydrology National Engineering Handbook, Part 630 (May 2010). Chapter 15, Time of Concentration.

Sheet Flow T_c

$$T_t = \frac{0.007(nl)^{0.8}}{(P_2)^{0.5}S^{0.4}} \quad \text{(eq. 15-8)}$$

where:

T_t = travel time, h

n = Manning's roughness coefficient (0.15, short-grass prairie)

l = sheet flow length, ft

P_2 = 2-year, 24-hour rainfall, in. (3.83 inches)

S = slope of land surface, ft/ft

Shallow Concentrated Flow (Swales) T_c

See Drainage Swale Flow Analysis, Appendix IV.D3, for max velocity of 4 fps.

Channel Flow T_c

$$V = \frac{1.49r^{\frac{2}{3}}s^{\frac{1}{2}}}{n} \quad \text{(eq. 15-10)}$$

where:

V = Average velocity, ft/s

r = hydraulic radius, ft

$= \frac{a}{P_w}$

a = cross-sectional flow area, ft2

P_w = Wetted perimeter, ft

s = slope of the hydraulic grade line, ft/ft

n = Manning's n value for open channel flow (0.027, grass or 0.033, gabions/TRM)

POST-CLOSURE DRAINAGE CHANNELS

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
POST-CLOSURE DRAINAGE CHANNELS

Hyd. No. [1]	Channel Name	Receiving Basin	Channel Length (ft)	Bottom Slope (ft/ft)	Bottom Width (ft)	Sideslope (XH:1V)	Flow (cfs)	Flow velocity (fps)	Normal Depth (ft)	Depth (ft)	Mannings Coefficient	Lining Material
4	East - 1	Stormwater Pond	190	0.0100	8	3	9.86	2.68	0.40	3.00	0.027	Grass
7	East - 2	Stormwater Pond	1,480	0.0100	8	3	76.07	5.18	1.25	3.00	0.027	Grass
11	West - 1	Stormwater Pond	280	0.0100	8	3	43.66	4.35	0.93	3.00	0.027	Grass
14	West - 2	Stormwater Pond	1,335	0.0100	8	3	101.45	5.61	1.46	3.00	0.033	Grass

Notes:

1.) Hyd. No. refers to Hydraflow Hydrograph modeling input. See Appendix IV.C2.

ATTACHMENT IV.C2

HYDRAFLOW HYDROGRAPHS POST-CLOSURE OUTPUT FILES

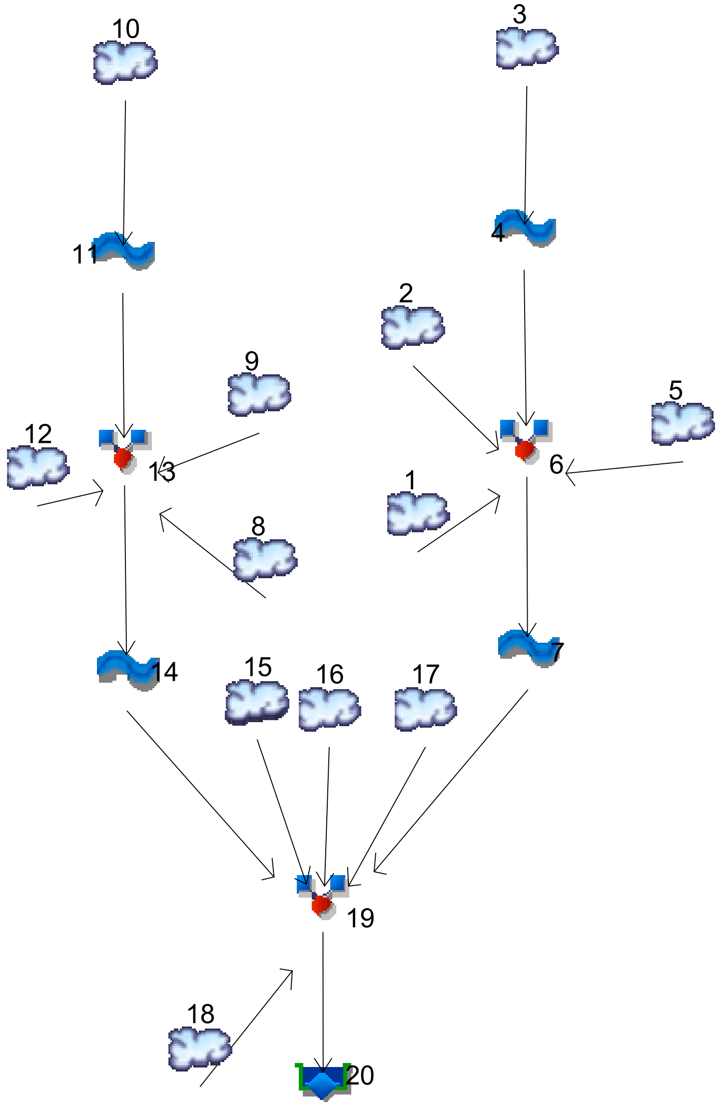
STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED
PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.C2-2
through IV.C2-25

Watershed Model Schematic

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020



Project: Sandy Creek - Post-Development Model (092021).gpw

Monday, 10 / 4 / 2021

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	45.41	2	726	156,851	------	------	------	DA-1A
2	SCS Runoff	5.905	2	728	22,836	------	------	------	DA-1B
3	SCS Runoff	6.840	2	724	20,760	------	------	------	DA-1C
4	Reach	6.878	2	726	20,759	3	------	------	East Channel - 1
5	SCS Runoff	30.78	2	724	93,418	------	------	------	DA-1D
6	Combine	85.61	2	726	293,864	1, 2, 4, 5	------	------	Inflow to East Channel - 2
7	Reach	76.07	2	730	293,862	6	------	------	East Channel - 2
8	SCS Runoff	42.21	2	726	145,779	------	------	------	DA-2A
9	SCS Runoff	5.413	2	728	20,933	------	------	------	DA-2B
10	SCS Runoff	58.71	2	724	178,187	------	------	------	DA-2C
11	Reach	43.66	2	728	178,183	10	------	------	West Channel - 1
12	SCS Runoff	27.07	2	724	82,156	------	------	------	DA-2D
13	Combine	112.33	2	726	427,051	8, 9, 11, 12	------	------	Inflow to West Channel - 2
14	Reach	101.45	2	730	427,048	13	------	------	West Channel - 2
15	SCS Runoff	62.43	2	726	215,624	------	------	------	DA-3A
16	SCS Runoff	1.840	2	728	7,117	------	------	------	DA-3B
17	SCS Runoff	38.28	2	724	116,185	------	------	------	DA-3C
18	SCS Runoff	38.60	2	724	134,400	------	------	------	Stormwater Pond Area
19	Combine	287.57	2	728	1,194,238	7, 14, 15, 16, 17, 18	------	------	Pond Inflow
20	Reservoir	5.198	2	1252	1,066,999	19	446.59	975,015	Existing Pond

Hydrograph Report

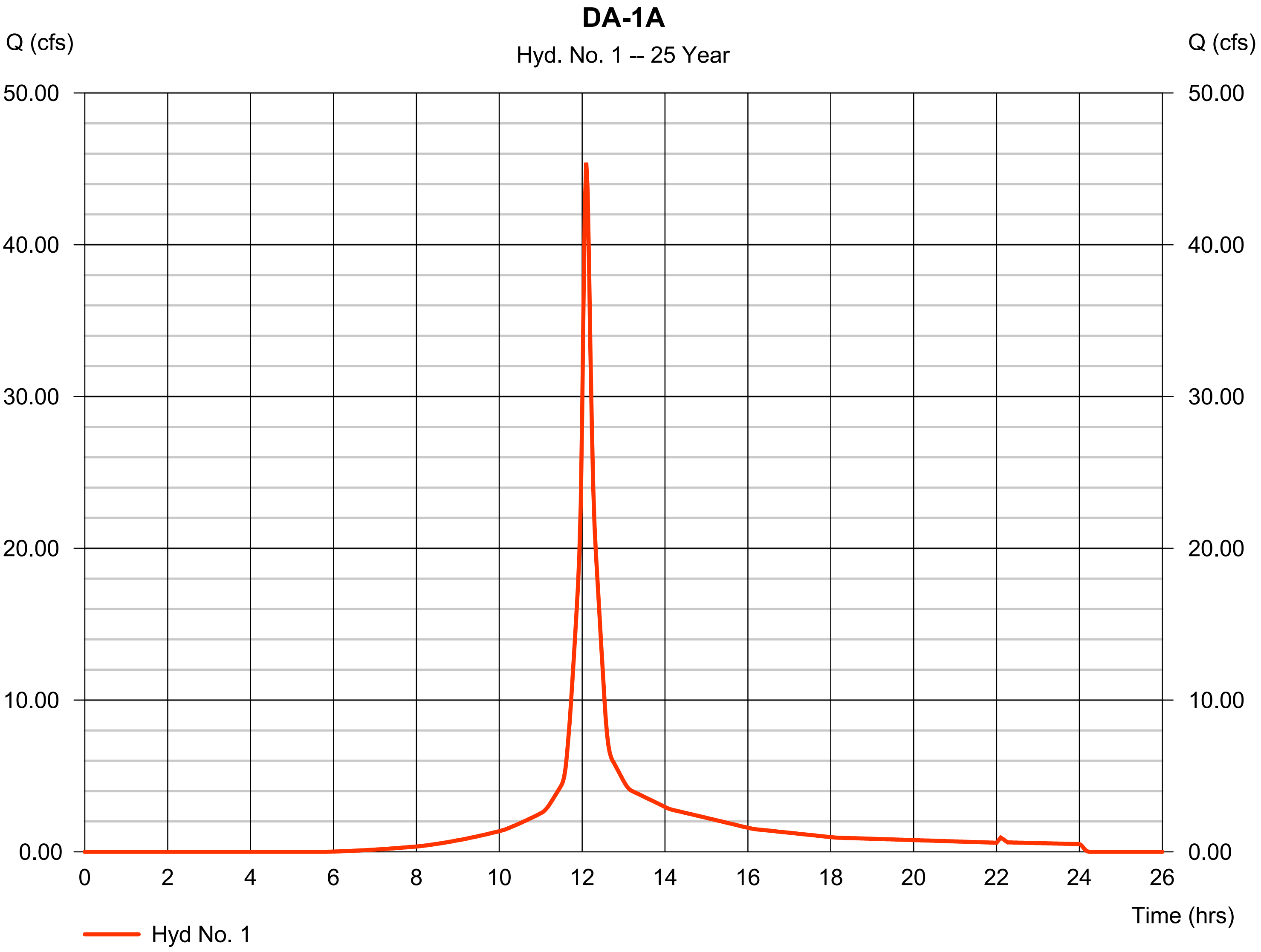
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 1

DA-1A

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 2 min
Drainage area = 8.500 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 7.42 in
Storm duration = 24 hrs

Peak discharge = 45.41 cfs
Time to peak = 12.10 hrs
Hyd. volume = 156,851 cuft
Curve number = 80
Hydraulic length = 0 ft
Time of conc. (Tc) = 9.00 min
Distribution = Type III
Shape factor = 484

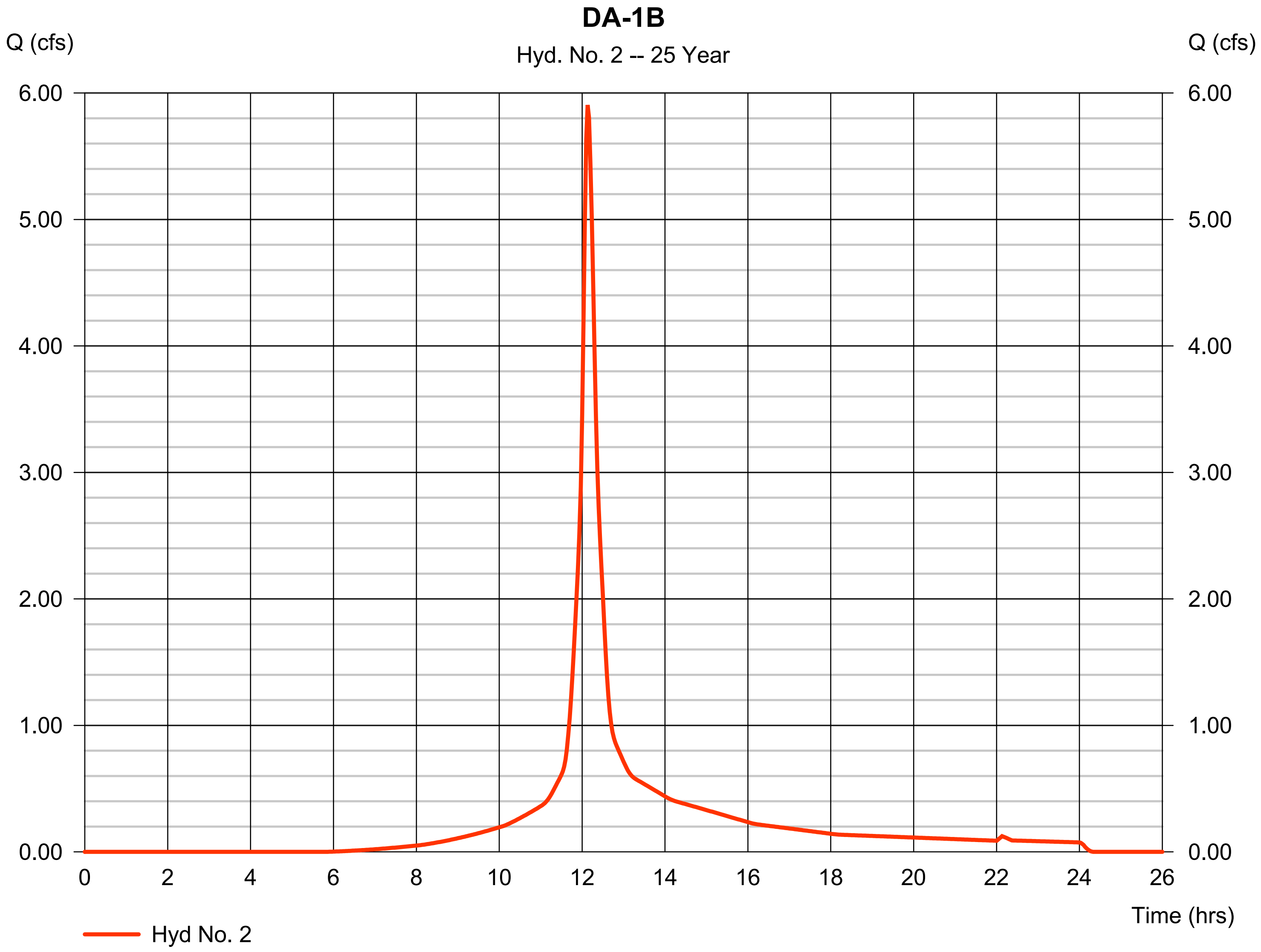


Hydrograph Report

Hyd. No. 2

DA-1B

Hydrograph type	= SCS Runoff	Peak discharge	= 5.905 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 22,836 cuft
Drainage area	= 1.200 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

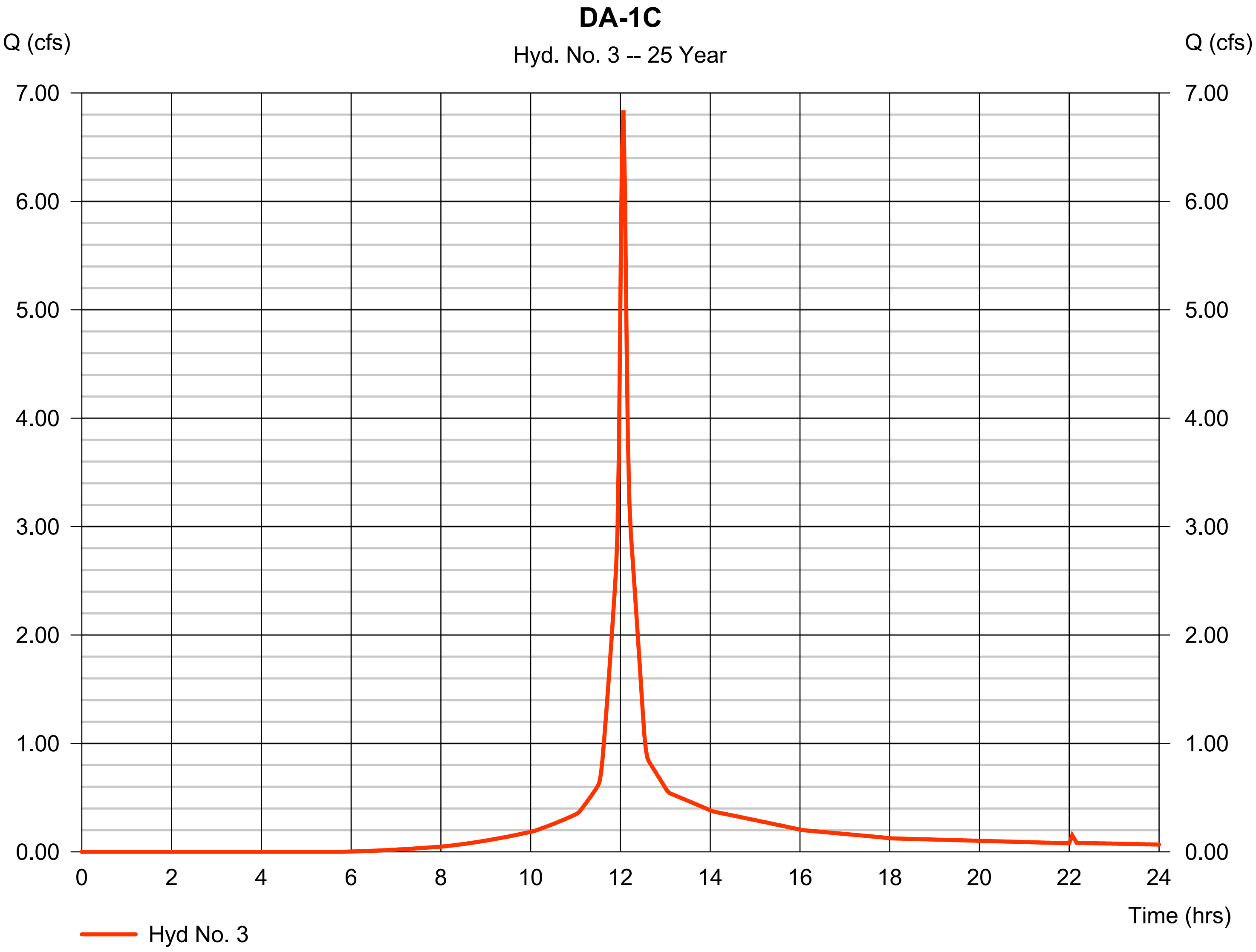


Hydrograph Report

Hyd. No. 3

DA-1C

Hydrograph type	= SCS Runoff	Peak discharge	= 6.840 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 20,760 cuft
Drainage area	= 1.200 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 4.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



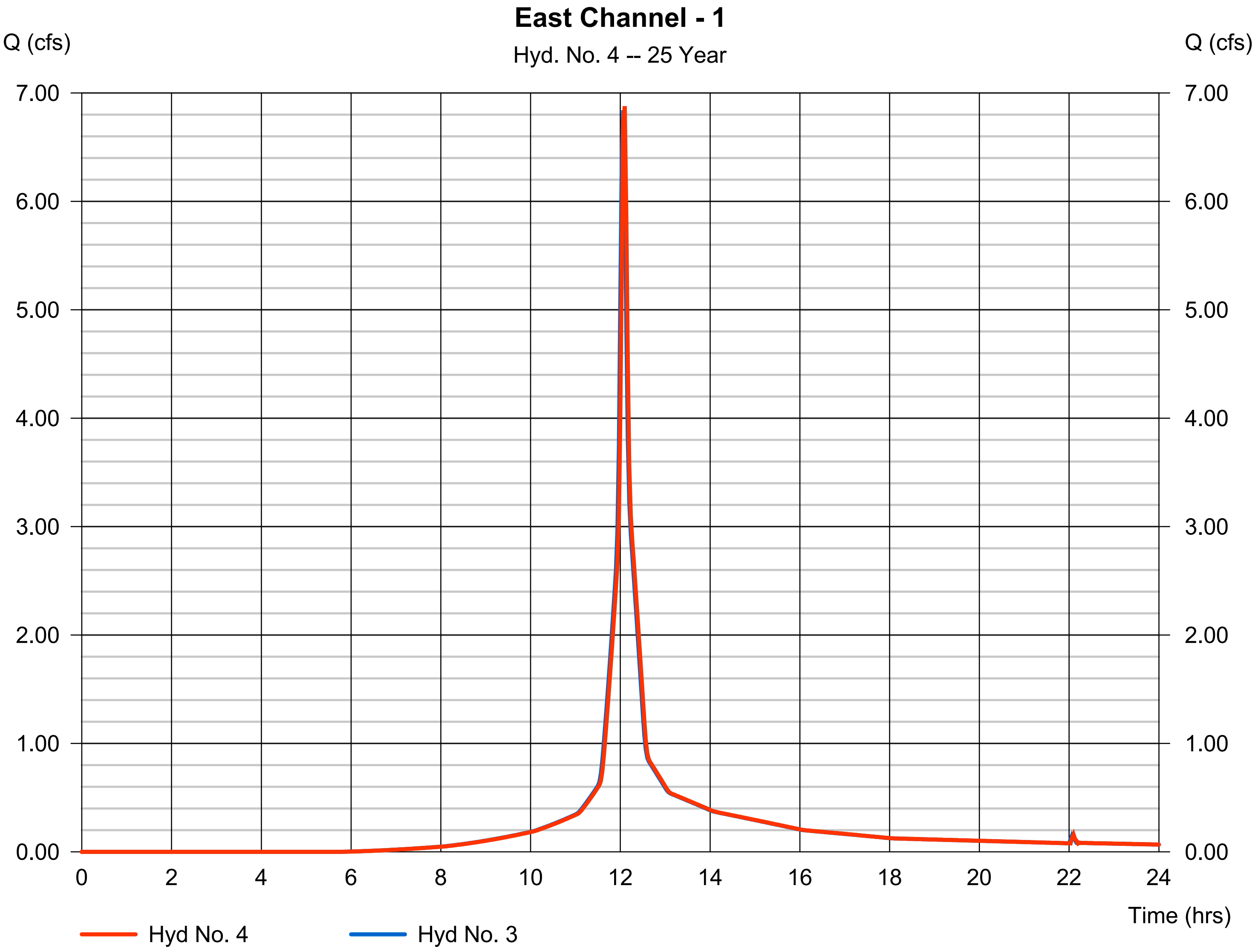
Hydrograph Report

Hyd. No. 4

East Channel - 1

Hydrograph type	= Reach	Peak discharge	= 6.878 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 20,759 cuft
Inflow hyd. No.	= 3 - DA-1C	Section type	= Trapezoidal
Reach length	= 190.0 ft	Channel slope	= 1.0 %
Manning's n	= 0.009	Bottom width	= 8.0 ft
Side slope	= 3.0:1	Max. depth	= 4.0 ft
Rating curve x	= 4.136	Rating curve m	= 1.386
Ave. velocity	= 4.76 ft/s	Routing coeff.	= 1.3513

Modified Att-Kin routing method used.



Hydrograph Report

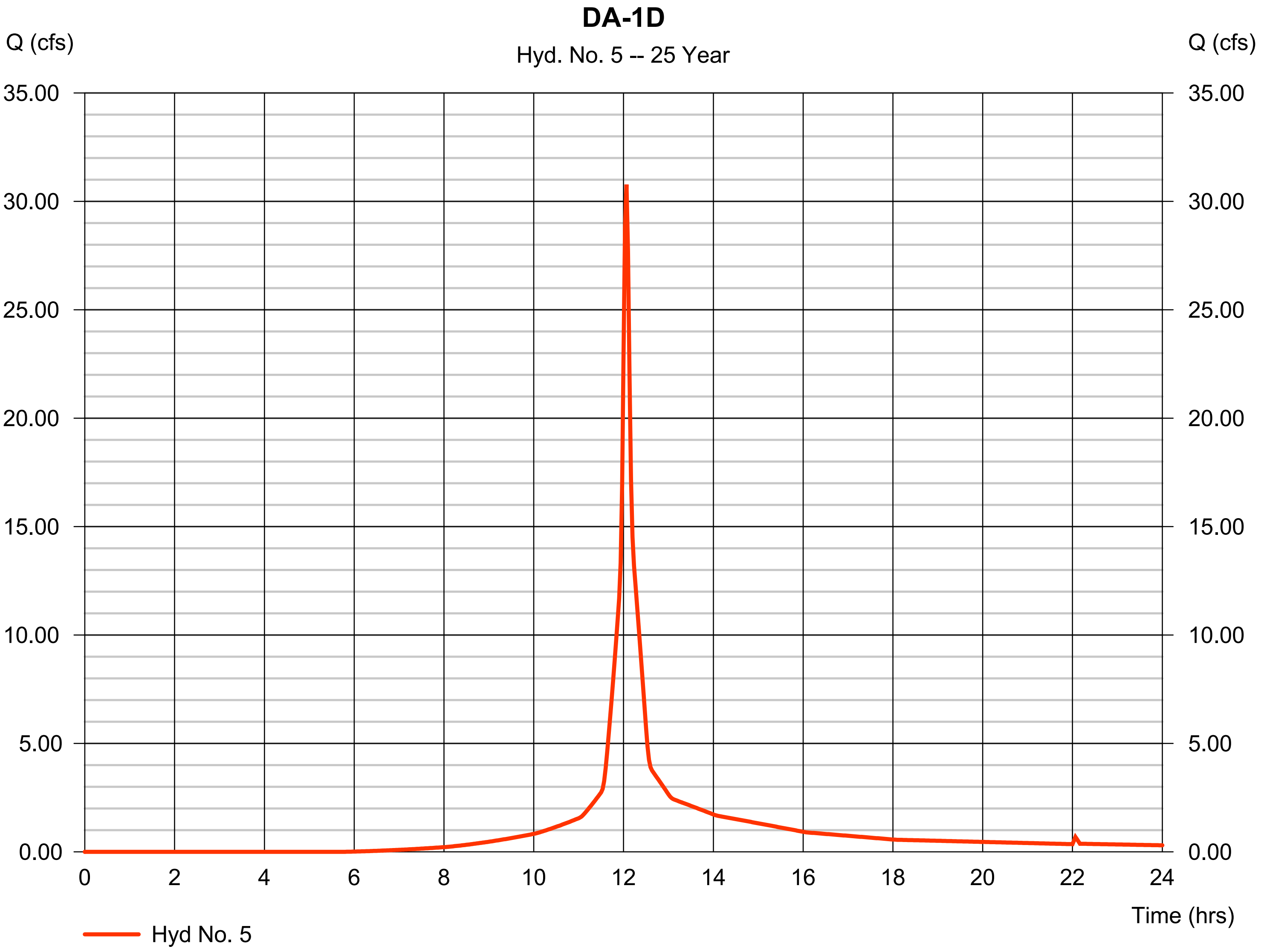
Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 5

DA-1D

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 2 min
Drainage area = 5.400 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 7.42 in
Storm duration = 24 hrs

Peak discharge = 30.78 cfs
Time to peak = 12.07 hrs
Hyd. volume = 93,418 cuft
Curve number = 80
Hydraulic length = 0 ft
Time of conc. (Tc) = 5.00 min
Distribution = Type III
Shape factor = 484

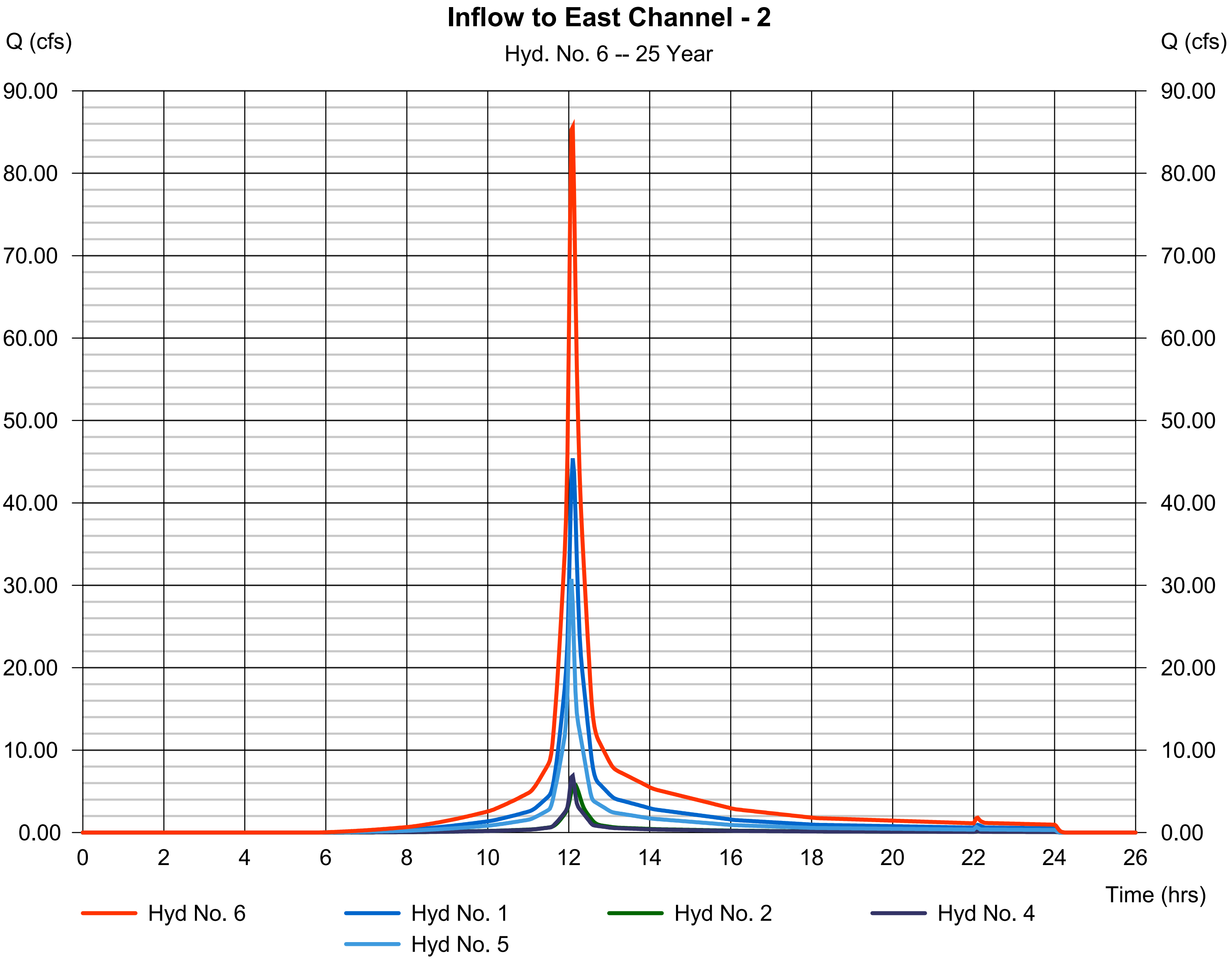


Hydrograph Report

Hyd. No. 6

Inflow to East Channel - 2

Hydrograph type	= Combine	Peak discharge	= 85.61 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 293,864 cuft
Inflow hyds.	= 1, 2, 4, 5	Contrib. drain. area	= 15.100 ac



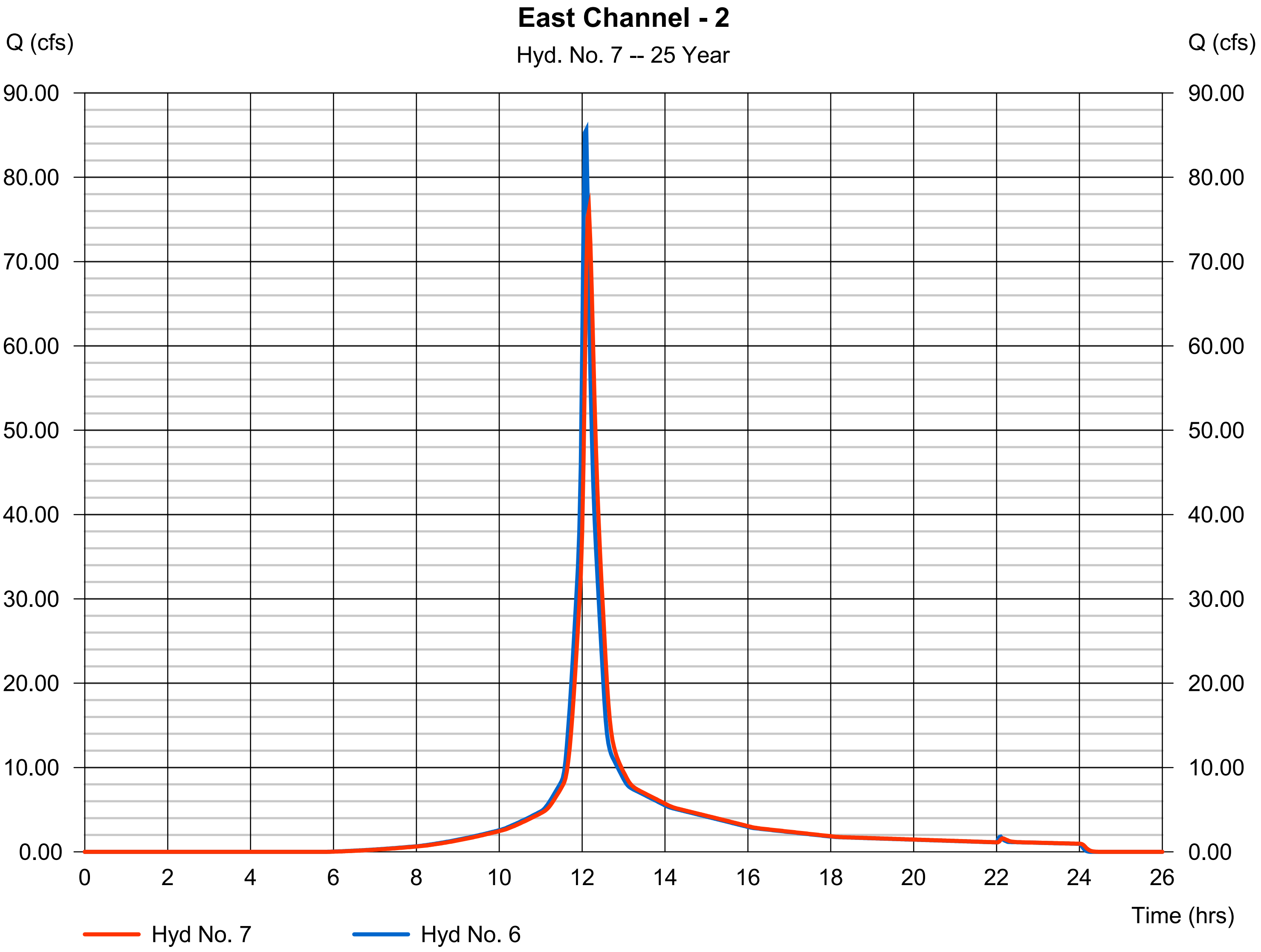
Hyd. No. 7

East Channel - 2

Hydrograph type = Reach
Storm frequency = 25 yrs
Time interval = 2 min
Inflow hyd. No. = 6 - Inflow to East Channel - 2
Reach length = 1480.0 ft
Manning's n = 0.027
Side slope = 3.0:1
Rating curve x = 1.379
Ave. velocity = 4.36 ft/s

Peak discharge = 76.07 cfs
Time to peak = 12.17 hrs
Hyd. volume = 293,862 cuft
Section type = Trapezoidal
Channel slope = 1.0 %
Bottom width = 8.0 ft
Max. depth = 4.0 ft
Rating curve m = 1.386
Routing coeff. = 0.3933

Modified Att-Kin routing method used.

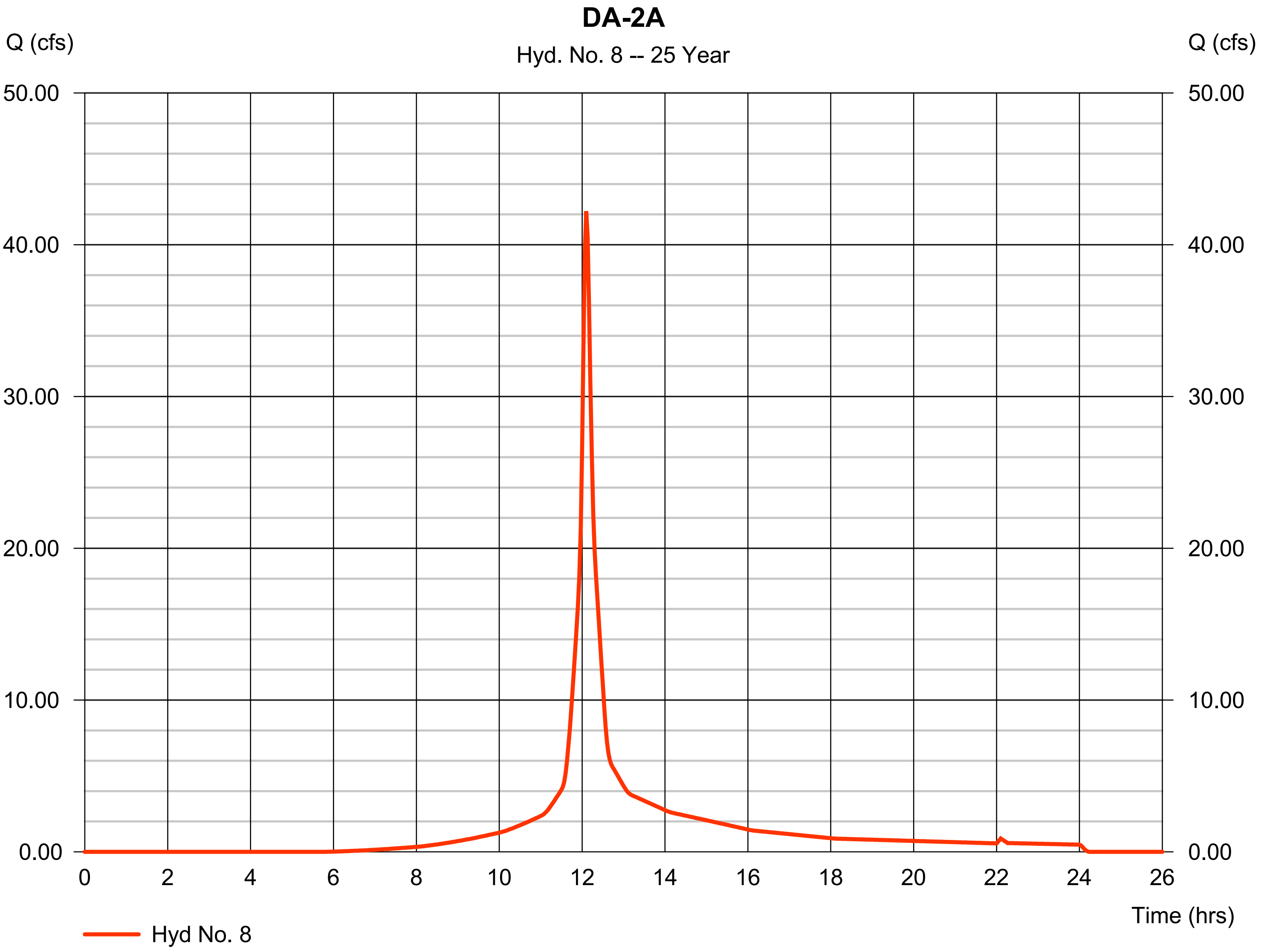


Hydrograph Report

Hyd. No. 8

DA-2A

Hydrograph type	= SCS Runoff	Peak discharge	= 42.21 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 145,779 cuft
Drainage area	= 7.900 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 8.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



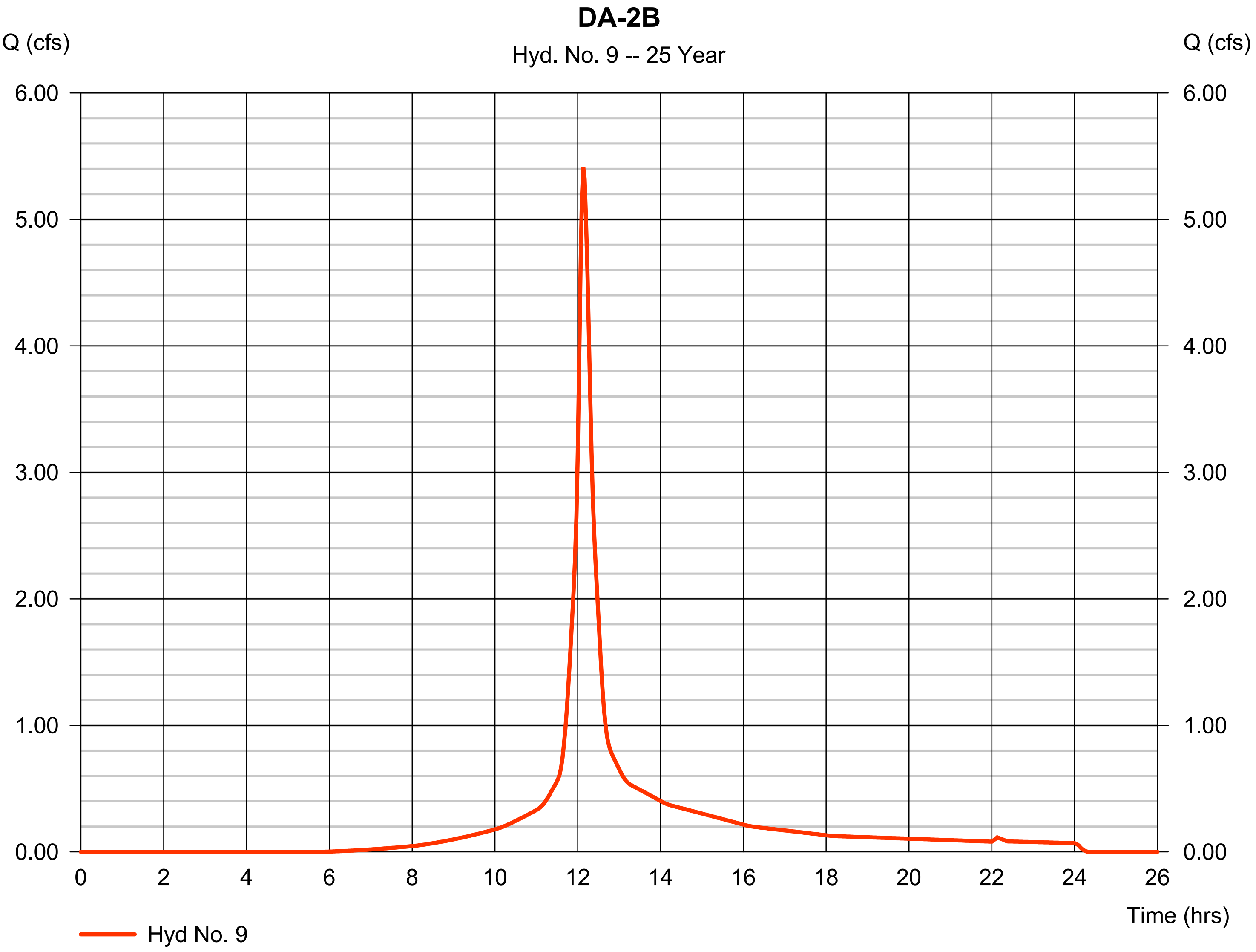
Hydrograph Report

Hyd. No. 9

DA-2B

Hydrograph type = SCS Runoff
Storm frequency = 25 yrs
Time interval = 2 min
Drainage area = 1.100 ac
Basin Slope = 0.0 %
Tc method = User
Total precip. = 7.42 in
Storm duration = 24 hrs

Peak discharge = 5.413 cfs
Time to peak = 12.13 hrs
Hyd. volume = 20,933 cuft
Curve number = 80
Hydraulic length = 0 ft
Time of conc. (Tc) = 10.00 min
Distribution = Type III
Shape factor = 484

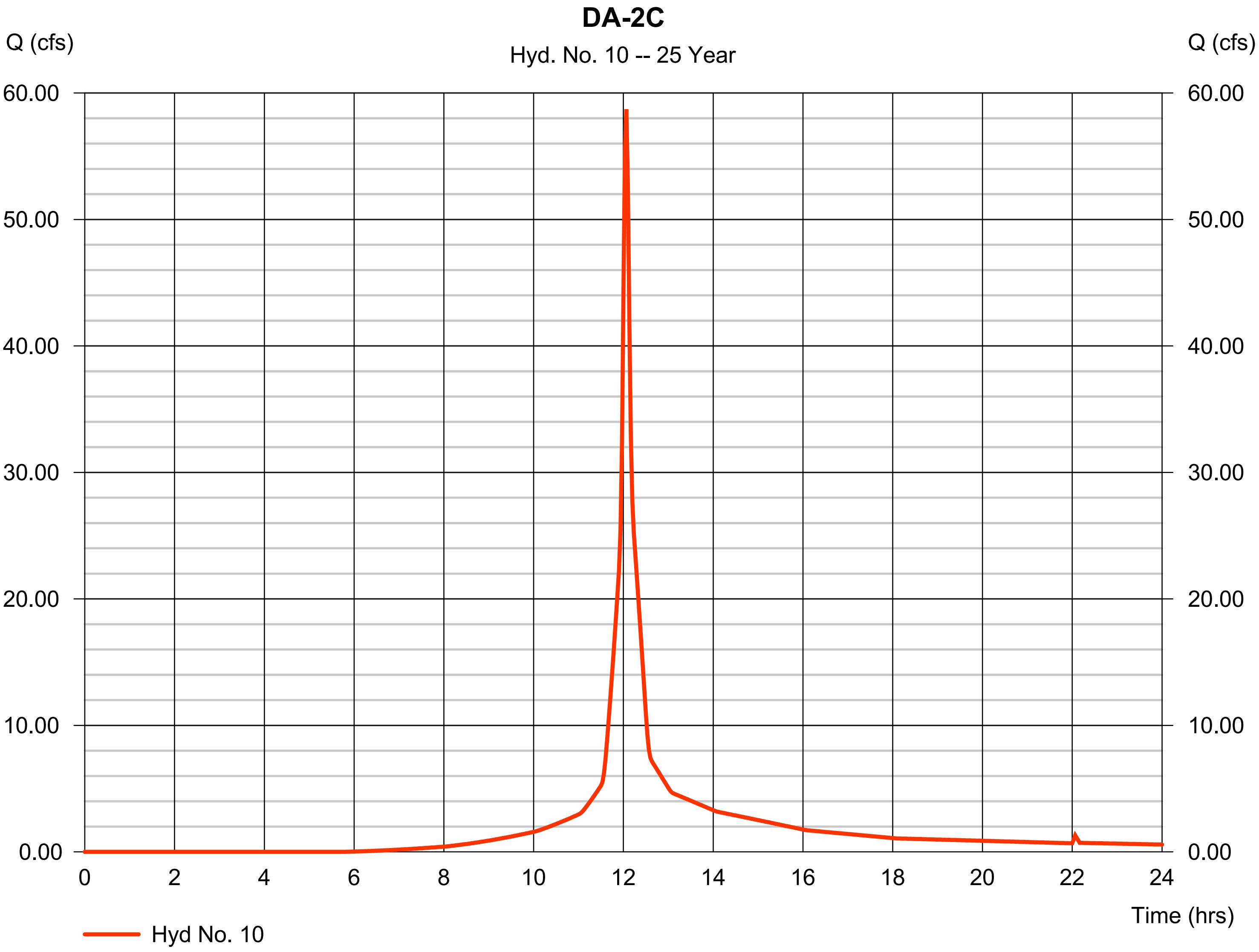


Hydrograph Report

Hyd. No. 10

DA-2C

Hydrograph type	= SCS Runoff	Peak discharge	= 58.71 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 178,187 cuft
Drainage area	= 10.300 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 4.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



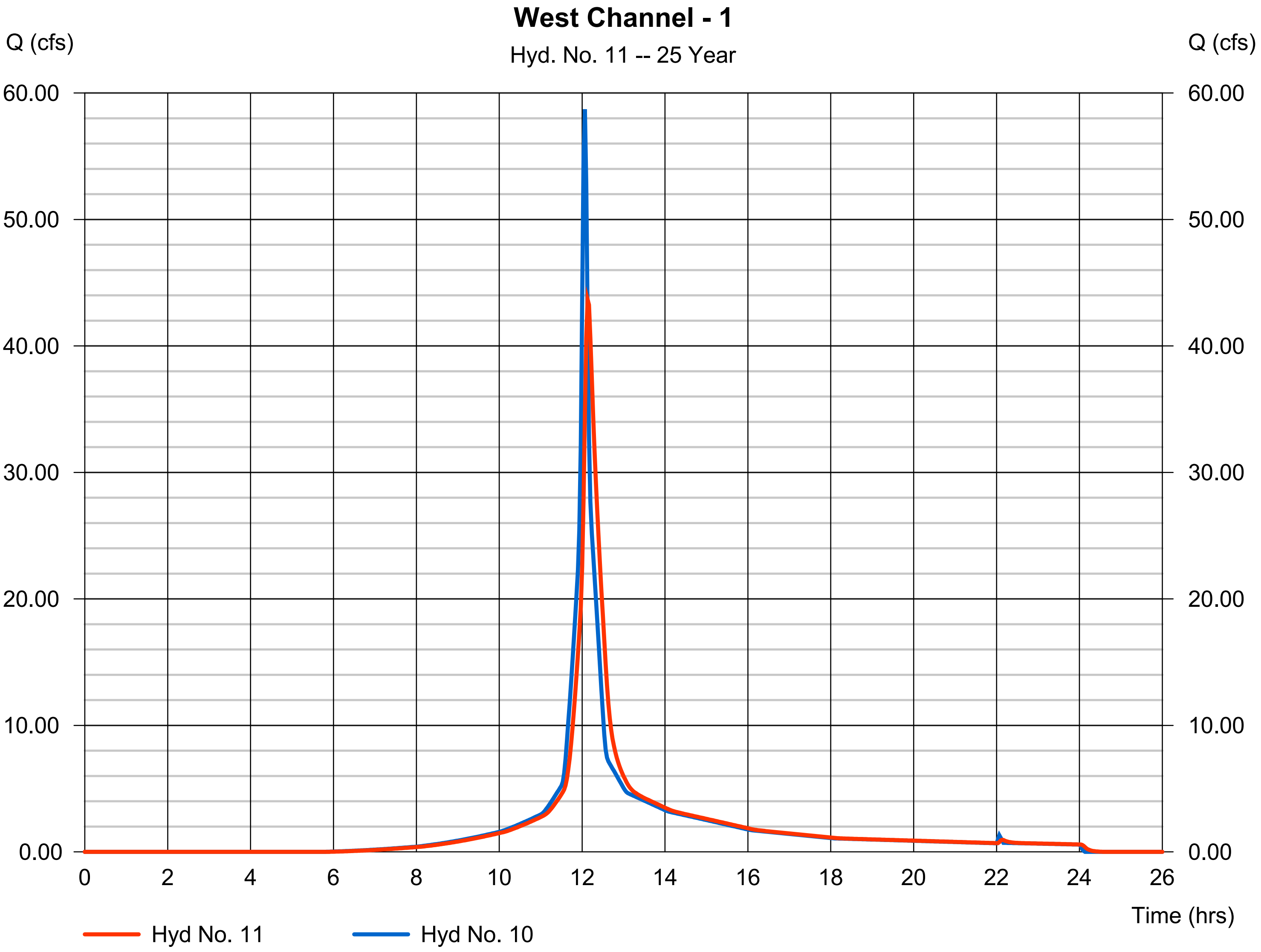
Hydrograph Report

Hyd. No. 11

West Channel - 1

Hydrograph type	= Reach	Peak discharge	= 43.66 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 178,183 cuft
Inflow hyd. No.	= 10 - DA-2C	Section type	= Trapezoidal
Reach length	= 2285.0 ft	Channel slope	= 1.0 %
Manning's n	= 0.027	Bottom width	= 8.0 ft
Side slope	= 3.0:1	Max. depth	= 4.0 ft
Rating curve x	= 1.379	Rating curve m	= 1.386
Ave. velocity	= 3.92 ft/s	Routing coeff.	= 0.2498

Modified Att-Kin routing method used.

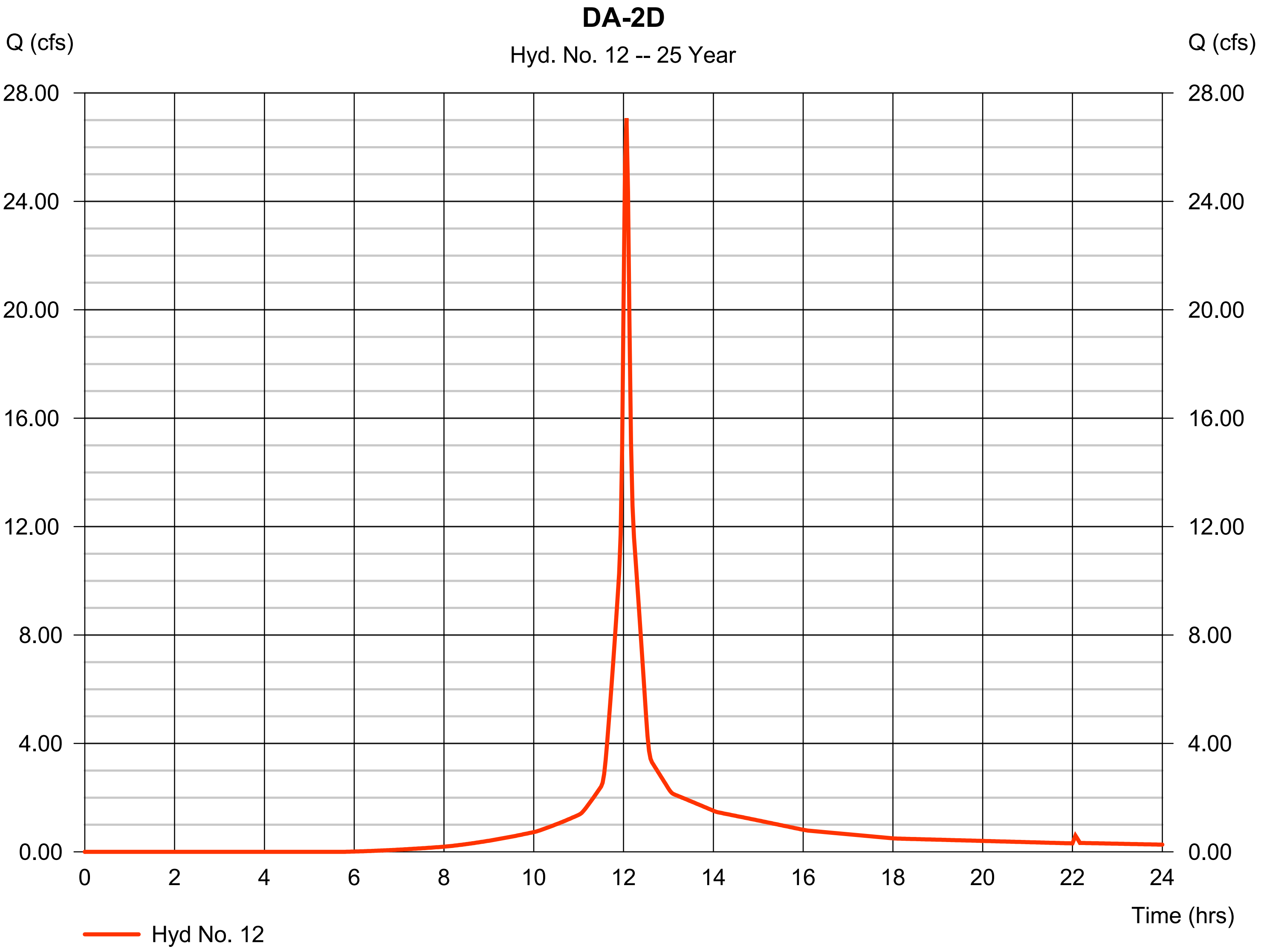


Hydrograph Report

Hyd. No. 12

DA-2D

Hydrograph type	= SCS Runoff	Peak discharge	= 27.07 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 82,156 cuft
Drainage area	= 4.749 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



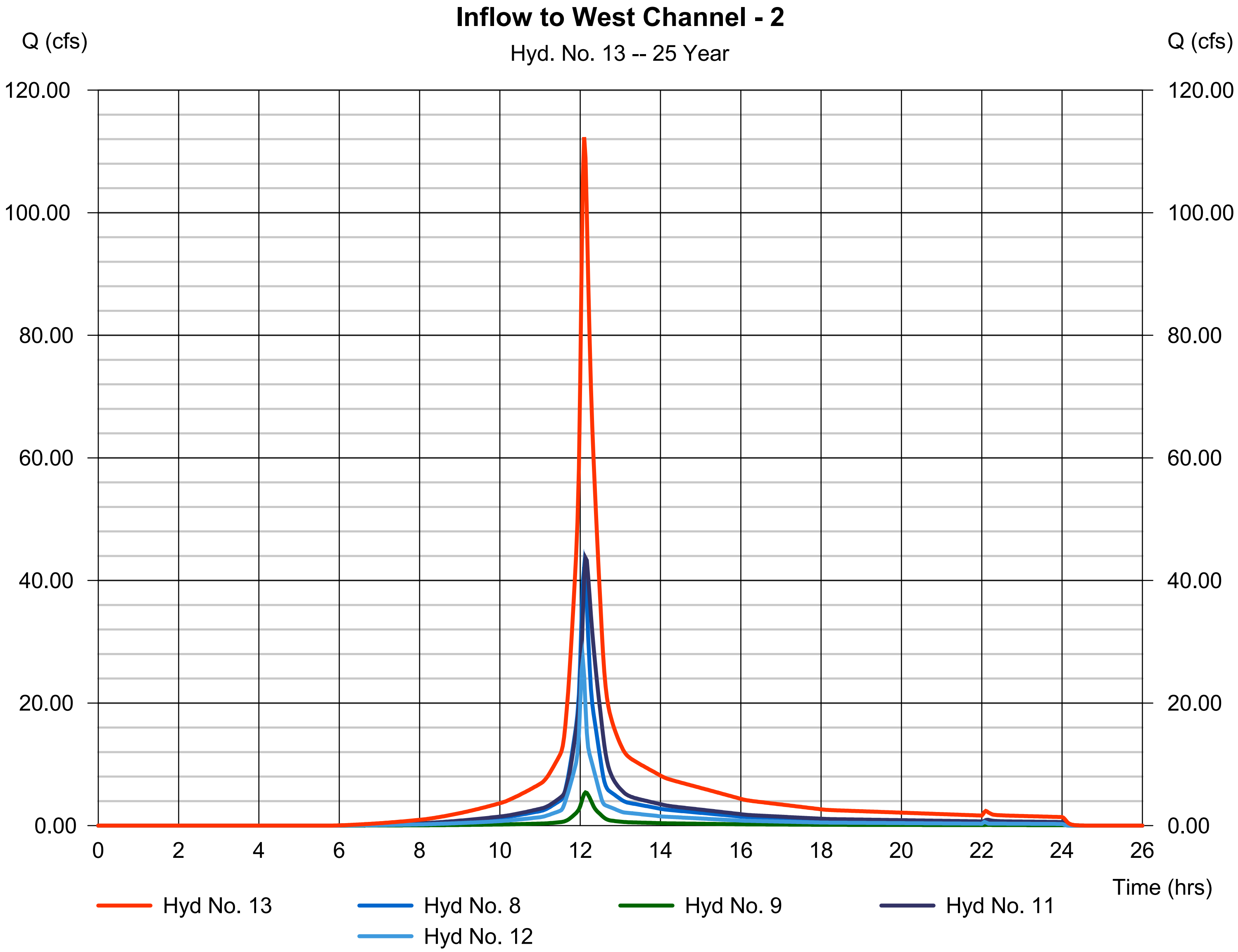
Hydrograph Report

Hyd. No. 13

Inflow to West Channel - 2

Hydrograph type = Combine
Storm frequency = 25 yrs
Time interval = 2 min
Inflow hyds. = 8, 9, 11, 12

Peak discharge = 112.33 cfs
Time to peak = 12.10 hrs
Hyd. volume = 427,051 cuft
Contrib. drain. area = 13.749 ac



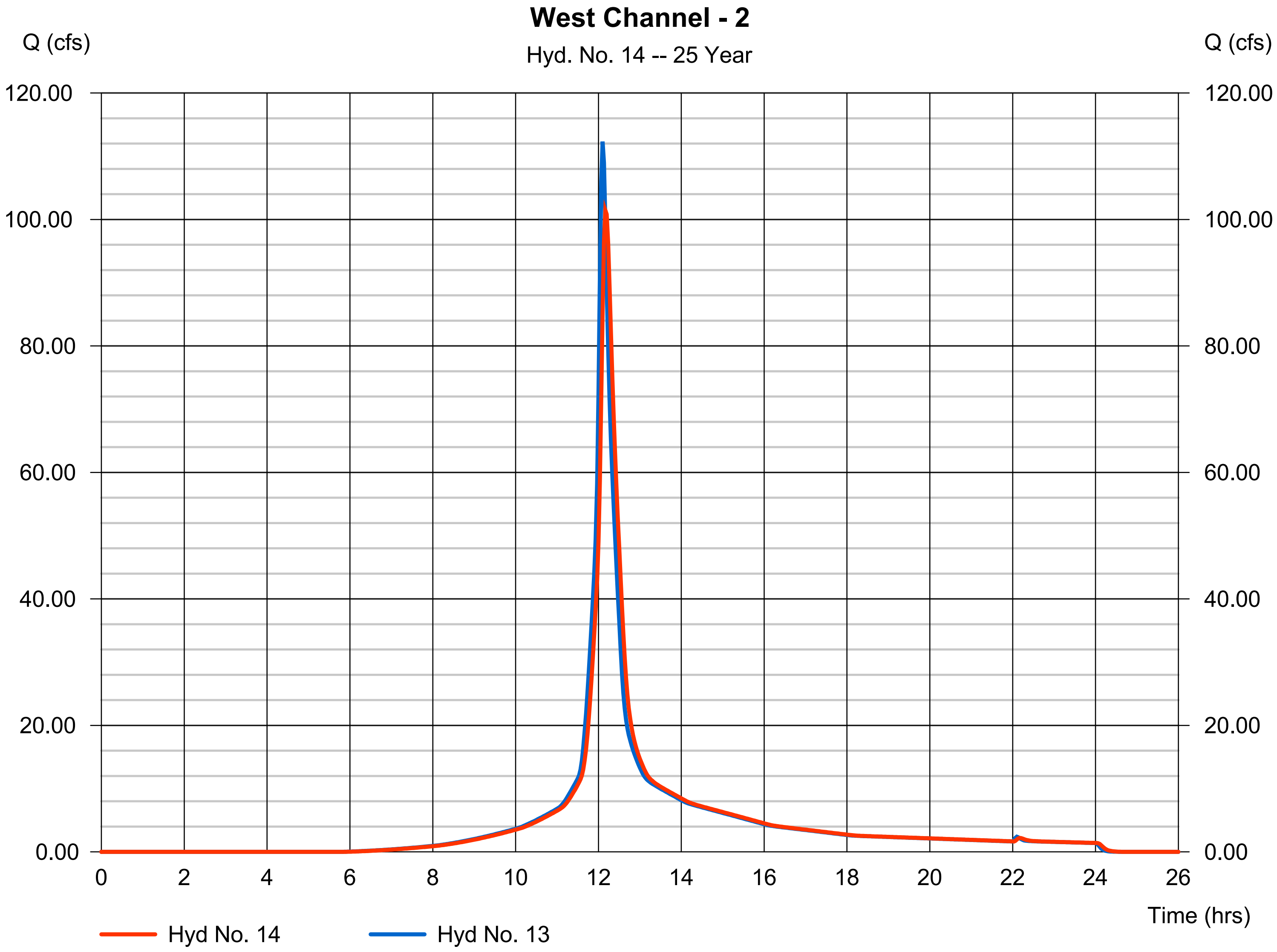
Hydrograph Report

Hyd. No. 14

West Channel - 2

Hydrograph type	= Reach	Peak discharge	= 101.45 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.17 hrs
Time interval	= 2 min	Hyd. volume	= 427,048 cuft
Inflow hyd. No.	= 13 - Inflow to West Channel - 2	Section type	= Trapezoidal
Reach length	= 1335.0 ft	Channel slope	= 1.0 %
Manning's n	= 0.033	Bottom width	= 8.0 ft
Side slope	= 3.0:1	Max. depth	= 4.0 ft
Rating curve x	= 1.128	Rating curve m	= 1.386
Ave. velocity	= 4.07 ft/s	Routing coeff.	= 0.4042

Modified Att-Kin routing method used.



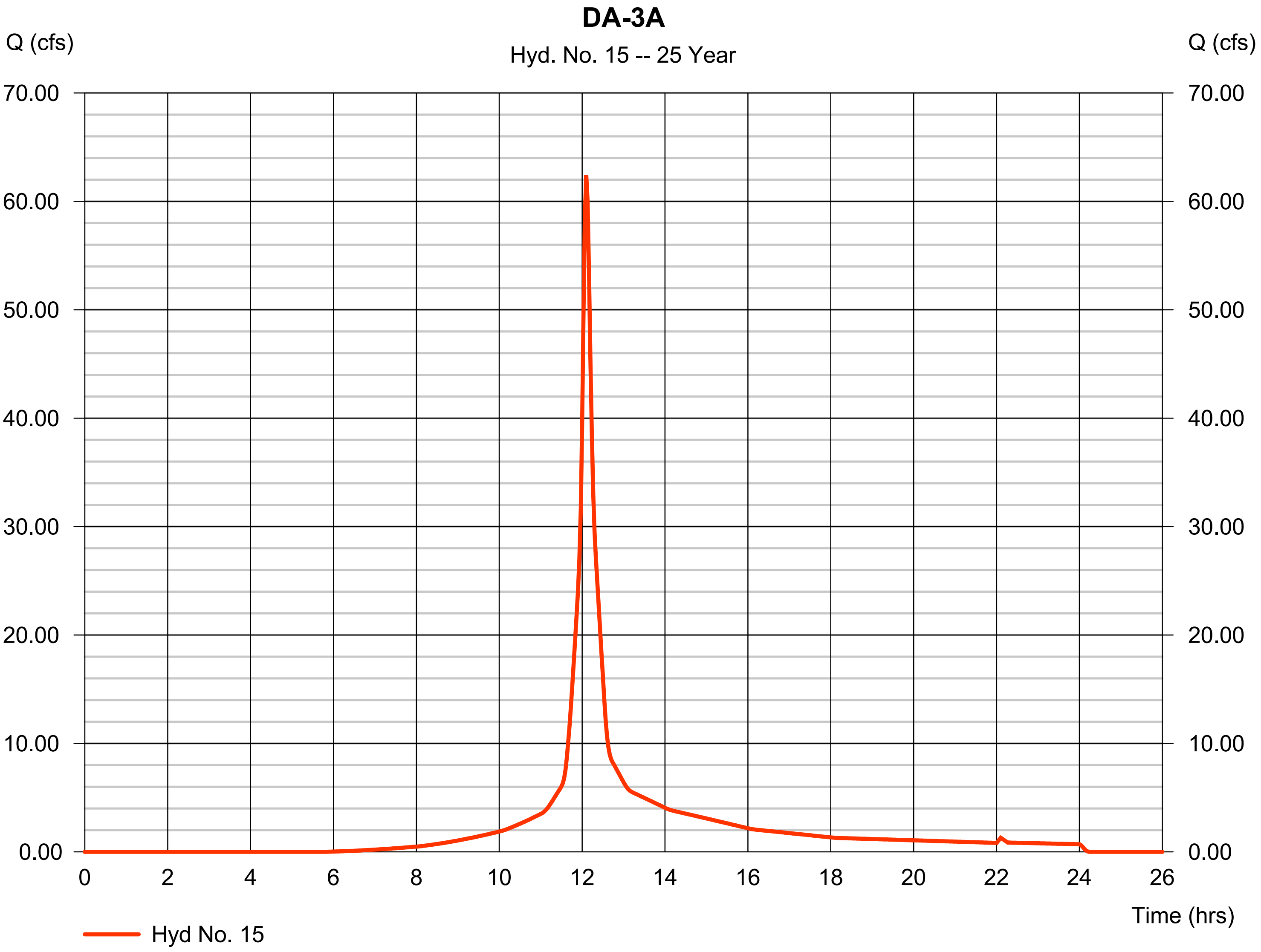
Hydrograph Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 10 / 4 / 2021

Hyd. No. 15

DA-3A

Hydrograph type	= SCS Runoff	Peak discharge	= 62.43 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.10 hrs
Time interval	= 2 min	Hyd. volume	= 215,624 cuft
Drainage area	= 11.685 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 7.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

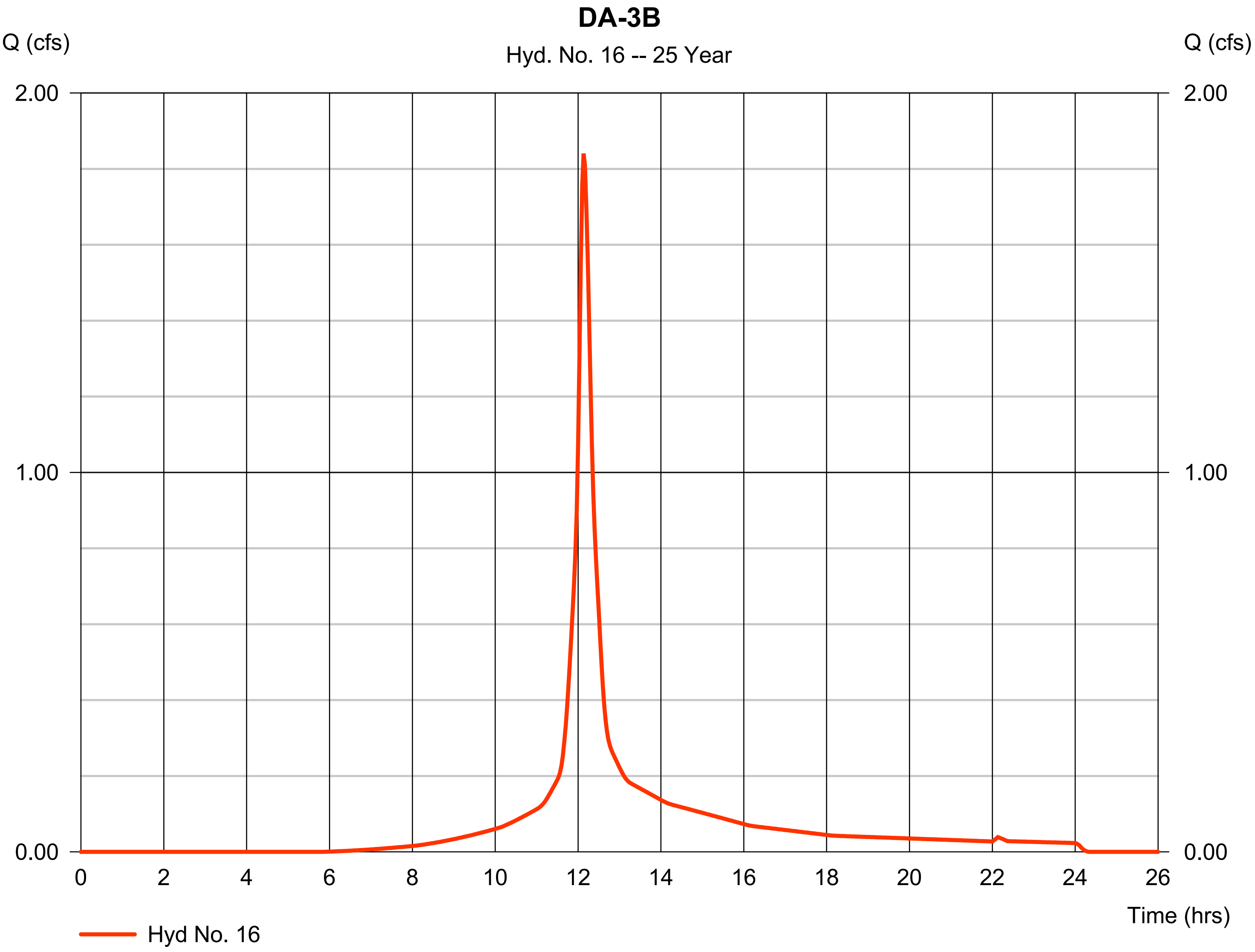


Hydrograph Report

Hyd. No. 16

DA-3B

Hydrograph type	= SCS Runoff	Peak discharge	= 1.840 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 7,117 cuft
Drainage area	= 0.374 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 10.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

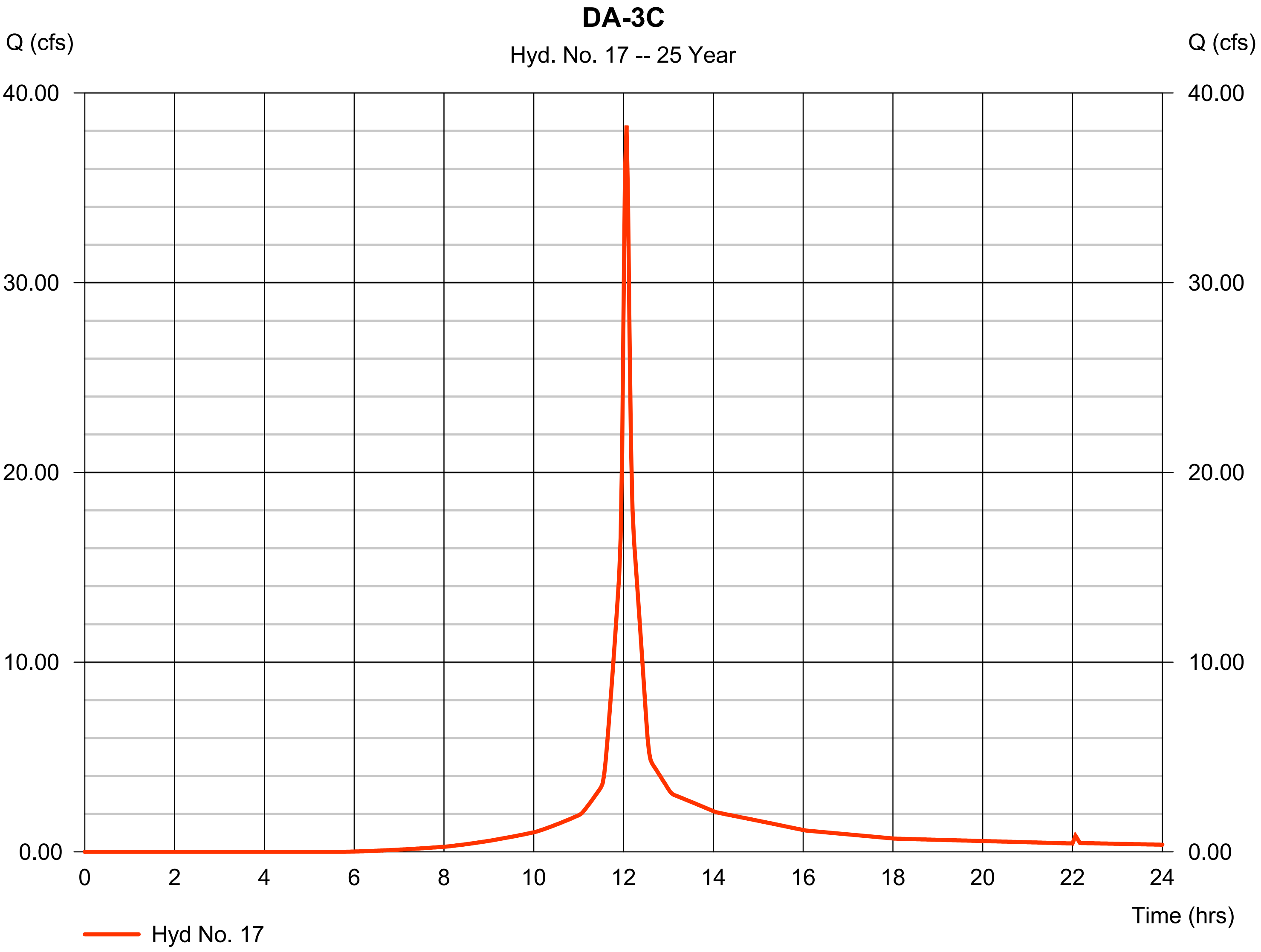


Hydrograph Report

Hyd. No. 17

DA-3C

Hydrograph type	= SCS Runoff	Peak discharge	= 38.28 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 116,185 cuft
Drainage area	= 6.716 ac	Curve number	= 80
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 5.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

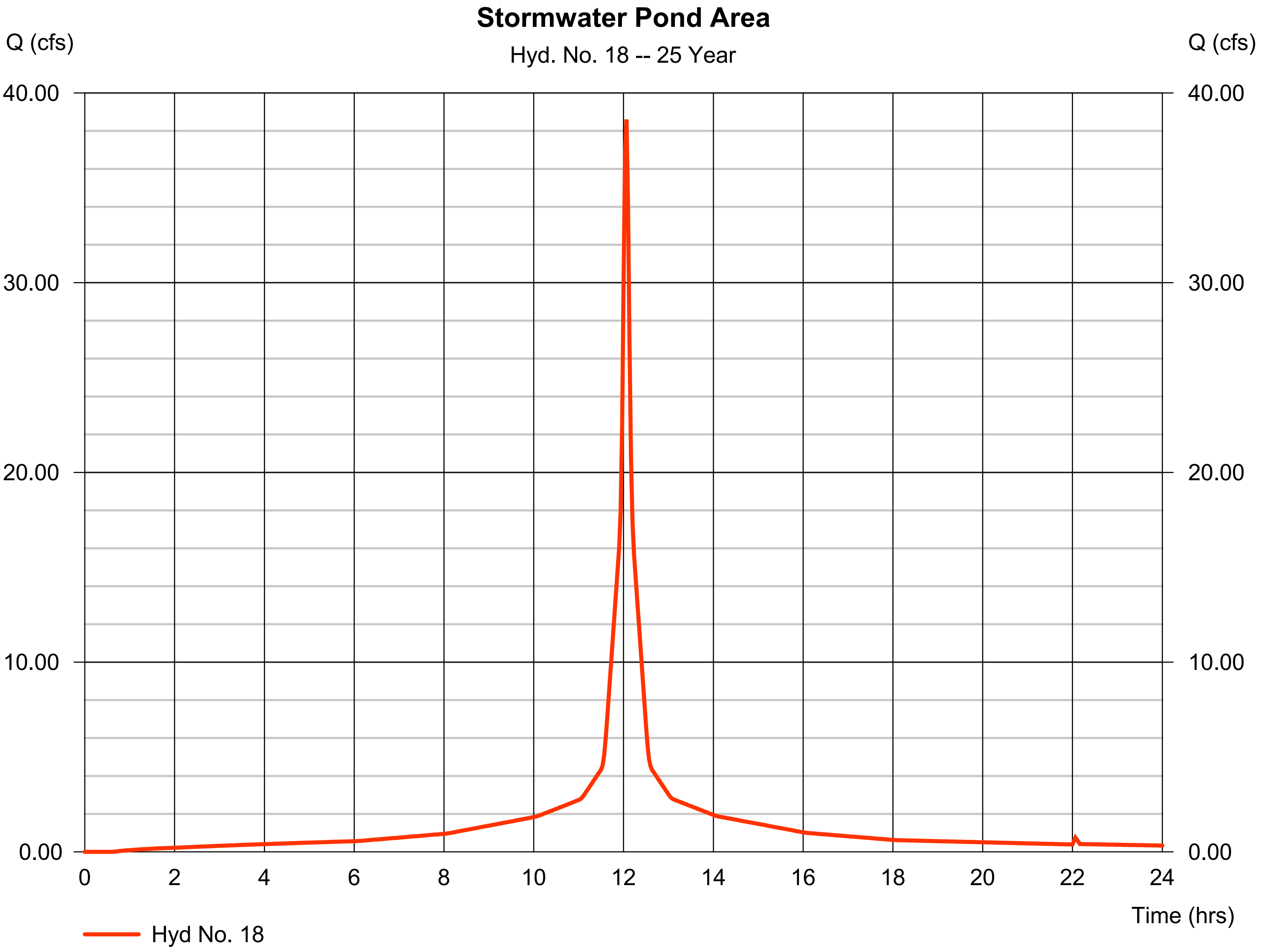


Hydrograph Report

Hyd. No. 18

Stormwater Pond Area

Hydrograph type	= SCS Runoff	Peak discharge	= 38.60 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.07 hrs
Time interval	= 2 min	Hyd. volume	= 134,400 cuft
Drainage area	= 5.500 ac	Curve number	= 98
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= User	Time of conc. (Tc)	= 4.00 min
Total precip.	= 7.42 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

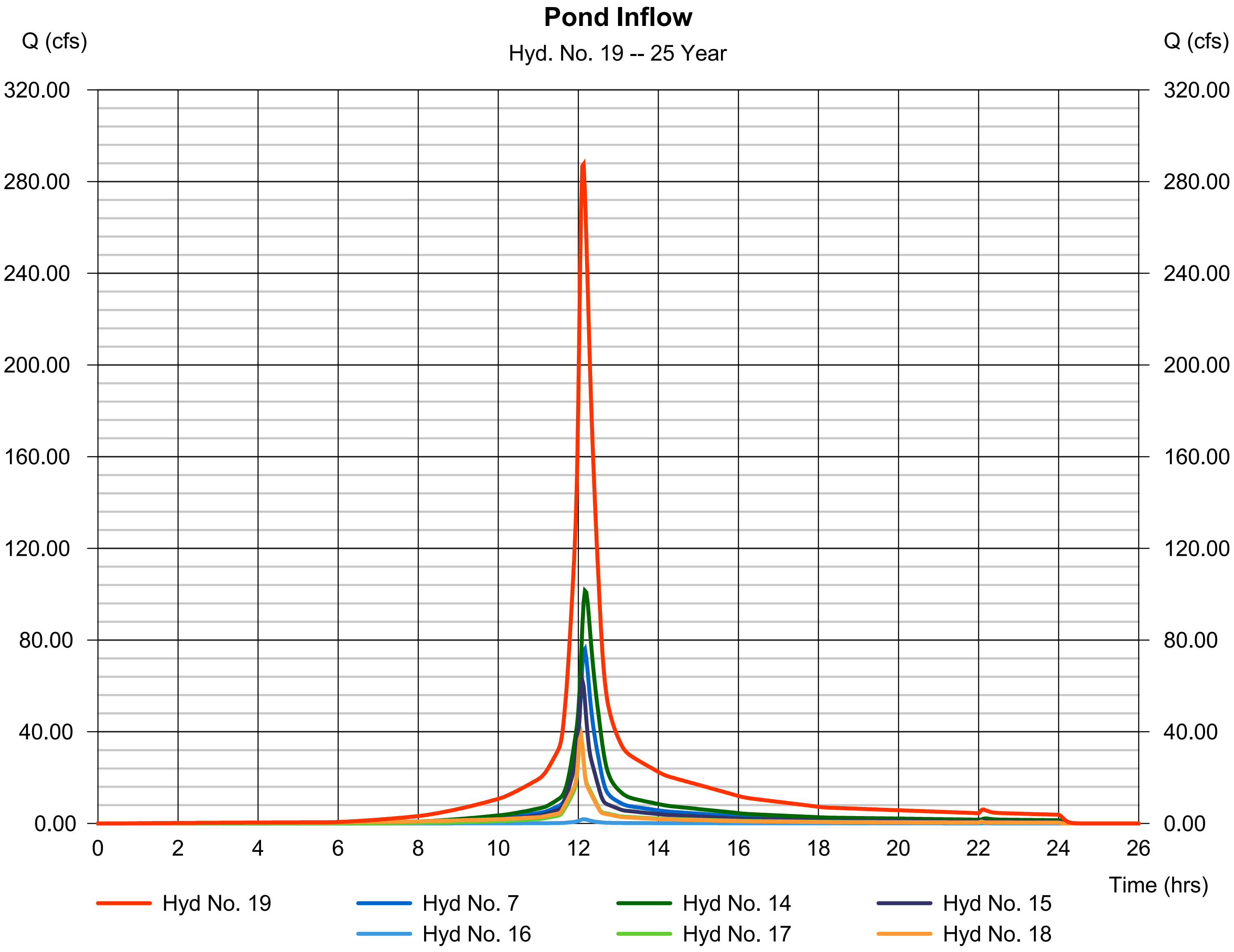


Hydrograph Report

Hyd. No. 19

Pond Inflow

Hydrograph type	= Combine	Peak discharge	= 287.57 cfs
Storm frequency	= 25 yrs	Time to peak	= 12.13 hrs
Time interval	= 2 min	Hyd. volume	= 1,194,238 cuft
Inflow hyds.	= 7, 14, 15, 16, 17, 18	Contrib. drain. area	= 24.275 ac



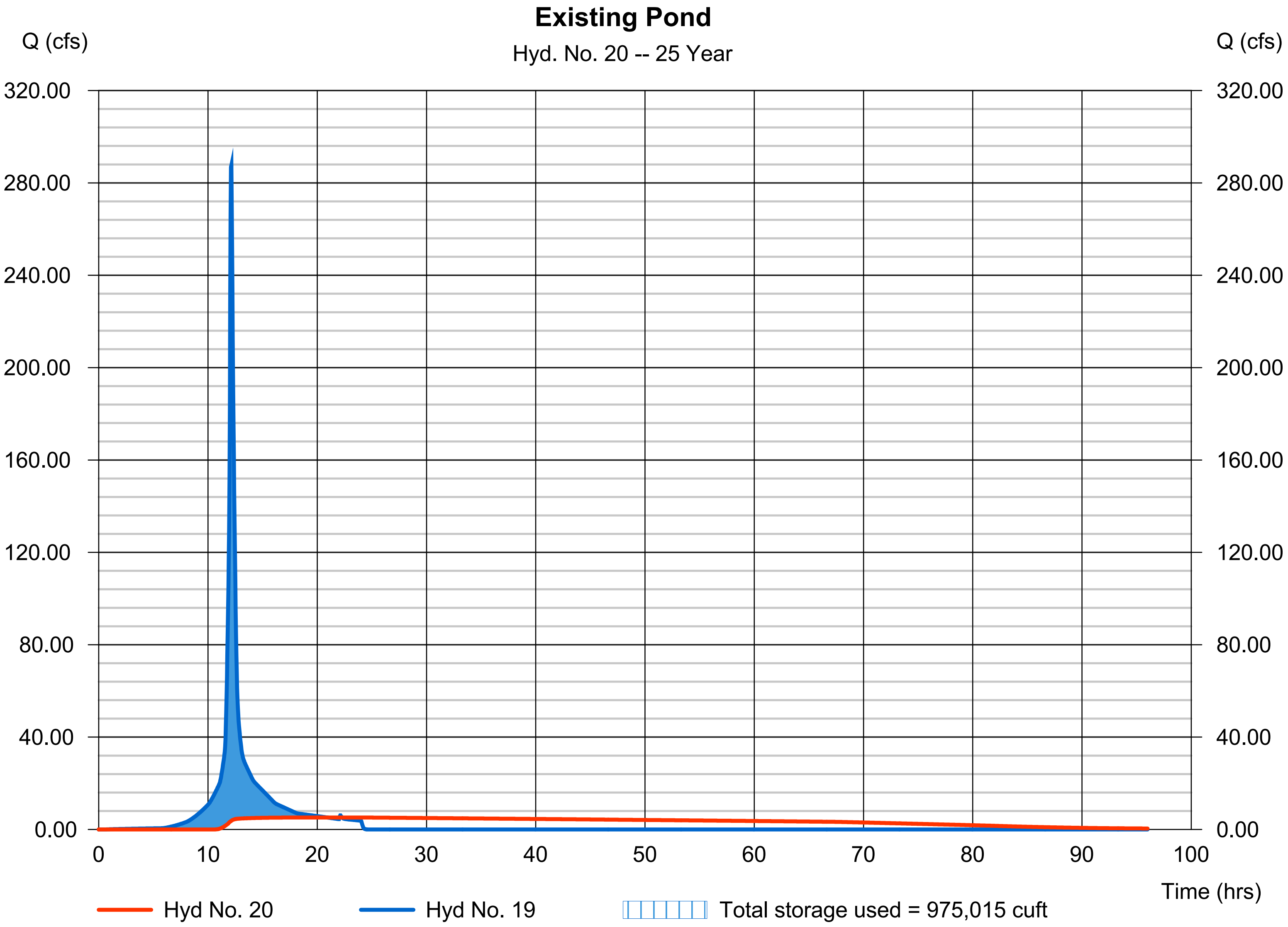
Hydrograph Report

Hyd. No. 20

Existing Pond

Hydrograph type	= Reservoir	Peak discharge	= 5.198 cfs
Storm frequency	= 25 yrs	Time to peak	= 20.87 hrs
Time interval	= 2 min	Hyd. volume	= 1,066,999 cuft
Inflow hyd. No.	= 19 - Pond Inflow	Max. Elevation	= 446.59 ft
Reservoir name	= Detention Pond	Max. Storage	= 975,015 cuft

Storage Indication method used.



Pond Report

Pond No. 1 - Detention Pond

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 438.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	438.00	90,680	0	0
2.00	440.00	100,759	191,331	191,331
4.00	442.00	111,280	211,930	403,262
6.00	444.00	122,252	233,422	636,683
8.00	446.00	133,639	255,780	892,464
10.00	448.00	145,428	278,956	1,171,420
12.00	450.00	157,640	302,956	1,474,376
14.00	452.00	170,219	327,744	1,802,120
16.00	454.00	183,212	353,316	2,155,436

Culvert / Orifice Structures

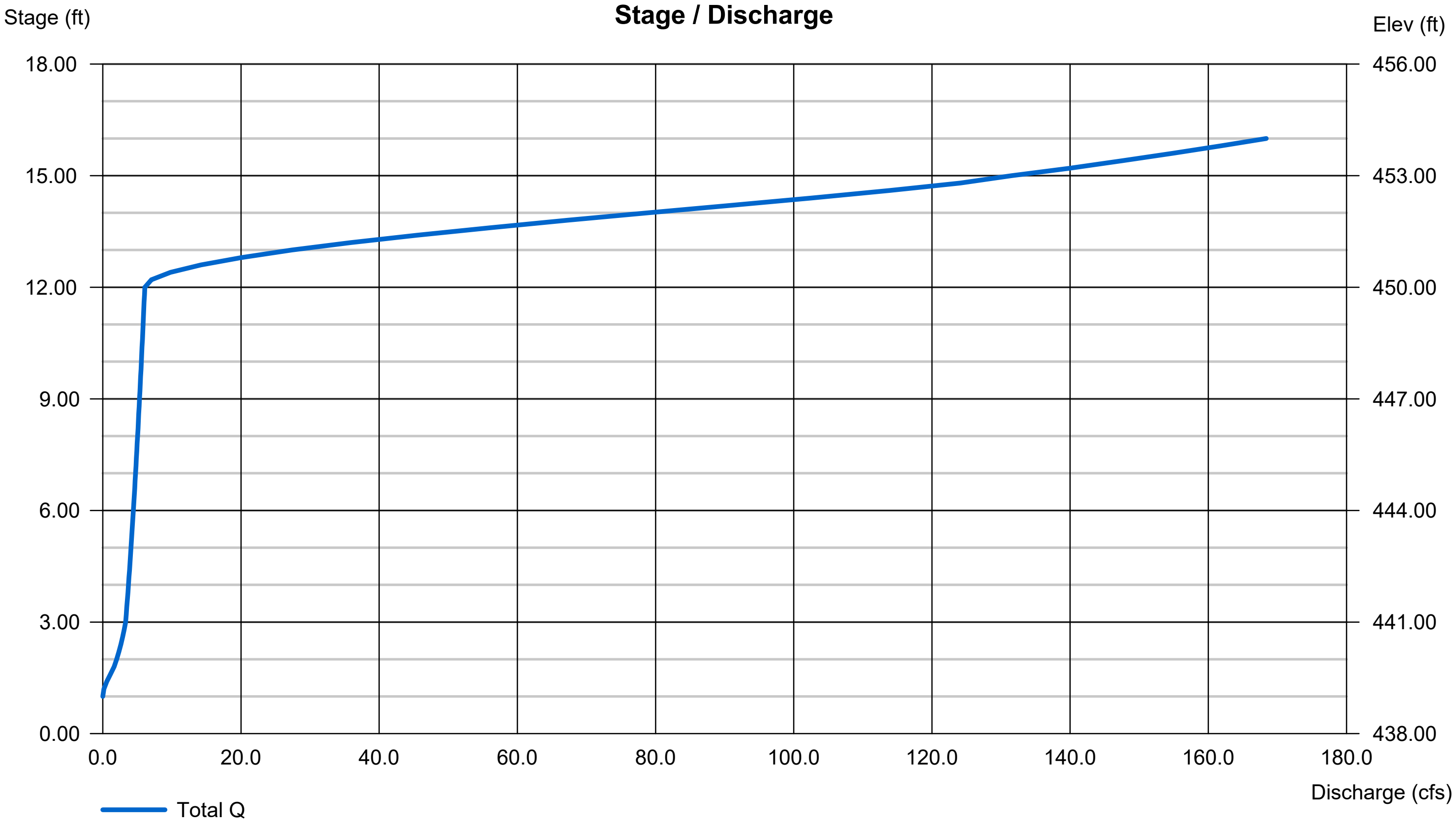
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 10.00	36.00	0.00	0.00
Span (in)	= 10.00	36.00	0.00	0.00
No. Barrels	= 1	3	0	0
Invert El. (ft)	= 439.00	450.00	0.00	0.00
Length (ft)	= 130.00	50.00	0.00	0.00
Slope (%)	= 2.00	2.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Contour)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	--------
2	69.8703	13.1000	0.8658	--------
3	0.0000	0.0000	0.0000	--------
5	79.2597	14.6000	0.8369	--------
10	88.2351	15.5000	0.8279	--------
25	102.6072	16.5000	0.8217	--------
50	114.8193	17.2000	0.8199	--------
100	127.1596	17.8000	0.8186	--------

File name: SampleFHA.idf

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.69	4.61	3.89	3.38	2.99	2.69	2.44	2.24	2.07	1.93	1.81	1.70
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.57	5.43	4.65	4.08	3.65	3.30	3.02	2.79	2.59	2.42	2.27	2.15
10	7.24	6.04	5.21	4.59	4.12	3.74	3.43	3.17	2.95	2.77	2.60	2.46
25	8.25	6.95	6.03	5.34	4.80	4.38	4.02	3.73	3.48	3.26	3.07	2.91
50	9.04	7.65	6.66	5.92	5.34	4.87	4.49	4.16	3.88	3.65	3.44	3.25
100	9.83	8.36	7.30	6.50	5.87	5.36	4.94	4.59	4.29	4.03	3.80	3.60

Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	0.00	0.00	0.00	0.00	7.42	0.00	9.99
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom 0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ATTACHMENT IV.C3

HYDRAULIC ANALYSIS

- Overland Flow Velocity Analysis
- Drainage Swale Flow Analysis
- Downchute Flow Analysis
- Perimeter Channel Flow Analysis (Hydraflow Express Output Files)
- Containment and Diversion Berm Analysis
- Hydraulic Analysis References

STATE OF TEXAS
BRETT J. DeVRIES
128061
LICENSED
PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.C3-2
through IV.C3-35

OVERLAND FLOW VELOCITY ANALYSIS

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
FINAL COVER
OVERLAND FLOW VELOCITY

Required:

Calculate the peak velocity on final cover sideslopes and topslopes. Compare calculated peak velocities to permissible non-erodible flow velocity for final cover.

Method:

1. Determine the time of concentration (t_C) and sheet flow velocity on final cover using the Manning's Kinematic Solution.
2. Determine the shallow concentrated flow velocity on final cover using a derivation of Manning's Equation.
3. Compare peak velocity to permissible non-erodible velocity.

References:

1. Texas Department of Transportation, *Bridge Division Hydraulic Manual*, November 2004.
2. Natural Resouces Conservation Service, *Urban Hydrology for Small Watersheds*, *Technical Release 55*, Junes 1986.

Solution:

Calculate the expected peak overland flow velocity on the final cover, using the above methods, for both Case 1 - 175-foot Final Cover Sideslope and Case 2 - 125-foot Final Cover Topslope.

Note: The sideslope length is the greatest spacing between drainage swales on final cover, and the topslope length is the greatest flow length on the final cover topslope.

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
FINAL COVER
OVERLAND FLOW VELOCITY

Case 1: 175-foot Final Cover Sideslope:

1. Determine the time of concentration (t_C) and sheet flow velocity on final cover sideslopes using the Manning's Kinematic Solution.

Sheet Flow Velocity:

Sheet Flow Length = 100 ft
Slope = 0.2857 ft/ft

Sheet Flow Time of Concentration Equation:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{25,24})^{0.5}S^{0.4}}$$

Where:
t_c = sheet flow time of concentration (hr)
n = Manning's roughness coefficient
L = slope length
$P_{25,24}$ = 25-year, 24-hour rainfall depth (in)
S = slope (ft/ft)

Sheet Flow Velocity Equation:

$$V = \frac{L}{60t_c}$$

Where:
V = sheet flow velocity (fps)
t_c = sheet flow time of concentration (min)
L = sheet flow length (ft)

Calculate t_c:

n = 0.15 (surface roughness for short grass)
L = 100
$P_{25,24}$ = 7.42
S = 0.2857

t_c = 0.037 hr
2.22 min

Calculate the sheet flow velocity:

L = 100
t_c = 2.22

V = 0.75 fps

2. Determine the shallow concentrated flow velocity on the sideslopes using a derivation of Manning's Equation.

Shallow Concentrated Flow Velocity:

Shallow Concentrated Flow Length = 75 ft
Slope = 0.2857 ft/ft

Rational Method Equation:

$$Q = CiA$$

Where:
Q = flow rate (cfs)
C = runoff coefficient
i = rainfall intensity (in/hr)
A = drainage area (ac) (assume unit width for flow area)

Intensity Equation:

$$i = b / (t_c + d)^e$$

Where:
i = rainfall intensity (in/hr)
b = Constant for Limestone County = 103.67
d = Constant for Limestone County = 14.4
e = Constant for Limestone County = 0.812
t_c = time of concentration (min) (noted below)

Time of Concentration Equation:

$$t_c = \frac{L}{V} = 0.87$$ min (see note below)

Note: (t_c is solved through trial and error by manually adjusting the value for the time of concentration until the ratio of length to velocity and t_c to reach the peak flow rate, as calculated using the Rational Method, are equal)

Calculate peak flow rate for unit width of flow:

C = 0.7
t_c = 0.87 min (see note above)
i = 11.33 in/hr
A = 0.0017 ac (Unit width of flow, w = 1 ft. Therefore, A = L/43560)

$$\boxed{Q = 0.014 \text{ cfs}}$$

Calculate approximate depth of flow derived from Manning's Method Equation (see attached derivation, page 6A-E-69):

$$d = \left(\frac{Qn}{1.49S^{0.5}}\right)^{0.6}$$

Q = 0.014 cfs
n = 0.025 (Manning's n for channel flow, conservative)
S = 0.2857 ft/ft

d = 0.010 ft = 0.11 in

Calculate shallow concentrated flow velocity:

$$V = \frac{Q}{A} = \frac{Q}{d}$$

V = 1.43 fps

3. Compare peak velocity to permissible non-erodible velocity.

Case 1 Conclusion:

The peak velocity between drainage swales on the final cover sideslopes is associated with the shallow concentrated flow component of overland flow. The calculated sideslope shallow concentrated flow velocity is less than the permissible non-erodible velocity of 5.0 ft/s on final cover, as discussed Section 4.1.2.2 of the report.

Case 2: 125-foot Final Topslope:

1. Determine the time of concentration (t_C) and sheet flow velocity on final cover topslopes using the Manning's Kinematic Solution.

Sheet Flow Velocity:

Sheet Flow Length = 100 ft
Slope = 0.03 ft/ft

Sheet Flow Time of Concentration Equation:

$$t_c = \frac{0.007(nL)^{0.8}}{(P_{25,24})^{0.5}S^{0.4}}$$ **(as described above)**

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
FINAL COVER
OVERLAND FLOW VELOCITY

Sheet Flow Velocity Equation:

$$V = \frac{L}{60t_c}$$ **(as described above)**

Calculate t_c:

$n =$ 0.15 (surface roughness for short grass)
$L =$ 100
$P_{25,24} =$ 7.42
$S =$ 0.03

$t_c =$	0.091	hr
	5.47	min

Calculate the sheet flow velocity:

$L =$ 100
$t_c =$ 5.47

$V =$	0.30	fps

2. Determine the shallow concentrated flow velocity on the topslopes using a derivation of Manning's Equation.

Shallow Concentrated Flow Velocity:

Shallow Concentrated Flow Length = 25 ft
Slope = 0.0300 ft/ft

Rational Method Equation:

$Q = CiA$ **(as described above)**

Where:
$Q =$ flow rate (cfs)
$C =$ runoff coefficient
$i =$ rainfall intensity (in/hr)
$A =$ drainage area (ac) (assume unit width for flow area)

Intensity Equation:

$i = b / (t_c + d)^e$ **(as described above)**

Time of Concentration Equation:

$$t_c = \frac{L}{V} = 1.18$$ min (see note below)

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
FINAL COVER
OVERLAND FLOW VELOCITY

Note: (t_c is solved through trial and error by manually adjusting the value for the time of concentration until the ratio of length to velocity and t_c to reach the peak flow rate, as calculated using the Rational Method, are equal)

Calculate peak flow rate for unit width of flow:

C =	0.35		
t_c =	1.18	min	(see note above)
i =	11.15	in/hr	
A =	0.0006	ac	(Unit width of flow, w = 1 ft. Therefore, A = L/43560)

Q = 0.002 cfs

Calculate approximate depth of flow derived from Manning's Method Equation (see attached derivation, page 6A-E-69):

$$d = \left(\frac{Qn}{1.49 S^{0.5}} \right)^{0.6}$$

Q =	0.002	cfs
n =	0.025	(Manning's n for channel flow, conservative)
S =	0.03	ft/ft

d = 0.006 ft = 0.08 in

Calculate shallow concentrated flow velocity:

$$V = \frac{Q}{A} = \frac{Q}{d}$$

V = 0.35 fps

3. Compare peak velocity to permissible non-erodible velocity.

Case 2 Conclusion:

The peak velocity on the final cover topslope is associated with the shallow concentrated flow component of overland flow. The calculated topslope shallow concentrated flow velocity is less than the permissible non-erodible velocity of 5.0 ft/s on final cover, as discussed in Section 4.1.2.1 of the plan.

DRAINAGE SWALE FLOW ANALYSIS

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
DRAINAGE SWALE FLOW ANALYSIS

Required: Calculate the flow velocity and normal depth for sizing drainage swales installed on final cover.

Method:

1. Determine peak discharge rate associated with the 25 - year, 24 - hour storm event for the swale contributing drainage areas using the Rational Method (see Section 4.1.2.2 of report).
2. Determine Mannings "n" and runoff coefficient "C".
3. Using the specified channel geometry, evaluate the peak velocity and flow depth using Hydraflow Express program.
4. Compare the worst case flow velocity with the permissible velocity of 5 fps.

Solution:

Rational Method Calculations for Typical Swale Contributing Areas

Drainage Area [2]	Runoff Coef. C[3]	Rainfall Int. I, (in/hr)[4]	Area (acres)	Peak Discharge (cfs)
SW-1	0.70	7.7	3.4	18.4
SW-2	0.70	7.7	2.2	11.9
SW-3	0.70	7.7	1.6	8.7
SW-4	0.70	7.7	2.5	13.8
SW-5	0.70	7.7	2.4	13.1
SW-6	0.70	7.7	1.8	9.5
SW-7	0.35	7.7	0.9	2.5

$$I = \frac{b}{(t_c + d)^e}$$

Where, I = Rainfall intensity, in/hr
b= 103.67
d= 14.4
e= 0.812
t_c = 10 min

(b, d, e are associated with a 25 - year, 24 - hour storm for McClennan Co.)

Typical Swale Summary Calculations[1]

Drainage Area [2]	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n[3]	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
SW-1	18.4	0.01	0.027	2	3.5	0.0	1.30	3.95
SW-2	11.9	0.01	0.027	2	3.5	0.0	1.11	3.50
SW-3	8.7	0.01	0.027	2	3.5	0.0	0.99	3.22
SW-4	13.8	0.01	0.027	2	3.5	0.0	1.17	3.65
SW-5	13.1	0.01	0.027	2	3.5	0.0	1.15	3.59
SW-6	9.5	0.01	0.027	2	3.5	0.0	1.02	3.31
SW-7	2.5	0.01	0.027	2	3.5	0.0	0.62	2.35

Conclusions:

From above drainage swale summary calculations, the greatest calculated flow velocity in a sideslope swale is 3.95 fps , which is less than the permissible velocity of 7 fps. Therefore, drainage swales installed on the final cover sideslope will be constructed with a minimum depth of 2.3 feet. Drainage swales will be constructed with a minimum 1-foot of freeboard above calculated peak flow depth. See Drawing IV.C5 for drainage swale details.

Notes:

1. Calculations were performed using the Hydraflow Express program developed by Autodesk, Inc. (Version 2020).
2. Contributing drainage areas are depicted on Drawing IV.C2-B.
3. Refer to Hydraulic Calculation References for Mannings "n" and runoff coefficient, C, references.
4. Rainfal Intensity (I) calculated for tc = 10 min, using equation for rainfall intensity shown above. Refer to Hydraulic Calculation References for coefficient b,d, and e references.

Channel Report

SW-1, Lower Northeast Sideslope Swale (Worst Case)

Trapezoidal

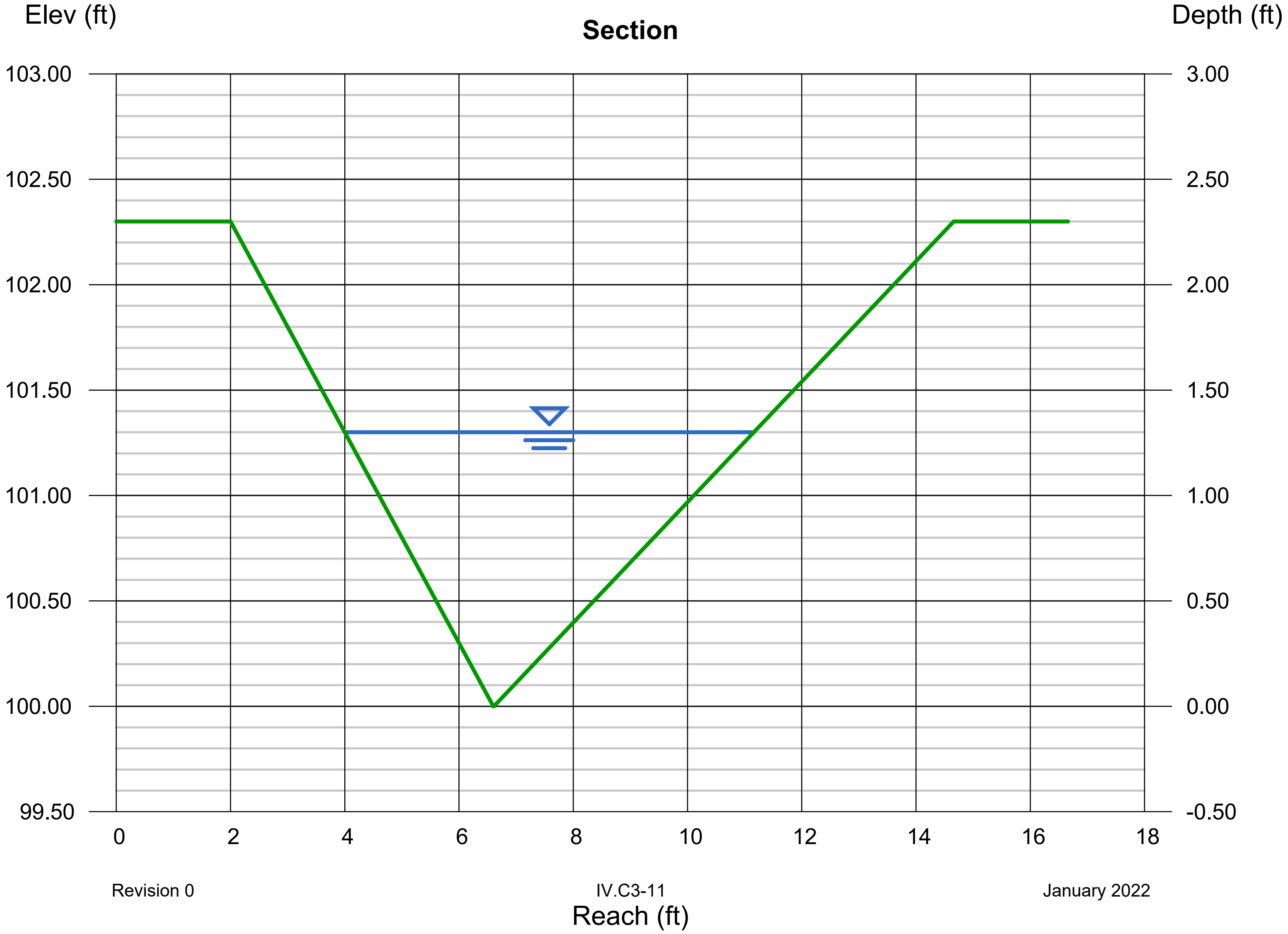
Bottom Width (ft)	= 0.01
Side Slopes (z:1)	= 2.00, 3.50
Total Depth (ft)	= 2.30
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.027

Calculations

Compute by:	Known Q
Known Q (cfs)	= 18.40

Highlighted

Depth (ft)	= 1.30
Q (cfs)	= 18.40
Area (sqft)	= 4.66
Velocity (ft/s)	= 3.95
Wetted Perim (ft)	= 7.65
Crit Depth, Yc (ft)	= 1.23
Top Width (ft)	= 7.16
EGL (ft)	= 1.54



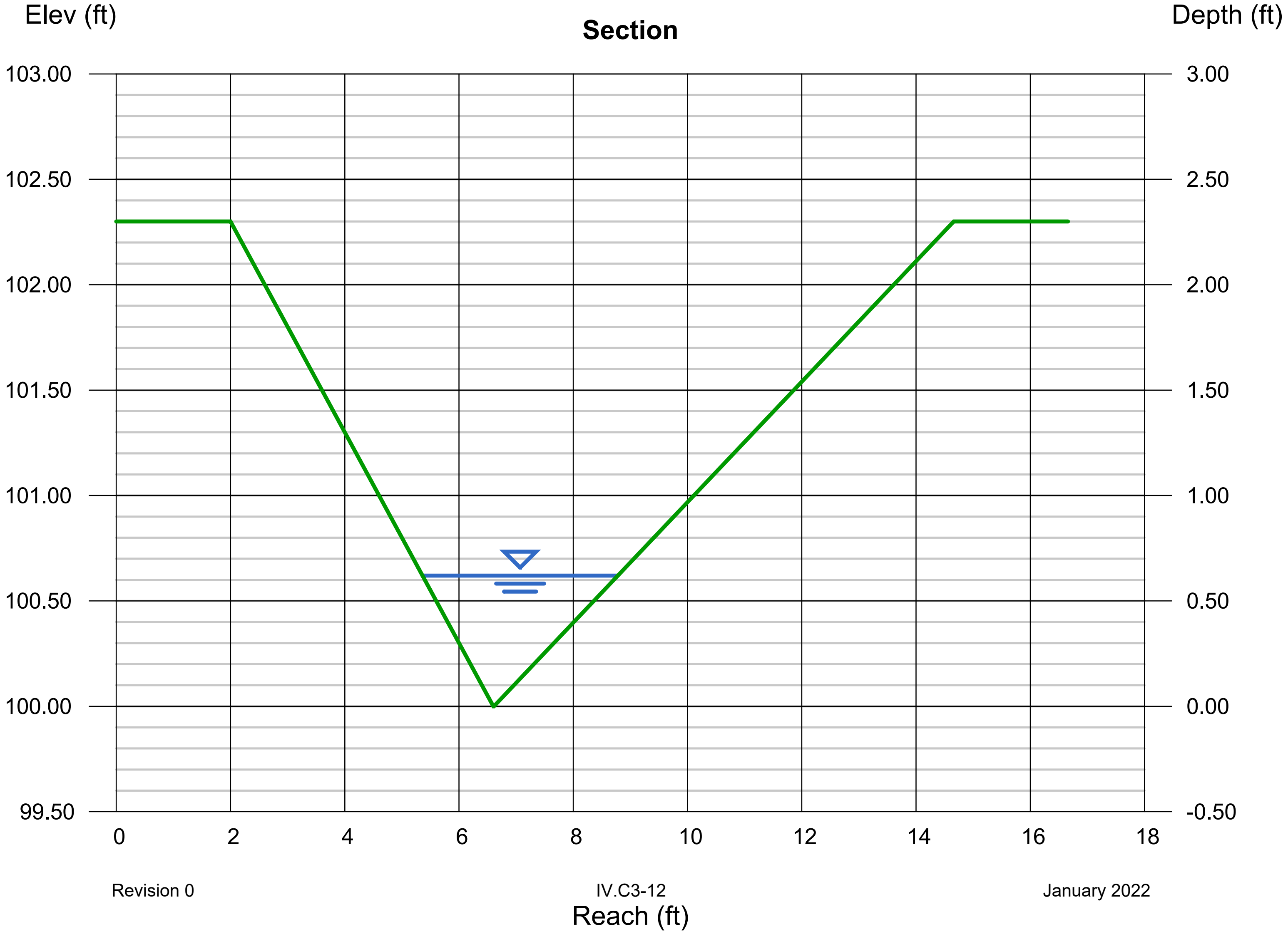
Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 30 2021

SW-7, West Topslope Swale (Worst Case)

Trapezoidal	
Bottom Width (ft)	= 0.01
Side Slopes (z:1)	= 2.00, 3.50
Total Depth (ft)	= 2.30
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.027
Calculations	
Compute by:	Known Q
Known Q (cfs)	= 2.50

Highlighted	
Depth (ft)	= 0.62
Q (cfs)	= 2.500
Area (sqft)	= 1.06
Velocity (ft/s)	= 2.35
Wetted Perim (ft)	= 3.65
Crit Depth, Yc (ft)	= 0.56
Top Width (ft)	= 3.42
EGL (ft)	= 0.71



DOWNCHUTE FLOW ANALYSIS

Prepd By: AA
Date: October 2021

Chkd By: BG
Date: January 2022

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
DOWNCHUTE FLOW ANALYSIS

Required: Calculate the peak flow depth for sizing downchutes installed on final cover.

Method:

1. Determine peak discharge rate associated with the 25 - year, 24 - hour storm event for downchute contributing drainage areas using the Rational Method (see Section 4.1.2.2 of report).
2. Determine Mannings "n" and runoff coefficient "C".
3. Using the specified channel geometry, evaluate the peak velocity and flow depth using Hydraflow Express program.

Solution:

$$I = \frac{b}{\left(t_c + d\right)^e}$$

Where, I = Rainfall intensity, in/hr
b= 103.67
d= 14.4
e= 0.812
t_c= 10 min

(b, d, e are associated with a 25 - year, 24 - hour storm for McLennan Co.)

Rational Method Calculations for Typical Swale Contributing Areas

	Drainage Area ^{2}	Runoff Coef. C^3	Rainfall Int. I, (in/hr)^4	Area (acres)	Peak Discharge (cfs)
East	DC-1	0.70	7.7	9.7	52.8
	DC-2	0.70	7.7	9.0	48.5
West	DC-3	0.70	7.7	5.2	27.9

Typical Swale Summary Calculations[1]

Drainage Area ^{2}	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n^3	Sideslope (left)	Sideslope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)
DC-1	52.8	0.2857	0.033	2	2	15.0	0.32	10.55
DC-2	48.5	0.2857	0.033	2	2	15.0	0.30	10.36
DC-3	27.9	0.2857	0.033	2	2	15.0	0.22	8.21

Conclusions: Based on the greatest contributing drainage areas shown on Drawing 2, downchutes installed on final cover will be constructed 2 feet deep (assuming 1-foot of freeboard), with a 15-foot bottom width, and 2H:1V sideslopes. Gabions, rip rap, or dissipation blocks will be installed at the toe of the landfill berm with the perimeter channels to dissipate the peak velocity. Typical details for downchutes are depicted on Drawing 5.4.

Notes:

1. Calculations were performed using the Hydraflow Express program developed by Autodesk, Inc. (Version 2020).
2. Contributing drainage areas are depicted on Drawing IV.C2-B.
3. Refer to Hydraulic Calculation References for Mannings "n" and runoff coefficient, C, references.
4. Rainfal Intensity (I) calculated for tc = 10 min, using equation for rainfall intensity shown above. Refer to Hydraulic Calculation References for coefficient b,d, and e references.

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.

Thursday, Sep 30 2021

DC-1, Drainage Area 1

Trapezoidal

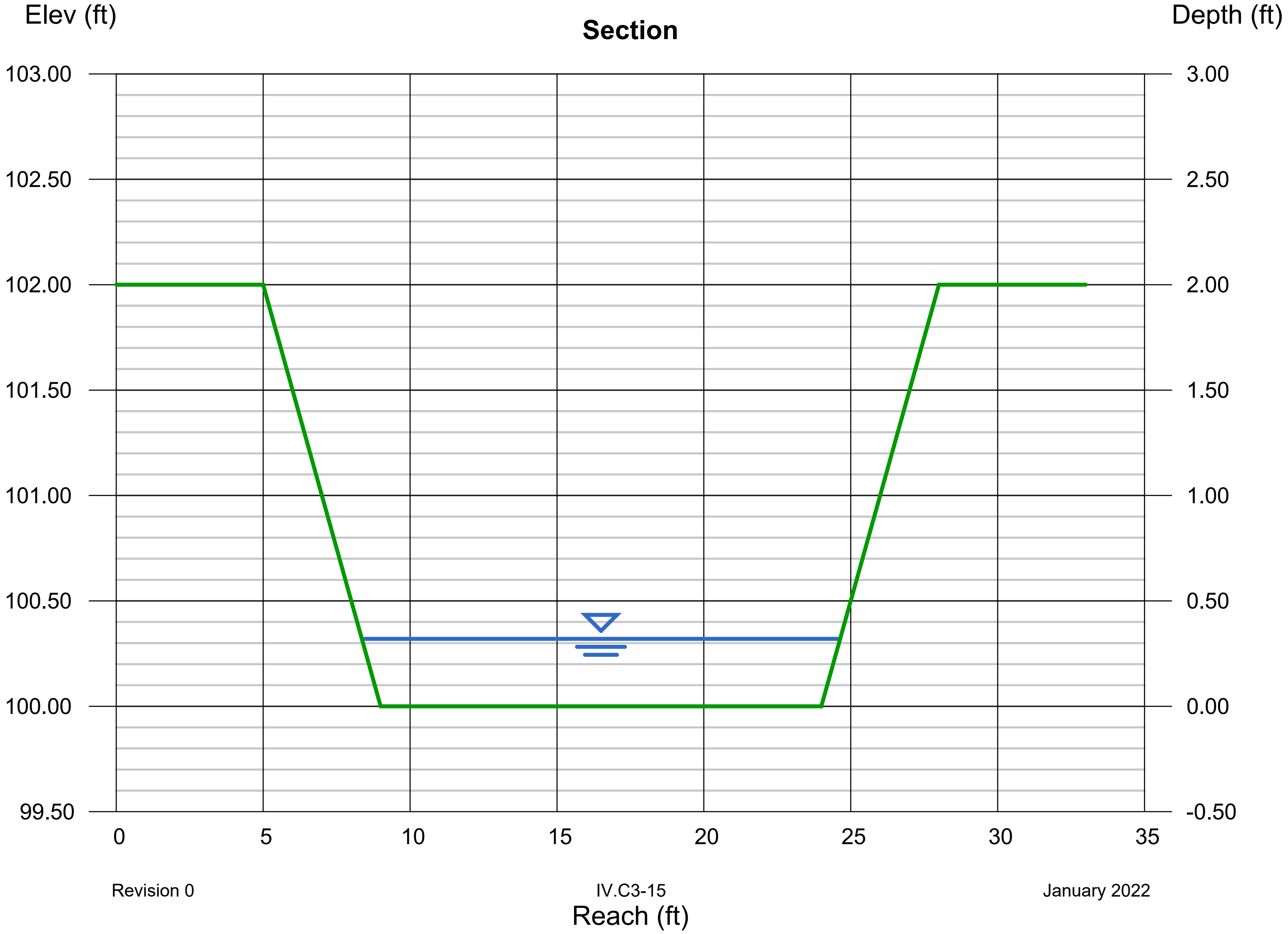
Bottom Width (ft)	= 15.00
Side Slopes (z:1)	= 2.00, 2.00
Total Depth (ft)	= 2.00
Invert Elev (ft)	= 100.00
Slope (%)	= 28.57
N-Value	= 0.033

Calculations

Compute by:	Known Q
Known Q (cfs)	= 52.80

Highlighted

Depth (ft)	= 0.32
Q (cfs)	= 52.80
Area (sqft)	= 5.00
Velocity (ft/s)	= 10.55
Wetted Perim (ft)	= 16.43
Crit Depth, Yc (ft)	= 0.71
Top Width (ft)	= 16.28
EGL (ft)	= 2.05



Channel Report

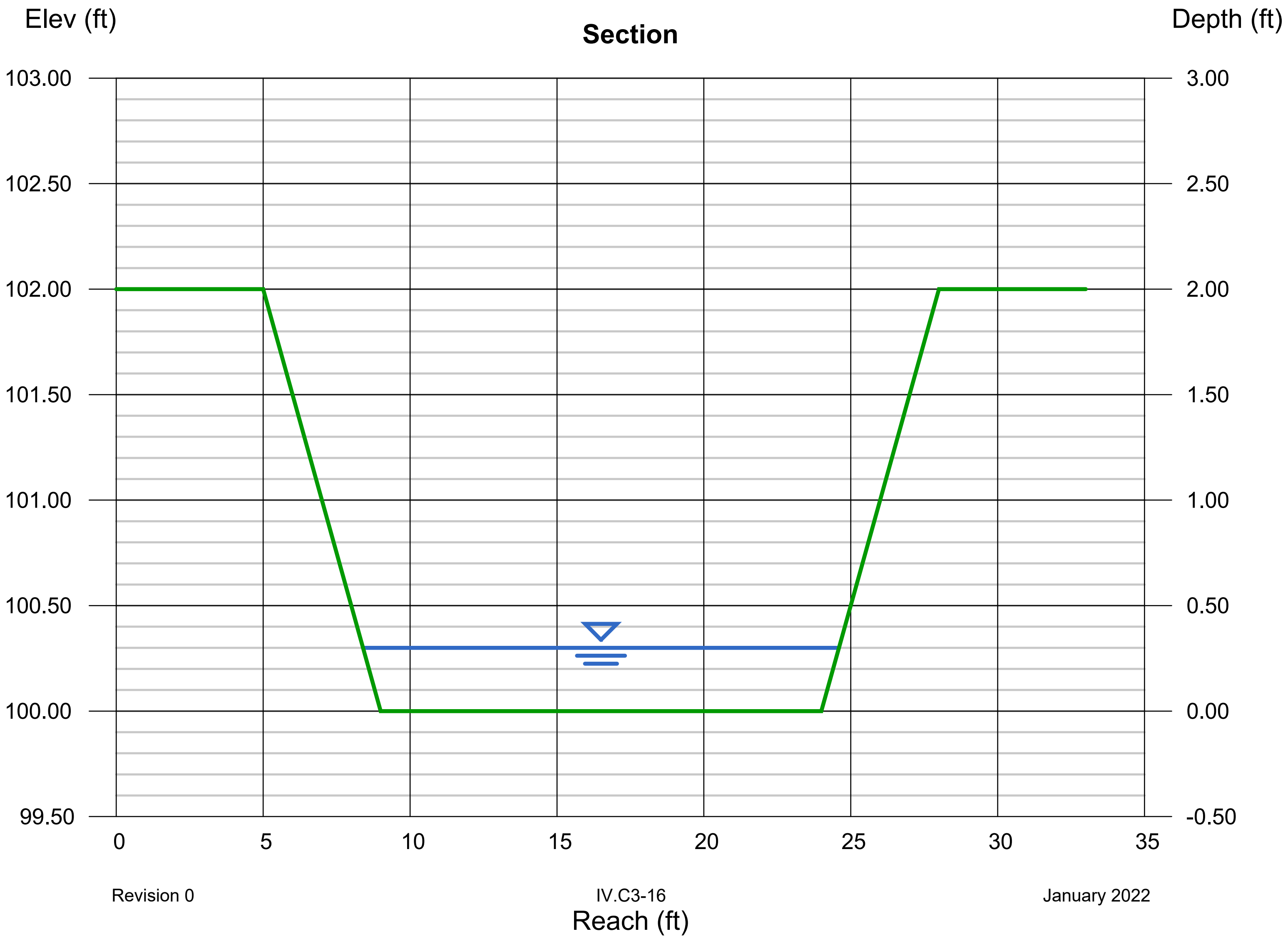
Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Thursday, Sep 30 2021

DC-2, Drainage Area 2

Trapezoidal
Bottom Width (ft) = 15.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 2.00
Invert Elev (ft) = 100.00
Slope (%) = 28.57
N-Value = 0.033

Calculations
Compute by: Known Q
Known Q (cfs) = 48.50

Highlighted
Depth (ft) = 0.30
Q (cfs) = 48.50
Area (sqft) = 4.68
Velocity (ft/s) = 10.36
Wetted Perim (ft) = 16.34
Crit Depth, Yc (ft) = 0.67
Top Width (ft) = 16.20
EGL (ft) = 1.97



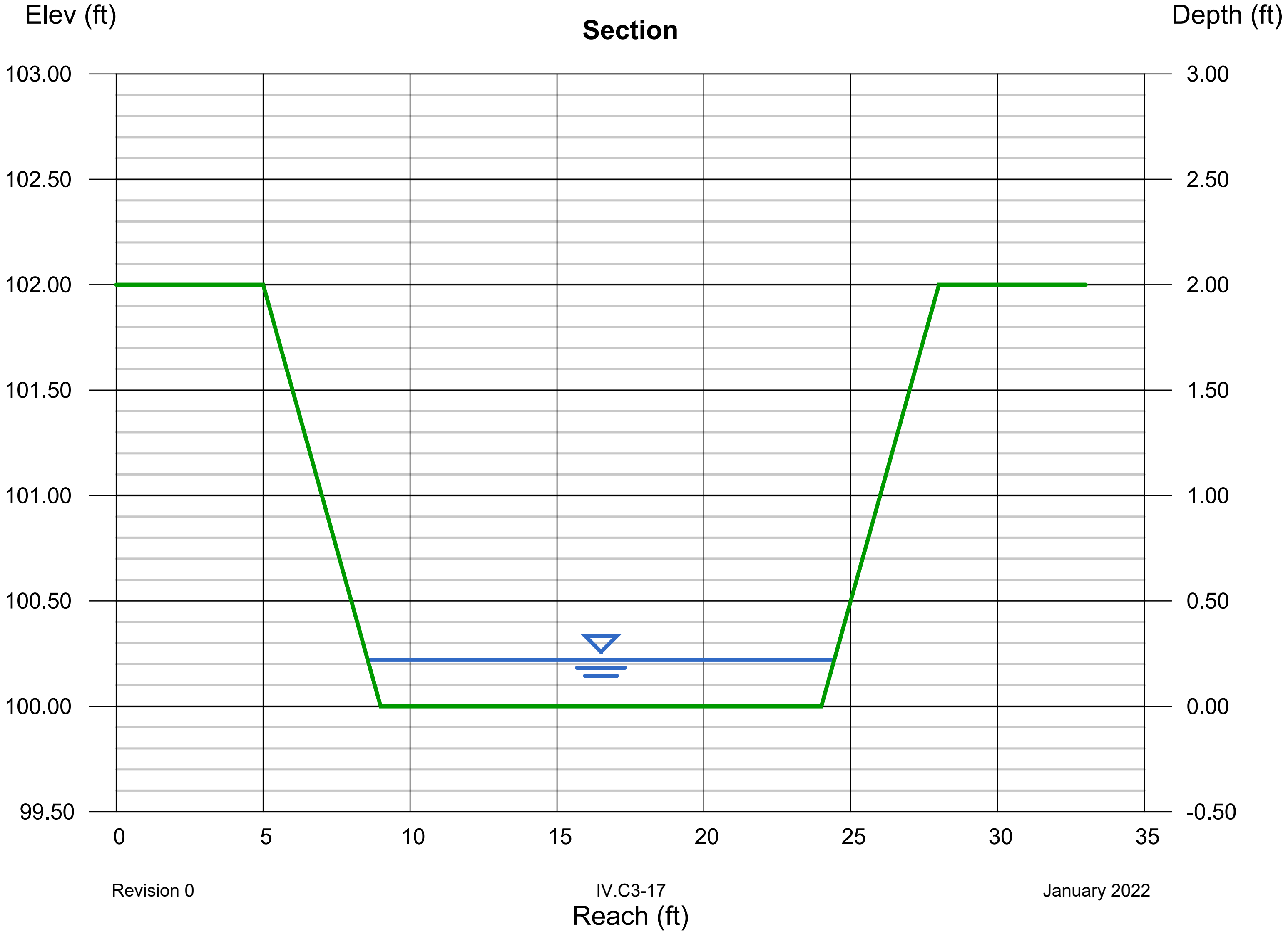
Channel Report

DC-3, Drainage Area 3

Trapezoidal
Bottom Width (ft) = 15.00
Side Slopes (z:1) = 2.00, 2.00
Total Depth (ft) = 2.00
Invert Elev (ft) = 100.00
Slope (%) = 28.57
N-Value = 0.033

Calculations
Compute by: Known Q
Known Q (cfs) = 27.90

Highlighted
Depth (ft) = 0.22
Q (cfs) = 27.90
Area (sqft) = 3.40
Velocity (ft/s) = 8.21
Wetted Perim (ft) = 15.98
Crit Depth, Yc (ft) = 0.47
Top Width (ft) = 15.88
EGL (ft) = 1.27



PERIMETER CHANNEL FLOW ANALYSIS
(HYDRAFLOW EXPRESS OUTPUT FILES)

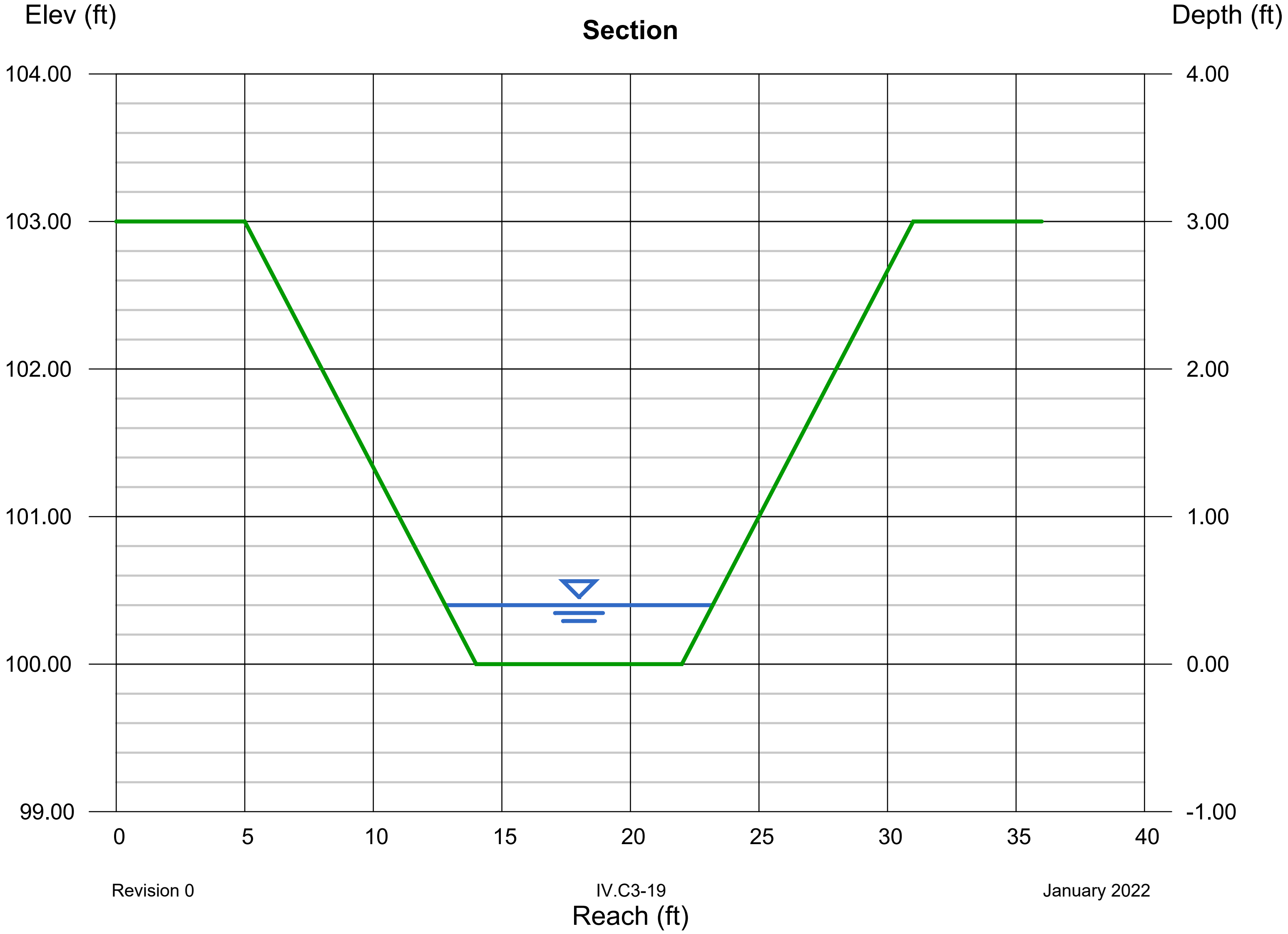
Channel Report

East Channel - 1

Trapezoidal
Bottom Width (ft) = 8.00
Side Slopes (z:1) = 3.00, 3.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = 0.027

Calculations
Compute by: Known Q
Known Q (cfs) = 9.86

Highlighted
Depth (ft) = 0.40
Q (cfs) = 9.860
Area (sqft) = 3.68
Velocity (ft/s) = 2.68
Wetted Perim (ft) = 10.53
Crit Depth, Yc (ft) = 0.35
Top Width (ft) = 10.40
EGL (ft) = 0.51



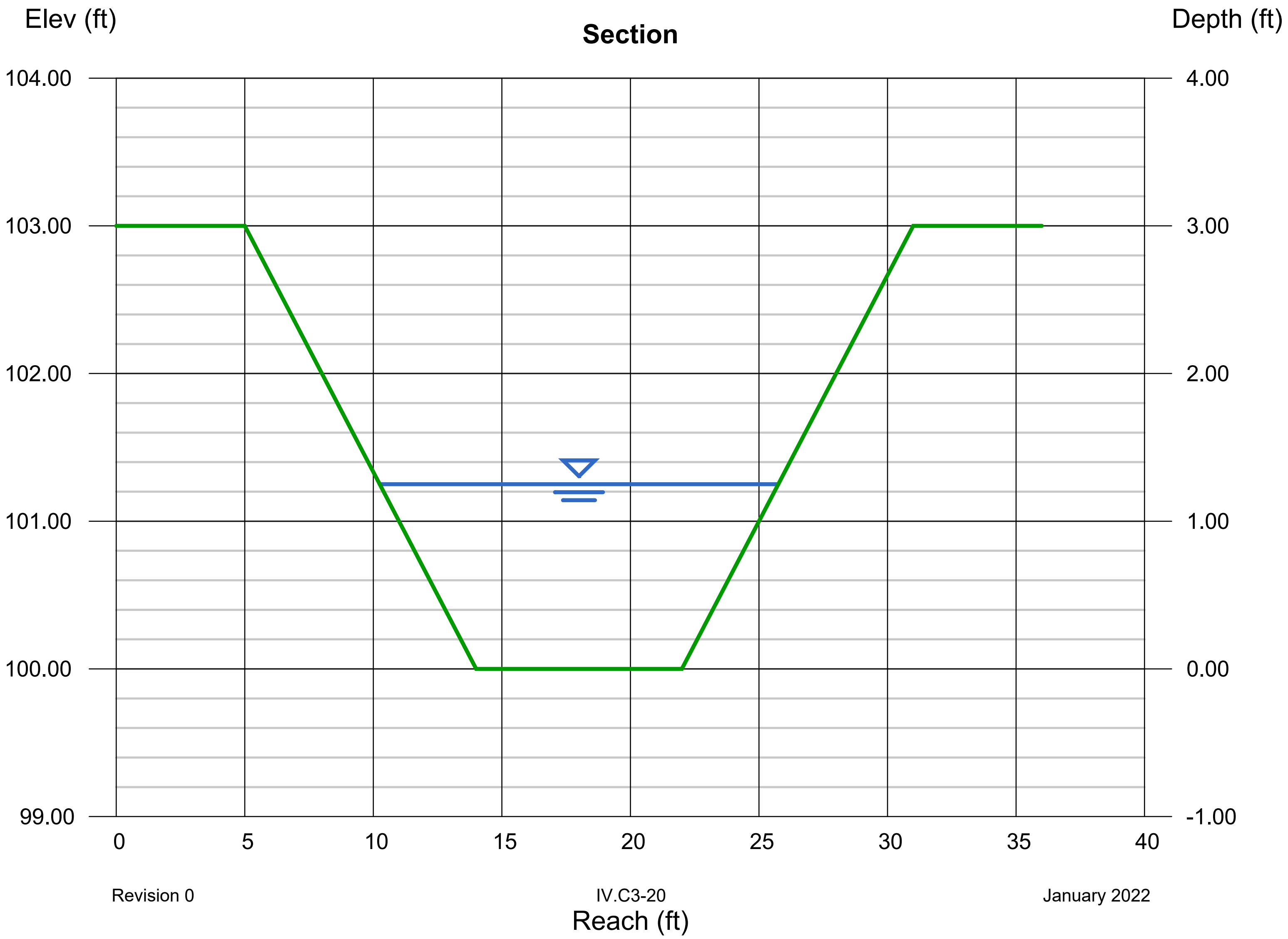
Channel Report

East Channel - 2

Trapezoidal
Bottom Width (ft) = 8.00
Side Slopes (z:1) = 3.00, 3.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = 0.027

Calculations
Compute by: Known Q
Known Q (cfs) = 76.07

Highlighted
Depth (ft) = 1.25
Q (cfs) = 76.07
Area (sqft) = 14.69
Velocity (ft/s) = 5.18
Wetted Perim (ft) = 15.91
Crit Depth, Yc (ft) = 1.21
Top Width (ft) = 15.50
EGL (ft) = 1.67



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc.   Monday, Oct 4 2021

West Channel - 1

Trapezoidal

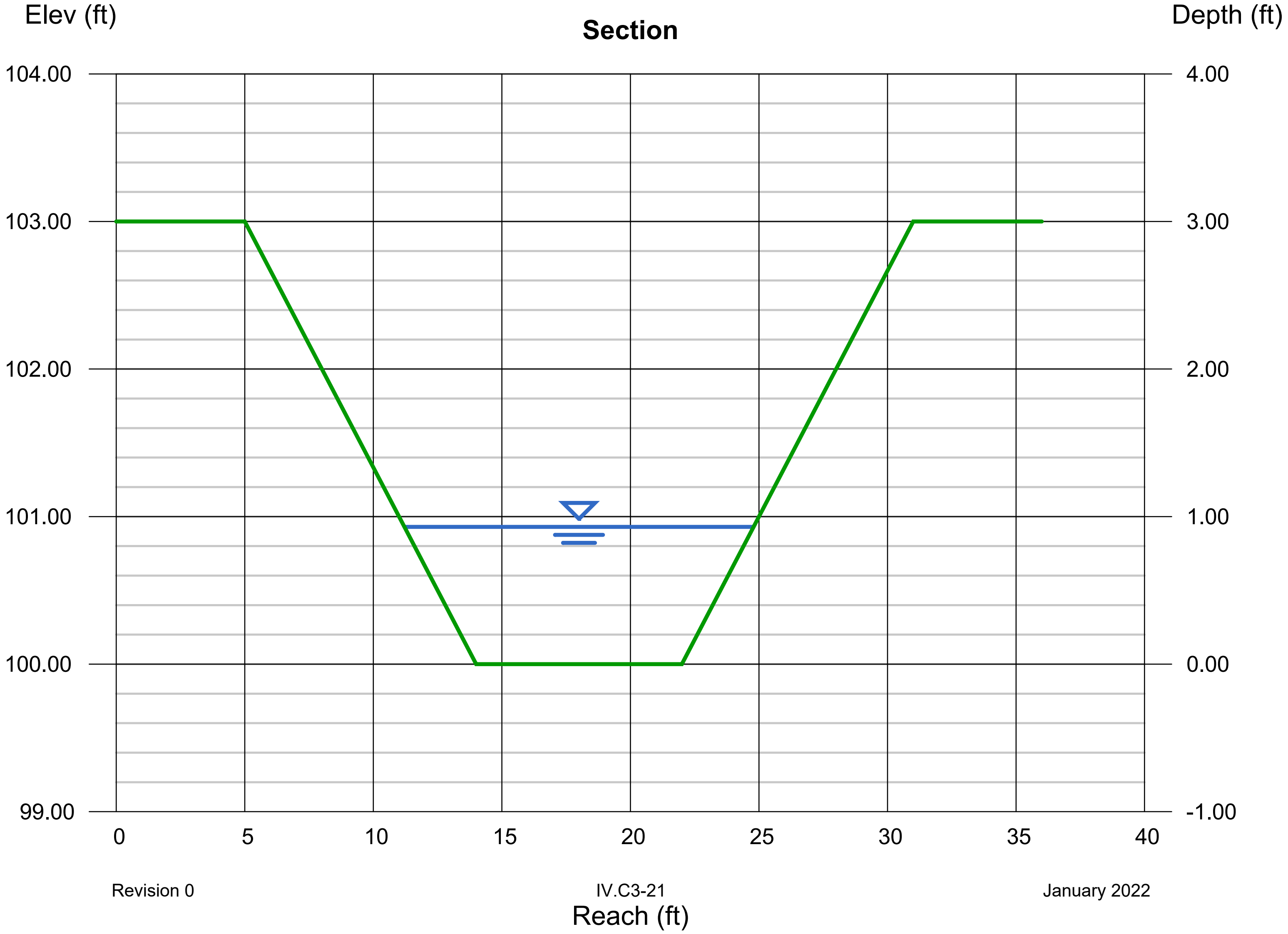
Bottom Width (ft)	= 8.00
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 3.00
Invert Elev (ft)	= 100.00
Slope (%)	= 1.00
N-Value	= 0.027

Calculations

Compute by:	Known Q
Known Q (cfs)	= 43.66

Highlighted

Depth (ft)	= 0.93
Q (cfs)	= 43.66
Area (sqft)	= 10.03
Velocity (ft/s)	= 4.35
Wetted Perim (ft)	= 13.88
Crit Depth, Yc (ft)	= 0.87
Top Width (ft)	= 13.58
EGL (ft)	= 1.22



Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Monday, Oct 4 2021

West Channel - 2

Trapezoidal

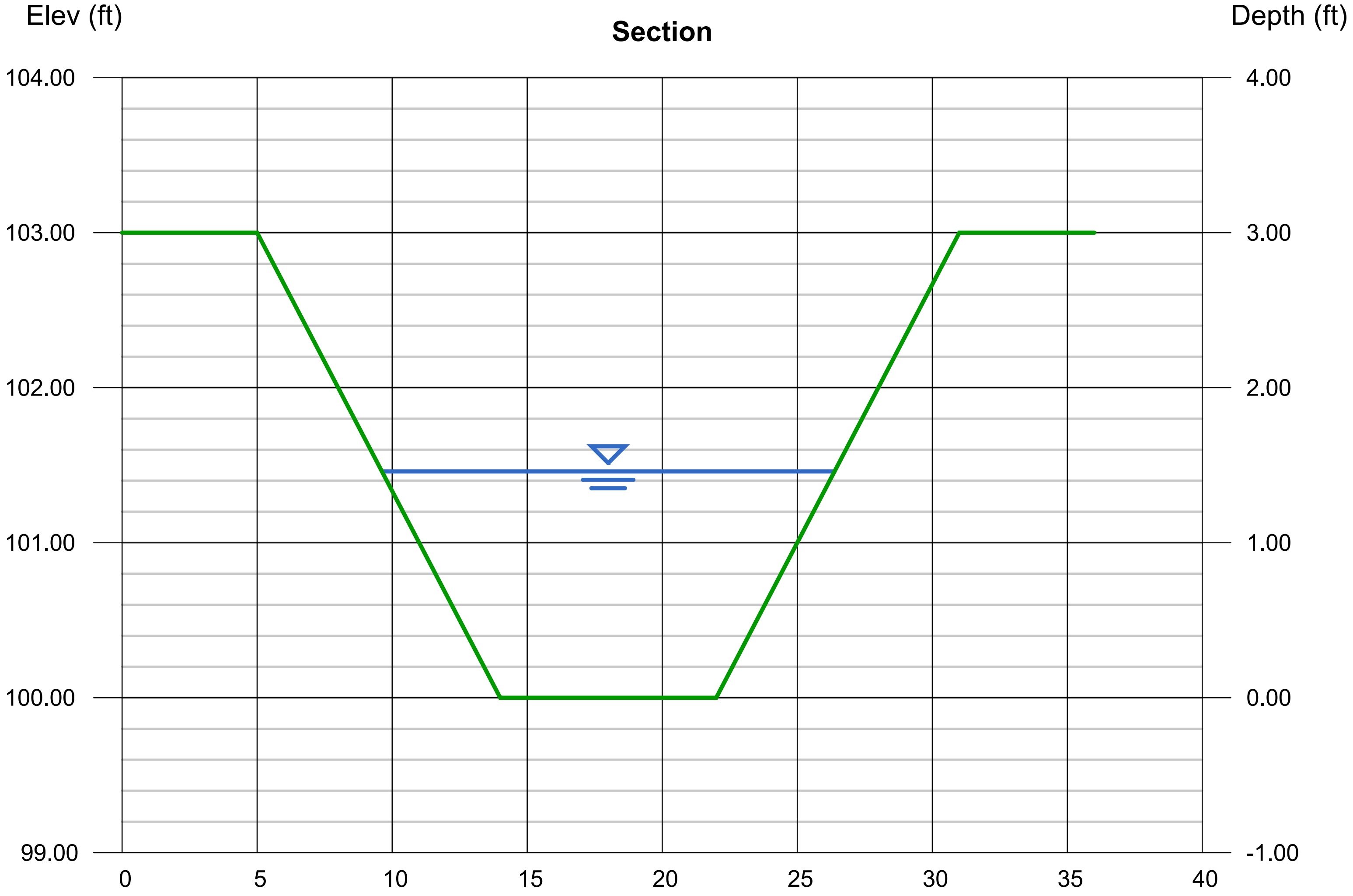
Bottom Width (ft) = 8.00
Side Slopes (z:1) = 3.00, 3.00
Total Depth (ft) = 3.00
Invert Elev (ft) = 100.00
Slope (%) = 1.00
N-Value = 0.027

Calculations

Compute by: Known Q
Known Q (cfs) = 101.45

Highlighted

Depth (ft) = 1.46
Q (cfs) = 101.45
Area (sqft) = 18.07
Velocity (ft/s) = 5.61
Wetted Perim (ft) = 17.23
Crit Depth, Yc (ft) = 1.43
Top Width (ft) = 16.76
EGL (ft) = 1.95



CONTAINMENT AND DIVISION BERM ANALYSIS

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
CONTAINMENT AND DIVERSION BERM ANALYSIS

Required:

1. Determine the height of the containment and diversion berms required for run-on control over exposed CCR waste.

Procedure:

Containment and Diversion Berm Calculations

A. Determine the 25-year, 24-hour flow rates for the containment and diversion berm run-on drainage areas by the Ration
B. Calculate the capacity of the containment and diversion berm swales at various slopes.
C. Calculate the height of the containment and diversion berm required for the flow rate of run-on surface or contact wate

References:

1. National Oceanic and Atmospheric Administration (NOAA) Atlas 14 Precipitation Frequency Data Server, 25-year, 24-hour rainfall depth
2. Texas Department of Transportation, "Bridge Division Hydraulic Manual", 2004.

1. Containment and Diversion Berm

As shown on Drawing IV.C7, several scenarios were analyzed to determine the adequacy of the berm configuration.

Hydraulic calculations are summarized in Tables 1 and 2.

The diversion berms were analyzed using the Rational Method.

$$Q = CIA$$

Where: $C =$ run-off coefficient (intermediate cover and exposed CCR) = 0.5
$I =$ intensity (in/hr)
$A =$ drainage area (ac)

$$I = b / (t_c + d)^e$$

$b =$ = 103.67
$d =$ = 14.39
$e =$ = 0.8123

From Rainfall Intensity-Duration Frequency Coefficients for McLennan County:

Note: b, d, e are associated with a 25 - year, 24 - hour storm for McLennan Co. Consistent with TxDOT guidance, a minimum time of 10 minutes was used to calculate the rainfall intensity.

$\boxed{I = 7.74 \text{ in/hr}}$

Diversion Berm Summary (Table 1)

Area (ac)	Flow Rate (cfs)
0.5	1.9
1.0	3.9
2.0	7.7
5.0	19.4
8.0	31.0

SANDY CREEK ENERGY STATION
COAL COMBUSTION RESIDUAL WASTE MANAGEMENT FACILITY
TABLE 2 - CONTAINMENT AND DIVERSION BERM SUMMARY SHEET

For 3% Diversion Berm Area Slope

Drainage Area	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Berm Depth (ft)	Flow Top Width (ft)
0.5	1.9	0.01	0.025	2	33.3	0	0.3	1.6	0.8	1.3	9.3
1.0	3.9	0.01	0.025	2	33.3	0	0.4	1.9	0.8	1.4	12.2
2.0	7.7	0.01	0.025	2	33.3	0	0.5	2.2	0.8	1.5	15.8
5.0	19.4	0.01	0.025	2	33.3	0	0.6	2.8	0.9	1.6	22.3
8.0	31.0	0.01	0.025	2	33.3	0	0.8	3.1	0.9	1.8	26.6

Note: Calculations were performed using the Hydraflow Express program developed by Autodesk, Inc. (Version 2020).

For 3.5H:1V Diversion Berm Area Slope

Drainage Area	Flow Rate (cfs)	Bottom Slope(ft/ft)	Manning's n	Side Slope (left)	Side Slope (right)	Bottom Width (ft)	Normal Depth (ft)	Flow Vel. (fps)	Froude Number	Berm Depth (ft)	Flow Top Width (ft)
0.5	1.9	0.01	0.025	2	3.5	0	0.5	2.4	0.8	1.5	3.0
1.0	3.9	0.01	0.025	2	3.5	0	0.7	2.9	0.8	1.7	3.9
2.0	7.7	0.01	0.025	2	3.5	0	0.9	3.4	0.9	1.9	5.0
5.0	19.4	0.01	0.025	2	3.5	0	1.3	4.2	0.9	2.3	7.1
8.0	31.0	0.01	0.025	2	3.5	0	1.5	4.8	1.0	2.5	8.5

Note: Calculations were performed using the Hydraflow Express program developed by Autodesk, Inc. (Version 2020).

HYDRAULIC ANALYSIS REFERENCE

Hydraulic Design Manual

Texas
Department
of Transportation

Revised September 2019

Table 4-10: Runoff Coefficients for Urban Watersheds

Type of drainage area	Runoff coefficient
Business:	
Downtown areas	0.70-0.95
Neighborhood areas	0.30-0.70
Residential:	
Single-family areas	0.30-0.50
Multi-units, detached	0.40-0.60
Multi-units, attached	0.60-0.75
Suburban	0.35-0.40
Apartment dwelling areas	0.30-0.70
Industrial:	
Light areas	0.30-0.80
Heavy areas	0.60-0.90
Parks, cemeteries	0.10-0.25
Playgrounds	0.30-0.40
Railroad yards	0.30-0.40
Unimproved areas:	
Sand or sandy loam soil, 0-3%	0.15-0.20
Sand or sandy loam soil, 3-5%	0.20-0.25
Black or loessial soil, 0-3%	0.18-0.25
Black or loessial soil, 3-5%	0.25-0.30
Black or loessial soil, > 5%	0.70-0.80
Deep sand area	0.05-0.15
Steep grassed slopes	0.70
Lawns:	
Sandy soil, flat 2%	0.05-0.10
Sandy soil, average 2-7%	0.10-0.15
Sandy soil, steep 7%	0.15-0.20
Heavy soil, flat 2%	0.13-0.17
Heavy soil, average 2-7%	0.18-0.22

Table 4-10: Runoff Coefficients for Urban Watersheds

Type of drainage area	Runoff coefficient
Heavy soil, steep 7%	0.25-0.35
Streets:	
Asphaltic	0.85-0.95
Concrete	0.90-0.95
Brick	0.70-0.85
Drives and walks	0.75-0.95
Roofs	0.75-0.95

Rural and Mixed-Use Watershed

Table 4-11 shows an alternate, systematic approach for developing the runoff coefficient. This table applies to rural watersheds only, addressing the watershed as a series of aspects. For each of four aspects, the designer makes a systematic assignment of a runoff coefficient “component.” Using Equation 4-22, the four assigned components are added to form an overall runoff coefficient for the specific watershed segment.

The runoff coefficient for rural watersheds is given by:

$$C = C_r + C_i + C_v + C_s$$

Equation 4-22.

Where*:*

C = runoff coefficient for rural watershed

C_r = component of coefficient accounting for watershed relief

C_i = component of coefficient accounting for soil infiltration

C_v = component of coefficient accounting for vegetal cover

C_s = component of coefficient accounting for surface type

The designer selects the most appropriate values for C_r, C_i, C_v, and C_s from Table 4-11.

Procedure for using the Rational Method

The rational formula estimates the peak rate of runoff at a specific location in a watershed as a function of the drainage area, runoff coefficient, and mean rainfall intensity for a duration equal to the time of concentration. The rational formula is:

$$Q = \frac{CIA}{Z}$$

Equation 4-20.

Where:

Q = maximum rate of runoff (cfs or m^3/sec.)

C = runoff coefficient

I = average rainfall intensity (in./hr. or mm/hr.)

A = drainage area (ac or ha)

Z = conversion factor, 1 for English, 360 for metric

Rainfall Intensity

The rainfall intensity (I) is the average rainfall rate in in./hr. for a specific rainfall duration and a selected frequency. The duration is assumed to be equal to the time of concentration. For drainage areas in Texas, you may compute the rainfall intensity using Equation 4-21, which is known as a rainfall intensity-duration-frequency (IDF) relationship (power-law model).

$$I = \frac{b}{(t_c + d)^e}$$

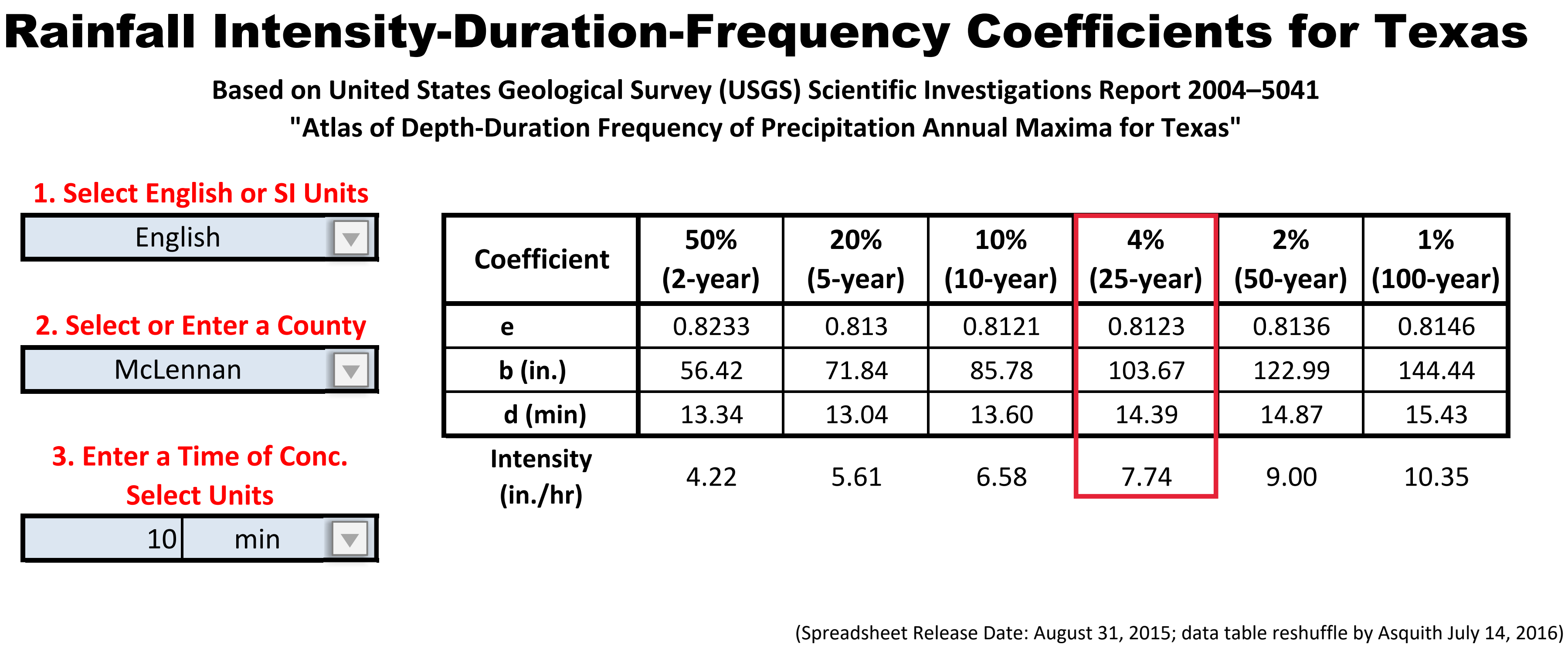
Equation 4-21.

Where:

I = design rainfall intensity (in./hr.)

tc = time of concentration (min) as discussed in Section 11

e, b, d = coefficients for specific frequencies listed by county in the EBDLKUP-2015v2.1.xlsx spreadsheet lookup tool (developed by Cleveland et al. 2015). These coefficients are based on rainfall frequency-duration data contained in the Atlas of Depth-Duration Frequency (DDF) of Precipitation of Annual Maxima for Texas (TxDOT 5-1301-01-1). Also see video/tutorial on the use of the EBDLKUP-2015v2.1.xlsx spreadsheet tool.



Rainfall Intensity-Duration-Frequency Coefficients for Texas

Based on United States Geological Survey (USGS) Scientific Investigations Report 2004–5041
"Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas"

1. Select English or SI Units

English

2. Select or Enter a County

McLennan

3. Enter a Time of Conc.
Select Units

10 min

Coefficient	50% (2-year)	20% (5-year)	10% (10-year)	4% (25-year)	2% (50-year)	1% (100-year)
e	0.8233	0.813	0.8121	0.8123	0.8136	0.8146
b (in.)	56.42	71.84	85.78	103.67	122.99	144.44
d (min)	13.34	13.04	13.60	14.39	14.87	15.43
Intensity (in./hr)	4.22	5.61	6.58	7.74	9.00	10.35

(Spreadsheet Release Date: August 31, 2015; data table reshuffle by Asquith July 14, 2016)

United States
Department of
Agriculture

Natural
Resources
Conservation
Service

Conservation
Engineering
Division

Technical
Release 55

June 1986

Urban Hydrology for Small Watersheds

TR-55

To show bookmarks which navigate through the document.

Click the show/hide navigation pane button ▤ , and then

click the bookmarks tab. It will navigate you to the contents,

chapters, rainfall maps, and printable forms.

Sheet flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks; and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot or so. Table 3-1 gives Manning's n values for sheet flow for various surface conditions.

Table 3-1 Roughness coefficients (Manning's n) for sheet flow

Surface description	n [1]
Smooth surfaces (concrete, asphalt, gravel, or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils:	
Residue cover ≤20%	0.06
Residue cover >20%	0.17
Grass:	
Short grass prairie	0.15
Dense grasses [2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods:[3]	
Light underbrush	0.40
Dense underbrush	0.80

[1] The n values are a composite of information compiled by Engman (1986).

[2] Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.

[3] When selecting n , consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Final Cover: n= 0.15

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overtop and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \qquad \text{[eq. 3-3]}$$

where:

T_t = travel time (hr),
n = Manning's roughness coefficient (table 3-1)
L = flow length (ft)
P_2 = 2-year, 24-hour rainfall (in)
s = slope of hydraulic grade line (land slope, ft/ft)

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (that part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time. Rainfall depth can be obtained from appendix B.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from figure 3-1, in which average velocity is a function of watercourse slope and type of channel. For slopes less than 0.005 ft/ft, use equations given in appendix F for figure 3-1. Tillage can affect the direction of shallow concentrated flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in figure 3-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.

Design Hydrology and Sedimentology for Small Catchments

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3- 1

where the value of I is

Retardance	I
A	10.000
B	7.643
C	5.601
D	4.436
E	2.876

This relationship can be used in computer programs to make hydraulic computations for vegetated waterways. The relationships should not be used outside the range of the curves shown in Fig. 4.14.

The graphs of Fig. 4.15 are solutions to Manning's equation using the curves in Fig. 4.14. They can be used as a design aid for solving Manning's equation for all retardance classes.

Example Problem 4.11 Vegetated channel 1

Design a channel to carry 25 cfs on a 4% slope. Use a parabolic channel. The soil is easily eroded, and the grass may be mowed to 2.5 in. or it may be uncut.

Solution: Select Bermuda grass. Bermuda grass is in retardance B if unmowed and retardance D if mowed. The permissible velocity is selected from Table 4.5 as 6 fps. First design for the mowed condition

$$A = Q/v = 25/6 = 4.17 \text{ ft}^2.$$

Table 4.4 Guide to Selection of Vegetal Retardance[a]

Stand	Length of vegetation (in.)	Retardance class
Good	>30	A
	11–24	B
	6–10	C
	2–6	D
	<2	E
Fair	>30	B
	11–24	C
	6–10	D
	2–6	D
	<2	E

[a] Soil Conservation Service (1979) engineering field manual.

Table 4.5 Permissible velocities for Vegetated Channels (Ree, 1949)

	Permissible velocity (fps)					
	Erosion-resistant soils (% slope)			Easily eroded soils (% slope)		
Cover	0–5	5–10	Over 10	0–5	5–10	Over 10
Bermuda grass	8	7	6	6	5	4
Buffalo grass Kentucky bluegrass Smooth brome Blue grama Tall fescue	7	6	5	5	4	3
Lespedeza sericea Weeping lovegrass Kudzu Alfalfa Crabgrass	3.5	NR[a]	NR	2.5	NR	NR
Grass mixture	5	4	NR	4	3	NR
Annuals for temporary protection	3.5	NR	NR	2.5	NR	NR

[a] Not recommended.

ATTACHMENT IV.C4

SOIL LOSS ANALYSIS

STATE OF TEXAS
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LICENSED
PROFESSIONAL ENGINEER

Brett DeVries 1/13/22

Inclusive of pages IV.C4-2
through IV.C4-13

SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
SOIL LOSS ANALYSIS

Required: Determine expected soil loss for the landfill topslope and sideslope with final cover consistent with 30 TAC §330.305(d)(2).

Method:

Expected soil loss is calculated using the Universal Soil Loss Equation (USLE)/Revised Universal Soil Loss Equation (RUSLE). The annual soil loss calculated for final cover conditions is compared to the permissible soil loss of 3 tons/acre/year, as referenced from the TCEQ's "Surface Water Drainage and Erosional Stability Guidance for Municipal Solid Waste Landfill", dated May, 2018.

References:

1. SCS National Engineering Handbook, *Section 3 - Sedimentation, Chapter 3 - Erosion*.
2. TNRCC, Use of the USLE in Final Cover/Configuration Design, 1993.
2. USDA, *Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), 1997.*
3. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Limestone County, Texas.*
3. United States Department of Agriculture, Soil Conservation Service, *Soil Survey of Hill County*, Texas.
4. Reference: USDA, *Predicting Rainfall Erosion Losses, A Guide to Conservation Planning*, Agriculture Handbook Number 537, 1978.
5. TCEQ, *Surface Water Drainage and Erosional Stability Guidance for Municipal Solid Waste Landfill, May 2018.*

Solution:

1. Soil loss equation: A = RKLSCP

Where:
A = Soil Loss (tons/ac/yr)
R = Rainfall/Runoff Erosivity actor
K = Soil Erodibility Factor
L = Slope Length Factor
S = Slope Steepness Factor
C = Cover Management Factor
P = Support Practice Factor

The rainfall factor, R, is a product of rainfall energy and maximum 30-min intensity.
Average annual R values for Eastern United States is presented in Figure 2-1 of USDA 1997.
Values of the R Factor (see page IV.D4-4), the R factor for the Site is:

R = 295

The soil erodibility, K, factor represents the resistance of a soil surface to erosion as a function of the soil's physical and chemical properties. As shown in soil surveys for McLennan County for the applicable on-site soils (see page IV.D4-5), the weighted average K factor for the area is:

K = 0.289

SANDY CREEK ENERGY STATION
CCR WASTE MANAGEMENT FACILITY
SOIL LOSS ANALYSIS

Solution (Cont.): The effect of topography on soil erosion are determined by the slope length factor, L, and slope steepness factor, S. The slopes of interest are represented by either of the following: (1) topslope above and sideslope below the first drainage swale placed on final cover or (2) sideslope area between consecutive drainage swales on final cover.

Topslope Conditions			Sideslope Conditions		
slope =	3	%	slope =	28.57	%
length, l =	125	ft	length, l =	175	ft

Topographic factor, combined slope length and slope steepness factors LS, is based on a low rill/interill erosion ratio (**see page IV.D4-12**).

Topslope, LS = 0.65 Sideslope, LS = 5.395

The cover and cropping management factor, C, represents the percentage of soil loss that would occur if the surface were partially protected by some combination of cover and management practices. Using of Table 2 - Factor C for Permanent Pasture, Range, and Idle Land (**see page IV.D4-13**) for 90% ground cover yields the following C value.

C = 0.006

The erosion control practice factor, P, measures the effect of control practices that reduce the erosion potential of the runoff by influencing drainage patterns, runoff concentration, and runoff velocity. Use of Table 3, for Countouring, Countouring, Stripcropping and Terracing (**see page IV.D4-14**), the P factor is determined to be:

P = 0.90

2. Soil loss calculations:

Slope Condition	R	K	LS	C	P	A (tons/ac /yr)
3% slope 125 ft length	295	0.289	0.650	0.006	0.90	0.30
28.57% slope 175 ft length	305	0.289	5.395	0.006	0.90	2.57

Conclusions:

From review of the annual soil loss, a value of less than 3 tons/acre/year is achieved, consistent with TCEQ's guidance document for addressing erosional stability during all phases of landfill operation.

Prep By: AA
Date: September 2021

SANDY CREEK ENERGY STATION
R Factor

Chkd By: BG
Date: September 2021

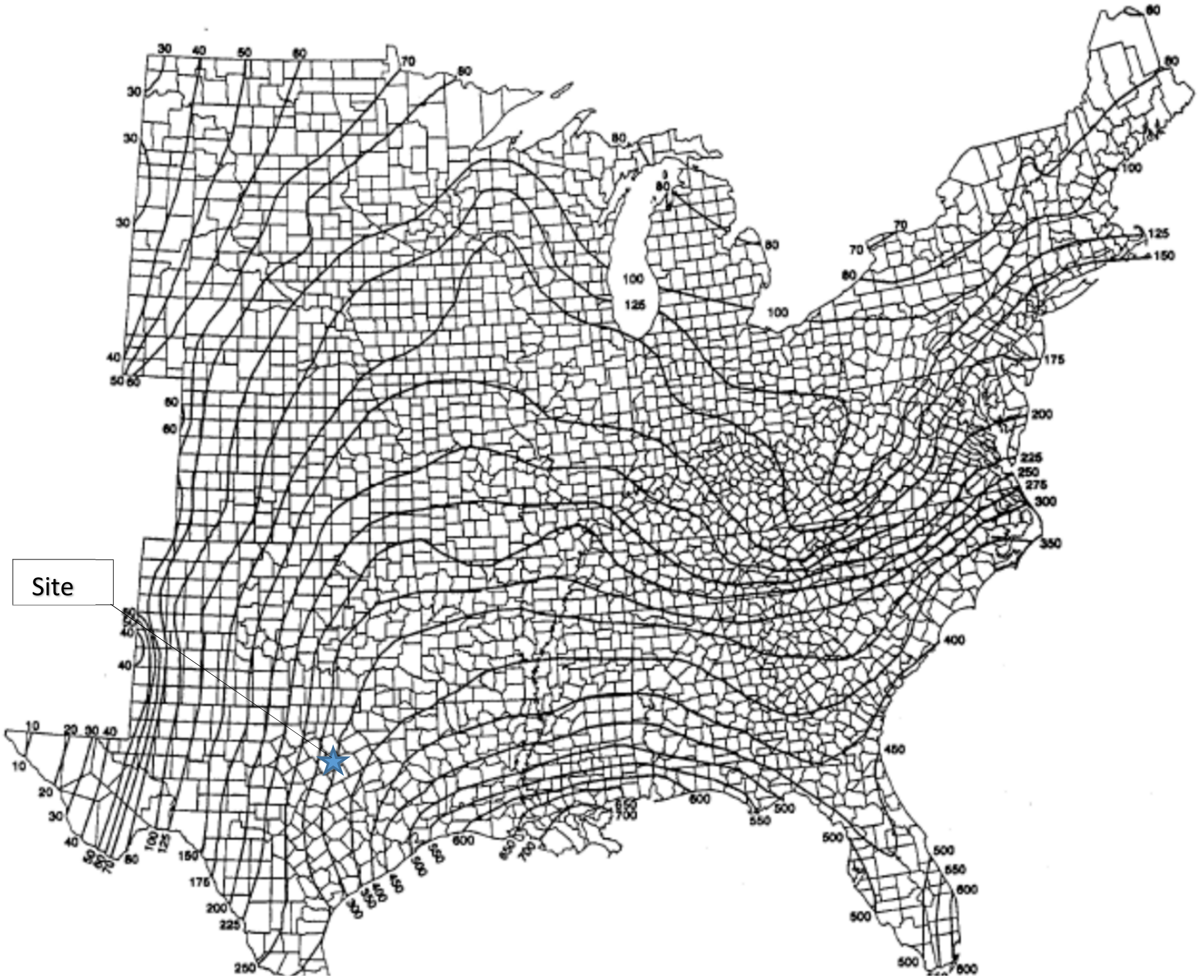

Figure 1. Isoerodent Map of Average Annual Rainfall Runoff Erosivity Factor, R.

Reference: USDA, Predicting Soil Erosion by Water: A Guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agricultural Research Service, Agriculture Handbook Number 703, 1997.

Soil Map—McLennan County, Texas

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
BrB	0-5	10-18	1.45-1.60	0.6-2.0	0.11-0.20	5.6-7.3	<2	Low	0.43	5	5	1-2
Bremond	5-24	40-50	1.35-1.50	<0.06	0.14-0.18	5.6-7.3	<2	High	0.32			
	24-55	30-50	1.40-1.65	<0.06	0.15-0.18	6.1-8.4	<2	High	0.32			
	55-80	27-50	1.40-1.65	<0.06	0.15-0.18	6.6-8.4	2-8	High	0.32			
BuA	0-24	40-60	1.35-1.50	<0.06	0.12-0.18	6.1-8.4	<2	Very high	0.32	5	4	1-3
Burleson	24-40	40-60	1.40-1.55	<0.06	0.12-0.18	6.1-8.4	0-4	Very high	0.32			
	40-80	35-60	1.40-1.55	<0.06	0.12-0.18	7.4-8.4	0-4	Very high	0.32			
CaB	0-15	2-12	1.40-1.60	2.0-6.0	0.06-0.10	5.6-7.3	<2	Low	0.20	5	2	<1
Chazos	15-40	35-50	1.35-1.50	0.06-0.2	0.10-0.18	5.6-6.5	<2	Moderate	0.32			
	40-55	20-40	1.35-1.55	0.06-0.2	0.10-0.18	5.6-7.3	<2	Moderate	0.32			
	55-80	27-45	1.40-1.60	0.06-0.2	0.10-0.18	6.1-8.4	<2	Moderate	0.32			
CfB	0-5	40-60	1.30-1.55	<0.06	0.12-0.15	6.1-8.4	0	Very high	0.32	2	4	1-3
Crawford	5-38	40-60	1.30-1.55	<0.06	0.12-0.15	6.1-8.4	0-2	Very high	0.32			
	38-48	---	---	0.2-2.0	---	---	---	----------	----			
CrB	0-9	5-20	1.50-1.60	0.6-2.0	0.11-0.20	5.6-7.3	<2	Low	0.43	4	5	.5-2
Crockett	9-24	40-55	1.35-1.60	<0.06	0.08-0.14	5.6-7.3	<4	High	0.32			
	24-36	35-55	1.40-1.65	<0.06	0.08-0.14	6.1-8.4	<4	High	0.32			
	36-55	20-50	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	Moderate	0.32			
	55-80	30-60	1.50-1.70	<0.06	0.11-0.15	6.1-8.4	<4	High	0.32			
DeB	0-14	35-57	1.18-1.32	0.06-0.2	0.12-0.18	7.9-8.4	<2	High	0.32	3	4	1-4
Denton	14-22	35-55	1.28-1.50	0.06-0.2	0.12-0.18	7.9-8.4	<2	High	0.32			
	22-36	20-37	1.40-1.65	0.6-2.0	0.11-0.14	7.9-8.4	<2	Moderate	0.43			
	36-52	12-35	1.40-1.65	0.6-2.0	0.08-0.12	7.9-8.4	<2	Moderate	0.43			
	52-60	---	---	0.06-2.0	---	---	---	----------	----			
DsC	0-7	2-12	1.30-1.60	6.0-20	0.05-0.08	5.1-7.3	0	Low	0.20	5	2	.3-1
Desan	7-65	2-12	1.30-1.60	6.0-20	0.05-0.08	5.1-7.3	0	Low	0.17			
	65-80	12-25	1.35-1.65	0.6-2.0	0.12-0.16	5.1-6.5	0	Low	0.24			
DuB	0-8	3-12	1.30-1.60	6.0-20	0.05-0.10	5.6-7.3	<2	Low	0.20	5	2	<1
Dutek	8-30	3-12	1.30-1.60	6.0-20	0.05-0.10	5.6-7.3	<2	Low	0.20			
	30-58	18-35	1.30-1.65	0.6-2.0	0.12-0.17	4.5-6.5	<2	Low	0.24			
	58-80	5-20	1.30-1.60	2.0-20	0.05-0.10	4.5-6.5	<2	Low	0.20			
EcB	0-4	40-60	1.35-1.55	0.2-0.6	0.05-0.12	7.4-8.4	0-2	Moderate	0.15	1	8	2-11
Eckrant	4-15	40-60	1.35-1.60	0.2-0.6	0.05-0.12	7.4-8.4	0-2	Moderate	0.10			
	15-40	---	---	0.06-2.0	---	---	---	----------	----			
EdD	0-4	20-40	1.30-1.50	0.6-2.0	0.10-0.13	7.9-8.4	<2	Low	0.24	1	8	<2
Eddy	4-8	20-40	1.30-1.50	0.6-2.0	0.03-0.07	7.9-8.4	<2	Low	0.24			
	8-20	---	---	0.06-2.0	---	---	---	----------	----			
EeD*:												
Eddy	0-4	20-40	1.30-1.50	0.6-2.0	0.10-0.13	7.9-8.4	<2	Low	0.24	1	8	<2
	4-10	20-40	1.30-1.50	0.6-2.0	0.03-0.07	7.9-8.4	<2	Low	0.24			
	10-20	---	---	0.06-2.0	---	---	---	----------	----			
Urban land.												
EsE	0-4	40-50	1.35-1.55	<0.06	0.12-0.18	6.6-8.4	<2	High	0.32	3	4	1-3
Ellis	4-28	40-60	1.35-1.55	<0.06	0.12-0.18	6.6-8.4	<2	High	0.32			
	28-60	40-60	1.40-1.65	<0.06	0.10-0.15	6.6-8.4	<2	High	0.32			

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors		Wind erodi- bility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
FaB Fairlie	0-5	35-50	1.35-1.50	<0.06	0.14-0.20	7.4-8.4	0-2	High	0.32	4	4	1-4
	5-32	40-60	1.40-1.55	<0.06	0.14-0.20	7.4-8.4	0-2	High	0.32			
	32-42	40-60	1.40-1.60	<0.06	0.14-0.20	7.4-8.4	0-2	High	0.32			
	42-60	---	---	0.06-2.0	---	---	---	---	---			
FbB*:												
Fairlie	0-14	35-50	1.35-1.50	<0.06	0.14-0.20	7.4-8.4	0-2	High	0.32	4	4	1-4
	14-32	40-60	1.40-1.55	<0.06	0.14-0.20	7.4-8.4	0-2	High	0.32			
	32-45	40-60	1.40-1.60	<0.06	0.14-0.20	7.4-8.4	0-2	High	0.32			
	45-60	---	---	0.06-2.0	---	---	---	---	---			
Urban land.												
FeE2 Ferris	0-6	40-65	1.40-1.50	<0.06	0.15-0.18	7.9-8.4	0-2	Very high	0.32	4	4	.5-2
	6-38	40-65	1.40-1.50	<0.06	0.12-0.18	7.9-8.4	0-2	Very high	0.32			
	38-60	40-75	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	0-2	High	0.32			
Fr Frio	0-4	30-50	1.25-1.45	0.2-0.6	0.14-0.20	7.9-8.4	<2	Moderate	0.32	5	4	1-4
	4-42	30-50	1.25-1.45	0.2-0.6	0.14-0.20	7.9-8.4	<2	Moderate	0.32			
	42-80	35-50	1.30-1.55	0.2-0.6	0.14-0.20	7.9-8.4	<2	Moderate	0.32			
Ga Gaddy	0-8	5-15	1.35-1.50	6.0-20	0.07-0.11	7.4-8.4	0	Low	0.17	5	2	0-.5
	8-80	5-35	1.50-1.70	6.0-20	0.06-0.10	7.9-8.4	0	Low	0.17			
GhD Gholson	0-8	5-20	1.35-1.55	2.0-6.0	0.11-0.17	6.1-7.3	<2	Low	0.37	5	3	<2
	8-48	20-35	1.50-1.65	0.6-2.0	0.15-0.19	6.1-7.8	<2	Low	0.37			
	48-72	5-20	1.50-1.65	2.0-6.0	0.12-0.16	6.6-8.4	<2	Low	0.37			
	72-80	5-20	1.50-1.65	2.0-6.0	0.07-0.15	6.6-8.4	<2	Low	0.32			
Go Gowen	0-12	27-30	1.35-1.50	0.6-2.0	0.15-0.20	6.6-8.4	0-2	Moderate	0.28	5	6	1-4
	12-80	20-35	1.40-1.60	0.6-2.0	0.15-0.20	6.6-8.4	0-2	Moderate	0.28			
HeB Heiden	0-6	40-60	1.30-1.50	<0.06	0.15-0.20	7.9-8.4	0-2	Very high	0.32	5	4	1-4
	6-35	40-60	1.35-1.55	<0.06	0.14-0.18	7.9-8.4	0-2	Very high	0.32			
	35-55	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	0-2	Very high	0.32			
	55-80	40-60	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	0-2	Very high	0.32			
HeC Heiden	0-6	40-60	1.30-1.50	<0.06	0.15-0.20	7.9-8.4	0-2	Very high	0.32	5	4	1-4
	6-22	40-60	1.35-1.55	<0.06	0.14-0.18	7.9-8.4	0-2	Very high	0.32			
	22-52	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	0-2	Very high	0.32			
	52-80	40-60	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	0-2	Very high	0.32			
HeD Heiden	0-6	40-60	1.30-1.50	<0.06	0.15-0.20	7.9-8.4	0-2	Very high	0.32	5	4	1-4
	6-14	40-60	1.35-1.55	<0.06	0.14-0.18	7.9-8.4	0-2	Very high	0.32			
	14-50	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	0-2	Very high	0.32			
	50-80	40-60	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	0-2	Very high	0.32			
HgB Heiden	0-6	40-60	1.30-1.50	<0.06	0.11-0.18	7.9-8.4	0-2	High	0.20	5	4	1-4
	6-38	40-60	1.35-1.55	<0.06	0.14-0.18	7.9-8.4	0-2	Very high	0.32			
	38-55	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	0-2	Very high	0.32			
	55-80	40-60	1.45-1.65	<0.06	0.11-0.15	7.9-8.4	0-2	Very high	0.32			
HoB Houston Black	0-6	50-60	1.20-1.40	<0.06	0.15-0.20	7.4-8.4	0-2	Very high	0.32	5	4	1-5
	6-35	50-60	1.25-1.50	<0.06	0.12-0.18	7.4-8.4	0-2	Very high	0.32			
	35-80	45-65	1.30-1.55	<0.06	0.10-0.16	7.4-8.4	0-4	Very high	0.32			
KrC Krum	0-6	35-55	1.35-1.55	0.2-0.6	0.15-0.20	7.4-8.4	0-2	High	0.32	5	4	1-3
	6-42	40-60	1.25-1.50	0.2-0.6	0.12-0.18	7.9-8.4	0-2	High	0.32			
	42-80	35-60	1.30-1.55	0.2-0.6	0.07-0.18	7.9-8.4	0-2	High	0.32			

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
LaD	0-6	20-35	1.25-1.40	0.6-2.0	0.12-0.15	7.9-8.4	<2	Moderate	0.32	5	4L	1-3
Lamar	6-44	20-35	1.30-1.50	0.6-2.0	0.12-0.15	7.9-8.4	<2	Moderate	0.32			
	44-80	20-35	1.35-1.60	0.6-2.0	0.12-0.15	7.9-8.4	<2	Moderate	0.32			
LeB	0-20	28-45	1.20-1.40	0.6-2.0	0.16-0.20	7.9-8.4	<2	High	0.32	5	4L	1-3
Lewisville	20-52	30-45	1.20-1.45	0.6-2.0	0.14-0.18	7.9-8.4	<2	High	0.37			
	52-80	30-50	1.30-1.50	0.6-2.0	0.14-0.18	7.9-8.4	<2	High	0.37			
LoB	0-12	35-50	1.20-1.40	0.2-0.6	0.15-0.20	7.9-8.4	<2	High	0.32	4	4L	1-3
Lott	12-52	35-50	1.25-1.45	0.2-0.6	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
	52-80	16-35	1.30-1.60	0.6-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
LoD	0-16	35-50	1.20-1.40	0.2-0.6	0.15-0.20	7.9-8.4	<2	High	0.32	4	4L	1-3
Lott	16-44	35-50	1.25-1.45	0.2-0.6	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
	44-60	16-35	1.30-1.60	0.6-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
MaA	0-10	10-25	1.50-1.65	0.6-2.0	0.11-0.15	5.6-7.3	0-2	Low	0.43	5	3	1-2
Mabank	10-65	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	0-2	High	0.32			
	65-80	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	2-8	High	0.32			
MbA*:												
Mabank	0-7	10-25	1.50-1.65	0.6-2.0	0.11-0.15	6.1-7.3	0-2	Low	0.43	5	3	1-2
	7-60	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	0-2	High	0.32			
	60-80	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	2-8	High	0.32			
Bremond	0-8	10-18	1.45-1.60	0.6-2.0	0.11-0.20	5.6-7.3	<2	Low	0.43	5	5	1-2
	8-60	40-50	1.35-1.50	<0.06	0.14-0.18	5.6-7.3	<2	High	0.32			
	60-80	27-50	1.40-1.65	<0.06	0.15-0.18	6.6-8.4	2-8	High	0.32			
McE	0-7	35-40	1.20-1.40	0.2-0.6	0.15-0.20	7.9-8.4	<2	Moderate	0.32	4	4L	<2
McLennan	7-32	35-50	1.20-1.50	0.2-0.6	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
	32-80	35-65	1.30-1.60	0.2-0.6	0.08-0.15	7.9-8.4	<2	High	0.32			
MnB	0-8	10-20	1.40-1.55	2.0-6.0	0.10-0.15	6.1-7.8	<2	Low	0.24	5	3	.1-1
Minwells	8-38	35-45	1.35-1.60	0.06-0.2	0.11-0.16	6.1-7.8	<2	Moderate	0.32			
	38-60	20-35	1.35-1.60	0.2-0.6	0.10-0.16	6.6-8.4	<2	Moderate	0.32			
	60-80	3-25	1.35-1.60	2.0-6.0	0.01-0.09	6.6-8.4	<2	Low	0.15			
MnC2	0-4	10-20	1.40-1.55	2.0-6.0	0.10-0.15	6.1-7.8	<2	Low	0.24	5	3	.1-1
Minwells	4-28	35-45	1.35-1.60	0.06-0.2	0.11-0.16	6.1-7.8	<2	Moderate	0.32			
	28-60	20-35	1.35-1.60	0.2-0.6	0.10-0.16	6.6-8.4	<2	Moderate	0.32			
	60-80	3-25	1.35-1.60	2.0-6.0	0.01-0.09	6.6-8.4	<2	Low	0.15			
OgB	0-18	40-50	1.25-1.45	0.06-0.2	0.13-0.18	6.6-7.8	<2	High	0.32	1	4	1-3
Oglesby	18-35	---	---	0.06-2.0	---	---	---	----------	----			
Ov	0-20	40-55	1.40-1.50	0.06-0.2	0.15-0.20	7.9-8.4	0-2	High	0.32	5	4	1-3
Ovan	20-80	40-55	1.40-1.50	<0.06	0.15-0.20	7.9-8.4	0-2	High	0.32			
PcB	0-8	20-30	1.40-1.60	0.2-0.6	0.15-0.20	6.1-7.3	<2	Moderate	0.37	5	6	1-3
Payne	8-30	35-55	1.40-1.55	<0.06	0.12-0.18	6.1-7.8	<2	Moderate	0.32			
	30-72	35-55	1.45-1.60	<0.06	0.12-0.18	7.9-8.4	<2	Moderate	0.32			
Pg*, Pr*.												
Pits												
PvB	0-9	40-55	1.25-1.45	0.2-0.6	0.12-0.18	7.9-8.4	0-2	High	0.32	1	4	1-4
Purves	9-15	35-55	1.25-1.45	0.2-0.6	0.08-0.18	7.9-8.4	0-2	High	0.15			
	15-35	---	---	0.06-2.0	---	---	---	----------	----			

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
QuC--------------	0-12	22-35	1.25-1.42	0.6-2.0	0.14-0.19	7.9-8.4	0-2	Moderate	0.32	2	4L	1-3
Queeny	12-20	---	---	0.01-0.6	---	---	---	----------	----			
	20-60	---	---	0.2-2.0	---	---	---	----------	----			
ReF*:												
Real------------	0-6	22-40	1.25-1.55	0.6-2.0	0.05-0.10	7.9-8.4	0	Low-------	0.15	2	8	1-4
	6-14	22-40	1.25-1.55	0.6-2.0	0.05-0.10	7.9-8.4	0	Low-------	0.10			
	14-40	---	---	0.2-2.0	---	---	---	----------	----			
Rock outcrop.												
RgB--------------	0-16	5-15	1.40-1.60	2.0-6.0	0.04-0.10	6.1-7.3	<2	Low-------	0.10	4	8	.5-2
Riesel	16-48	35-55	1.35-1.50	0.06-0.2	0.05-0.12	5.6-7.3	<2	Moderate	0.17			
	48-55	35-55	1.40-1.55	0.06-0.2	0.05-0.16	5.6-7.3	<2	Moderate	0.17			
	55-80	3-12	1.45-1.65	6.0-20	0.03-0.05	6.6-8.4	<2	Low-------	0.10			
SaB--------------	0-18	45-60	1.30-1.45	<0.06	0.12-0.16	7.4-8.4	0-2	High------	0.32	2	4	1-4
San Saba	18-38	45-60	1.30-1.50	<0.06	0.12-0.16	7.4-8.4	0-2	High------	0.32			
	38-48	---	---	0.06-2.0	---	---	---	----------	----			
SgB--------------	0-6	40-60	1.40-1.55	<0.06	0.12-0.18	7.9-8.4	0-2	High------	0.32	4	4	1-3
Sanger	6-34	40-60	1.40-1.55	<0.06	0.12-0.18	7.9-8.4	0-2	High------	0.32			
	34-66	40-60	1.40-1.55	<0.06	0.12-0.18	7.9-8.4	0-2	High------	0.32			
	66-80	40-60	1.40-1.60	<0.06	0.12-0.18	7.9-8.4	0-2	High------	0.32			
Sh---------------	0-10	60-80	1.20-1.40	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32	5	4	.5-3
Ships	10-74	60-80	1.20-1.40	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32			
	74-80	35-80	1.25-1.50	<0.06	0.12-0.18	7.9-8.4	<2	Very high	0.32			
SsB--------------	0-20	40-60	1.25-1.55	<0.06	0.15-0.18	7.4-8.4	0-2	High------	0.32	5	4	1-4
Slidell	20-37	40-60	1.25-1.55	<0.06	0.15-0.18	7.4-8.4	0-2	High------	0.32			
	37-72	40-60	1.35-1.55	<0.06	0.13-0.18	7.4-8.4	0-2	High------	0.32			
StC*:												
Stephen---------	0-8	40-55	1.35-1.55	0.2-0.6	0.10-0.15	7.9-8.4	<2	Moderate	0.32	2	4	1-4
	8-12	---	---	0.06-2.0	---	---	---	----------	----			
	12-28	---	---	0.06-2.0	---	---	---	----------	----			
Eddy------------	0-5	20-40	1.30-1.50	0.6-2.0	0.10-0.13	7.9-8.4	<2	Low-------	0.24	1	8	.5-2
	5-9	20-40	1.30-1.50	0.6-2.0	0.03-0.07	7.9-8.4	<2	Low-------	0.24			
	9-20	---	---	0.06-2.0	---	---	---	----------	----			
SuD*:												
Stephen---------	0-10	40-55	1.35-1.55	0.2-0.6	0.10-0.15	7.9-8.4	<2	Moderate	0.32	2	4	1-4
	10-15	---	---	0.06-2.0	---	---	---	----------	----			
	15-30	---	---	0.06-2.0	---	---	---	----------	----			
Urban land.												
SyB--------------	0-8	3-15	1.40-1.60	2.0-6.0	0.05-0.10	5.1-7.3	<2	Low-------	0.17	5	2	.5-2
Styx	8-27	3-15	1.40-1.60	2.0-6.0	0.05-0.10	5.1-7.3	<2	Low-------	0.17			
	27-80	25-35	1.30-1.65	0.6-2.0	0.12-0.16	5.1-6.5	<2	Low-------	0.24			
SzB--------------	0-19	20-40	1.30-1.50	0.6-2.0	0.11-0.16	7.9-8.4	<2	Moderate	0.28	5	4L	1-3
Sunev	19-80	20-40	1.40-1.60	0.6-2.0	0.11-0.16	7.9-8.4	<2	Low-------	0.28			
Tn---------------	0-5	40-60	1.40-1.50	0.06-0.2	0.15-0.20	7.4-8.4	0-2	Very high	0.32	5	4	1-4
Tinn	5-80	40-60	1.40-1.50	<0.06	0.13-0.18	7.4-8.4	0-2	Very high	0.32			

See footnote at end of table.

Table 14.--Physical and Chemical Properties of the Soils--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors		Wind erodi- bility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
To---------------	0-8	40-60	1.40-1.50	0.06-0.2	0.15-0.20	7.4-8.4	0-2	Very high	0.32	5	4	1-4
Tinn	8-80	40-60	1.40-1.50	<0.06	0.13-0.18	7.4-8.4	0-2	Very high	0.32			
Ur*.												
Urban land												
Wd---------------	0-6	8-26	1.20-1.35	0.6-2.0	0.12-0.20	7.9-8.4	0-2	Low-------	0.43	5	6	1-4
Weswood	6-60	10-20	1.30-1.55	0.6-2.0	0.12-0.20	7.9-8.4	0-2	Low-------	0.43			
	60-80	27-45	1.30-1.55	0.2-0.6	0.13-0.18	7.9-8.4	0-2	Moderate	0.32			
We---------------	0-8	27-35	1.20-1.35	0.6-2.0	0.12-0.20	7.9-8.4	0-2	Low-------	0.43	5	6	1-4
Weswood	8-60	10-20	1.30-1.55	0.6-2.0	0.12-0.20	7.9-8.4	0-2	Low-------	0.43			
	60-80	27-45	1.30-1.55	0.2-0.6	0.13-0.18	7.9-8.4	0-2	Moderate	0.32			
WnA--------------	0-8	27-35	1.35-1.50	0.2-0.6	0.10-0.17	5.6-7.3	0	Moderate	0.43	5	6	.5-2
Wilson	8-47	35-50	1.50-1.60	<0.06	0.12-0.15	5.6-7.8	0-4	High------	0.37			
	47-80	35-60	1.50-1.60	<0.06	0.12-0.15	6.6-8.4	2-8	High------	0.37			
Ya---------------	0-12	10-18	1.30-1.55	2.0-6.0	0.15-0.20	7.4-8.4	<2	Low-------	0.32	5	4L	.5-1
Yahola	12-28	5-18	1.40-1.70	2.0-6.0	0.11-0.20	7.9-8.4	<2	Low-------	0.32			
	28-80	5-18	1.50-1.70	2.0-6.0	0.07-0.20	7.9-8.4	<2	Low-------	0.32			
Yg*:												
Yahola----------	0-10	10-18	1.30-1.60	2.0-6.0	0.11-0.15	7.4-8.4	<2	Low-------	0.20	5	3	.5-1
	10-42	5-18	1.40-1.70	2.0-6.0	0.11-0.20	7.9-8.4	<2	Low-------	0.32			
	42-80	5-18	1.50-1.70	2.0-6.0	0.07-0.20	7.9-8.4	<2	Low-------	0.32			
Gaddy-----------	0-8	5-15	1.35-1.50	6.0-20	0.07-0.11	7.4-8.4	0	Low-------	0.17	5	2	0-.5
	8-80	5-35	1.50-1.70	6.0-20	0.06-0.10	7.9-8.4	0	Low-------	0.17			

* See description of the map unit for composition and behavior characteristics of the map unit.

Soil Type	Percent Area	K Factor
HeB	31.8%	0.32
HeD	47.1%	0.32
Ov	0.6%	0.32
RgB	20.5%	0.17
	100.0%	

Weighted Average: **0.2893**

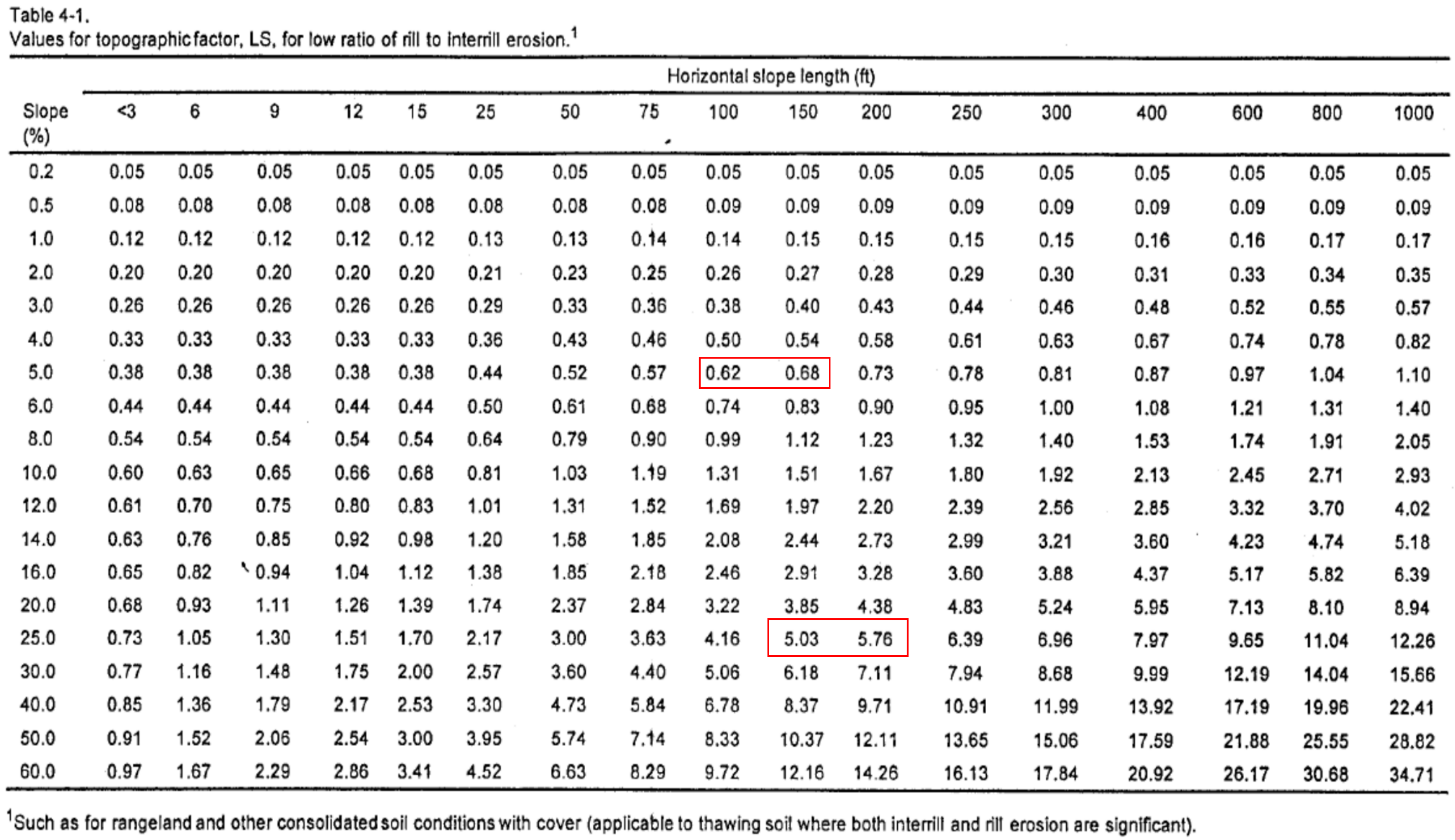

Table 4-1.
Values for topographic factor, LS, for low ratio of rill to interrill erosion.[1]

	Horizontal slope length (ft)															
Slope (%)	<3	6	9	12	15	25	50	75	100	150	200	250	300	400	600	800	1000
0.2	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
0.5	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
1.0	0.12	0.12	0.12	0.12	0.12	0.13	0.13	0.14	0.14	0.15	0.15	0.15	0.15	0.16	0.16	0.17	0.17
2.0	0.20	0.20	0.20	0.20	0.20	0.21	0.23	0.25	0.26	0.27	0.28	0.29	0.30	0.31	0.33	0.34	0.35
3.0	0.26	0.26	0.26	0.26	0.26	0.29	0.33	0.36	0.38	0.40	0.43	0.44	0.46	0.48	0.52	0.55	0.57
4.0	0.33	0.33	0.33	0.33	0.33	0.36	0.43	0.46	0.50	0.54	0.58	0.61	0.63	0.67	0.74	0.78	0.82
5.0	0.38	0.38	0.38	0.38	0.38	0.44	0.52	0.57	0.62	0.68	0.73	0.78	0.81	0.87	0.97	1.04	1.10
6.0	0.44	0.44	0.44	0.44	0.44	0.50	0.61	0.68	0.74	0.83	0.90	0.95	1.00	1.08	1.21	1.31	1.40
8.0	0.54	0.54	0.54	0.54	0.54	0.64	0.79	0.90	0.99	1.12	1.23	1.32	1.40	1.53	1.74	1.91	2.05
10.0	0.60	0.63	0.65	0.66	0.68	0.81	1.03	1.19	1.31	1.51	1.67	1.80	1.92	2.13	2.45	2.71	2.93
12.0	0.61	0.70	0.75	0.80	0.83	1.01	1.31	1.52	1.69	1.97	2.20	2.39	2.56	2.85	3.32	3.70	4.02
14.0	0.63	0.76	0.85	0.92	0.98	1.20	1.58	1.85	2.08	2.44	2.73	2.99	3.21	3.60	4.23	4.74	5.18
16.0	0.65	0.82	0.94	1.04	1.12	1.38	1.85	2.18	2.46	2.91	3.28	3.60	3.88	4.37	5.17	5.82	6.39
20.0	0.68	0.93	1.11	1.26	1.39	1.74	2.37	2.84	3.22	3.85	4.38	4.83	5.24	5.95	7.13	8.10	8.94
25.0	0.73	1.05	1.30	1.51	1.70	2.17	3.00	3.63	4.16	5.03	5.76	6.39	6.96	7.97	9.65	11.04	12.26
30.0	0.77	1.16	1.48	1.75	2.00	2.57	3.60	4.40	5.06	6.18	7.11	7.94	8.68	9.99	12.19	14.04	15.66
40.0	0.85	1.36	1.79	2.17	2.53	3.30	4.73	5.84	6.78	8.37	9.71	10.91	11.99	13.92	17.19	19.96	22.41
50.0	0.91	1.52	2.06	2.54	3.00	3.95	5.74	7.14	8.33	10.37	12.11	13.65	15.06	17.59	21.88	25.55	28.82
60.0	0.97	1.67	2.29	2.86	3.41	4.52	6.63	8.29	9.72	12.16	14.26	16.13	17.84	20.92	26.17	30.68	34.71

[1] Such as for rangeland and other consolidated soil conditions with cover (applicable to thawing soil where both interrill and rill erosion are significant).

Reference: USDA, Predicting Soil Erosion by Water: A guide to Conservation Planning with the Revised Universal Soil Loss Equation (RUSLE), Agricultural Research Service, Agriculture Handbook Number 703, 1997.

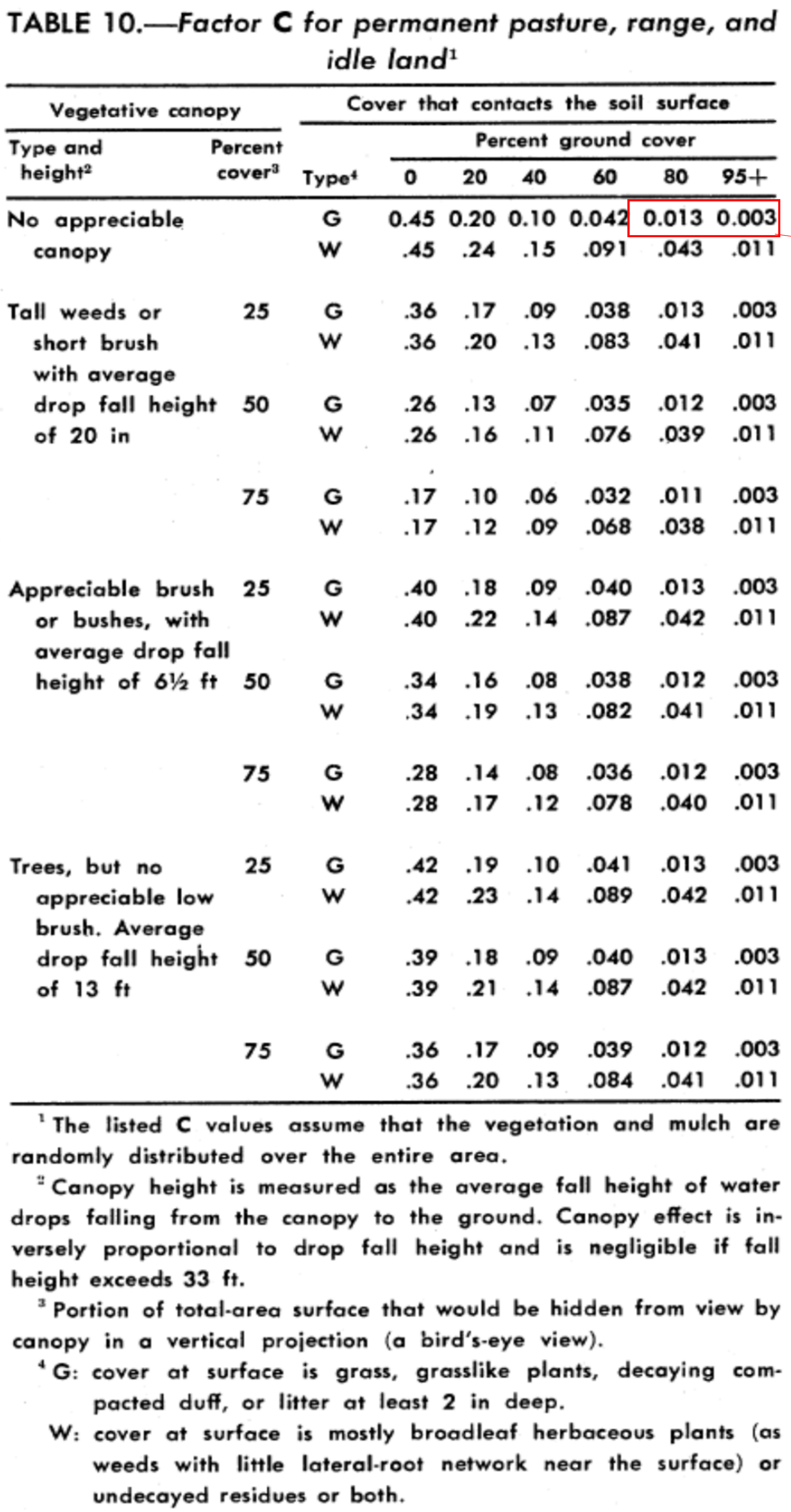

TABLE 10.—*Factor* C *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

---

[1] The listed C values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Final
Cover (use 0.06)

Reference: USDA, Predicting Rainfall Erosion Losses, A Guide to Conservation Planning, Agriculture Handbook Number 537, 1978.

Table 3 P Factors for Contouring, Contour Stripcropping and Terracing

Land Slope	P values	
%	Contouring†	Terracing†
2.0 to 7	0.50	0.50
8.0 to 12	0.60	0.60
13.0 to 18	0.80	0.80
19.0 to 24	0.90	0.90

(This table appeared in SCS (5), p.9)

† Contouring and terracing columns are suitable for MSWLF cover. Contour stripcropping is not suitable for the type of vegetative cover normally practiced at municipal landfills.

Table 4 Guide for Assigning Soil Loss Tolerance Values (T)
to Solid Having Different Rooting Depths

Rooting Depth	Soil Loss Tolerance Values Annual Soil Loss - (Tons/Acre)
Inches	Non-Renewable Soil a/
10 - 20	1
20 - 40	2
40 - 50	3
50 - 60	4
60 +	< 5

(This table appears in SCS (6) p.4)

a/ Soils with unfavorable substrata such as rock or soft rock that cannot be renewed by economical means. Most of the MSWLF covers with constructed, or recompacted clay cap and/or flexible membrane should use this performance criteria.