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

Cell 3 Compliance Demonstration

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STATE OF TEXAS
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LICENSED PROFESSIONAL ENGINEER

6/7/21

SCS ENGINEERS

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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 1×10^{-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.**

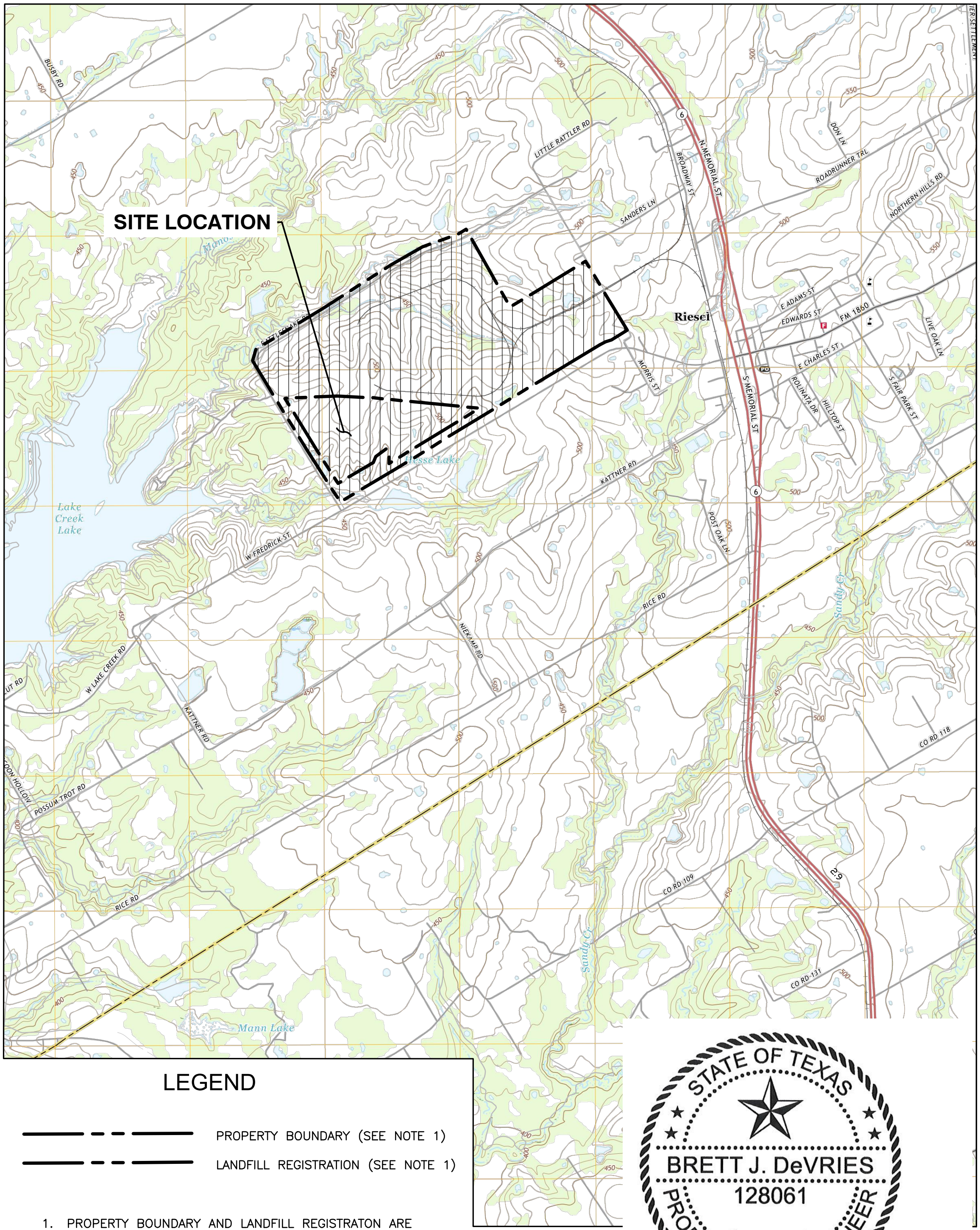
“(f) Upon completion of construction of the CCR landfill or any lateral expansion of a CCR landfill, the owner or operator must obtain a certification from a qualified professional engineer or approval from the Participating State Director or approval from EPA where EPA is the permitting authority that 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



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.

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128061

6/7/21

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

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SCALE IN FEET

QUADRANGLE LOCATION

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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
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DWN. BY: ORA
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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.

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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
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SITE LOCATION MAP

DATE:
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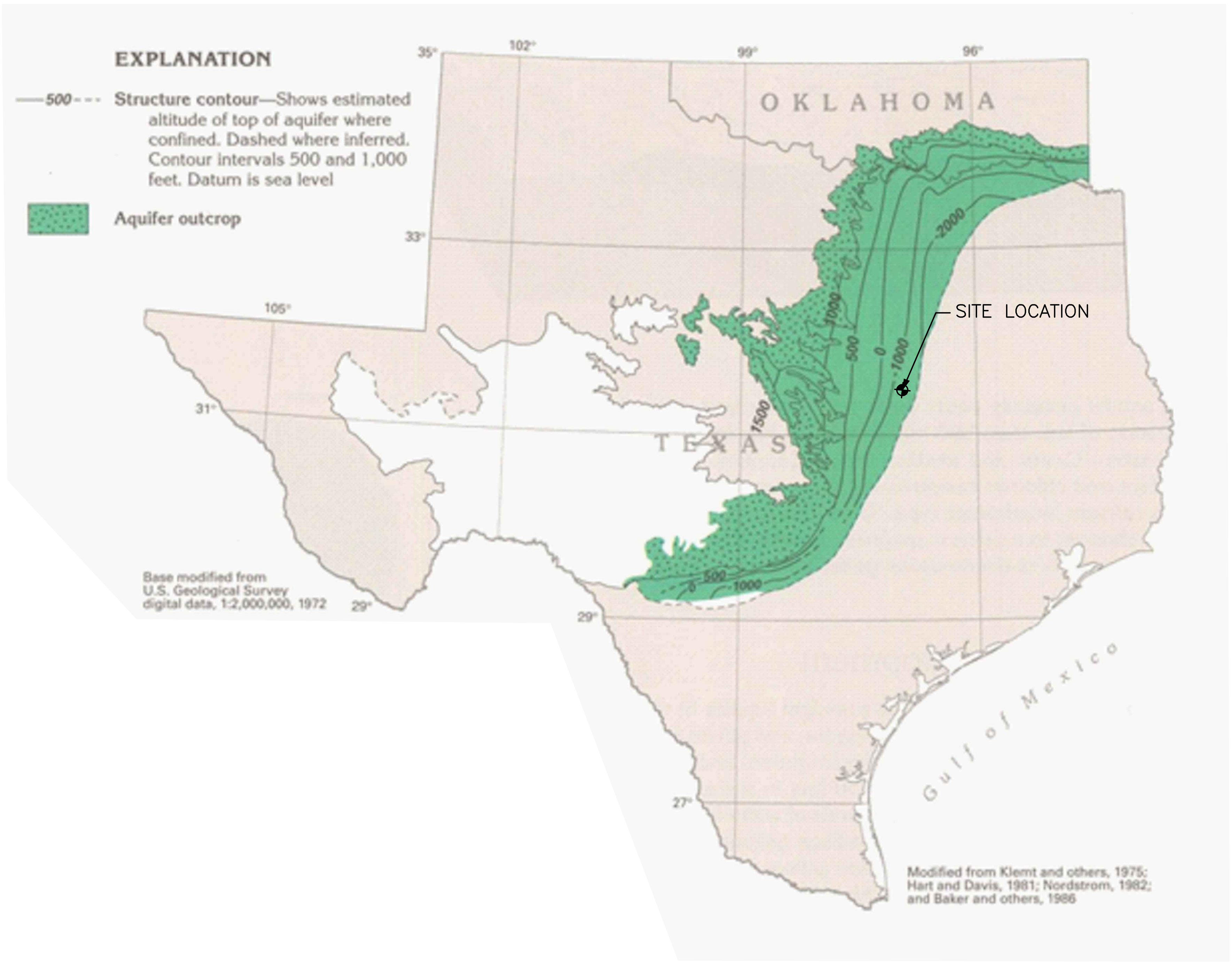
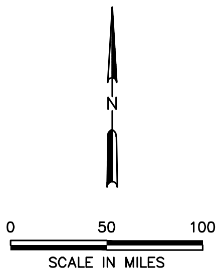
FIGURE NO.
2





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

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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
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DATE: 02/2021
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FIGURE NO. **3**

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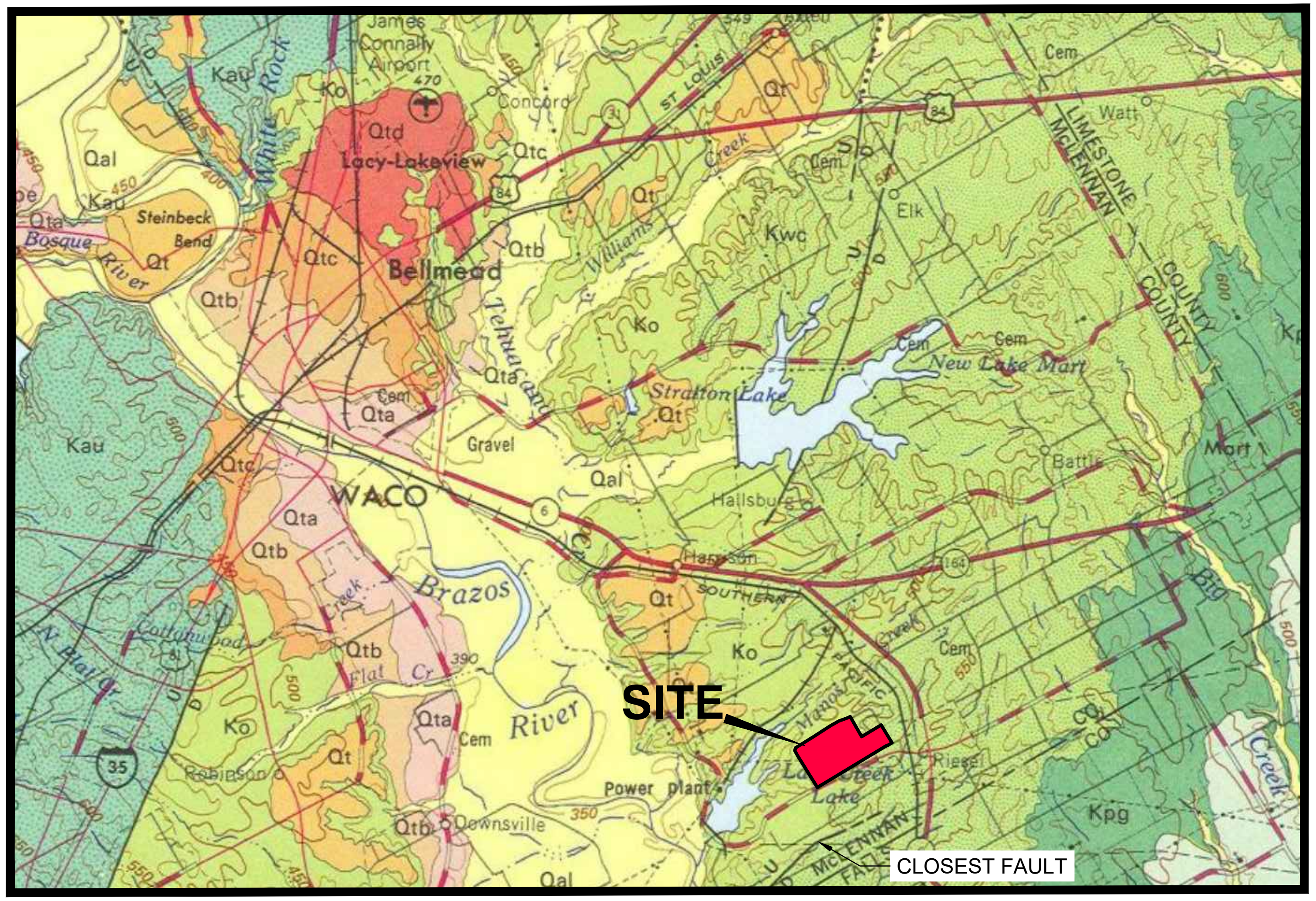
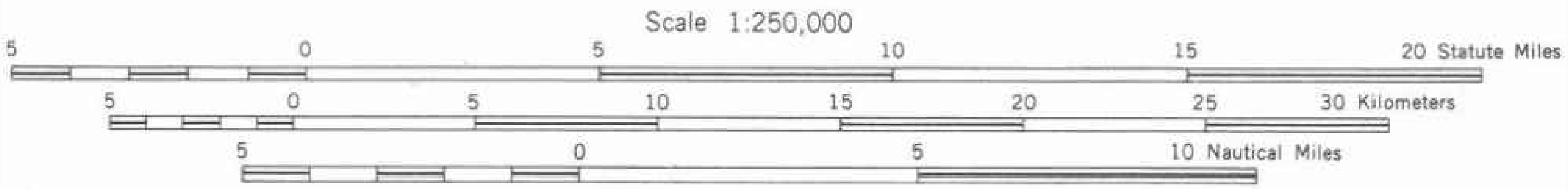
2/19/2021 7:59 AM \\BED-FS02\Data\Civil 3D Projects\CADD\SANDY CREEK\12220089.00 T20_DWG\EXH - Geologic Map





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

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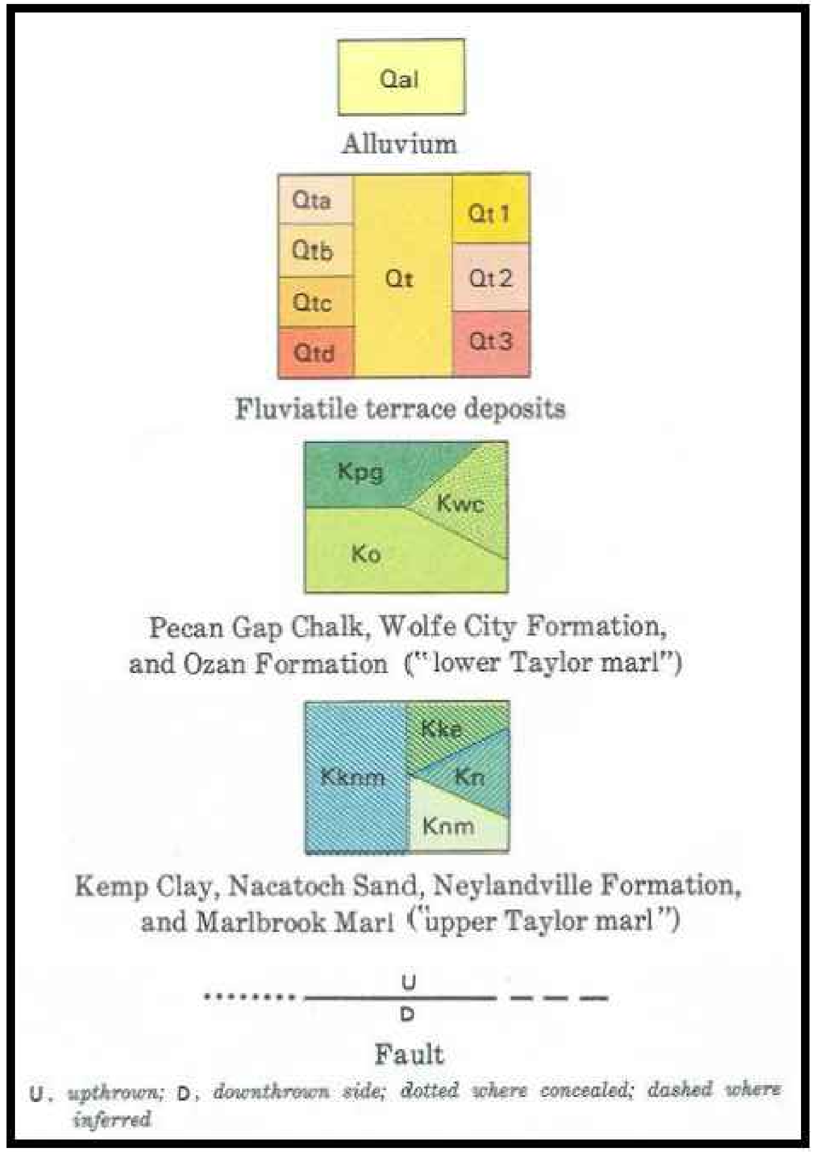
128061

6/7/21

EXPLANATION



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
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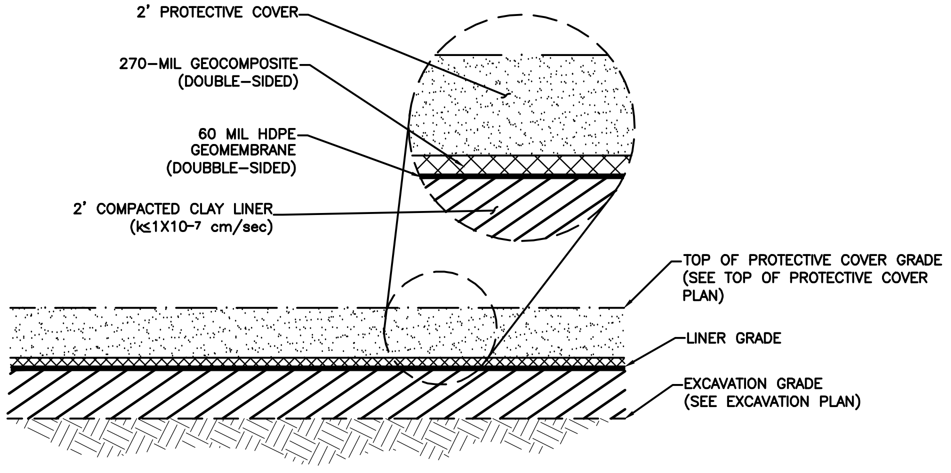
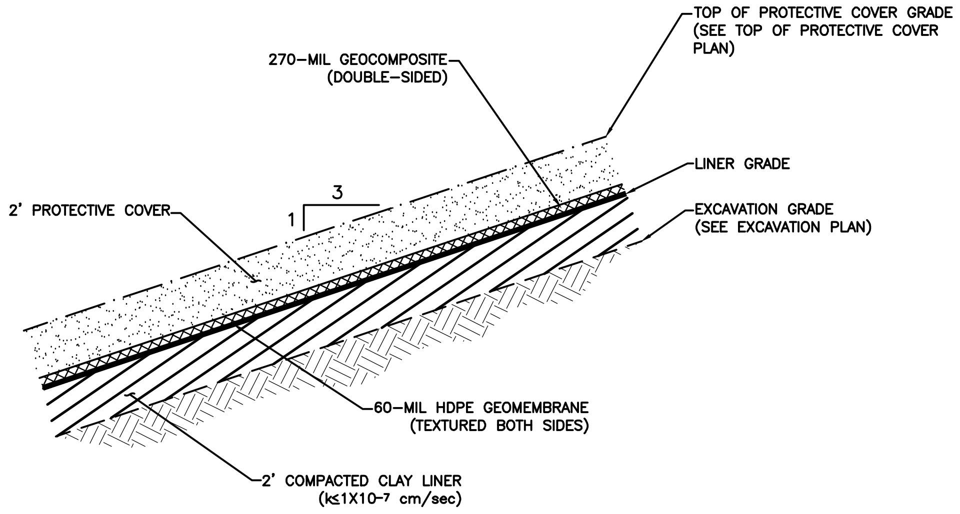
FIGURE NO. 4



BOTTOM LINER

NTS



SIDESLOPE LINER

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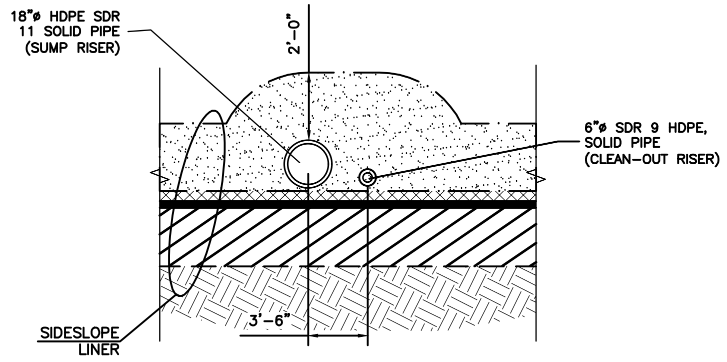

SUMP RISER PIPE COVER

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.

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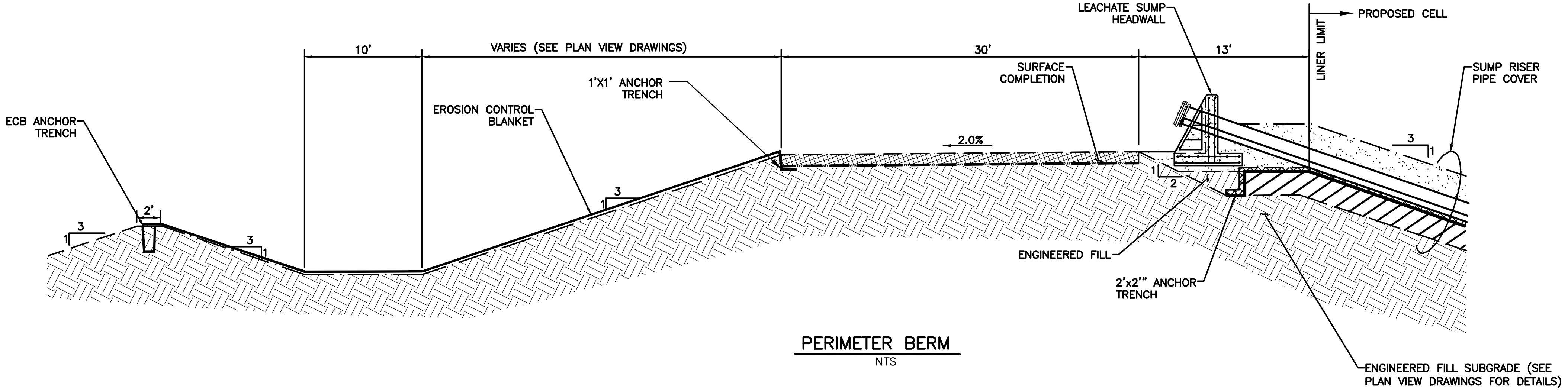
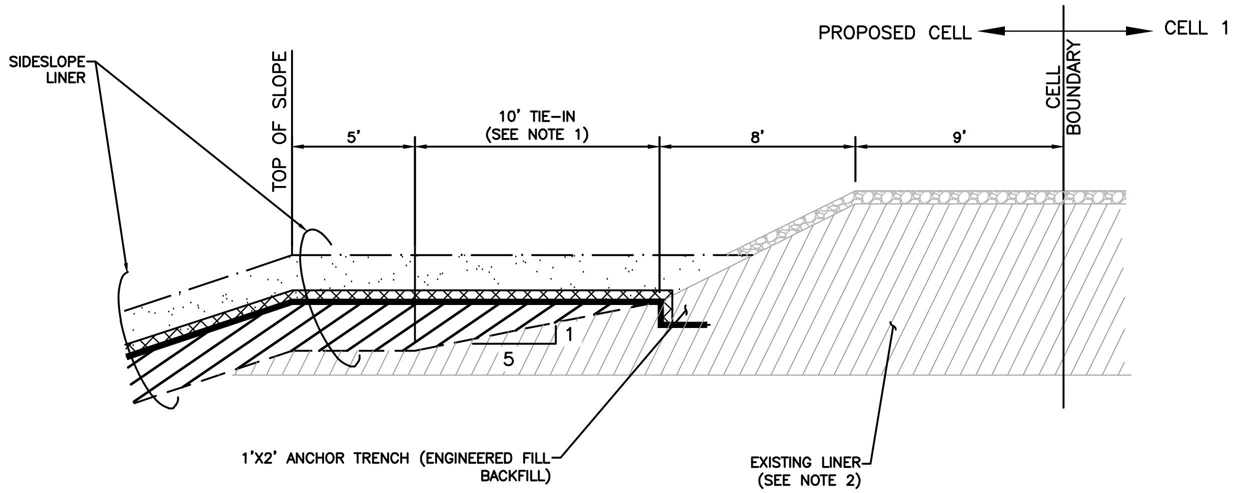


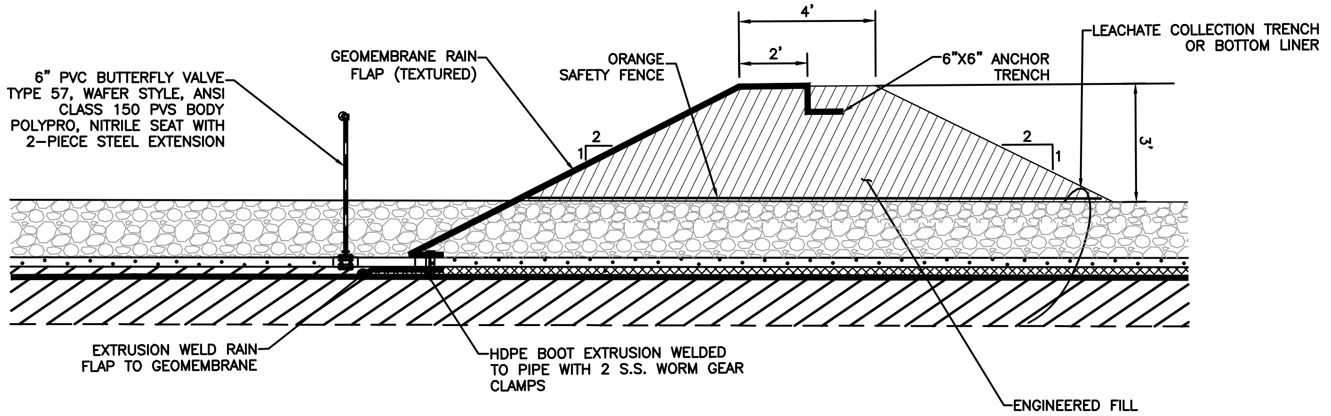
PERIMETER BERM

NTS



LINER TIE-IN

NTS



INTERCELL BERM

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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
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FIGURE NO.
5

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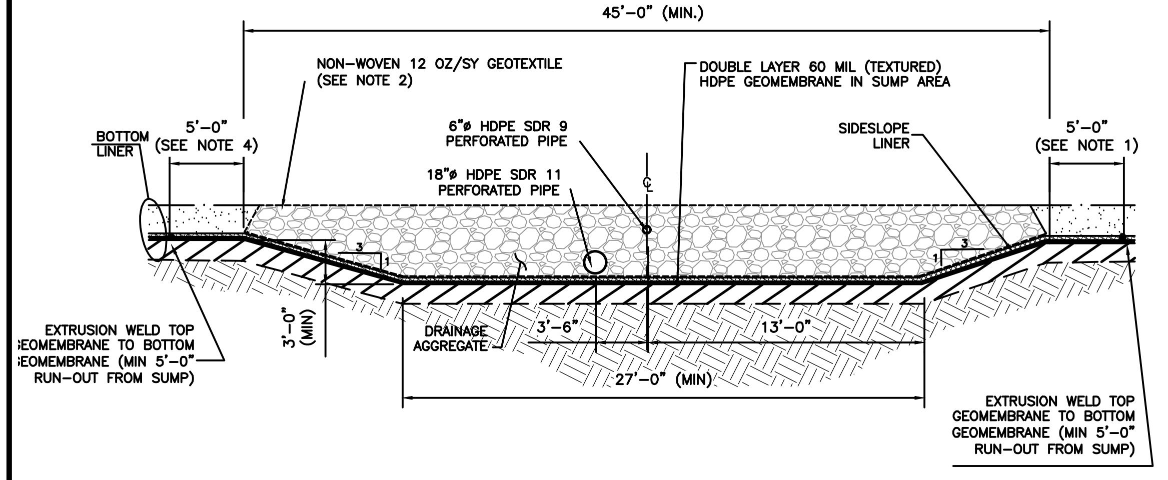
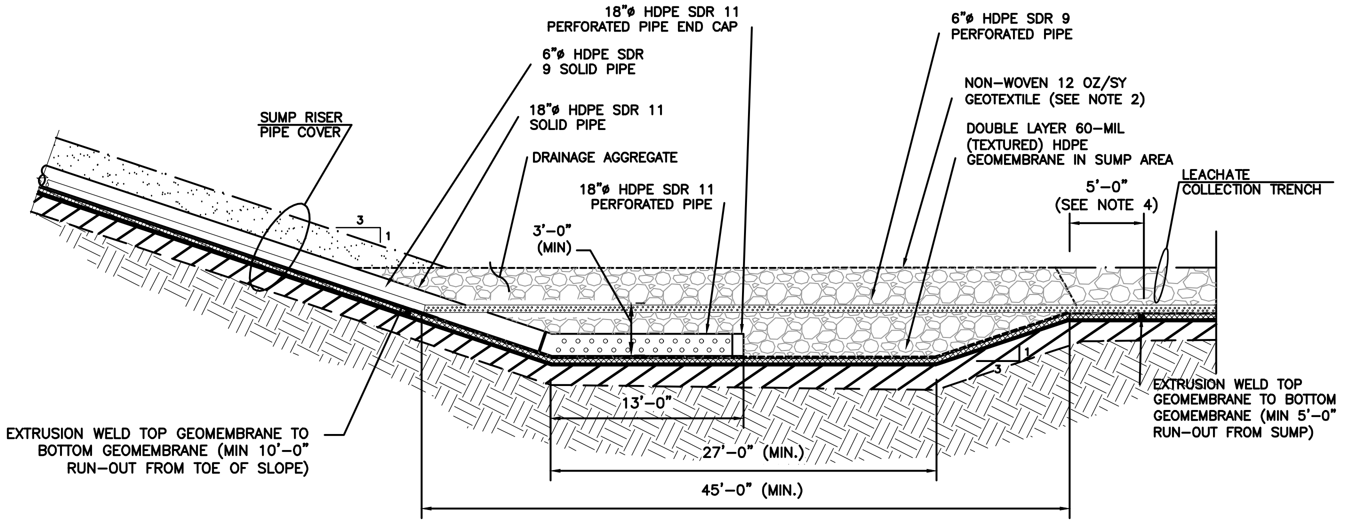
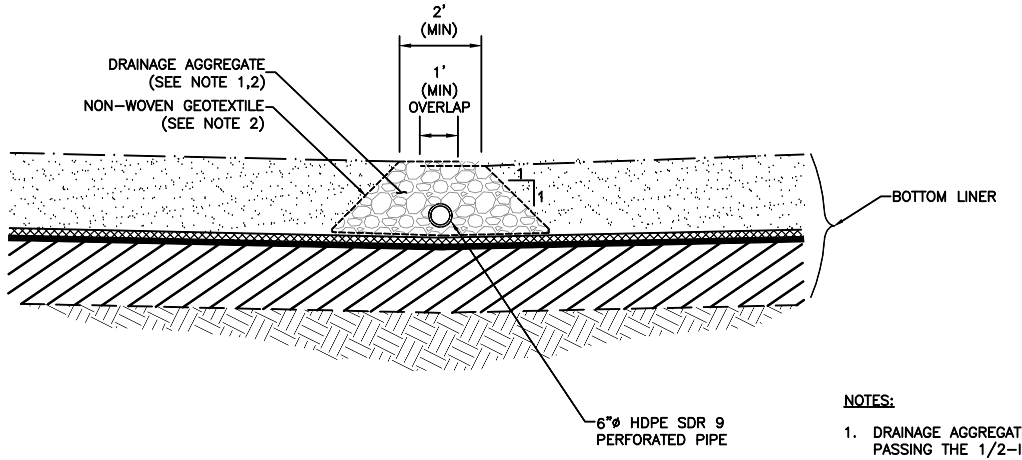


TRANSVERSAL VIEW

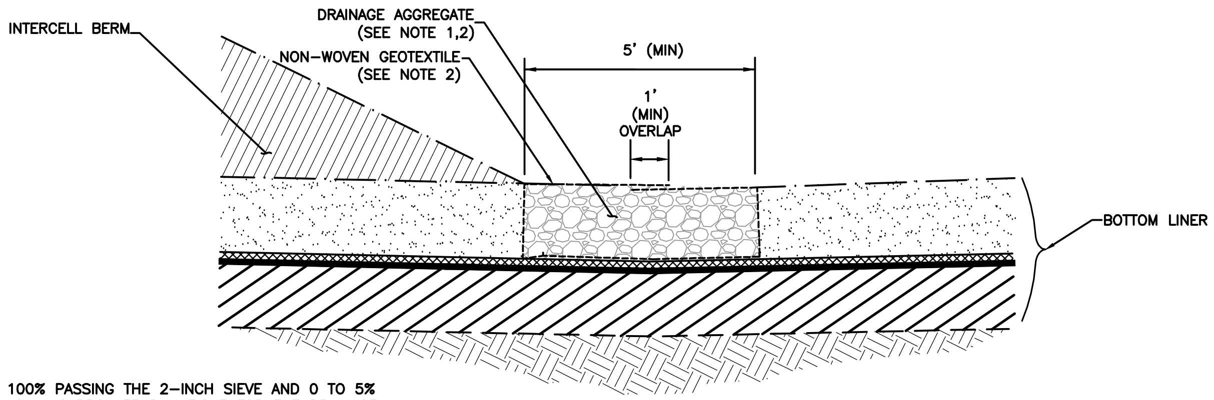


LONGITUDINAL VIEW

LEACHATE COLLECTION SUMP
NTS



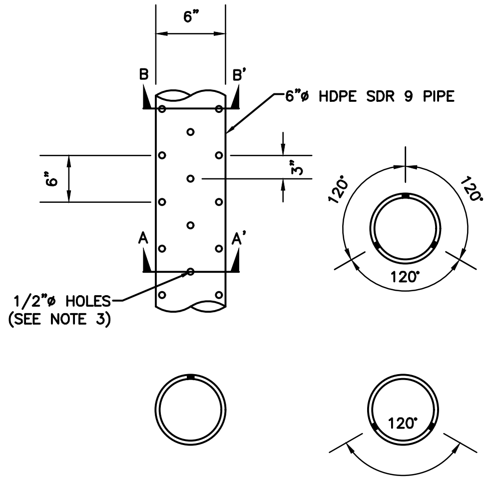
LEACHATE COLLECTION TRENCH
NTS



CHIMNEY DRAIN
NTS

NOTES:

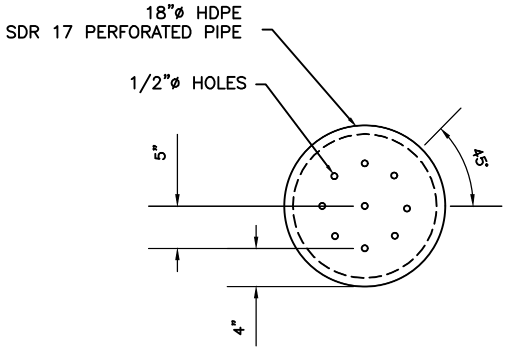
1. DRAINAGE AGGREGATE SHALL HAVE A GRADATION OF 100% PASSING THE 2-INCH SIEVE AND 0 TO 5% PASSING THE 1/2-INCH SIEVE. THE PERCENT OF CALCIUM CARBONATE BY WEIGHT FOR THE DRAINAGE AGGREGATE SHALL NOT EXCEED 15 PERCENT, AS DETERMINED BY JLT-S-105-89 OR ASTM D3042 MODIFIED.
2. DRAINAGE AGGREGATE SHALL BE 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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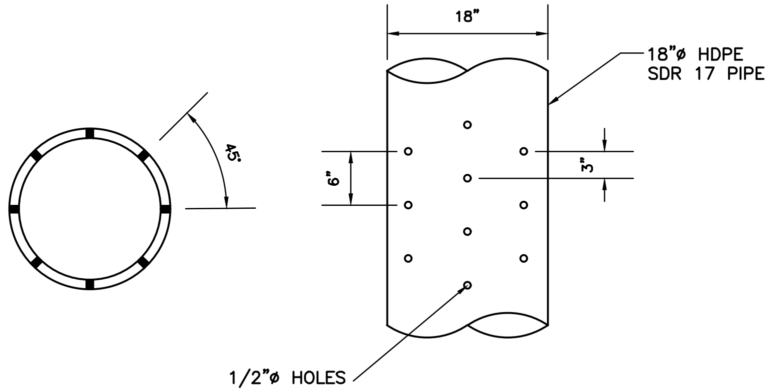
128061
6/1/21



18"ø HDPE SDR 17 PERFORATION
NTS

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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
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02/2021

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FIGURE NO.
6

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

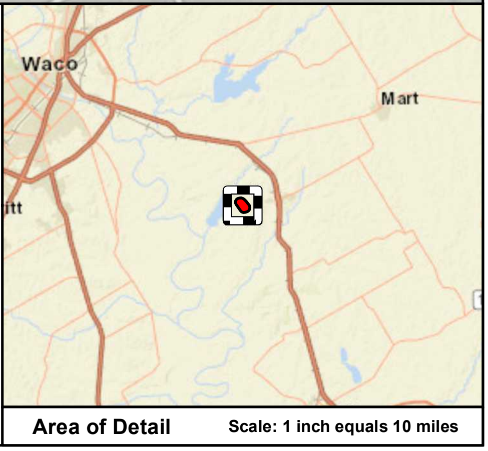
1 in = 1,000 feet

Feet
0 1,000

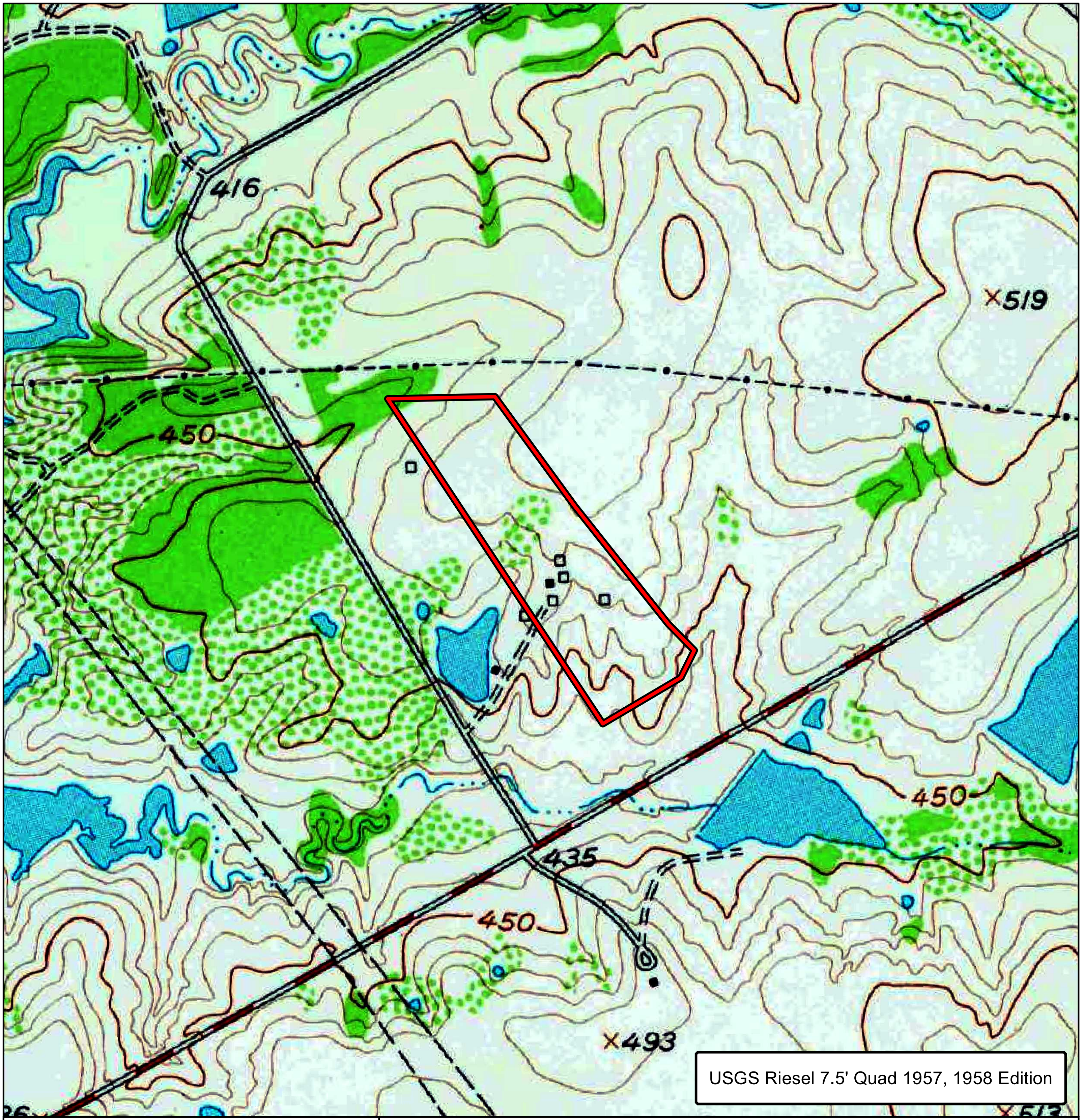
N
W E
S

File Ref. 04.306.003
Date: 11/1/2020

🟥 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

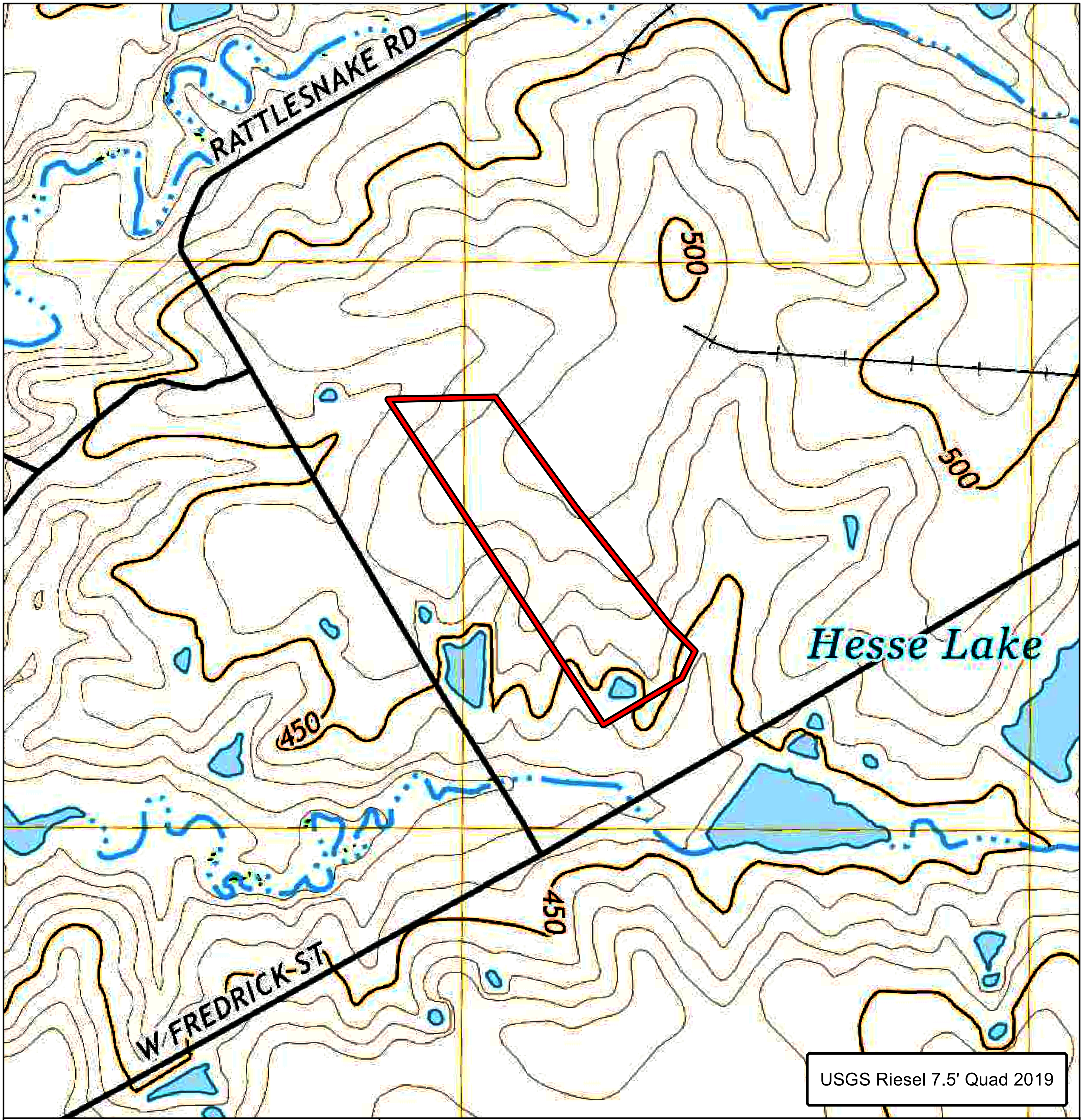
Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 750 feet

Feet
0 750

N
W E
S

File Ref. 04.306.003
Date: 11/1/2020



USGS Riesel 7.5' Quad 2019

Figure 2B.
Topographic Setting

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 750 feet

File Ref. 04.306.003
Date: 11/1/2020

🟥 Survey Area

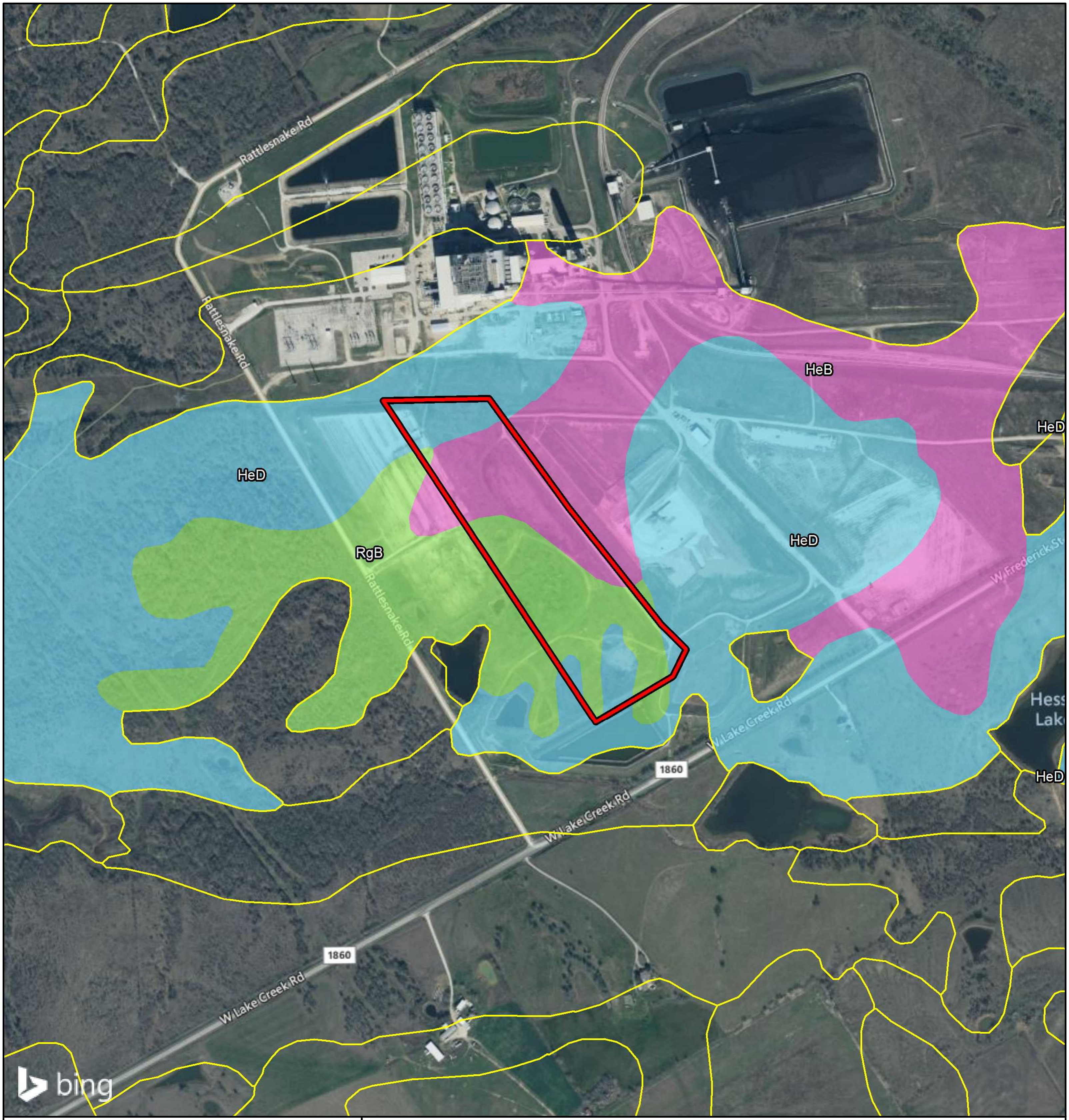


Figure 3.
Soils Map

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

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

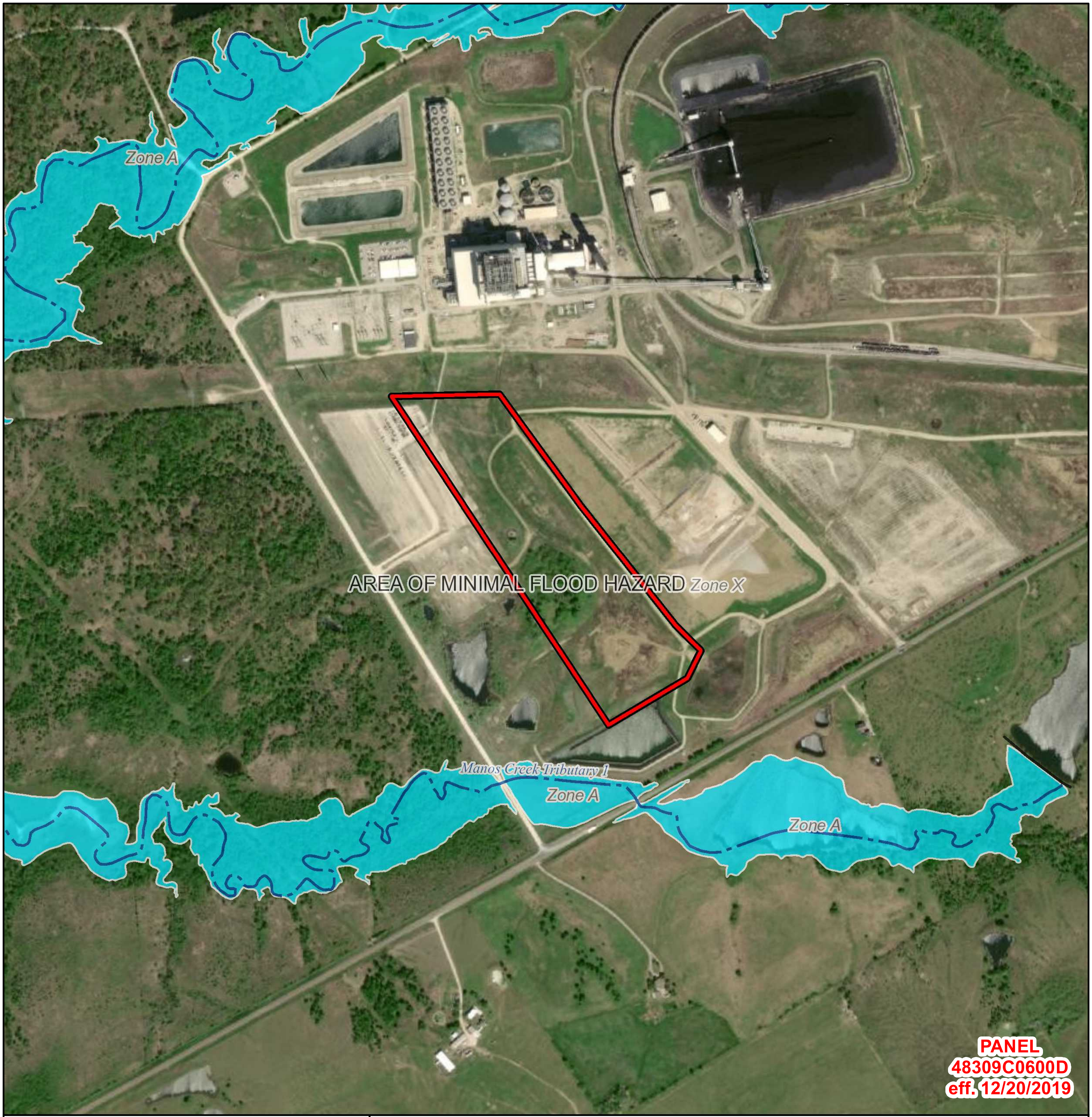


Figure 4.
Federal Emergency Management Agency Flood Insurance Rate Map

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

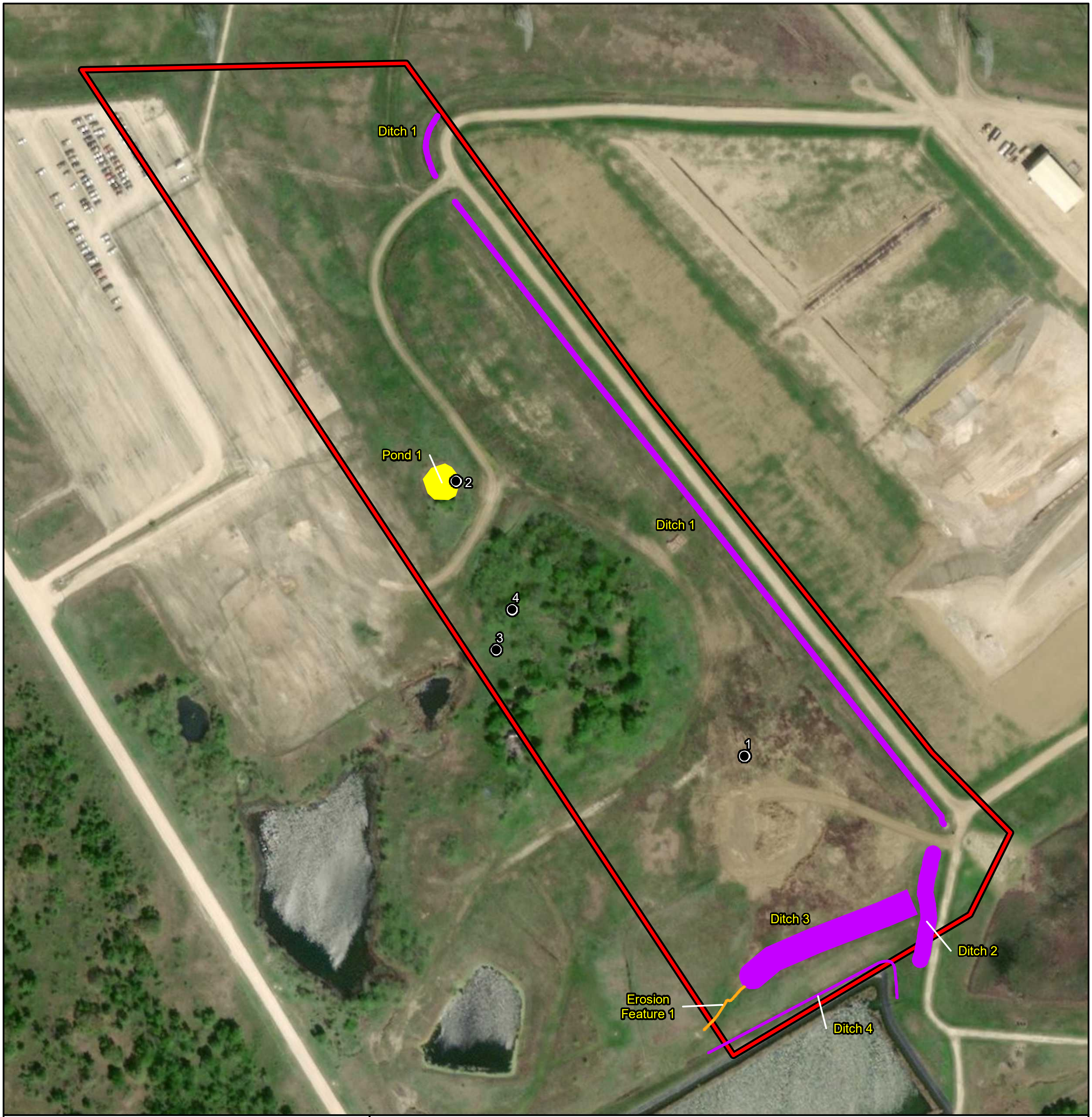


**Figure 5.
Aquatic Resources Identified within the Survey Area**

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

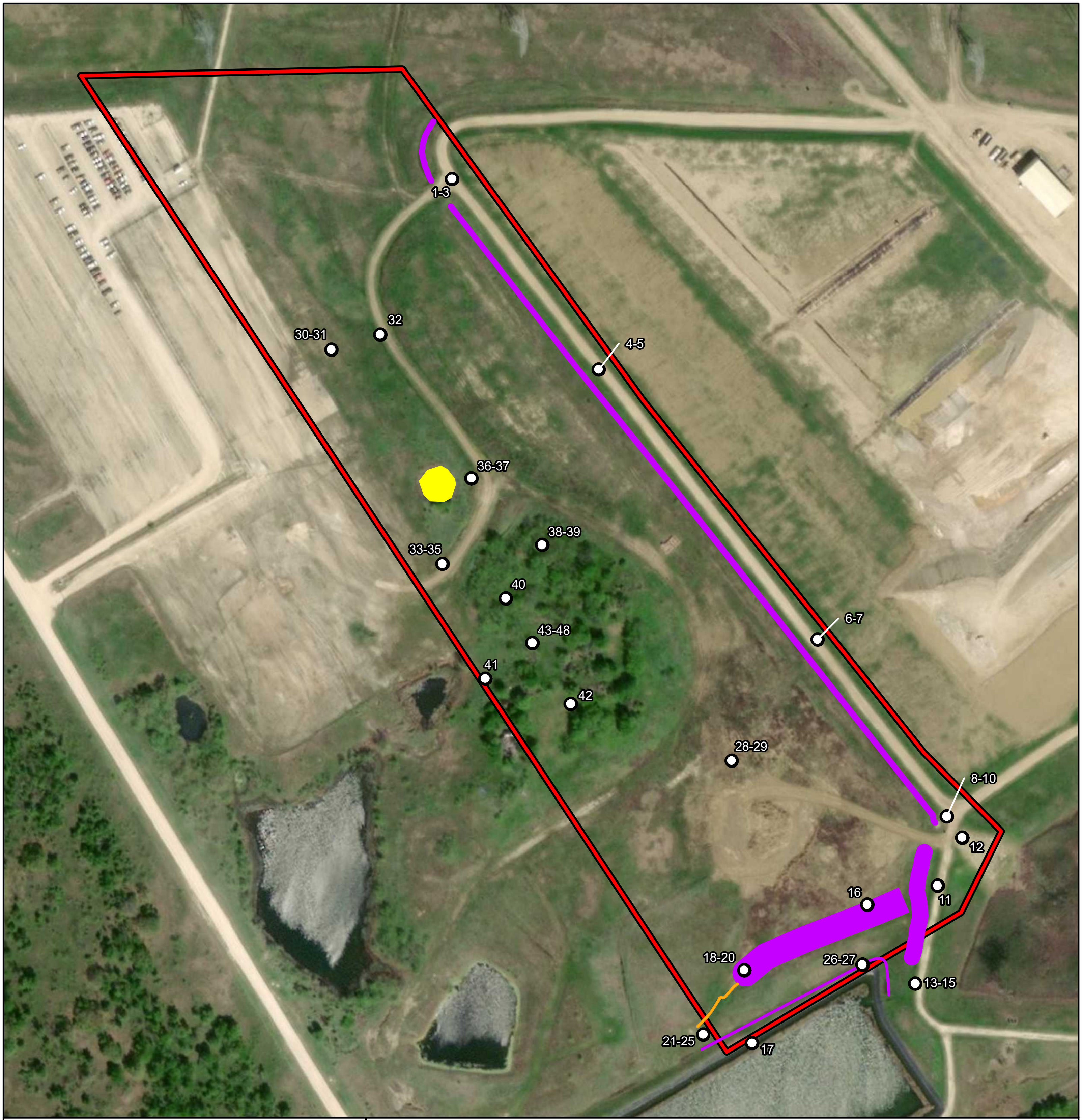
▭ Survey Area
● Wetland Determination Data Form

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

WETLAND DETERMINATION DATA FORM – Great Plains Region

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.

	Absolute % Coverage	Dominant Species?	Indicator Status
Tree Stratum (Plot Size: 30' Radius)			
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

Remarks: Herbaceous community

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** ☒

SOILS

Sampling Point: 1

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)	%	Type¹	Loc²		
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	

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. ²Location: 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 Soils³:

☐ 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)

³Indicators 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? (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 indicators of hydrology in the plot

WETLAND DETERMINATION DATA FORM – Great Plains Region

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.

	Absolute % Coverage	Dominant Species?	Indicator Status
Tree Stratum (Plot Size: Depression)			
1. *None*			
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot Size: Depression)			
1. *None*			
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot Size: Depression)			
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.			
= Total Cover	75		
Woody Vine Stratum (Plot Size: Depression)			
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? (includes capillary fringe) Yes? ☒ No? ☐ Depth (inches): 0

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

WETLAND DETERMINATION DATA FORM – Great Plains Region

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 (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox Features %	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? 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: hill slope - no concave or converging slope landforms

WETLAND DETERMINATION DATA FORM – Great Plains Region

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	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
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)
- ☐ 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? Yes? ☐ No? ☒ Depth (inches): N/A
(includes capillary fringe)

Wetland Hydrology Present? Yes ☐ **No** ☒

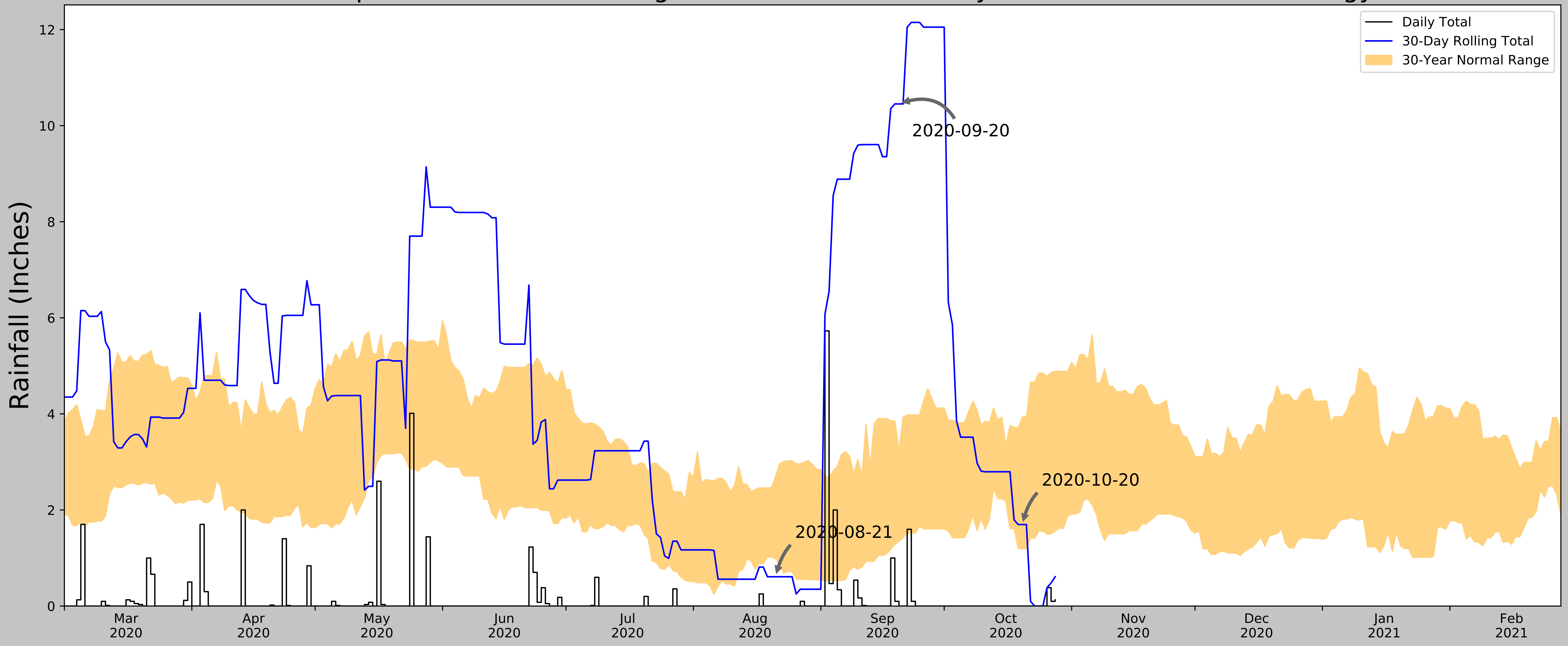
Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks: No 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	30^{th} %ile (in)	70^{th} %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 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

---

[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.

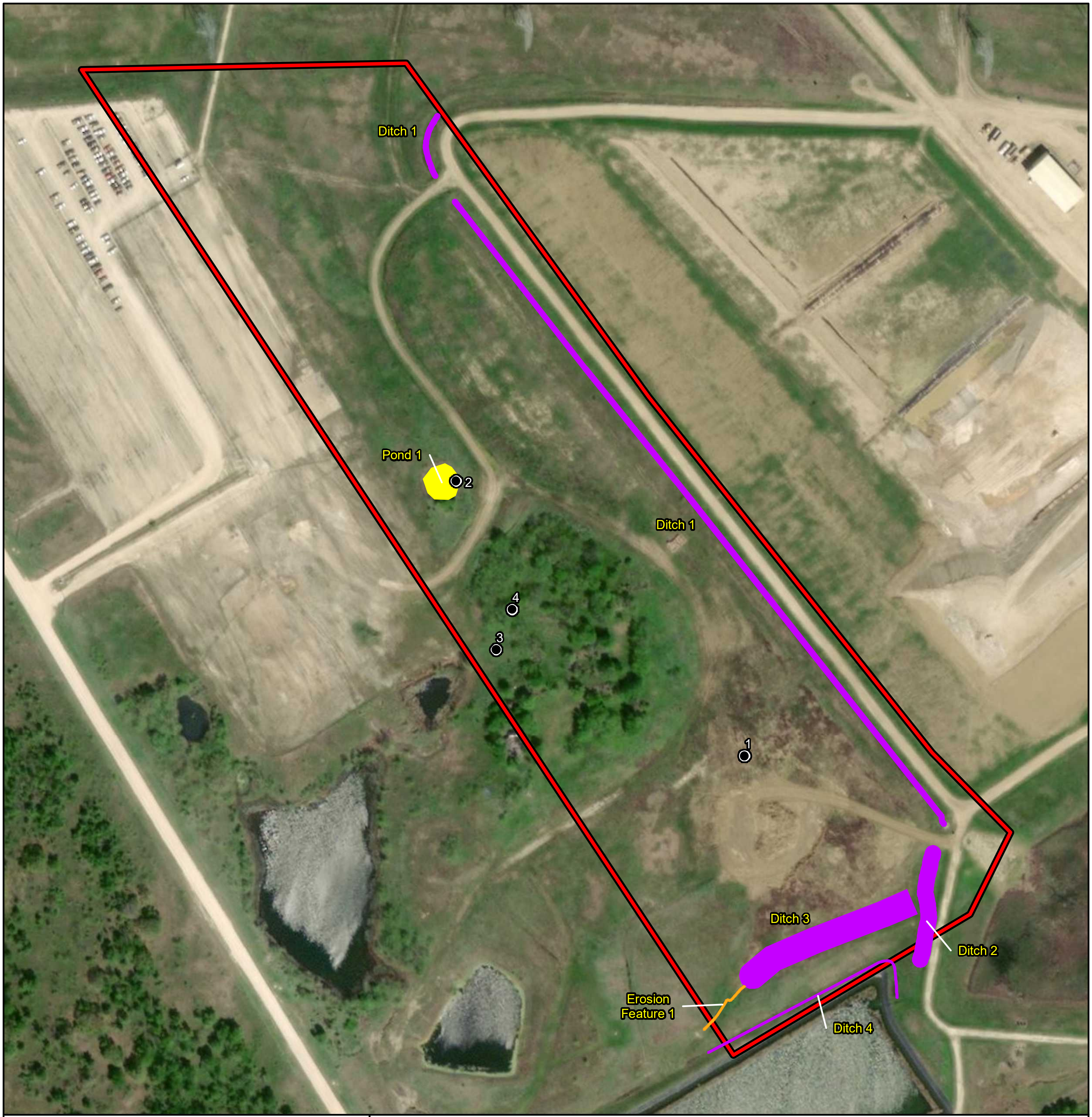


Figure 5.
Aquatic Resources Identified within the Survey Area

Sandy Creek Energy Station
City of Riesel
McLennan County, Texas

1 in = 250 feet

Feet
0 250

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

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

BRETT J. DeVRIES
128061

6/7/21

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

1901 Central Dr., Suite 550
Bedford, TX 76021
817-571-2288

Table of Contents

Appendices

Appendix A – Site Description and Geologic Summary

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

BRETT J. DeVRIES
128061

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

BRETT J. DeVRIES
128061

6/17/21

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

BRETT J. DeVRIES
128061

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.

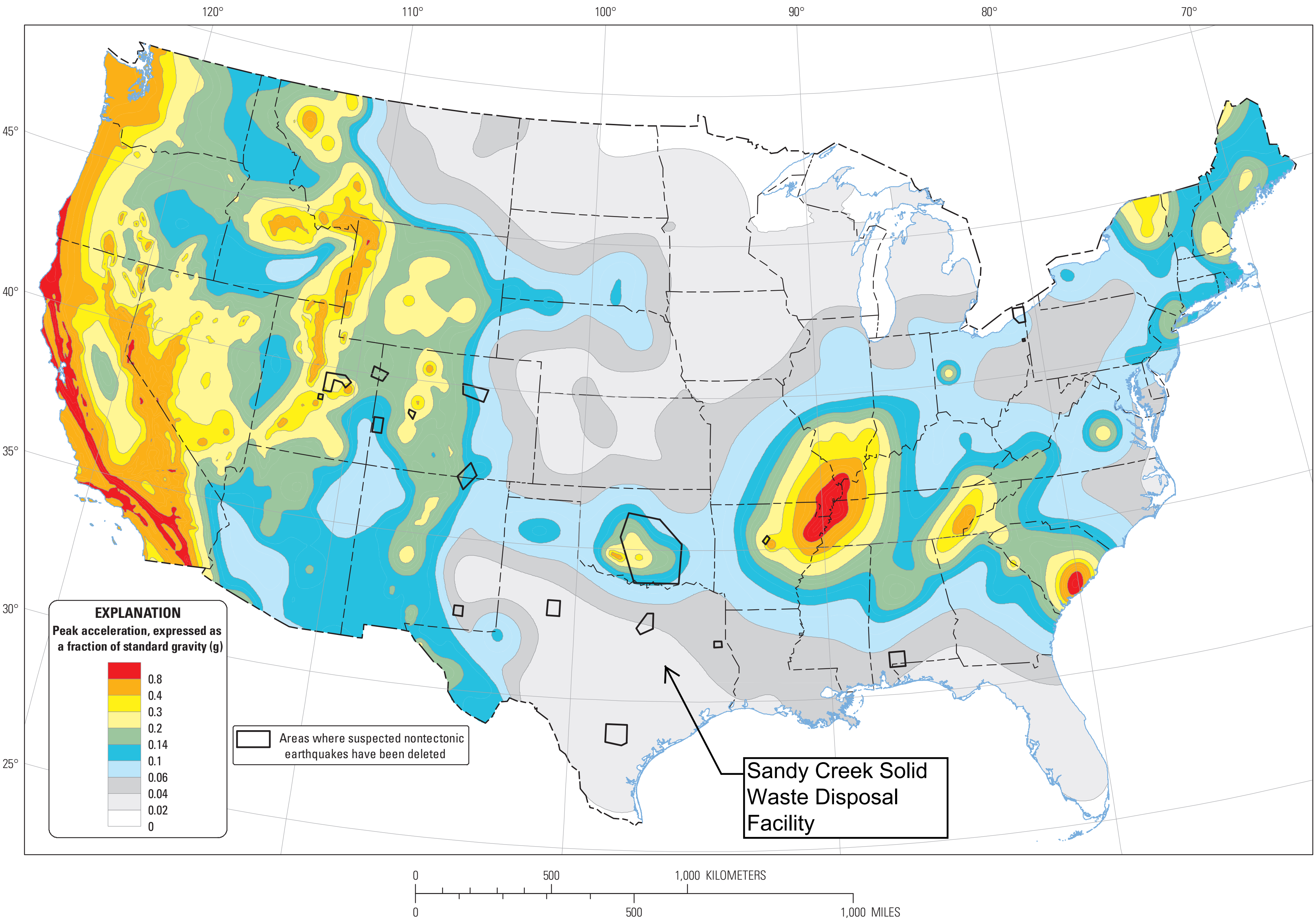
Settlement below a disposal facility can be a concern if the facility is underlain by extensive soft, fine-grained soils. Soft soils are subject to consolidation settlement depending on the load over the soft soils. The disposal facility soils consist of stiff to hard clay. Because the clays are stiff 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

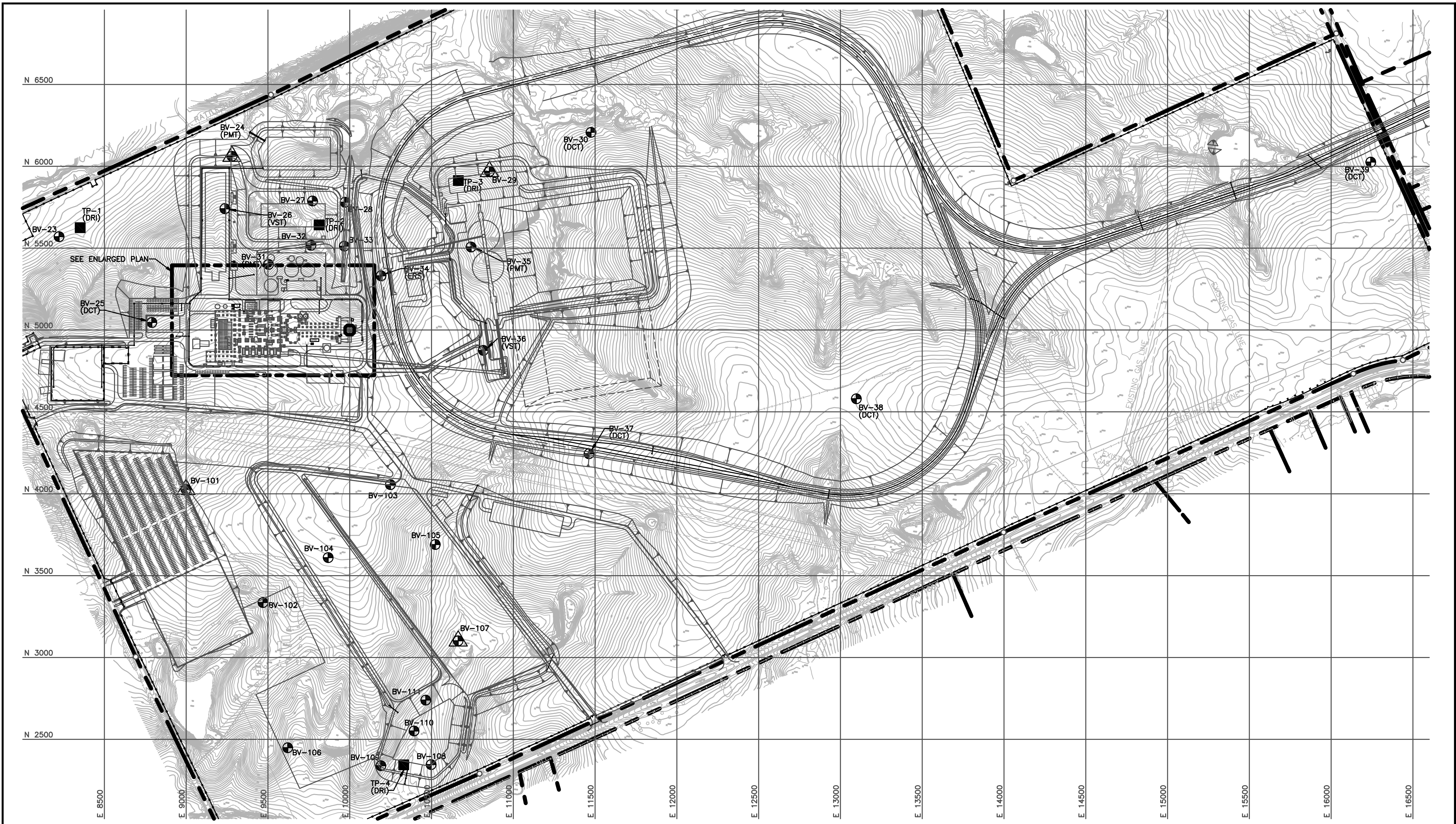


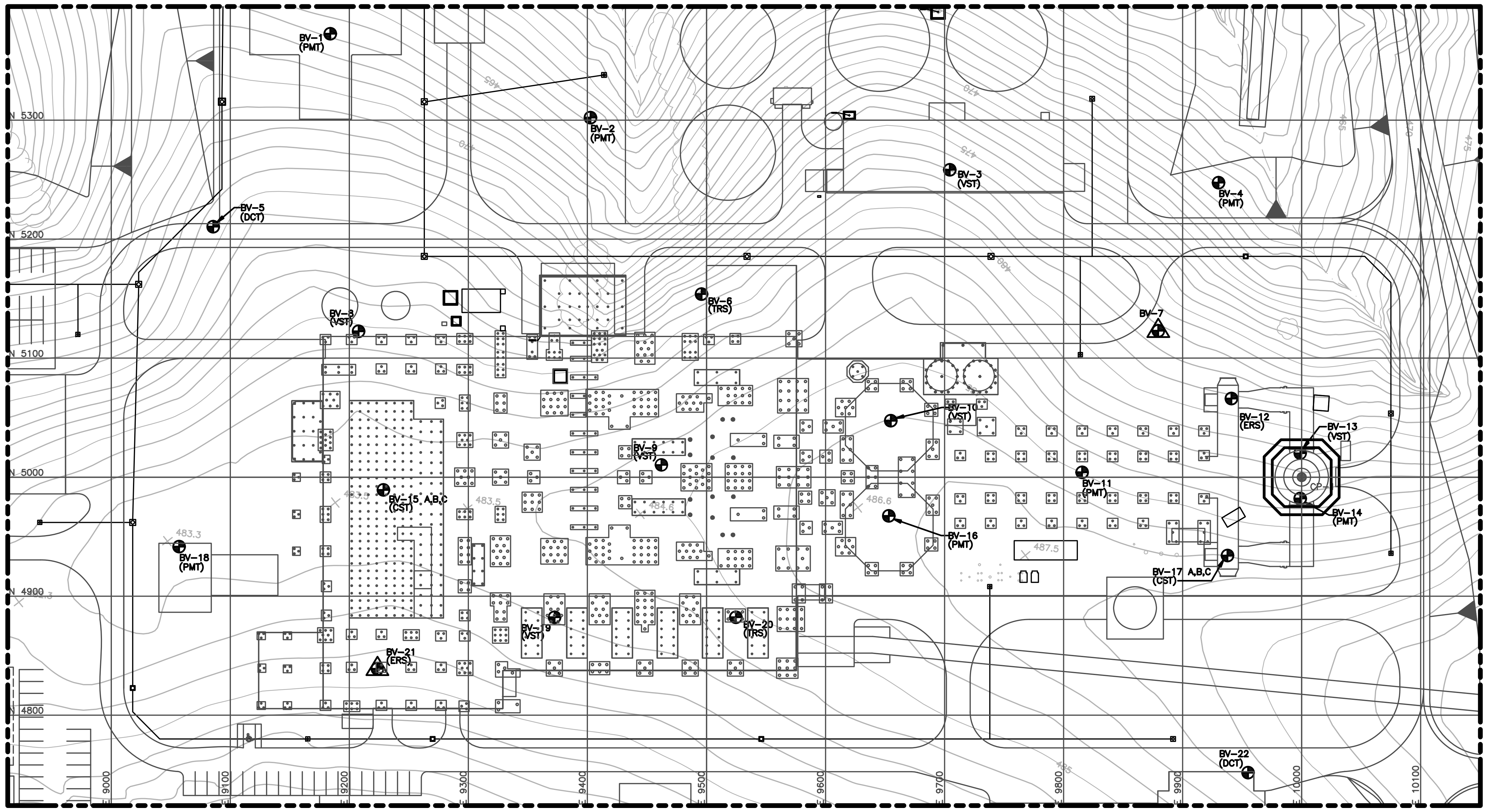
Two-percent probability of exceedance in 50 years map of peak ground acceleration

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

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

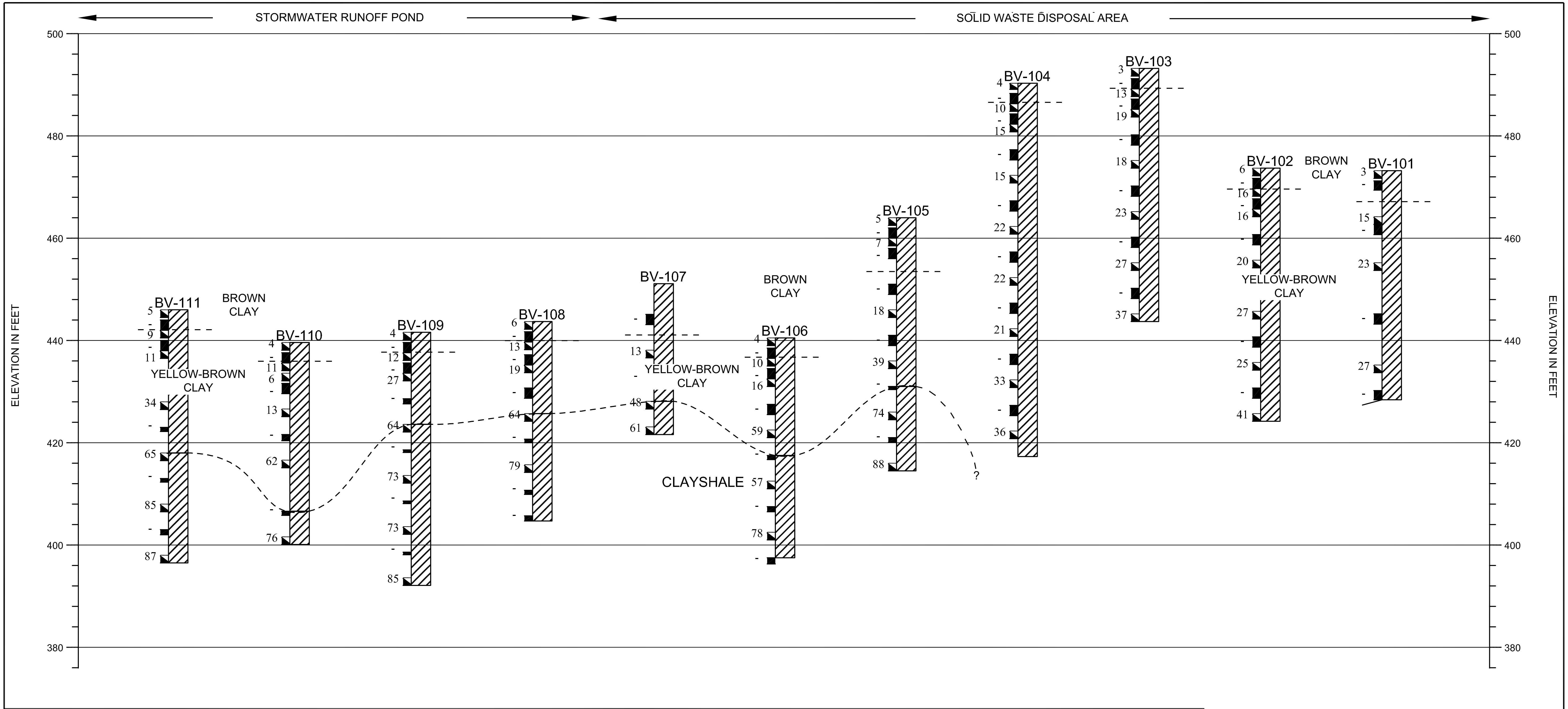
ENGINEER JCB
DRAWN SLS
CHECKED
DATE

SANDY CREEK ENERGY STATION
UNIT 1

SUBSURFACE INVESTIGATION
BORING LOCATION AND ISITU TEST PLAN

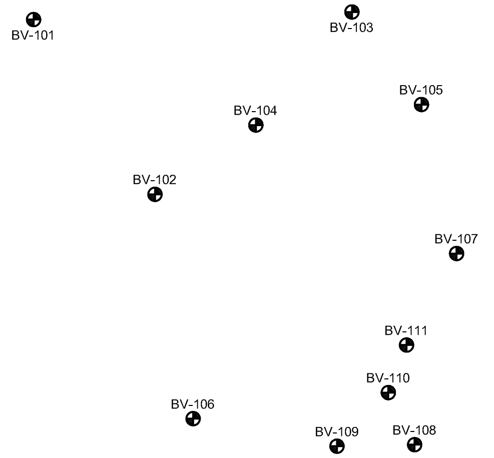
PROJECT
DRAWING NUMBER 149060-DS-0001
REV C
CODE
AREA

SEA33930 A1ASL017 04/11/08 E1 1=1 11:24:18 ACAD 16.1s (LMS Tech)



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.

JDH57765 E1 ACAD 16.1s (LMS Tech)
A1ASL017 1=1
10/08/10 12:54:54

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

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

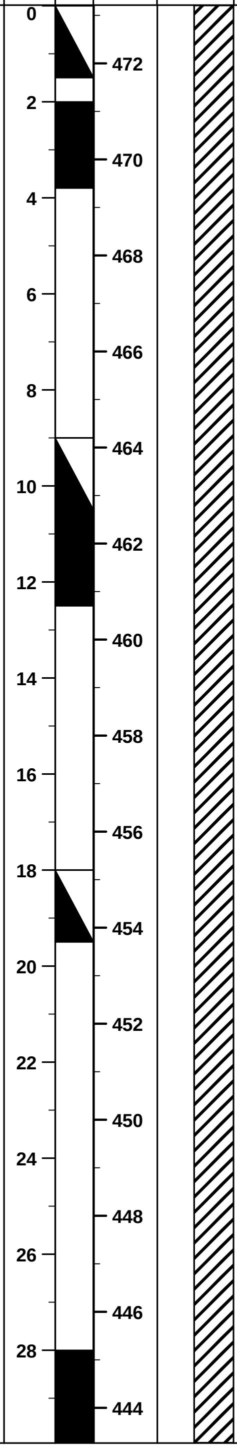
CLIENT Sandy Creek Energy Associates	**PROJECT** Sandy Creek Energy Station	**PROJECT NO.** 149060

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 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	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					
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**
SPT	7	10	13	14	27	1.5	38	◣	434	▨	grading very stiff
TW	8	1.8	-	-	-	1.8	44	■	430	▨	grading dark gray; fissile

REMARKS

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

BLACK & VEATCH

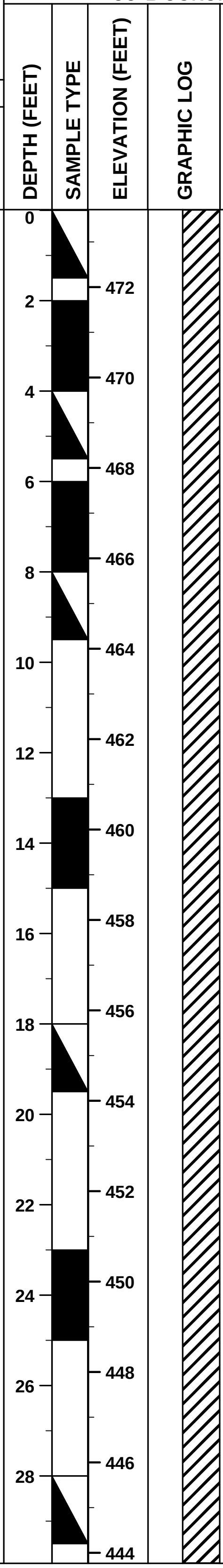
BORING LOG

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	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	2.0	-	-	-	2.0		
SPT	11	9	11	14	25	1.5		
TW	12	2.0	-	-	-	2.0		
SPT	13	15	18	23	41	1.5	grading hard	
								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

SAMPLE TYPE

ELEVATION (FEET): 442 440 438 436 434 432 430 428 426 424 422 420 418 416 414

GRAPHIC LOG

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	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
							0				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.
SPT	1	2	2	1	3	0.8			492			
							2				grading stiff	
TW	2	2.0	-	-	-	2.0			490			
							4					
SPT	3	2	5	8	13	1.5						@2' PP=2.0 tsf
									488		grading yellow-brown & gray seams	@4' PP=2.5 tsf
							6					@6' PP=4.5 tsf
TW	4	2.0	-	-	-	1.6			486			
							8				grading very stiff	Reacts w/HCL
SPT	5	5	8	11	19	1.5			484			
							10					
									482			
							12					
									480			PP=4.5 tsf
TW	6	2.0	-	-	-	2.0	14					
									478			
							16					
									476			
							18					
SPT	7	6	8	10	18	1.5			474			
							20					
									472			
							22					
									470			
TW	8	2.0	-	-	-	2.0	24					
									468			
							26					
									466			
							28				grading w/quartz seams	
SPT	9	7	11	12	23	1.5			464			

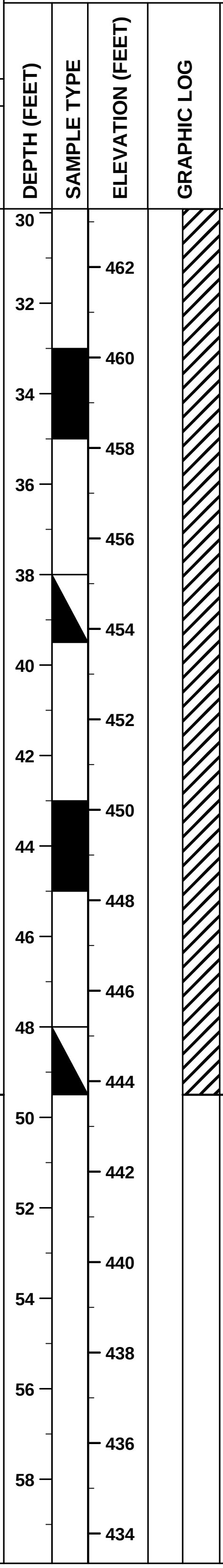
BLACK & VEATCH

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 / 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	2.0	-	-	-	2.0	grading iron oxide staining	PP=4.5 tsf
							@ 36.0' quartz seams grades out	
SPT	11	7	12	15	27	1.5		
TW	12	2.0	-	-	-	2.0	grading blue-gray	PP=4.5 tsf
SPT	13	11	17	20	37	1.5	grading hard	
								Bottom of boring at 49.5'. Water level not recorded. Boring backfilled with bentonite chips.



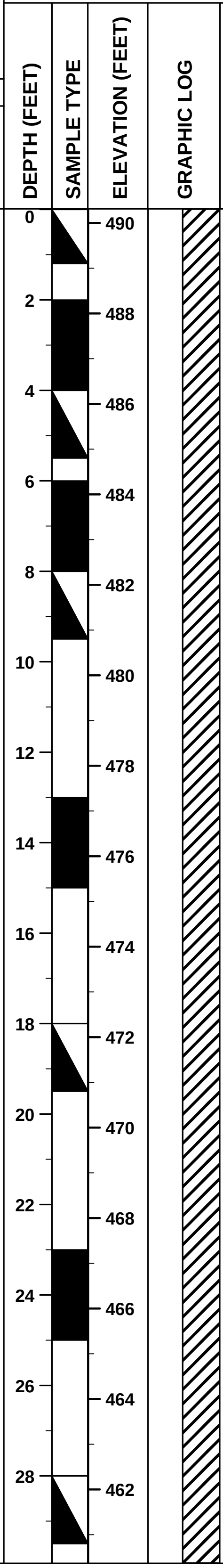
BLACK & VEATCH

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

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	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				
							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	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						
							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	▨		
							74		416			Bottom of boring at 73.0'. Water level not recorded. Boring backfilled w/ bentonite chips.
							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	DEPTH (FEET)	ELEVATION (FEET)	CLASSIFICATION OF MATERIALS	REMARKS
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
							2	462	grading stiff	
TW	2	2.0	-	-	-	1.5				
							4	460	grading firm	
SPT	3	3	3	4	7	1.5				
							6	458	grading yellow-brown & gray seams; very stiff	
TW	4	2.0	-	-	-	1.7				
							8	456		
							10	454		
							12	452		
									grading fissile	PP>4.5 tsf
TW	5	2.0	-	-	-	2.0	14	450		
							16	448		
							18	446		PP>4.5 tsf
SPT	6	6	8	10	18	1.5				
							20	444		
							22	442		
									grading w/occasional cemented quartz seams	PP>4.5 tsf
TW	7	2.0	-	-	-	1.8	24	440		
							26	438		
							28	436	grading blue-gray; hard; gray seams grades out	PP>4.5 tsf
SPT	8	12	15	24	39	1.5				

BLACK & VEATCH

BORING LOG

BORING NO. BV-105
SHEET 2 OF 2

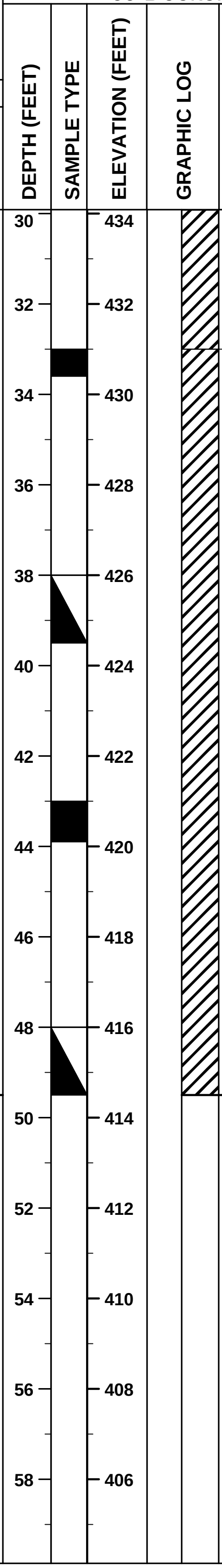
CLIENT	PROJECT	PROJECT NO.
Sandy Creek Energy Associates	Sandy Creek Energy Station	149060

PROJECT LOCATION	COORDINATES		GROUND ELEVATION (DATUM)	TOTAL DEPTH
Reisel, Texas	N 3690.0'	E 10524.0'	464.0 ft (MSL)	49.5 (feet)

SURFACE CONDITIONS	COORDINATE SYSTEM	DATE START	DATE FINISHED
Side 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	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)	CLASSIFICATION OF MATERIALS	REMARKS
TW	9	0.6	-	-	-	0.6	33.0	CLAYSHALE; gray; hard; moist; high plasticity; fissile	TW refusal
SPT	10	21	32	42	74	1.5		grading w/frequent cemetations	
TW	11	0.9	-	-	-	0.9			Thick walled tube driven 100 blows
SPT	12	32	42	46	88	1.5			
									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

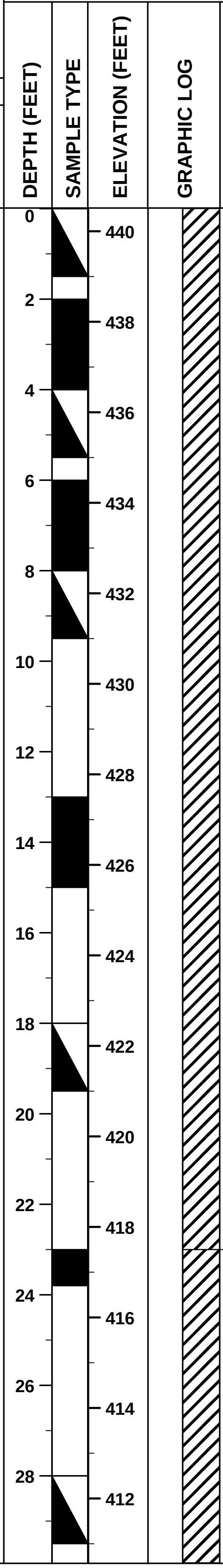
PROJECT LOCATION Reisel, Texas	**COORDINATES** N 2448.0' E 9621.0'	**GROUND ELEVATION (DATUM)**	**TOTAL DEPTH** 44.2 (feet)

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 / **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	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

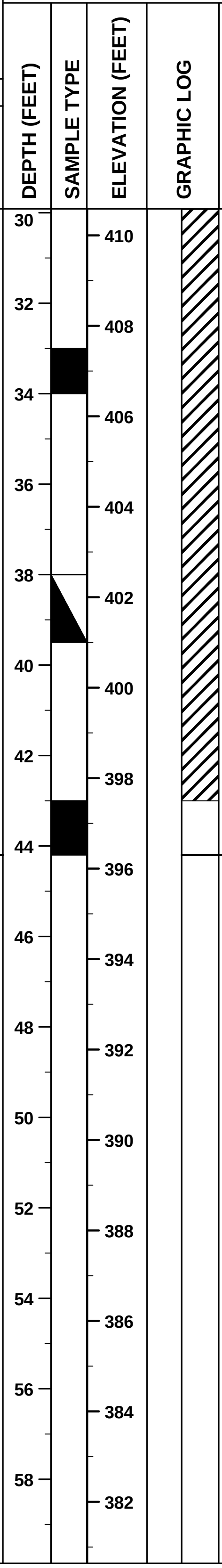
BLACK & VEATCH

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.



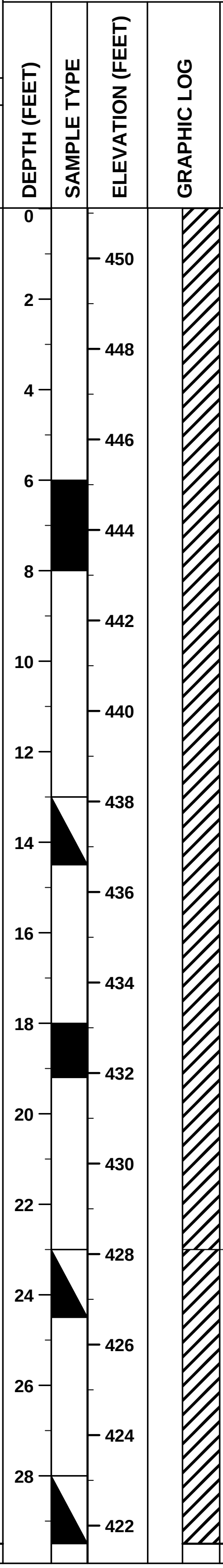
BORING LOG

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	CLASSIFICATION OF MATERIALS	REMARKS
ROCK CORING								
CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD		
							<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.
TW	1	2.0	-	-	-	1.2	grading very stiff	PP=2.5 tsf
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'
SPT	4	16	20	28	48	1.5	23.0 <u>CLAYSHALE</u>; gray; hard; moist; high plasticity; fissile; w/some gravel	Harder drilling
SPT	5	19	25	36	61	1.5		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	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
ROCK CORING: CORE SIZE	RUN NUMBER	RUN LENGTH	RUN RECOVERY	RQD RECOVERY	PERCENT RECOVERY	RQD
SPT	1	3	3	3	6	1.2
TW	2	2.0	-	-	-	2.0
SPT	3	3	6	7	13	1.5
TW	4	2.0	-	-	-	2.0
SPT	5	7	9	10	19	1.5
TW	6	2.0	-	-	-	2.0
SPT	7	16	26	38	64	1.5
TW	8	0.7	-	-	-	0.7
SPT	9	20	33	46	79	1.5

DEPTH (FEET)	ELEVATION (FEET)
0	
	442
2	
	440
4	
	438
6	
	436
8	
	434
10	
	432
12	
	430
14	
	428
16	
	426
18	
	424
20	
	422
22	
	420
24	
	418
26	
	416
28	
	414

CLASSIFICATION OF MATERIALS

CLAY; brown; firm; moist; high plasticity; w/some sand & 1" gravel (6" Topsoil)

grading yellow-brown

grading stiff

grading very stiff; w/some quartz sand

grading mottled dark gray

18.0

CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/occasional cementation

@ 19.5' grading dark gray

REMARKS

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

TW4 PP=4.0 tsf

PP>4.5 tsf

PP>4.5 tsf

PP>4.5 tsf

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 / 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		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

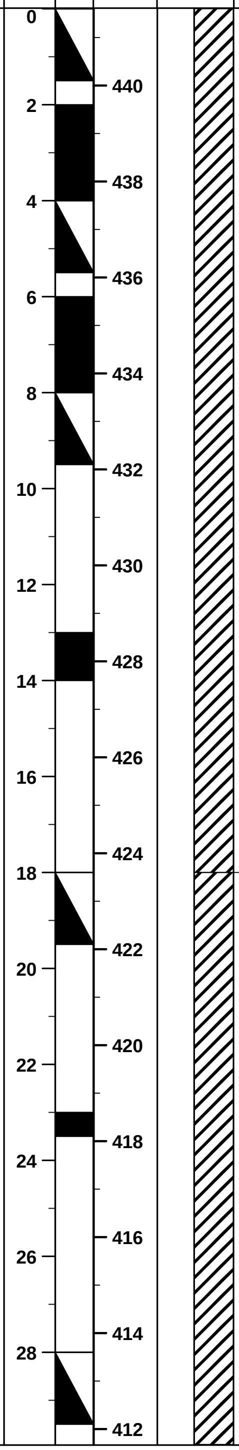
BORING LOG

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

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	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					
									410			
							32					
TW	10	0.5	-	-	-	0.5						Tube end crushed.
									408			
							34					
									406			
							36					
									404			
							38					
SPT	11	22	32	41	73	1.5						
									402			
							40					
									400			
							42					
TW	12	0.5	-	-	-	0.5						
									398			
							44					
									396			
							46					
									394			
							48					
SPT	13	27	39	46	85	1.5						
									392			Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							50					
									390			
							52					
									388			
							54					
									386			
							56					
									384			
							58					
									382			

BLACK & VEATCH

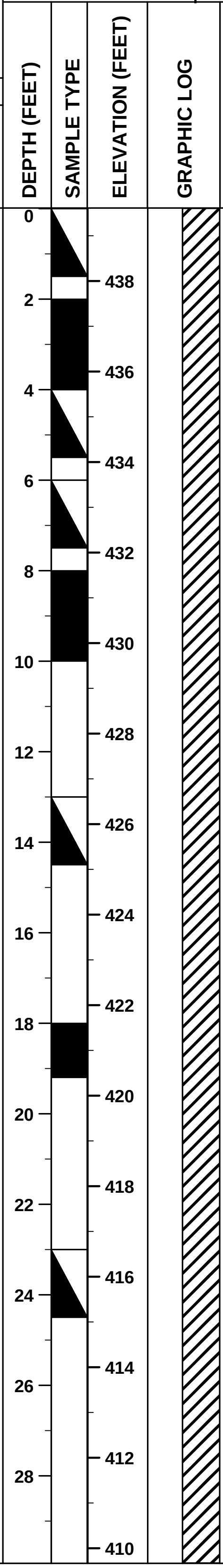
BORING LOG

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			▨		
									408	▨		
							32			▨		
TW	9	0.8	-	-	-	0.8	33.0	■		▨	CLAYSHALE: gray; hard; moist; high plasticity; fissile; w/trace cementation	Tube end crushed.
									406	▨		
							34			▨		
									404	▨		
							36			▨		
									402	▨		
							38			▨		
SPT	10	22	34	43	76	1.5		◣		▨		
									400			Bottom of boring @ 39.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							40					
									398			
							42					
									396			
							44					
									394			
							46					
									392			
							48					
									390			
							50					
									388			
							52					
									386			
							54					
									384			
							56					
									382			
							58					
									380			

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	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	3	5	1.2	0		446		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.
TW	2	2.0	-	-	-	1.5	2		444			
SPT	3	2	4	5	9	1.4	4		442		grading stiff	
TW	4	2.0	-	-	-	1.8	6		440		grading yellow; w/trace sand	@6' PP=1.5 tsf
SPT	5	2	4	7	11	1.5	8		438		@ 9.0' grading yellow-brown	@8' PP=3.5 tsf
							10		436			
							12		434			PP>4.5 tsf
TW	6	2.0	-	-	-	2.0	14		432			
							16		430			
SPT	7	10	15	19	34	1.5	18		428		grading hard; w/some sand @ 18.5' grading w/1" gravel @ 19.5' grading gray-brown	PP>4.5 tsf
							20		426			
TW	8	0.8	-	-	-	0.8	22		424		grading w/occasiional quartz seams	
							24		422			
							26		420			
SPT	9	20	27	38	65	1.5	28		418		28.0 CLAYSHALE; gray; hard; moist; high plasticity; fissile; w/trace cementation	

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	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		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		◣		▨		
							50		396			Bottom of boring @ 49.5'. Water level not recorded. Boring backfilled w/ bentonite chips.
							52		394			
							54		392			
							56		390			
							58		388			

Appendix D

Slope Stability Analysis

SCS ENGINEERS Environmental Consultants & Contractors

June 2021
File No. 16220089.00

TECHNICAL MEMORANDUM

BRETT J. DeVRIES
128061

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.

Black & Veatch Corp., Sandy Creek Energy Station, Geotechnical Design Report – Revision 0, 2009, Sandy Creek Services LLC.

Koerner, G.R. and D. Narejo, 2005, Direct Shear Database of Geosynthetic-to-Geosynthetic and Geosynthetic-to-Soil Interfaces, GRI Report #30.

SCS Engineers, 2020, April 2020 Semiannual Groundwater Monitoring Report Submittal, Sandy Creek Energy Station, McLennan County, TX.

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.

Stark, Timothy and Alan Poeppel, 1994, Landfill Liner Interface Strengths from Torsional-Ring-Shear Tests, Journal of Geotechnical Engineering, Vol. 120, No. 3, American Society of Civil Engineers.

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°	1.532	1.5
Circular Slip Method Drained Clay Shear Strength = 20° Geomembrane Interface Friction of 17°	1.633	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 17°	1.546	1.5
Sliding Block Method Drained Clay Shear Strength = 20° Geomembrane Interface Friction of 17°	1.546	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 9°	1.098	>1.0
Sliding Block Method Drained Clay Shear Strength = 20° Geomembrane Interface Friction of 9°	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°	1.790	1.5
Circular Slip Method Drained Clay Shear Strength = 20° Geomembrane Interface Friction of 17°	1.711	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 17°	1.552	1.5
Sliding Block Method Drained Clay Shear Strength = 20° Geomembrane Interface Friction of 17°	1.548	1.5
Sliding Block Method Underdrained Clay Shear Strength = 3,000 psf Geomembrane Interface Friction of 9°	1.110	>1.0
Sliding Block Method Drained Clay Shear Strength = 20° Geomembrane Interface Friction of 9°	1.105	>1.0

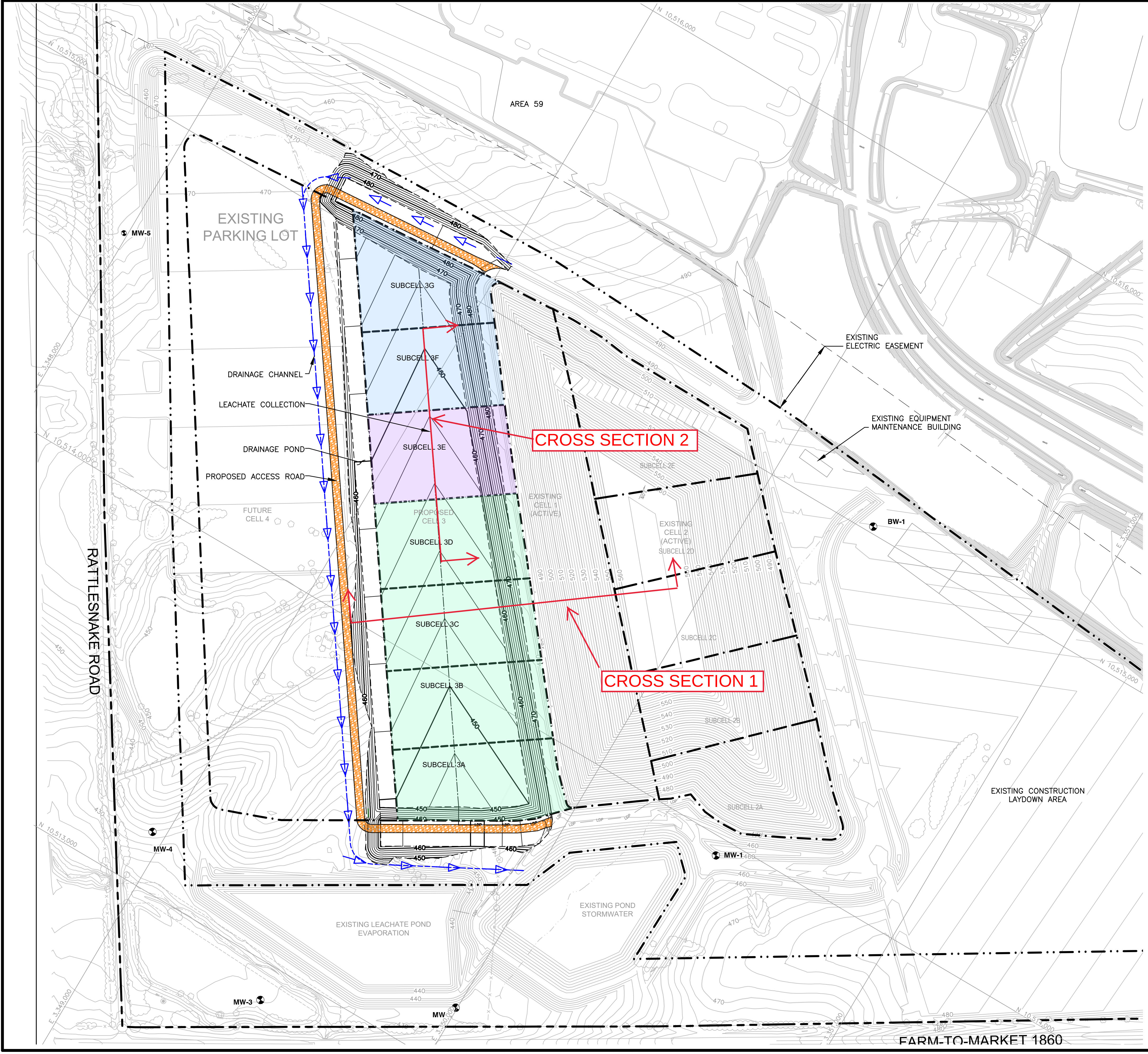
Created by: KRG, 12/31/2020
Last Revision by: PEG, 1/14/2021
Checked by: PEG, 1/14/2021

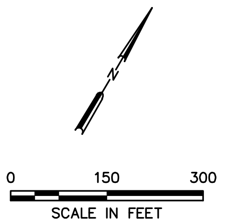
I:\16220089\Deliverables\Unstable Areas Demonstration\Appendices\Appendix D\[Attachment D1_Factor of Safety Results Summary Table.xlsx]FS Results Summary

Attachment D2

Cross Section Locations

11/13/2020 12:57 PM G:\SANDY CREEK\16220089.00 T2_DWG\EXCAVATION PLAN





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
△			
△			
△			
△			
△			
△			

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

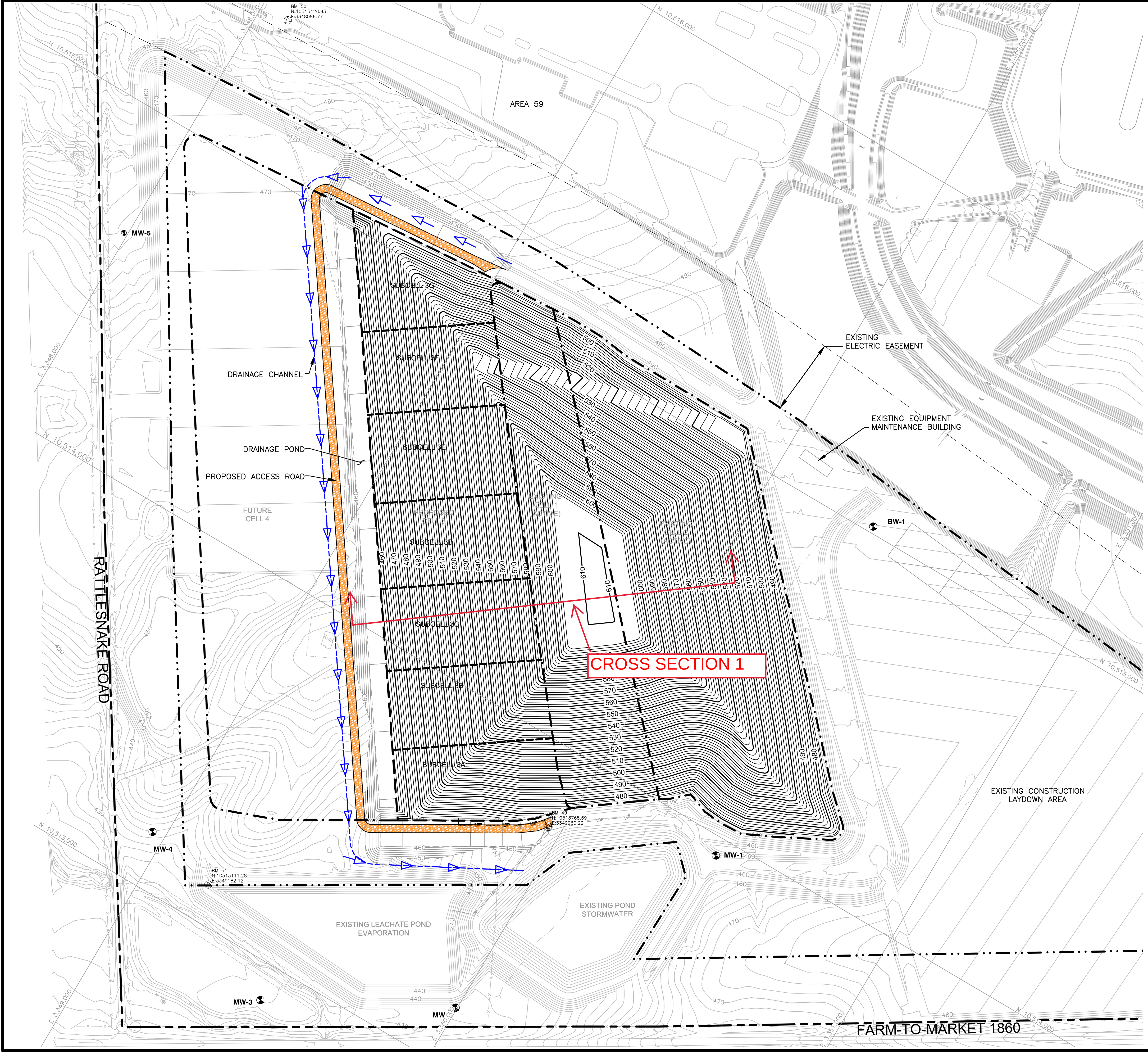
PROJ. NO. 16220089.00
DWN. BY: JLJ
Q/A RVW BY: RRK
DSN. BY: BJD
CHK. BY: BJD
APP. BY: RRK

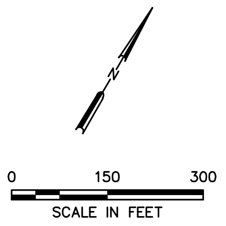
CADD FILE: EXCAVATION PLAN

DATE: 10/2020

SCALE: AS SHOWN

DRAWING NO.
1





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 INTERIM GRADE CONTOUR
— LDP — LDP — 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
△			
△			
△			
△			
△			
△			

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

11/13/2020 1:13 PM G:\SANDY CREEK\16220089.00 T2_DWG\INTERIM COVER

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

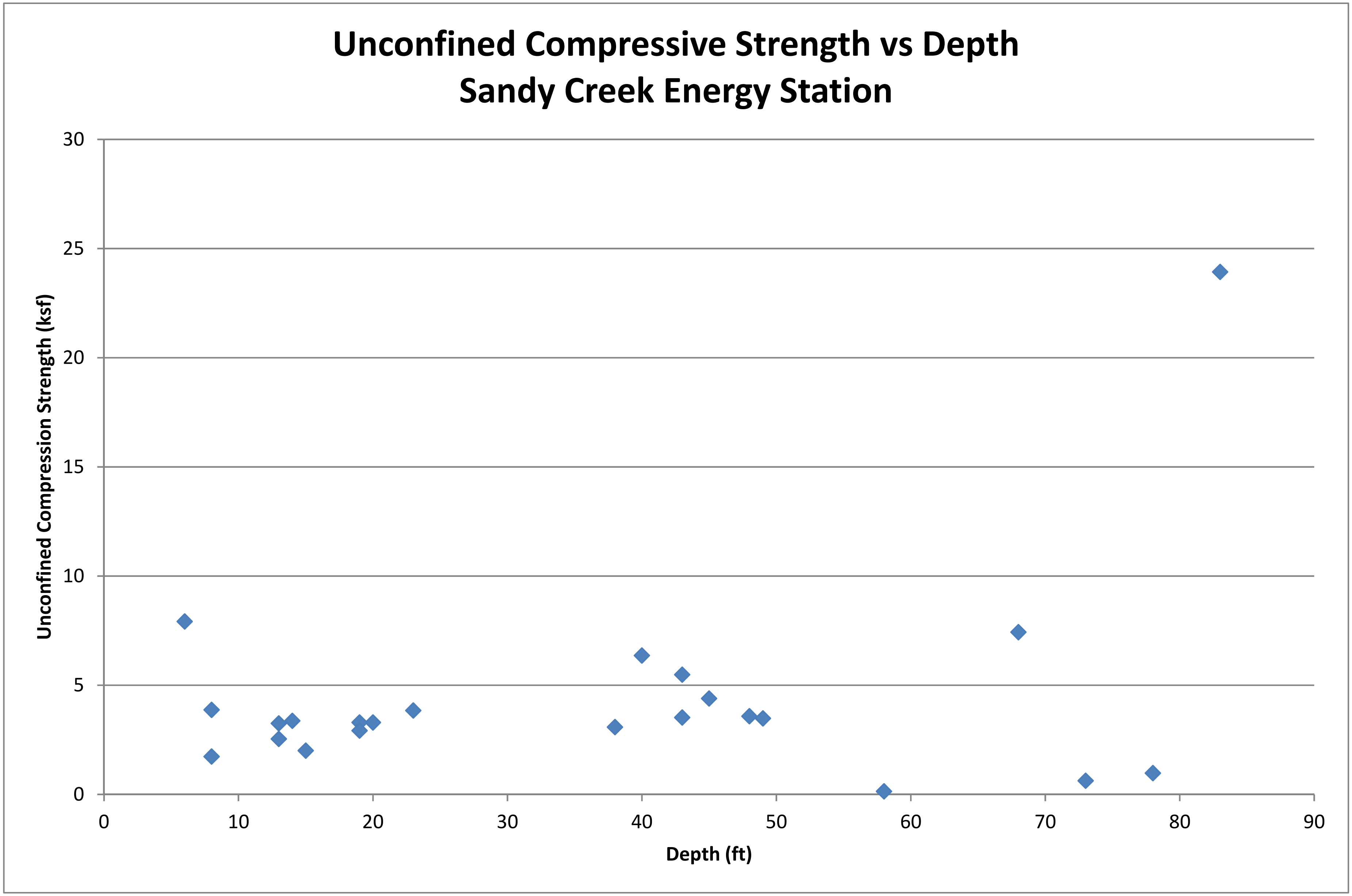
							Unconsolidated Undrained Compression		CU Bar *
Boring No.	**Depth (ft)**		**Moisture Content (%)**	**Dry Density (pcf)**	**Vane Shear TV (tsf)**	**Unconfined Compression (ksf)**	**Confining Pressure (lb/in^2)**	**Shear Strength (ksf)**	**Drained Friction Angle (degrees)**
BV-105			17.7	103.0					30.8
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.

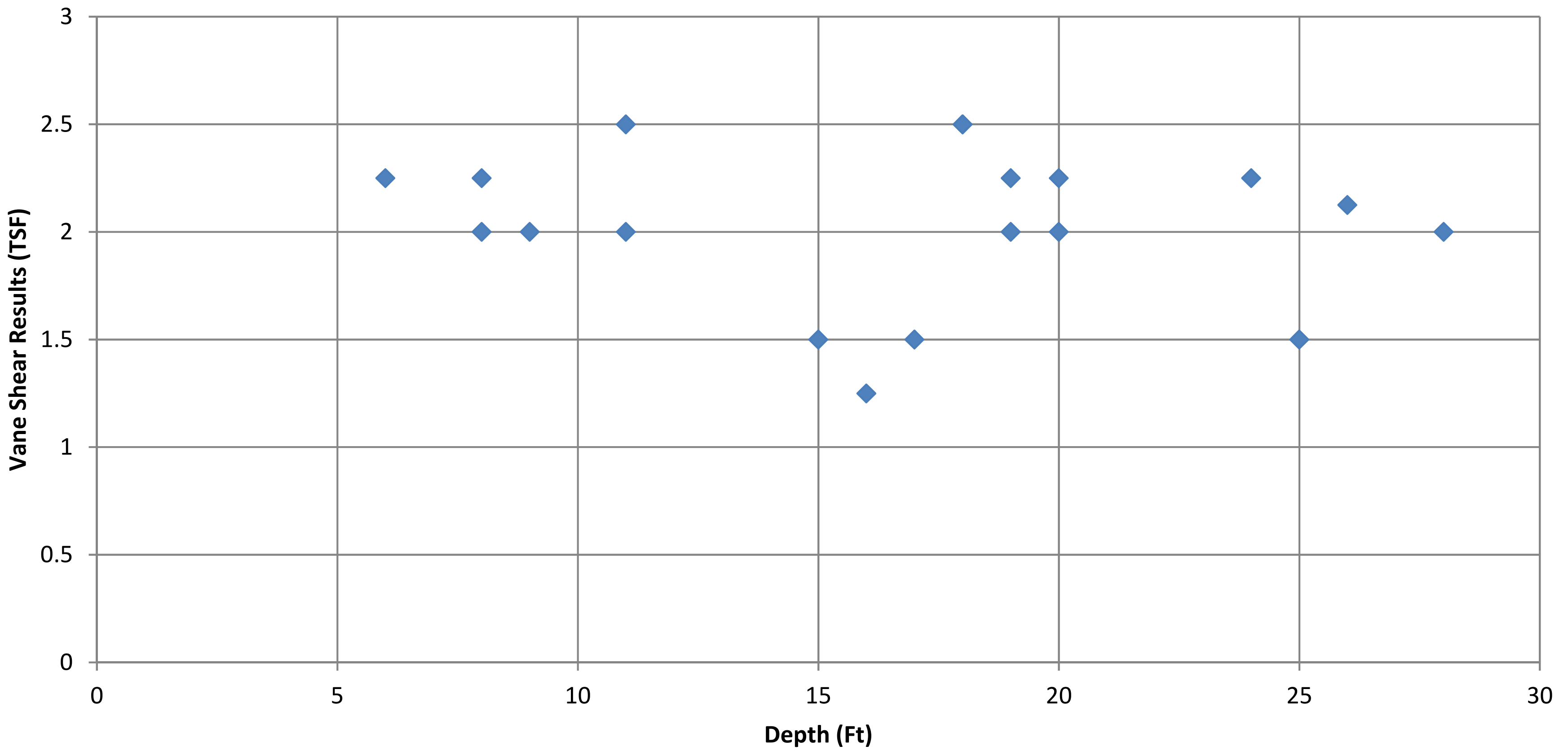
Created by:	KRG	Date:	9/12/2018
Last revision by:	KRG	Date:	9/24/2018
Checked by:	DLN	Date:	9/24/2018

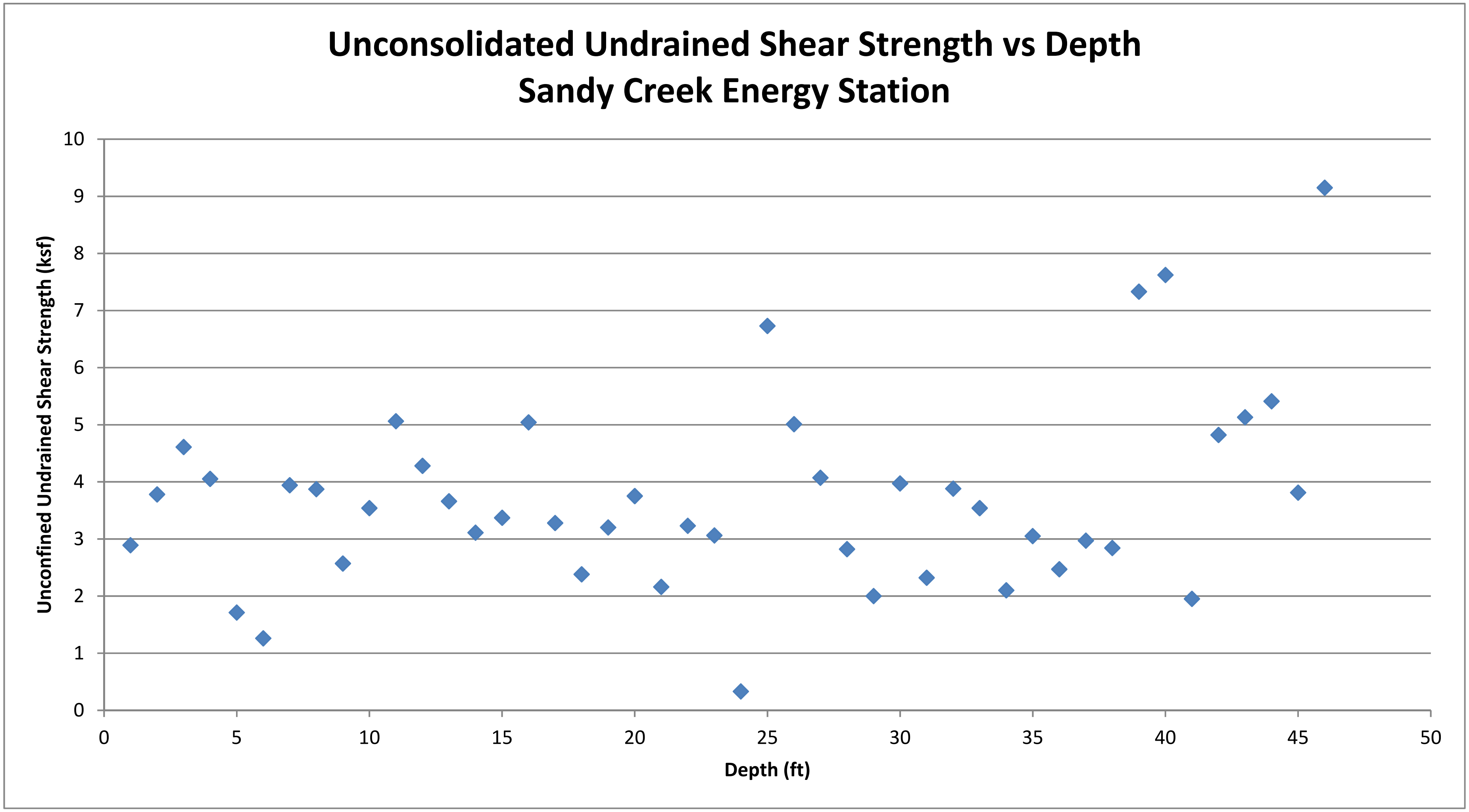
I:\16215106\[Geotechnical Lab Results.xlsx]Sheet1



Unconfined Compressive Strength vs Depth
Sandy Creek Energy Station

Depth vs Vane Shear
Sandy Creek Energy Station





Unconsolidated Undrained Shear Strength vs Depth
Sandy Creek Energy Station

Attachment D4

Slope/W Outputs

BRETT J. DeVRIES
128061

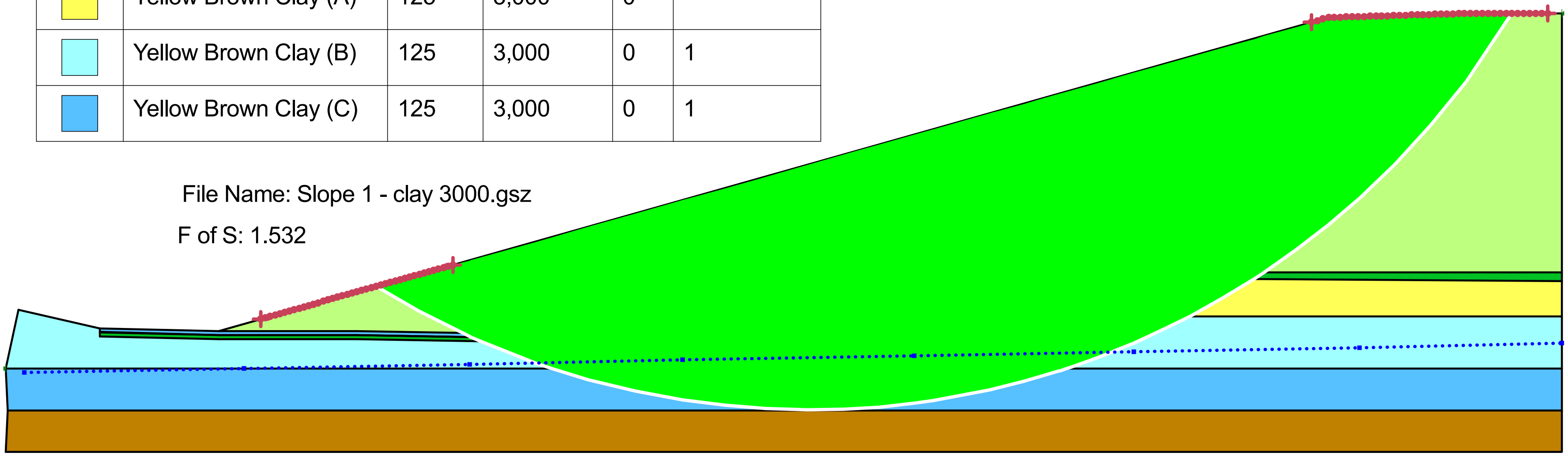
6/17/21

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

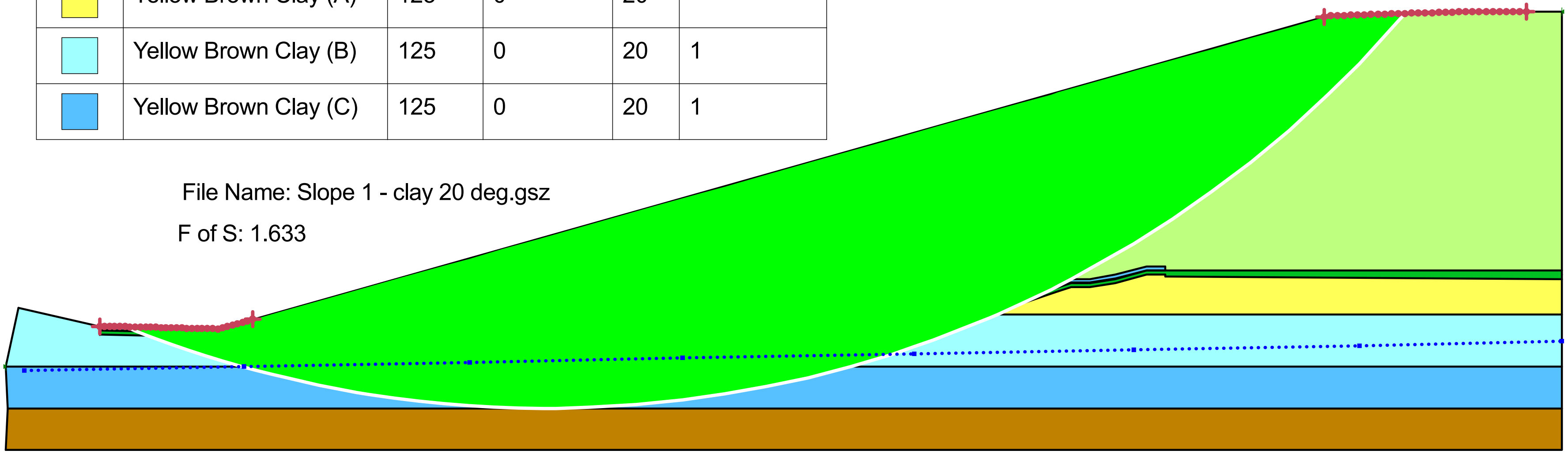
Regions

	Material	Points	Area (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	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
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Point 32	546	486
Point 33	555	486
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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
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Point 55	504	480
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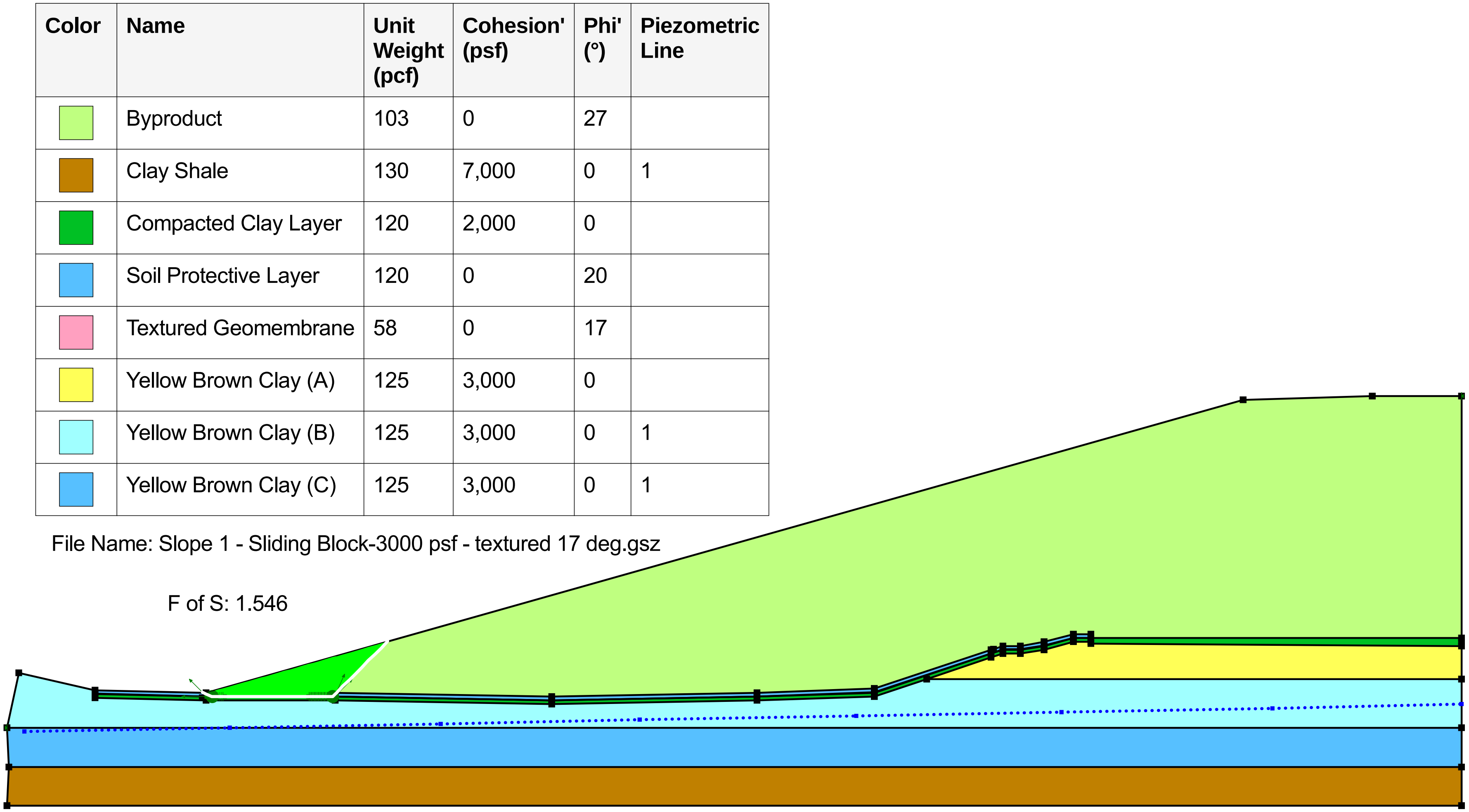
Point 58	531	484
Point 59	546	488
Point 60	555	488
Point 61	555	483
Point 62	745	486
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

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	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
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Point 25	279	454
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Point 27	444	458
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Point 32	546	486
Point 33	555	486
Point 34	168	456.1
Point 35	279	454.1
Point 36	384	456.1
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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

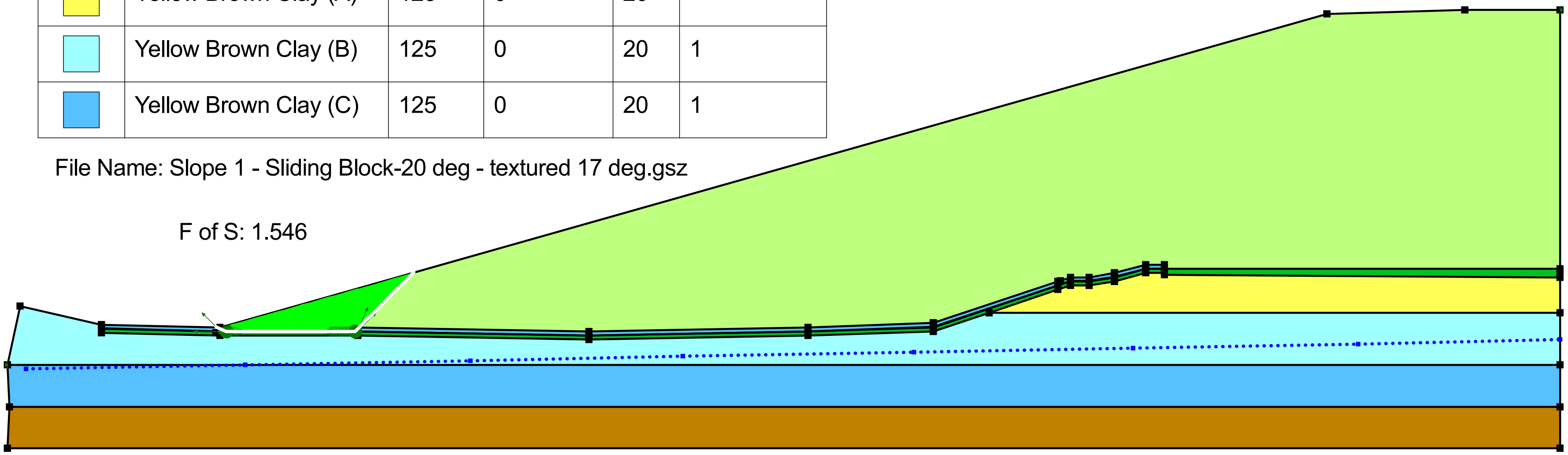
Regions

	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
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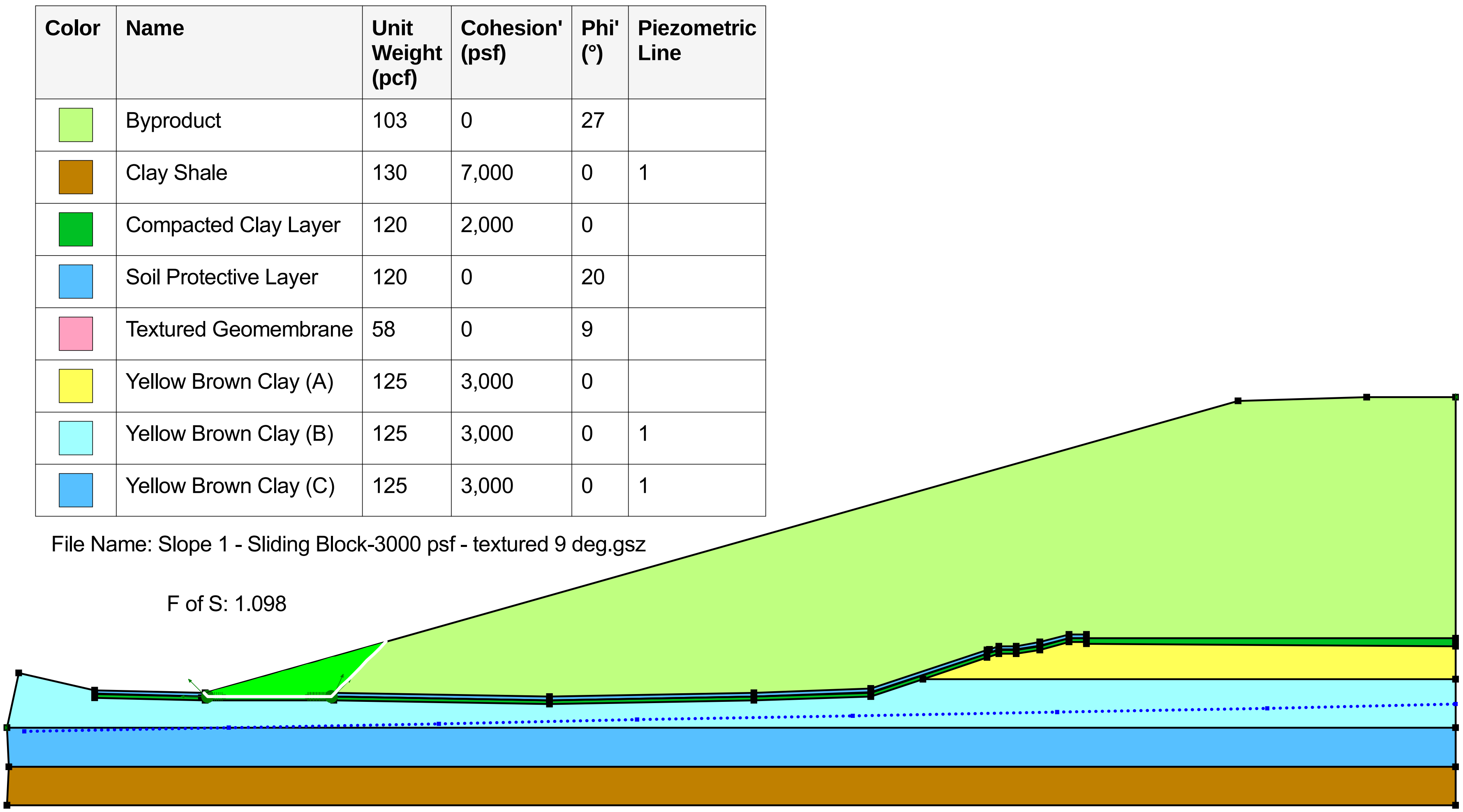
Point 63	505	480.3333
Point 64	45	457.3
Point 65	45	457.4
Point 66	45	459.3
Point 67	101.92936	456.0016
Point 68	167.9024	456
Point 69	45	459
Point 70	44.84243	455.3513

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
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

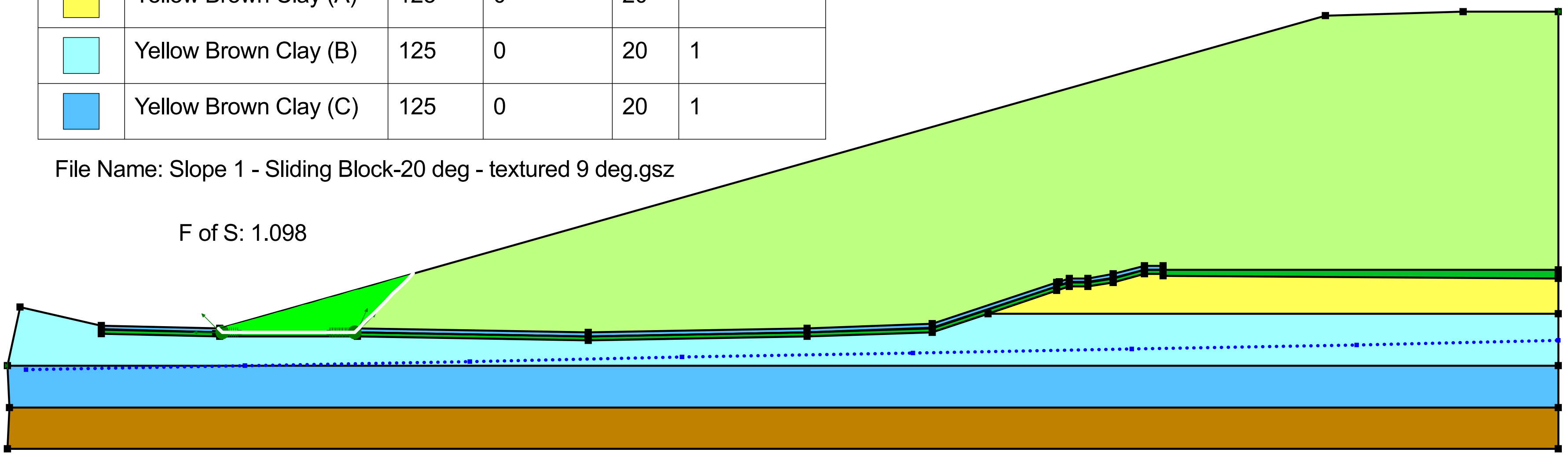
Regions

	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	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

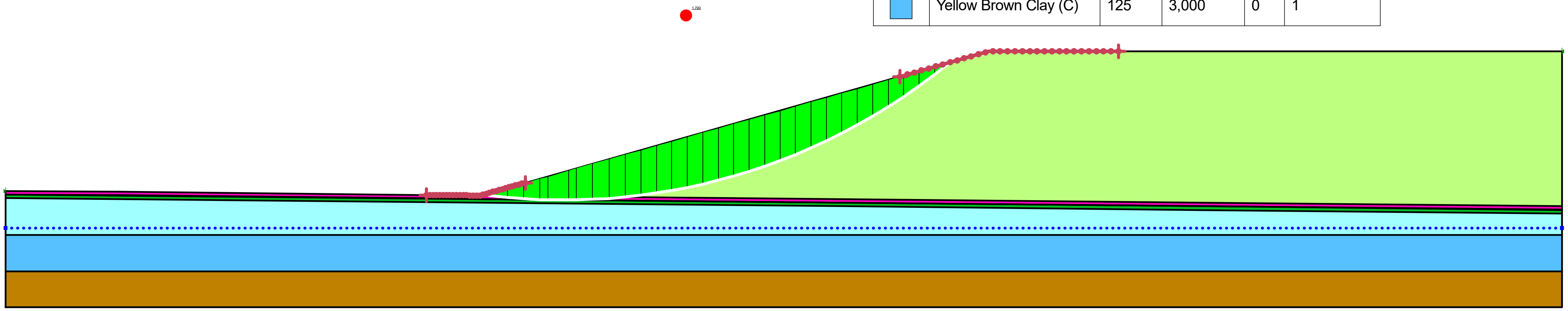
Regions

	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

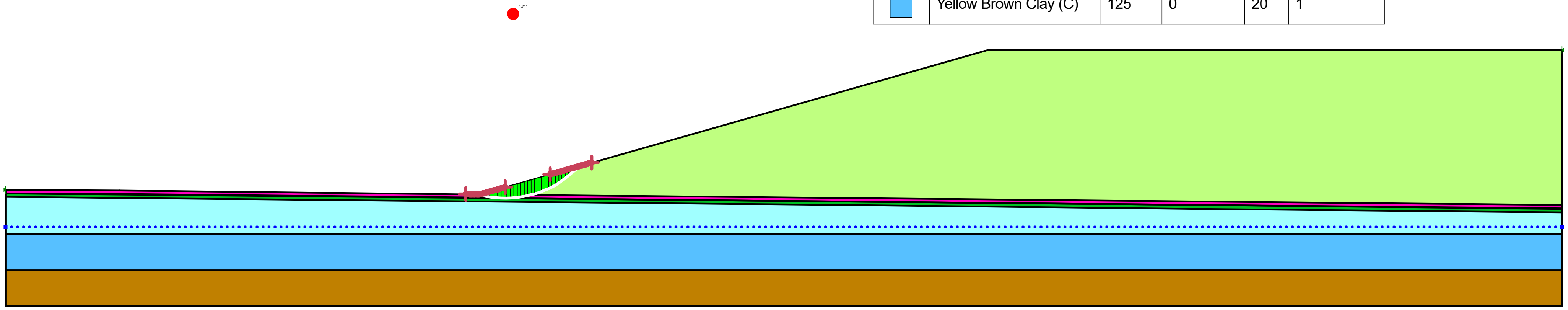
Regions

	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

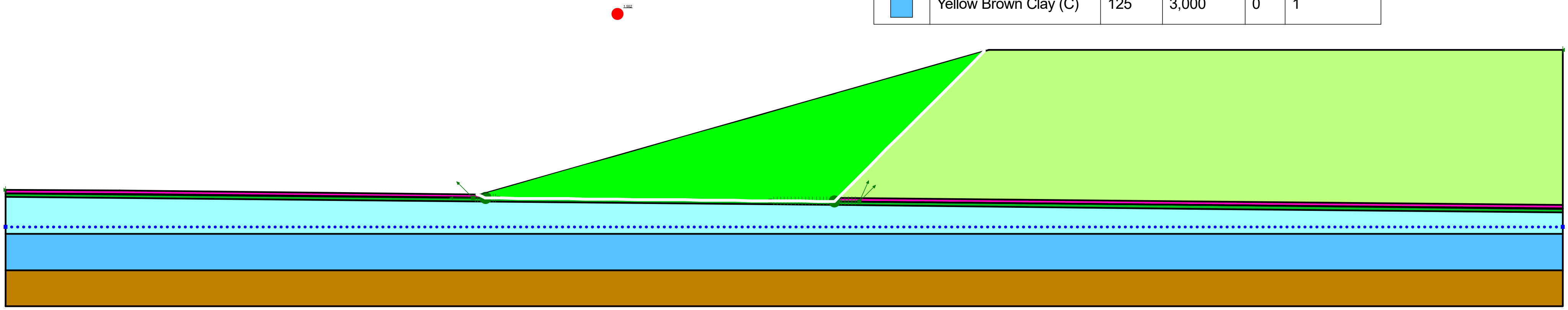
Regions

	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

Sandy Creek Energy Station
File Name: Slope 2 - Sliding Block-3000 psf - textured 17 deg.gsz

F of S: 1.552

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: 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

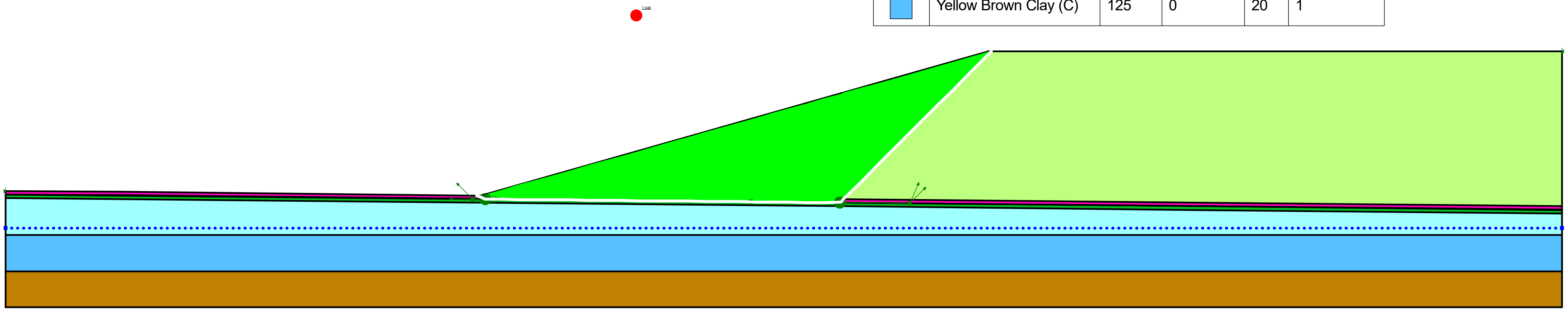
Regions

	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

File Version: 8.16
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

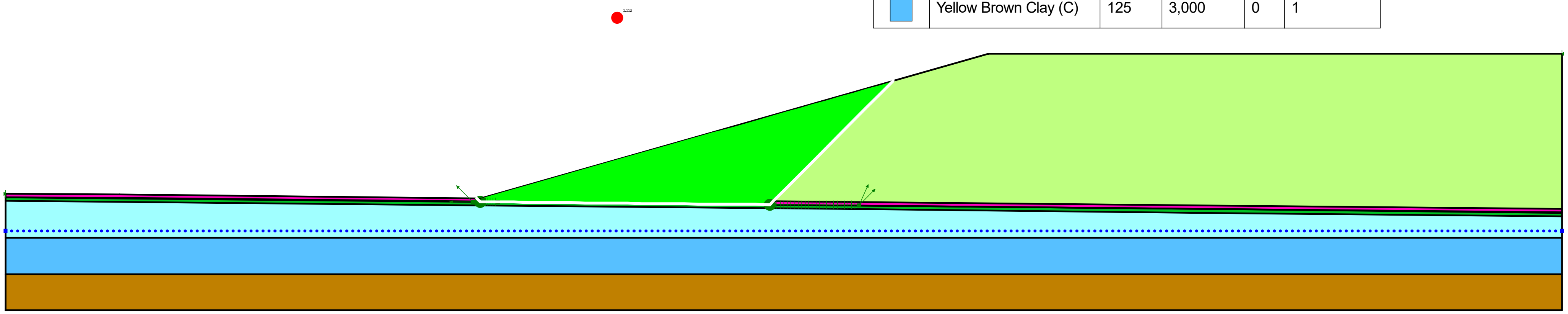
Regions

	Material	Points	Area (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	9	
🟦	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 9 deg.gsz

F of S: 1.110



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

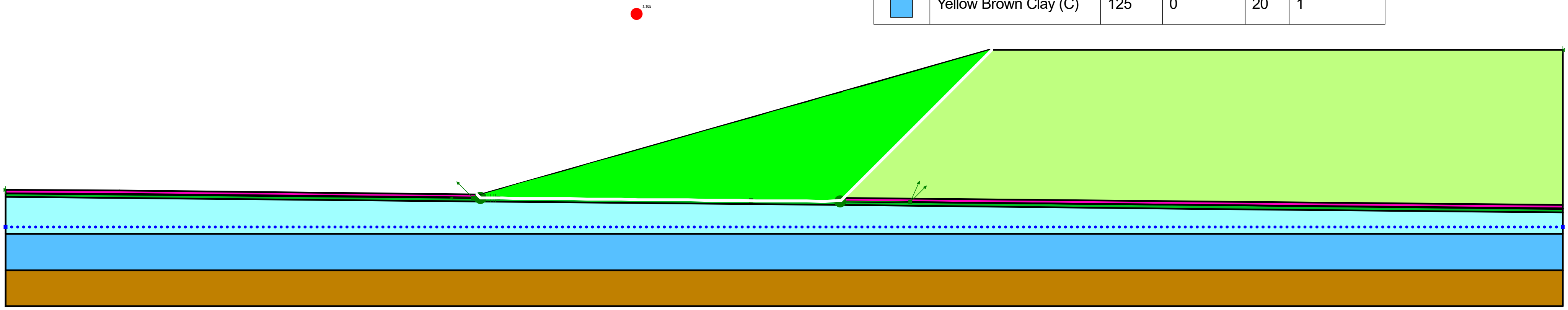
Regions

	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

File Version: 8.16
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

STATE OF TEXAS
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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

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Appendices

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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 x 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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6/7/21

SCS Engineers
TBPE Reg. #F-3407
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

STATE OF TEXAS
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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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6/7/21

SCS Engineers
TBPE Reg. #F-3407
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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TBPE Reg. #F-3407
Inclusive of Attachment 4.1

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
PIPE STRUCTURAL STABILITY
6-INCH DIAMETER HDPE PIPE

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.

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
PIPE STRUCTURAL STABILITY
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	**P_{DES}**	**t**	**r_m**	**S_A**	**VAF**	**P_{RD} (psf)**	**σ_{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.

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE

Prep'd By: SDS
Chkd By: RRK
Date: February 2021

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
			$\Sigma =$	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.

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
PIPE STRUCTURAL STABILITY
18-INCH DIAMETER HDPE PIPE

P_{RD} = (VAF) P_{DES} (Ref. 3)

σ_{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)

$P_{cr} = 1.63\ ((RB'M_sE) / (DR-1)^3)^{0.5}$ (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

STATE OF TEXAS
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LICENSED PROFESSIONAL ENGINEER

6/7/21

SCS Engineers
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:

$$q_{allow} = q_{ult}\ [(1/FS_{SCB} \times FS_{CR} \times FS_{IN} \times FS_{CC} \times FS_{BC})]$$ **(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

$\boxed{q_{allow=} \quad 3.00\text{E-}04 \quad \text{cm/s}}$

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.

$n = 1\text{-}[m/\rho t] \times 100$ **(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 = 0.083
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

$n = 1-[m/\rho t] \times 100$ **(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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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 dat

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 ENERGY STATION DISPOSAL FACILITY
GEOCOMPOSITE FLOW CAPACITY DEMONSTRATION

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

		Minimum Required	**GSE PermaNet HL (bi-planar) Double-Sided**		
Fill Condition	P (psf)	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

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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

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.

<u>Solution - Perforations Configuration (B):</u>

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:

$$\frac{D_{85} \text{ of Filter}}{\text{Hole Diameter}} = 2.0 \quad \geq 1.7 \quad \text{(acceptable)}$$

<u>In Addition:</u>

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.

<u>Conclusion:</u>
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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SANDY CREEK ENERGY STATION DISPOSAL FACILITY
LEACHATE COLLECTION SUMP DESIGN

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.

SANDY CREEK ENERGY STATION DISPOSAL FACILITY
LEACHATE COLLECTION SUMP DESIGN

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:

$$STORAGE = \frac{V_{TOT}}{V_{REQ}}$$

V_{REQ} = 2,857 cu. ft.
V_{TOT} = 3,562 cfd

Storage = 1.25 days

C. Calculate the average daily pump cycle time, based on a specified pump size.

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

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) = **45** ft
Sump Bottom Dimension ($X_{B)}$ = **27** ft
Sump Sideslopes = **3** (X)H:1V
Sump Design Depth = **3** ft