RECEIVED
MAY 22 2019
DISTRICT II-ARTESIA O.C.D.

District I
1625 N. French Dr., Hobbs, NM 88240
District II
811 S. First St., Artesia, NM 88210
District III
1000 Rio Brazos Road, Aztec, NM 87410
District IV
1220 S. St. Francis Dr., Santa Fe, NM 87505

State of New Mexico
Energy Minerals and Natural Resources
Department
Oil Conservation Division
1220 South St. Francis Dr.
Santa Fe, NM 87505

Form C-147
Revised April 3, 2017

Recycling Facility and/or Recycling Containment

Type of Facility: ☒ Recycling Facility ☒ Recycling Containment*

Type of action: ☒ Permit ☒ Registration
☐ Modification ☐ Extension
☐ Closure ☐ Other (explain) _____

*** At the time C-147 is submitted to the division for a Recycling Containment, a copy shall be provided to the surface owner.**

Be advised that approval of this request does not relieve the operator of liability should operations result in pollution of surface water, ground water or the environment. Nor does approval relieve the operator of its responsibility to comply with any other applicable governmental authority's rules, regulations or ordinances.

1.
Operator: XTO Permian Operating, LLC (For multiple operators attach page with information) OGRID #: 373075
Address: 6401 Holiday Hill Road, Bldg 5, Midland, TX 79707
Facility or well name (include API# if associated with a well): Shanghai
OCD Permit Number: _____ (For new facilities the permit number will be assigned by the district office)
U/L or Qtr/Qtr _____ Section 22 Township 25 South Range 29 East County: Eddy County
Surface Owner: ☒ Federal ☐ State ☐ Private ☐ Tribal Trust or Indian Allotment

2.
☒ **Recycling Facility:**
Location of recycling facility (if applicable): Latitude 32.118675° Longitude -103.974825° NAD83
Proposed Use: ☒ Drilling* ☒ Completion* ☒ Production* ☒ Plugging *
The re-use of produced water may NOT be used until fresh water zones are cased and cemented
☐ Other, ***requires permit for other uses. Describe use, process, testing, volume of produced water and ensure there will be no adverse impact on groundwater or surface water.***
☒ Fluid Storage
☐ Above ground tanks ☒ Recycling containment ☐ Activity permitted under 19.15.17 NMAC explain type _____
☐ Activity permitted under 19.15.36 NMAC explain type: _____ ☐ Other explain _____
☐ For multiple or additional recycling containments, attach design and location information of each containment
☐ **Closure Report (required within 60 days of closure completion):** ☐ Recycling Facility Closure Completion Date: _____

3.
☒ **Recycling Containment:**
☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)
Center of Recycling Containment (if applicable): Latitude 32.117775° Longitude -103.974687 NAD83
☐ For multiple or additional recycling containments, attach design and location information of each containment
☒ Lined ☒ Liner type: Thickness 60 mil ☐ LLDPE ☒ HDPE ☐ PVC ☒ Other 40 mil HDPE (secondary liner)
☐ String-Reinforced
Liner Seams: ☒ Welded ☐ Factory ☒ Other Field Volume: 1,000,000 bbl each Dimensions: L 1500 ft x W 1200 ft x D 16 ft
☐ Recycling Containment Closure Completion Date: _____

4.

Bonding:

☒ Covered under bonding pursuant to 19.15.8 NMAC per 19.15.34.15(A)(2) NMAC **(These containments are limited to only the wells owned or operated by the owners of the containment.)**

☐ Bonding in accordance with 19.15.34.15(A)(1). Amount of bond $_____ **(work on these facilities cannot commence until bonding amounts are approved)**

☐ Attach closure cost estimate and documentation on how the closure cost was calculated.

5.

Fencing:

☐ Four foot height, four strands of barbed wire evenly spaced between one and four feet

☒ Alternate. Please specify_Eight (8) feet high game fence with three (3) strands of barbed wire on top_____

6.

Signs:

☒ 12"x 24", 2" lettering, providing Operator's name, site location, and emergency telephone numbers

☐ Signed in compliance with 19.15.16.8 NMAC

7.

Variances:

Justifications and/or demonstrations that the proposed variance will afford reasonable protection against contamination of fresh water, human health, and the environment.

Check the below box only if a variance is requested:

☒ Variance(s): Requests must be submitted to the appropriate division district for consideration of approval. If a Variance is requested, include the variance information on a separate page and attach it to the C-147 as part of the application.

If a Variance is requested, it must be approved prior to implementation.

8.

Siting Criteria for Recycling Containment

Instructions: The applicant must provide attachments that demonstrate compliance for each siting criteria below as part of the application. Potential examples of the siting attachment source material are provided below under each criteria.

General siting

Ground water is less than 50 feet below the bottom of the Recycling Containment. NM Office of the State Engineer - iWATERS database search; USGS; Data obtained from nearby wells	☐ Yes ☒ No ☐ NA
Within incorporated municipal boundaries or within a defined municipal fresh water well field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3, as amended. - Written confirmation or verification from the municipality; written approval obtained from the municipality	☐ Yes ☒ No ☐ NA
Within the area overlying a subsurface mine. - Written confirmation or verification or map from the NM EMNRD-Mining and Minerals Division	☐ Yes ☒ No
Within an unstable area. - Engineering measures incorporated into the design; NM Bureau of Geology & Mineral Resources; USGS; NM Geological Society; topographic map	☐ Yes ☒ No
Within a 100-year floodplain. FEMA map	☐ Yes ☒ No
Within 300 feet of a continuously flowing watercourse, or 200 feet of any other significant watercourse, or lakebed, sinkhole, or playa lake (measured from the ordinary high-water mark). - Topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 1000 feet from a permanent residence, school, hospital, institution, or church in existence at the time of initial application. - Visual inspection (certification) of the proposed site; aerial photo; satellite image	☐ Yes ☒ No
Within 500 horizontal feet of a spring or a fresh water well used for domestic or stock watering purposes, in existence at the time of initial application. - NM Office of the State Engineer - iWATERS database search; visual inspection (certification) of the proposed site	☐ Yes ☒ No
Within 500 feet of a wetland. - US Fish and Wildlife Wetland Identification map; topographic map; visual inspection (certification) of the proposed site	☐ Yes ☒ No

9.
Recycling Facility and/or Containment Checklist:
Instructions: Each of the following items must be attached to the application. Indicate, by a check mark in the box, that the documents are attached.

- ☒ Design Plan - based upon the appropriate requirements.
- ☒ Operating and Maintenance Plan - based upon the appropriate requirements.
- ☒ Closure Plan - based upon the appropriate requirements.
- ☒ Site Specific Groundwater Data -
- ☒ Siting Criteria Compliance Demonstrations –
- ☒ **Certify that notice of the C-147 (only) has been sent to the surface owner(s)**

10.
Operator Application Certification:
I hereby certify that the information and attachments submitted with this application are true, accurate and complete to the best of my knowledge and belief.

Name (Print): Joseph Parker Title: Regulatory Coordinator

Signature: Date: 2/21/19

e-mail address: joseph_parker@xtoenergy.com Telephone: 432-571-8233

11.
OCD Representative Signature: _____ **Approval Date:** _____

Title: _____ **OCD Permit Number:** _____

☐ OCD Conditions _____
☐ Additional OCD Conditions on Attachment

XTO ENERGY, INC.

C-147 REGISTRATION PACKAGE

SHANGHAI RECYCLING CONTAINMENT FACILITY
SECTION 22, TOWNSHIP 25 SOUTH, RANGE 29 EAST

EDDY COUNTY, NM

RECEIVED
MAY 22 2019
DISTRICT II-ARTESIA O.C.D.

Shanghai Containment

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Appendices

Part 1
Introduction

XTO Energy, Inc. (XTO) is requesting registration under NMAC 19.15.34 for the following recycling containment and recycling facility in the development area on a tract of land of located in Section 22, Township 25 South, Range 29 East, in Eddy County, New Mexico.

The proposed recycling facility will be solely for recycling of fluids used for completing wells owned and operated by XTO. The recycling containment ponds will cover an area of 41.304 acres and will consist of two double lined containment ponds with leak detection that will each hold approximately 500,000 barrels. The facility is expected to be in use for at least 5 years.

Figure 1-1 contains a **Site Vicinity Map** identifying the location of the proposed recycling containment and the recycling facility. Both the recycling containment and the recycling facility will be located on the same tract of land.

Compliance with the requirements of NMAC 19.15.34 are described in the application. XTO is requesting a total of three (3) variances from the requirements. Those variance requests are described in detail in Part 3 of this application.

A copy of Form C-147 found in **Part 2** has been submitted to the surface owner, as required under 19.15.34.10.A.

Part 2

NMOCD Form C-147

Part 3

Variance Requests

The following paragraphs describe the variances that have been requested.

3.1 Liner

XTO is requesting a variance to rule 34 Part 12(A)(4) requiring the secondary (lower) liners to be 30-mil string reinforced LLDPE or equivalent with a hydraulic conductivity no greater than $1x10^{-9}$ cm/sec. XTO is requesting approval to use 40 mil HDPE in place of the specified material. The proposed 40 mil HDPE is appropriate material for the proposed use of the containment and is compatible with the water that will be stored. This material will provide equal or better environmental protections than the specified 30 mil string reinforced LLDPE. The proposed 40 mil HDPE will be seamed in a manner that will allow nondestructive pressure testing of the seams to ensure proper sealing.

The proposed liner system cross section is as follows: prepare subgrade, 8 oz. geotextile, 40-mil HDPE, single sided 200-mil geonet, 60-mil HDPE (smooth on bottom, textured on slopes). This cross section is shown on Sheet C-6 in **Appendix G.**

3.2 Fencing

The recycling containment will be constructed with an eight (8) foot high game fence with three (3) strands of barbed wire on top to deter wildlife and human access. This is a variance from the required four (4) foot fence with at least four (4) stands of barbed wire evenly spaced in the intervals between one (1) foot and four (4) foot above ground level and provides equivalent or greater wildlife and human deterrence. The fence will be gated to provide access to XTO personnel and will be closed and locked when access in not required.

3.3 Netting and Wildlife Protection

The game fence, as described above, surrounding the recycling containment and recycling facility will be effective in excluding terrestrial wildlife. XTO is proposing to install an audible avian deterrence system in lieu of installing netting. XTO is proposing to install an electronic sonic/ultrasonic avian deterrence system equivalent or equal to the Bird-X BroadBand Pro or the Bird-X Mega Blaster Pro.

This type of system has been utilized by other recycling containment operators in southeast New Mexico and has been demonstrated to be an effective deterrent for avian species, including migratory birds. The O&M plan calls for the operator to inspect for and within 30 days of discovery, report the discovery of dead migratory birds or other wildlife to the appropriate wildlife agency and to the division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.

Part 4

Siting Requirements

4.1 Distance to Groundwater

This section describes the hydrology and geology surrounding the XTO Shanghai recycling containment and recycling facility. **Figure 1-1** shows the location of the proposed XTO recycling containment and recycling facility. **Figure 1-2** is a 7.5-minute USGS topographic map that shows the surface elevations at the site and surrounding area.

The New Mexico Oil and Gas Division (NMOCD) requires that groundwater (freshwater as defined by NMOCD rules) at the location be greater than 50-feet below the containment bottom. **Figure 2-1** (**Boring Log No. B-1** found in **Appendix I**) and the discussion below demonstrates that depth to groundwater at the proposed location is greater than 50-feet beneath the bottom (75-feet from surface) of the recycling containment and the recycling facility. **Figure 1-3** is a geologic map from the U.S. Geological Survey, Mineral Resources Program of geologic units and structural features in the general location of the proposed recycling containment and the recycling facility. **Figure 2-2** shows the proposed recycling containment and the recycling facility location is located within an unmapped aquifer system. Other major aquifers in the area include the Pecos River Basin alluvial aquifer system, Capitan Reef, Roswell Basin, and High Plains Aquifer. Available groundwater within the area of the proposed recycling containment and the recycling facility is noted to be within the Carlsbad Basin, by the New Mexico OSE. The Carlsbad Basin contains two major water-bearing features include the Capitan Reef and shallower alluvial and terrace aquifer systems. Water-bearing zones include the Carlsbad and Capitan Limestones, and the Rustler and Dockum Formations.

A geological map for the vicinity of the site was obtained from the U.S. Geological Survey, Mineral Resources Program and was used to review the geologic setting for the proposed recycling containment and recycling facility location (Figure 1-3). Based on the review of the geologic map, the recycling containment and the recycling facility location lies within the Eolian and Piedmont deposits (Qe/Qp) and Older alluvial deposits of upland plains and piedmont areas (Qoa). The Eloian and Piedmont deposits consist of deposits of interlayered eolian sands and piedmont-slope deposits. The Older alluvial deposits are of upland plains and piedmont areas, and calcic soils and eolian cover sediments of High Plains region.

On September 22, 2018 site-specific geotechnical borings were conducted to a depth of 75 feet with no detected or observed groundwater presence. The test boring logs may be found in Appendix I.

4.2 Distance to Surface Water

Figure 2-2 demonstrates that the site location is not within 300-feet of a continuously flowing watercourse or other significant watercourse, or within 200-feet of a lakebed, sinkhole, or playa lake (as measured from the ordinary high-water mark). Figure 2-2 shows that there are no continuously flowing watercourses or other water bodies defined by NMOCD rules. The closest

surface water bodies are the Pecos River, located approximately 4 miles west and Willow Lake, which is located approximately 7 miles northwest of the proposed recycling containment and recycling facility location.

4.3 Distance to Permanent Residences, Institutions, or Structures

Figure 2-3 demonstrates the site location is not within 1,000-feet of an occupied permanent residence, school, hospital, institution, church, or other permanent structure in existence at the time of initial application. Harroun School is approximately 11 miles north of the proposed recycling containment and recycling facility location.

4.4 Distance to Non-Public Water Supply

The site is not located within 500-horizontal feet of a private, domestic fresh water well or spring that less than five households use for domestic or stock watering purposes. In addition, the site is not located within 1,000-feet of any other fresh water well or spring, as documented at the time of this application. **Figure 2-4** shows the location of area water wells, active or plugged, relative to the proposed site location. The nearest fresh water well listed is CP 03617, which is located approximately 0.75 miles from pond boundary according to the NMOSE/ISC database accessed on September 12, 2018. No springs were identified within the mapping area.

4.5 Distance to Municipal Boundaries and Freshwater Fields

Figure 2-5 demonstrates that the location is not located within incorporated municipal boundaries or within a defined municipal fresh water field covered under a municipal ordinance adopted pursuant to NMSA 1978, Section 3-27-3. The closest municipality to the site is Malaga, New Mexico located approximately 9 miles northwest of the site. In addition, the municipalities of Loving, NM is located approximately 15 miles northwest of the site, and Livingston Wheeler, NM located approximately 26 miles northwest of the site. The closest municipal well field is located approximately 27 miles northwest (Sheep's Draw well field) and 63 miles northeast (Double Eagle well field) both serving the community of Carlsbad, New Mexico.

4.6 Distance to Wetlands

The U.S Fish and Wildlife National Wetlands Inventory maps were reviewed for the area of the site. **Figure 2-6** demonstrates the site is not located within 100 feet of a mapped wetland. The closest mapped wetland is a Riverine with the wetland code "R4SBJ" (Riverine, Intermitten, Streambed, Intermittently Flooded) located approximately 500 feet south of the site.

4.7 Distance to Subsurface Mines

General knowledge based on a search of the New Mexico Energy, Minerals, and Natural Resources Department (NM EMNRD) Mining and Minerals Division database confirms that there are no subsurface mines in proximity of the recycling containment and recycling facility (**Figure 2-7**). The only identified facilities in the general vicinity are caliche and aggregate mines.

4.8 Distance to High or Critical Karst Areas (Unstable Areas)

The recycling containment and the recycling facility are located within a BLM-identified medium potential karst zone. **Figure 2-8** shows BLM inventory data of existing cave/karst features, and results of the site-specific geotechnical studies are detailed in Appendix I.

4.9 Distance to 100-Year Floodplain

The Federal Emergency Management Agency (FEMA) Flood Insurance maps were reviewed for the location of the site. The site is not located within a "Printed Flood Map Boundary." **Figure 2-9** demonstrates the area of the site is not located within a 100-year Floodplain.

Appendix A

Design and Construction Plan

General Specifications

Appendix A contains the design drawings and details for the recycling containment, which are designed and stamped by a Professional Engineer licensed in the State of New Mexico. **Appendix H** contains the construction specifications to accompany the design drawings and details. These design drawings and specifications meet or exceed the NMOCD requirements for recycling containments. **Appendix I** contains the geotechnical engineering testing results for the recycling containment site.

This plan addresses construction of double lined earthen containment. Field conditions may create the need for minor modifications of the containment design (i.e. changing length, width or depth) during construction.

The following general specifications have been incorporated into the design and will be met during construction.

- The recycling containment is designed and will be constructed to ensure confinement of produced water, to prevent releases, and to prevent overtopping due to wave action or rainfall. The recycling containment is being designed using a three (3) foot freeboard as the design criteria.
- The recycling containment, as designed, will be constructed with a proper foundation and interior slopes consisting of a firm, unyielding base, which is smooth and free of rocks, debris, sharp objects and irregularities. In addition, an 8 oz. non-woven geotextile will be installed under the secondary (lower) liner as needed to provide additional protection from any protuberances in the foundation and to reduce any localized stress-strain.
- The recycling containment will be constructed with inside and outside slope grades of three horizontal feet to one vertical foot (3H:1V), which is flatter and provides greater stability than the NMOCD 2H:1V specifications for the inside grade.
- The recycling containment will be constructed with a 40 mil HDPE secondary (lower) liner, a 60 mil HPDE primary (upper) liner, and a leak detection system.
- The exterior of both liners with be anchored in the bottom of a 24-inch deep compacted earth filled trench, which exceeds the NMOCD 18-inch specification.
- Liner seams will be minimized and orientated vertically rather than across slopes. Factory welded seams will be utilized to the maximum extent possible. Sloped liner panels will extend a minimum of five (5) feet beyond the point of grade change to prevent seams from resting on the grade break.

- All field seams and welds will be subjected to non-destructive field testing by qualified personnel per the appropriate testing standard to ensure proper thermal sealing. Field seams will be overlapped a minimum of 6-inches.
- The primary (upper) liner will be protected from excessive hydraulic force or mechanical damage from discharge or suction within the recycling containment. No discharge or suction lines will penetrate the liners.
- The recycling containment will be constructed with a 200 mil geonet leak detection system located between the primary (upper) and the secondary (lower) liners. The system is properly designed to facilitate effective drainage, collection, and removal of liquid above the secondary (lower) liner and the leakage detection at the earliest possible time.
- The recycling containment is designed to prevent run on of surface water. The minimal distance from the existing surface elevation to the top of the containment berm will be approximately 10 feet.

Stockpiling of Topsoil

Where topsoil is present, prior to constructing the recycling containment, it will be stripped and stockpiled on site for use as final cover or fill.

Signs

An upright sign no less than 12 inches by 24 inches with lettering no less than 2 inches in height will be installed in a conspicuous place on the fence surrounding the recycling containment. The sign will be installed in such a manner and location that a person can easily read the sign. The sigh will include:

- The operator's name;
- The location of the site by quarter-quarter or unit letter, section, township and range; and
- Emergency telephone number.

Fencing

The recycling containment will be constructed with an eight (8) foot high game fence equipped with 3 strands of barbed wire at the top to deter unauthorized wildlife and human access. The fence will be gated to provide access to operations personnel and will be closed and locked when access is not required.

Netting and Wildlife Protection

The game fence, as described above, surrounding the recycling containment and recycling facility will be effective in excluding terrestrial wildlife. XTO, is proposing to install an audible avian deterrence system in lieu of installing netting. XTO is proposing to install an electronic sonic/ultrasonic avian deterrence system equivalent or equal to the Bird-X BroadBand Pro or the Bird-X Mega Blaster Pro.

This type of system has been utilized by other recycling containment operators in southeast New Mexico and has been demonstrated to be an effective deterrent for avian species, including migratory birds. The O&M plan calls for the operator to inspect for and within 30 days of discovery, report the discovery of dead migratory birds or other wildlife to the appropriate wildlife agency and to the division district office in order to facilitate assessment and implementation of measures to prevent incidents from reoccurring.

Appendix B

Operating and Maintenance Plan

The recycling containment will be operated in such a manner to contain liquids and solids. The integrity of the liner and leak detection system will be monitored in such a manner to prevent contamination of fresh water and protect public health and the environment as described below. The purpose of the recycling containment is to facilitate recycling of treated produced water from nearby oil and gas wells for new well completions. When treated produced water is not needed for well completion activity, produced water will be properly injected at one of XTO's or a third party's authorized SWDs. The recycling containment will not be used for disposal of produced water or other oilfield wastes.

The recycling containment and associated leak detection system will be inspected at least weekly by XTO field operations personnel while it contains any fluid and the results of the inspection will be documented on an inspection checklist. The completed checklists will be retained and made available for review upon request. These inspections will address, at a minimum, the following:

- Removal of any visible layer of oil from the liquid surface;
- Verification that a minimum of three (3) foot freeboard is maintained;
- If a liner breach is identified above the liquid surface, the liner will be repaired, or liner replacement will be initiated within 48 hours of detection. Alternatively, the NMOCD district office will be contacted within 48 hours to seek and extension for liner repair / replacement;
- If a liner breach is identified below the liquid surface, all liquid above the identified breach will be removed, the NMOCD district office will be notified, and liner repair / replacement shall be initiated within 48 hours of discovery;
- Visual inspection of berm integrity and condition to ensure the prevention of surface water run-on; and
- Determination that an oil absorbent boom is present and in proper condition to contain an unanticipated release.

The containment will be equipped with permanent HDPE stingers (supported by a sacrificial liner) for withdrawal of fluid during operations so that external discharge or suction lines do not penetrate the liner.

Treated produced water deposits into and withdrawals from the recycling containment will be measured and documented to determine when the system has ceased operations (less than 20% of the total fluid capacity is used during each rolling six-month period following the initial withdrawal of produced water.

XTO will submit Form C-148 monthly to NMOCD within 30 days of the end of the calendar month listing: volumes of produced water received; volumes of fresh or brackish water received; and total volumeof water leaving the recycling facility.

Upon cessation of operation, the NMOCD district office will be notified. XTO will submit to NMOCD a completed Form C-148 within 30 days following the end of each calendar month. Each submittal will certify that the recycling containment has not ceased operation based on the 20% threshold described above.

Appendix C
Closure Plan

After operations cease (less than 20% of the total fluid capacity is used every six months following the initial withdrawal of produced water), all fluids will be removed within 60 days and the recycling containment closed within six months.

All removed liquids, solids, and liner materials will be removed and transferred to an NMOCD-approved disposal facility within the six-month period.

A five-point composite sample will be collected from beneath the containment and tested for contamination. The composite sample will include stained or wet soil areas, if any, and analyzed for constituents listed in Table I of 19.15.34.14 NMAC.

- If any contaminant concentration exceeds the values listed in Table I (based on depth from bottom of containment to groundwater), the NMOCD district office will be contacted requesting approval before proceeding with closure activity.
- If all contaminant concentrations are less than or equal to the values listed in Table I, closure will proceed by backfilling with non-waste containing, uncontaminated, earthen material.

Within 60 days of completing closure, a Closure Report on NMOCD Form C-147, including required attachments, will be submitted to document all closure activities including sampling results and details of any backfilling, capping, or covering, were applicable. The Closure Report will certify that all information in the report and attachments is correct and that all applicable closure requirements and conditions specified in NMOCD rules and directives have been met.

The recycling containment's locations will be reclaimed to a safe and stable condition that blends with the surrounding undisturbed areas. Topsoil and subsoil will be replaced to their original relative positions and contoured to achieve erosion control, long-term stability, and preservation of surface water flow patterns.

The location will be reseeded in the first favorable growing season following closure with the goal of substantially restoring the impact surface location to the existing condition prior to construction of the recycling containment. Surface reclamation will be deemed complete when: all ground surface disturbing activities have been completed; a uniform vegetative cover with a life-form ratio of plus or minus 50% of pre-disturbance levels has been established; and a total percent plant over of at least 70%, excluding noxious weeds, has been established.

Surface reclamation obligations imposed by the Bureau of Land Management or New Mexico State Trust Land on lands managed by those agencies will supersede these requirements, provided that these other requirements provide equal or greater protection of fresh water, human health, and the environment. NMOCD will be notified when reclamation and re-vegetation are complete.

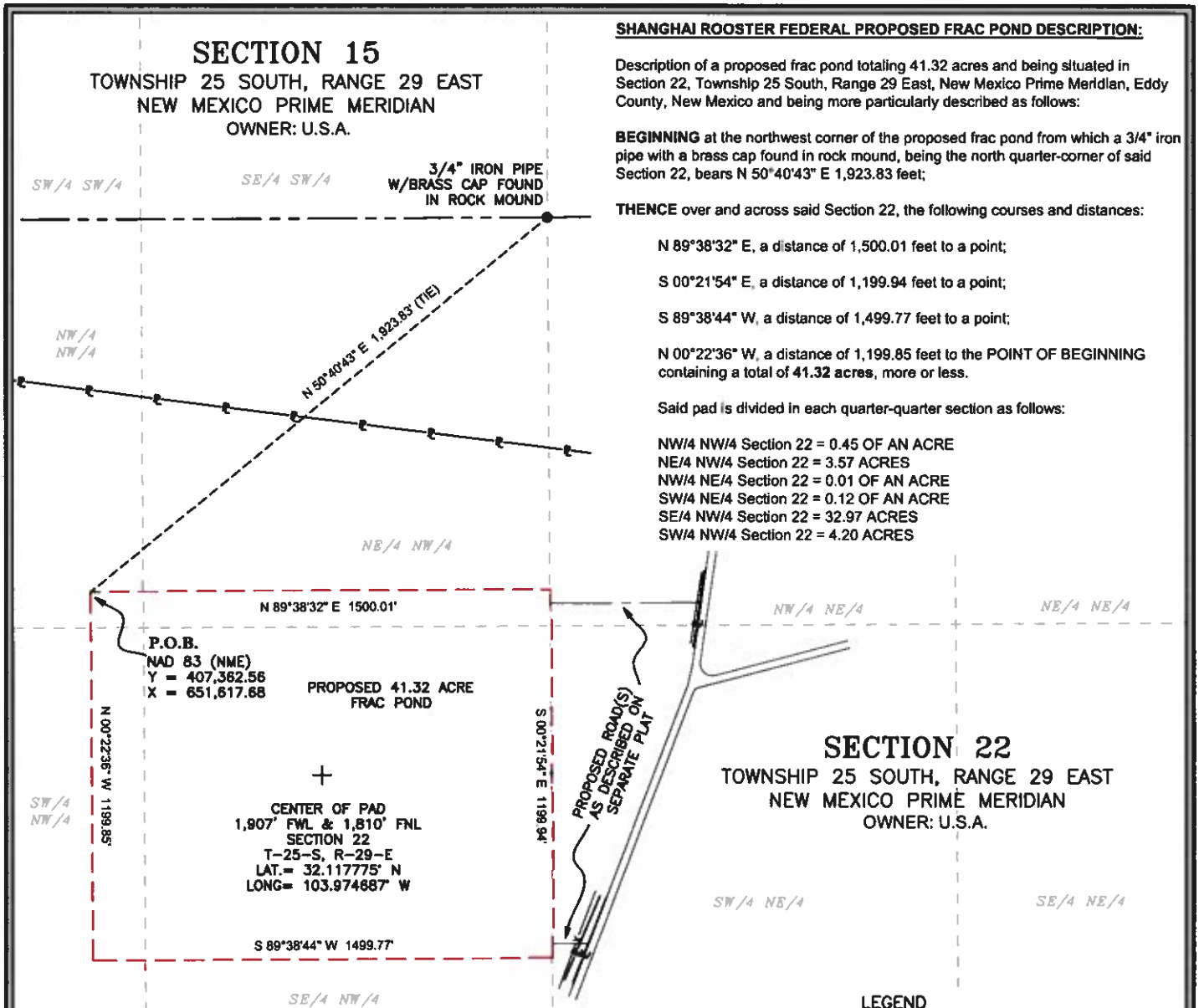
Appendix D

Financial Assurance Requirement

XTO has existing financial assurance in place with NMOCD as required by 19.15.8 NMAC and use of the recycling containment will be limited to support completion of only wells owned and operated by XTO. Therefore, no additional financial assurance associated with the recycling containment is required.

Appendix E

Site Location



SHANGHAI ROOSTER FEDERAL PROPOSED FRAC POND DESCRIPTION:

Description of a proposed frac pond totaling 41.32 acres and being situated in Section 22, Township 25 South, Range 29 East, New Mexico Prime Meridian, Eddy County, New Mexico and being more particularly described as follows:

BEGINNING at the northwest corner of the proposed frac pond from which a 3/4" iron pipe with a brass cap found in rock mound, being the north quarter-corner of said Section 22, bears N 50°40'43" E 1,923.83 feet;

THENCE over and across said Section 22, the following courses and distances:

N 89°38'32" E, a distance of 1,500.01 feet to a point;

S 00°21'54" E, a distance of 1,199.94 feet to a point;

S 89°38'44" W, a distance of 1,499.77 feet to a point;

N 00°22'36" W, a distance of 1,199.85 feet to the POINT OF BEGINNING containing a total of **41.32 acres**, more or less.

Said pad is divided in each quarter-quarter section as follows:

NW/4 NW/4 Section 22 = 0.45 OF AN ACRE
NE/4 NW/4 Section 22 = 3.57 ACRES
NW/4 NE/4 Section 22 = 0.01 OF AN ACRE
SW/4 NE/4 Section 22 = 0.12 OF AN ACRE
SE/4 NW/4 Section 22 = 32.97 ACRES
SW/4 NW/4 Section 22 = 4.20 ACRES

LEGEND

- SECTION LINE
- PROPOSED FRAC POND
- EXISTING ROAD
- EXISTING FENCE
- EXISTING PIPELINE
- P.O.B. POINT OF BEGINNING
- FOUND MONUMENT AS NOTED

GENERAL NOTES

1. BEARINGS AND COORDINATES SHOWN HEREON ARE MERCATOR GRID AND CONFORM TO THE NEW MEXICO COORDINATE SYSTEM "NEW MEXICO EAST ZONE" NORTH AMERICAN DATUM 1983. DISTANCES ARE SURFACE VALUES.
2. LATITUDE AND LONGITUDE VALUES SHOWN HEREON ARE RELATIVE TO THE NORTH AMERICAN DATUM (NAD83).

0 250' 500'
1" = 500 FEET

I, MARK DILLON HARP, NEW MEXICO PROFESSIONAL SURVEYOR NO. 23786, DO HEREBY CERTIFY THAT THIS SURVEY PLAT AND THE ACTUAL SURVEY ON THE GROUND UPON WHICH IT IS BASED WERE PERFORMED BY ME OR UNDER MY DIRECT SUPERVISION; THAT I AM RESPONSIBLE FOR THIS SURVEY, THAT THIS SURVEY MEETS THE MINIMUM STANDARDS FOR SURVEYING IN NEW MEXICO, AND THAT IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND BELIEF.

MARK DILLON HARP
REGISTERED PROFESSIONAL LAND SURVEYOR
STATE OF NEW MEXICO NO. 23786

MARK DILLON HARP NEW MEXICO 23786 PROFESSIONAL SURVEYOR

FSC INC
SURVEYORS+ENGINEERS
550 Bailey Ave., 205 - Fort Worth, TX 76107
Ph: 817.349.9800 - Fax: 979.732.5271
TBPE Firm 17957 | TBPLS Firm 10193887
www.fscinc.net

XTO ENERGY, INC.

PROPOSED SHANGHAI ROOSTER FEDERAL FRAC POND

SURVEY FOR A PROPOSED FRAC POND SITUATED IN THE NW/4 OF SECTION 22, TOWNSHIP 25 SOUTH, RANGE 29 EAST, N.M.P.M., EDDY COUNTY, NEW MEXICO

DATE:	9-18-2018	PROJECT NO:	2018010297
DRAWN BY:	AI	SCALE:	1" = 500'
CHECKED BY:	DH	SHEET:	1 OF 1
FIELD CREW:	KN	REVISION:	NO

Appendix F

Figures

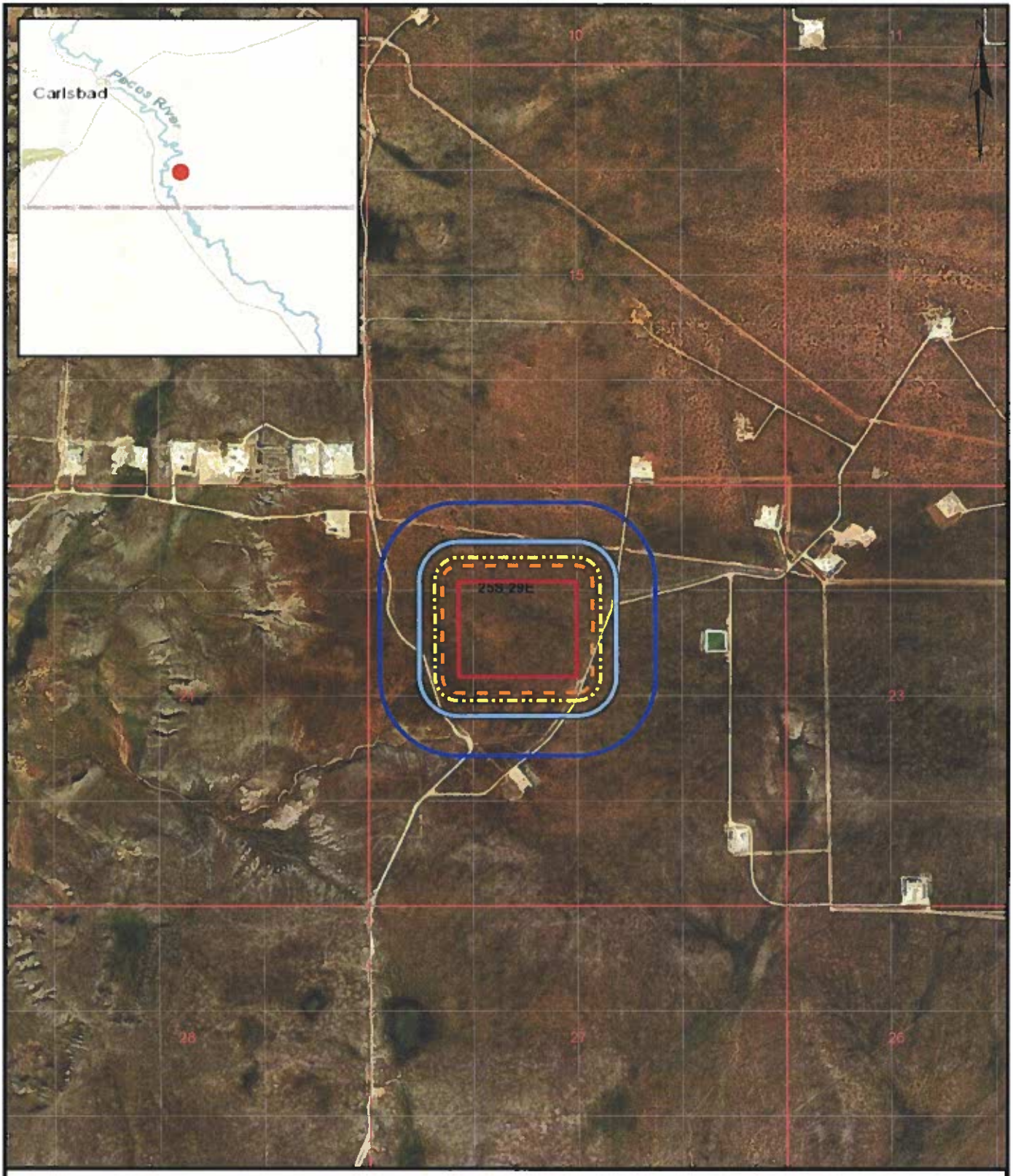


Figure 1-1 Site Vicinity Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

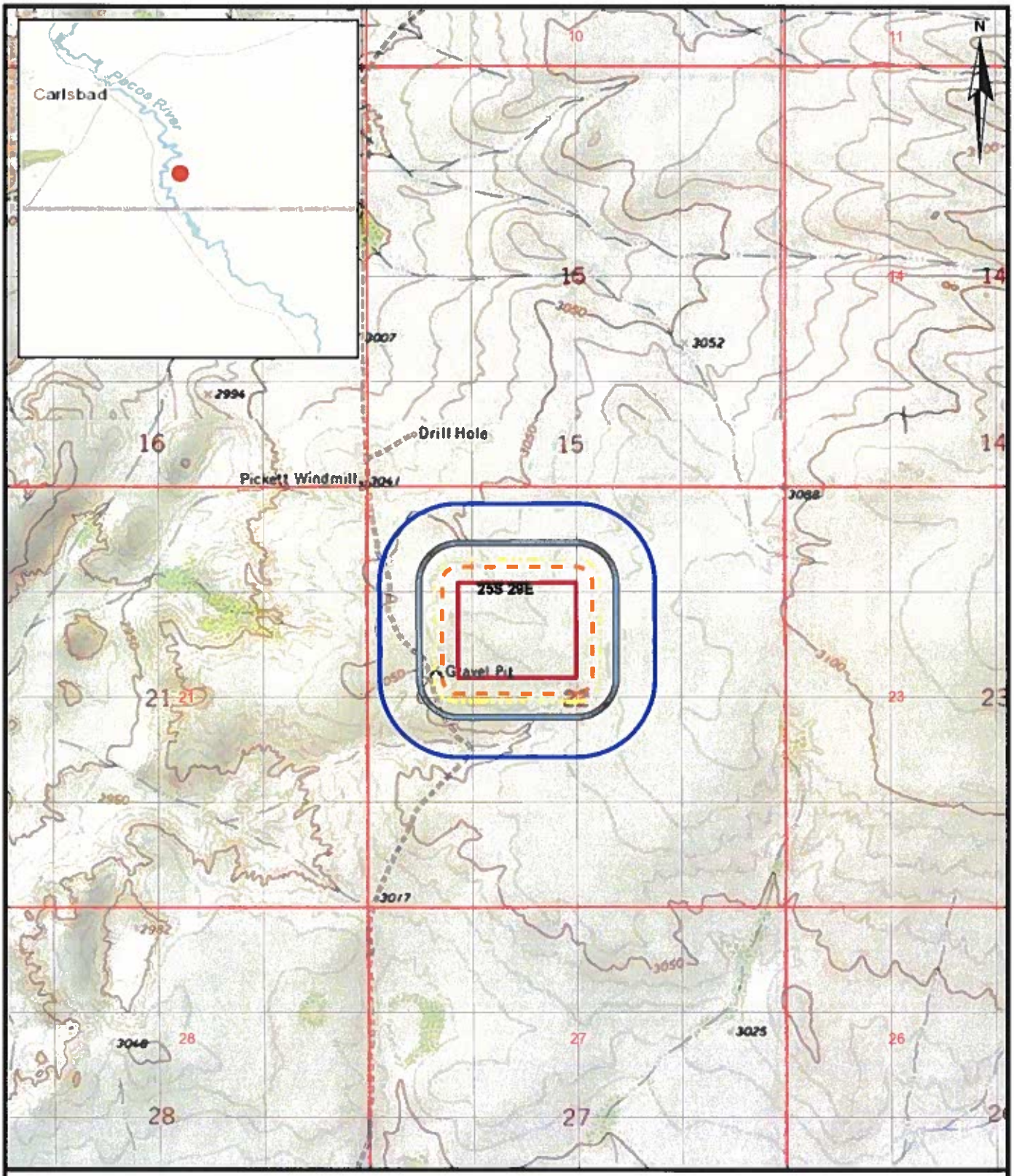


Figure 1-2 USGS 7.5 Minute Topographic Map

XTO Energy Inc. Proposed BEU Shanghai
Recycling Containment Location

Proposed Facility Boundary

Feet
0 1,000 2,000 4,000

200'
300'
500'
1000'

CDM Smith

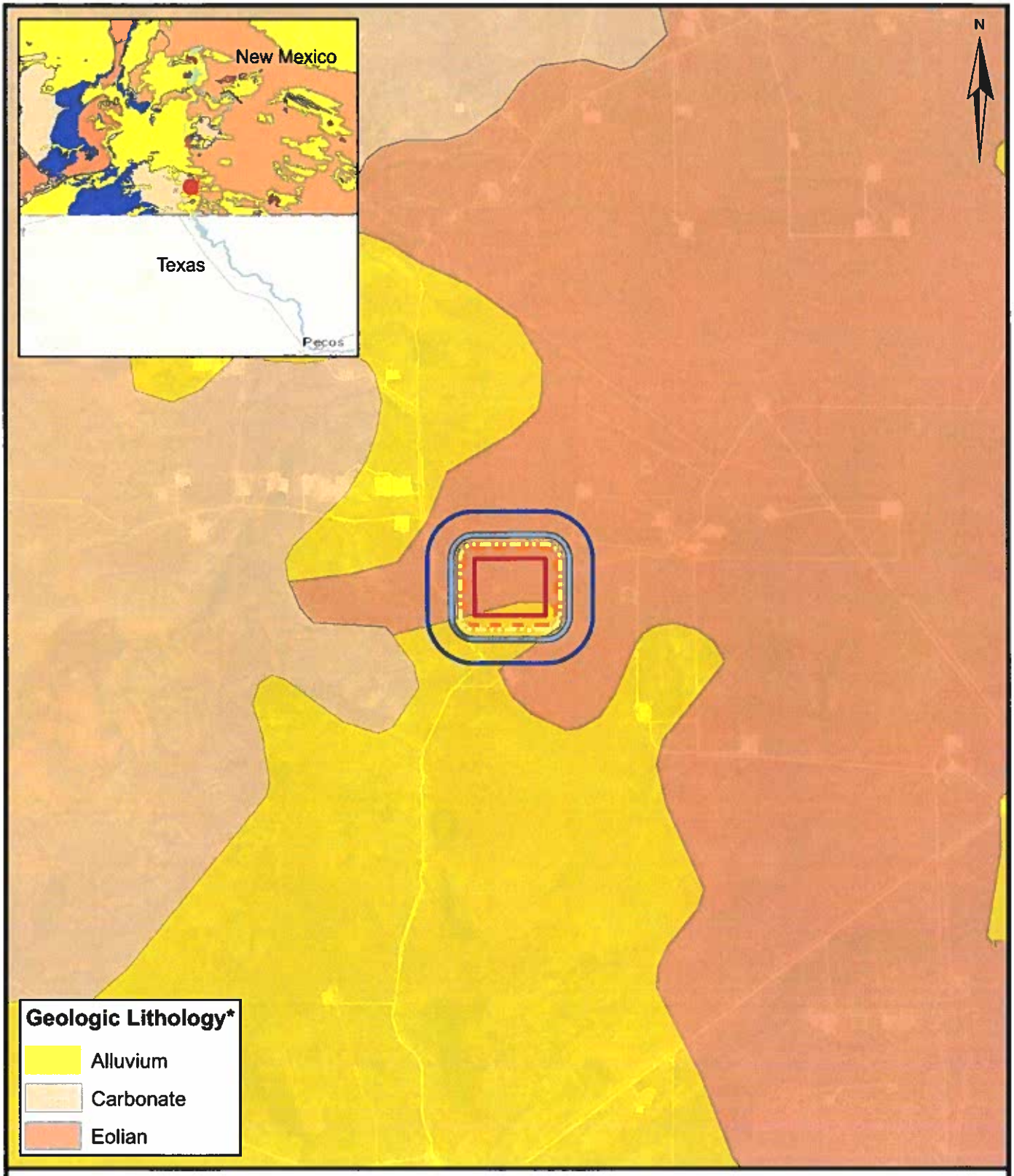


Figure 1-3 USGS Geologic Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location


New Mexico
Texas
180
285
20
N
3923 ft
Salt Lake
Eddy
Lea
National Parks Rural Hwy
285
Pecos River Basin Alluvial
TEXAS
Reeves
Loving
Loving
Figure 2-2 Aquifer Map
XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location
Proposed Facility Boundary
Aquifer Name*
Capitan Reef
High Plains
Pecos River Basin Alluvial
Rio Grande System
Roswell Basin System
0
3.75
7.5
15
Miles
*Bureau of Land Management, Carlsbad Field Office
CDM Smith

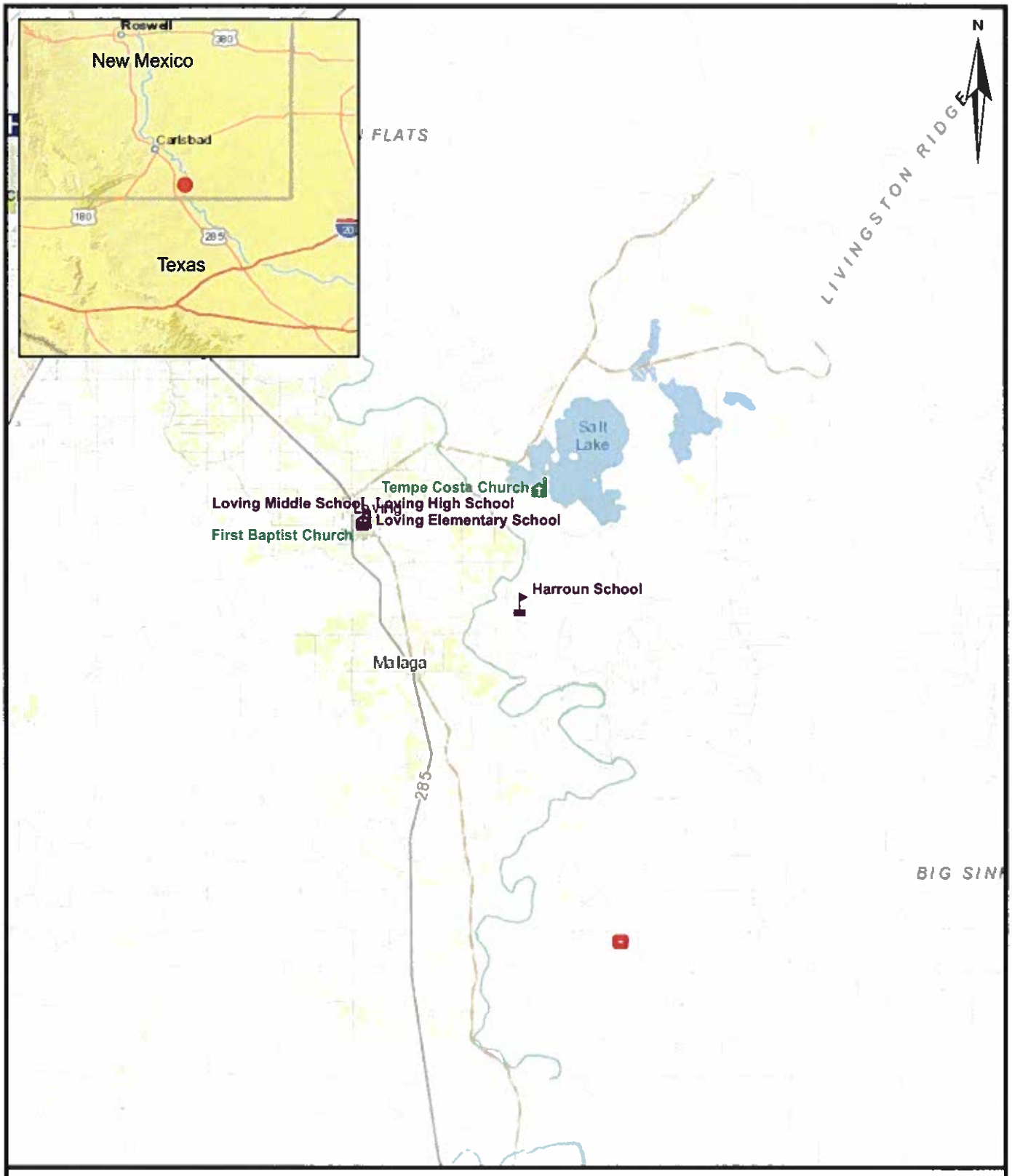


Figure 2-3 Distance From Structures Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

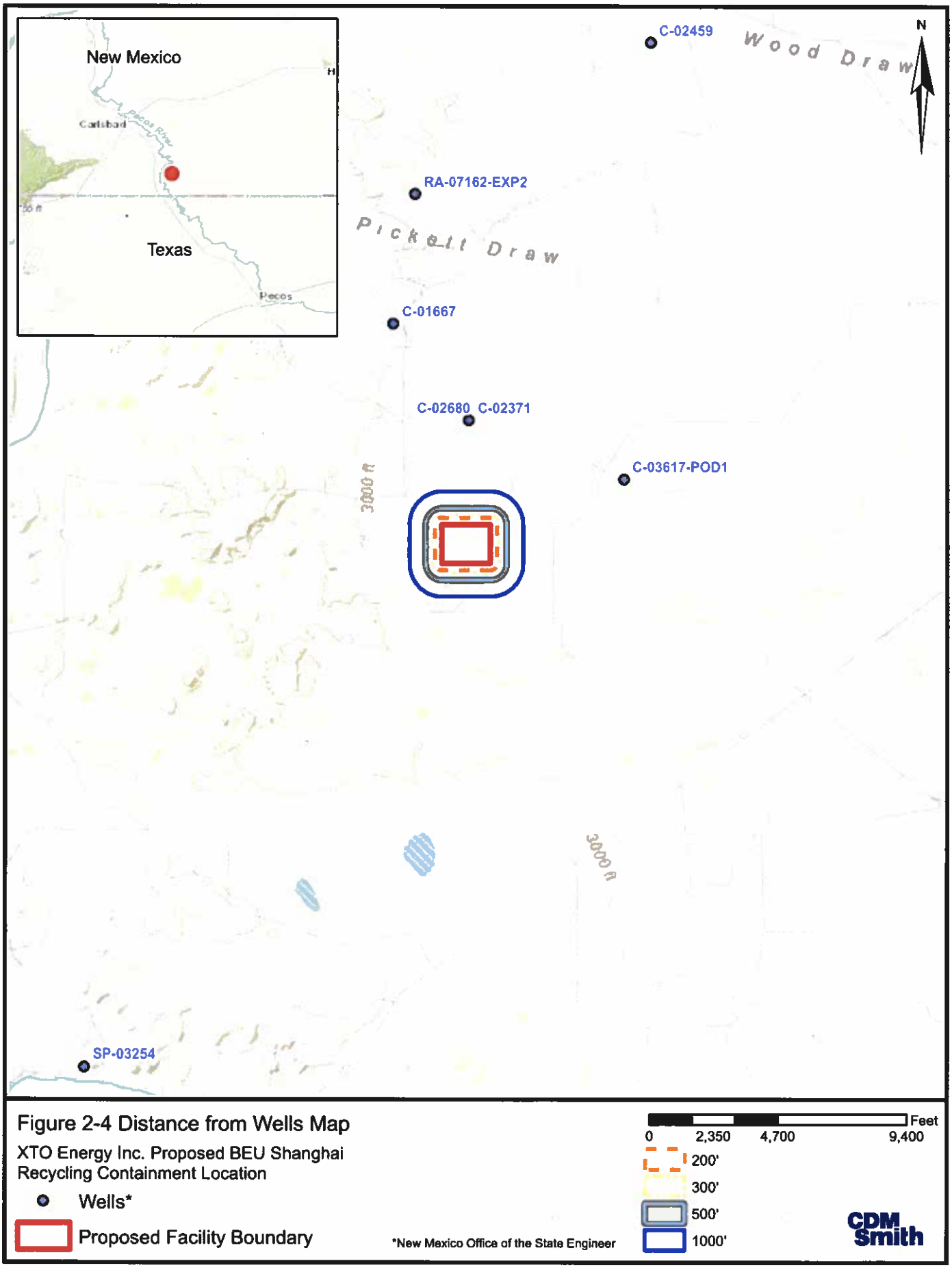


Figure 2-4 Distance from Wells Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

Wells*

Proposed Facility Boundary

*New Mexico Office of the State Engineer

Feet
0 2,350 4,700 9,400

200'
300'
500'
1000'

CDM Smith

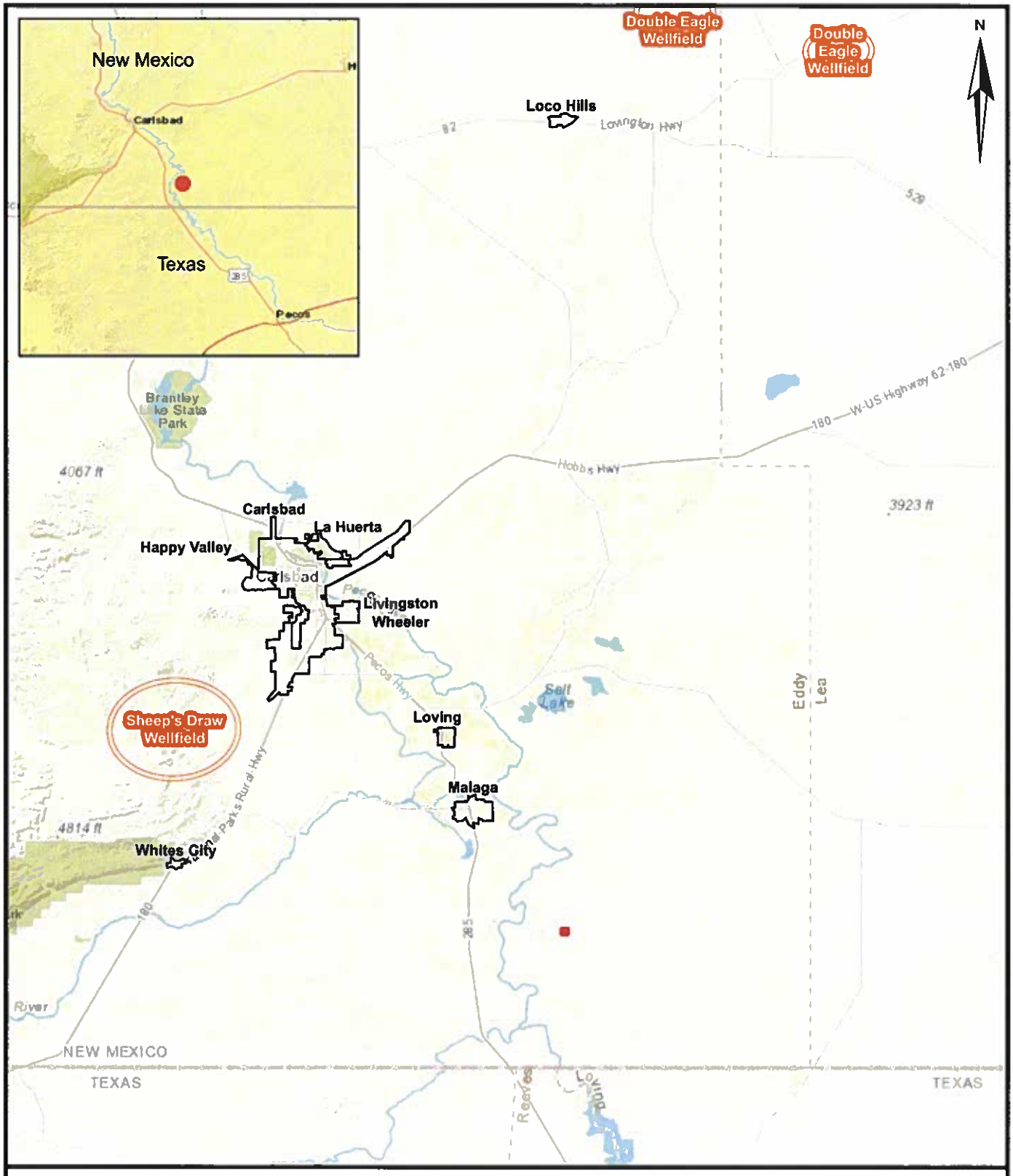


Figure 2-5 Distance From Municipalities and Freshwater Fields

Miles
0 4.5 9 18

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

Proposed Facility Boundary

US Census Designated Place

Freshwater Field*

*City of Carlsbad Municipal Water System
2017 Annual COnsumer Report of the Quality of Your Drinking Water
http://www.cityofcarlsbadnm.com/CCR%202016.pdf

CDM Smith

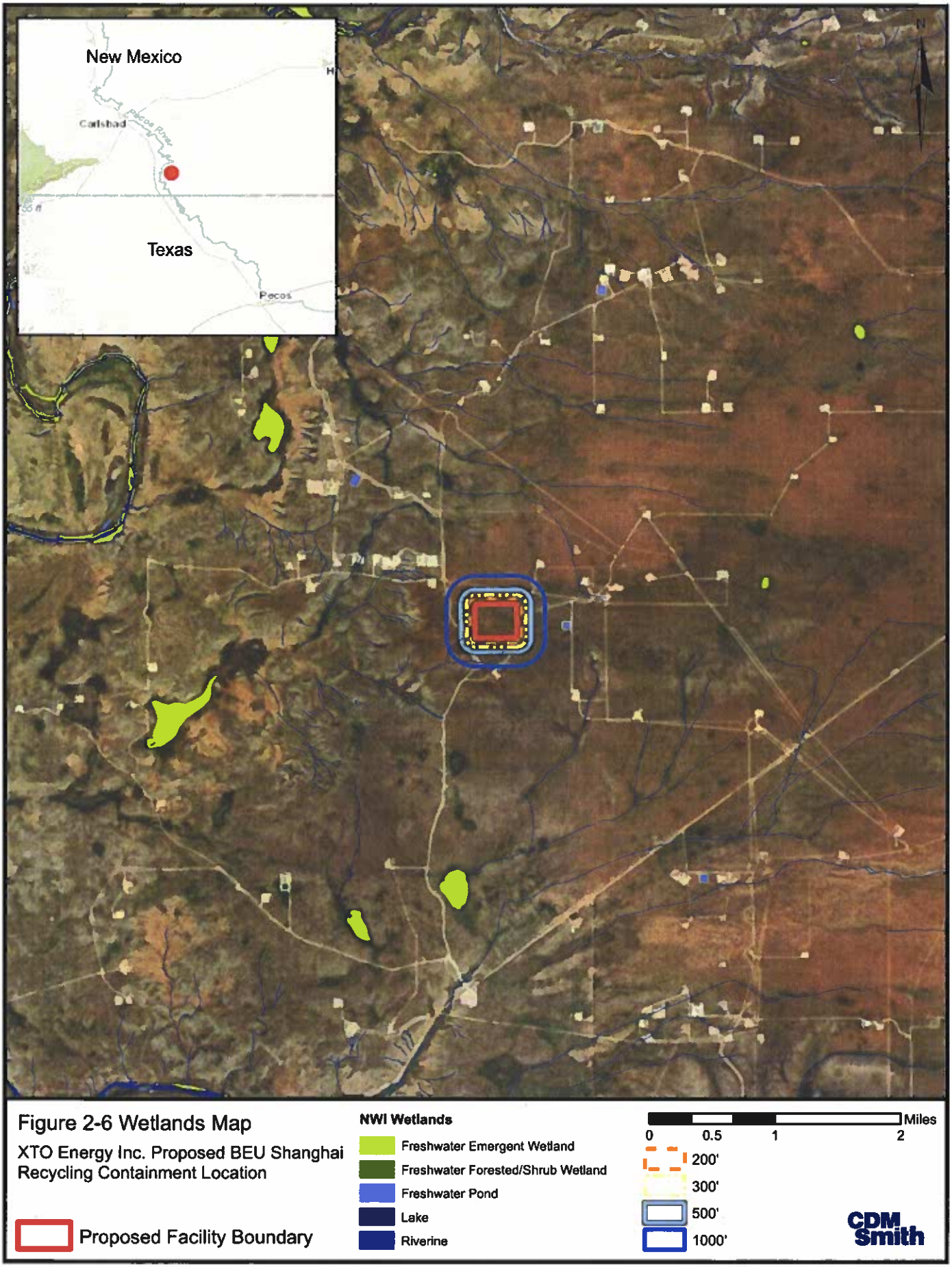

New Mexico
Carlsbad
Texas
Pecos
N
Figure 2-6 Wetlands Map
XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location
Proposed Facility Boundary
NWI Wetlands
Freshwater Emergent Wetland
Freshwater Forested/Shrub Wetland
Freshwater Pond
Lake
Riverine
Miles
0
0.5
1
2
200'
300'
500'
1000'
CDM Smith

Figure 2-7 Distance to Active Mines Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

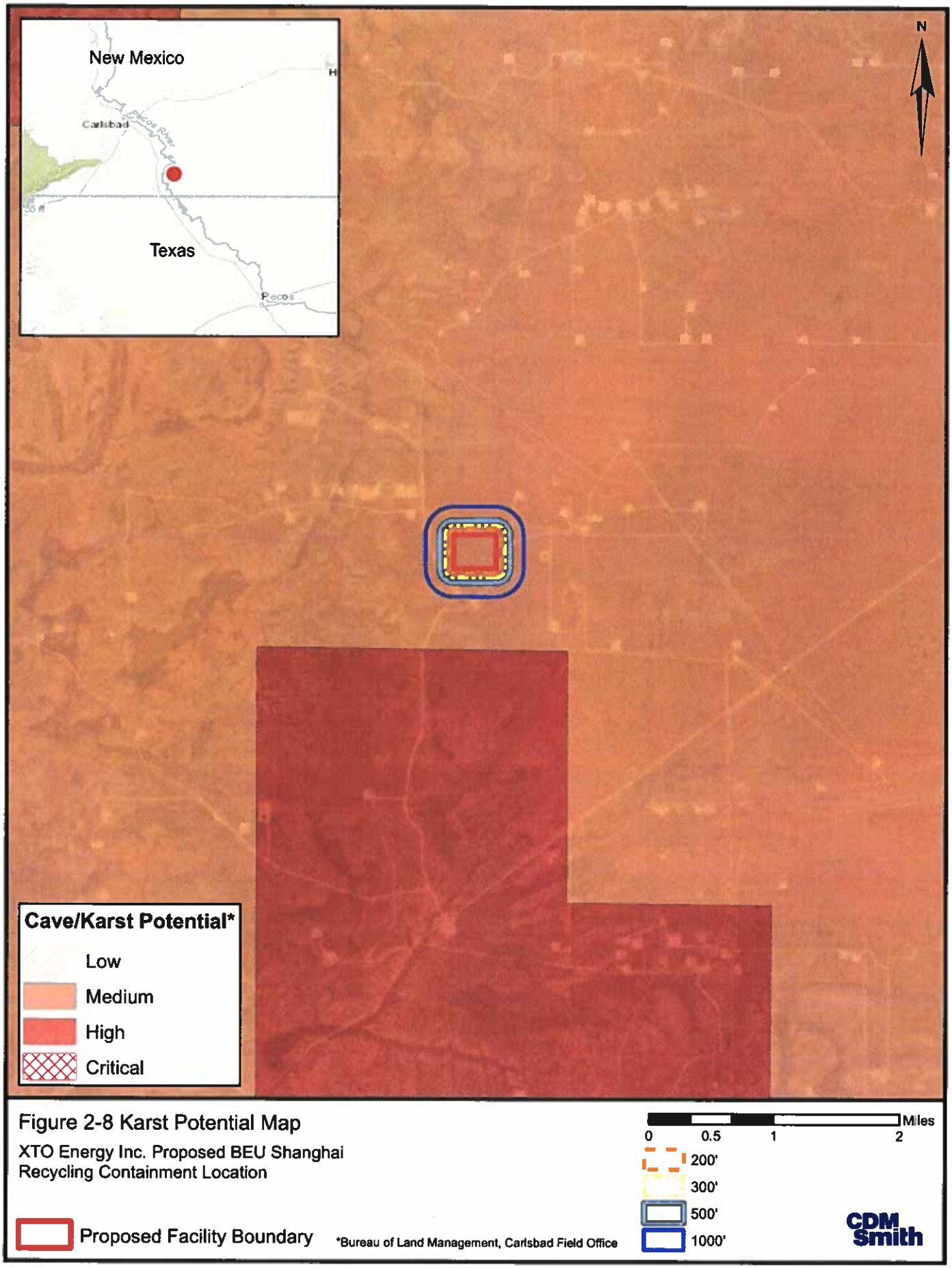


Figure 2-8 Karst Potential Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

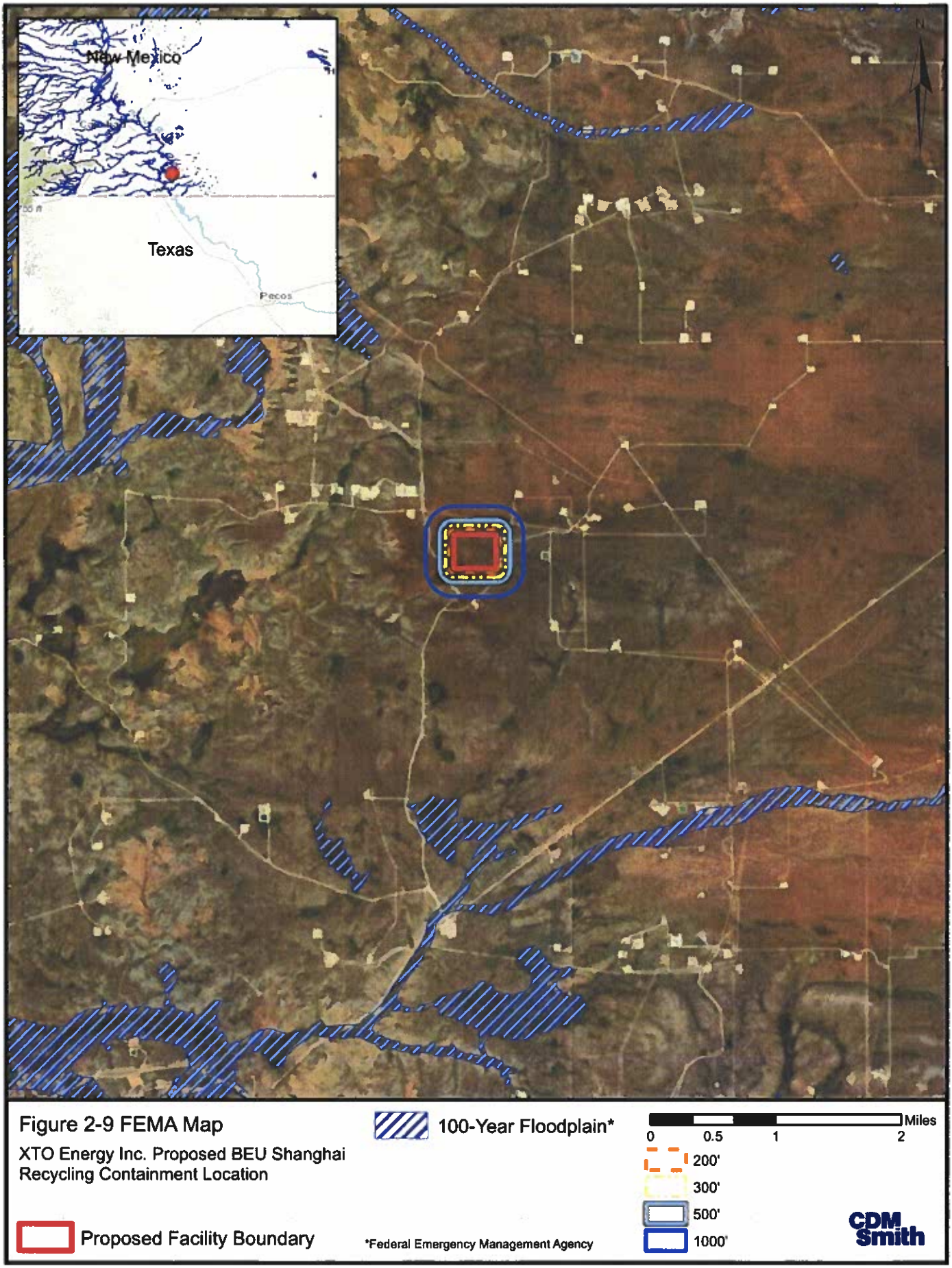


Figure 2-9 FEMA Map

XTO Energy Inc. Proposed BEU Shanghai Recycling Containment Location

Appendix G

Engineering Design Drawings

XTO ENERGY, INC.
MIDLAND, TEXAS

SHANGHAI
TWIN DOUBLE LINED 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PITS

OCTOBER 2018

LOCATION PLAN

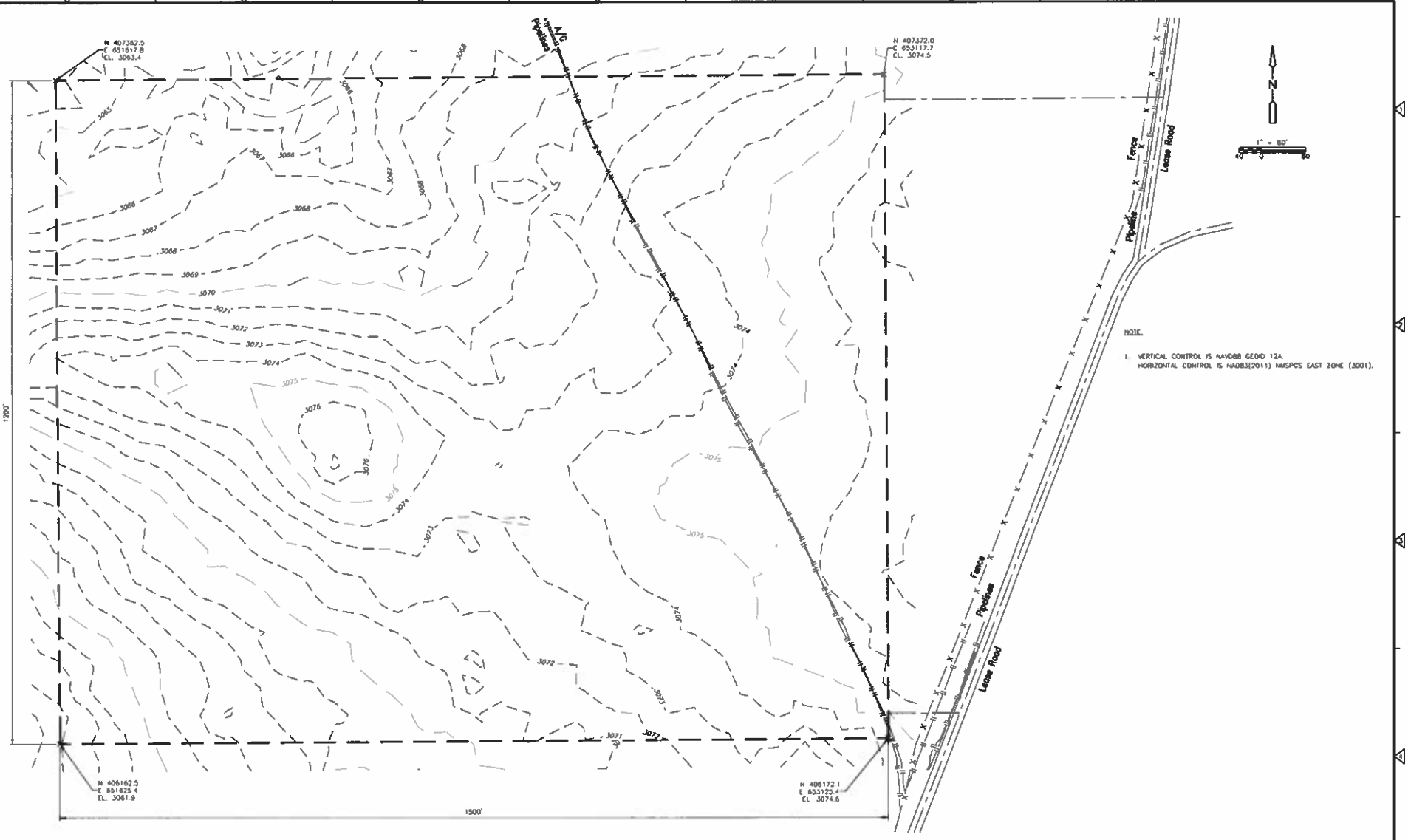
N

DRAWING INDEX

ISSUED FOR CONSTRUCTION

PREPARED BY:

CDM Smith
11490 Westheimer Road Suite 700
Houston, TX 77077
Tel: (713) 423-7300
TBPE Firm Registration No. F-3043



REV NO	DATE	DRWN	CHKD	REMARKS
2	10/23/18	EM	EP	ISSUED FOR CONSTRUCTION
1	10/5/18	EM	EP	ISSUED FOR CONSTRUCTION
0	9/21/18	EM	EP	ISSUED FOR REVIEW

DESIGNED BY E. JANOWIAK
DRAWN BY E. JANOWIAK
SHEET CHK'D BY K. POOSEKAR
CROSS CHK'D BY R. DE LA VEGA
APPROVED BY R. DE LA VEGA
DATE OCTOBER 2018

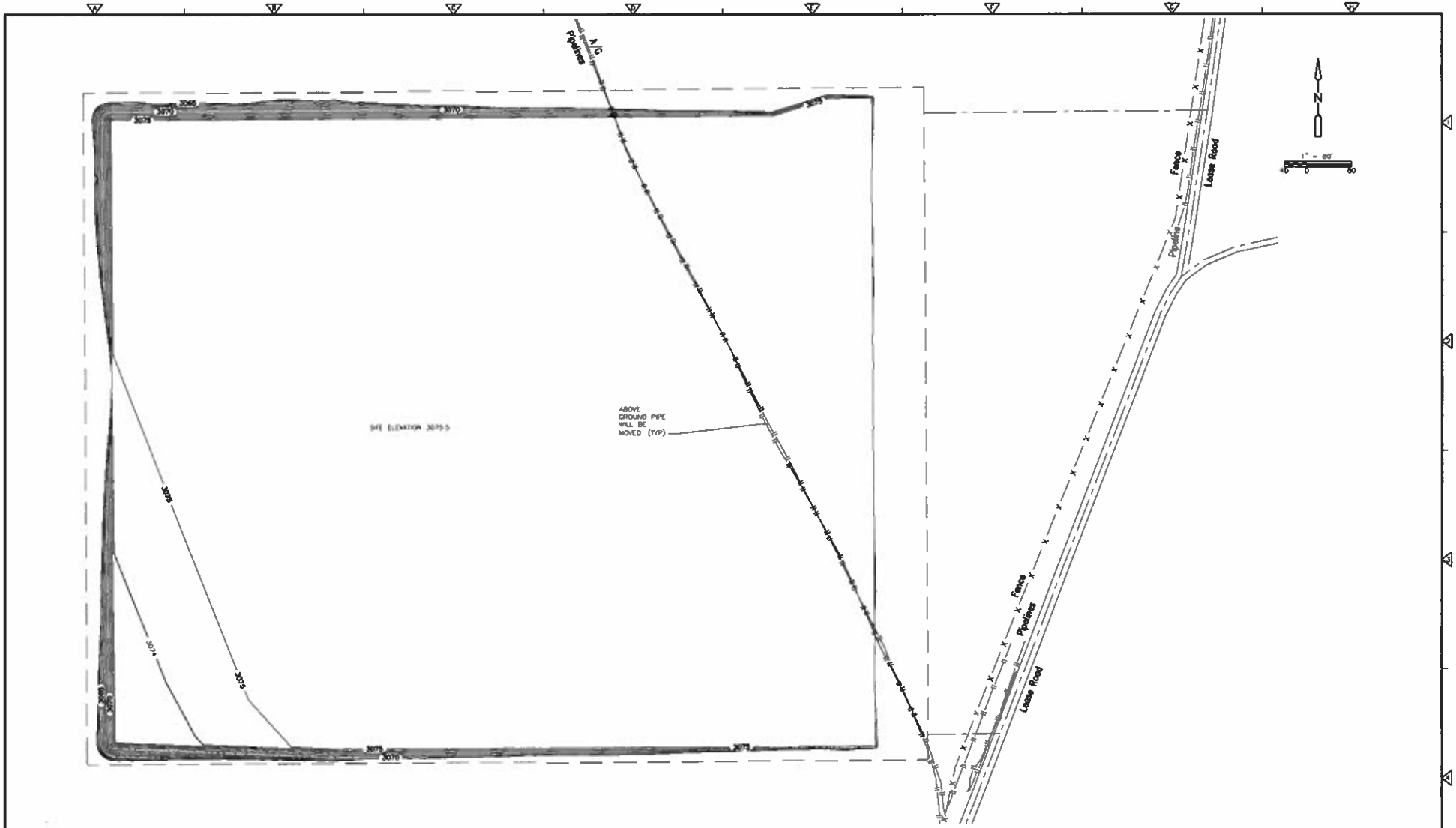
CDM Smith
11490 Westheimer Road, Suite 700
Houston, TX 77077
Tel (713) 425-7300
TBPE Firm Registration No. F-3043

XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

EXISTING SITE GRADE

PROJECT NO. 140829-231007
FILE NAME G-1A
SHEET NO
G-1A

ISSUED FOR CONSTRUCTION



REV NO	DATE	DRWN	CHKD	REMARKS
2	10/22/18	TMJ	KP	ISSUED FOR CONSTRUCTION
1	10/5/18	TMJ	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	TMJ	KP	ISSUED FOR REVIEW

DESIGNED BY: C. JANGWANI
DRAWN BY: C. JANGWANI
SHEET CHK'D BY: K. POOSTKAR
CROSS CHK'D BY: R. DE LA VEGA
APPROVED BY: R. DE LA VEGA
DATE: OCTOBER 2018

CDM Smith
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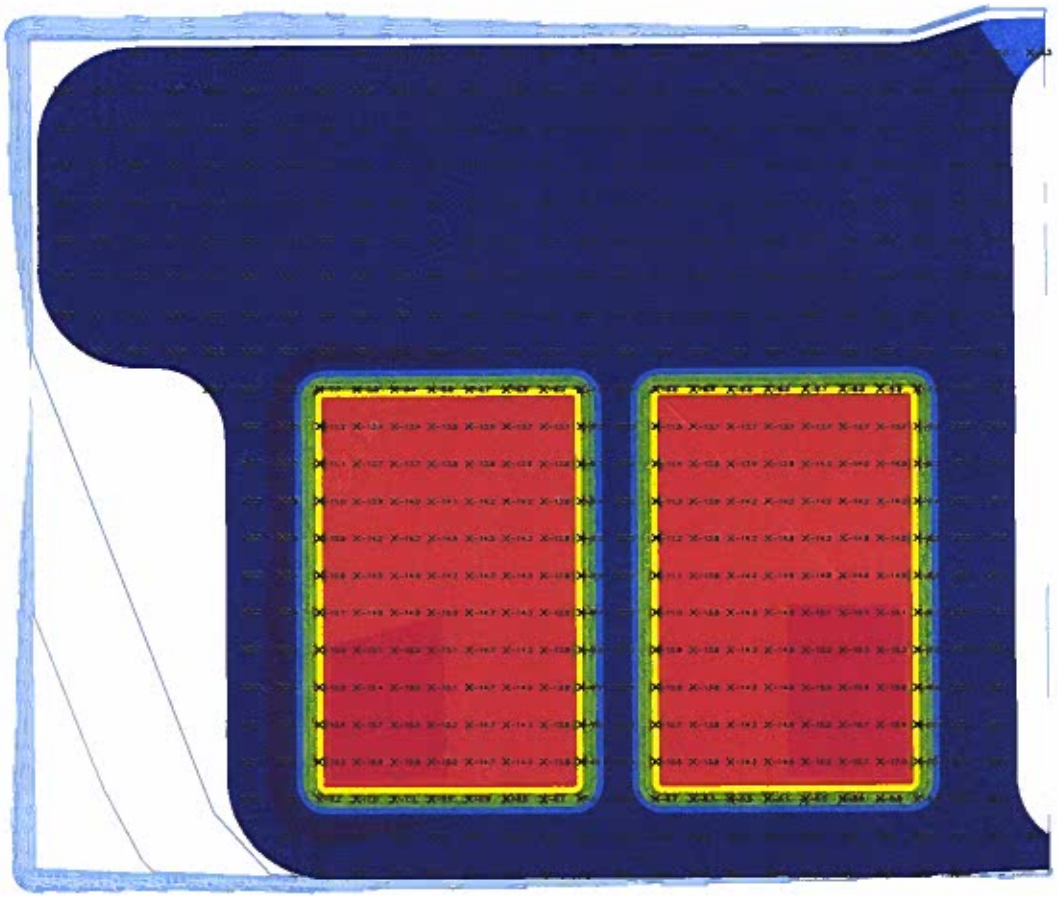
TBPE Firm Registration No. F-3043

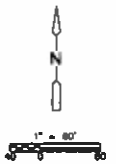
XTO ENERGY INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

PROPOSED SITE GRADING PLAN

PROJECT NO. 148079-231697
FILE NAME: G-1B
SHEET NO: G-1B

ISSUED FOR CONSTRUCTION





ELEVATIONS TABLE				
NUMBER	MINIMUM ELEVATION	MAXIMUM ELEVATION	AREA (SF)	COLOR
1	-18.0	-15.0	67927	
2	-15.0	-12.0	288387	
3	-12.0	-9.0	31453	
4	-9.0	-6.0	32467	
5	-6.0	-3.0	33481	
6	-3.0	0.0	39073	
7	0.0	3.0	782554	
8	3.0	6.0	28167	

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut	Fill	Net
CUT-FILL	1.000	1.000	1283511.07 Sq. Ft.	217306.76 Cu. Yd.	49129.28 Cu. Yd.	168177.48 Cu. Yd.<Cut>
Totals			1283511.07 Sq. Ft.	217306.76 Cu. Yd.	49129.28 Cu. Yd.	168177.48 Cu. Yd.<Cut>

REV. NO.	DATE	DRWN	CHKD	REMARKS
2	10/23/18	DM	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	DM	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	DM	KP	ISSUED FOR REVIEW

DESIGNED BY: E. JANOVIAK
DRAWN BY: E. JANOVIAK
SHEET CHK'D BY: M. FERDEHAR
CROSS CHK'D BY: R. DE LA VEGA
APPROVED BY: R. DE LA VEGA
DATE: OCTOBER 2018

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Houston TX 77077
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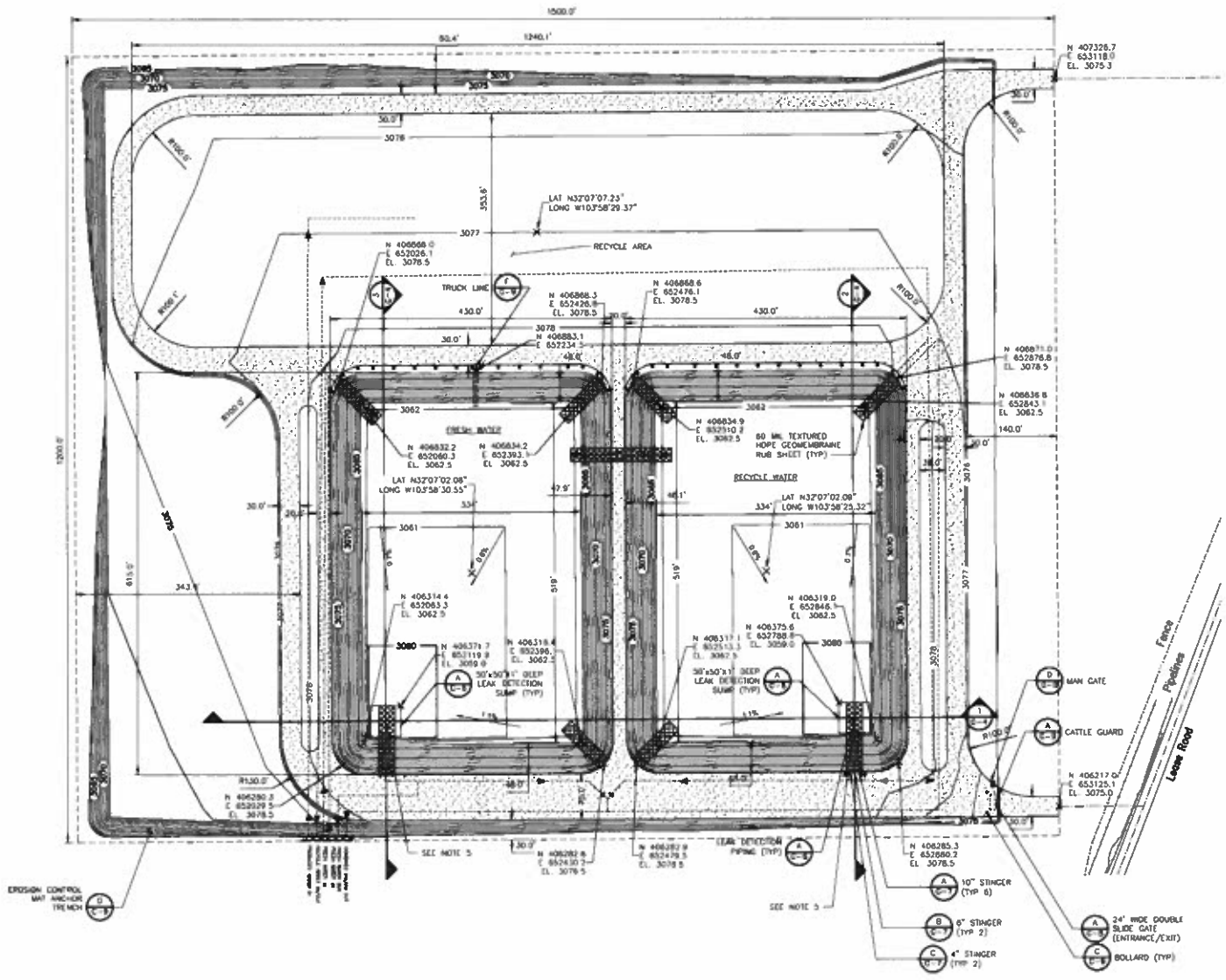
TBPE Firm Registration No. F-3043

XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

MASS GRADING CONDITION WITH CUT/FILL PLAN

PROJECT NO. 148629-231007
FILE NAME: G-2
SHEET NO. G-2

ISSUED FOR CONSTRUCTION



N

1" = 80'

NOTES:

1. FILL FOR BERMS SHALL BE PLACED AND COMPACTED IN HORIZONTAL LIFTS WITH MAXIMUM LOOSE LIFT THICKNESS OF 12 INCHES, OR AS DIRECTED BY ENGINEER. CONSTRUCT EACH LAYER CONTINUOUSLY AND APPROXIMATELY HORIZONTAL FOR THE WIDTH AND LENGTH OF THE DIKE. FILL SHALL BE COMPACTED TO AT LEAST 95 PERCENT OF MAXIMUM DRY DENSITY DETERMINED BY THE ASTM D1557 AND AT MOISTURE CONTENT WITHIN +2% TO -2% OF OPTIMUM MOISTURE CONTENT AS DETERMINED BY A MODIFIED PROCTER SOILS TEST ON SAMPLES FROM THE SOURCE AREA (ASTM D1557).
2. FILL SHALL NOT BE PLACED AND COMPACTED WHEN THE MATERIALS ARE TOO WET TO PROPERLY COMPACT. MATERIAL WHICH IS TOO WET SHALL BE SPREAD ON THE FILL AREA AND PERMITTED TO DRY, ASSISTED BY HARROWING IF NECESSARY, UNTIL THE MOISTURE CONTENT IS REDUCED TO ALLOWABLE LIMITS. IF THE ENGINEER DETERMINES THAT ADDED MOISTURE IS REQUIRED, WATER SHALL BE APPLIED UNIFORMLY OVER THE AREA TO BE TREATED, AND GIVE COMPLETE AND ACCURATE CONTROL OF THE AMOUNT OF WATER TO BE USED. IF TOO MUCH WATER IS ADDED, THAT AREA SHALL BE PERMITTED TO DRY BEFORE COMPACTION IS CONTINUED
3. PERFORM ONE NUCLEAR DENSITY GAUGE TEST PER 2500 CY OR AS DIRECTED BY ENGINEER.
4. EARTHWORK CONTRACTOR SHALL PERFORM A VISUAL INSPECTION OF THE FINISHED COMPACTED POND BOTTOM AND SIDE SLOPES BEFORE HDPE LINER INSTALLATION, REMOVING ALL DEBRIS, SHARP OBJECTS AND GRAVEL LARGER THAN ½ INCH.
5. PIPELINES ARE SHOWN FOR LOCATION PURPOSES. VALVES AND FITTINGS NOT SHOWN
6. WHEN ANY PIPING EQUIPMENT, INLET, OR OUTLET IS IN DIRECT CONTACT WITH THE LINER, AN APRON CONSISTING OF 60 MIL HDPE MATERIAL SHALL BE INSTALLED BENEATH THE EQUIPMENT OR STRUCTURE TO PROTECT THE PRIMARY LINER SYSTEM.

LEGEND

- 3075 — PROPOSED INDEX CONTOUR
- PROPOSED INTERMEDIATE CONTOUR
- ABOVEGROUND PIPELINE
- ABOVEGROUND PIPELINE ROUTING SHOWN TO ILLUSTRATE CONNECTION AT SITE BOUNDARY ONLY. ACTUAL ROUTING MAY BE VARIED DURING CONSTRUCTION.
- LOCATION OF BOLLARD
- RUB SHEETS
- 30' GRAVEL ROAD

REV NO	DATE	DRWN	CHKD	REMARKS
2	10/23/18	EM	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	EM	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	EM	KP	ISSUED FOR REVIEW

DESIGNED BY E. JANOWIK
DRAWN BY E. JANOWIK
SHEET CHK'D BY K. POOLEKAR
CROSS CHK'D BY R. DE LA VEGA
APPROVED BY R. DE LA VEGA
DATE OCTOBER 2018

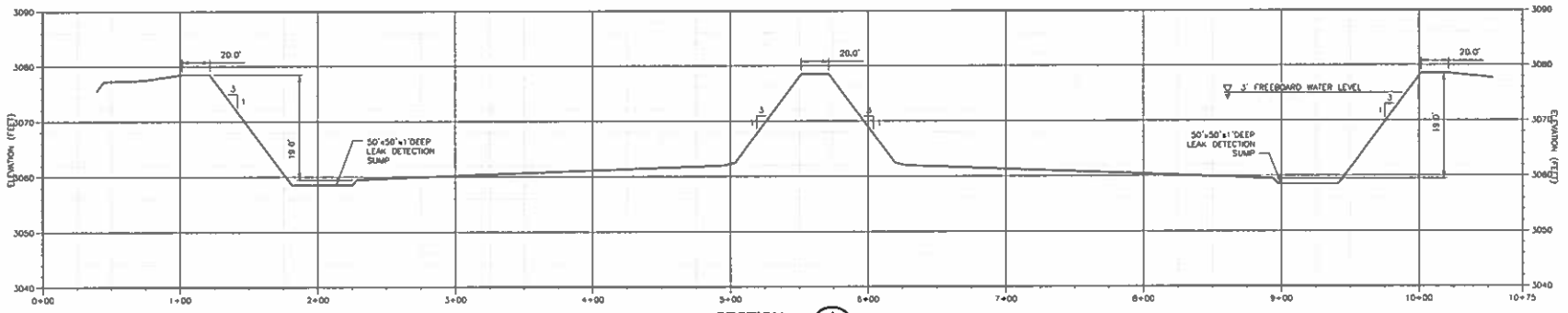
CDM Smith

XTO ENERGY INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

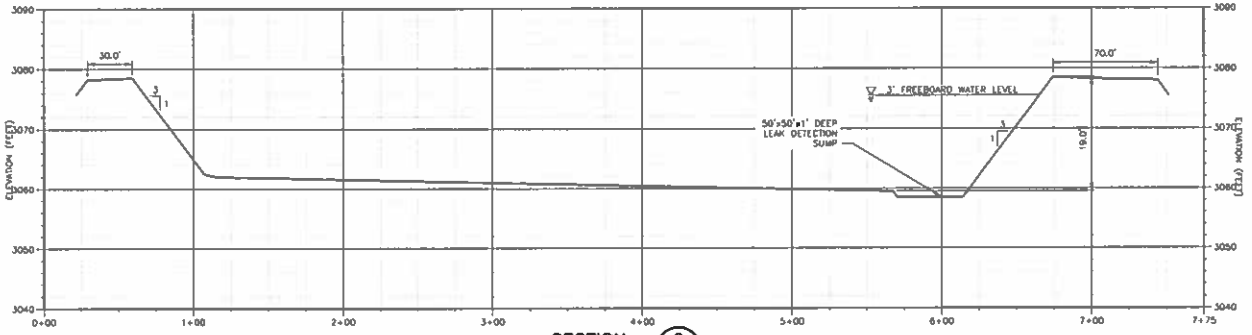
PROPOSED CONTAINMENT GRADING

PROJECT NO. 148629-231697
FILE NAME: G-3
SHEET NO. G-3

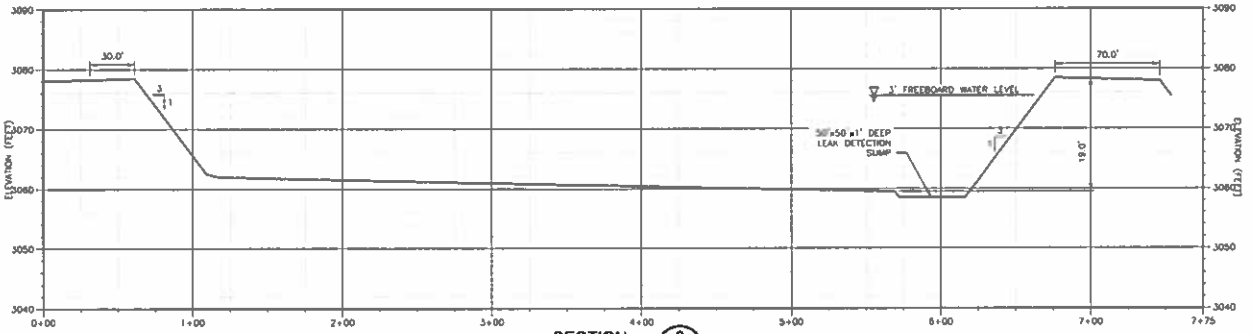
ISSUED FOR CONSTRUCTION



SECTION 1
HORZ: 1" = 40'
VERT: 1" = 10'
G-3



SECTION 2
HORZ: 1" = 40'
VERT: 1" = 10'
G-3



SECTION 3
HORZ: 1" = 40'
VERT: 1" = 10'
G-3

HORIZONTAL 1" = 40'
VERTICAL 1" = 10'

REV NO	DATE	DRWN	CHKD	REMARKS
2	10/23/18	[illegible]	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	[illegible]	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	[illegible]	KP	ISSUED FOR REVIEW

DESIGNED BY E. JANDHAM
DRAWN BY E. JANDHAM
SHEET CHK'D BY K. POOSEKAR
CROSS CHK'D BY R. DE LA VEGA
APPROVED BY R. DE LA VEGA
DATE OCTOBER 2018

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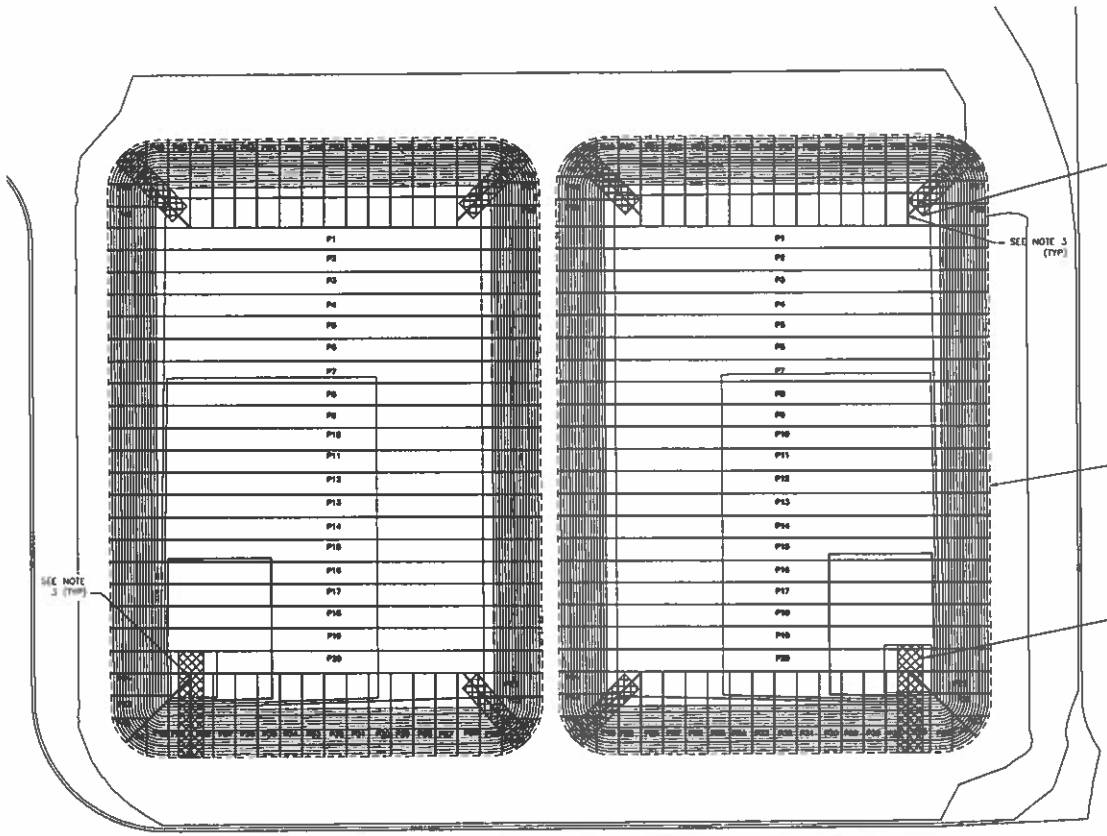
XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

PROPOSED CONTAINMENT SECTIONS

PROJECT NO. 148829-231607
FILE NAME. G-4
SHEET NO
G-4

ISSUED FOR CONSTRUCTION



NOTES:

1. INSTALLER TO SIGN SUBGRADE ACCEPTANCE FORM (PROVIDED BY OWNER REPRESENTATIVE) DAILY PRIOR TO INSTALLATION.
2. CONTRACTOR TO PROVIDE SUBMITTAL OF LINER PANEL LAYOUT.
3. A 3' DIAMETER MINIMUM PIECE OF 40 MIL LINER SHALL BE EXTRUDED WELDED WHERE THE CORNER SECTIONS MEET FOR SEAM REINFORCEMENT.
4. INSTALL A FULL DOUBLE WIDTH SECTION OF BLACK 60 MIL TEXTURED HDPE GEOMEMBRANE RUB SHEET. EXTRUDE WELD THE ENTIRE LENGTH OF RUB SHEET ON ALL SIDES.
5. CONTRACTOR SHALL PLACE SANDBAGS ON LINER DURING INSTALLATION AS REQUIRED TO PREVENT WIND UPLIFT UNTIL POND IS FILLED TO A DEPTH OF 3 FEET.
6. CONTRACTOR SHALL INSPECT GRADED SURFACE FOR DEBRIS, ROCKS OR OTHER MATERIAL THAT MAY DAMAGE THE LINER.
7. CONTRACTOR SHALL ROLL SURFACE WITH A SMOOTH ROLLER TO ELIMINATE RUTS.
8. CONTRACTOR SHALL USE GREY 60 MIL HDPE GEOMEMBRANE AS THE PRIMARY LINER AND BLACK 40 MIL HDPE MEMBRANE AS THE SECONDARY LINER.
9. LINER TO BE INSTALLED PER MANUFACTURER'S RECOMMENDED PROCEDURES (GSE INSTALLATION QUALITY ASSURANCE MANUAL AND THE GSE DROP-IN SPECIFICATIONS FOR GEOMEMBRANES – WWW.GSEWORLD.COM).
10. ALL SEAMS MUST BE WELDED WITH A 6" MINIMUM OVERLAP.
11. CONTRACTOR SHALL NON-DESTRUCTIVELY TEST ALL SEAMS THEIR FULL LENGTH USING AN AIR PRESSURE OR VACUUM TEST. THE PURPOSE OF THIS TEST IS TO CHECK THE CONTINUITY OF THE SEAM PER THE INSTALLATION QUALITY ASSURANCE MANUAL.
12. FOR AIR PRESSURE TESTING, THE FOLLOWING PROCEDURES ARE APPLICABLE TO THE SEAMS WELD WITH DOUBLE SEAM FUSION WELDER.
    a. THE EQUIPMENT USED SHALL CONSIST OF AN AIR TANK OR PUMP CAPABLE OF PRODUCING A MINIMUM 35 PSI AND A SHARP NEEDLE WITH A PRESSURE GAUGE ATTACHED TO INSERT INTO THE AIR CHAMBER.
    b. SEAL BOTH ENDS OF THE SEAM BY HEATING AND SQUEEZING THEM TOGETHER. INSERT THE NEEDLE WITH THE GAUGE INTO THE AIR CHANNEL. PRESSURIZE THE AIR CHANNEL TO 35 PSI. NOTE TIME TEST STARTS AND WAIT A MINIMUM OF 5 MINUTES TO CHECK. IF PRESSURE AFTER 5 MINUTES HAD DROPPED LESS THAN 2 PSI THE TEST IS SUCCESSFUL (THICKNESS OF MATERIAL MAY CAUSE VARIANCE).
    c. CUT OPPOSITE SEAM END AND LISTEN FOR PRESSURE RELEASE TO VERIFY FULL SEAM HAS BEEN TESTED.
    d. IF THE TEST FAILS, FOLLOW THESE PROCEDURES.
        i. WHILE CHANNEL IS UNDER PRESSURE WALK THE LENGTH OF THE SEAM LISTENING FOR A LEAK.
        ii. WHILE CHANNEL IS UNDER PRESSURE APPLY A SOAPY SOLUTION TO THE SEAM EDGE AND LOOK FOR BUBBLES FORMED BY AIR ESCAPING.
        iii. RE-TEST THE SEAM IN SMALLER INCREMENTS UNTIL THE LEAK IS FOUND.
    e. ONCE LEAK IS FOUND USING ONE OF THE PROCEDURES ABOVE, CUT OUT THE AREA AND RETEST THE PORTIONS OF THE SEAMS BETWEEN THE LEAK AREAS PER 12B AND 12C ABOVE. CONTINUE THIS PROCEDURE UNTIL ALL SECTIONS OF THE SEAM PASS THE PRESSURE TEST.
    f. REPAIR THE LEAK WITH A PATCH AND VACUUM TEST.
13. ALL NON-DESTRUCTIVE TESTS WILL BE NOTED IN THE NON-DESTRUCTIVE LOGS.
14. LINER SHALL BE PROTECTED WITH A 10 OZ. NONWOVEN GEOTEXTILE IF ROCK OR OTHER ANGULAR MATERIALS WITH A DIMENSION GREATER THAN 3/4 INCH ARE PRESENT.
15. BOTH DESTRUCTIVE AND NON DESTRUCTIVE FIELD TESTING OF LINER IS REQUIRED.
16. DESTRUCTIVE TESTING SPOTS MUST BE INDICATED ON AS-BUILT DRAWINGS.
17. LINER SEAMS SHALL BE MINIMIZED AND ORIENTED VERTICALLY RATHER THAN ACROSS THE SLOPE. FACTORY WELD SEAMS SHALL BE UTILIZED TO THE MAXIMUM EXTENT POSSIBLE.
18. SLOPE LINER PANELS SHALL EXTEND A MINIMUM OF FIVE FEET BEYOND THE POINT OF THE GRADE CHANGE TO PREVENT SEAMS FROM RESTING ON THE GRADE BREAK.

LEGEND

P1 LINER PANEL NUMBER

RUB SHEETS

REV. NO.	DATE	DRWN	CHKD	REMARKS
2	10/23/18	EMJ	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	EMJ	KP	ISSUED FOR CONSTRUCTION
0	9/14/18	EMJ	KP	ISSUED FOR REVIEW

DESIGNED BY: E. JAMOMAK
DRAWN BY: E. JAMOMAK
SHEET CHK'D BY: K. POOSEKAR
CROSS CHK'D BY: R. DE LA VEGA
APPROVED BY: R. DE LA VEGA
DATE: OCTOBER 2018

CDM Smith
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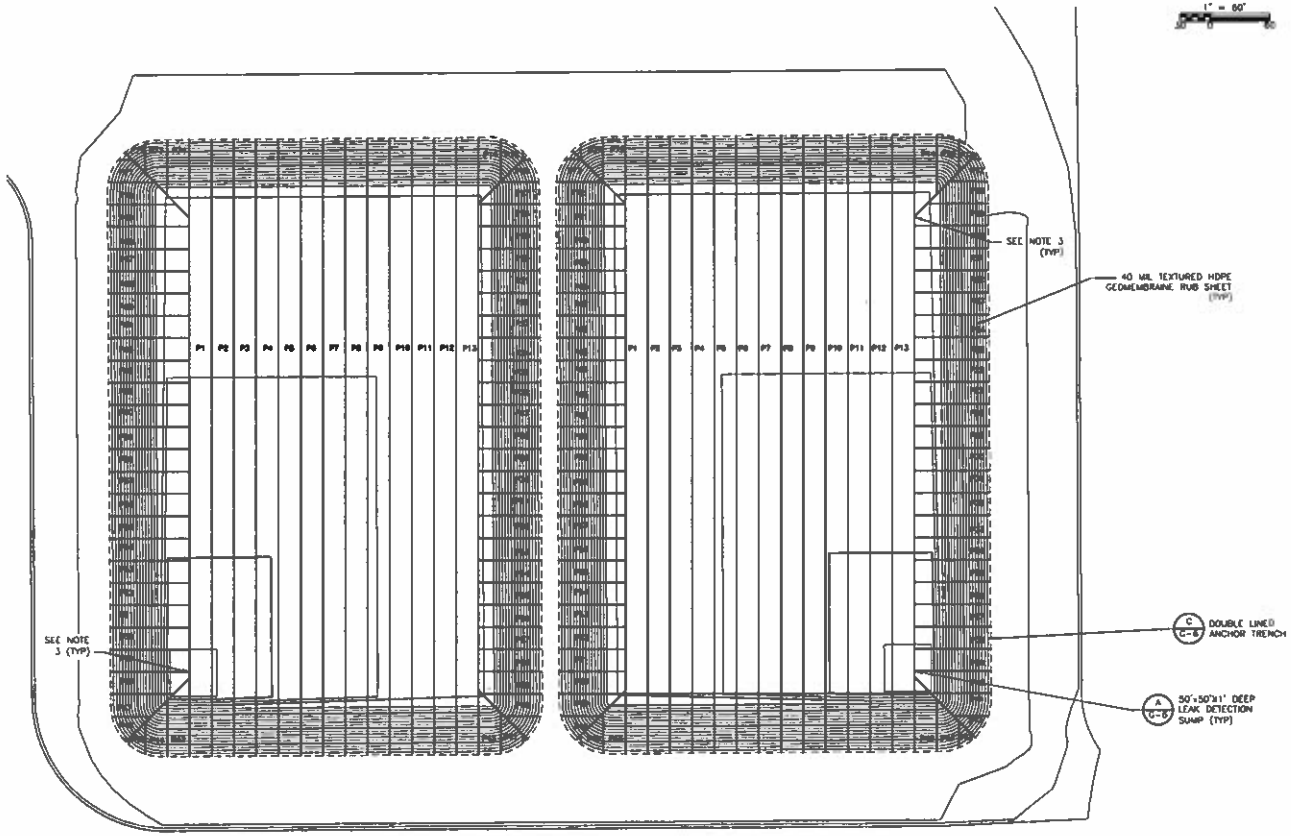
Houston TX 77077
Tel (713) 423-7380
TBPE Firm Registration No. F-3043

XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

PROPOSED HDPE PRIMARY (UPPER) LINER PANEL LAYOUT

PROJECT NO. 140829-231007
FILE NAME: G-5A
SHEET NO G-5A

ISSUED FOR CONSTRUCTION



NOTES:

1. INSTALLER TO SIGN SUBGRADE ACCEPTANCE FORM (PROVIDED BY OWNER REPRESENTATIVE) DAILY PRIOR TO INSTALLATION.
2. CONTRACTOR TO PROVIDE SUBMITTAL OF LINER PANEL LAYOUT.
3. A 3' DIAMETER MINIMUM PIECE OF 40 MIL LINER SHALL BE EXTRUDED WELDED WHERE THE CORNER SECTIONS MEET FOR SEAM REINFORCEMENT.
4. CONTRACTOR SHALL PLACE SANDBAGS ON LINER DURING INSTALLATION AS REQUIRED TO PREVENT WIND UPLIFT UNTIL POND IS FILLED TO A DEPTH OF 3 FEET.
5. CONTRACTOR SHALL INSPECT GRADED SURFACE FOR DEBRIS, ROCKS OR OTHER MATERIAL THAT MAY DAMAGE THE LINER.
6. CONTRACTOR SHALL ROLL SURFACE WITH A SMOOTH ROLLER TO ELIMINATE RUTS.
7. CONTRACTOR SHALL USE BLACK 40 MIL HDPE MEMBRANE AS THE SECONDARY LINER.
8. LINER TO BE INSTALLED PER MANUFACTURER'S RECOMMENDED PROCEDURES (GSE INSTALLATION QUALITY ASSURANCE MANUAL AND THE GSE DROP-IN SPECIFICATIONS FOR GEOMEMBRANES - www.GSEWORLD.COM).
9. ALL SEAMS MUST BE WELDED WITH A 6" MINIMUM OVERLAP.
10. CONTRACTOR SHALL NON-DESTRUCTIVELY TEST ALL SEAMS THEIR FULL LENGTH USING AN AIR PRESSURE OR VACUUM TEST. THE PURPOSE OF THIS TEST IS TO CHECK THE CONTINUITY OF THE SEAM PER THE INSTALLATION QUALITY ASSURANCE MANUAL.
11. FOR AIR PRESSURE TESTING, THE FOLLOWING PROCEDURES ARE APPLICABLE TO THE SEAMS WELD WITH DOUBLE SEAM FUSION WELDER.
    a. THE EQUIPMENT USED SHALL CONSIST OF AN AIR TANK OR PUMP CAPABLE OF PRODUCING A MINIMUM 35 PSI AND A SHARP NEEDLE WITH A PRESSURE GAUGE ATTACHED TO INSERT INTO THE AIR CHAMBER.
    b. SEAL BOTH ENDS OF THE SEAM BY HEATING AND SQUEEZING THEM TOGETHER. INSERT THE NEEDLE WITH THE GAUGE INTO THE AIR CHANNEL. PRESSURIZE THE AIR CHANNEL TO 35 PSI. NOTE TIME TEST STARTS AND WAIT A MINIMUM OF 5 MINUTES TO CHECK. IF PRESSURE AFTER 5 MINUTES HAD DROPPED LESS THAN 2 PSI THE TEST IS SUCCESSFUL (THICKNESS OF MATERIAL MAY CAUSE VARIANCE).
    c. CUT OPPOSITE SEAM END AND LISTEN FOR PRESSURE RELEASE TO VERIFY FULL SEAM HAS BEEN TESTED.
    d. IF THE TEST FAILS, FOLLOW THESE PROCEDURES
        i. WHILE CHANNEL IS UNDER PRESSURE WALK THE LENGTH OF THE SEAM LISTENING FOR A LEAK.
        ii. WHILE CHANNEL IS UNDER PRESSURE APPLY A SOAPY SOLUTION TO THE SEAM EDGE AND LOOK FOR BUBBLES FORMED BY AIR ESCAPING.
        iii. RE-TEST THE SEAM IN SMALLER INCREMENTS UNTIL THE LEAK IS FOUND.
    e. ONCE LEAK IS FOUND USING ONE OF THE PROCEDURES ABOVE, CUT OUT THE AREA AND RETEST THE PORTIONS OF THE SEAMS BETWEEN THE LEAK AREAS PER 12B AND 12C ABOVE. CONTINUE THIS PROCEDURE UNTIL ALL SECTIONS OF THE SEAM PASS THE PRESSURE TEST.
    f. REPAIR THE LEAK WITH A PATCH AND VACUUM TEST.
12. ALL NON-DESTRUCTIVE TESTS WILL BE NOTED IN THE NON-DESTRUCTIVE LOGS.
13. LINER SHALL BE PROTECTED WITH A 10 OZ. NONWOVEN GEOTEXTILE IF ROCK OR OTHER ANGULAR MATERIALS WITH A DIMENSION GREATER THAN 3/4 INCH ARE PRESENT.
14. BOTH DESTRUCTIVE AND NON DESTRUCTIVE FIELD TESTING OF LINER IS REQUIRED.
15. DESTRUCTIVE TESTING SPOTS MUST BE INDICATED ON AS-BUILT DRAWINGS.
16. LINER SEAMS SHALL BE MINIMIZED AND ORIENTED VERTICALLY RATHER THAN ACROSS THE SLOPE. FACTORY WELD SEAMS SHALL BE UTILIZED TO THE MAXIMUM EXTENT POSSIBLE.
17. SLOPE LINER PANELS SHALL EXTEND A MINIMUM OF FIVE FEET BEYOND THE POINT OF THE GRADE CHANGE TO PREVENT SEAMS FROM RESTING ON THE GRADE BREAK.

LEGEND

P1 LINER PANEL NUMBER

REV. NO.	DATE	DRWN	CHKD	REMARKS
2	10/23/18	LMJ	KP	ISSUED FOR CONSTRUCTION
1	10/04/18	LMJ	KP	ISSUED FOR CONSTRUCTION
0	9/14/18	LMJ	KP	ISSUED FOR REVIEW

DESIGNED BY: C. JANDHYAM
DRAWN BY: C. JANDHYAM
SHEET CHK'D BY: K. PODDEKAR
CROSS CHK'D BY: R. DE LA VEGA
APPROVED BY: R. DE LA VEGA
DATE: OCTOBER 2018

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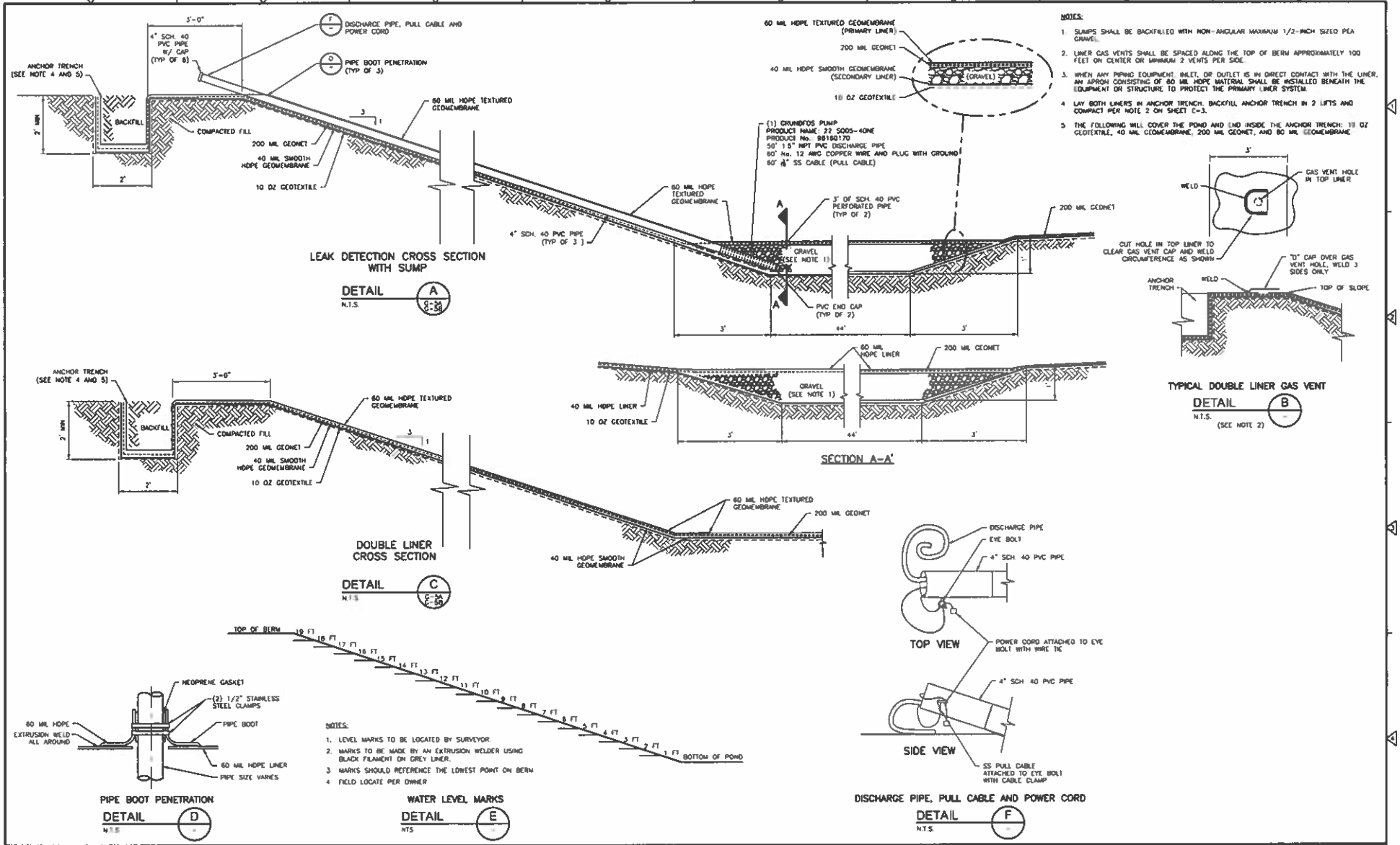
Tel (713) 452-7300
TBPE Firm Registration No. F-3043

XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

PROPOSED HDPE SECONDARY (LOWER) LINER PANEL LAYOUT

PROJECT NO. 148829-231607
FILE NAME: G-5B
SHEET NO. G-5B

ISSUED FOR CONSTRUCTION



REV NO	DATE	DRAWN	CHKD	REMARKS
2	10/23/18	EMJ	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	EMJ	KP	ISSUED FOR CONSTRUCTION
0	9/14/18	EMJ	KP	ISSUED FOR REVIEW

DESIGNED BY C. JANOVIAK
DRAWN BY C. JANOVIAK
SHEET CHK'D BY K. POOSEKAR
CROSS CHK'D BY R. DE LA VEGA
APPROVED BY R. DE LA VEGA
DATE OCTOBER 2018

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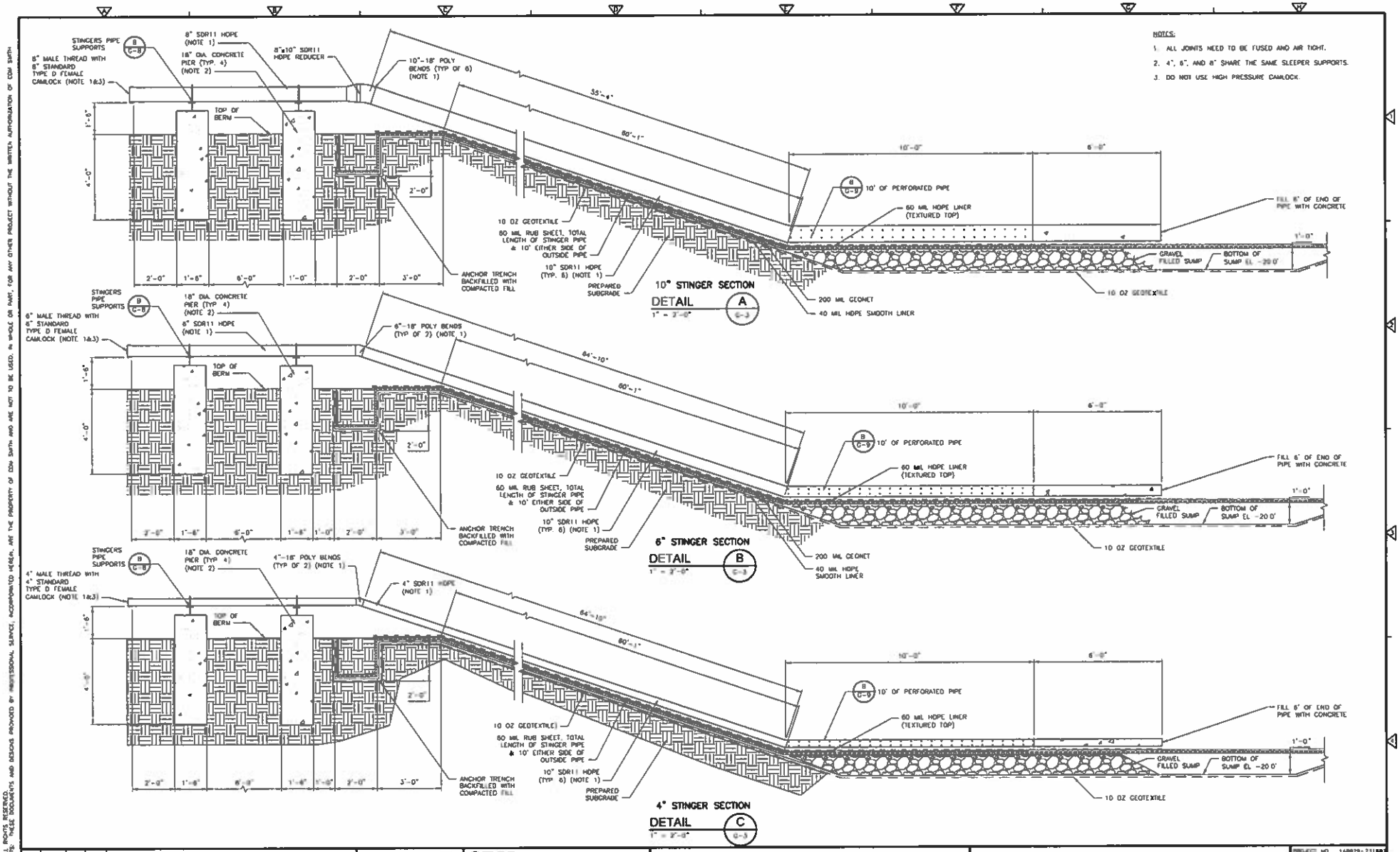
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

DOUBLE LINER AND LEAK DETECTION DETAILS

PROJECT NO. 148029-231002
FILE NAME: G-6
SHEET NO
G-6

ISSUED FOR CONSTRUCTION



REV NO.	DATE	DRWN	CHKD	REMARKS
3	10/23/18	EMJ	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	EMJ	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	EMJ	KP	ISSUED FOR REVIEW

DESIGNED BY E. JANOWAK
DRAWN BY E. JANOWAK
SHEET CHK'D BY K. PODSELAR
CROSS CHK'D BY R. DE LA VEGA
APPROVED BY R. DE LA VEGA
DATE OCTOBER 2018

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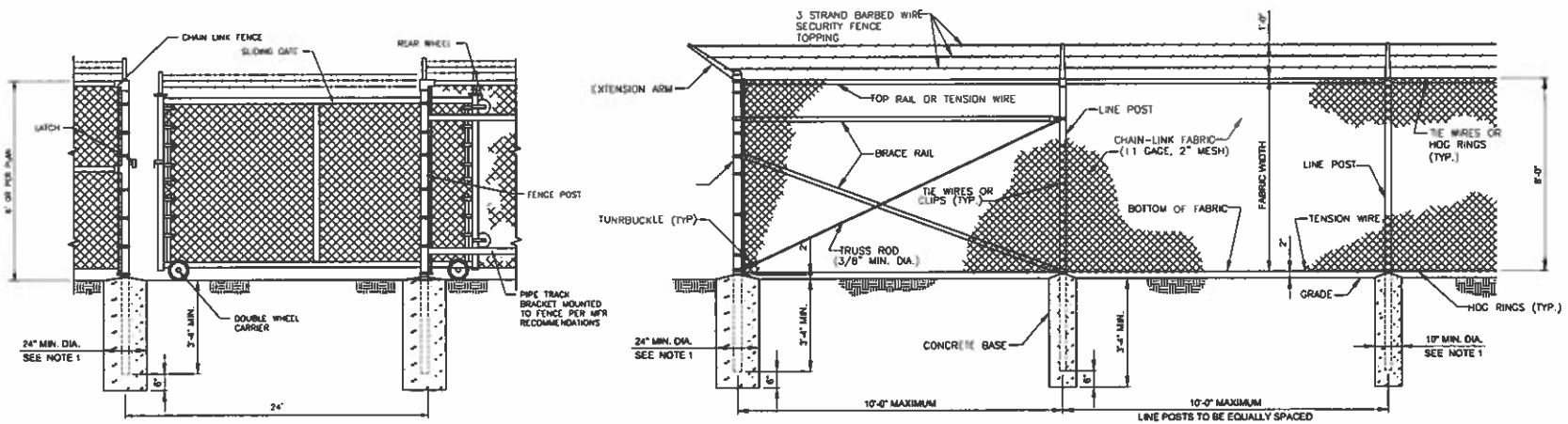
TBPE Firm Registration No. F-3043

XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

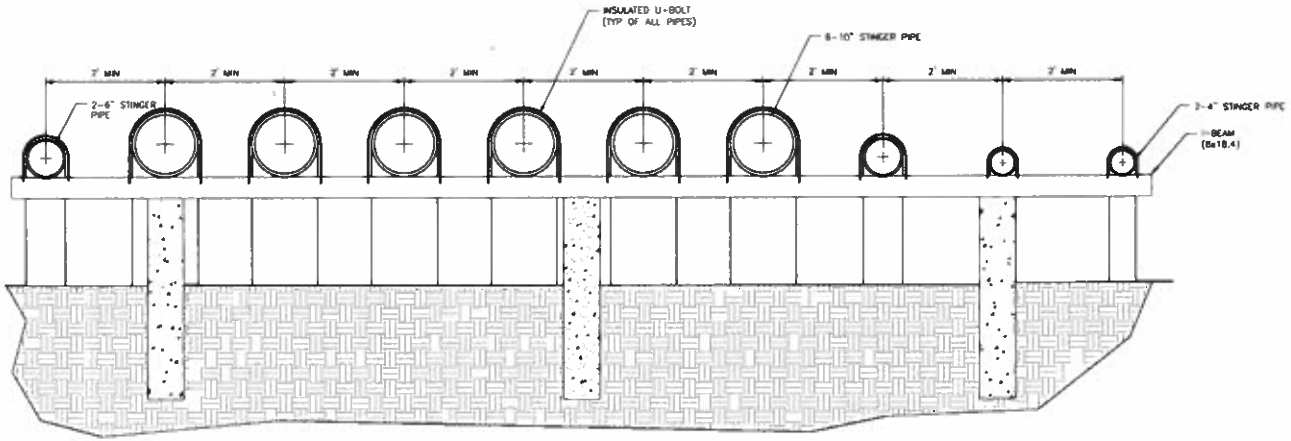
STINGER SECTIONS

PROJECT NO. 140029-231B02
FILE NAME. G-7
SHEET NO
G-7

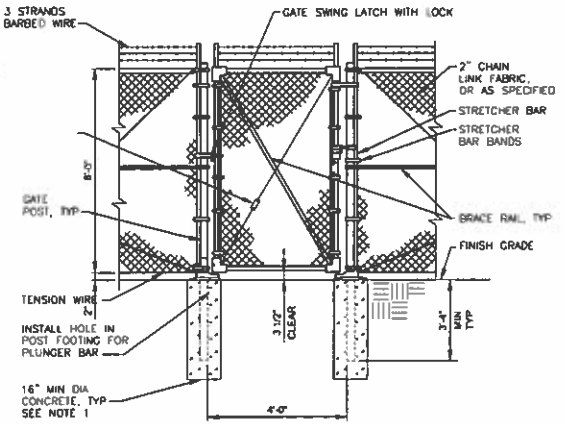
ISSUED FOR CONSTRUCTION



DETAIL A (G-3)
NTS



STINGER SYSTEM ANCHOR
DETAIL B (G-3)
NTS



4 FOOT WIDE MAN GATE
DETAIL D (G-3)
NTS

REV NO	DATE	DRAWN	CHKD	REMARKS
3	10/23/18	EMJ	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	EMJ	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	EMJ	KP	ISSUED FOR REVIEW

DESIGNED BY: E. JANOWIAK
DRAWN BY: E. JANOWIAK
SHEET CHK'D BY: K. POOSER AR
CROSS CHK'D BY: R. DE LA VEGA
APPROVED BY: R. DE LA VEGA
DATE: OCTOBER 2018

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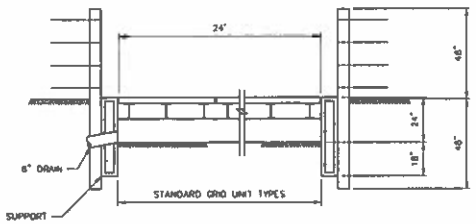
tel: (713) 423-7300
TBPE Firm Registration No. F-3043

XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

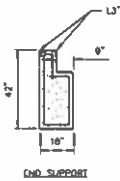
STINGER AND FENCING DETAILS

PROJECT NO. 140029 / 231867
FILE NAME: G-8
SHEET NO
G-8

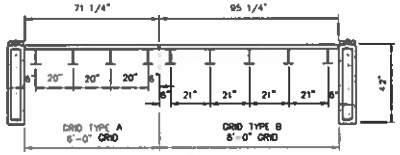
ISSUED FOR CONSTRUCTION



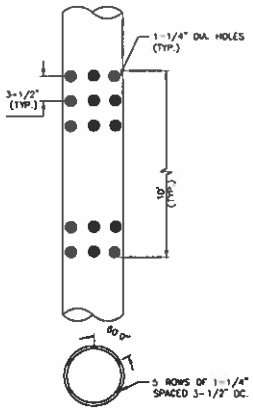
SECTION VIEW



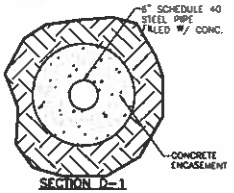
END SUPPORT



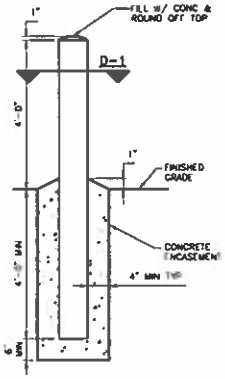
STANDARD GRID UNIT TYPES



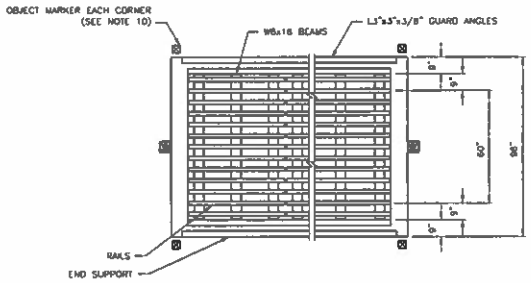
PERFORATED PIPE DETAIL
DETAIL B
NTS G-3



SECTION D-1

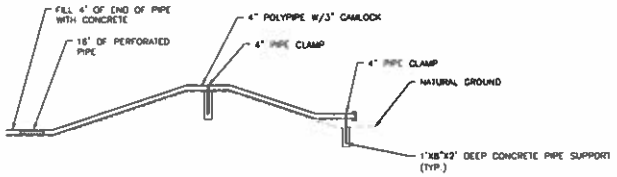


BOLLARD
DETAIL C
NTS G-3

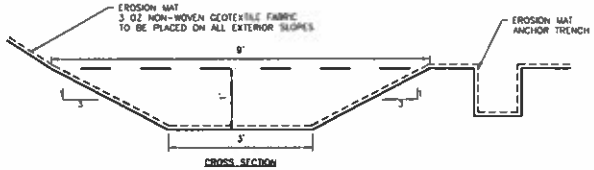


PLAN VIEW

CATTLE GUARD
DETAIL A
NTS G-3



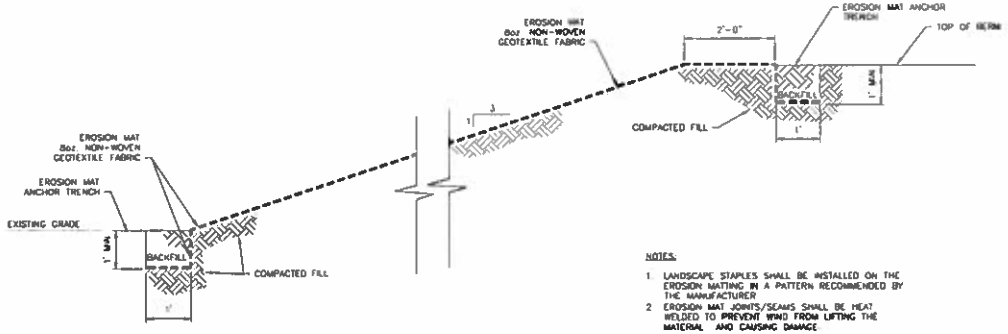
TRUCK-LINE
DETAIL F
N.T.S. G-3



CROSS SECTION

1. THE SWALE SHALL BE EXCAVATED AND SHAPED TO THE PROPER GRADE AND CROSS SECTION.
2. EXCESS EARTH SHALL BE GRADED OR DISPOSED OF SO THAT IT WILL NOT RESTRICT FLOW TO THE SWALE OR INTERFERE WITH ITS FUNCTIONING.

DRAINAGE SWALE DETAIL
DETAIL E
NTS G-1B



NOTES:
1. LANDSCAPE STAPLES SHALL BE INSTALLED ON THE EROSION MATTING IN A PATTERN RECOMMENDED BY THE MANUFACTURER
2. EROSION MAT JOINTS/SEAMS SHALL BE HEAT WELDED TO PREVENT WIND FROM LIFTING THE MATERIAL AND CAUSING DAMAGE

EROSION CONTROL MAT ANCHOR TRENCH
DETAIL D
NTS G-3

REV. NO	DATE	DRWN	CHKD	REMARKS
2	10/23/18	DWJ	KP	ISSUED FOR CONSTRUCTION
1	10/4/18	DWJ	KP	ISSUED FOR CONSTRUCTION
0	9/21/18	DWJ	BP	ISSUED FOR REVIEW

DESIGNED BY E. JANOWIAK
DRAWN BY E. JANOWIAK
SHEET CHK'D BY K. POOSLEAH
CROSS CHK'D BY R. DE LA VEGA
APPROVED BY R. DE LA VEGA
DATE OCTOBER 2018

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XTO ENERGY, INC.
MIDLAND, TEXAS
SHANGHAI
TWIN 500,000 BBL
NON-COMMERCIAL FLUID RECYCLING PIT

CATTLE GUARD AND MISCELLANEOUS DETAILS

PROJECT NO. 140029.231697
FILE NAME G-9
SHEET NO. G-9

ISSUED FOR CONSTRUCTION

Appendix H

Specifications

SECTION 02100
SITE PREPARATION

PART 1 - GENERAL

1.1 SUMMARY

A. Requirements of this Section shall consist of CONTRACTOR providing all required clearing, grubbing, and stripping related labor, materials, equipment, tools, and services for the WORK.

1.2 DEFINITIONS

A. Clearing: Clearing shall consist of removal of all vegetation and the satisfactory disposal of brush, rubbish, and any other vegetation.

B. Grubbing: Grubbing shall consist of the removal and disposal of roots, root mats, stumps, logs, peat, and other objectionable matter which could adversely affect the quality of the subgrade or borrow materials.

C. Topsoil: Topsoil is the upper soil horizon which is characterized by a significant organic content.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 AREAS TO BE CLEARED AND GRUBBED

A. Perform clearing and grubbing only in areas identified by the ENGINEER OR OWNER. Clear and grub all areas where WORK is to take place.

B. Clear and grub all borrow areas to the extent necessary to provide fill materials free of all objectionable matter described above.

C. Vegetation located outside the construction limits shall not be damaged.

3.2 DISPOSAL OF CLEARED AND GRUBBED MATERIALS

A. All brush, vegetation, rubbish, organic soils, and other debris from clearing and grubbing operations, including all debris remaining from previous clearing operations, shall be stockpiled separately at a location designated by the OWNER.

3.3 EXCAVATING, STOCKPILING, AND WASTING TOPSOIL

A. If present, excavate topsoil from areas designated for project grading or construction, as encountered. In addition, excavate topsoil from areas designated for use as waste locations for earth subsoil material.

B. Remove lumped soil, vegetative material, boulders, and rocks from the excavated topsoil to be stockpiled.

C. Stockpile, if available, sufficient topsoil material on-site for use as vegetative cover for future reclamation purposes. Protect stockpile from erosion and grade to prevent ponding of water. Organic soils shall be segregated from soil materials that may be suitable for other uses described in these SPECIFICATIONS and shown on the DRAWINGS.

D. Dispose of excess topsoil and waste topsoil not intended for reuse in a location selected by the OWNER. Disposal and handling of this material shall be performed following the requirements of the appropriate government agencies.

END OF SECTION 02100

SECTION 02200
EXCAVATION, BACKFILL AND COMPACTION

PART 1 - GENERAL

1.1 SUMMARY

A. The section describes the following:

1. All excavation required to reach planned grades and contours, install project components, and to construct temporary run-on and run-off conveyance systems.
2. Placement of various fill materials:
   a. Compacted embankment fill
   b. Drainage Aggregate (Drain Rock)
3. Material placement and compaction
4. Site grading
5. Foundation preparation
6. Construction of fills and backfills
7. Compaction requirements
8. Site grading

B. The WORK shall be done in accordance with the SPECIFICATIONS and as shown on the DRAWINGS.

C. The WORK includes furnishing all labor, tools, materials, equipment, and supervision necessary to construct the project as described in the contract documents.

1.2 TOLERANCES

A. All excavations shall be constructed within the tolerance as shown in these SPECIFICATIONS except where dimensions or grades are shown or specified as minimum or maximum in the DRAWINGS. All grading shall be performed to maintain slopes and drainages as shown in the DRAWINGS.

B. Excavate to within a horizontal and vertical tolerance of ± 0.1 -foot on all slopes flatter than 10% and within a vertical tolerance of ± 0.2 -foot on all slopes 10% or steeper unless otherwise approved by the ENGINEER or OWNER.

C. Place Drain Rock Aggregate within a vertical tolerance of ±0.1-ft, regardless of the steepness of the slope.

1.3 SUBSURFACE CONDITIONS

A. Subsurface investigations have been performed at the site by the ENGINEER. The results of the subsurface investigations can be provided to the CONTRACTOR at the CONTRACTOR'S request during the bidding interval.

B. The CONTRACTOR shall identify and locate utility lines, flow lines, wells, survey monuments, and other nearby structures prior to performing work. Utilities, flow lines, wells, survey monuments and other nearby structures shall be protected from damage during the WORK. Any damage to utility lines, flow lines, wells, survey monuments, and other nearby structures during the WORK shall be repaired by the CONTRACTOR at no additional cost to the OWNER. Costs associated with these repairs shall include the actual repair costs and all engineering costs required by the ENGINEER to coordinate and obtain regulatory approval of repairs, if required.

1.4 SUBMITTALS

A. Imported materials that may include Drain Rock Aggregate, Engineered Fill or others shall have material properties such as grain size distribution submitted to the OWNER or ENGINEER for material approval prior to delivery to the site.

1.5 REFERENCES

A. American Society for Testing and Materials (ASTM):

Where reference is made to one of the standards listed below, the revision in effect at the time of the bid shall apply.

1. ASTM D422 – Standard Test Method for Particle Size Analysis of Soils.

2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

3. ASTM D854 – Standard for Test Method for Specific Gravity of Soil Solids by Water Pycnometer.

4. ASTM D1140 – Standard Test Method for Amount of Material in Soils Finer than the Number 200 (75 micrometer) Sieve.

5. ASTM D1556 – Standard Test Method for Density and Limit Weight of Soil in Place by the Sand Cone Method.

6. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

7. ASTM D2434 – Test Method for Permeability of Granular Soils

8. ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).

9. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual Manual Procedure).

10. ASTM D2922 – Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).

11. ASTM D2937 – Standard Test Method for Density of Soil in Place by Drive-Cylinder Method.

12. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).

13. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils

14. ASTM D6913 – Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

15. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Geotechnical Data Report for the proposed JRU LEGG Containment Site.

1.6 QUALITY ASSURANCE

A. The CONTRACTOR will retain an independent testing laboratory approved by ENGINEER for testing during earthwork operations. The CONTRACTOR shall coordinate and schedule all tests as required by the Drawings and Specifications.

PART 2 - PRODUCTS

2.1 ENGINEERED FILL

A. Engineered Fill is defined as material obtained from excavations associated with the WORK or designated on-site borrow sources, approved by the ENGINEER, that meet the requirements of the SPECIFICATIONS.

B. Engineered Fill material shall be free of debris, organics, oversized material (clods or rocks greater than 1 inch in diameter), frozen material, ice, snow, deleterious, or other unsuitable materials.

C. The aggregate for the fill material should conform to the requirements as shown in Table 1 Grade 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for Grade 1. Do not use additives such as, but not limited to lime, cement, or fly ash, to modify aggregate to meet requirement of Table 1. As per the geotechnical study, the on-site material meets these requirements and are suitable as Engineered Fill.

D. The CONTRACTOR will provide laboratory testing results to the OWNER for all fill material used in construction for verification of material compliance as required for the project.

E. Based on the results of the geotechnical investigation, native soils at the JRU LEGG Containment site are suitable for use as "Engineered Fill" as described in this Section.

2.2 ENGINEERED FILL MATERIAL USED IN SUBGRADE PREPARATION

A. The upper six (6) inches of the pond bottom, interior embankment slopes, and sump shall be regular, smooth, and compacted; and shall be free of sharp changes in elevation, rocks larger than 1.0 inch, clods, organic debris, and standing water, other unsuitable objects, deleterious materials, or soft unsuitable areas. One hundred percent of the prepared subgrade soil material gradation shall pass a U.S. standard #4 sieve.

B. Engineered Fill material used for the prepared pond bottom shall meet the liner manufacturer's specifications for material suitable for liner placement.

2.3 DRAINAGE AGGREGATE (DRAIN ROCK)

A. Drainage Aggregate (Drain Rock) is defined as engineered fill material consisting of selected or processed granular material that meets the requirements of the SPECIFICATIONS and is in accordance with this section. Drain Rock shall be obtained from on-site approved stockpiles or outside sources approved by the ENGINEER or OWNER.

B. The Drain Rock shall be clean washed sand and gravel with the following gradation:

Gradation	
Sieve Size	**Percent by Weight**
1 ½ inch	100
1 inch	95-100
½ inch	25-60
No. 4	0-10
No. 8	0-5

Particles shall be rounded and free of sharp, angular edges that may damage the liner.

C. Drain Rock Aggregate shall be free of organic material, frozen material, ice, snow, or excess moisture.

D. Drain Rock Aggregate material must be hard, durable, and not subject to grain crushing. Individual rock fragments shall be dense, sound, and resistant to abrasion and shall be free from cracks, seams, and other defects that would tend to increase their destruction from water and frost actions. Drain Rock Aggregate shall be less than 5 percent carbonate.

E. Material shall be poorly-graded within the SPECIFICATION limits with a uniform grading of coarse to fine particles. No gap-graded material, as determined by the ENGINEER, shall be acceptable.

F. Verify that all necessary pre-construction submittals such as conformance testing of the Drain Rock Aggregate have been performed prior to placement or importing.

PART 3 - EXECUTION

3.1 PREPARATION, EXAMINATION, AND PROTECTION OF EARTHWORK

A. Provide construction staking and grade control. Establish and set required lines, levels, grade, contours, and datum by construction staking.

B. Provide for dust control in accordance with site requirements and OWNER'S direction.

C. Provide for dewatering as necessary for finish excavation and fill placement.

D. Locate, identify, and protect all utilities and existing structures from damage (including overhead and suspended utilities).

E. Protect temporary or permanent bench marks, survey stakes, settlement monuments, existing structures, fences and existing WORK from damage or displacement by construction equipment and vehicular traffic.

F. Coordinate traffic control, operations, and haul routes with the OWNER and LINER CONTRACTOR.

G. Note that topography shown on DRAWINGS may differ from topography at time of construction.

H. Protect the exposed surfaces of compacted lifts from drying and cracking due to excessive heat, or softening due to excessive moisture, until overlying fill material is placed and compacted.

I. Any earthen surface upon which the liner is installed shall be prepared and compacted in accordance with the project SPECIFICATIONS. The surface shall be smooth, firm, and unyielding. The top six-inches of fill beneath the surface shall be free of:

1. Vegetation/Roots/Sticks
2. Construction debris
3. Sharp, angular rocks
4. Rocks larger than 1 inch in diameter
5. Void spaces
6. Abrupt elevation changes
7. Standing water
8. Cracks larger than six millimeters in width
9. Any other foreign matter that could contact the liner

J. Immediately prior to liner deployment, LINER CONTRACTOR shall arrange for the subgrade to be final-graded by the EARTHWORK CONTRACTOR to fill in all voids or cracks, then smooth-rolled to provide the best practicable surface for the liner. At completion of this activity, no wheel ruts, footprints or other irregularities in the subgrade are permissible. Furthermore, all protrusions extending more than 0.5-inches from the surface shall be removed, crushed, or pushed into the surface with a smooth-drum roller compactor.

K. On a continuing basis, the OWNER's REPRESENTATIVE shall examine the subgrade for suitability before liner placement.

L. It shall be the CONTRACTOR'S responsibility to indicate to the OWNER or ENGINEER any change in the condition of the subgrade that could cause the subgrade to be non-compliance with any SPECIFICATION requirement. If the CONTRACTOR has not notified the OWNER or ENGINEER of changes that cause the subgrade to be non-compliant and installs the liner, then the CONTRACTOR has determined and assumes responsibility that the subgrade is acceptable for liner installation.

M. At the crest of the embankments, an anchor trench for the liner shall be constructed by the EARTHWORK CONTRACTOR as detailed on the DRAWINGS. Any deviation from the anchor trench details shown on the DRAWINGS requires review and approval by the ENGINEER. No loose soil shall be allowed at the bottom of the trench, and no sharp corners or protrusions shall exist anywhere within the trench.

N. Verify as applicable that all underlying components such as geomembrane and piping have been installed, tested, and accepted in accordance with the DRAWINGS and SPECIFICATIONS.

3.2 EXCAVATION

A. Excavate material shown on the DRAWINGS and as necessary to complete the WORK. Excavation carried below the grade lines shown on the drawings shall be repaired as specified by the OWNER unless previously approved by the OWNER. Correction of all over-excavated areas shall be at the CONTRACTOR's sole expense.

B. All necessary precautions shall be taken to preserve the material below and beyond the established lines of all excavation in the soundest possible condition. Any damage to the

WORK beyond the required excavation lines due to wetting, drying, or the CONTRACTOR'S operations shall be repaired at the CONTRACTOR'S sole expense.

C. Excavation, shaping, and any other work related to material removal, shall be carried out by the method(s) considered most suitable, provided it meets the design intent as determined by the ENGINEER.

D. Limits of excavation to accomplish the WORK safely shall be determined by the CONTRACTOR. Any minimum excavation limits shown on the DRAWINGS are for material identification only and do not necessarily represent safe limits. All excavations shall be free of overhangs, and the sidewalls shall be kept free of loose material. As a minimum, the CONTRACTOR shall slope, bench and shore all excavations as necessary to prevent any unsafe conditions as required by OSHA 29 CFR 1926.651 and 1926.652.

E. Accurate trimming of the slopes of excavations to be filled will not be required, but such excavations shall conform as closely as practical to the established lines and grades.

F. For pipe trench excavations, grade trench bottom to provide uniform bearing for the entire length of pipe to be installed. Fill in voids, gaps, low points ("dips" or "bellys") and bridging areas within trench bottom and along the entire length of pipe.

G. Subsoil not to be used in the construction of earth fills or reclamation shall be stockpiled in areas designated by OWNER and in accordance with applicable laws, rules, and regulations.

H. Permanently stockpiled earth material shall be graded to drain and blended seamlessly into the natural landscape.

I. Provide and operate equipment adequate to keep all excavations and trenches free of water.

J. Excavate unsuitable areas of the subgrade and replace with approved fill materials. Compact to density equal to requirements for subsequent fill material.

K. The subgrade of each pond shall be proof-rolled and compacted in place prior to fill placement or grading.

L. Grade top perimeter of excavation to prevent surface water from draining into excavation.

3.3 MISCELLANEOUS EXCAVATION

A. The CONTRACTOR shall perform all excavations necessary for the placing of seeding and plants, for constructing roadways, and any other miscellaneous earth excavation required under this Contract.

3.4 FILL PLACEMENT

A. General

1. Transport, process, place, spread, compact, and complete fill using the appropriate equipment to achieve lift thickness, design lines and grades and compaction specified in the DRAWINGS and SPECIFICATIONS.

2. To the extent practicable, fill shall be placed by routing the hauling and spreading units approximately parallel to the axis of the embankment.

3. Hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their traveled routes evenly over the surface of the fill.

4. Protect installed measurement instrumentation, structures, and utilities from damage.

5. Care shall be taken at all times to avoid segregation of material being placed, and all pockets of segregated or undesirable material shall be removed and replaced with material matching the surrounding material.

6. Each zone shall be constructed with materials meeting the specified requirements and shall be free from lenses, pockets, and layers of materials that are substantially different in gradation from surrounding material in the same zone.

7. No material shall be placed on material that is too soft, smooth, wet, or dry, or that has been damaged by drying, cracking, frost, runoff, or construction activities. Previously completed portions of the subgrade that are deemed unsuitable for construction shall be repaired until approved by the ENGINEER. **The top 8 inches of the foundation surface shall be scarified, moisture conditioned (as necessary), and compacted so fill material will bond firmly to surfaces of excavation.** Remove standing water prior to placement of all fill material.

8. To the extent practicable, fill materials shall be brought to the placement area at the recommended moisture content.

9. Moisture conditioning is the operation required to increase or decrease the moisture content of material to within the specified limits for proper material placement and compaction. If moisture conditioning is necessary, it may be carried out by whatever method CONTRACTOR deems suitable, provided it produces the moisture content specified in the SPECIFICATIONS.

3.5 TRENCH BACKFILL

A. Backfilling over pipes, culverts, and pipe boxes shall begin as soon as practicable after the pipe, culvert or box has been laid, jointed and inspected. All backfilling shall be performed expeditiously.

1. Sand bedding material shall be placed around the lower half of the pipe, culvert or box and thoroughly rodded and tamped to fill all voids and provide uniform support. Material shall be thoroughly compacted by machine tamping in 6-inch thick layers as required to provide 95% of the Modified Proctor maximum dry density per ASTM D1557.

2. Common fill shall be placed around the upper half of the pipe, culvert or box and to a minimum depth of 12-inches over the top of the pipe, culvert or box. Common Fill shall be thoroughly compacted by machine tamping in 6-inch thick layers as required to provide 95% of the Modified Proctor maximum dry density per ASTM D1557.

3. The remainder of the trench shall be backfilled with Common Fill in loose layers not to exceed 8-inches in thickness and thoroughly compacted by machine tamping as required to provide 95% of the Modified Proctor maximum dry density per ASTM D1557.

4. Backfilling under haunches shall be performed manually by tamping rods or similar hand equipment to eliminate voids underneath.

5. The minimum frequency of Moisture Content ASTM D3017 and In Place Density ASTM D2922 testing shall be 1 test per lift per 50 linear feet of trench for all material types.

3.6 ROAD SUBGRADE

A. The final 8-inch lift of road subgrades shall be compacted to 95% of the Modified Proctor maximum dry density per ASTM D1557. The minimum frequency of Moisture Content ASTM D3017 and In Place Density ASTM D2922 testing shall be 1 test per lift per 10,000 square feet or as directed by the ENGINEER.

3.7 MOISTURE CONTROL

A. Prior to and during all compacting operations, maintain moisture content within the limits recommended herein. Maintain uniform moisture content throughout the lift. To the extent practicable, add water to materials that are too dry at the site of excavation. Supplement, if necessary, by sprinkling and mixing water into the fill material prior to compaction. The moisture content shall be at or no more than 2 percent above the optimum moisture content in accordance with ASTM D2216.

B. Do not attempt to compact fill material containing excessive moisture. Aerate material by blading, disking, harrowing, or other methods, to dry the material to acceptable moisture content.

3.8 LIFT THICKNESS REQUIREMENTS

A. Berm Fill:

1. Placement lift thickness for Engineered Fill shall not exceed 6 inches prior to compaction with hand-operated compaction equipment and should not exceed 8 inches with heavy machine operated compaction equipment. It is the CONTACTOR's responsibility to ensure that the compaction achieved meets the specifications.
2. Fill placement for anchor trenches shall not exceed 6 inches in loose lift thickness for each lift.

B. Drain Rock Aggregate:

1. Drain Rock Aggregate shall be placed and spread in lifts not exceeding 8 inches in thickness.

3.9 COMPACTION AND MOISTURE CONTENT REQUIREMENTS

A. After material placement, spreading, and leveling to the appropriate lift thickness, all material shall be uniformly compacted in accordance with the requirements for each type of fill as indicated on the following table:

Table 2: Compaction and Moisture Content Requirements

Fill Material	Compaction Specifications	Moisture Content
Engineered Fill	95% of the Modified Proctor maximum dry density	±2% of Optimum
Drain Rock Aggregate	Place uniform thickness and tamp with dozer or loader bucket	No requirements

3.10 COMPACTION EQUIPMENT

A. Compaction equipment shall be maintained in good working condition at all times to ensure that the amount of compaction obtained is the maximum for the equipment.

B. Compactor:

1. The fill is required to be compacted with a heavy vibratory-optional roller and a maximum roller speed of approximately 2 mph.
2. The compactor shall be of self-propelled design to develop 10,000 pounds in weight per linear foot of width at rest on level ground or equivalent as approved by the ENGINEER.

C. Special Compactors:

1. Special compactors shall be used to compact materials that, in the opinion of the ENGINEER, cannot be compacted properly by the specified roller because of location or accessibility.
2. Special compaction measures shall be adopted, such as hand-held compactors, smooth drum rollers, or other methods approved by the ENGINEER, to compact fill material in trenches, around structures, around geomembrane, and in other confined areas that are not accessible to the Compactor. The final surface on which the geomembrane will be placed shall be compacted with a smooth drum roller.
3. Anchor trenches shall be compacted with a hand-operated compaction machine.

3.11 COMPACTION TESTING OF ENGINEERED FILL

Field compaction testing of each lift shall be performed a minimum of one test every 100 to 300 linear feet or 5000 square feet.

3.12 SITE GRADING

A. Perform all placement of fill to lines and grades as shown in the DRAWINGS and/or established by the ENGINEER, with proper allowance for surface treatments (topsoil placement, etc.) where specified or shown. Neatly blend all new grading into surrounding, existing terrain.

END OF SECTION 02200

SECTION 02776

HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required to install High Density Polyethylene (HDPE) geomembrane as shown on the Drawings and specified herein.

1.2 SUBMITTALS

A. The CONTRACTOR shall submit a Subgrade Acceptance Letter to the ENGINEER prior to installation of the geomembrane stating the subgrade is acceptable and does not void the warranty.

B. The CONTRACTOR shall submit the following product data to the ENGINEER:

1. Resin Data:

    a. Certification stating that the resin meets the SPECIFICATION requirements.

2. Geomembrane Roll:

    a. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin.

C. Pre-Construction Submittals: Submit the following within 10 days of Notice to Proceed. Pre-Construction materials shall be submitted to the OWNER and ENGINEER.

1. The MANUFACTURER'S Information
    a. The MANUFACTURER'S name and address and primary contact.
    b. The manufacturing plant name and address where the geomembrane for this project will be produced.
    c. The MANUFACTURER'S qualifications including:
        1) Evidence of production of at least 10 million square feet of geomembrane that meets the specifications.
        2) Certification that the MANUFACTURER has sufficient capacity to provide the required material in the given timeframe.
        3) A list of at least 10 projects for which geomembrane has been supplied by the MANUFACTURER, three of which shall have been for projects of similar size.
    d. Product name and the MANUFACTURER'S description of the proposed geomembrane and five (5) representative samples of the product proposed for use on this project.
    e. The MANUFACTURER'S material properties sheets (cut sheets) of proposed geosynthetic products meeting the requirements of the specification.

    f. The MANUFACTURER'S Quality Control (MQC) Plan, including examples of geomembrane certification documents, name and address of the quality control testing laboratory, quality control laboratory certification, examples of retesting notification, and documentation.

g. The MANUFACTURER'S written instructions for storing, handling, installing, seaming, protecting from hydration, and repairing the proposed geomembrane, including recommendations for handling equipment (model number and load capacity).
h. Samples product warranty.

2. CONTRACTOR'S Information:
   a. CONTRACTOR'S name and address and primary contact.
   b. CONTRACTOR'S qualifications including a list of at least three previous projects of similar size to this project, including project name, location, size and date of installation, and evidence of installing at least 1 million square feet of geomembrane.
   c. The Construction Quality Control (CQC) Plan, including examples of subgrade certification documents, daily record documents, methods for repairing geomembrane and subgrade and example documents to certify repairs, method for removing rejected materials, proposed staffing, and proposed equipment.
   d. Description of welding equipment, techniques, and material, including a list of proposed equipment.
   e. A complete set of forms to be used for record installation CQC data.
   f. Résumés of key installation personnel. The Installation Supervisor, Master Seamers, and QC Representative must be clearly identified.
   g. Workmanship warranty.

D. The CONTRACTOR shall furnish SHOP DRAWINGS to the OWNER and ENGINEER as follows:

1. Installation layout SHOP DRAWINGS.
   a. Must show proposed panel layout including field seams and details.
   b. Must show panel identification numbers.
   c. Installed square footage of the geomembrane.
   d. Must be approved prior to installing the geomembrane.
   e. Approved SHOP DRAWINGS will be for concept only and actual panel placement will be determined by site conditions.

E. CONTRACTOR'S geomembrane field installation quality assurance plan.

F. The CONTRACTOR will submit the following to the OWNER and ENGINEER upon completion of installation:

1. Certificate stating the geomembrane have been installed in accordance with the contract documents.
2. Material and installation warranties:
   a. Material shall be warranted against MANUFACTURER's defects for a period of five (5) years from the date of geomembrane installation.
   b. Installation shall be warranted against defects in workmanship for a period of one (1) year from the date of geomembrane completion.
3. As-built drawings showing actual geomembrane placement, seams, testing locations and results, and anchor trench details.

1.3 REFERENCES

Note: Where reference is made to one of the standards listed below, the revision in effect at the time of bid opening shall apply.

A. American Society for Testing and Materials (ASTM)

1. ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement

2. ASTM D1004 – Test Method for Initial Tear Resistance of Plastic Film and Sheeting

3. ASTM D1238 – Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer

4. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics

5. ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry

6. ASTM D4218 – Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

7. ASTM D4716 - Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head

8. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples

9. ASTM D4833 – Test Method for Index Puncture Resistance of Geomembranes and Related Products

10. ASTM D5035 - Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)

11. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geomembrane

12. ASTM D5596 – Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geomembrane

13. ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber

14. ASTM D5820 – Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes

15. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geomembrane by High-Pressure Differential Scanning Calorimetry

16. ASTM D5994 – Test Method for Measuring Core Thickness of Textured Geomembrane

17. ASTM D6364 - Standard Test Method for Determining Short-Term Compression Behavior of Geomembrane

18. ASTM D6392 – Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

19. ASTM D6693 – Test Method for Determining Tensile Properties of Non-Reinforced Polyethylene and Non-Reinforced Flexible Polypropylene Geomembranes

20. ASTM D7179 - Standard Test Method for Determining Geomembrane Breaking Force

21. ASTM D7406 - Standard Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products
22. ASTM D7466 – Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

B. Geosynthetic Research Institute (GRI)

1. GRI-GM9 Cold Weather Seaming of Geomembranes.

2. GRI GM10 – Specification for the Stress Crack Resistance of Geomembrane Sheet.

3. GRI GM12 – Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage.

4. GRI GM13 – Test Properties, Testing Frequency for HDPE Smooth and Textured Geomembranes.

5. GRI GM14 – Test Frequencies for Destructive Seam Testing Selecting, Variable Intervals for Taking Geomembrane Destructive Samples Using the Method of Attributes.

6. GRI GM 19 – Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.4 DEFINITIONS

A. Lot – A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembrane. Finished roll will be identified by a roll number traceable to the resin lot used.

B. ENGINEER – Party, independent from manufacturer and CONTRACTOR, that is responsible for observing and documenting activities related to quality assurance during the lining system construction.

C. Geomembrane Manufacturer – The party responsible for manufacturing the geomembrane rolls.

D. Geosynthetic Quality Assurance Laboratory (testing laboratory) – Party, independent from the OWNER, manufacturer, and CONTRACTOR, responsible for conducting laboratory tests on samples of geomembrane obtained at the site or during manufacturing.

E. CONTRACTOR – Party responsible for field handling, transporting, storing, deploying, seaming and testing of the geomembrane seams.

F. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed value reported.

G. Panel – Unit area of a geomembrane that will be seamed in the field that is 10 square yards or larger.

H. Patch – Unit area of a geomembrane that will be seamed in the field that is less than 10 square yards.

I. Subgrade Surface – Soil layer surface which immediately underlies the geosynthetic material(s).

1.5 QUALIFICATIONS

A. MANUFACTURER

1. MANUFACTURER shall have manufactured a minimum of 10 million square feet of HDPE geomembrane material during the last year.
2. MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of polyethylene geomembrane material during the last year.
3. MANUFACTURER shall have a GAI-LAP Accredited Laboratory at the manufacturing facility.
4. MANUFACTURER shall have ISO 9001; 2008 certification.

B. CONTRACTOR

1. CONTRACTOR shall have installed a minimum of 10,000,000 square feet of geomembrane in the last 3 years.
2. CONTRACTOR shall have worked in a similar capacity on at least 3 projects similar in complexity to the project described in the contract documents, and within a total of at least 400,000 square feet of geomembrane installation on each project.
3. The Installation Supervisor shall have worked in a similar capacity on at least 3 projects similar in size and complexity to the project described in the Contract Documents in the last 5 years.

1.6 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Geomembrane labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geomembrane roll shall be wrapped with a material that will protect the geomembrane from damage due to shipment, water, sunlight, and contaminants.

C. The CONTRACTOR shall note any visible damage to roll materials on the Bill of Lading prior to unloading roll materials. Should any visible damage be noted, CONTRACTOR or ENGINEER shall notify the MANUFACTURER in writing immediately.

D. Labeling – Each roll of geomembrane delivered to the site shall be labeled by the manufacturer. The label will identify:

1. Manufacturer's name
2. Product identification
3. Thickness
4. Length
5. Width
6. Roll number
7. Date and time of production
8. Resin lot number

E. Delivery – Rolls of liner will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

F. Storage – The on-site storage location for geomembrane material, provided by the CONTRACTOR to protect the geomembrane from punctures, abrasions and excessive dirt and moisture, should have the following characteristics:

1. Level (no wooden pallets)
2. Smooth
3. Dry
4. Protected from theft and vandalism
5. Adjacent to the area being lined
6. Geomembrane shall not be stacked higher than three rolls

G. Handling – Materials are to be handled to prevent damage. The CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the geomembrane.

1.7 WARRANTY

A. Material shall be warranted, against manufacturer's defects for a period of five (5) years from the date of geomembrane installation.

B. Installation shall be warranted against defects in workmanship for a period of one year from the date of geomembrane completion.

PART 2 - PRODUCTS

2.1 HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

A. Material shall be **smooth (both sides) 40-mil black LLPDE** and **60-mil grey HDPE (textured on one side and smooth on other)** or equivalent HDPE geomembrane meeting the thickness, texture, and color requirements as shown on the DRAWINGS.

B. Geomembrane Rolls

1. Geomembrane rolls must not exceed a combined maximum total of 1 percent by weight of additives other than carbon black.
2. Geomembrane shall be free of holes, pinholes, bubbles, blisters, excessive contamination by foreign matter, and nicks and cuts on roll edges.

3. Geomembrane material is to be supplied in roll form. Each roll is to be identified with labels indicating roll number, thickness, length, width, and manufacturer.
4. All liner sheets produced at the factory shall be inspected prior to shipment and be tested by an acceptable method of inspecting for pinholes. If pinholes are located, identified and indicated during manufacturing, these pinholes may be corrected during installation.

2.2 RESIN

1. Resin shall be first quality, compounded polyethylene resin.

2. Resin testing values and testing frequencies requirements are presented in Table 1 below. Natural resin (without carbon black) shall meet the following additional minimum requirements:

TABLE 1: RAW MATERIAL VALUES

Property	Test Method [1]	Testing Frequencies	Value
Density (g/cm3)	ASTM D 1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	Once Per Resin Lot	$\leq$ 1.0

[1]Manufacturer may utilize test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geomembrane.

2.3 EQUIPMENT

A. Welding equipment and accessories shall meet the following requirements:

1. Gauges showing temperatures in apparatus (extrusion welder) or wedge (wedge welder) shall be present.
2. An adequate number of welding apparatus shall be available to avoid delaying WORK.
3. Power source must be capable of providing constant voltage under combined line load.

B. Extrudate Rod or Bead

1. Extrudate material shall be made from the same type of resin as the geomembrane.
2. Additives shall be thoroughly dispersed.
3. Materials shall be free of contamination by moisture or foreign matter.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Preparation of surfaces to be lined shall be completed by the EARTHWORK CONTRACTOR but the LINER CONTRACTOR will be responsible for inspecting the prepared surfaces to verify that the surfaces are acceptable for liner placement and free from any rocks, clods, sticks, surface irregularities or debris which could damage the liner. Acceptance of the subgrade shall be provided in a written submittal.

B. All geomembrane installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

3.2 DEPLOYMENT

A. Assign each panel a simple and logical identifying code. The coding system shall be subject to approval and shall be determined at the WORK site.

B. Visually inspect the geomembrane during deployment for imperfections and mark faulty or suspect areas.

C. The geomembrane installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

D. Deployment of geomembrane panels shall be performed in a manner that will comply with the following guidelines:

1. Unroll geomembrane using methods that will not damage geomembrane and will protect underlying surface from damage (spreader bar, protected equipment bucket).
2. The geomembrane roll shall be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.
3. Use full length rolls or those with a significant length remaining at the top of the slope so that no roll end occurs on side slopes.
4. Place ballast (commonly sandbags) on geomembrane, which will not damage geomembrane, to prevent wind uplift.
5. Personnel walking on geomembrane shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geomembrane.
6. Do not allow heavy vehicular traffic directly on geomembrane. Rubber-tired ATVs and trucks are acceptable if wheel contact is less than six (6) pounds per square inch.

E. Sufficient material (slack) shall be provided to allow for thermal expansion and contraction of the material. This practice will be used to prevent excessive tension (trampolines) from developing. This is particularly important in cold weather conditions.

F. Anchor trench compacting equipment shall not come into direct contact with the geomembrane.

3.3 FIELD SEAMING

A. Seams shall meet the following requirements:

1. To the maximum extent possible, orient seams parallel to line of slope, i.e., down and not across slope.
2. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.
3. Slope seams (panels) shall extend a minimum of five feet beyond the grade break into the flat area.
4. Use a sequential seam numbering system compatible with panel numbering system that is agreeable to the ENGINEER and CONTRACTOR.
5. All seam overlaps shall be aligned consistent with the requirements of the welding equipment being used. Seams shall be made by lapping the uphill material over the downhill material with sufficient overlap. Extrusion seaming shall have a minimum overlap of six (6) inches. Wedge-welded seaming shall have a minimum overlap of six inches.
6. Seaming of the geomembrane at material temperatures below 32 degrees F and above 170 degrees F must be successfully demonstrated to the ENGINEER using prequalification test seams to demonstrate that the seams comply with these SPECIFICATIONS.

B. During Welding Operations

1. Provide at least one master seamer who shall provide direct supervision over other welders as necessary.

C. Extrusion Welding

1. Hot-air tack adjacent pieces together using procedures that do not damage the geomembrane.
2. Clean geomembrane surfaces by disc grinder or equivalent. Number 80-grit sandpaper shall be used.
3. Grinding shall not reduce the thickness of the geomembrane more than one mil.
4. Purge welding apparatus of heat-degraded extrudate before welding.
5. Extrusion welding shall be considered a secondary means of welding and shall be used for repairs unless otherwise approved by ENGINEER.

D. Hot Wedge Welding

1. Welding apparatus shall be a self-propelled device equipped with an electronic controller which displays applicable temperatures.
2. Clean seam area of dust, mud, moisture and debris immediately ahead of hot wedge welder.
3. Protect against moisture build-up between sheets.
4. Hot wedge welding shall be considered the primary method of welding and shall be used for panel seaming unless otherwise approved by ENGINEER.

E. Trial Welds

1. Perform trial welds on geomembrane samples to verify welding equipment is operating properly.
2. Make trial welds under the same surface and environmental conditions as the production welds, i.e., in contact with subgrade and similar ambient temperature.
3. A minimum of two trial welds shall be required per day, per welding apparatus, one made prior to the start of work and one completed at mid-shift. Additional trial welds will be required after repairs are made to the apparatus.
4. Cut six one-inch wide by six-inch long test strips from the trial weld.
5. Quantitatively test three specimens for peel adhesion, and then three specimens for shear strength.
6. Trial weld specimens shall pass when the results shown in Table 2 are achieved in both peel and shear test.

TABLE 2: MINIMUM WELD VALUES FOR HDPE GEOMEMBRANES

Property	Test Method	Minimum Value
Peel Strength (fusion), ppi	ASTM D 6392	98
Peel Strength (extrusion), ppi	ASTM D 6392	78
Shear Strength (fusion & ext.), ppi	ASTM D 6392	121

7. The break, when peel testing, occurs in the liner material itself, not through peel separation (Film Tear Bond (FTB) break).
8. The break is ductile.
9. A test will be considered a failure if one specimen on either peel or shear testing does not meet the requirements on Table 2 or does not achieve an FTB break.

10. Repeat the trial weld, in its entirety, when any of the trial weld samples fail in either peel or shear.
11. No welding equipment or welder shall be allowed to perform production welds until equipment and welders have successfully completed two additional trial welds.

F. Seaming shall not proceed when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. The CONTRACTOR shall demonstrate that acceptable seaming can be performed by completing acceptable trial welds.

G. Defects and Repairs

1. Examine all seams and non-seam areas of the geomembrane for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
2. Repair and non-destructively test each suspect location in both seam and non-seam areas. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

3.4 FIELD QUALITY ASSURANCE

A. The manufacturer and CONTRACTOR shall participate in and conform to all terms and requirements of the OWNER'S quality assurance program. The CONTRACTOR shall be responsible for assuring this participation.

B. Quality assurance requirements are as specified in this section.

C. Field Testing

1. Non-destructive testing shall be carried out as the seaming progresses, not at completion of all field seaming. Each seam shall be non-destructive tested with either of the following tests.

a. Vacuum Testing

1) Shall be performed in all extrusion welds performed during installation and in accordance with ASTM D 5641.
2) The vacuum box assembly shall consist of the following:

a) Rigid housing;
b) Transparent viewing window;
c) Soft rubber gasket attached to bottom of housing;
d) Porthole or valve assembly;
e) Vacuum gauge; and
f) A vacuum pump capable of delivering a minimum of a 27psi vacuum.

3) When vacuum testing, the installer shall:

a) Carefully trim all overlapped material using an approved cutting instrument. The "pull-tear" method of overlap removal shall not be accepted;
b) Clean windows, gasket surfaces, and check for leaks;
c) Wet a strip of geomembrane approximately 1 foot by 2.5 feet (length of box) with soapy solution;
d) Place the vacuum box over the wetted area;
e) Ensure that a leak-tight seal is created;

f) Apply a minimum vacuum pressure of five psi;
g) For a period of not less than 15 seconds, examine the length of weld through the viewing window for the presence of soap bubbles;
h) If no bubbles appear after 15 seconds, move the box over the next adjoining area with a minimum three inches of overlap and repeat the process;
i) Areas where soap bubbles appear shall be marked, repaired, and re-tested;
j) All vacuum testing will be documented by the CONTRACTOR'S QC Technician and submitted to the ENGINEER at the end of each WORK shift. The liner shall be indelibly marked near the seam to indicate passing or failing test results accordingly.

b. Air Pressure Testing

1) Shall be performed in all hot wedge welds performed during installation and in accordance with ASTM D 5820
2) The equipment for pressure testing shall include the following:

a) Air pumps equipped with a pressure gauge capable of generating and sustaining a pressure of 30 pounds per square inch (psi); and
b) Sharp hollow needles or other pressure feed devices approved by the ENGINEER. The liner shall be indelibly marked near the tested area to indicate passing or failing test results accordingly.

3) To perform the air pressure test, the installer's QC Technician shall:

a) Pass air through the channel to guarantee a clear pathway;
b) Seal both ends of the seam to be tested;
c) Insert a needle or other approved pressure-feed device into the tunnel created by double hot wedge seaming;
d) Energize the air pump to 30 psi;
e) Close the valve while sustaining the air pressure and allow the air to reach ambient liner temperature;
f) Read the pressure gauge;
g) Sustain the test for a minimum of five (5) minutes and re-read the pressure gauge;
h) If the loss of pressure exceeds three psi after a two-minute period or does not stabilize, faulty areas shall be located and repaired. After testing, pressure-feed devices shall be removed and insertion points sealed; and
i) All pressure testing shall be documented by the CONTRACTOR'S QC Technician and submitted to the ENGINEER by the end of each WORK shift. The liner shall be indelibly marked near the seam to indicate passing or failing test results accordingly.

c. Alternative testing methods other than vacuum or pressure testing may be proposed by the CONTRACTOR and will be subject to the approval of the ENGINEER prior to their use.

d. At locations where seams cannot be non-destructively tested, the CONTRACTOR shall:

1) Cap-strip seams with the same geomembrane when possible; and
2) If the seam is accessible to testing equipment prior to final installation, non-destructively test the seam prior to final installation.

e. Seaming and cap-stripping operations will be observed by the ENGINEER for uniformity and completeness.

2. Destructive Testing (performed by the CONTRACTOR with observation from the ENGINEER)

a. Location and frequency of testing

1) Collect destructive test samples at a frequency of one per every 500 lineal feet of seam length per machine used.
2) Test locations will be determined after seaming.
3) Exercise method of attributes as described by GRI GM-14 to minimize test samples taken.

b. Sampling Procedures are performed as follows:

1) The CONTRACTOR shall cut samples at locations designated by the ENGINEER as seaming progresses in order to obtain field laboratory test results before the geomembrane is covered.
2) The ENGINEER will number each sample, and the location will be noted on the installation as-built.
3) Samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise (length may vary to minimize cutting of the liner).
4) Cut 10 two-inch wide by six-inch long test strips from each end of the samples for field testing.
5) The remaining sample shall be distributed as follows:

a) One portion for CONTRACTOR, 12 by 12 inches
b) Additional samples may be archived if required by OWNER

6) The CONTRACTOR shall repair all holes in the geomembrane resulting from destructive sampling.
7) Repair and test the continuity of the repair in accordance with these SPECIFICATIONS.

c. Destructive testing procedures

1) Destructive testing shall be performed in accordance with ASTM D6392.
2) Quantitatively test five (5) specimens for peel adhesion, and then five (5) specimens for shear strength.
3) Destructive testing specimens shall pass when the results shown in Table 2 are achieved in both peel and shear test.
4) The break, when peel testing, shall occur in the liner material itself, not through peel separation (FTB).
5) The break is to be ductile.

6) A test will be considered a failure if one specimen on either peel or shear testing does not meet the requirements on Table 2 or does not achieve an FTB break.

3. Failed Seam Procedures

a. If the seam fails, the CONTRACTOR shall follow one of two options:

1) Reconstruct the seam between any two passed test locations.
2) Trace the weld to intermediate locations at least 10 feet minimum or where the seam ends in both directions from the location of the failed test. If necessary the failed seam shall be traced to previous days of seaming for the particular machine.
3) All tracing events shall be recorded by the ENGINEER.

b. An additional sample is required for the next seam welded using the same welding device regardless of the length of the next seam.
c. If the new sample passes, then the failed seam shall be reconstructed or capped between the test sample locations.
d. If any sample fails, the process shall be repeated to establish the zone in which the seam is to be reconstructed.

3.5 REPAIR PROCEDURES

A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

B. Repair any portion of unsatisfactory geomembrane or seam area failing a destructive or non-destructive test.

C. Install additional liner anywhere excessive tension (trampolines) exists and to avoid excessive tension.

D. The CONTRACTOR shall be responsible for repair of defective areas.

E. Agreement upon the appropriate repair method shall be decided between the ENGINEER or OWNER and CONTRACTOR by using one of the following repair methods:

1. Patching – Used to repair large holes, tears, undispersed raw materials and contamination by foreign matter. Patch materials shall be of the same material type and thickness as the material being repaired. A patch shall be a minimum of 12 inches larger in all directions than the area requiring repair. All patches shall have rounded corners;
2. Abrading and Re-welding – Used to repair short section of a seam;
3. Spot Welding – Used to repair pinholes or other minor, localized flaws, or where geomembrane thickness has been reduced;
4. Capping – Used to repair long lengths of failed seams;
5. Flap Welding – Used to extrusion-weld the flap (excess outer portion) of a fusion weld in lieu of a full cap; or
6. Remove the unacceptable seam and replace with new material.

F. The following procedures shall be observed when a repair method is used:

1. All geomembrane surfaces shall be clean and dry at the time of repair;
2. Surfaces of the geomembrane which are to be repaired by extrusion welds shall be lightly abraded to assure cleanliness; and
3. Extend patches or caps at least six inches for extrusion welds and six inches for wedge welds beyond the edge of the defect, and around all corners of patch material.

G. Repair Verification

1. Number and log each patch repair (performed by the ENGINEER)
2. Non-destructively test each repair using methods described in this SPECIFICATION

3. Any rips, tears or damaged areas on the deployed geomembrane shall be removed and patched. The patch shall be secured to the original geomembrane by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out, the two portions of the geomembrane shall be cut out, and the two portions of the geomembrane shall be joined in accordance with these SPECIFICATIONS.

3.6 DEPTH OR ELEVATION MARKINGS

A. Following completion of geomembrane install depth or elevation markings as shown on the DRAWINGS.

END OF SECTION 02776

SECTION 02273
NONWOVEN GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

A. The WORK described in this SPECIFICATION section includes the manufacture and installation of geotextile fabrics as stand-alone items only and not included as part of a composite drainage net.

1.2 SUBMITTALS

A. Product Data

1. The CONTRACTOR shall provide to the ENGINEER a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile. The certification shall state that the furnished geotextile meets Minimum Average Roll Value (MARV) requirements of the SPECIFICATION as evaluated under the manufacturer's quality control program. The certification shall be attested to by a person having legal authority to bind the manufacturer.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM D4354 – Practice for Sampling of Geomembrane for Testing
   2. ASTM D4355 – Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Arc Type Apparatus)
   3. ASTM D4533 – Test Method for Index Trapezoid Tearing Strength of Geotextiles
   4. ASTM D4632 – Test Method for Grab Breaking Load and Elongation of Geotextiles
   5. ASTM D4751 – Test Method for Determining Apparent Opening Size of a Geotextile
   6. ASTM D4833 – Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
   7. ASTM D4873 – Guide for Identification, Storage, and Handling of Geotextiles
   8. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
   9. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles

B. American Association for Laboratory Accreditation (A2LA)

C. Geosynthetic Accreditation Institute (GAI) – Laboratory Accreditation Program (LAP)

D. National Transportation Product Evaluation Program (NTPEP)

1.4 DEFINITIONS

A. Minimum Average Roll Value (MARV): Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance testing will exceed value reported.

1.5 QUALIFICATIONS

MANUFACTURER shall have manufactured a minimum of 10,000,000 square feet of geotextile material during the last year.

1.6 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Geotextiles labeling, shipment, and storage shall follow ASTM D4873. Product labels shall clearly show the manufacturer or supplier name, style name, and roll number.

B. Each geotextile roll shall be wrapped with a material that will protect the geotextile from damage due to shipment, water, sunlight, and contaminants.

C. During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames (including welding sparks), excess temperatures, and any other environmental conditions that may damage the physical properties of the geotextile.

PART 2 - PRODUCTS

2.1 GEOTEXTILE

A. The geotextile shall be Nonwoven Geotextile or equivalent. The geotextile shall be manufactured with fibers consisting of long-chain synthetic polymers composed of at least 95% by weight of polyfins or polyesters. They shall form a stable network such that the filaments or yarns retain their dimensional stability relative to each other, including selvages.

B. Woven slit film geotextiles (i.e., geotextiles made from yarns of a flat, tape-like character) shall not be allowed.

C. The geotextile shall meet the requirements of Table 1. All numeric values in Table 1 except Apparent Opening Size (AOS) represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 1: 8 OZ GEOTEXTILE REQUIREMENTS

Property	Test Method	Units	Value
Mass per unit Area	ASTM D5261	oz/yd^2	8
Grab Tensile Strength	ASTM D4632	lbs	205
Grab Tensile Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs	85
CBR Puncture Strength	ASTM D4833	lbs	535
Permittivity	ASTM D4491	sec^{-1}	1.3
Apparent Opening Size	ASTM D4751	U.S. Sieve	80
Water Flow Rate	ASTM D4491	gpm/ft^2	90
UV Resistance[1]	ASTM D4355	%	70

[1] After 500 hrs

2.2 QUALITY CONTROL

A. Manufacturing Quality Control: Testing shall be performed at a laboratory accredited by GAI-LAP and A2LA for tests required for the geotextile, at a frequency meeting or exceeding ASTM D4354.

B. Geotextile properties, other than sewn seam strength, burst strength, and ultraviolet stability shall be tested by NTPEP to verify conformance with this SPECIFICATION.

C. Sewn seam strength shall be verified based on testing of either conformance samples obtained using Procedure A of ASTM D4354, or based on manufacturer's certifications and testing of quality assurance samples obtained using Procedure B of ASTM D4354. A lot size for conformance or quality assurance sampling shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.

D. Ultraviolet stability shall be verified by an independent laboratory on the geotextile or a geotextile of similar construction and yarn type.

PART 3 - EXECUTION

3.1 PREPARATION

A. Grading shall be done in such a way so as to prevent large voids from occurring along the geotextile contact. The graded surface shall be smooth and free of debris.

3.2 INSTALLATION

A. The geotextile installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

B. The geotextile shall be placed loosely with no wrinkles or folds, and with no void spaces between the geotextile and the ground surface. Successive sheets of geotextiles shall be overlapped a minimum of 12 inches, with the upstream sheet overlapping the downstream sheet.

C. Should the geotextile be damaged during installation or drainage aggregate placement, a geotextile patch shall be placed over the damaged area extending beyond the damaged area a distance of 12 inches, or the specified seam overlap, whichever is greater.

END OF SECTION 02273

SECTION 02240
COMPOSITE DRAINAGE NET

PART 1 - GENERAL

1.1 SUMMARY

A. This section covers the technical requirements for the manufacturing and installation of the Composite Drainage Net (CDN). All materials must meet or exceed the requirements of this SPECIFICATION, and all work will be performed in accordance with the procedures provided in these project SPECIFICATIONS unless approved by the ENGINEER.

1.2 REFERENCES

A. American Society for Testing and Materials (ASTM)
   1. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique
   2. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics
   3. ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
   4. ASTM D4354 - Practice for Sampling of Geomembrane for Testing
   5. ASTM D4716 - Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
   6. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
   7. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geomembrane
   8. ASTM D7179 - Standard Test Method for Determining Geomembrane Breaking Force

B. Geosynthetic Research Institute (GRI)

   1. GRI GC7 – Determination of Adhesion and Bond Strength of Geocomposites
   2. GRI GC8 – Determination of the Allowable Flow Rate of a Drainage Geocomposite

C. Relevant publications from the Environmental Protection Agency (EPA):

   1. Daniel, D.E. and R.M. Koerner, (1993), Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, EPA/600/R-93/182.

1.3 DEFINITIONS

A. Geomembrane Manufacturer (MANUFACTURER) - The party responsible for manufacturing the CDN rolls.

B. Lot - A quantity of resin (usually the capacity of one rail car) used to manufacture polyethylene geomembrane rolls. The finished rolls will be identified by a roll number traceable to the resin lot.

1.4 QUALIFICATIONS

A. MANUFACTURER

MANUFACTURER shall have manufactured a minimum of 1 million square feet of CDN material during the last year.

B. CONTRACTOR

a. CONTRACTOR shall have installed a minimum of 3,000,000 square feet of CDN in the last 3 years.
b. CONTRACTOR shall have worked in a similar capacity on at least 5 projects similar in complexity to the project described in the contract documents, and within a total of at least 3,000,000 square feet of CDN installation on each project.
c. The Installation Supervisor shall have worked in a similar capacity on at least 5 projects similar in size and complexity to the project described in the Contract Documents in the last 5 years.

1.5 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Labeling - Each roll delivered to the site shall be wrapped and labeled by the MANUFACTURER. The label will identify:

1. manufacturer's name
2. product identification
3. length
4. width
5. roll number

B. Delivery - Rolls will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.

C. Storage - The on-site storage location provided by the CONTRACTOR to protect the CDN from abrasions, excessive dirt and moisture shall have the following characteristics:

1. level (no wooden pallets)
2. smooth
3. dry
4. protected from theft and vandalism
5. adjacent to the area being lined

D. Handling

1. The CONTRACTOR shall handle all rolls in such a manner to ensure they are not damaged in any way.
2. The CONTRACTOR shall take any necessary precautions to prevent damage to underlying layers during placement of the drainage material.

1.6 WARRANTY

A. The Manufacturer shall warrant that the CDN shall be of merchantable quality (as defined by the Uniform Commercial Code). The Manufacturer shall guarantee that the CDN furnished is suitable for the purpose intended and free from defects of material and workmanship. In the event, the CDN fails to perform as specified the Manufacturer shall promptly replace defective materials without any costs to the OWNER.

B. Installation shall be warranted against defects in installation and in workmanship for a period of 2-years commencing with the date of final acceptance. The guarantee shall include the services of qualified service technicians and all materials required for the repairs at no expense to the OWNER.

PART 2 - PRODUCTS

2.1 COMPOSITE DRAINAGE NET (CDN)

A. A CDN shall be manufactured by extruding two crossing strands to form a bi-planar drainage net structure.

B. The CDN materials shall be used as shown on the DRAWINGS. Each type of CDN specified shall have properties that meet or exceed the values listed in the following tables below.

TABLE 1: 200-MIL CDN PROPERTIES

Property	Test Method	Frequency	Value
Geomembrane (prior to lamination)			
Geomembrane Core	ASTM D 5199	1/50,000 ft^2	200
Transmissivity[1], gal/min/ft	ASTM D 4716	1/540,000 ft^2	9.6
Density, g/cm^3	ASTM D 1505	1/50,000 ft^2	0.94
Creep Reduction Factor	ASTM D 7406/7361	Per formulation	Maximum of 1.2 at 15,000 lb/ft^2
Tensile Strength (MD), lb/in	ASTM D 5035/7179	1/50,000 ft^2	45
Carbon Black Content, %	ASTM D 1603[2]/4218	1/50,000 ft^2	2.0

[1]Gradient of 0.1, normal load of 25,000 lb/ft^2, water at 70° F, between steel plates for 15 minutes.
[2]Modified.

C. Resin

1. Resin shall be new first quality, compounded polyethylene resin.

2. Resin testing values and testing frequencies requirements are presented in Table 2 below. Natural resin (without carbon black) shall meet the following additional minimum requirements:

TABLE 2: RAW MATERIAL PROPERTIES

Property	Test Method[(1)]	Value
Density (g/cm^3)	ASTM D 1505	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	< 1.0

[1]Manufacturer may utilize test equipment and procedures that enable effective and economical confirmation that the product will conform to specifications based on the noted procedures. Some test procedures have been modified for application to geomembrane.

2.2 MANUFACTURING QUALITY CONTROL

1. The CDN shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the ENGINEER.
2. The CDN shall be tested according to the test methods and frequencies listed on Tables 1 which has been prepared based on product data sheets.

PART 3 - EXECUTION

3.1 FAMILIARIZATION

A. Inspection

1. Prior to implementing any of the work in the Section to be lined, the CONTRACTOR shall carefully inspect the installed work of all other Sections and verify that all work is complete to the point where the installation of the Section may properly commence without adverse impact.

2. If the CONTRACTOR has any concerns regarding the installed work of other Sections, the CONTRACTOR shall notify the ENGINEER.

3.2 MATERIAL PLACEMENT AND INSTALLATION

A. The CDN installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

B. The CDN roll should be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the ENGINEER.

C. Use full length rolls or those with a significant length remaining at the top of the slope so that no roll end occurs on side slopes.

D. In the presence of wind, all geomembrane, including the CDN, shall be weighted down with ballast (i.e. sandbags or approved equal)

E. Ballast shall be used during placement and remain until replaced with cover material or liquids.

F. The CDN shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the CDN.

G. The drainage rock material shall be placed on the CDN in a manner that does not permit vehicular traffic directly on the CDN, and prevents damage to the CDN. No equipment shall be driven upon the CDN layer or geomembrane.

3.3 SEAMS AND OVERLAPS

A. Each component of the CDN will be secured or seamed to the like component at overlaps.

B. CDN Components

1. Butt seams should be shingled down in the direction of the slope, with the CDN portion of the top overlapping the CDN portion of the bottom CDN a minimum of 24 inches across the roll width and as recommended by the manufacturer. The overlaps shall be joined by tying the CDN structure with cable ties. These ties shall be spaced every 12 inches along the roll width.

2. Adjacent edge seams across the roll length should be shingled down in the direction of the slope, with the CDN portion of the top overlapping the CDN portion of the bottom CDN a minimum of 6 inches across the roll length. The overlaps shall be joined by tying the CDN structure with cable ties. These ties shall be spaced every 5 feet minimum along the roll width.

3.4 REPAIR

A. Prior to covering the deployed CDN, each roll shall be inspected for damage resulting from construction

B. Any rips, tears or damaged areas on the deployed CDN shall be removed and patched. The patch shall be secured to the original CDN by tying every 6 inches with the approved tying devices. If the area to be repaired is more than 50 percent of the width of the panel, the damaged area shall be cut out and the two portions of the CDN shall be cut out and the two portions of the CDN shall be joined in accordance with Subsection 3.03 of this part.

END OF SECTION 02240

SECTION 02623
HIGH DENSITY POLYETHYLENE (HPDE) PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. The WORK of this SPECIFICATION section shall consist of furnishing and installing the leakage collection and conveyance piping and appurtenances associated with the sump and collection trench as shown on the DRAWINGS.

B. The CONTRACTOR shall furnish all labor, materials, tools, equipment, and services for construction of the polyethylene piping and appurtenances.

C. Although such WORK may not be specifically indicated, CONTRACTOR shall furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a fully functional installation.

1.2 PIPEWORK AND APPURTENANCES

A. All drainage, collection and conveyance pipework shall be carefully fabricated and placed as shown on the DRAWINGS and approved by the OWNER.

B. All pipe invert elevations and gradients shall be accurately set. CONTRACTOR shall adequately anchor or ballast the pipe to prevent movement during construction.

1.3 WARRANTY

A. The pipe manufacturer shall provide a warranty against manufacturing defects of material and workmanship for a period of 10 years after the final acceptance of the project by the OWNER. The manufacturer shall replace, at no additional cost to the OWNER, any defective pipe material within the warranty period.

1.4 REFERENCES

A. Provide IPS size HDPE pipe in accordance with the following standards and all other mandatory ASTM requirements detailed therein.

1. American Society for Testing and Materials (ASTM) most current versions and other applicable standards.
    a. ASTM D3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
    b. ASTM F714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter

1.5 SUBMITTALS

A. The CONTRACTOR shall submit the following:

1. Shop drawings of HDPE pipe, fittings, and manner of securing; a list of materials to be furnished; and the name of the pipe manufacturer;
2. Product data sheets showing compliance with the product requirements of this Section
3. Certifications of welder's qualifications for HDPE pipe fusion required for the project.

B. Submit manufacturer's installation instructions and maintain a copy on-site for reference during construction.

1.6 PIPE WELDERS QUALIFICATIONS

A. All operators conducting fusion welding activities must be certified by the manufacturer as technically qualified and properly experienced for fusion welding of HDPE pipe.

B. Submit names of certified operators in accordance with this Section.

PART 2 - PRODUCTS

2.1 HDPE PIPE

A. HDPE pipe and fittings shall be high-density, high molecular weight polyethylene pipe PE4710.

B. High density polyethylene (HDPE) resin: compounded and manufactured specifically for producing HDPE pipe.

C. Pipe: Manufactured in accordance with ASTM D3350 and ASTM F714.

D. Dimension Ratio (DR): As required by the DRAWINGS.

E. HDPE pipes shall be supplied in standard laying lengths not exceeding 40 feet.

F. HDPE pipes and fittings shall be homogeneous throughout and free of visible cracks, holes (other than manufactured perforations per design), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index, and other physical properties.

G. Fitting at the toe of the slope for the leachate detection sump (LDS) pipe shall consist of a fabricated bend constructed of the same material as the pipe.

PART 3 - EXECUTION

3.1 GENERAL

A. Coordinate details of the prefabricated pipe penetration through the primary liner with the liner manufacturer and CONTRACTOR.

3.2 HANDLING AND PLACEMENT

A. HDPE pipe and fittings shall be installed as indicated on the DRAWINGS.

B. The CONTRACTOR shall exercise care when transporting, handling and placing pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

C. The CONTRACTOR shall comply with the pipe manufacturer's recommendations for handling, storage, and installation of all polyethylene pipe and fittings.

D. Ropes, fabric, or rubber-protected slings and/or straps shall be used when handling pipe. Chains, cables or hooks shall not be used as a means of handling pipe.

E. Pipe or fittings shall not be dropped or dragged over sharp objects.

F. The maximum allowable depth of cuts, gouges, or scratches on the exterior surface of pipe or fittings is 10% of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges, and scratches. CONTRACTOR shall be required to remove and replace damaged pipe, at no additional cost to the OWNER.

G. Whenever pipe laying is not actively in progress, the open ends of pipes that have been placed shall be closed using watertight plugs.

3.3 INSTALLATION

A. Pipe shall be laid on geotextile within pond leak collection system as shown on the DRAWINGS.

B. All polyethylene pipe and fittings shall be installed in accordance with this SPECIFICATION and in conformance with the pipe manufacturer's written instructions.

C. The CONTRACTOR shall carefully examine all pipe and fittings for cracks, damage, or defects before installation.

D. The interiors of all pipes and fittings shall be inspected, and foreign materials shall be completely removed from the pipe and fitting interiors before they are moved into their final positions.

E. Do not damage underlying WORK, soil layers or geosynthetic installations during pipe installation operations. Repair all damaged WORK.

3.4 JOINTS AND CONNECTIONS

A. Fusion joining equipment shall be as supplied by, leased from, or approved by the pipe manufacturer.

B. Joining techniques and operating procedures shall carefully follow written instructions provided by the pipe manufacturer and the joint equipment supplier. A copy of such instructions, including heating time, cooling time, fusion temperature, and fusion pressure for each size of pipe shall be present at any location in which butt-fusion is being carried out.

3.5 PERFORATIONS

A. Perforations as shown on the DRAWINGS may be manufactured or field constructed with approval from the ENGINEER or OWNER.

END OF SECTION 02623

Appendix I

Geotechnical Report

Terracon GeoReport

Geotechnical Exploration Report

Proposed XTO Four Ponds – Shanghai Site

Eddy County, New Mexico

October 5, 2018

Terracon Project No. A4185248 – Task 4

Prepared for:

CDM Smith Inc.

Houston, Texas

Prepared by:

Terracon Consultants, Inc.

Midland, Texas

October 5, 2018

CDM Smith Inc.
11490 Westheimer Road, Suite 700
Houston, Texas 77077

Attn: Mr. Karthik B. Poosekar
P:281.384.9480
E: poosekarkb@cdmsmith.com

Re: Geotechnical Exploration Report
Proposed XTO Four Ponds – Shanghai Site
Pecos Highway and Black River Village Road
Eddy County, New Mexico
Terracon Project No. A4185248 – Task 4

Dear Mr. Poosekar:

We have completed the Geotechnical Exploration services for the above referenced project. This study was performed in general accordance with Terracon Proposal Nos. PA41851248 dated August 25, 2018, PA4185252 dated August 30, 2018 and CDM Smith's Purchase Order No. 84929 dated September 10, 2018. This report presents the findings of the subsurface exploration and laboratory program completed for this project site.

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

Sincerely,
Terracon Consultants, Inc.

Jitendra "JT" Thakur, Ph.D., P.E. (Texas)
Geotechnical Department Manager

J. Dan Cosper, P.E.
Senior Associate

REPORT TOPICS

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

ATTACHMENTS

EXPLORATION AND TESTING PROCEDURES
SITE LOCATION AND EXPLORATION PLANS
EXPLORATION RESULTS (Boring Logs, Test Pit Logs, and Laboratory Data)
SUPPORTING INFORMATION (General Notes and Unified Soil Classification System

Geotechnical Exploration Report
Proposed XTO Four Ponds – Shanghai Site
Pecos Highway and Black River Village Road
Eddy County, New Mexico
Terracon Project No. A4185248 – Task 4
October 5, 2018

INTRODUCTION

This report presents the results of our subsurface exploration and laboratory program completed for the Proposed XTO Four Ponds – Shanghai Site that is located about 10 miles southeast from the intersection of Pecos Highway and Black River Village Road in Eddy County, New Mexico. The purpose of these services is to provide information and geotechnical engineering data relative to:

- subsurface material conditions
- laboratory test data
- groundwater observations
- Test pit observation for karst potential

The geotechnical engineering scope of services for this project included the advancement of one soil-test boring to a depth of approximately 75 feet below existing ground surface (bgs) and excavation of eight test pits extending to excavator refusal depths of 1.5 to 2 feet bgs to evaluate presence of karst features or sinkholes if any.

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

PROJECT DESCRIPTION

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

Item	Description
Parcel Information	The Proposed XTO Four Ponds – Shanghai Site is located about 10 miles southeast from the intersection of Pecos Highway and Black River Village Road in Eddy County, NM. See **Site Location**

Item	Description
Project description	A new pond will be constructed at the project site. The purpose of these services is to provide information and geotechnical data and results of our laboratory testing program completed for this project site.
Existing improvements	None
Current Ground Cover	The project site is covered to varying degrees with mesquite brush and cactus with exposed soils in between.
Existing topography	Relatively level

Maps showing the site and boring locations are shown on the **Site Location** and **Exploration Plan**. The results of the laboratory testing performed on soil samples obtained from the site during our field exploration operations are included in the **Exploration Results** section of this report.

GEOTECHNICAL CHARACTERIZATION

Subsurface Profile

Subsurface conditions encountered on the project site are generalized in the following table.

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/Density
1	75[2]	Silty Sand "CALICHE"[1]; brown to tan	Dense to Very Dense[3]

1. The subsurface materials encountered in our boring are not expected to experience substantial volumetric changes with fluctuations in moisture content.
2. Our boring was terminated within this stratum at the planned termination depth of about 75 feet bgs.
3. Dense to very dense soils with standard penetration resistances (N-values) of 30 blows per foot (bpf) to greater than 100 bpf were encountered in this stratum.

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

Groundwater Conditions

The boring was advanced in the dry using hollow stem auger and air rotary drilling techniques that allow short-term groundwater observations to be made while drilling. Groundwater seepage was not observed within the maximum depths of exploration during or at the completion of drilling. Groundwater level fluctuations occur due to seasonal variations in the amount of rainfall, runoff and other factors not evident at the time the borings were performed. Therefore, groundwater levels during construction or at other times in the life of the structure may be higher or lower than

the levels indicated on the boring logs. The possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project.

GEOTECHNICAL OVERVIEW

The subsurface conditions on the project site generally consist of medium dense to very dense sandy soils with varying amounts of silt, sand, and gravel. No groundwater was encountered in our boring within the maximum drilling depth at the time of our field exploration operations. We note that groundwater levels could be different at later times due to factors not apparent at the time of drilling. No karst potential or sink holes were observed in any of the test pits excavated on site. We recommend more detailed exploration such as geophysical method be used to better understand about the potential for karst or sinkhole formations on site.

GENERAL COMMENTS

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

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

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

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

Any use or reliance of the provided information by third parties is done solely at their own risk. No warranties, either express or implied, are intended or made.

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

EXPLORATION AND TESTING PROCEDURES

Field Exploration

As requested our drilling crew and supervisory staff visited the site and advanced an exploratory boring to a depth of 75 feet bgs testing for subsurface densities and acquiring soils samples throughout the depth of exploration. In addition to the boring, eight test pits extending to excavator refusal depths of 1.5 to 2 feet bgs were excavated using excavator.

Boring and test Pit Layout and Elevations: We use handheld GPS equipment to record boring and test pit locations with an estimated horizontal accuracy of +/-20 feet. If available, approximate elevations are obtained by interpolation from available topographic maps.

Subsurface Exploration Procedures: We advance soil borings with a truck-mounted drill rig using hollow stem auger and air rotary drilling techniques. Five samples are obtained in the upper 10 feet of each boring and at intervals of 5 feet thereafter. Soil sampling is typically performed using thin-wall tube and/or split-barrel sampling procedures. In the thin-walled tube sampling procedure, a thin-walled, seamless steel tube with a sharp cutting edge is pushed hydraulically into the soil to obtain a relatively undisturbed sample. In the split barrel sampling procedure, a standard 2-inch outer diameter split barrel sampling spoon is driven into the ground by a 140-pound automatic hammer falling 30 inches. The number of blows required to advance the sampling spoon the last 12 inches of a normal 18-inch penetration is recorded as the Standard Penetration Test (SPT) resistance value. The SPT resistance values, also referred to as N-values, are indicated on the boring logs at the test depths. The samples are placed in appropriate containers, taken to our soil laboratory for testing, and classified by a geotechnical engineer. In addition, we observe and record groundwater levels during drilling and sampling.

Our exploration team prepares field boring logs as part of standard drilling operations including sampling depths, penetration distances, and other relevant sampling information. Field logs include visual classifications of materials encountered during drilling, and our interpretation of subsurface conditions between samples. Final boring logs, prepared from field logs, represent the geotechnical engineer's interpretation, and include modifications based on observations and laboratory tests.

Eight test pits extending to excavator refusal depths of 1.5 to 2 feet bgs were excavated using excavator to evaluate presence of karst features or sinkholes if any.

Property Disturbance: We backfill borings and test pits with auger cuttings and with excavated soils after completion, respectively. Our services do not include repair of the site beyond backfilling our boreholes/test pits, Excess auger/soil cuttings are dispersed in the general vicinity of the borehole/test pits. Because backfill material often settles below the surface after a period,

we recommend boreholes/test pits are checked periodically and backfilled, if necessary. We can provide this service, or grout the boreholes/test pits for additional fees, at your request.

Laboratory Testing

The project engineer reviews field data and assigns various laboratory tests to better understand the engineering properties of various soil and rock strata. Exact types and number of tests cannot be defined until completion of field work. Procedural standards noted below are for reference to methodology in general. In some cases, local practices and professional judgement require method variations. Standards noted below include reference to other related standards. Such references are not necessarily applicable to describe the specific test performed.

- ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D422 Standard Test Method for Particle-Size Analysis of Soils

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

SITE LOCATION AND EXPLORATION PLANS

SITE LOCATION

Proposed XTO Four Ponds- Shanghai Site ■ Eddy County, NM October 3, 2018 ■ Terracon Project No. A4185248

Terracon GeoReport

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY QUADRANGLES INCLUDE: MALAGA, NM (1/1/1985), PIERCE CANYON, NM (1/1/1968), RED BLUFF, NM (1/1/1985) and ROSS RANCH, NM (1/1/1968).

EXPLORATION PLAN

Proposed XTO Four Ponds- Shangai Site ■ Eddy County, NM

October 3, 2018 ■ Terracon Project No. A4185248

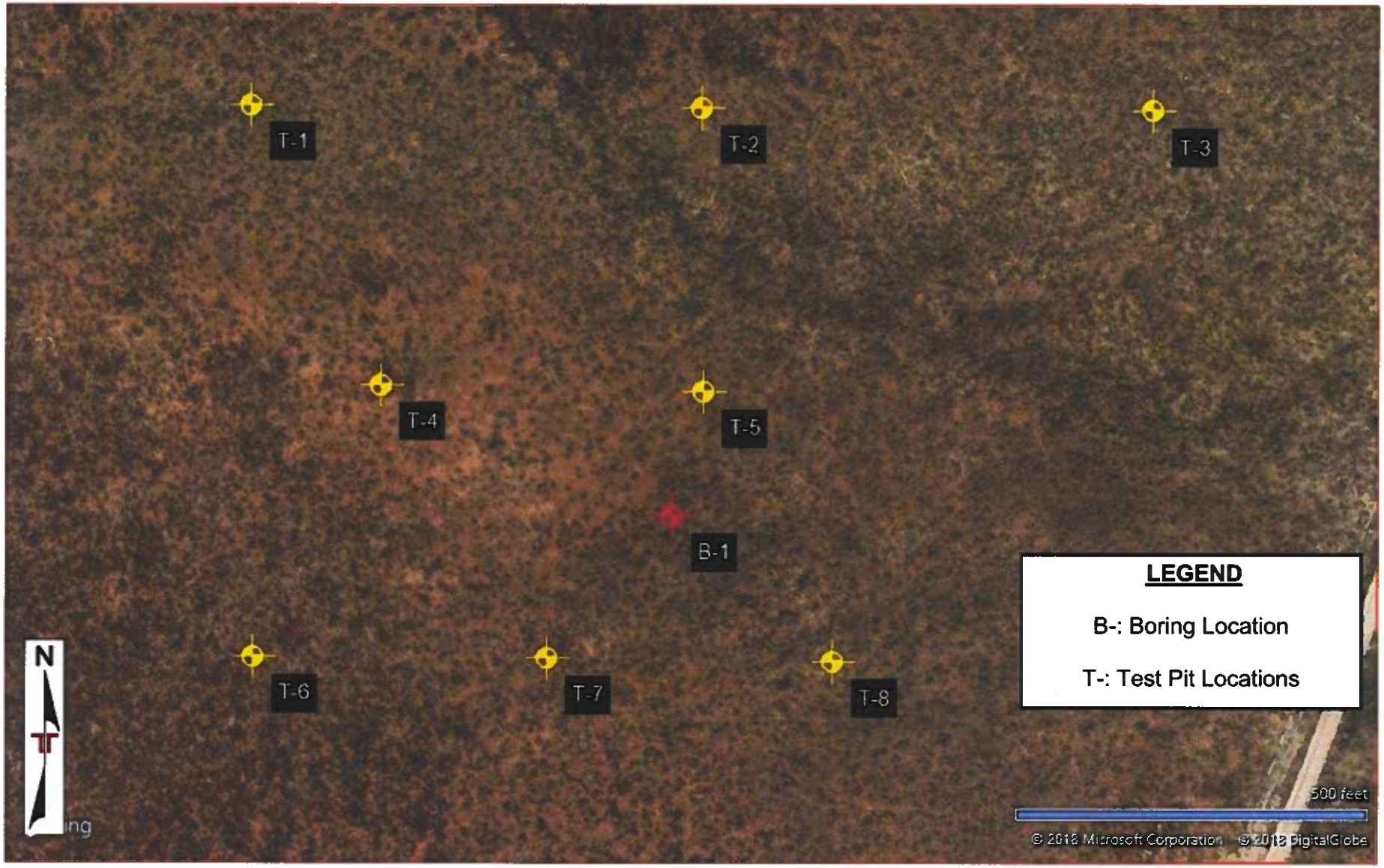


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

AERIAL PHOTOGRAPHY PROVIDED BY MICROSOFT BING MAPS

EXPLORATION RESULTS

BORING LOG NO. B1-S

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith Inc.
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, NM

LOCATION See Exploration Plan

Latitude: 32.11776° Longitude: -103.974685°

Approximate Surface Elev: 3073 (Ft.) +/-

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						22-46-47 N=93			
							2	NP	29
			5			19-12-18 N=30			
						19-37-50/-1"			
						36-50/2"			
			10			50/4"			
						18-19-23 N=42			
			15						
						13-25-38 N=63	3	NP	26
			20						
						50/2"			
			25						
			30						
			35						
			40						
			45						
			50						
			55						
			60						
			65						
			70						
			75						

SILTY SAND locally called caliche (SM), brown to tan, very dense

dense at 2'

dense at 13'

No SPT tests were codncuted below 25 feet per client's instruction

75.0 2998+/-

Boring Terminated at 75 Feet

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Boring backfilled with auger cuttings upon completion.

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

See Supporting Information for explanation of symbols and abbreviations.

Elevation Information was obtained from Google Earth

Notes:
-Augered down from 26' to 75', no SPT samples taken and blow counts recorded.

WATER LEVEL OBSERVATIONS

No groundwater table encountered

Dry at completion

Terracon
10400 State Highway 191
Midland, TX

Boring Started: 9/20/2018 Boring Completed: 9/20/2018

Drill Rig: CME 75 Driller:

Project No.: A4185248

TEST PIT LOG NO. T-1

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1189° Longitude: -103.9767°

Approximate Surface Elev: 3067 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), brown				
	1.5	3065.5+/-			

Test Pit Terminated at 1.5 Feet

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:12

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

TEST PIT LOG NO. T-2

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1189° Longitude: -103.9746°

Approximate Surface Elev: 3071 (Ft.) +/-

GRAPHIC LOG	DEPTH		ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
		SILTY SAND (SM), brown				
	1.5		3069.5+/-			
		Test Pit Terminated at 1.5 Feet				

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:20

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

TEST PIT LOG NO. T-3

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1189° Longitude: -103.9725°

Approximate Surface Elev: 3076 (Ft.) +/-

DEPTH	ELEVATION (FL.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
		SILTY SAND (SM), brown			
2.0	3074+/-				

Test Pit Terminated at 2 Feet

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:04

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

TEST PIT LOG NO. T-4

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1178° Longitude: -103.9761°

Approximate Surface Elev: 3075 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (FT.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), brown				
	1.5	3073.5+/-			

Test Pit Terminated at 1.5 Feet

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:17

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

TEST PIT LOG NO. T-5

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1178° Longitude: -103.9746°

Approximate Surface Elev: 3073 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (FL)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), brown				
	1.5	3071.5+/-			

Test Pit Terminated at 1.5 Feet

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:27

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

TEST PIT LOG NO. T-6

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1168° Longitude: -103.9767°

Approximate Surface Elev: 3067 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), brown				
	2.0	3065+/-			
	Test Pit Terminated at 2 Feet				

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 4:01

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL A4185248 SHANGAI POND_TEST PITS.GPJ TERRACON_DATATEMPLATE.GDT 10/5/18

TEST PIT LOG NO. T-7

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1168° Longitude: -103.9753°

Approximate Surface Elev: 3072 (Ft.) +/-

GRAPHIC LOG	DEPTH	ELEVATION (FL)	DEPTH (FL.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
	SILTY SAND (SM), brown				
	1.5	3070.5+/-			

Test Pit Terminated at 1.5 Feet

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:04

WATER LEVEL OBSERVATIONS

No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

TEST PIT LOG NO. T-8

PROJECT: Proposed XTO Four Ponds- Shanghai Site

CLIENT: CDM Smith
Houston, Texas 77077

SITE: Pecos Hwy and Black River Village Rd
Eddy County, New Mexico

LOCATION See Exploration Plan

Latitude: 32.1168° Longitude: -103.974°

Approximate Surface Elev: 3073 (Ft.) +/-

GRAPHIC LOG	DEPTH		ELEVATION (FL)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE
		SILTY SAND (SM), brown				
	1.5		3071.5+/-			
		Test Pit Terminated at 1.5 Feet				

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

Advancement Method:
Backhoe

Abandonment Method:
Test pits backfilled with soil cuttings upon completion

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

See Supporting Information for explanation of symbols and abbreviations.

Elevations are approximate

Notes:
-excavation time in (mm:ss) was 2:09

WATER LEVEL OBSERVATIONS

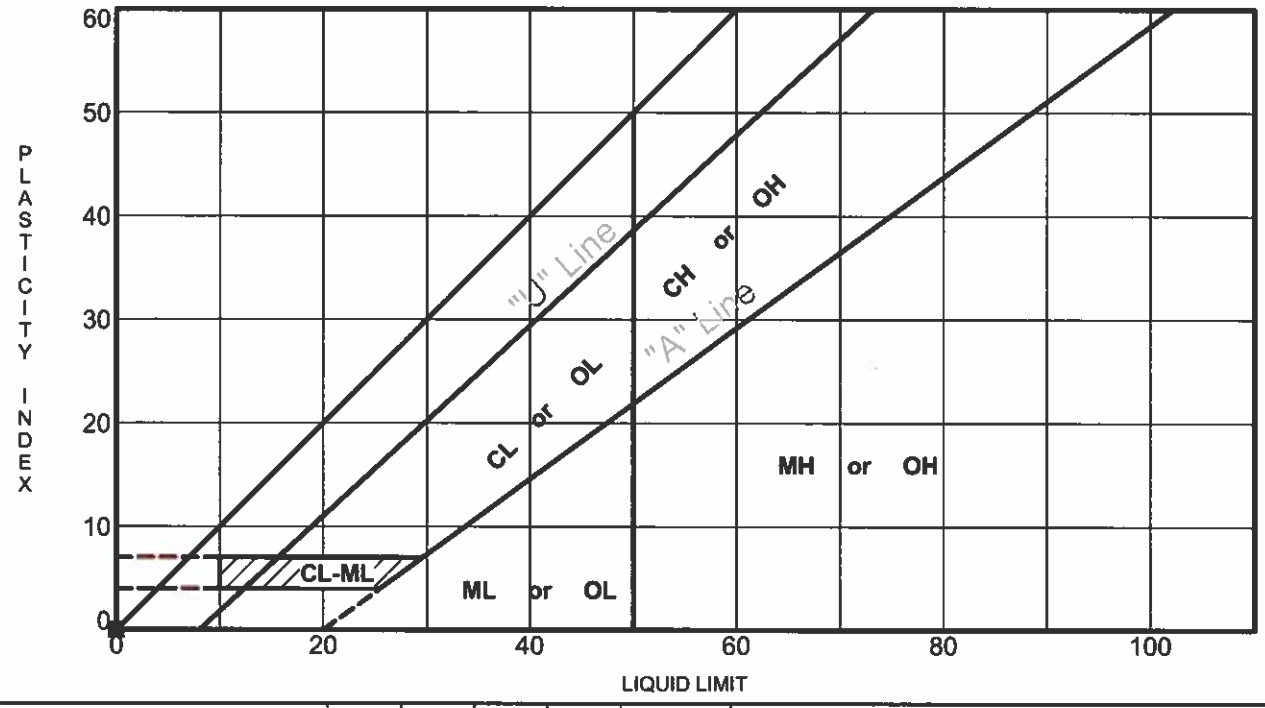
No free water observed

Terracon
10400 State Highway 191
Midland, TX

Test Pit Started: 09-22-2018	Test Pit Completed: 09-22-2018
Excavator:	Operator:
Project No.: A4185248	

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
B1-S	2 - 3.5	NP	NP	NP	29	SM	SILTY SAND
B1-S	18.5 - 20	NP	NP	NP	26	SM	SILTY SAND

PROJECT: Proposed XTO Four Ponds-Shanghai Site

SITE: Pecos Hwy and Black River Village Rd Eddy County, NM

Terracon
10400 State Highway 191
Midland, TX

PROJECT NUMBER: A4185248

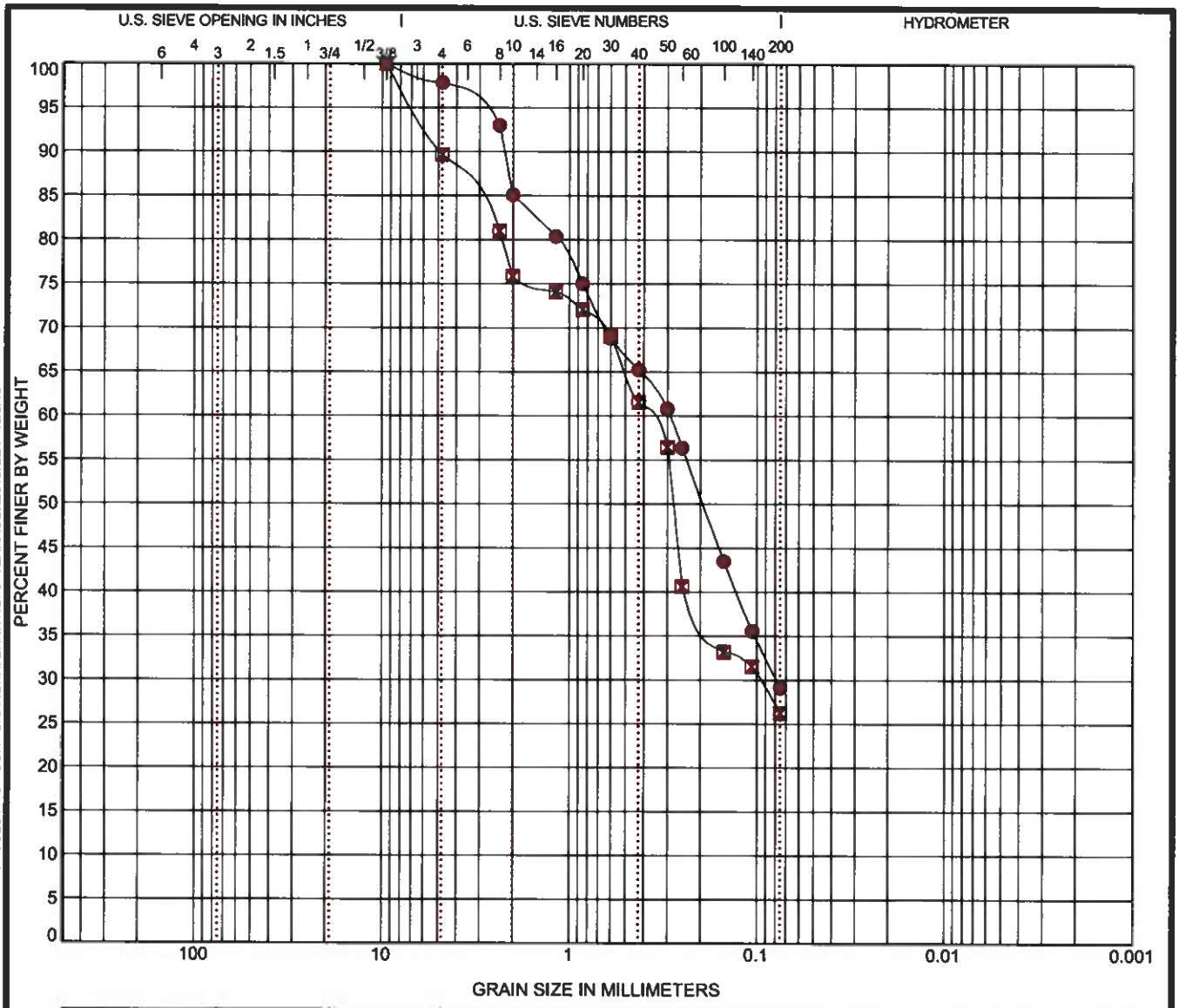
CLIENT: CDM Smith Inc.
Houston, Texas 77077

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS A4185248 PROPOSED XTO FOUR - SHANGHAI DANNY.GPJ TERRACON2015.GDT 10/5/18

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification	WC (%)	LL	PL	PI	Cc	Cu
B1-S	2 - 3.5	SILTY SAND (SM)	2	NP	NP	NP		
B1-S	18.5 - 20	SILTY SAND (SM)	3	NP	NP	NP		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Fines	%Clay
B1-S	2 - 3.5	9.5	0.29	0.079		2.1	68.7	29.1		
B1-S	18.5 - 20	9.5	0.382	0.096		10.3	63.5	26.2		

PROJECT: Proposed XTO Four Ponds-Shanghai Site

SITE: Pecos Hwy and Black River Village Rd Eddy County, NM

Terracon
10400 State Highway 191
Midland, TX

PROJECT NUMBER: A4185248

CLIENT: CDM Smith Inc.
Houston, Texas 77077

EXHIBIT: B-1

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 A4185248 PROPOSED XTO FOUR - SHANGHAI DANNY.GPJ TERRACON2015.GDT 10/5/18

SUPPORTING INFORMATION

UNIFIED SOIL CLASSIFICATION SYSTEM

Proposed XTO Four Ponds – Shanghai Site ■ Eddy County, New Mexico

October 5, 2018 ■ Terracon Project No. A4185248 – Task 4

Terracon GeoReport

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

[Q] PI plots below "A" line.