TETRA TECH

December 4, 2017

To: Mr. Brad Jones or Permitting Specialist
Environmental Permitting
New Mexico Oil Conservation Division, District I
1220 South St. Francis Dr.
Santa Fe, New Mexico 87505

Cc: Mr. Scott Spicher
Mr. Mike Solomon
3Bear Energy, LLC
1512 Larimer Street, Suite 540
Denver, CO 80202

Subject: **Application for a Permit to Maintain and Use a Pit (Form C-147)**
3 Bear Energy, LLC; OGRID #372603
Libby Water Recycling and Containment Facility
Sec. 26, Township 20 South, Range 34 East
Lea County, New Mexico

Dear Mr. Jones or Permitting Specialist,

Tetra Tech is submitting a permit application, Form C-147, for a Recycling Facility and Recycling Containment in accordance with NMAC 19.15.34 requirements on behalf of Mr. Scott Spicher, Vice President of 3Bear Energy, LLC.

3Bear Energy, LLC respectfully requests authorization to operate a Recycling Facility and Recycling Containment in Section 26, Township 20 South, Range 34 East, Lea County, New Mexico. The attached application includes the signed C-147 from the owner and operator, 3Bear Energy, LLC, and describes their compliance with the requirements of NMAC 19.15.34.9 through 19.15.34.15 within.

3Bear Energy, LLC is eager to begin operations of this water recycling facility and respectfully requests and encourages any comments or considerations to be communicated via telephone communication in addition to written communication. Please contact Mr. Nathan Langford with Tetra Tech at 432-687-8130 or Mr. Mike Solomon with 3Bear Energy, LLC at 720-202-2824 should you wish to discuss the application further.

Sincerely,
TETRA TECH, INC.

Nathan A. Langford, P.E.
Project Manager

Attachments (1): NMOCD, FORM C-147 Registration Application Package; 3 Bear Energy, LLC, Libby Water Recycling Facility, Lea County, New Mexico

Tetra Tech
4000 North Big Spring St., Suite 401. Midland, Texas 79705
Tel 432.682.4559 Fax 432.682.3946 www.tetratech.com

TETRA TECH

C-147 Registration Application Package

3Bear Energy, LLC
Libby Site Water Recycling Facility
Lea County, New Mexico

December 4, 2017

complex world

CLEAR SOLUTIONS™

C-147 Registration Application Package

3Bear Energy, LLC
Libby Water Recycling and Containment Facility
Section 26, Township 20 South, Range 34 East
Lea County, New Mexico

Prepared for:

3BEAR ENERGY, LLC

1512 Larimer St., Suite 540
Denver, Colorado 80202

Prepared by:

Tetra Tech, INC

4000 N. Big Spring St., Suite 401
Midland, Texas 79705

Tetra Tech Project No. 212C-MD-00980.601

December 4, 2017

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PROFESSIONAL GEOSCIENTIST'S CERTIFICATION

I hereby certify that the geoscience components of this application for the Libby Water Recycling and Containment Facility in Section 26, Township 20 South, Range 34 East in Lea County, New Mexico, are prepared by review of published data as described here within and have been prepared under my direction and responsible supervision.

12-4-17

Ismael Tavarez, P.G.
PG License No. 2010

Date

The following attachments include geoscience components for the C-147 application:

- Section 3.2 – Distance to Groundwater
- Section 3.3 – Distance to Surface Water
- Section 3.4 – Distance to Permanent Residence and Institutions
- Section 3.5 – Distance to Domestic and Stock Water Supplies
- Section 3.6 – Distance to Municipal Boundaries and Freshwater Fields
- Section 3.8 – Site Geology
- Section 3.9 – Distance to Subsurface Mines
- Section 3.10 – Distance to Cave Karst Features

1.0 INTRODUCTION

3Bear Energy, LLC (3Bear) requests registration under 19.15.34 NMAC for a Produced Water Recycling and Containment Facility and associated storage containment in the Brininstool New Mexico development area, located in Section 26, Township 20 South, Range 34 East in Lea County, New Mexico. The Libby Water Recycling and Containment Facility will receive produced waters from other New Mexico Oil Conservation Division (NMOCD) authorized oil and gas exploration and production operators. 3Bear will collect, treat, and store the treated waters for purpose of delivery to other NMOCD authorized oil and gas exploration and production operators for use in well drilling and completion operations.

The Libby Water Recycling and Containment facility is located on the north end of an approximate, 60-acre property, which is private land owned by 3Bear Energy, LLC. The facility will be operated by 3Bear Energy, LLC and 3 Bear Field Services (OGRID# 372603). The Water Recycling and Containment facility includes the following:

1) A produced water recycle tank system with five storage tanks (with options for future expansion) and a gun barrel separator for the separation of hydrocarbons;
2) Transfer pumps, skid mounted;
3) Recycled water containment pond equipped with an aeration system;
4) Salt water disposal well;
5) Truck unloading area (future);
6) In line filtration units (future);

The Libby Water Recycling and Containment facility is on located at the north end of the property and utilizes approximately 8 acres of the 60-acre property. The 60-arce property will also include a separate gas plant, a crude oil storage area, and an equipment storage yard. The gas plant, and a crude oil storage area and an equipment storage yard operations are adjacent (to the south) of the Water Recycling and Containment Facility. The operation of the gas plant, and a crude oil storage area and an equipment storage yard facilities is not part of this permit application.

The operator's and Libby Water Recycling and Containment Facility's compliance with the requirements of 19.15.34.9 through 19.15.34.15 is described in this application.

Figures 1 and 2 attached to this application are maps identifying the location of the Libby Water Recycling and Containment Facility in proximity to municipalities and State and Federal properties.

A copy of Form C-147, in Section 2, is provided to the surface land owner as required under 19.15.34.10.A.

2.0 NMOCD FORM C-147

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: 3Bear Field Services, LLC (For multiple operators attach page with information) OGRID #: 372603

Address: 1512 Larimer Street, Suite 540; Denver CO. 80202

Facility or well name (include API# if associated with a well): Libby Berry Fee SWD #1;

OCD Permit Number: _____(For new facilities the permit number will be assigned by the district office)

U/L or Qtr/Qtr SW/4 Section 26 Township 20 South Range 34 East County: Lea

Surface Owner: ☐ Federal ☐ State ☒ Private ☐ Tribal Trust or Indian Allotment

2.

☒ **Recycling Facility:** (Section 26, T20S, R34E)

Location of recycling facility (if applicable): Latitude 32.543858ºN Longitude -103.525344 ºW 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:** (Section 26, T20S, R34E)

☐ Annual Extension after initial 5 years (attach summary of monthly leak detection inspections for previous year)

Center of Recycling Containment (if applicable): Latitude 32.544383ºN Longitude -103.526851 ºW 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 _____

☐ String-Reinforced

Liner Seams: ☒ Welded ☐ Factory ☒ Other Field-Welded Seams Volume: 279,558 bbl Dimensions: L 810’ x W 810’ x D 13’

☐ 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 $__2,192,173_____ **(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__ Six-foot, game fencing, with 4" mesh fabric._____

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 (FEMA MAP DATA NOT AVAILABLE FOR PROPERTY)	☐ 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): Scott Spicher Title: Vice President

Signature: Scott Spicher Date: 12-1-17

e-mail address: scott@3bearLLC.com Telephone: 303-862-3960

11.
OCD Representative Signature: _____ **Approval Date:** January 18, 2018

Title: Environmental Specialist **OCD Permit Number:** 1RF-24

☐ OCD Conditions _____
☐ Additional OCD Conditions on Attachment

fOY1801835611 pOY1801835707

3.0 SITING REQUIREMENTS AND HYDROGEOLOGIC DATA – SECTION 26 CONTAINMENT POND

3.1 Location

The proposed 3Bear, Libby Water Recycling and Containment Facility (Containment Facility) is located in Section 26, Township 20 South, Range 34 East in Lea County, New Mexico on private property, owned by 3Bear Energy, LLC. See Figures 1 and 2 attached to this application.

3.2 Distance to Groundwater

No water wells are listed in Section 26 in the Groundwater Report 6, Geology and Groundwater Conditions in Southern Lea County, New Mexico, on the New Mexico Office of the State Engineers database, or on the USGS Groundwater Data Nation Water Information System. The nearest water well to the site, with a reported depth to groundwater, is located in Section 24, approximately 1.0 mile to the northeast of the site and has a reported depth to groundwater of 270 feet below ground surface. According to a Chevron Texaco Groundwater Trend map, the approximate depth to water is between 75 feet and 100 feet below surface.

As part of the geotechnical investigation at the containment site, 3Bear drilled five borings at the containment location on the site for purposes of the geotechnical investigation and identification of groundwater depths, if existing within proximity of the bottom of the containment. The five borings included four shallow borings to a depths of approximately 40 feet and a single boring to a depth of 100 feet below grade surface (bgs) at the proposed containment location. No groundwater was encountered at the time of drilling. No groundwater was observed in the 100-foot boring after 24 hours. The Report of Geotechnical Study for the Libby Water Recycling and Containment Facility, dated November 2017, is included in Appendix C.

3.3 Distance to Surface Water

No continuously flowing watercourses or other significant water features, as defined by NMOCD rules, are located with the prescribed setbacks. The site is not located within 300 feet of a continuously flowing watercourse or within 200 feet of any other significant watercourse, lakebed, sinkhole, or playa lake. The nearest watercourse is a riverine feature, which is located approximately 2,530 feet to the southeast of the site. See Figure 5 attached to this application.

3.4 Distance to Permanent Residence and Institutions

No permanent residences, schools, hospitals, institutions, or churches are located within 1,000 feet of the site, at the time of registration. The only development and structures are associated with oil and gas production.

3.5 Distance to Domestic and Stock Water Supplies

No springs or fresh water wells used for domestic or stock water purposes are located within 500 feet of the site at the time of registration. Five water wells are located within a 1 mile radius of the site. The nearest fresh water well is located approximately 1,500 feet northeast of the site. See Figure 6, attached to this application.

3.6 Distance to Municipal Boundaries and Fresh Water Fields

The site is not located within an incorporated municipal boundary or within the defined municipal fresh water fields. The nearest communities to the site are:

- Village of Monument, which is not incorporated and is located approximately 16 miles northeast of the site.
- Oil Center; which is not incorporated and is located approximately 15.5 miles east of the site.
- City of Eunice, which is incorporated and is located approximately 18 miles southeast of the site. The City of Eunice operated a well field approximately 20 miles north of the city and approximately 23 miles northeast of the site.

3.7 Distance to Wetlands

The site is not located within 500 feet of an identified wetland. The nearest mapped feature according to the U.S. Fish and Wildlife Service's National Wetlands inventory is approximately 2,530 ft. southeast of the site location. See Figure 5 attached to this application.

3.8 Site Geology

Formation

The Geology and Groundwater Conditions in Southern Lea County, New Mexico, Ground-Water Report 6, located the site within the Laguna Valley formation. The Laguna Valley formation consists of Pleistocene drift sand underlain by alluvium (Qal). Some areas of drift sand deposits consist of local dunes 20 to 40 feet high which is stable to semi-stable over most of the area. The surface of the Laguna Valley formation is irregular and has no drainage features, with the exception of the edges of playas. The Laguna Valley formation in the area of the site slopes to the west.

Soils

According to the USDA Natural Resources Conservation Service, National Cooperative Soil Survey, the soils at the site are the Pyote and Maljamar fine sands (PU). The PU is located in plains and consists of 45% Pyote soils, 45% Maljamar soils, and 10% of minor components and is generally used as rangeland.

The Pyote soils are found on almost level to slightly undulating uplands and consists of yellow to red loose fine grained sand to approximately 36" below surface. These sands are underlain by yellow to red fine sandy loam to approximately 74" and white gravelly fine sandy loam from 74" to 80" below surface. The Pyote soils are well drained, with negligible run off, and moderately rapid permeability.

The Maljamar soils are located on sandy plains and consist of yell to red fine sand to 20" below surface. The fine sand is underlain by yellow to red loamy sand to 24", sandy clay loam to 50", and white dense fractured caliche to 52" below surface. The Maljamar soils are well drained soils with very slow runoff and moderate permeability.

Aquifer

The site overlies the Quaternary fill of the Laguna Valley area. The water in the Ogallala formation of the High Plains enters the Quaternary fill of alluvium. The saturated thickness of the Quaternary fill of the Laguna Valley ranges from 15 feet to 30 feet and flows to the southeast. The Ogallala aquifer consists of quartz sand, which is poorly to well cemented with calcium carbonate and contains minor amounts of clay and is capped in most areas by a dense layer of caliche. The formation ranges in thickness, up to 100 feet.

The water in the Quaternary alluvium is generally high in silica, moderately high in calcium-plus-magnesium, low in sodium-plus-potassium, moderately low in sulfate and chloride, and moderately high in dissolved solids.

3.9 Distance to Subsurface Mines

Search of the New Mexico Mining and Minerals Division database indicates there are no subsurface mines in the proximity of the containment pond. The only identified facilities in the general area are surface caliche and aggregate pits. One potash mine is located approximately 15 miles west of the site. A copy of the Active Mines Map from the New Mexico Mining and Minerals Division (November 2014), which shows the approximate proximity of the facility to active mines is provided as a figure attached to this application.

3.10 Distance to Cave/Karst Features

The containment pond is located within a BLM-identified low karst potential zone area. No cave/karst surveys were performed during this assessment.

3.11 Distance to 100-Year Floodplains

Upon review of the FEMA GIS data-base, there is no published 100-year flood plain information associated with the Section 26, Township 20 South, Range 34 East within Lea County, New Mexico. Based on geographical location and topography, the facility and the containment are not located in immediate proximity of any surface waters or draws and are unlikely to be located within a 100-year flood plain.

4.0 CONTAINMENT DESIGN AND CONSTRUCTION

The proposed 3Bear Libby Water Recycling and Containment Facility will include a containment pond to store recycled waters. The proposed containment pond is designed to meet the criteria required in NMAC 19.15.34.12. The containment is designed and will be constructed as a primarily incised containment system, including a perimeter exterior berm, which extends a height of one to four feet above the surrounding finish grade. The containment pond will consist of 3H:1V side slopes as to meet the NMOCD requirement and recommended requirements for constructability. The maximum operational capacity of the containment is 279,558 barrels (bbls). The pond will be operated with three-feet of additional freeboard and will be constructed and installed such that materials are compatible with the fluids contained within. The containment pond is equipped with a dual geosynthethic liner and leak detection system. The containment pond liner and leak detection system, materials and installation methods are described below. The containment pond is equipped with a run-on control berm to the north, east, and west ends of the containment and a drainage channel on the south end of the containment. These systems are designed to prevent any surface water run-on from entering the containment system. A copy of the civil engineering drawings and specifications for the Libby Water Recycling and Containment Facility by Tetra Tech, Inc. is provided in Appendix B.

Containment Pond

The proposed containment pond will be lined with a double-layer synthetic membrane liner. The primary flexible membrane liner (FML) will control contact storm water and leachate. The secondary FML will control potential leakage of affected liquid through the primary FML.

The containment pond will be lined to minimize potential for vertical migration of fluids. The maximum operational water surface elevation will be at or just below the surrounding grade of the site, however the liner system will also protect against slope stability failures of the containment structure. A copy of the civil engineering drawings and specifications for the Libby Water Recycling and Containment Facility by Tetra Tech, Inc. is provided in Appendix B. Liner components, from top to bottom, will consist of the following:

- primary flexible membrane liner (FML) barrier
- liner leak detection system, geonet drain
- secondary FML barrier
- geotextile layer
- compacted, stable native subgrade soil

The containment pond liner components will be protected and supported by other associated materials as described below to maintain the integrity of the liner.

Primary FML

The primary FML will be a 60-mil nominal thickness HDPE geomembrane. Alternatively, if the primary FML is used as a component of the leak detection drain as described below for that component, a geocomposite FML will be used to provide a 60-mil nominal thick FML component. To reduce potential for interface slip failure, a single-sided geocomposite FML is used on side slopes to improve interface friction properties at those locations.

The parts of the primary FML covering the bottom of the containment, including the parts in the leachate collection lateral and leachate removal sump, and the side slopes will be smooth-surface FML.

The primary FML panels will be connected with thermal fusion welds to produce a continuous membrane barrier.

The primary FML product used within the containment will be 60-mil GSE Lining Technology “HD Smooth Geomembrane” or equal. Specifications for these products are shown in Appendix D.

Liquid Leak Detection Drain

The liquid leak detection (LLD) drain will be an open three-dimensional HDPE synthetic drainage net.

The liquid leak detection drain will be supported by the secondary FML. The entire liner, including the leak detection drainage net, will be graded to drain to a leak detection drain sump that is filled with graded fine gravel supported by the secondary FML.

A leak detection drainage net is located in the gravel-filled sump and in the adjacent surface runout between the primary FML and the secondary FML. The LLD header and associated

gravel-filled trench will be graded to an associated leak detection sump. A geotextile cushion or additional geocomposite will be placed over the top of the gravel filling the gravel-filled leak detection trench to reduce the potential for damage to the overlying primary FML. A leachate collection underdrain lateral will be installed beneath the geonet drainage layer, and will extend from the east end of the containment pond to the leachate detection sump. This will increase the total capacity of the leak detection drainage system to convey the necessary leachate flow along the primary flow path at the center of the pond to the sump.

The LLD geonet product used will be GSE Lining Technology "Hypernet Geonet" or equal. Specifications for that product are shown in Appendix D.

Liquids collected in the LLD sump will be evacuated with an onsite centrifugal pump and will be transferred to the Recycle Water System Area for treatment and recirculation to the containment or to the on-site SWD well for disposal.

Secondary FML

The secondary FML will be a 60-mil nominal thick HDPE geomembrane.

The parts of the secondary FML covering the bottom of the landfill, including the parts in the liquid leak detection drain underdrain and sump, and the side slopes will be smooth-surface FML.

The secondary FML product used within the pit will be 60-mil GSE Lining Technology "HD Smooth Geomembrane" or equal. Specifications for that product are shown Appendix D.

Geotextile Layer

The geotextile component will be made of nonwoven synthetic resin fiber. The geotextile will reduce potential for puncture of the secondary liner by protruding smaller rock aggregates or any potential voids, if they exist. Given the gradation of the subgrade, this layer adds an additional component of separation of direct contact of the liner with the subgrade materials.

Liner Subgrade

The liner subgrade will support the secondary FML. The liner subgrade will be supported by stable native soil.

The upper part of the liner subgrade will be a 6-inch nominal compacted thickness layer of compacted, stable native soil. The use of native soil in the upper part of the subgrade will reduce the potential for damage to the overlying secondary FML. The material used for the compacted fill will be native soil free of aggregates larger than one-inch, sharp objects, protrusions, organic matter, wastes, and unstable materials.

The surface of the compacted layer will be graded and compacted to produce a smooth surface, free of depressions and sharp changes in elevation. It will be suitable for effective support, placement, and installation of the secondary FML, overlying liner components, and the related construction and operating loads.

Liner Interior Grades

The liner bottom will be graded to produce a slope of approximately 1% to the location of a central underdrain. The underdrain and the associated liner leak detection components will be graded to drain to the associated LLD sumps at approximately 0.5% to 1%. The containment's interior side slopes will have a slope of approximately 3 horizontal to 1 vertical (3H:1V).

As noted above, the LLD drainage net will drain to the LLD sump. The primary FML will separate the liquid in the pond and will convey fluids to the liquid collection sump (LCS). Consequently, leachate in the LLD sump an associated components will not mix with, nor add volume to, liquid primary pond containment. Fluids will be transferred from the pond at the LCS via transfer pumps to the truck loading station or to the recycle system for recirculation.

Liner and Perimeter berm

The containment will be surrounded by a perimeter berm to the north, east and west ends of the containment to prohibit storm water run-on. The perimeter berm crest will be constructed at a constant elevation set at least 2 feet above the adjacent design grade surface elevation of the containment. At the south end of the containment a drainage channel will be used to divert and convey any stormwater, which collects in the area to south of the containment and to the north of the main facility gas plant, which is located to the south of the containment pond.

The maximum operational water surface elevation is at 3,705 feet AMSL and will contact the liner on the perimeter side slopes at a level that provides at least 3 feet of freeboard below the adjacent, designed perimeter grade.

The perimeter of the containment will have a 15-foot wide crest at minimum with a 10:1 exterior side slope, typical.

Geosynthetic Anchor Trenches

Anchor trenches will be excavated in the crest of the perimeter dikes to anchor the liner geosynthetics (i.e. the primary FML, the LLD geocomposite/geonet, the secondary FML). Anchor trenches will be 24" X 24" deep and will be constructed per the engineering drawings and technical specifications. This exceeds the NMOCD 18" specifications.

Liner Borrow Sources

Native soil or suitable imported soil are suitable for use as engineered fill and will be used to construct the liner earthwork. See the Report of Geotechnical Study for the Libby Water Recycling and Containment Facility, dated November 2017 in Appendix C.

Liner Construction Sequence

The containment liner will be constructed in stages and in accordance with the engineering specifications for the system. The specifications meet the NMOCD requirements for installation. A copy of the specifications is provided in Appendix B.

4.1 General Specifications

The containment construction and liner system installation will be performed in accordance with the engineering drawings and specifications. The civil engineering drawings and specifications for the recycle water storage containment by Tetra Tech, Inc. is provided in Appendix B.

4.2 Stockpiling of Topsoil

Where topsoil is present, it will be stripped and stockpiled against the sides of the containment berms and facility berms and will be used as final cover or fill material for the containment at time of closure.

4.3 Signs

A sign with no less than 12 inches by 24 inches to include lettering with no less than two inches in height, will be installed in a visible area on the perimeter fencing of the facility and in immediate proximity of the containment. The sign will include the following:

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

4.4 Fencing

Fencing will be constructed at the facility and will consist of an eight-foot tall chain-link fencing along the extent of the perimeter of the entire 60-acre site including the Libby Water Recycle and containment facility and the adjacent Libby Gas Plant facility. An additional, six-foot tall, game fencing will be installed around the containment. The game fencing around the containment will be keyed in to the existing grade to deter animals from burrowing under the fencing. The fencing will also encompass the perimeter berms of the containment pond system. The facility will be gated to provide access to operations personnel and will be locked when the facility is not is operation. This will prevent unauthorized personnel access and access from animals. This fencing system is a variance from the minimum four-foot fence with barbed-wire strands required by the NMOCD. The system will provide an equivalent or greater deterrent from unauthorized access.

4.5 Netting and Wildlife Protection

The fencing as described in Section 4.4 will provide protection to wildlife by preventing access to the facility grounds and the containment system. 3Bear will also implement a system designed to prevent access to the containment system by migratory birds. Due to the size of the containment system (approximately 811 feet by 333 feet), 3Bear has determined that it is not feasible to construct or install a netting system on this type of containment. Due to the infeasibility of installation of the netting system, 3Bear proposes to install an audible bird deterrence system as an alternative. This type of system has been used by other operators in the southeast New Mexico as effective protection for birds and migratory birds. A copy of the specifications for the Bird-X Mega Blaster PRO system is provided in Appendix D. This proposed system or equivalent will be utilized and is included as a variance from the specified netting systems described in NMAC 19.15.34. However, this system is designed to provide equal protection by deterrence of avian species.

As part of the operations described in Section 5.0, inspections of the containment will be conducted at least once per week. Inspections will include visual observations and monitoring

will be performed during normal operations and conducted on a minimum weekly basis. The visual observations will include observations of any adverse impacts to wildlife. If any dead migratory birds or other wildlife is detected, 3Bear will notify the New Mexico Department of Game and Fish and the NMOCD District Office as reasonably possible and within 30 days of discovery.

5.0 OPERATING AND MAINTENANCE PLAN

The Libby Water Recycling and Containment Facility will consist of the following:

1) A produced water recycle tank system with five storage tanks (with options for future expansion) and a gun barrel separator for the separation of hydrocarbons;
2) Transfer pumps, skid mounted;
3) Recycled water containment pond equipped with an aeration system;
4) Salt water disposal well;
5) Truck unloading area (future);
6) In line filtration units (future);

Water will be delivered to the facility from authorized exploration and production operator's primarily via pipeline and trucks (future). Waters at the facility will be accepted from only NMOCD approved operators. The expected throughput of the system will start at 15,000 bbls per day and range from 25,000 bbls/day to 50,000 bbls/day with future contracts. Waters will be treated by hydrocarbon separation in an in-line gun barrel tank. Water will then flow through buffering tanks before being processed through an in-line Pall filtration system. Water will be delivered from the filtration system to the containment for storage or to an AST for reuse.

This facility/operator will not discharge into or store any hazardous waste (as defined by 40 CFR 261 and NMAC 19.15.2.7.H.3) in the containment.

The water recycling containment will be operated to contain the liquids and any solids stored within. The integrity of the liner and liquid leak detection system will be monitored to maintain integrity of the system to prevent contamination of fresh waters and protect public health and the environment. The water recycling containment will be operated to recycle field-generated produced waters and will not be used for disposal of oilfield wastes. Introduction or extraction of fluids into the containment are accomplished through hardware and equipment that will prevent damage to the liner system as shown in the Appendix B.

The water recycling containment and associated liner, leak detection system will be inspected at least once per week, while in use. The results of the inspection, including the monitoring of the liquid leak detection sump, will be documented on an inspection checklist and these records will be maintained by the facility owner. The inspection records will be maintained and available for review upon request.

When the recycling containment is not in use, ballast will be maintained in the pond, to prevent wear and liner deterioration due to potential liner uplift from winds. The facility will be enclosed by fencing and the fencing will be closed and secured by a locked gate when not in operation to prevent unauthorized access. Fencing shall be maintained in good repair.

The following inspection, maintenance, and monitoring procedures will be implemented weekly unless otherwise noted.

1. Dike Integrity: The perimeter of the water recycling containment will be inspected for evidence of storm water run-on, significant erosion, and/or leakage out of the perimeter dikes.

2. Oil Removal: Crude oils will not be stored in the water recycling containment. The containment pond will be inspected on a weekly basis for visual indication of oil on the

liquid surface. Any visible layer of oils will be removed from the liquid surface. Collected oils will be transferred and will be stored within oil tanks on-site.

3. Liner Integrity: The water recycling containment liners will be inspected from the crest of the perimeter dikes to confirm liner interior coverage and perimeter anchor integrity (to ensure liner is intact within the anchor trench). Additionally, assuming there is no indication in the leak detection system of a leak, the liner within the containment pond system will be visually inspected on a monthly basis or as the containment pond is emptied or drained for indications of potential wear or deterioration of the primary liner system.

4. Adequate Freeboard: A staff gauge or water level indicator will be installed in the containment pond to allow for water surface level monitoring. The level of water in the water recycling containment will be monitored on a daily basis during normal operations to verify that there is at least three (3) feet of freeboard from the perimeter design grade to the adjacent top of the water surface to ensure the required freeboard level of three feet is maintained during operation and overtopping is prevented. The operational level of the containment will be documented weekly.

5. Sump Riser Integrity: The exposed parts of the liner leak detection (LLD) sump riser and will be inspected for integrity and presence of leaks.

6. Sump Levels: An LLD sump liquid level gauge(s) will be installed in the LLD sump. The LLD sump liquid level gauges, in the water recycling containment, will be observed to confirm sump liquid level at levels not greater than one-foot above the associated containing secondary flexible membrane liner (FML) at the perimeter of the sump. The sump level gauges will be inspected and recorded weekly.

7. Sump Control Operability: A LLD sump level controls and alarms will be installed adjacent to the containment pond. The controls and associated alarms will be inspected and tested for control panel device functionality.

8. Exposed Geocomposite Liquid Collection Integrity: Any exposed liner composite synthetic drainage net will be inspected for rips, tears or other damage. Damaged geotextile components and the composite drainage net will be repaired or replaced as needed.

9. Leak Detection Flow Volume: Each LLD sump increment flow volume will be recorded when encountered during the inspection. The total LLD increment flow volume will be .

10. Recordkeeping for Inspections: The date, time, and observations made during each inspection will be recorded. The record will be maintained by 3Bear while the water recycling containment is open, and if requested by the NMOCD, the record will be filed with the NMOCD after closure. Logs of the inspections and inspection records will be made available to the NMOCD upon request.

11. Liner System Integrity Inspections and Repair: In the event that leakage from the containment into the leak detection LLD sump is suspected by positive fluid level measurements, the operator will evacuate the contents of the sump and monitor the sump on a daily basis for a week to determine the leakage rate into the sump.

    If the leakage rate is exceeding the action leakage rate or if a visible defect or breach in the liner is detected (below the water surface):

a) The containment pond will then be emptied and placed out-of-service immediately and the liner will be inspected for system integrity. Any breach of the liner or associated liner leak detection system will be repaired prior to the containment pond being placed back into service.
b) The NMOCD district office will be notified within 48 hours of the breach and the positive leakage and any repairs of the liner system will be initiated within 48 hours of detection. The NMOCD will be contacted to request an extension for liner repair as needed. Liner repairs will be tested for integrity via vacuum box or seam weld testing (as applicable) or other equivalent method prior to being placed back into service. Geosynthetics repairs and integrity testing will be performed in accordance with the engineering specifications and the manufacturer's requirements.
c) Any liquids evacuated from the sump associated with the leakage will be recorded.
d) The operator will provide the NMOCD with a report describing the inspection and/or repair within 20 days of the initial notification.

12. Spill Response: 3Bear will have spill response equipment, such as an oil absorbent boom or other device, and response personnel available within a reasonable time necessary to contain and unanticipated release from the containment system. Drainage systems and in proximity of the containment and water recycle area and containments will be inspected on a weekly basis for indications of a leak or release.
    A Spill Response, Control and Countermeasures (SPCC) Plan, to include an Oil Spill Contingency Plan, will be implemented for the facility.

    The operator will report releases of fluids in a manner consistent with and as required by NMAC 19.15.29 and any local or federal requirements, as applicable.

13. Wildlife Inspections: The operator will inspect the containment and surrounding areas for dead migratory birds and other wildlife. The operator will report the discovery within 30 days of discovery and will 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.

14. Site-Generated Wastes: Site generated wastes will be collected on site and transported off-site to an approved and NMOCD permitted disposal facility. Solid wastes may be transported to a permanent disposal facility. Liquid wastes may either be disposed of at the permitted on-site SWD (for permitted RCRA exempt wastes) or may be transported off-site for disposal at a permitted facility.

15. Operational Records: Accurate records will be maintained at the facility to include total volumes of water received, volumes of waters for treatment and recycling, volumes of waters for disposal, volumes of waters for sale (leaving the facility), and volumes of treated waters deposited into and withdrawn from the containment pond. 3 Bear will submit a completed FORM C-148 to the NMOCD within 30 days following the end of each calendar month. The submittal will describe the operation and certify that the recycling containment operation have not ceased based on use of the 20% threshold of the containment's total operational fluid capacity, every six months until closure in compliance with NMAC 19.15.34.13.

    The operator will maintain accurate records that identify the sources and disposition of all recycled waters that shall be made available upon request.

16. Secession of Operations: 3Bear will notify the NMOCD district office and secession of operations of the water recycling facility and the containment pond. The containment pond will be drained of fluids and the facility closure plan, described in Section 6.0, will be initiated within 60 days.

6.0 CLOSURE PLAN

Upon secession of operations the NMOCD district office will be notified and all fluids will be removed within 60 days and the recycling containment will be closed within six months. A part of the facility closure, any solids and liner materials and leak detection system components will be removed. All removed liquids, solids, and liner/leak detection materials will be removed and transported to an off-site, NMOCD approved disposal facility within the closure period.

Upon removal and disposal of materials, 3Bear will initiate a sampling program for the closure at the containment site. A five-point composite sample will be collected at a pre-determined spacing from beneath the containment and tested by a qualified laboratory for potential contamination. The composite sample will include any stained or saturated soils or areas. The sample will be analyzed for the constituents listed in the Closure Criteria for Recycling Containments Table 1 of NMAC 19.15.34.14.

In the event, any contaminant concentration exceeds the values listed for Closure Criteria for Recycling Containments (based on the depth of the bottom of the containment to groundwater), 3Bear will contact the NMOCD and request approval for a proposed approach prior to proceeding with the closure activities. Alternative proposed closure, if required, will be performed in accordance with NMOCD requirements and recommendations.

If all constituent concentrations are less than or equal to the values listed in the Closure Criteria for Recycling Containments Table 1, 3Bear will proceed with the closure plan by backfilling the containment area with non-contaminated earthen materials. The site will be backfilled and regraded to tie-in with the immediate surrounding grade. Backfill material will be compacted to stabilize the subgrade and minimize future potential subsidence conditions at the site. Grading will be accomplished such that the finished surface will blend into the surrounding grade and that grading will be contoured to allow for positive surface drainage from the property and so that contouring will be restored to original relative conditions. Top-soils, if present will be replaced and contoured to achieve stability and minimize erosion.

Upon completion of the grading activities and the site closure activities, 3Bear will submit a Closure Report with the NMOCD FORM C-147 and the required attachments. The Closure Report will document all closure activities, including waste materials disposal, construction, backfilling, and grading. The report will be provided within 60 days of closure and will include the sampling results and analysis for the closure of the site.

The site will be re-seeded to promote vegetative growth and restore the site to its pre-existing conditions. The reseeding activity will consist of seeding of local native grasses to the area and surface reclamation with a goal coverage of ground disturbing areas. Surface reclamation is determined to be completed when the following are complete:

- all ground disturbing activities are completed;
- a uniform vegetative cover with a ratio of plus or minus 50% of the pre-construction surface level has been established; and
- at least 70% of a total percent plant, excluding noxious weeds, are established;

3 Bear will notify the NMOCD upon completion of re-vegetation and reclamation of the site.

7.0 FINANCIAL ASSURANCE REQUIREMENTS

This section describes cost estimates for closure of the water recycling containment at the 3Bear Libby Water Recycling and Containment facility. The estimated costs shown are based on current prices and equipment rates for necessary closure construction. The estimated costs shown for construction materials, including borrow soils, are based on use of material purchased from an off-site commercial source. The estimated costs shown for disposal of waste and demolition debris are based on disposal in an authorized commercial disposal facility. Disposal costs assume that no naturally occurring radioactive materials (NORM) are needed to be disposed.

The estimated cost for closure of the water recycling containment are based on removal of waste materials and closure as described in Section 6.0. The cost includes estimates for removal of the recycle water system tanks and associated piping and estimates for plugging the SWD well. A contingency is included in each estimated cost total. A summary of the estimated costs and a breakdown of the estimated cost is shown in Tables 7.1, 7.2, and 7.3 below. The total estimated cost for closure of the Libby Water Recycle and Containment facility is $2,170,094.

Financial Assurance
Pursuant to the requirements of NMAC 19.15.34.15, 3Bear Energy, LLC plans to file a Surety Bond or an Irrevocable Standby Letter of Credit from an authorized bank, payable to the State of New Mexico, for financial assurance meeting the requirements. Financial assurance will be submitted on the required NMOCD forms in the amount of $2,170,094 upon approval of this application.

NMOCD Permit to Maintain and Use a Commercial Water Recycling Facility - FORM C-147

3Bear Energy, LLC - Libby Site Impoundment and SWD Closure Cost Estimate

Table 7.1 - Summary Table

Summary of Closure Cost Estimates for 3Bear Energy, LLC - Libby Site	
Description	**Estimated Cost**
Impoundment Razing and Reclamation	$1,366,573
Water Recycle	$438,239
SWD Plugging	$168,000
Contingency 10%	$197,281
Total Estimated Closure Costs:	**$2,170,094**

NMOCD Permit to Maintain and Use a Commercial Water Recycling Facility - FORM C-147

3Bear Energy, LLC - Libby Site Impoundment and SWD Closure Cost Estimate

Table 7.2 - Impoundment Estimated Closure Costs

Equip	Cost $/hr
Trackhoe	$185.00
D8 Dozer	$195.00
Loader	$105.00
30 Bbl Water Truck	$98.00
Sheepsfoot	$98.00

Material Moved/Recompacted for Libby Impoundment

Excavation (CY)	Fill (CY)	Net Total (CY)
91451	2099	89352

Assumptions:

Move material at 1,200 CY per day

Compact material at 400 CY per day

Cost Estimations:

Estimated Costs for Razing/Backfill/Grading Libby Impoundment:

	Equip	Cost $/hr	# of Hours	Cost
	Trackhoe	185	745	$137,751.00
	D8 Dozer	195	745	$145,197.00
	Loader	105	2792	$293,186.25
	30 Bbl Water Truck	98	2457	$240,803.64
	Sheepsfoot	98	2234	$218,912.40
	Grader	115	62	$7,130.00
Total Estimated Cost for Razing/Backfill/Grading the Libby Impoundment:				**$1,035,850.29**
	Cost per CY			$11.33

Liner Removal/Material Disposal:

Assumptions:

Move material at 1,200 CY per day

Area is ~6.2 acres or ~270,100 CF

	Equip	Cost $/hr	# of Hours	Cost
	Trackhoe	185	50	$7,709.88
	D8 Dozer	195	0	$0.00
	Loader	105	33	$3,500.70
	30 Bbl Water Truck	98	0	$0.00

	Sheepsfoot	98	0	$0.00
	TOTAL:			**$11,210.58**
	Cost per CY			$2.24

Estimated Soils/Liner Volume for Disposal (at a 6" Depth) is		5001	CY.
Estimated Cost for Hauling waste soils per CY:	$15.00		
Estimated Cost for Disposal per Ton:	$30.00		

Total Estimated Cost for Disposal:	*$277,556*

Total Estimated Cost for Liner Removal and Disposal:	$288,766
Environmental Sampling Analysis and Engineering Support:	$26,717
Estimated Cost for Reseeding:	$4,030
Total Estimated Costs:	**$1,366,573**

NMOCD Permit to Maintain and Use a Commercial Water Recycling Facility - FORM C-147

3Bear Energy, LLC - Libby Site Water Recycle Tanks and SWD Closure Cost Estimate

Table 7.3 - Water Recycle Tanks and SWD Estimated Closure Costs

Recycle Tank Removal & Disposal

Description	Cost, $Ea	Qty	Unit	# of Units	Est. Cost, $
Material Removal/Disposal	$55	5	CY	1481	$407,275
Tank	$1,500	5	EA	1	$7,500
Tank Piping	$8	5	LF	120	$4,800
Pump Removal	$1,200	2	EA	1	$2,400
Containment	$3,500	1	EA	1	$3,500
Environmental Sampling, Analysis and Project Support	$3,500	1	EA	1	$12,764
Total Estimated Cost:					**$438,239**

Plugging SWD Well	Est. Cost, $
SWD Well Plugging at 13,300 feet bgs	**$168,000**

Note: Estimated Costs Assume that there is no NORM existing for any of the disposed waste materials.

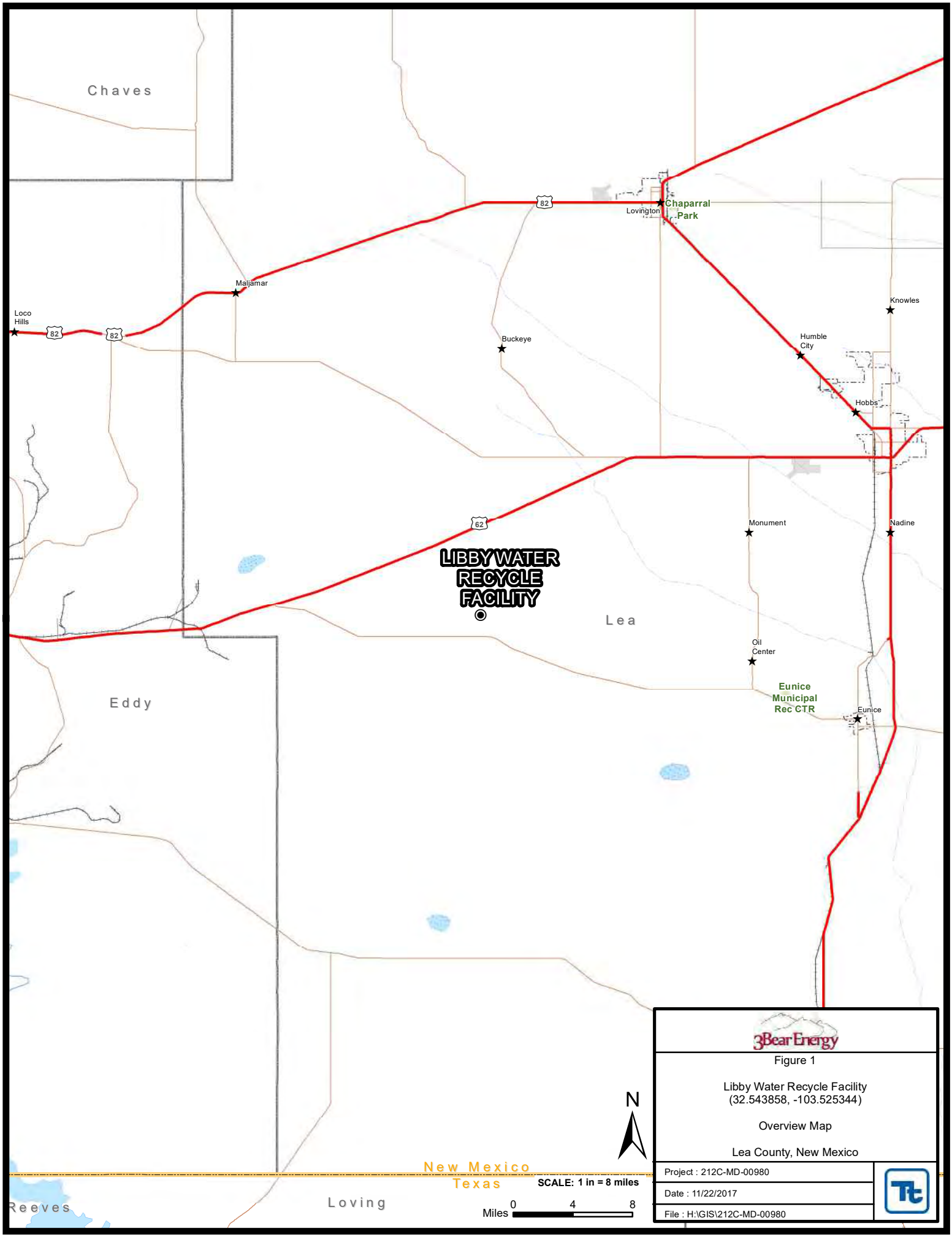
8.0 VARIANCE REQUESTS

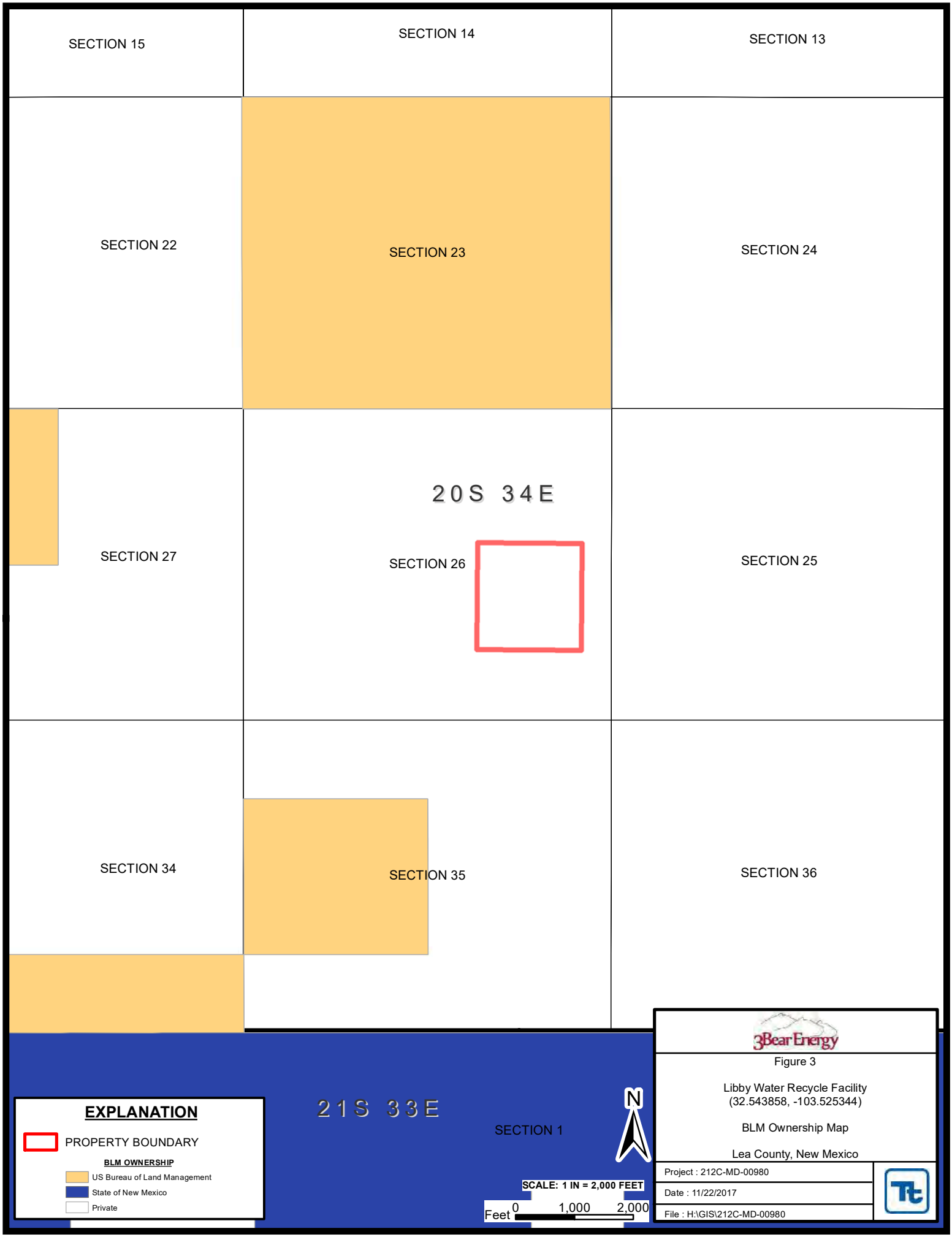
A. Secondary Liner Specifications:
The containment is designed and will be constructed such that the secondary liner will be a 60-mil HDPE liner. This liner system is selected for the following reasons:
- The 60-mil HDPE has a maximum hydraulic conductivity of $1x10^{-12}$ cm/sec, which exceeds the hydraulic conductivity performance of $1X10^{-9}$ cm/sec specified by the NMAC requirements;
- The US EPA recommends 60-mil minimum thickness for HDPE in the Guide for Industrial Waste Management for double lined, systems;
- HDPE liner life expectancy exceeds the typical and anticipated operational life expectancy of the recycle containment system;

B. Fencing:
As described in Section 4.4, a six-foot high game fencing will be installed around the containment instead of the four foot high, barb-wire strand fencing described in the FORM C-147 and NMAC. The proposed fencing will provide equivalent or better deterrent to animal and unauthorized personnel access to the facility and associated containment.

C. Netting:
As described in Section 4.5, the water recycle containment will be equipped with an audible bird protective system (i.e. Bird-X Mega Blaster PRO). The audible system is designed to effectively deter birds from approaching the containment area. This system has been used by other operators in southeast New Mexico and has been proven to be effective. 3Bear has determined that installation of the netting system for a 811' X 333' containment is not practicable and has determined that the proposed audible system, such as the "Bird-X Mega Blaster PRO", is a safe and reliable alternative.

FIGURES


Chaves
Eddy
Lea
Loving
Reeves
Loco Hills
Malljamar
Buckeye
Lovington
Chaparral Park
Knowles
Humble City
Hobbs
Monument
Nadine
Oil Center
Eunice Municipal Rec CTR
Eunice
82
62
LIBBY WATER RECYCLE FACILITY
New Mexico
Texas
N
SCALE: 1 in = 8 miles
Miles 0 4 8
3Bear Energy
Figure 1
Libby Water Recycle Facility
(32.543858, -103.525344)
Overview Map
Lea County, New Mexico
Project : 212C-MD-00980
Date : 11/22/2017
File : H:\GIS\212C-MD-00980
Mapped By: Isabel Marmolejo



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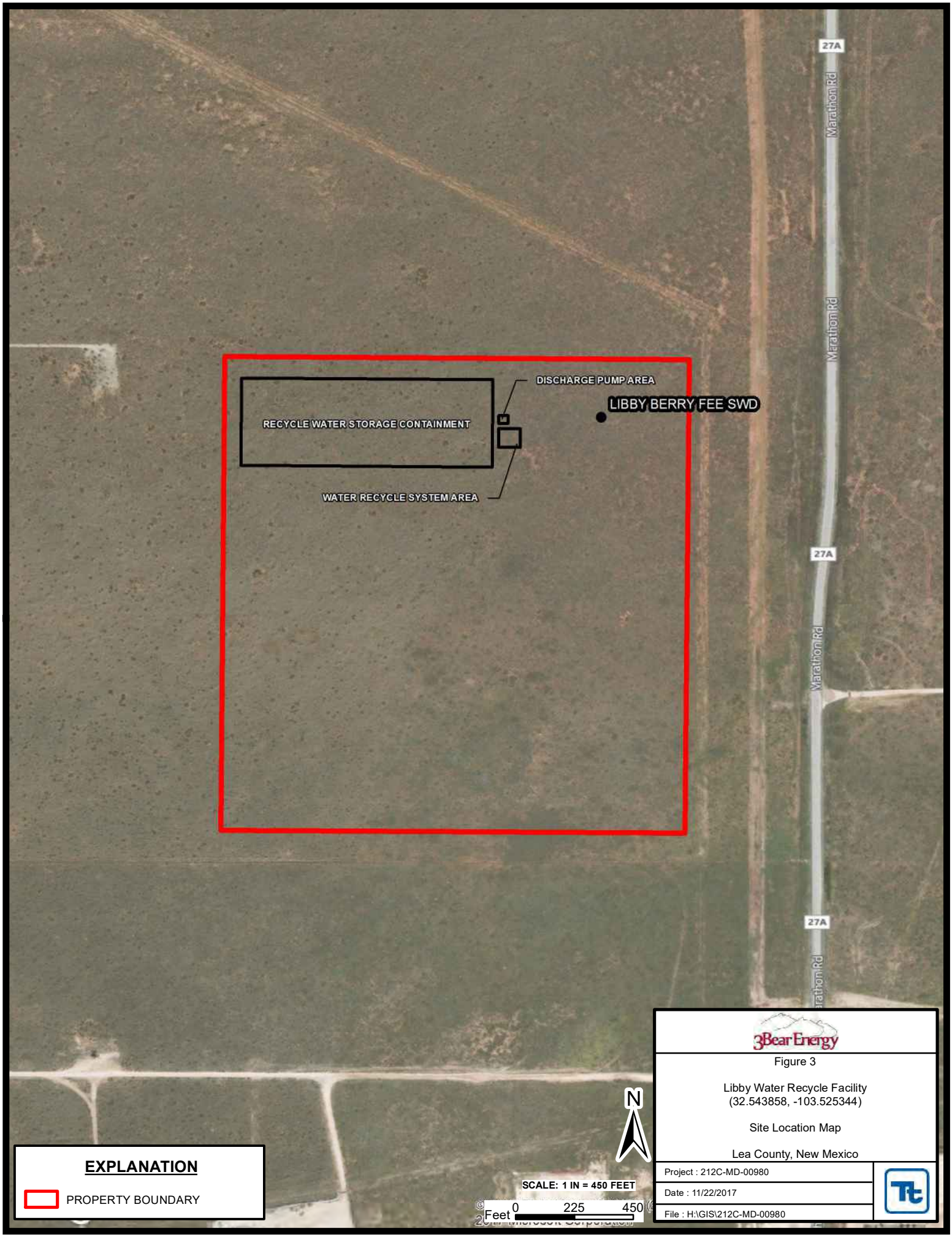


3Bear Energy

Figure 3

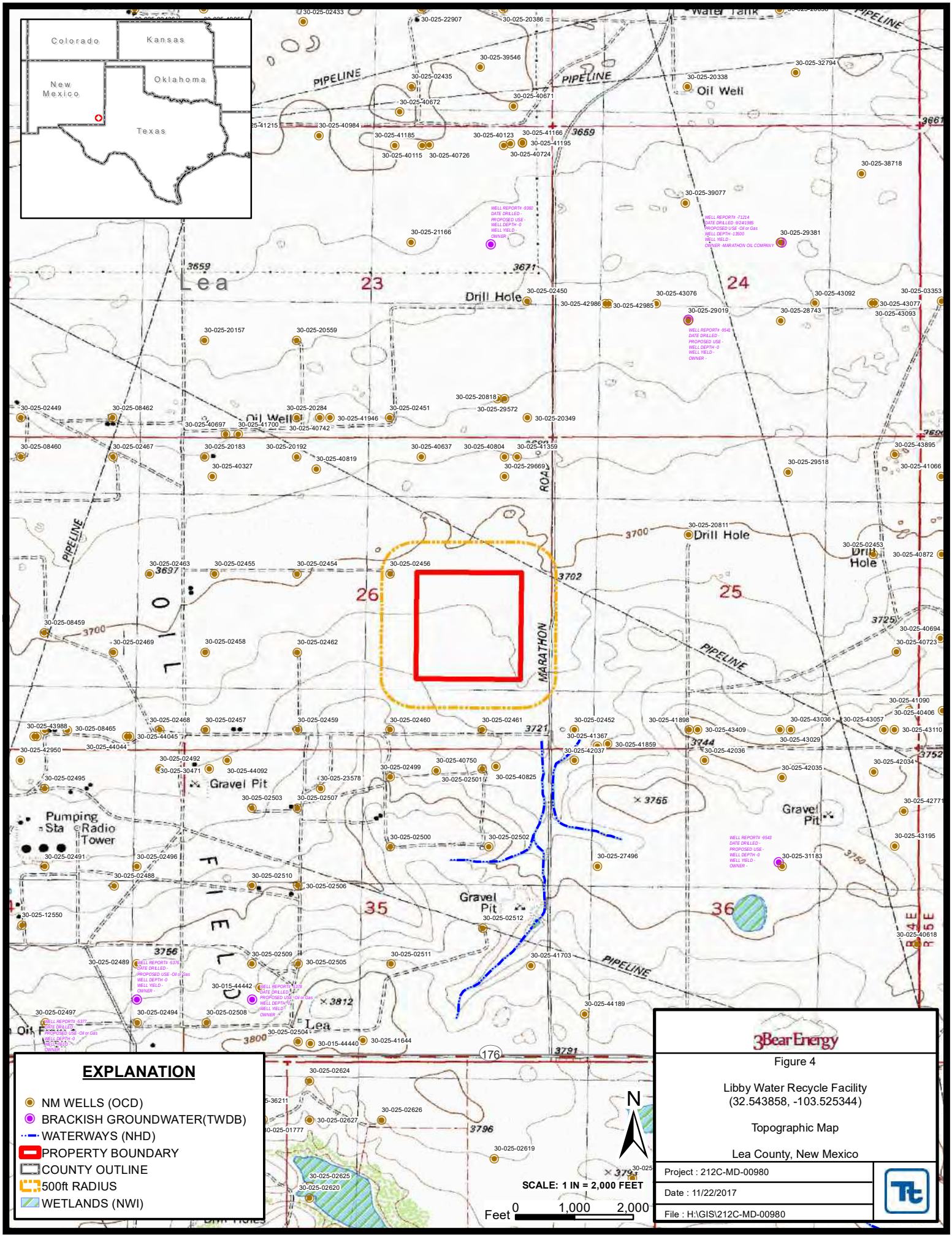
Libby Water Recycle Facility
(32.543858, -103.525344)

Site Location Map

Lea County, New Mexico

Project : 212C-MD-00980	
Date : 11/22/2017	
File : H:\GIS\212C-MD-00980	

Mapped By: Isabel Marmolejo



EXPLANATION

- NM WELLS (OCD)
- BRACKISH GROUNDWATER(TWDB)
- WATERWAYS (NHD)
- PROPERTY BOUNDARY
- COUNTY OUTLINE
- 500ft RADIUS
- WETLANDS (NWI)

3Bear Energy

Figure 4

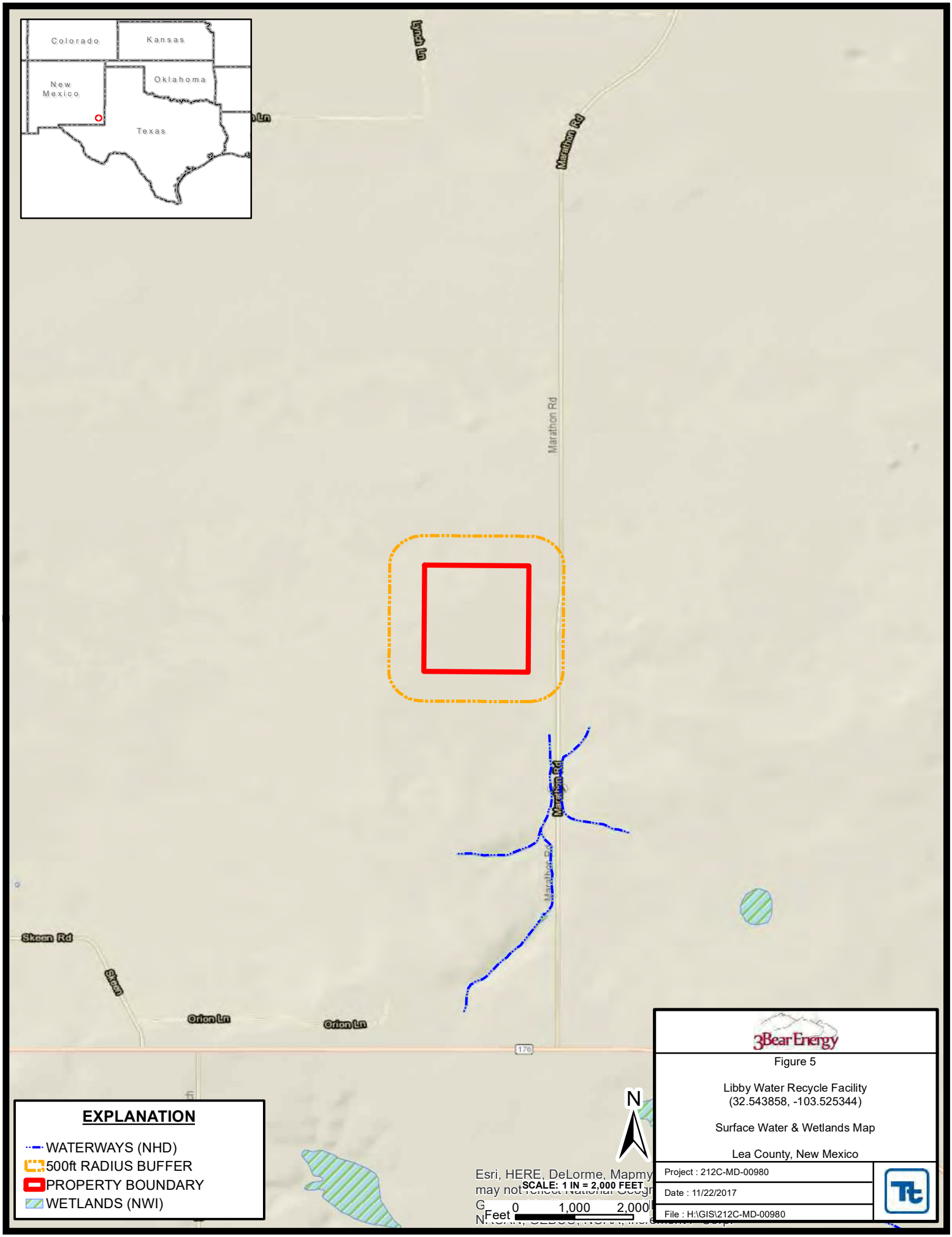
Libby Water Recycle Facility
(32.543858, -103.525344)

Topographic Map

Lea County, New Mexico

Project : 212C-MD-00980	
Date : 11/22/2017	
File : H:\GIS\212C-MD-00980	

Mapped By: Isabel Marmolejo



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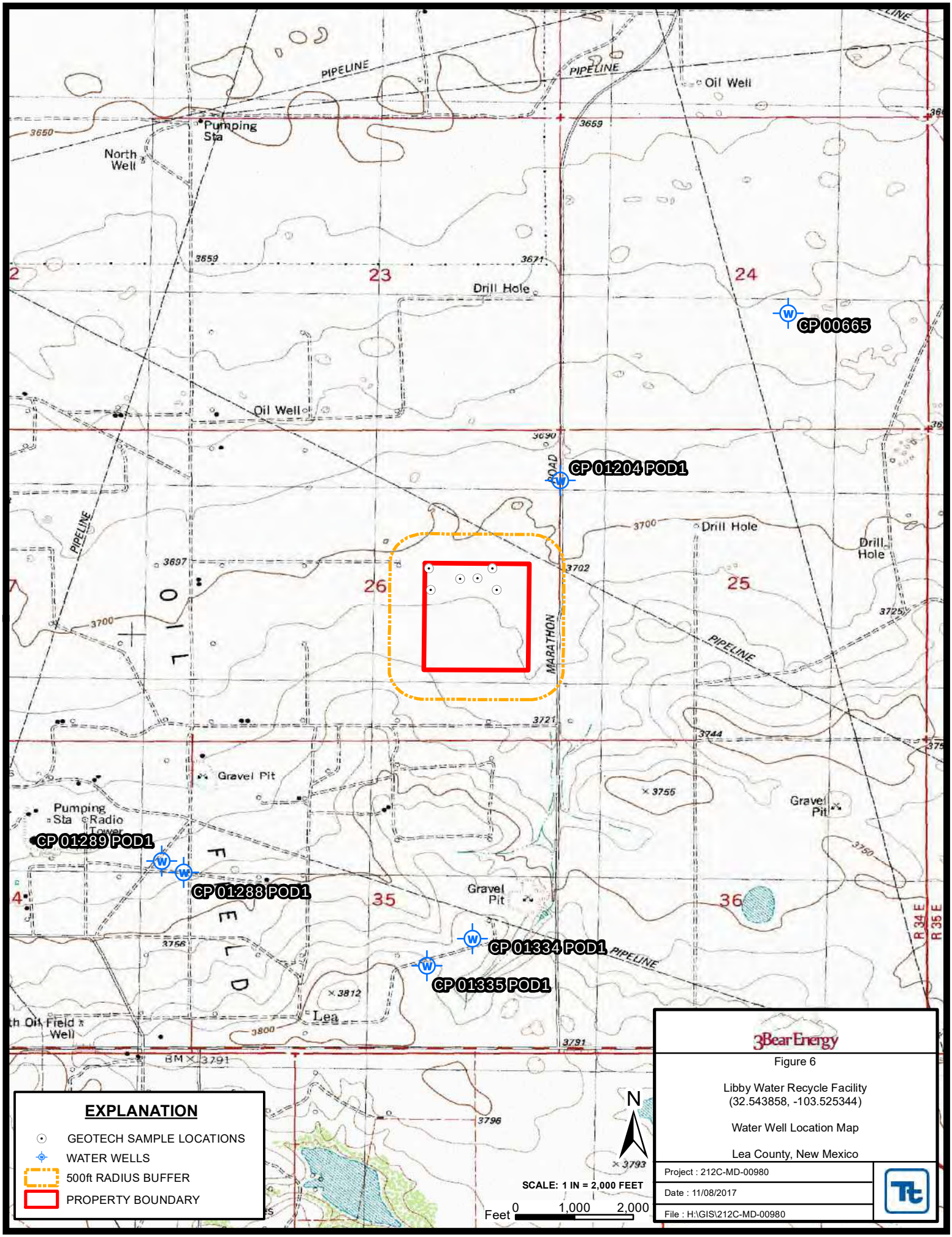
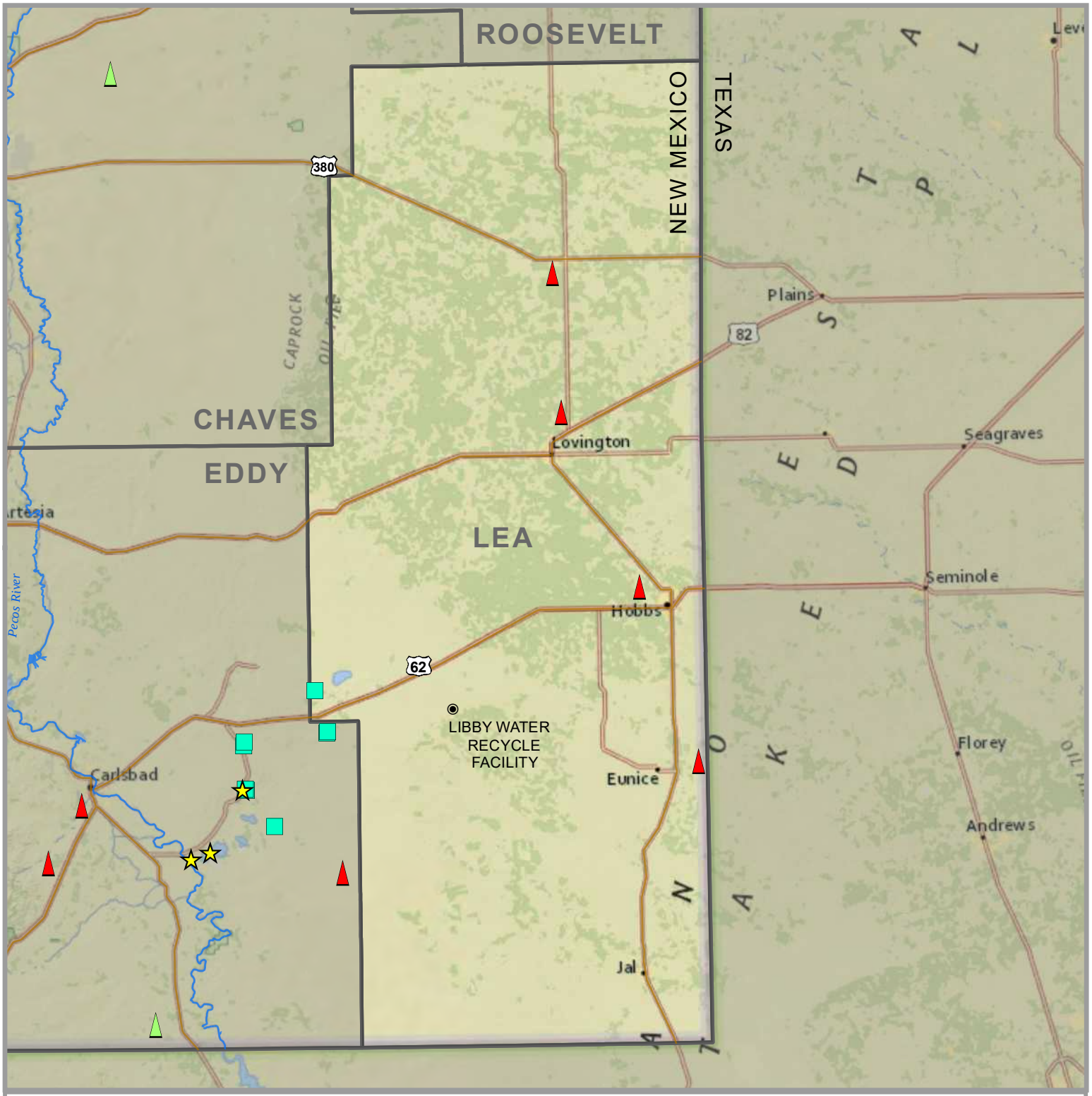


Mapped By: Isabel Marmolejo

Active Mines in Lea County, New Mexico, November 2014



Metals

Coal
Potash
Copper
Gold & Silver
Molybdenum

Industrial Minerals

Calcite
Gemstone
Gypsum
Humate
Perlite
Pumice
Salt
Silica / Flux
Silver Silica
Zeolites

Aggregate & Stone

Aggregate
Caliche
Clay & Shale
Dimension & Flagstone
Limestone
Red Dog
Scoria
Travertine

Data: November 2014 database query, Mining & Minerals Division, Mine Registration, Reporting & Safeguarding Program.
Basemap: Esri ArcGIS Online, National Geographic.
Map: Linda S. DeLay, GISP

NAD 83 UTM NM Zone13

N
W
E
S

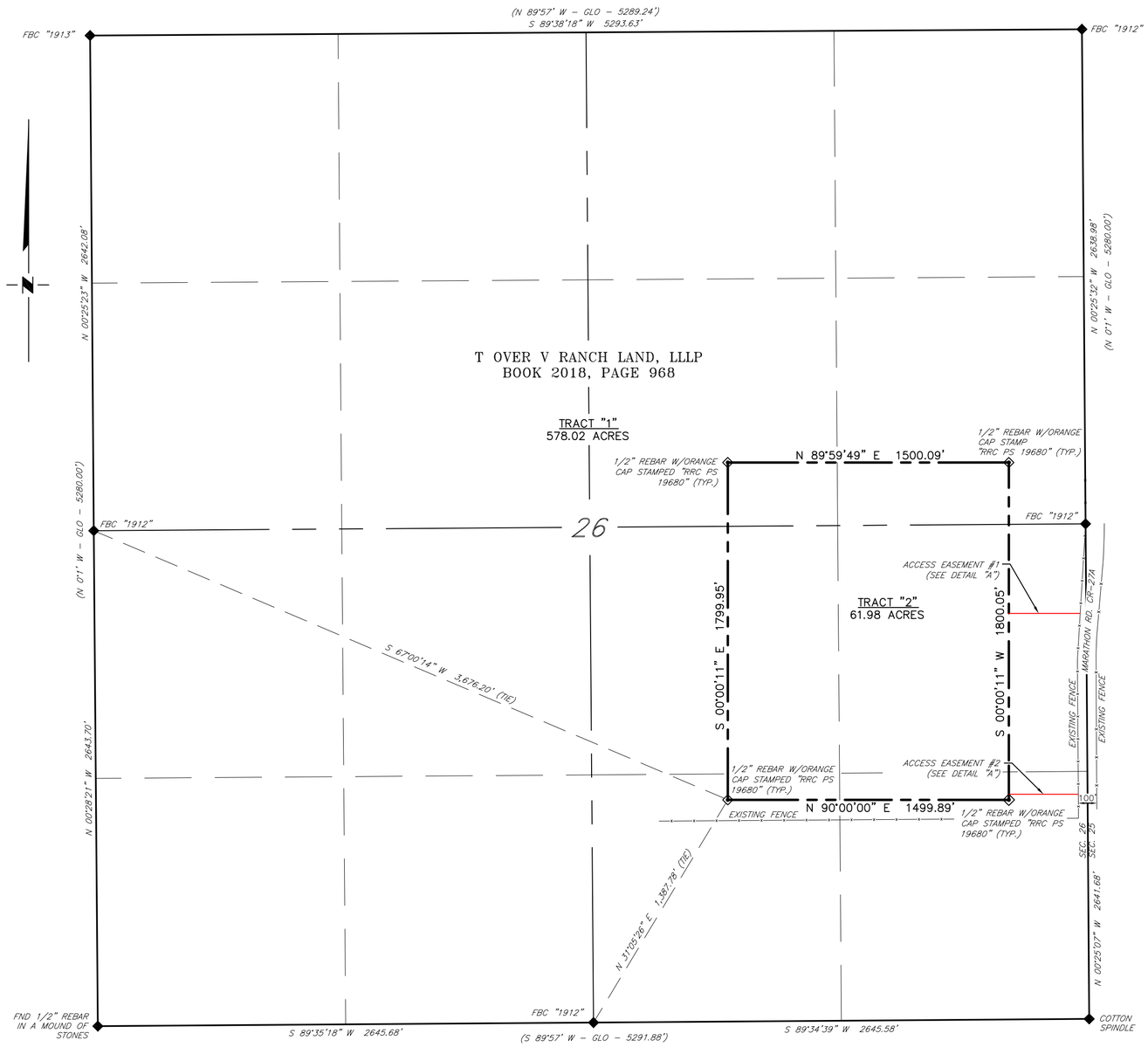
0 5 10 20
Miles

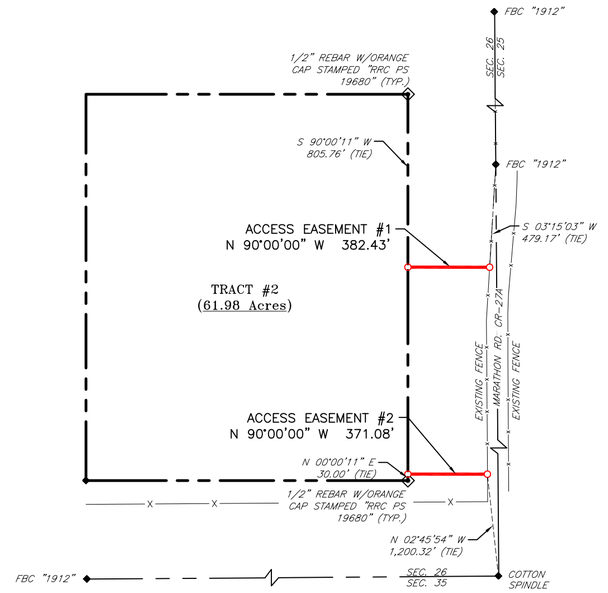
9.0 APPENDICES

APPENDIX A – Libby Water Recycling and Containment Survey Plats

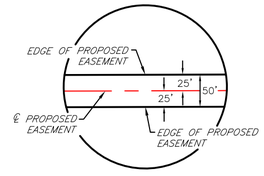
CLAIM OF EXEMPTION PLAT FOR T OVER V RANCH LAND, LLLP

SECTION 26, TOWNSHIP 20 SOUTH. RANGE 34 EAST,
N. M. P. M., LEA CO., NEW MEXICO



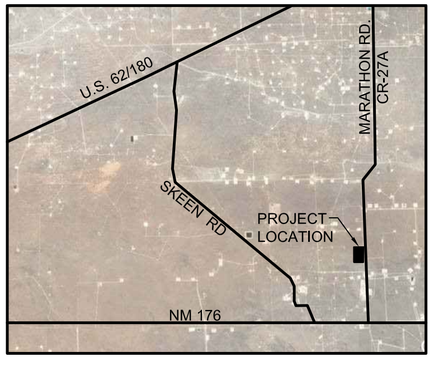


DETAIL "A"
N.T.S



EASEMENT DETAIL
N. T. S.

LOCATION MAP



LEGEND

(XX°XX'XX" XXX.XX')	RECORD BEARING AND DISTANCE
XX°XX'XX" XXX.XX'	MEASURED BEARING AND DISTANCE
□	MEASURED BEARING AND DISTANCE
◈	1/2" RBR W/ORANGE CAP STAMPED "RRC PS 19680"
◆	FOUND MONUMENT AS NOTED
——//——	UNDERGROUND CABLE
——	GAS LINE
——	ELECTRIC LINE
— — — —	EXISTING BOUNDARY LINE
——— - - ———	PROPOSED BOUNDARY LINE
——x——x——	EXISTING FENCELINE

SCALE: 1" = 500'
0 250' 500'

BEARINGS ARE GRID NAD 83 NM EAST
DISTANCES ARE HORIZ. GROUND.

ROBERT M. HOWETT
NEW MEXICO
19680
PROFESSIONAL SURVEYOR
8/11/17

State of New Mexico, County of _____,
I hereby certify that this instrument was filed for record on:

The _____ Day of _____, 20____ A.D.

At _____ O'Clock_____M.

Cabinet _____ Slide_____

Book_____ Page_____

By_____,
County Clerk

By_____,
Deputy

NO.	REVISION	DATE

JOB NO.: LS1706381
DWG. NO.: Exempt.Plat

RRC
308 W. BROADWAY ST., HOBBS, NM 88240 (575) 964-8200

SCALE: 1"=500'
DATE: 6-23-2017
SURVEYED BY: JM/EF
DRAWN BY: LPS
APPROVED BY: RMH
SHEET : 1 OF 2

CLAIM OF EXEMPTION PLAT FOR T OVER V RANCH LAND, LLLP
SECTION 26, TOWNSHIP 20 SOUTH. RANGE 34 EAST,
N. M. P. M., LEA CO., NEW MEXICO

ORIGINAL DESCRIPTION:
Being Section 26, Township 20 South, Range 34 East, according to a deed filed for record in Book 2018, Page 968, of the Deed Records of Lea County, New Mexico;

TRACT 1
All of Section 26, Township 20 South, Range 34 East, N.M.P.M., Lea County, New Mexico, less and except Tract 2.

Said Tract of land contains 578.02 acres more or less.

TRACT 2
Beginning at a 1/2" rebar with orange cap stamped, "RRC PS 19680", for the Southwest corner of Tract 2, which bears N 31°05'26" E, 1,387.78 feet, from a brass cap, stamped "1912", found for the South quarter corner of Section 26 and being S 67°00'14" E, 3,676.20 feet, from a brass cap, stamped "1912", found for the West quarter corner of Section 26;

Thence N 00°00'11" W, 1,799.95 feet, to a 1/2" rebar with orange cap stamped, "RRC PS 19680";
Thence N 89°59'49" E, 1,500.09 feet, to a 1/2" rebar with orange cap stamped, "RRC PS 19680";
Thence S 00°00'11" W, 1,800.05 feet, to a 1/2" rebar with orange cap stamped, "RRC PS 19680";
Thence S 90°00'00" E, 1,499.89 feet, to the Point of Beginning.

Said Tract of land contains 61.98 acres more or less.

SUBJECT TO RESERVATIONS, RESTRICTIONS, EASEMENTS OF RECORD AND IN OPEN VIEW AND LEA COUNTY PROPERTY TAXES.

ACCESS EASEMENT #1
A strip of land 50 feet wide, being 382.43 feet or 23.178 rods in length, lying in Section 26, Township 20 South, Range 34 East, N. M. P. M., Lea County, New Mexico, being 25 feet left and 25 feet right of the following described survey of a centerline across the lands of T Over V Ranch Land, LLLP, according to a deed filed for record in Book 2018, Page 968, of the Deed Records of Lea County, New Mexico:

BEGINNING at Engr. Sta. 0+00, a point on the West Right of Way line of County Road - 27A (Marathon Rd.), which bears, S 03°15'03" W, 479.17 feet, from a brass cap, stamped "1912", found for the East quarter corner of Section 26;

Thence N 90°00'00" W, 382.43 feet, to Engr. Sta. 3+82.43, the End of Survey, a point on the East line of Tract 2, which bears, S 00°00'11" W, 805.76 feet from a 1/2" rebar with an orange cap stamped "RRC PS 19680" , found for the Northeast corner of Said Tract 2.

Said strip of land contains 0.439 acres, more or less.

ACCESS EASEMENT #2
A strip of land 50 feet wide, being 371.08 feet or 22.489 rods in length, lying in Section 26, Township 20 South, Range 34 East, N. M. P. M., Lea County, New Mexico, being 25 feet left and 25 feet right of the following described survey of a centerline across the lands of T Over V Ranch Land, LLLP, according to a deed filed for record in Book 2018, Page 968, of the Deed Records of Lea County, New Mexico:

BEGINNING at Engr. Sta. 0+00, a point on the West Right of Way line of County Road - 27A (Marathon Rd.), which bears, N 02°45'54" W, 1,200.32 feet, from a cotton spindle, found for the Southeast corner of Section 26;

Thence N 90°00'00" W, 371.08 feet, to Engr. Sta. 3+71.08, the End of Survey, a point on the East line of Tract 2, which bears, N 00°00'11" W, 30.00 feet from a 1/2" rebar with an orange cap stamped "RRC PS 19680" , found for the Southeast corner of Said Tract 2.

Said strip of land contains 0.428 acres, more or less.

Said tracts are being platted with the free consent and in accordance with the desires of the undersigned owner(s) thereof surveyed and replatted as the same appears hereon.

In witness whereof, the undersigned owners of said land, has hereunto set their hand this _____day of _____ 2017.

_____
Daniel C. Berry, III

_____
Elizabeth Lee Berry

ACKNOWLEDGMENT

State of New Mexico:
County of Lea:

On this _____ day of _____, 2017, before me personally appeared _____ and _____ to me known to be the persons described in and who executed this foregoing instrument and acknowledged that they executed the same as their free act and will.

Witness my hand and official seal the day and year last item written.

_____.
Notary Public

MY COMMISSION EXPIRES_____

Certificate of Approval of Exemption to Subdivision Regulations by Lea County

Pursuant to Lea County regulations, section 7.5 (1997) the plat and claim of exemption meet the criteria for the sale, lease or other conveyance of a single parcel from a tract of land, except from a tract within a previously approved subdivision, within any five (5) year period; provided that a second or subsequent division of land created by the sale, lease or other conveyance from the remaining tract of land within five (5) years of the first sale, lease or other conveyance shall be subject to the provisions of the New Mexico Subdivision Act and these Regulations; provided further that a survey shall be filed with the county clerk indicating the five (5) year holding period for the sale or division of the remaining tract and the further division of the newly created tract, and is approved for claim of exemption on this _____ day of _____, 20____ AD.

Lea County, New Mexico

_____
Corey Needham, Lea County Manager Designee

ACKNOWLEDGMENT

State of New Mexico:
County of Lea:

On this _____ day of _____, 2017, before me personally appeared _____to me known to be the person described in and who executed this foregoing instrument and acknowledged that they executed the same as their free act and will

Witness my hand and official seal the day and year last item written.

_____.
Notary Public

CERTIFICATE OF SURVEY

I, Robert M. Howett, New Mexico Professional Surveyor, hereby certify that this Claim of Exemption Plat was prepared from an actual ground survey performed by me or under my supervision, that this survey is true and correct to the best of my knowledge and belief. That this Claim of Exemption Plat and the field survey upon which it is based meet the Minimum Standards for Surveying in New Mexico, and that this survey is not a land division or subdivision as defined in the New Mexico Subdivision Act.

_____ _____
Robert M. Howett, NMPS #19680 Date

ROBERT M. HOWETT NEW MEXICO 19680 PROFESSIONAL SURVEYOR

NO.	REVISION	DATE

JOB NO.: LS1706381
DWG. NO.: Exempt.Plat2

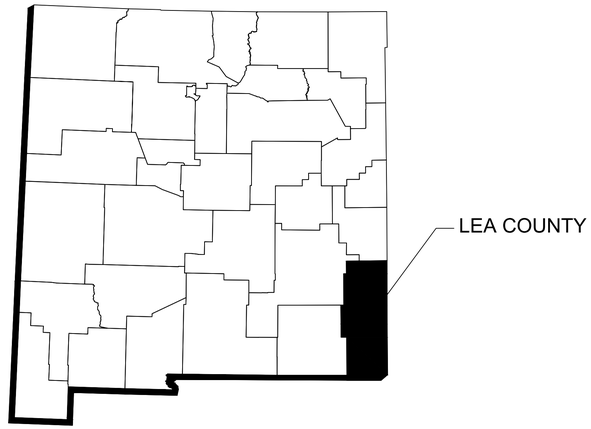
RRC
308 W. BROADWAY ST., HOBBS, NM 88240 (575) 964-8200

SCALE: N.T.S.
DATE: 6-23-2017
SURVEYED BY: JM/EF
DRAWN BY: LPS
APPROVED BY: RMH
SHEET : 2 OF 2

APPENDIX B – Libby Water Recycling and Containment Facility Layout and Containment Engineering Drawings, Details and Project Specifications

3BEAR ENERGY, LLC
LIBBY WATER RECYCLE AND IMPOUNDMENT

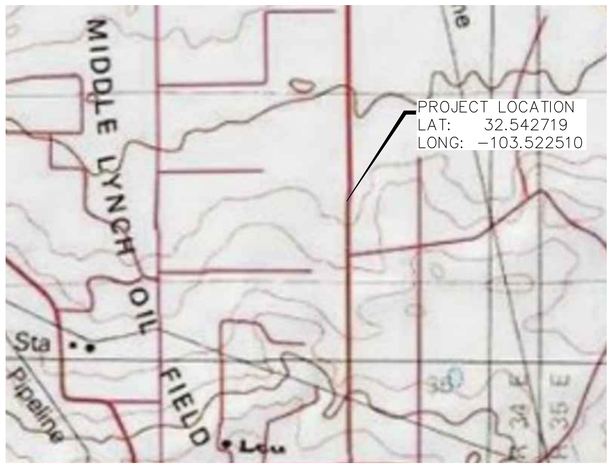
LEA COUNTY, NEW MEXICO



INDEX OF DRAWINGS

GENERAL NOTES

1. ALL TOPOGRAPHIC, UTILITY AND LOCATION INFORMATION IS BASED ON SURVEY INFORMATION FURNISHED BY 3BEAR ENERGY, LLC., THE CONTRACTOR HAS THE SOLE RESPONSIBILITY FOR FIELD VERIFICATION DURING CONSTRUCTION PERFORMANCE.
2. REFERENCE SURVEY DRAWINGS "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACTS 1 & 2 SECTION 26, T5O2, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017. & "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACT 1 SECTION 26, T2OS, R34E, N.M.P.M., LEA COUNTY NEW MEXICO" PREPARED BY RRC, DATED 06/23/2017.
3. COORDINATE INFORMATION IS BASED ON AND ARE BASED ON STATE PLANES COORDINATE NEW MEXICO EAST ZONE NAD83, THE CONTRACTOR SHALL IDENTIFY ANY DISCREPANCIES PRIOR TO PROCEEDING WITH CONSTRUCTION.
4. THE CONTRACTOR SHALL IDENTIFY AND LOCATE UTILITY LINES, MONITOR WELLS, SURVEY MONUMENTS, AND OTHER NEARBY STRUCTURES PRIOR TO PERFORMING WORK. UTILITIES, MONITOR WELLS, SURVEY MONUMENTS AND OTHER NEARBY STRUCTURES SHALL BE PROTECTED FROM DAMAGE DURING THIS WORK. ANY DAMAGE TO UTILITY LINES, MONITOR 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 THE REPAIRS IF REQUIRED.



LOCATION MAP
LIBBY WATER RECYCLE AND IMPOUNDMENT
LEA COUNTY, NEW MEXICO

Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD — NEW MEXICO — 24339 — PROFESSIONAL ENGINEER — 12/4/17

DESIGNED	TM
DRAWN	NJF
CHECKED	NL
DATE	12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

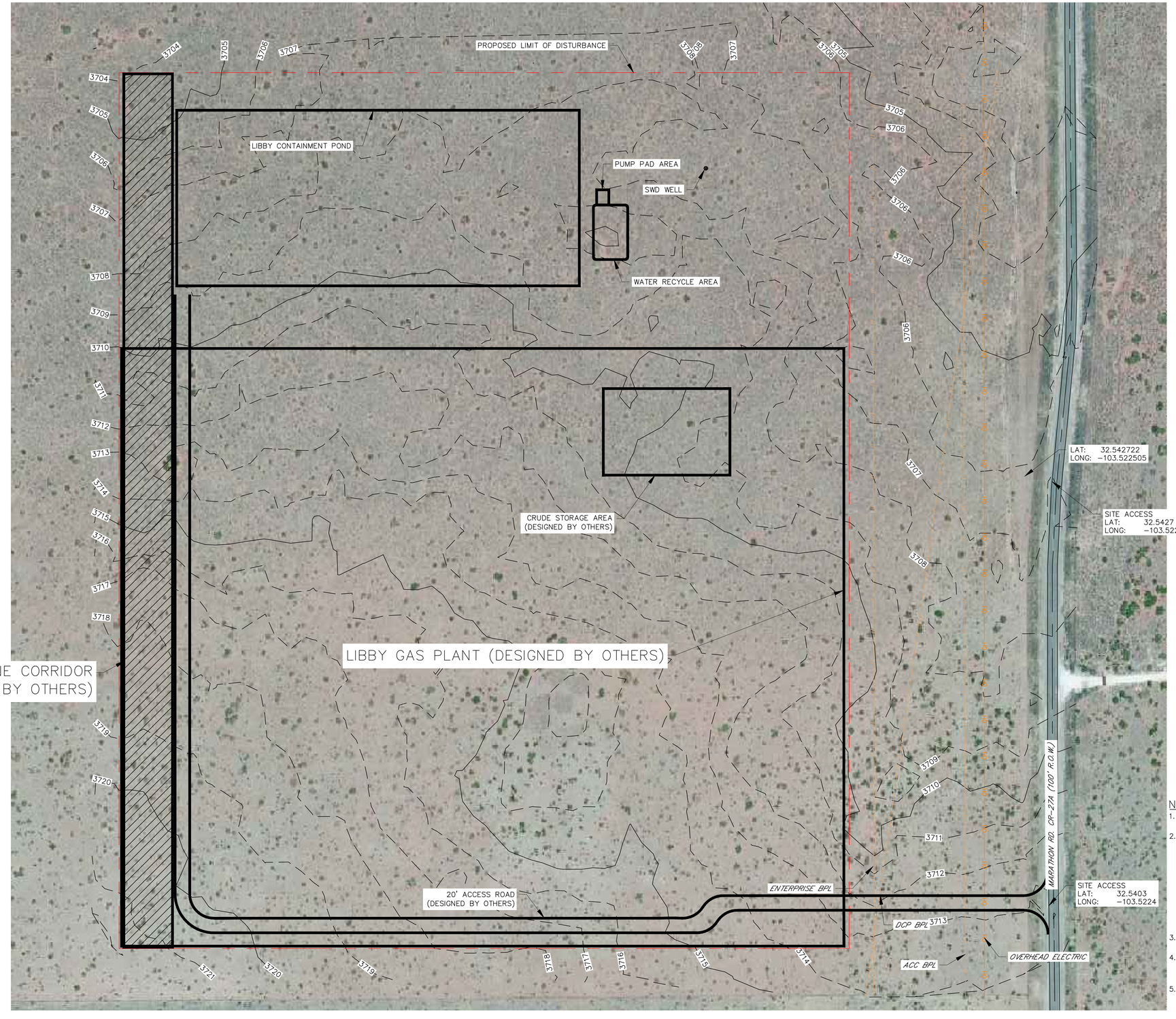
COVER LIST
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-001
SHEET NO. 1 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-001 – COVER.dwg PIT NICK.FLANDERS 12/4/2017 5:18:17 PM

LEGEND

- EXISTING 10' CONTOUR
- EXISTING 2' CONTOUR
- EXISTING ROAD
- EXISTING PIPE
- EXISTING OVERHEAD WIRES
- SITE BOUNDARY (APPROX.)



NOTES:

1. EXISTING CONTOURS SUPPLIED BY 3BEAR ENERGY LLC.
2. REFERENCE SURVEY DRAWINGS "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACTS 1 & 2 SECTION 26, T5S02, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017. & "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACT 1 SECTION 26, T20S, R34E, N.M.P.M., LEA COUNTY NEW MEXICO" PREPARED BY RRC, DATED 06/23/2017.
3. DRAWING COORDINATE SYSTEM IS NAD83 NEW MEXICO STATE PLANE, EAST ZONE, US FOOT
4. AERIAL PHOTOGRAPH PROVIDED BY ESRI's ONLINE WORLD IMAGERY MAP SERVICE (© 2015 ESRI AND ITS DATA SUPPLIERS).
5. PROPERTY BOUNDARIES SHOWN ARE APPROXIMATE AND ARE TO DEMONSTRATE PROXIMITY. BOUNDARIES SHOWN ARE NOT TO SCALE. REFER TO ZAP ENGINEERING SITE PLAN.

nm811 Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD NEW MEXICO 24339 PROFESSIONAL ENGINEER 12/4/17

DESIGNED	TM
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CHECKED	NL
DATE	12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 100'
VERTICAL SCALE: NA

EXISTING CONDITIONS PLAN
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-002
SHEET NO. 2 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-002 – EXISTING CONDITIONS.dwg PIT NICK.FLANDERS 12/4/2017 5:56:41 PM

PROPOSED LIMIT OF DISTURBANCE

PROPOSED FENCE (TYP.)

BERM

9' X 9' PIPE STAND

SWD WELL

3' MAN DOOR, SEE SHEET C-013

4" HDPE RELIEF PIPE

3" HDPE SUCTION PIPE

31' X 25' DISCHARGE PUMP AREA

8" HDPE SUCTION PIPE

TREATED WATER LINE TO IMPOUNDMENT

8" HDPE LCS RISER PIPE UNDER LINER

70.5' X 112' RECYCLE WATER SYSTEM CONTAINMENT AREA

LOCATION OF 12' TRUCK GATE, SEE SHEET C-013

PROPOSED DRAINAGE CHANNEL DESIGN BY 3BEAR ENERGY, LLC. (TYP.)

BUBBLER CONTROLS

INLET PRODUCED WATER FEED LINE TO THE FACILITY, DESIGNED BY OTHERS

N

LEGEND

- EXISTING ROAD
- EXISTING PIPE
- EXISTING OVERHEAD WIRES
- SITE BOUNDARY (APPROX.)
- PROPOSED CENTER OF BERM
- PROPOSED EDGE OF GRAVEL
- PROPOSED FENCE
- PROPOSED CHANNEL
- PROPOSED 12" UNDERDRAIN
- LOCATION OF WELL
- WATER STORAGE AREA
- PROPOSED SITE YARD
- PROPOSED SEEDED AREA

Know what's below. Call before you dig. nm811

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD, NEW MEXICO, 24339, PROFESSIONAL ENGINEER, 12/4/17

DESIGNED TM
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DATE 12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

NORTH

VERIFY SCALE
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0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

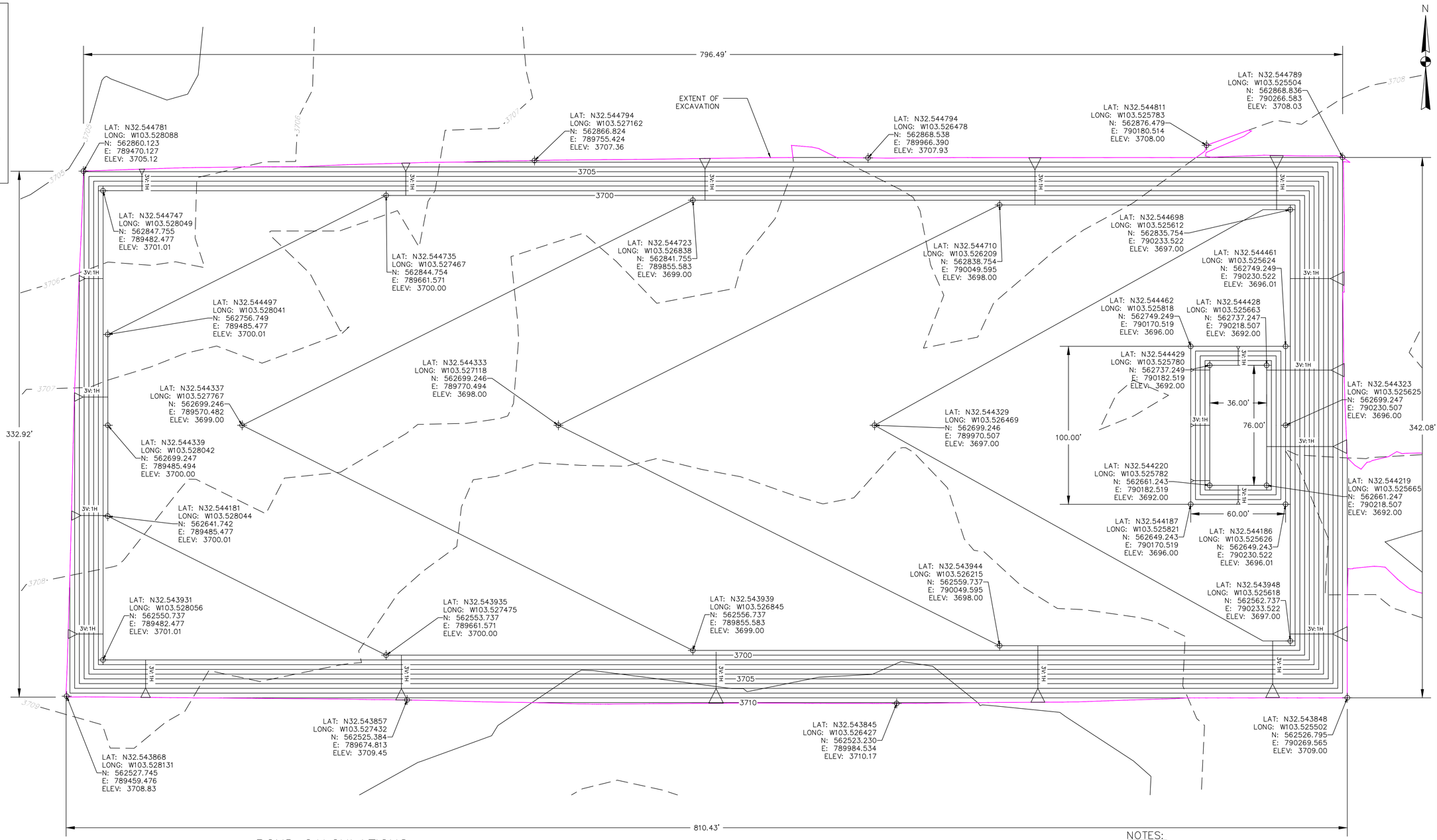
SCALES:
HORIZONTAL SCALE: 1" = 40'
VERTICAL SCALE: NA

GENERAL ARRANGEMENT
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-003
SHEET NO. 3 OF 23

LEGEND

- 20 — EXISTING 10' CONTOUR
- 16 — EXISTING 2' CONTOUR
- 5 — PROPOSED 5' CONTOUR
- PROPOSED 1' CONTOUR
- EXTENT OF EXCAVATION
- SITE BOUNDARY (APPROX.)
- 3V: 1H — CUT MARKER WITH SLOPE
- 3V: 1H — FILL MARKER WITH SLOPE



POND CALCULATIONS

POND AREA (FOOTPRINT) = 7.62 AC.
EXCAVATION VOLUME = 91,451 CU YD
FILL VOLUME = 2,099 CU YD
NET EXPORT = 89,352 CU YD
(NO COMPACTION VALUE ASSUMED)
CAPACITY AT MAXIMUM POND ELEVATION OF 3708' = 419,930 BBLs
CAPACITY AT 3' FREEBOARD @ ELEV. 3705' = 279,558 BBLs

NOTES:

1. EXISTING CONTOURS SUPPLIED BY ZAP ENGINEERING & CONSTRUCTION SERVICES, INC.
2. REFERENCE SURVEY DRAWINGS "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACTS 1 & 2 SECTION 26, TS02, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017. & "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACT 1 SECTION 26, T20S, R34E, N.M.P.M., LEA COUNTY NEW MEXICO" PREPARED BY RRC, DATED 06/23/2017.
3. DRAWING COORDINATE SYSTEM IS NAD83 NEW MEXICO STATE PLANE, EAST ZONE, US FOOT
4. GRADING DESIGN FOR POND IS BY 3BEAR ENERGY, LLC. AND ZAP ENGINEERING & CONSTRUCTION SERVICES, INC. EXCESS SOIL MATERIALS ARE TO BE USED BY 3 BEAR ENERGY LLC. FOR OVERALL SITE GRADING. NOT DESIGNED BY TETRA TECH, INC.

nm811 Know what's below. Call before you dig.

REVISIONS		
NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD — NEW MEXICO — 24339 — PROFESSIONAL ENGINEER — 12/4/17

DESIGNED TM
DRAWN NJF
CHECKED NL
DATE 12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

NORTH

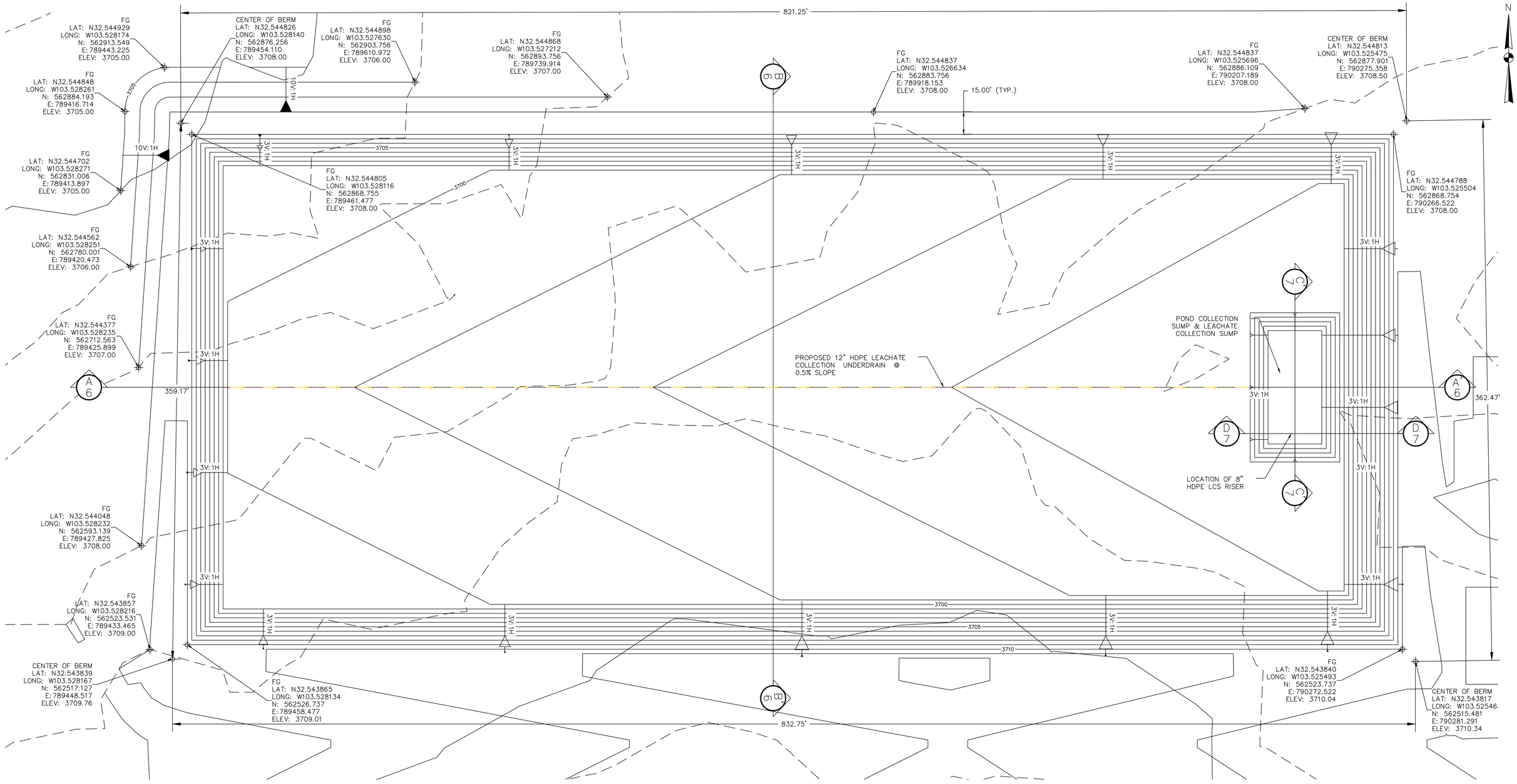
VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 — 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: NA

POND EXCAVATION PLAN
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-004
SHEET NO. 4 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-004 - POND EXCAVATION.dwg PIT NICK.FLANDERS 12/4/2017 5:59:24 PM



LEGEND

- 20 — EXISTING 5' CONTOUR
- 16 — EXISTING 1' CONTOUR
- 5 — PROPOSED 5' EXCAVATION CONTOUR
- PROPOSED 1' EXCAVATION CONTOUR
- SITE BOUNDARY (APPROX.)
- 3V:1H — CUT MARKER WITH SLOPE
- 3V:1H — FILL MARKER WITH SLOPE

POND CALCULATIONS

POND AREA (FOOTPRINT) = 7.62 AC.
EXCAVATION VOLUME = 91,451 CU YD
FILL VOLUME = 2,099 CU YD
NET EXPORT = 89,352 CU YD
(NO COMPACTION VALUE ASSUMED)
CAPACITY AT MAXIMUM POND ELEVATION OF 3708' =419,930 BBLs
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NOTES:

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2. REFERENCE SURVEY DRAWINGS "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACTS 1 & 2 SECTION 26, TS02, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017. & "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACT 1 SECTION 26, T20S, R34E, N.M.P.M., LEA COUNTY NEW MEXICO" PREPARED BY RRC, DATED 06/23/2017.
3. DRAWING COORDINATE SYSTEM IS NAD83 NEW MEXICO STATE PLANE, EAST ZONE, US FOOT
4. GRADING DESIGN FOR POND IS BY 3BEAR ENERGY, LLC. AND ZAP ENGINEERING & CONSTRUCTION SERVICES, INC. EXCESS SOIL MATERIALS ARE TO BE USED BY 3 BEAR ENERGY LLC. FOR OVERALL SITE GRADING. NOT DESIGNED BY TETRA TECH, INC.
5. POND RUN–ON CONTROL DRAINAGE CHANNEL DESIGNED BY OTHERS AND PROVIDED BY 3BEAR ENERGY, LLC.

nm811 Know what's below. Call before you dig.

REVISIONS		
NO.	DATE	DESCRIPTION
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NATHAN A. LANGFORD — NEW MEXICO — 24339 — PROFESSIONAL ENGINEER — 12/4/17

DESIGNED TM
DRAWN NJF
CHECKED NL
DATE 12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
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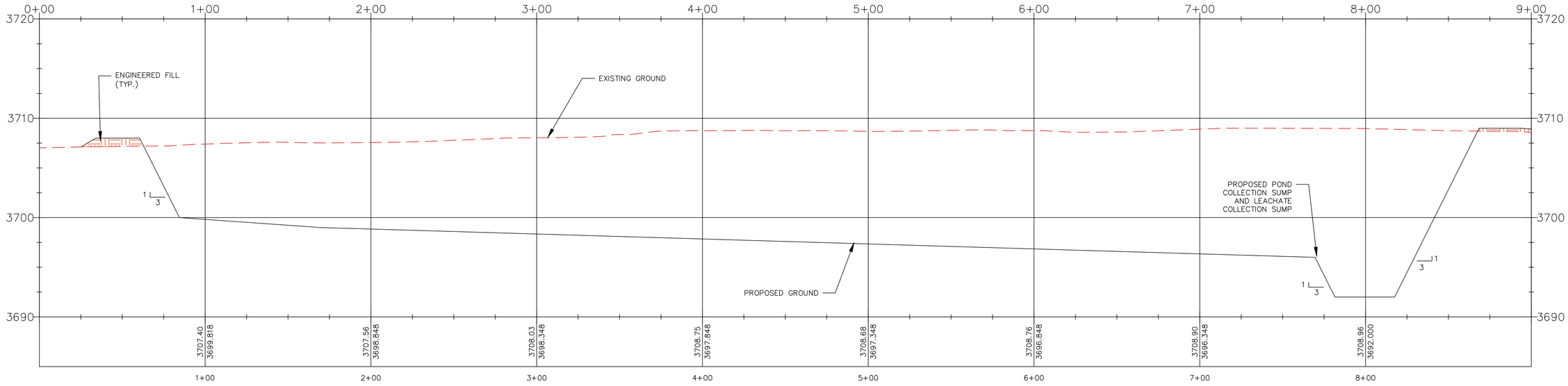
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: NA

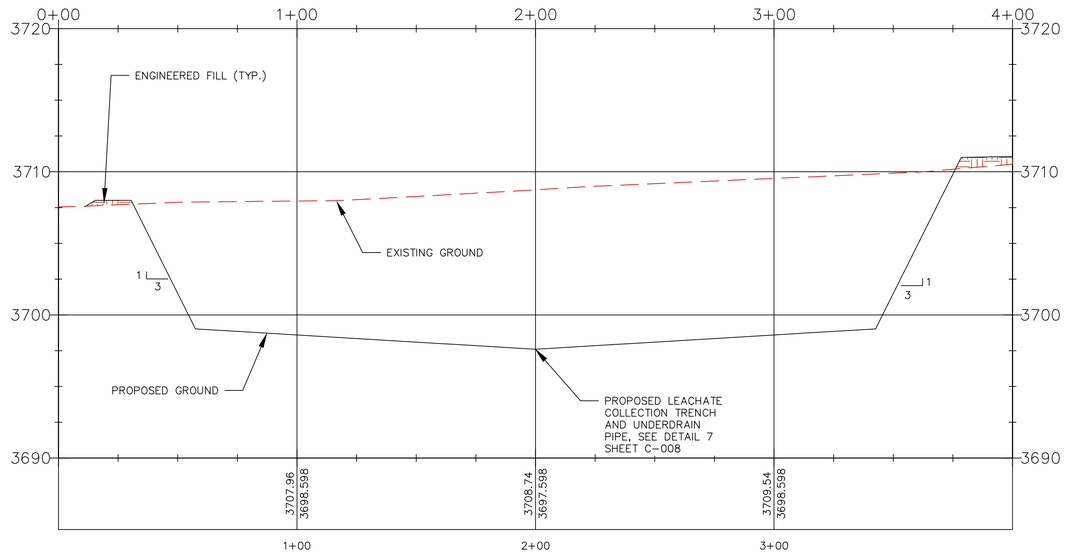
POND SITE GRADING PLAN
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-005
SHEET NO. 5 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-005 - POND SITE GRADING.dwg PIT NICK.FLANDERS 12/4/2017 6:01:25 PM



A – A' CROSS SECTION



B – B' CROSS SECTION

REVISIONS		
NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD NEW MEXICO 24339 PROFESSIONAL ENGINEER 12/4/17

DESIGNED TM
DRAWN NJF
CHECKED NL
DATE 12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

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0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: 1" = 5'

POND CROSS SECTIONS
LEA COUNTY, NEW MEXICO

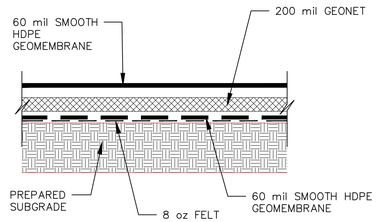
PROJECT NO. 212C-MD-00980
DRAWING NO. C-006
SHEET NO. 6 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-006 – SITE CROSS SECTIONS.dwg PIT NICK.FLANDERS 12/4/2017 4:33:40 PM

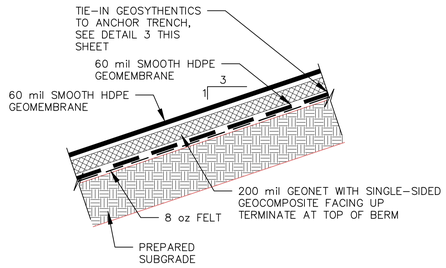
GRADING AND LAYOUT NOTES

1. ALL MATERIALS, WORKMANSHIP, AND CONSTRUCTION SHALL MEET OR EXCEED THE LATEST EDITION(S) OF THE NEW MEXICO DEPARTMENT OF TRANSPORTATION (NMDOT) STANDARDS, SPECIFICATIONS & DETAILS. WHERE THERE IS CONFLICT BETWEEN THESE PLANS AND THE JURISDICTIONAL SPECIFICATIONS, OR ANY APPLICABLE STANDARDS, THE HIGHER QUALITY STANDARD SHALL APPLY.
2. ALL EXISTING IMPROVEMENTS AND ELEVATIONS ARE BASED ON THE:
   A. "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACTS 1 & 2 SECTION 26, TS02, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017.
   B. "3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACT 1 SECTION 26, T20S, R34E, N.M.P.M., LEA COUNTY NEW MEXICO" PREPARED BY RRC, DATED 06/23/2017.

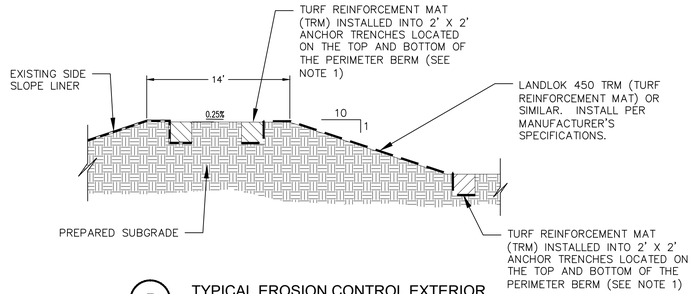
   TETRA TECH, INC. MAKES NO WARRANTY TO THE ACCURACY OF ANY OF THIS INFORMATION. CONTRACTORS'S SURVEYOR SHALL VERIFY ALL CONTROL, BOUNDARY INFORMATION, BELOW & ABOVE GRADE IMPROVEMENTS, UTILITIES, TOPOGRAPHY AND OTHER ITEMS PRIOR TO CONSTRUCTION.
3. PROPOSED IMPROVEMENTS AND PLANT LOCATION ARE BASED UPON THE 2D BACKGROUND RECEIVED FROM 3BEAR ENERGY, LLC. AND PREPARED BY ZAP ENGINEERING & CONSTRUCTION SERVICES, INC. IN CAD FORMAT ON 10/12/2017 (NO REV INFORMATION).
4. CONTRACTOR IS RESPONSIBLE FOR OBTAINING UTILITY LOCATES PRIOR TO CONSTRUCTION.
5. CONTRACTOR TO OBTAIN AT THEIR OWN COST ALL REQUIRED PERMITS THROUGH THE LOCAL MUNICIPALITY, STATE AND FEDERAL JURISDICTIONS. THIS INCLUDES APPLICABLE HIGHWAY ACCESS AND STORMWATER POLLUTION PREVENTION RELATED PERMITS.
6. CONTRACTOR IS RESPONSIBLE FOR MAINTAINING THE JOB SITE AT ALL TIMES DURING CONSTRUCTION.
7. CUT AND FILL SLOPES ARE MAXIMUM 3:1 AND AS SHOWN ON DRAWINGS.
8. ALL PROPOSED CONTOURS AND SPOT ELEVATIONS ARE TO FINISHED GROUND.
9. THE CONTRACTOR SHALL FOLLOW ALL REQUIREMENTS OF THE PROJECT GEOTECHNICAL ENGINEERING REPORT ("3BEAR ENERGY, LLC – LIBBY SITE, PROPOSED WATER RECYCLING FACILITY AND RECYCLED WATER STORAGE POND" PREPARED BY OLSSON ASSOCIATES, DATED 09/29/2017). THIS INCLUDES, BUT IS NOT LIMITED TO, ALL PROJECT EXCAVATION/OVEREXCAVATION, MATERIAL REMOVAL, SHORING AND BRACING, CUTOFF WALL, TRENCHING, BEDDING, BACKFILL & FILL MATERIAL, COMPACTION, UNDER-DRAIN, BASE COURSE/SURFACE COURSE SURFACING, PAVING, REINFORCEMENT, JOINTING, CONSTRUCTION TESTING & INSPECTION RECOMMENDATIONS AND REQUIREMENTS. CONTRACTOR AND OWNER SHALL REVIEW THE REQUIREMENTS, RECOMMENDATIONS, AND RISKS IDENTIFIED OR VARIANCES TO THE REQUIREMENTS PRIOR TO COMMENCEMENT OF CONSTRUCTION.
10. CONTRACTOR SHALL PROTECT ALL ADJACENT UNDERGROUND AND ABOVE GROUND IMPROVEMENTS FROM DAMAGE AND EROSION. ALL DISTURBED AREAS OFF-SITE SHALL BE RESTORED TO THEIR ORIGINAL CONDITION.
11. THE CONTRACTOR SHALL COORDINATE THE REMOVAL AND/OR ABANDONMENT OF ALL UTILITIES WITH THE APPROPRIATE UTILITY OWNER.
12. DIMENSIONS ARE TO EDGE OF SURFACING, BERM CENTERLINE, SWALE FLOWLINE, AND/OR BUILDING FACE UNLESS OTHERWISE SHOWN.
13. THE CONTRACTOR IS SPECIFICALLY CAUTIONED THAT THE LOCATION OF EXISTING UTILITIES AND IMPROVEMENTS ARE SHOWN IN THE APPROXIMATE LOCATION BASED ON INFORMATION PROVIDED BY OTHERS. NOT ALL UTILITIES OR IMPROVEMENTS MAY BE SHOWN. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION OF ALL EXISTING UTILITIES AND IMPROVEMENTS, WHETHER SHOWN OR NOT BEFORE COMMENCING WORK. THE CONTRACTOR SHALL BE FULLY AND SOLELY RESPONSIBLE FOR ANY AND ALL DAMAGES AND COSTS WHICH MIGHT OCCUR BY THE CONTRACTOR'S FAILURE TO EXACTLY LOCATE AND PRESERVE ANY AND ALL UTILITIES AND IMPROVEMENTS. THE CONTRACTOR SHALL NOTIFY ALL PUBLIC AND PRIVATE UTILITY COMPANIES AND DETERMINE THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO PROCEEDING WITH GRADING AND CONSTRUCTION. ALL WORK PERFORMED IN THE AREA OF UTILITIES AND IMPROVEMENTS SHALL BE PERFORMED AND INSPECTED ACCORDING TO THE REQUIREMENTS OF THE UTILITY OWNER. LIKEWISE, THE CONTRACTOR SHALL BE RESPONSIBLE FOR LOCATING AND MAPPING ANY EXISTING UTILITY OR IMPROVEMENT (INCLUDING DEPTH) WHICH MAY CONFLICT WITH THE PROPOSED CONSTRUCTION, AND FOR RELOCATING ENCOUNTERED UTILITIES AND IMPROVEMENTS AS DIRECTED BY THE OWNER. CONTRACTOR SHALL CONTACT AND RECEIVE APPROVAL FROM THE UTILITY OWNER AND ENGINEER BEFORE RELOCATING ANY ENCOUNTERED UTILITIES. CONTRACTOR IS RESPONSIBLE FOR SERVICE CONNECTION, AND RELOCATING AND RECONNECTING AFFECTED UTILITIES AND COORDINATED CONNECTIONS, AND RELOCATING AND RECONNECTING AFFECTED UTILITIES AS COORDINATED WITH UTILITY OWNER, INCLUDING NON-MUNICIPAL UTILITIES (TELEPHONE, PROPANE, CABLE, FLOWLINES, ETC., WHICH SHALL BE COORDINATED WITH THE UTILITY OWNER). THE CONTRACTOR SHALL IMMEDIATELY CONTACT THE OWNER AND ENGINEER UPON DISCOVERY OF A UTILITY DISCREPANCY OR CONFLICT. AT LEAST 48 HOURS PRIOR TO CONSTRUCTION, THE CONTRACTOR SHALL NOTIFY NEW MEXICO 811 (811, 800-321-2537, OR WWW.NM811.ORG).
14. ALL IMPORT MATERIALS SHALL BE TESTED AND ACCEPTED FOR USE BY THE GEOTECHNICAL ENGINEER PRIOR TO TRANSPORT TO THE SITE.
15. REFER TO THE STRUCTURAL PLANS FOR ALL SLAB AND FOUNDATION SYSTEMS AS WELL AS FINE GRADING REQUIREMENTS AROUND THE PROPOSED SLABS AND STRUCTURES.
16. CONTRACTOR TO NOTIFY THE ENGINEER IMMEDIATELY SHOULD THERE BE A CONFLICT BETWEEN THESE PLANS AND WHAT IS FOUND IN THE FIELD.



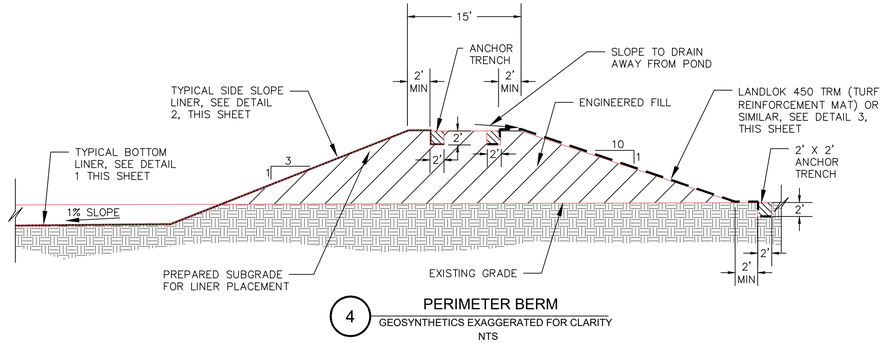
1 TYPICAL BOTTOM LINER
GEOSYNTHETICS EXAGGERATED FOR CLARITY
NTS



2 TYPICAL SIDE SLOPE LINER
GEOSYNTHETICS EXAGGERATED FOR CLARITY
NTS



3 TYPICAL EROSION CONTROL EXTERIOR PERIMETER BERM
NTS



4 PERIMETER BERM
GEOSYNTHETICS EXAGGERATED FOR CLARITY
NTS

BENCHMARK & BASIS OF BEARING INFORMATION

"3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACTS 1 & 2 SECTION 26, T20S, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017.
"3 BEAR ENERGY, LLC PRELIMINARY SURVEY OF PROPOSED 60 ACRE SITE – TRACT 1 SECTION 26, T20S, R34E, N.M.P.M., LEA COUNTY, NEW MEXICO" PREPARED BY RRC, DATES 06/23/2017.

PROJECT BENCHMARK: NOT PROVIDED

BASIS OF BEARING/COORDINATE BASE: BEARINGS ARE GRID NAD 83 NEW MEXICO EAST, DISTANCES ARE HORIZONTAL GROUND.

NOTES:

1. ANCHOR TRENCHES WILL BE INSTALLED PER THE DRAWINGS AND NOT RECOMMENDED BY THE MANUFACTURER.
2. EROSION CONTROL PROVIDED IN DETAIL 3 ARE RECOMMENDED.
3. DURING CONSTRUCTION AND OPERATIONAL PERIODS WHEN THE PONDS ARE NOT IN USE, BALLASTS, SUCH AS SANDBAGS OR SIMILAR, SHOULD BE PLACED ON TOP OF ALL LINER'S TO MINIMIZE POTENTIAL FOR LINER SYSTEM PULLOUT. SEE SPECIFICATIONS FOR DETAILS.
4. 8" LCS RISER LEAK DETECTION PIPE RISER WILL BE PERFORATED WITHIN SUMP. PERFORATIONS WILL BE ¼" DIAMETER HOLES AT 6" SPACING INTERVALS. PERFORATIONS WILL BE AT 120° AROUND THE CIRCUMFERENCE OF THE LEAK DETECTION RISER PIPE.
5. ANCHOR TRENCH WILL BE INSTALLED PER THE DRAWINGS AND AS RECOMMENDED BY THE MANUFACTURER.

Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD — NEW MEXICO — 24339 — PROFESSIONAL ENGINEER

DESIGNED	TM
DRAWN	NJF
CHECKED	NL
DATE	12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

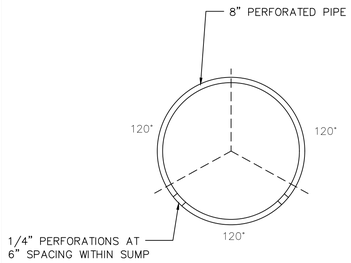
VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 — 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

POND NOTES & DETAILS
LEA COUNTY, NEW MEXICO

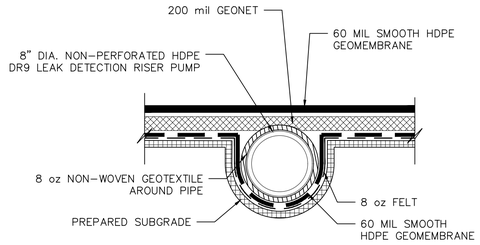
PROJECT NO. 212C-MD-00980
DRAWING NO. C-007
SHEET NO. 7 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-007 - POND DETAILS.dwg PIT NICK.FLANDERS 12/4/2017 4:34:44 PM



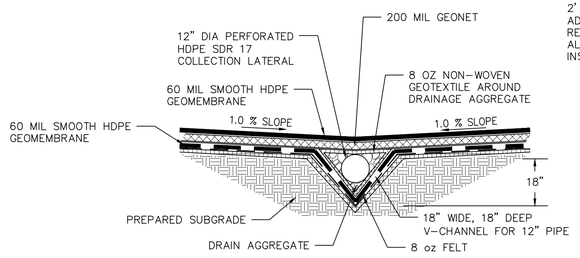
5 LDS RISER PIPE DETAIL

NTS



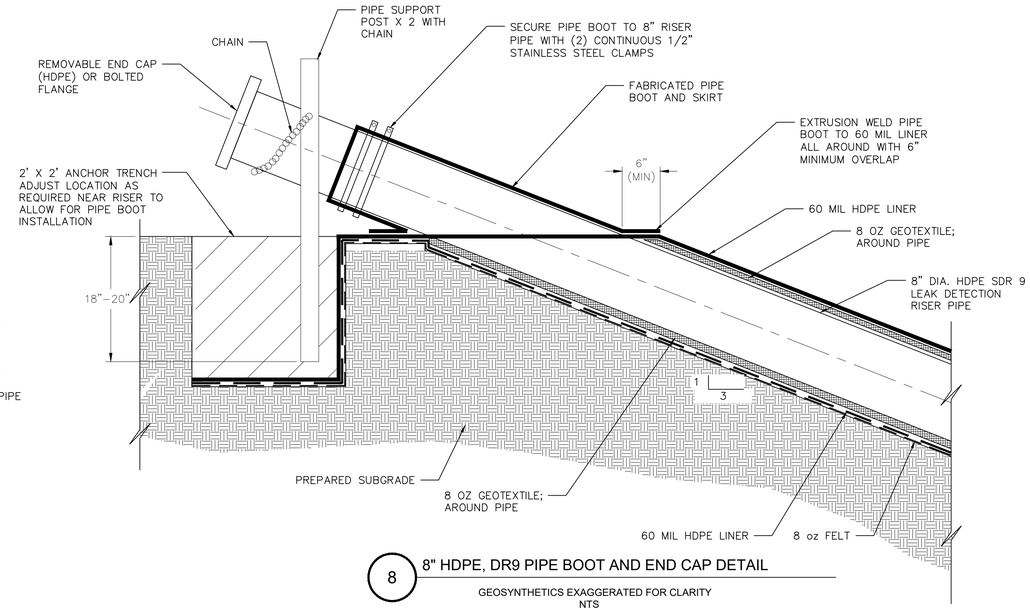
6 TYPICAL LDS RISER TRENCH DETAIL

GEOSYNTHETICS EXAGGERATED FOR CLARITY
NTS



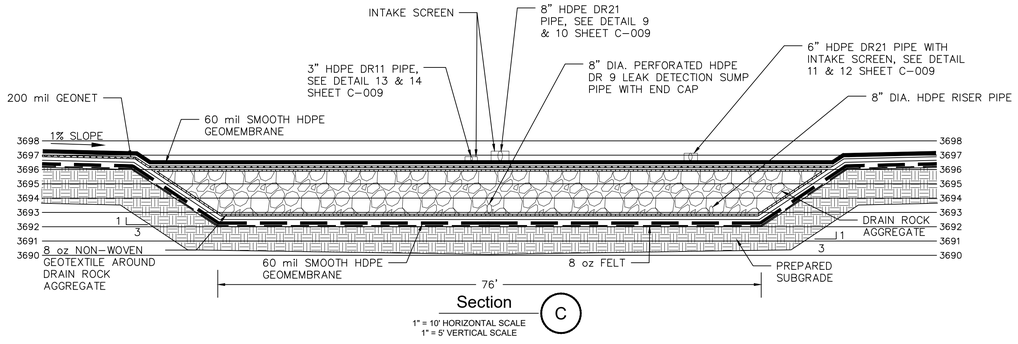
7 TYPICAL COLLECTION TRENCH

NTS



8 8" HDPE, DR9 PIPE BOOT AND END CAP DETAIL

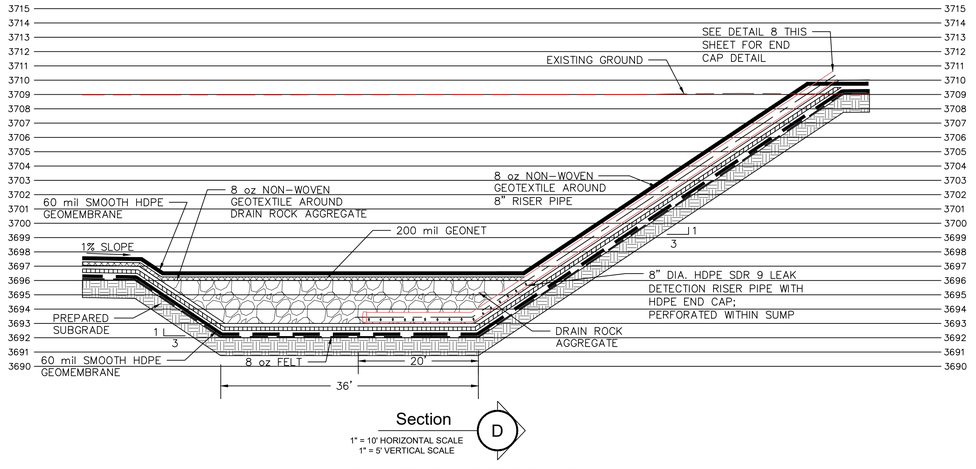
GEOSYNTHETICS EXAGGERATED FOR CLARITY
NTS



Section C

1" = 10' HORIZONTAL SCALE
1" = 5' VERTICAL SCALE

GEOSYNTHETICS EXAGGERATED FOR CLARITY



Section D

1" = 10' HORIZONTAL SCALE
1" = 5' VERTICAL SCALE

GEOSYNTHETICS EXAGGERATED FOR CLARITY

NOTES:

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2. ANCHOR TRENCH WILL BE INSTALLED PER THE DRAWINGS AND AS RECOMMENDED BY THE MANUFACTURER.
3. CONTRACTOR SHALL BE RESPONSIBLE FOR PROPERLY SUPPORTING ALL PIPING AND INSTALLATION OF HOLD DOWN STRAPS OR SPECIAL FITTINGS TO PREVENT ANY DAMAGE FROM MOVEMENT SUCH AS VIBRATION, THERMAL EXPANSION/CONTRACTION OR SAGGING. CONTRACTOR SHALL PROVIDE SUITABLE PRECAST OR FORMED CONCRETE SLEEPERS.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD
NEW MEXICO
24339
PROFESSIONAL ENGINEER

DESIGNED	TM
DRAWN	NJF
CHECKED	NL
DATE	12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

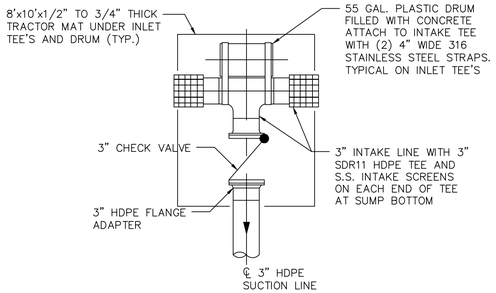
3Bear Energy

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

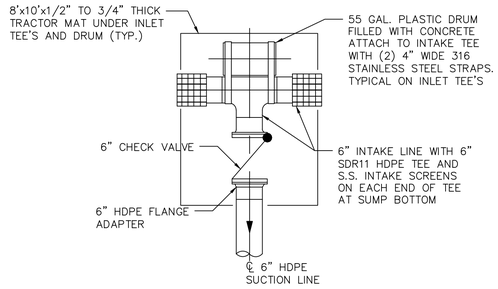
POND DETAILS
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-008
SHEET NO. 8 OF 23



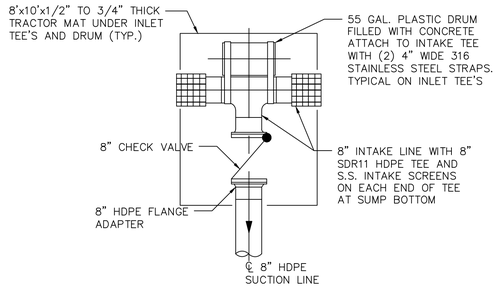
9 ENLARGED PLAN - 3" PUMP SUCTION LINE INLET

NTS



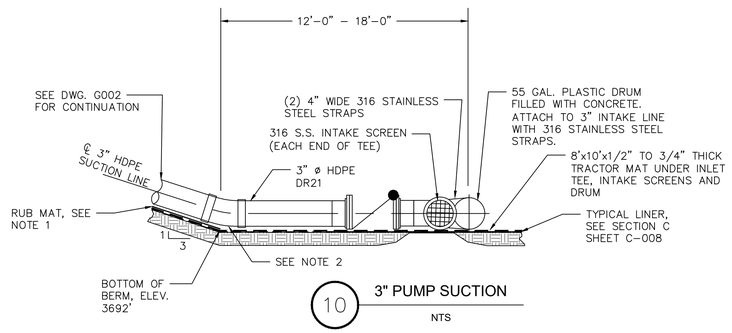
11 ENLARGED PLAN - 6" PUMP SUCTION LINE INLET

NTS



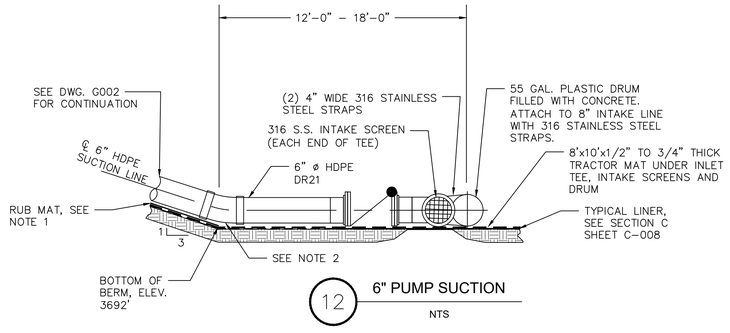
13 ENLARGED PLAN - 8" PUMP SUCTION LINE INLET

NTS



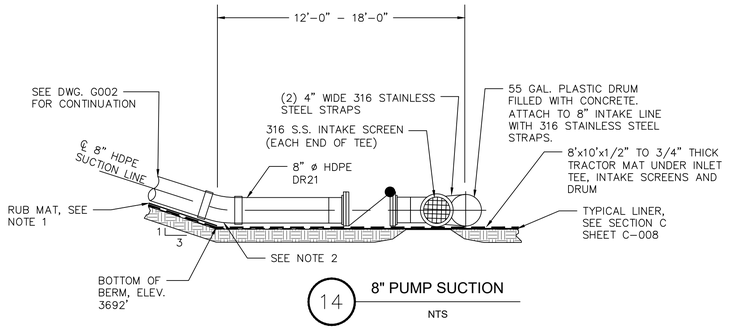
10 3" PUMP SUCTION

NTS



12 6" PUMP SUCTION

NTS



14 8" PUMP SUCTION

NTS

NOTES:

1. 8", 6" & 3" HDPE PIPE TO LAY ON 48" WIDE X 100 MIL THICK HDPE RUB SHEET.
2. CONTRACTOR TO CUSTOM FIT BEND.

Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD NEW MEXICO 24339 PROFESSIONAL ENGINEER 12/4/2017

DESIGNED	TM
DRAWN	NJF
CHECKED	NL
DATE	12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

VERIFY SCALE
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0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

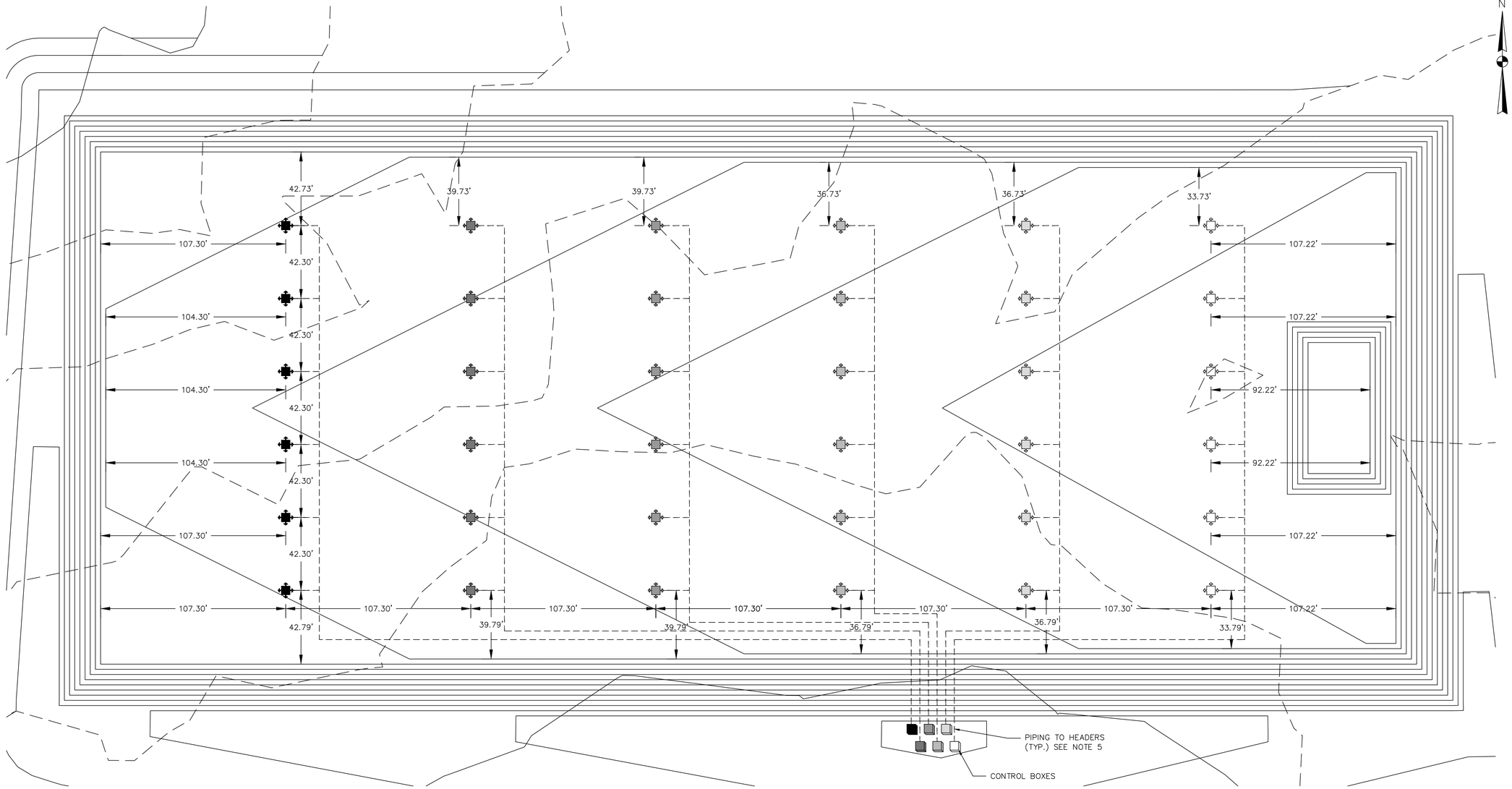
SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

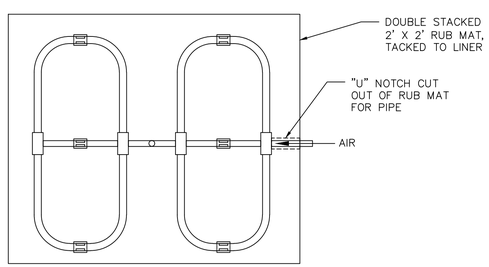
PIPING STAND DETAILS
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-009
SHEET NO. 9 OF 23

LEGEND

- EXISTING 5' CONTOUR
- EXISTING 1' CONTOUR
- PROPOSED 5' EXCAVATION CONTOUR
- PROPOSED 1' EXCAVATION CONTOUR
- SITE BOUNDARY (APPROX.)
- DIFFUSER HEADER
- PIPING TO DIFFUSER HEADERS





TOP VIEW

TYPICAL HEADDER DETAIL

NTS

NOTES:

1. EXISTING CONTOURS SUPPLIED BY ZAP ENGINEERING & CONSTRUCTION SERVICES, INC.
2. EXTERIOR OF BERM SHALL BE CAPPED WITH 6" COMPACTED CALICHE BORROW FILL MATERIAL. SEE SPECIFICATIONS.
3. DIMENSION AND COORDINATES SHOWN ARE TO THE PROJECTED TOP OF BERM CENTERLINE
4. DRAWING COORDINATE SYSTEM IS NAD83 NEW MEXICO STATE PLANE, EAST ZONE, US FOOT.
5. ADD RUB SHEETS AS NECESSARY BENEATH THE PIPING EQUIPMENT TO PROTECT LINER.
6. CONTRACTOR SHALL INSTALL DIFFUSERS IN ACCORDANCE WITH "ROBUST–AIRE™ DIFFUSER ASSEMBLY INSTALLATION INSTRUCTIONS (WWW.KASCOMARINE.COM).
7. WEIGHTED TUBING WILL BE INSTALLED PER MANUFACTURES INSTRUCTIONS FROM EACH COMPRESSOR TO THE DIFFUSER HEADER.
8. BUBBLER SYSTEM WILL BE INSTALLED PER MANUFACTURE INSTRUCTIONS.

nm811 Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD NEW MEXICO 24339 PROFESSIONAL ENGINEER 12/4/17

DESIGNED TM
DRAWN NJF
CHECKED NL
DATE 12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

NORTH

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: 1" = 30'
VERTICAL SCALE: NA

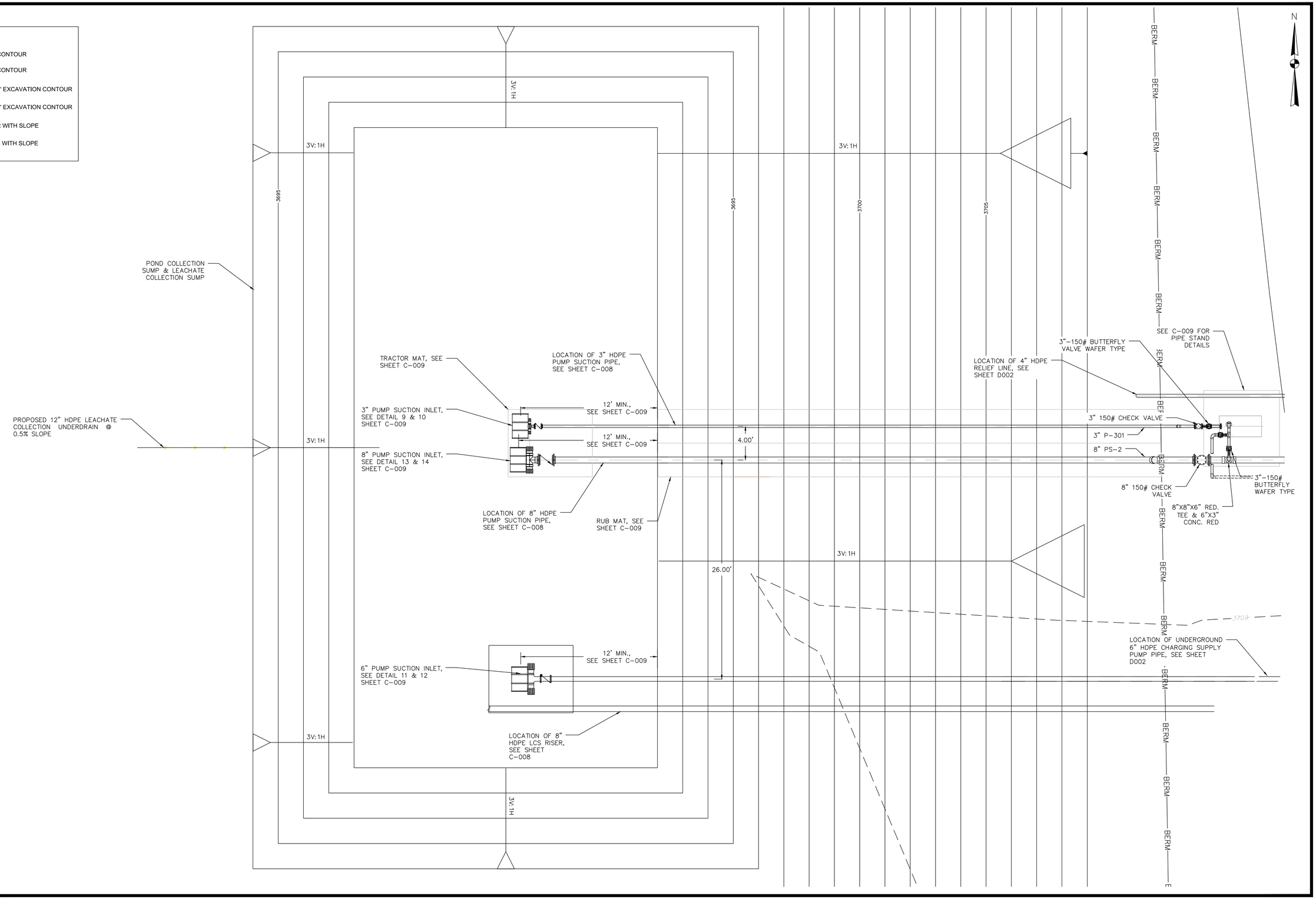
LIBBY SITE IMPOUNDMENT AND PRODUCED WATER RECIRCULAION SYSTEM DIFFUSER HEADER LAYOUT LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-010
SHEET NO. 10 OF 23

P:\Projects (After 8-23-13)\2017 Projects\3 Bear Energy\212C-MD-00980 -- Libby Site\Engineering\Civil Environmental\CAD\Design\Production Drawings\C-010 - DIFFUSER HEADER LAYOUT.dwg PIT NICK.FLANDERS 12/4/2017 4:37:30 PM

LEGEND

- 20 — EXISTING 5' CONTOUR
- 16 — EXISTING 1' CONTOUR
- 5 — PROPOSED 5' EXCAVATION CONTOUR
- PROPOSED 1' EXCAVATION CONTOUR
- CUT MARKER WITH SLOPE
- FILL MARKER WITH SLOPE



REVISIONS		
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NATHAN A. LANGFORD — NEW MEXICO — 24339 — PROFESSIONAL ENGINEER — 12/4/17

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4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

NORTH

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0 — 1"
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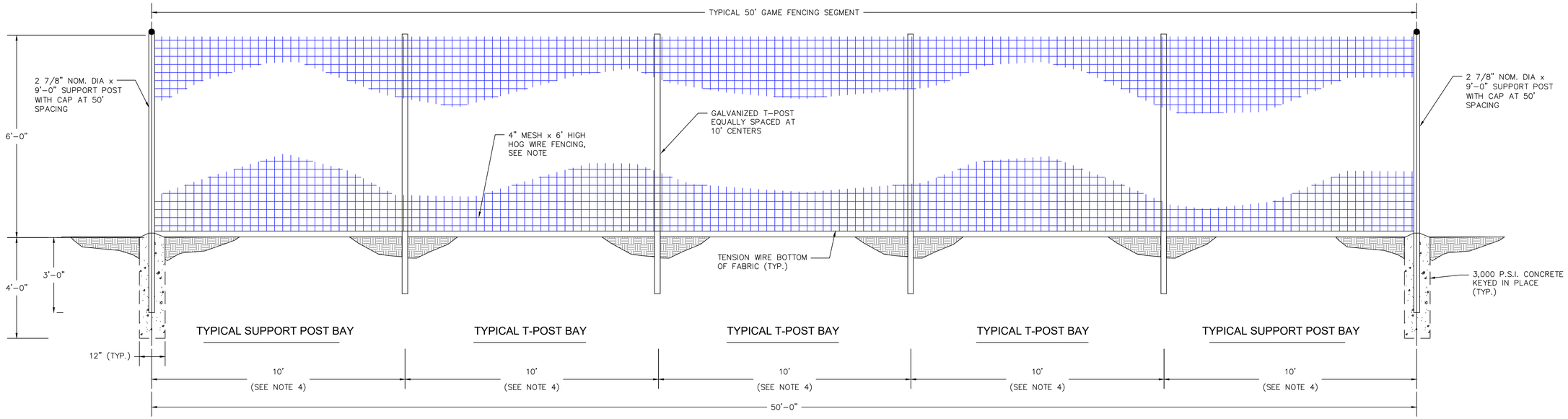
SCALES:
HORIZONTAL SCALE: 1" = 10'
VERTICAL SCALE: NA

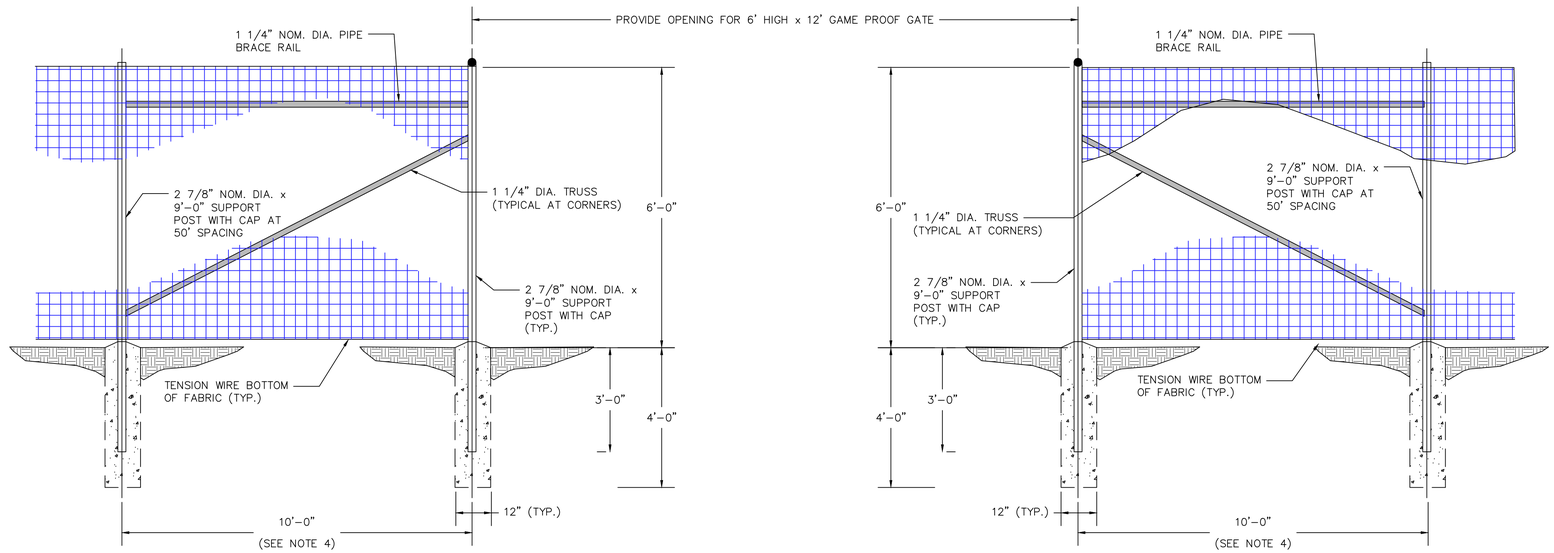
POND SUMP SITE PLAN
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-011
SHEET NO. 11 OF 23



13 TYPICAL FENCE DETAIL

NTS



14 TYPICAL @ CORNER AND/OR GATE POST DETAIL

NTS

NOTES:

1. ALL POSTS SHOULD BE AUGURED, DO NOT FORM
2. FOR PLAN AND LOCATION OF GATES SEE SHEET C-003.
3. CONCRETE SHALL REACH A MINIMUM STRENGTH OF 3,000 P.S.I. AT 28 DAYS.
4. T-POSTS SHALL BE INSTALLED EQUALLY SPACED ALONG FENCE LINE AT A MAXIMUM OF 10'0" CENTER TO CENTER.
5. ALL WIRE, FENCE FABRIC, POSTS, BRACE RAILS AND HARDWARE TO BE HOT DIPPED GALVANIZED.
6. SUPPORT POSTS SHALL BE INSTALLED EQUALLY SPACED ALONG FENCE LINE AT A MAXIMUM OF 50'-0" CENTER TO CENTER.

Know what's below. Call before you dig. nm811

REVISIONS

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NATHAN A. LANGFORD NEW MEXICO 24339 PROFESSIONAL ENGINEER 12/4/17

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VERTICAL SCALE: NA

FENCE DETAILS
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-012
SHEET NO. 12 OF 23

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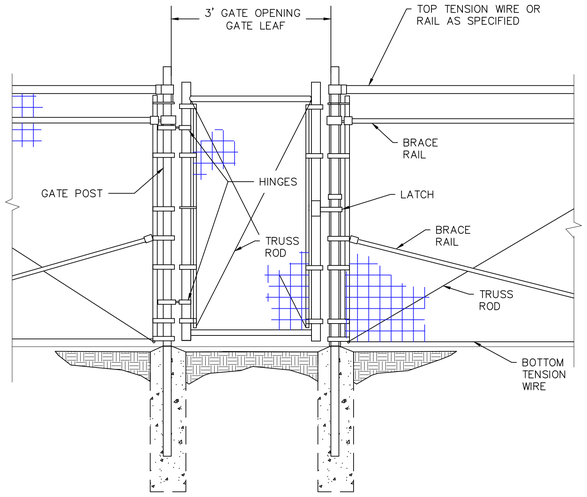
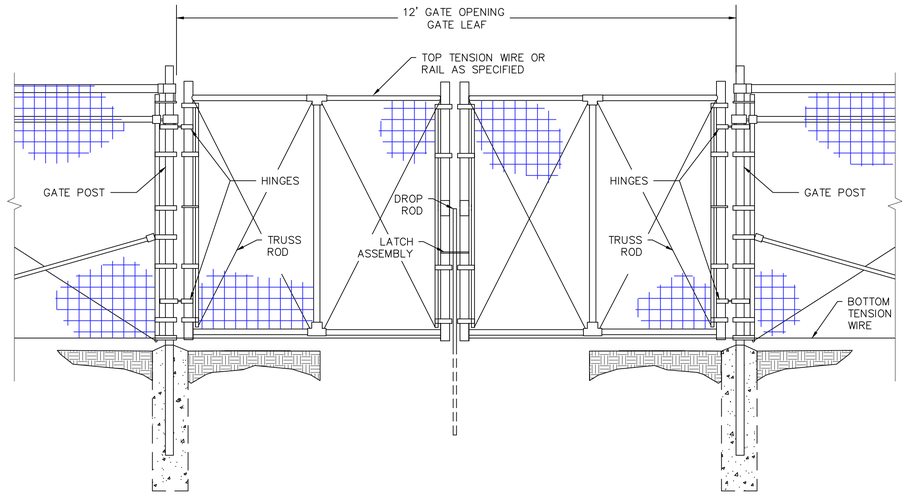


15 TYPICAL PERSONNEL GATE DETAIL

NTS



16 TYPICAL TRUCK GATE DETAIL

NTS

NOTES:

1. ALL POSTS SHOULD BE AUGURED, DO NOT FORM
2. FOR PLAN AND LOCATION OF GATES SEE SHEET C-003.
3. CONCRETE SHALL REACH A MINIMUM STRENGTH OF 3,000 P.S.I. AT 28 DAYS.
4. T-POSTS SHALL BE INSTALLED EQUALLY SPACED ALONG FENCE LINE AT A MAXIMUM OF 10'0" CENTER TO CENTER.
5. ALL WIRE, FENCE FABRIC, POSTS, BRACE RAILS AND HARDWARE TO BE HOT DIPPED GALVANIZED.
6. SUPPORT POSTS SHALL BE INSTALLED EQUALLY SPACED ALONG FENCE LINE AT A MAXIMUM OF 50'-0" CENTER TO CENTER.

nm811 Know what's below. Call before you dig.

REVISIONS

NO.	DATE	DESCRIPTION
A	12/04/2017	ISSUED FOR REVIEW

NATHAN A. LANGFORD
NEW MEXICO
24339
PROFESSIONAL ENGINEER
12/4/17

DESIGNED	TM
DRAWN	NJF
CHECKED	NL
DATE	12/04/2017

Tetra Tech Inc.
4000 N. BIG SPRING ST., SUITE 401
MIDLAND, TX 79705
(432) 682-4559

3BEAR ENERGY, LLC
LEA COUNTY, NEW MEXICO
GPS (WGS84): 32.542722°N, -103.522505°W

3Bear Energy

VERIFY SCALE
BAR IS ONE (1) INCH ON ORIGINAL DRAWING.
0 1"
IF NOT ONE (1) INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

SCALES:
HORIZONTAL SCALE: NA
VERTICAL SCALE: NA

FENCE GATE DETAILS
LEA COUNTY, NEW MEXICO

PROJECT NO. 212C-MD-00980
DRAWING NO. C-013
SHEET NO. 13 OF 23

Libby Water Recycling Containment
Section 26, Township 20 South, Range 34 East, Lea County, New Mexico – Technical Specifications for Construction

3Bear Energy, LLC
Denver, Colorado

Prepared for:

3Bear Energy, LLC
1512 Larimer Street, Suite 540
Denver, Colorado 80202

Prepared by:

Tetra Tech, Inc.
4000 North Big Spring St., Suite 401
Midland, Texas 79705
Phone: 432-682-4559

Tetra Tech Project No. 212C-MD-00890

November 2017

SECTION 00 01 10 – TABLE OF CONTENTS

END OF SECTION 00 01 10

DATE: 11/30/2017

SECTION 00 01 15 – LIST OF DRAWING SHEETS

PART 1 - GENERAL

1.01 DESCRIPTION

A. The DRAWINGS listed in this SPECIFICATIONS section form part of the contract documents.

B. CONTRACTOR shall completely coordinate the WORK shown on these DRAWINGS with all other contract WORK.

1.02 DRAWINGS INDEX

A. The following DRAWINGS are an integral part of the CONTRACT DOCUMENTS.

Drawing Number	Drawing Title
C-001	Cover
C-002	Existing Conditions
C-003	General Arrangement
C-004	Pond Excavation
C-005	Pond Site Grading
C-006	Pond (Site) Cross Sections
C-007	Pond Details (1 of 2)
C-008	Pond Details (2 of 2)
C-009	Pipe Stand Details
C-010	Diffuser Header Layout
C-011	Pond Sump Piping Arrangement
C-012	Fence Details
C-013	Fence Gate Details

MATERIALS (NOT USED)
EXECUTION (NOT USED)

SECTION 31 11 00 – CLEARING, GRUBBING, AND STRIPPING

PART 1 - GENERAL

1.01 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.

1.02 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

3.01 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 areas to a depth of approximately six inches and to the extent necessary to provide fill materials free of all objectionable matter described above. Clear and grub all areas within the extent of the property boundary and at least 10 feet beyond the proposed pond footprint, including the project area and all borrow areas.

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

3.02 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.

3.03 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 31 11 00

SECTION 31 23 00 - EARTHWORK

PART 1 - GENERAL

1.01 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 or Engineered 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
9. Erosion and Sediment Control

B. The WORK shall be done in accordance with the SPECIFICATIONS and as shown on the DRAWINGS. Erosion and sediment control to be specified and performed by others.

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

1.02 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.

1.03 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.

1.04 SUBMITTALS

A. Imported materials that will 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.

1.05 REFERENCES

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

1. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
2. ASTM D2434 – Test Method for Permeability of Granular Soils
3. ASTM D6913 – Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
4. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Tetra Tech, Inc. - Report of Geotechnical Study Libby Site Impoundment, November 2017.

1.06 DEFINITIONS

A. Liner – A completed system constructed as required by the DRAWINGS and SPECIFICATIONS, as specified in Section 33 47 13.

PART 2 - PRODUCTS

2.01 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 and the Tetra Tech, Inc. - Report of Geotechnical Study Libby Site Impoundment, November 2017.

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 Engineered Fill material for structural support shall consist of a uniform, granular material having 100 percent passing the 1 inch sieve, 30 to 70 percent passing the No. 4 sieve, and 3 to 15 percent passing the number 200 sieve. Do not use additives such as, but not limited to lime, cement, or fly ash, to modify aggregate to meet requirements.

D. The CONTRACTOR or contractor supplier 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 Libby Site, Lea County New Mexico, are suitable for use as "Engineered Fill" as described in this Section and Section 2.02.

2.02 ENGINEERED FILL MATERIAL USED IN SUBGRADE PREPARATION

A. The upper six 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, voids deeper than two inches, protrusions exceeding 1/4-inch, 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 be material suitable for liner placement.

2.03 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:

TABLE 2.1 – DRAIN ROCK GRADATION

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

TABLE 2.1 – DRAIN ROCK GRADATION	
Sieve Size	**Percent by Weight**
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 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

3.01 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 as needed.

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 or 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 geosynthetics and piping have been installed, tested, and accepted in accordance with the DRAWINGS and SPECIFICATIONS.

3.02 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.

3.03 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.
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.

3.04 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 soils at the site to be used for fill shall be compacted to at least 95 percent of the maximum dry density as determined by standard Proctor, ASTM D698. The moisture content shall be within minus 1 to 3 percent above optimum moisture content as determined by ASTM D698[1]. The soils shall be thoroughly mixed prior to placement and compaction to provide uniform water content throughout the fill.

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.

3.05 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 10 inches in thickness.

3.06 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 3.1 – COMPACTION AND MOISTURE CONTENT REQUIREMENTS

Fill Material	Compaction Specifications[1]	Moisture Content[1]
Engineered Fill	95% of modified Proctor maximum dry density with vibratory compactor	-1% to +3% of Optimum
Drainage Rock Aggregate	No requirements	No requirements

[1]As determined by ASTM D698

3.07 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. Fill is required to be compacted with a heavy vibratory-optional roller and a maximum roller speed of approximately 2 mph.
2. The roller/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 geosynthetics, and in other confined areas that are not accessible to the Compactor. The final surface on which the geosynthetics will be placed shall be compacted with a smooth drum roller.
3. Anchor trenches shall be compacted with a hand-operated compaction machine.

3.08 COMPACTION TESTING OF ENGINEERED FILL

A. Field compaction testing of each lift shall be performed by performing density and moisture testing of compacted fill placed and proof rolling to observe for soft areas and pumping of soils.

It is recommended that a heavy, rubber-tired vehicle weighing at least 25 tons, such as a loaded water or dump truck or equivalent be used for performance of proof rolling. In addition, a minimum of one density/moisture test for each vertical foot of compacted fill placed shall be performed. This testing frequency shall be a minimum of one test for every 150 linear feet or 5000 square-feet in area. For smaller areas, a minimum of three compaction tests shall be performed for every lift.

B. Lifts failing to meet the moisture and density testing requirements shall be reworked to meet the required specifications.

C. Compaction testing of anchor trenches shall be performed such that puncturing of the geosynthetic materials is avoided.

3.09 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 31 23 00

SECTION 33 47 13 - GEOSYNTHETICS

PART 1 - GENERAL

1.01 SUMMARY

A. The WORK described in this SPECIFICATION section includes specifications for manufacturing and installing HDPE geosynthetics.

1.02 SUBMITTALS

A. The CONTRACTOR shall submit a letter to the OWNER prior to installation of the geosynthetics 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. Geosynthetics 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 geosynthetics 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 geosynthetics and five 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 geosynthetics 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 geosynthetics, 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 geosynthetics 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 geosynthetics 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 years from the date of geosynthetics installation.

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

3. As-built drawings showing actual geosynthetics placement, seams, testing locations and results, and anchor trench details.

1.03 REFERENCES

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 D1505 – Standard Test Methods for Density of Plastics by the Density-Gradient Technique
5. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics
6. ASTM D3895 – Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
7. ASTM D4218 – Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
8. 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
9. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
10. ASTM D4833 – Test Method for Index Puncture Resistance of Geomembranes and Related Products
11. ASTM D5035 - Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
12. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
13. ASTM D5596 – Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
14. ASTM D5641 – Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
15. ASTM D5820 – Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
16. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry
17. ASTM D5994 – Test Method for Measuring Core Thickness of Textured Geomembrane
18. ASTM D6364 - Standard Test Method for Determining Short-Term Compression Behavior of Geosynthetics
19. ASTM D6392 – Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
20. ASTM D6693 – Test Method for Determining Tensile Properties of Non-reinforced Polyethylene and Non-reinforced Flexible Polypropylene Geomembranes
21. ASTM D7179 - Standard Test Method for Determining Geonet Breaking Force
22. ASTM D7406 - Standard Test Method for Time-Dependent (Creep) Deformation Under Constant Pressure for Geosynthetic Drainage Products
23. ASTM D7466 – Standard Test Method for Measuring the Asperity Height of Textured Geomembrane

B. Geosynthetic Research Institute (GRI)

1. GRI-GC8 Standard Guide for Determination of the Allowable Flow Rate of a Drainage Geocomposite

2. GRI GM14 - GM Sampling by Attributes
3. GRI GM10 – Specification for the Stress Crack Resistance of Geomembrane Sheet

4. GRI GM19 - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.04 DEFINITIONS

A. Lot – A quantity of resin (usually the capacity of one rail car) used in the manufacture of geosynthetics. 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. Geosynthetics Manufacturer – The party responsible for manufacturing the geosynthetics rolls.

D. Geosynthetic Quality Assurance Laboratory (testing laboratory) – Party, independent from the OWNER, manufacturer, and CONTRACTOR, responsible for conducting laboratory tests on samples of geosynthetics 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).

1.05 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 geonet 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 1,000,000 square feet of geosynthetics 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.

1.06 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

A. Geosynthetics 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 geonet roll shall be wrapped with a material that will protect the geonet 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 geosynthetics 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 geosynthetics material, provided by the CONTRACTOR to protect the geosynthetics 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. Geosynthetics shall not be stacked higher than three rolls

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

1.07 WARRANTY

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

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

PART 2 - PRODUCTS

2.01 HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

A. Material shall be GSE Environmental (GSE) HD Smooth Geomembrane 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 for compliance with the physical property requirements listed in Table 1, 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.

C. Geomembrane roll testing values for a 60-mil smooth and testing frequencies requirements are presented in Table 2.1 below.

TABLE 2.1: MINIMUM VALUES FOR 60-MIL SMOOTH HDPE GEOMEMBRANES			
Property	**Test Method (1)**	**Testing Frequencies**	**Minimum Value(s)**
Thickness, (minimum average) mil Lowest individual value	ASTM D5994 / D5199	Every roll	57 54
Density, g/cm3	ASTM D792 / D1505	200,000 lb	0.940
Tensile Properties (each direction) Strength at Break, lb/in-width Elongation at Break, %	ASTM D 6693, Type IV Dumbbell, 2 in/min G.L. = 2.0 in	20,000 lb	 228 700
Tear Resistance, lb	ASTM D1004	45,000 lb	42
Puncture Resistance, lb	ASTM D4833	45,000 lb	108
Carbon Black Content, %	ASTM D1603*/4218	20,000 lb	2.0 – 3.0
Carbon Black Dispersion	ASTM D5596	45,000 lb	+Note 1
Oxidative Induction Time, min (Standard OIT)	ASTM D3895, 200° C; 02, 1 atm	200,000 lb	≥ 100
Melt Flow, g/10 min.	ASTM D1238, 190° C; 2.16kg	200,000 lb	≤ 1.0
Oven Aging With HP OIT, (% retained after 90 hours)	ASTM D5721 ASTM D5885, 150° C; 500 psi O_2	Per resin formulation	80
UV Resistance With HP OIT, (% retained after 1600 hours)	ASTM D5885, 150° C; 500 psi O_2	Per resin formulation	50 (+Note 2)

THESE VALUES APPLY TO THE NON-CONDUCTIVE BLACK LAYERS.
NOTE 1: DISPERSION ONLY APPLIES TO NEAR SPHERICAL AGGLOMERATES. 9 OF 10 VIEWS SHALL BE CATEGORY 1 OR 2. NO MORE THAN 1 VIEW FROM CATEGORY 3.
NOTE 2: 20-HOUR CYCLE AT 75° C/4 HR DARK CONDENSATION @ 60° C.
*MODIFIED.

2.02 RESIN

1. Resin shall be first quality, compounded polyethylene resin.
2. Resin testing values and testing frequencies requirements are presented in Table 2.2 below. Natural resin (without carbon black) shall meet the following additional minimum requirements:

TABLE 2.2: RAW MATERIAL VALUES			
Property	**Test Method (1)**	**Testing Frequencies**	**Value**
Density (g/cm3)	ASTM D792 / D1505	Once Per Resin Lot	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	Once Per Resin Lot	≤ 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 geosynthetics.

2.03 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

3.01 EXAMINATION

A. Preparation of surfaces to be lined shall be completed by the EARTHWORKS 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 geosynthetics installation shall meet the manufacturer's recommendations for preparation, storage and placement or installation.

3.02 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 geosynthetics during deployment for imperfections and mark faulty or suspect areas.

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

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

1. Unroll geosynthetics using methods that will not damage geosynthetics and will protect underlying surface from damage (spreader bar, protected equipment bucket).
2. The geosynthetics 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 geosynthetics, which will not damage geosynthetics, to prevent wind uplift.
5. Personnel walking on geosynthetics shall not engage in activities or wear shoes that could damage it. Smoking will not be permitted on the geosynthetics.

6. Do not allow heavy vehicular traffic directly on geosynthetics. Rubber-tired ATVs and trucks are acceptable if wheel contact is less than six 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 geosynthetics. The specified fill material shall be placed and spread utilizing vehicles with a low ground pressure.

3.03 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 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. Geonet Components:

1. Adjacent edges along the length of the geonet roll shall be overlapped a minimum of 6 inches or as recommended by the ENGINEER.
2. The overlapped edges shall be joined by tying the geonet structure with cable ties.
3. These ties shall be spaced every 5 feet along the roll length.
4. Adjoining rolls across the roll width should be shingled down in the direction of the slope and joined together with cable ties spaced every foot along the roll width.

C. During Welding Operations

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

D. 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.

E. 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.

F. 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 3.1 are achieved in both peel and shear test.

Table 3.1: 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 3.1 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.

G. 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.

H. 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.

3.04 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.

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 27 psi 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 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) One portion for the third party laboratory, 12 by 18 inches
c) 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 specimens for peel adhesion, and then five specimens for shear strength.
3) Destructive testing specimens shall pass when the results shown in Table 3.1 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 3.1 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.

3.05 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 geonet shall be removed and patched. The patch shall be secured to the original geonet 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 geonet shall be cut out, and the two portions of the geonet shall be joined in accordance with these SPECIFICATIONS.

3.06 DEPTH OR ELEVATION MARKINGS

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

B. Paint shall be non-corrosive and weather resistant.

SECTION 33 47 13.15 - GEOTEXTILES

PART 1 - GENERAL

1.01 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 geocomposite.

1.02 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.

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM D4354 – Practice for Sampling of Geosynthetics 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)

1.04 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.

1.05 QUALIFICATIONS

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

1.06 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

2.01 GEOTEXTILE

A. The geotextile shall be GSE Environmental (GSE) 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 2.1. All numeric values in Table 2.1 except Apparent Opening Size (AOS) represent MARV in the weakest principal direction. Values for AOS represent maximum average roll values.

TABLE 2.1: 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	220
Grab Tensile Elongation	ASTM D4632	%	50
Trapezoid Tear Strength	ASTM D4533	lbs	90
CBR Puncture Strength	ASTM D4833	lbs	575
Permittivity	ASTM D4491	sec^{-1}	1.3
Apparent Opening Size	ASTM D4751	U.S. Sieve	80
Water Flow Rate	ASTM D4491	gpm/ft^2	95
UV Resistance[1]	ASTM D4355	%	70

[1]After 500 hrs

2.02 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

3.01 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.

3.02 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 33 47 13.15

SECTION 33 47 13.16 – GEONET DRAINAGE LAYERS

PART 1 - GENERAL

1.01 SUMMARY

A. This section covers the technical requirements for the manufacturing and installation of the geonet drainage layers. 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.

1.02 REFERENCES

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 D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique
   3. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics
   4. ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
   5. ASTM D4354 - Practice for Sampling of Geosynthetics for Testing
   6. 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
   7. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
   8. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
   9. ASTM D7179 - Standard Test Method for Determining Geonet Breaking Force

1.03 DEFINITIONS

A. Geonet Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geocomposite rolls.

B. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY) - Party, independent from the MANUFACTURER and CONTRACTOR, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the OWNER.

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

1.04 QUALIFICATIONS

A. MANUFACTURER

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

B. CONTRACTOR

a. CONTRACTOR shall have installed a minimum of 3,000,000 square feet of geosynthetics 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 geonet or geocomposite 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.

1.05 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 geonet 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.

1.06 WARRANTY

A. Geonet portion of the material shall be warranted against defects for a period of 5-years from the date of the installation.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geonet completion.

PART 2 - PRODUCTS

2.01 GEONET PROPERTIES

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

B. The geonet shall be GSE Environmental (GSE) HyperNet Geonet or equal. Geonet materials shall be used as shown on the DRAWINGS. Each type of geonet specified shall have properties that meet or exceed the values listed in the following tables below.

TABLE 2.1: 200-MIL HYPERNET GEONET PROPERTIES			
Property	**Test Method**	**Frequency**	**Value**
Geonet (prior to lamination)			
Geonet Core Thickness, mil	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 792 / 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 10,000 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 2.2 below. Natural resin (without carbon black) shall meet the following additional minimum requirements:

TABLE 2.2: RAW MATERIAL PROPERTIES		
Property	**Test Method[(1)]**	**Value**
Density (g/cm^3)	ASTM D 792 / 1505	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	$\leq$ 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 geosynthetics.

2.02 MANUFACTURING QUALITY CONTROL

1. The geonet shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the ENGINEER.

2. The geonet shall be tested according to the test methods and frequencies listed on Tables 2.1 which has been prepared based on product data sheets.

PART 3 - EXECUTION

3.01 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.

3.02 MATERIAL PLACEMENT AND INSTALLATION

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

B. The geonet 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 geosynthetics, including the geonets, 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 geonet shall be properly anchored to resist sliding. Anchor trench compacting equipment shall not come into direct contact with the geonet.

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

3.03 SEAMS AND OVERLAPS

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

B. Geonet Components

1. Butt seams should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geonet a minimum of 24 inches

across the roll width and as recommended by the manufacturer. The overlaps shall be joined by tying the geonet 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 geonet portion of the top overlapping the geonet portion of the bottom geonet a minimum of 6 inches across the roll length. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet minimum along the roll width.

3.04 REPAIR

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

B. Any rips, tears or damaged areas on the deployed geonet shall be removed and patched. The patch shall be secured to the original geonet 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 geonet shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.03 of this part.

END OF SECTION 33 47 13.16

SECTION 33 47 13.17 – GEOCOMPOSITE DRAINAGE LAYERS

PART 4 - GENERAL

4.01 SUMMARY

A. This section covers the technical requirements for the manufacturing and installation of the geocomposite drainage layers. 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.

4.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

10. ASTM D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
11. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics
12. ASTM D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
13. ASTM D4354 Practice for Sampling of Geosynthetics for Testing
14. ASTM D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
15. ASTM D4491 Standard Test Method for Water Permeability of Geotextiles by Permittivity
16. ASTM D4533 Test Method for Index Trapezoid Tearing Strength of Geotextiles
17. 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
18. ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
19. ASTM D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
20. ASTM D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products
21. ASTM D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
22. ASTM D5261 Standard Test Method for Measuring the Mass Per Unit Area of Geotextiles
23. ASTM D6241Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
24. ASTM D7005 Standard Test Method for Determining The Bond Strength (Ply-Adhesion) of Geocomposites
25. ASTM D7179 Standard Test Method for Determining Geonet Breaking Force

B. 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.

4.03 DEFINITIONS

A. Geocomposite Manufacturer (MANUFACTURER) - The party responsible for manufacturing the geocomposite rolls.

B. Geosynthetic Quality Assurance Laboratory (TESTING LABORATORY) - Party, independent from the MANUFACTURER and CONTRACTOR, responsible for conducting laboratory tests on samples of geosynthetics obtained at the site or during manufacturing, usually under the direction of the OWNER.

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

4.04 QUALIFICATIONS

A. MANUFACTURER

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

B. CONTRACTOR

d. CONTRACTOR shall have installed a minimum of 3,000,000 square feet of geosynthetics in the last 3 years.
e. 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 geonet or geocomposite installation on each project.
f. 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.

4.05 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 geonet 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.

4.06 WARRANTY

A. Geonet portion of the material shall be warranted against defects for a period of 5-years from the date of the geocomposite installation. Geotextile portion of the material shall be warranted against defects for a period of 6-months from the date of the geocomposite installation.

B. Installation shall be warranted against defects in workmanship for a period of 1-year from the date of geocomposite completion.

PART 5 - PRODUCTS

5.01 GEOCOMPOSITE PROPERTIES

A. The geocomposite shall be manufactured by adhering a geotextile to a single side of a geonet core.

B. Geocomposite materials shall be used as shown on the DRAWINGS. Each type of geocomposite specified shall have properties that meet or exceed the values listed in the following tables, 2.1 below.

TABLE 2.1: 200-MIL HYPERNET GEONET PROPERTIES

Property	Test Method	Frequency	Value
Geocomposite			
Transmissivity, gal/min/ft	ASTM D 4716	1/540,000 ft^2	4.8
Ply Adhesion, lb/in.	ASTM D 7005	1/50,000 ft^2	1.0
Geonet			
Geonet Core Thickness, mil	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 792 / 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

TABLE 2.1: 200-MIL HYPERNET GEONET PROPERTIES (Cont.)			
Property	**Test Method**	**Frequency**	**Value**
Geonet			
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 10,000 lb/ft^2, water at 70° F, between steel plates for 15 minutes.
[2]Roll Widths and Lengths have a tolerance of +/- 1%.

C. Resin
   1. Resin shall be new first quality, compounded polyethylene resin.
   2. Natural resin (without carbon black) shall meet the following additional Minimum requirements:

TABLE 2.2: RAW MATERIAL VALUES		
Property	**Test Method(1)**	**Value**
Density (g/cm^3)	ASTM D 1505	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	$\leq$ 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 geosynthetics.

5.02 MANUFACTURING QUALITY CONTROL

3. The geocomposite shall be manufactured in accordance with the Manufacturer's Quality Control Plan submitted to and approved by the ENGINEER.
4. The geocomposite shall be tested according to the test methods and frequencies listed on Tables 2.1 and 2.2 which has been prepared based on product data sheets.

PART 6 - EXECUTION

6.01 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.

6.02 MATERIAL PLACEMENT AND INSTALLATION

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

B. The geocomposite 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 geocomposites 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.

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

G. The drainage rock material shall be placed on the geocomposite in a manner that does not permit vehicular traffic directly on the geocomposite, and prevents damage to the geocomposite. Placement of the cover soil shall proceed immediately following the placement and inspection of the geocomposite.

H. No equipment shall be driven upon the geocomposite layer.

6.03 SEAMS AND OVERLAPS

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

B. Geonet Components

1. Butt seams should be shingled down in the direction of the slope, with the geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 24 inches across the roll width. The overlaps shall be joined by tying the geonet 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 geonet portion of the top overlapping the geonet portion of the bottom geocomposite a minimum of 6 inches across the roll length. The overlaps shall be joined by tying the geonet structure with cable ties. These ties shall be spaced every 5 feet along the roll width.

C. Geonet Components

1. The top layers of geotextiles shall be sewn together. The CONTRACTOR, upon approval by the ENGINEER, may propose to wedge weld the top layers of geotextile in lieu of sewing. The method for performing this work must be submitted to the ENGINEER for approval a minimum of 14 days before installation.

2. Geotextiles shall have a minimum 1-inch overlap before seaming or wedge welding. If wedge welding is proposed and approved, the CONTRACTOR must ensure that the geotextile is not burned, damaged, or punctured by the wedge welding process. The

geotextiles shall be joined continuously to the adjacent and adjoining rolls to prevent material from migrating into the geonet core of the geocomposite.

6.04 REPAIR

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

B. Any rips, tears or damaged areas on the deployed geocomposite shall be removed and patched. The patch shall be secured to the original geonet 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 geonet shall be cut out and the two portions of the geonet shall be joined in accordance with Subsection 3.03 of this part.

END OF SECTION 33 47 13.17

END OF SECTION 33 47 13

SECTION 40 23 00 - POLYETHYLENE PIPE

PART 1 - GENERAL

1.01 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.

1.02 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.

1.03 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
    c. ASTM F2620 – Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
    d. PPI TR – 33 Generic Butt Fusion Joining Procedure for Polyethylene Gas Pipe

1.04 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.

1.05 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

2.01 HDPE PIPE

A. HDPE pipe and fittings shall be high-density, high molecular weight polyethylene pipe PE 4710.

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

C. Pipe: Manufactured in accordance with ASTM D3350 and ASTM F 714.

D. The pipe manufacturer shall have an ongoing Quality Control program for incoming and outgoing materials, and shall assure that the pipe will meet the material requirements of this specification. HDPE resins for manufacturing of pipe shall be checked for density, melt flow rate, and contamination. The facility shall have the necessary testing equipment to verify that pipe meets the AWWA and NSF standards. Pipe shall be checked for outside diameter, wall thickness, length, and surface finish on the inside and outside. The Manufacturer's production facilities shall be open for inspection by the Owner or Engineer.

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

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

G. 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.

H. 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

3.01 GENERAL

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

3.02 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.

3.03 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.

3.04 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.

C. Fusion Joining Requirements:

1. All HDPE pipe shall be joined to itself by the heat fusion process which produces homogeneous, seal, leak tight joints. Tie-ins between sections of HDPE pipe shall be made by butt fusion whenever possible.

D. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620 or PPI TR-33. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians per PPI TN-42. A record or certificate of training for the fusion operator must be provided that documents training to the fundamentals of ASTM F 2620. Considerations should be given to and provisions made for adverse weather conditions, such as temperatures below freezing, precipitation, or wind, which is accepted by the owner/engineer.

3.05 PERFORATIONS

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

END OF SECTION 40 23 00

APPENDIX C – Libby Water Recycling and Containment Facility – Libby Site Report of Geotechnical Study for Proposed Water Recycling Facility and Recycled Water Storage Pond, November 2017

TETRA TECH

3Bear Energy, Libby Site

Proposed Water Recycling Facility and Recycled Water Storage Pond

Section 26, Township 20 South,
Range 34 East,
Lea County, New Mexico

November 2017

complex world

CLEAR SOLUTIONS™

Report of Geotechnical Study
Libby Site
Impoundment

Eddy County, New Mexico

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Tetra Tech Project No. 212C-MD-00980

Thomas A. Chapel
Principal Engineer

Reviewed by: Don Grahlherr, P.E.
Vice President
November 15, 2017

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EXECUTIVE SUMMARY

3Bear Company (3Bear) plans to construct a water storage basin at their "Libby" site located in Lea County, New Mexico. The water storage (pond) will measure approximately 812 feet long by 350 feet wide with a maximum depth of thirteen feet and capacity of approximately 279,000 barrels (bbl). We understand the pond will be a primarily incised, in-ground earthen storage facility designed with a double liner and a leak detection system.

The purpose of this study was to obtain information on subsurface conditions and to provide geotechnical design recommendations for the construction of the proposed pound. The general site location is shown on the Site Location Map (Figure 1) and Topographic Map (Figure 2).

Between September 20th and 22nd, 2017, Tetra Tech and our drilling subcontractor drilled five (5) exploratory soil borings to identify subsurface conditions and collect samples. Borings were drilled to depths ranging from 40 feet to 100 feet below the existing ground surface (bgs). Water was not encountered in the borings during or immediately after drilling. The boreholes were backfilled with the excavated soils following competition of drilling. Approximate locations of the borings are shown in Figure 3.

The borings encountered predominantly medium dense to very dense silty to clayey sand. At various depths, slight cementation of soils was observed.

Mapping by the Natural Resources Conservation Service (NRCS, 2016) identifies the site soils as the Pyote and Maljamar mapping units (Figure 4). These soils are both described as fine sands. Review of mapping by the U.S. Geological Survey (Figure 5) indicates that the eolian and alluvial deposits cover entirely the project site. Typically these deposits are a distinctive reddish-brown color and soils are weakly developed. Eolian sediments consist of wind-deposited sand and silt, augmented and modified by alluvial processes.

Additional investigation and construction recommendations for the development of the site are provided in the body of this report.

We have prepared this executive summary solely to provide a general overview, and it should not be used for any purpose except that for which it was intended. We recommend detailed review of the entire report for information about our findings, recommendations and other concerns related to geotechnical conditions for the site.

1.0 PURPOSE AND SCOPE OF STUDY

3Bear plans to construct a water storage basin at their "Libby" site located in Lea County, New Mexico. The water storage (pond) will measure approximately 812 feet long by 350 feet wide with a maximum depth of thirteen feet and capacity of approximately 279,000 barrels (bbl). The pond will be designed with a double liner and a leak detection system.

The scope of the study for this project included the following.

1) Request a New Mexico 811 Utility locate;

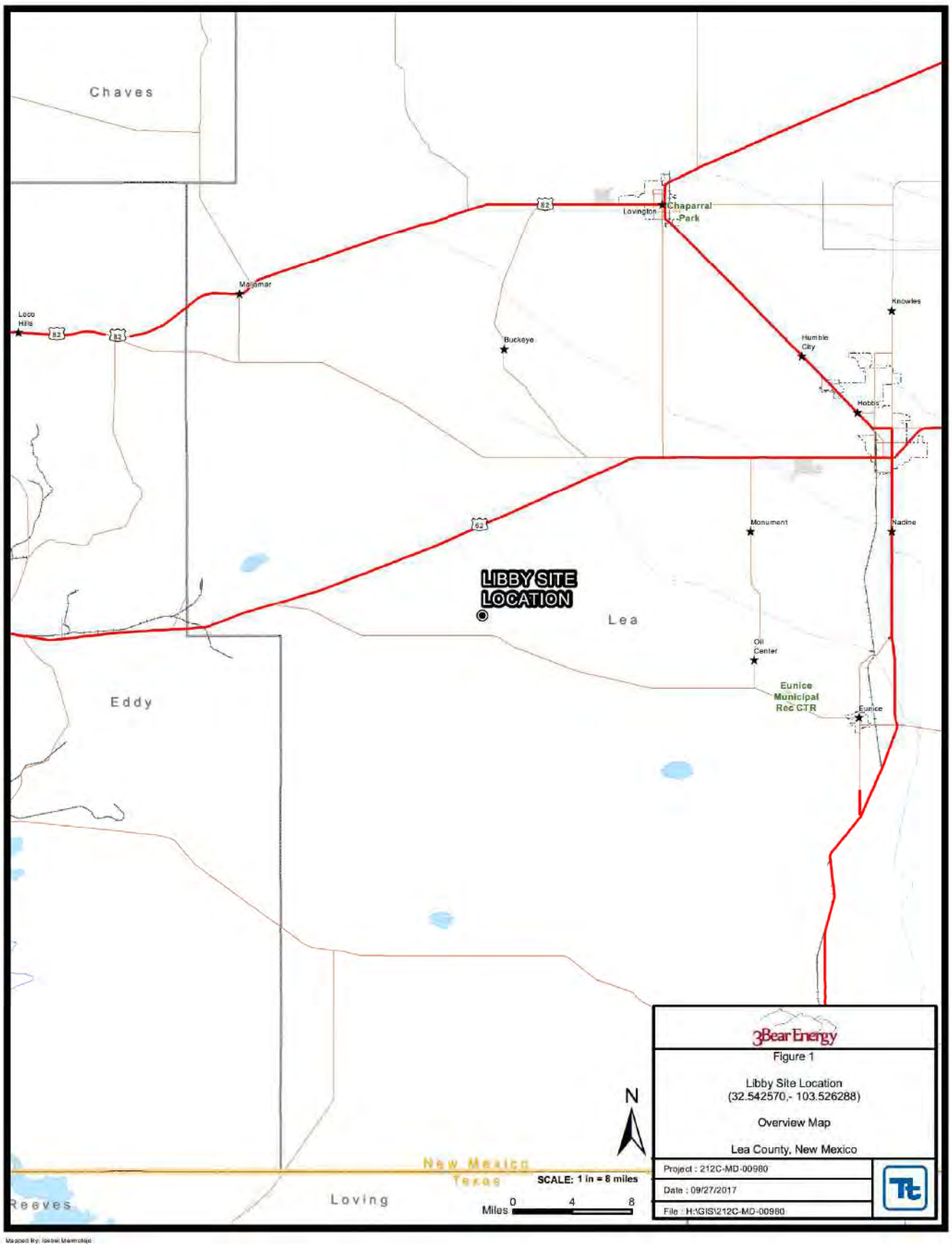
2) Mobilize a Failing 1500 Air Rotary rig to drill four (4) borings to a depth of 40 feet and one (1) boring to a depth of 100 feet to look for evidence of groundwater;

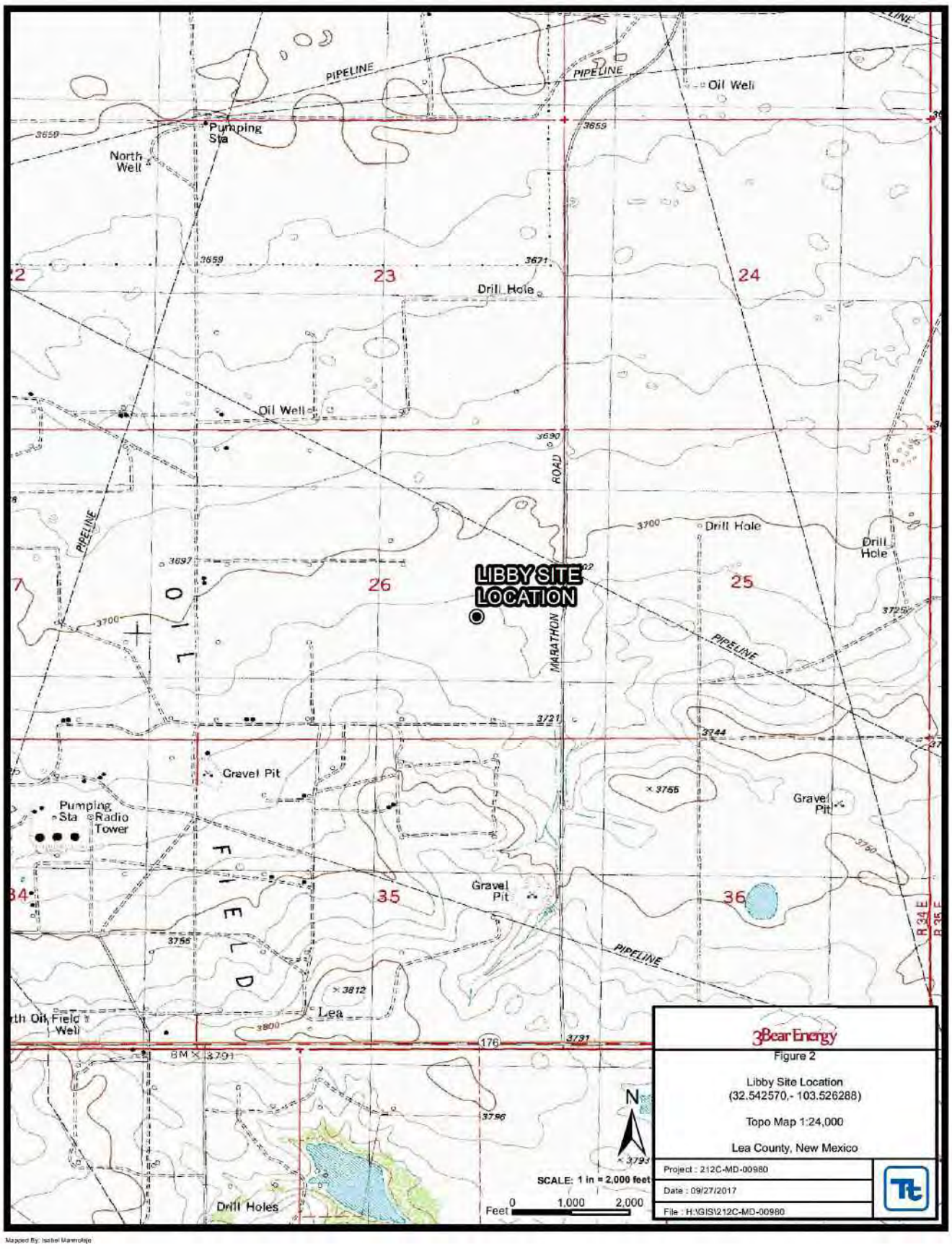
3) Perform Modified California Sampler Tests (MC) at every 5 or 10-foot interval to evaluate soil consistency and collect soil samples for evaluation;

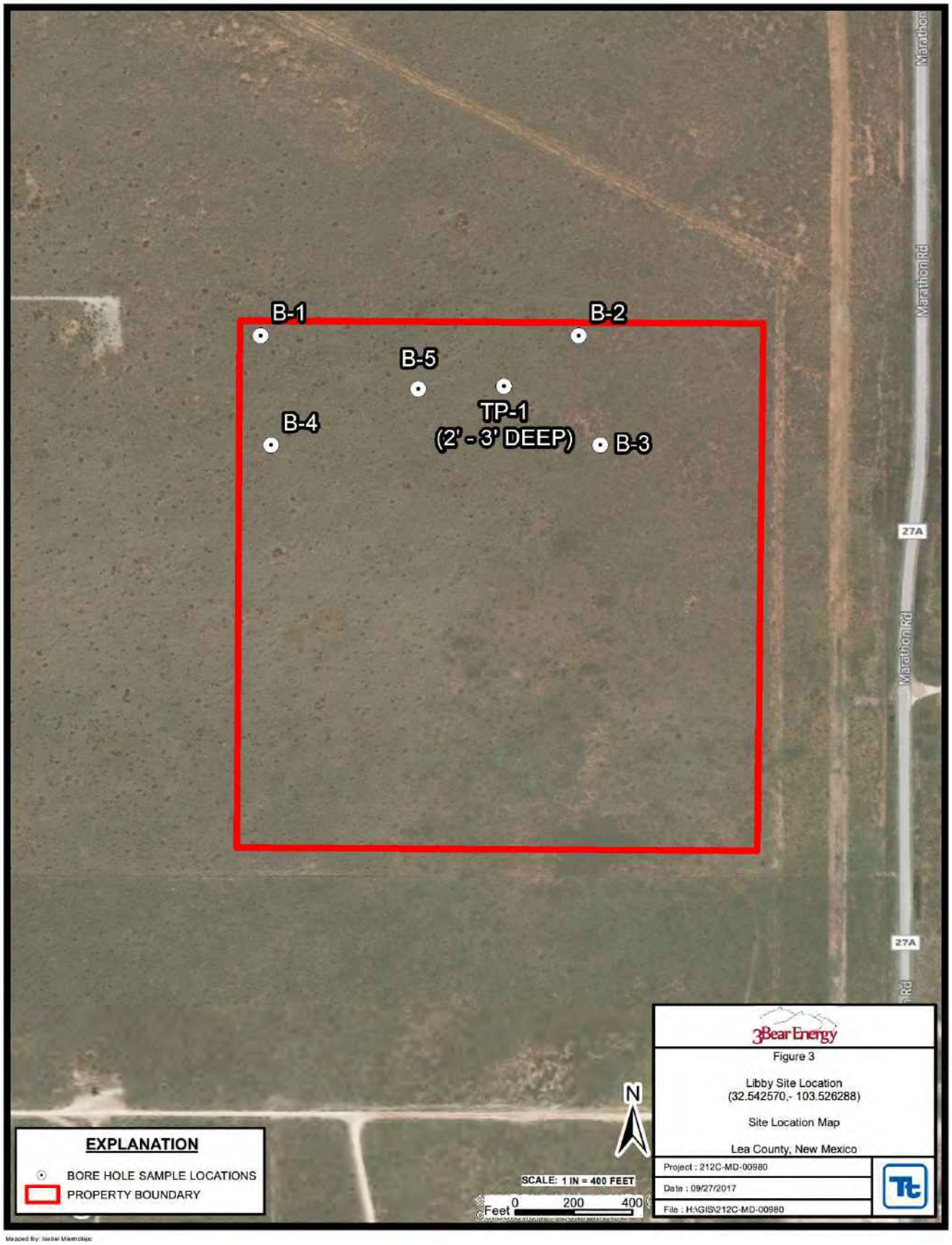
4) Backfill borings with soil cuttings after completion of drilling and 24-hour measurements, as required; and

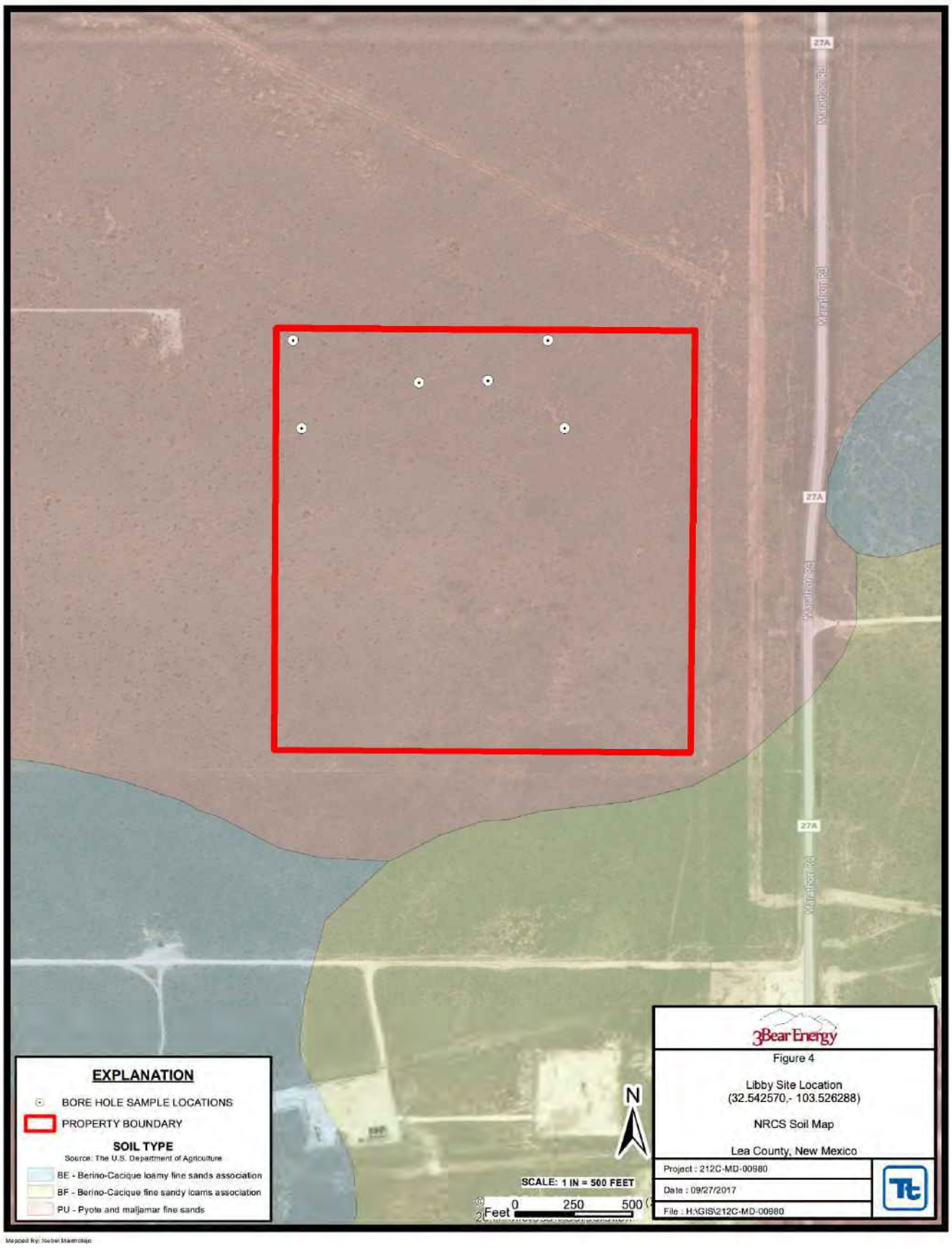
5) Provide geotechnical engineering design criteria and recommendations and prepare a geotechnical report.

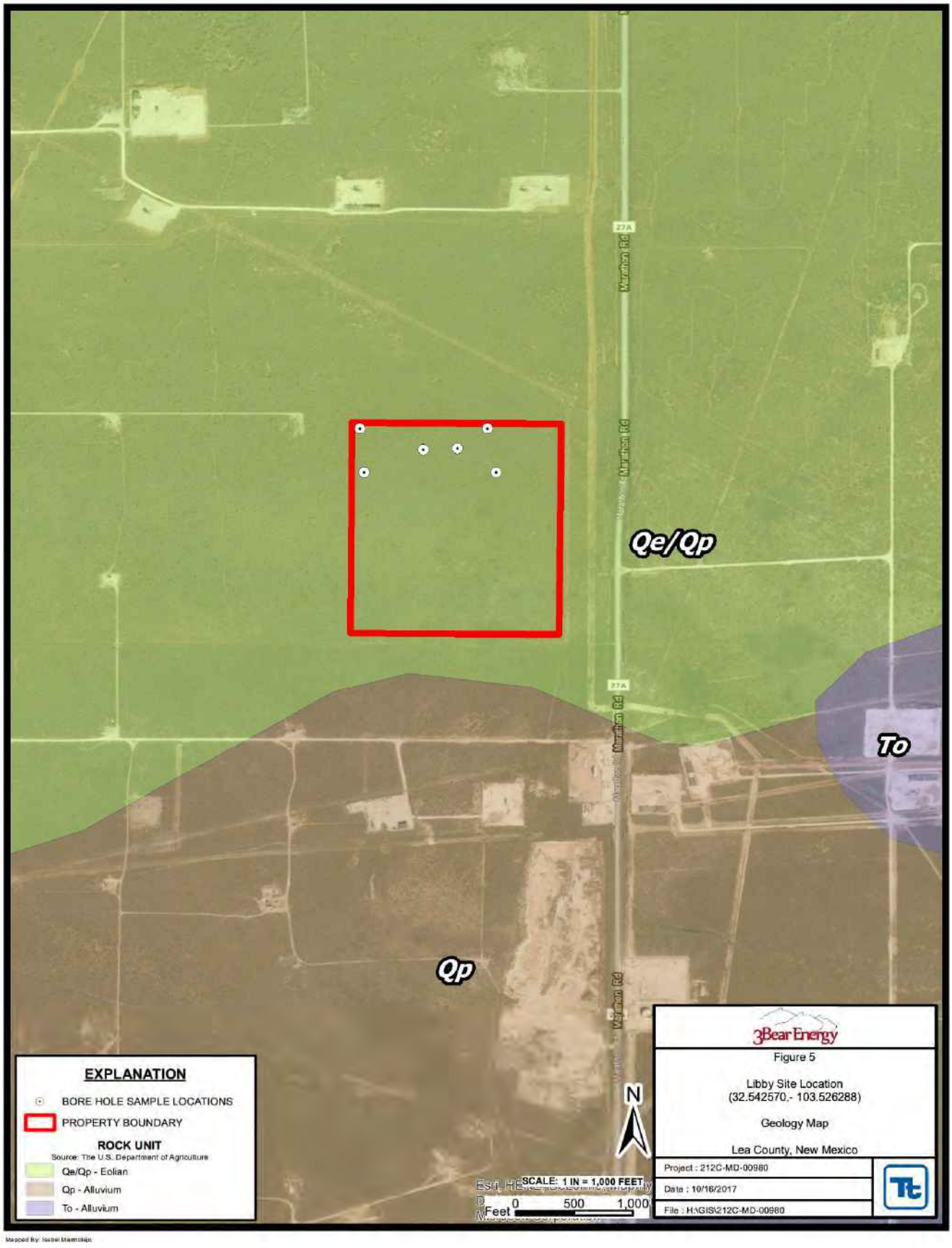
The general location of the site is shown on the Site Location Map, Figure 1 and Topographic Map, Figure 2.


Chaves
Eddy
Lea
Reeves
Loving
LIBBY SITE LOCATION
Lovington
Chaparral Park
Maljamar
Loco Hills
Buckeye
Knowles
Humble City
Hobbs
Monument
Nadine
Oil Center
Eunice Municipal Rec CTR
Eunice
New Mexico
Texas
N
SCALE: 1 in = 8 miles
0 4 8
Miles
3Bear Energy
Figure 1
Libby Site Location
(32.542570,- 103.526288)
Overview Map
Lea County, New Mexico
Project : 212C-MD-00980
Date : 09/27/2017
File : H:\GIS\212C-MD-00980


PIPELINE
PIPELINE
Oil Well
Pumping Sta
North Well
3659
3659
3671
23
24
Drill Hole
Oil Well
3690
ROAD
3700
Drill Hole
Drill Hole
3697
26
LIBBY SITE LOCATION
25
3700
3725
MARATHON
PIPELINE
3721
3744
Gravel Pit
3755
Gravel Pit
Pumping Sta
Radio Tower
3750
34
35
Gravel Pit
36
3755
PIPELINE
3812
Lea
3800
176
3731
BM 3791
3796
3793
Drill Holes
N
SCALE: 1 in = 2,000 feet
Feet 0 1,000 2,000
3Bear Energy
Figure 2
Libby Site Location
(32.542570,- 103.526288)
Topo Map 1:24,000
Lea County, New Mexico
Project : 212C-MD-00980
Date : 09/27/2017
File : H:\GIS\212C-MD-00980
Mapped By: Isabel Manmolejo


B-1
B-2
B-5
TP-1
(2' - 3' DEEP)
B-4
B-3
Marathon Rd
27A
N
EXPLANATION
BORE HOLE SAMPLE LOCATIONS
PROPERTY BOUNDARY
SCALE: 1 IN = 400 FEET
Feet 0 200 400
3Bear Energy
Figure 3
Libby Site Location
(32.542570,- 103.526288)
Site Location Map
Lea County, New Mexico
Project : 212C-MD-00980
Date : 09/27/2017
File : H:\GIS\212C-MD-00980


27A
Marathon Rd
EXPLANATION
BORE HOLE SAMPLE LOCATIONS
PROPERTY BOUNDARY
SOIL TYPE
Source: The U.S. Department of Agriculture
BE - Berino-Cacique loamy fine sands association
BF - Berino-Cacique fine sandy loams association
PU - Pyote and maljamar fine sands
N
SCALE: 1 IN = 500 FEET
Feet 0 250 500
3Bear Energy
Figure 4
Libby Site Location
(32.542570,- 103.526288)
NRCS Soil Map
Lea County, New Mexico
Project : 212C-MD-00980
Date : 09/27/2017
File : H:\GIS\212C-MD-00980


Marathon Rd
Qe/Qp
To
Qp
EXPLANATION
BORE HOLE SAMPLE LOCATIONS
PROPERTY BOUNDARY
ROCK UNIT
Source: The U.S. Department of Agriculture
Qe/Qp - Eolian
Qp - Alluvium
To - Alluvium
N
SCALE: 1 IN = 1,000 FEET
Feet 0 500 1,000
3Bear Energy
Figure 5
Libby Site Location
(32.542570,- 103.526288)
Geology Map
Lea County, New Mexico
Project : 212C-MD-00980
Date : 10/16/2017
File : H:\GIS\212C-MD-00980

2.0 SITE CONDITIONS

The project site for the proposed water storage basin is identified as the Libby Site. It is located 30 miles southwest of Hobbs in Lea County, New Mexico, and approximately 6 miles south of Highway 180 (Hobbs Highway) along County Rd 27-A (Marathon Road). GPS coordinates recorded at the NW corner of the site are 32.545028 N and 103.528528 W.

The site was wooded with some mesquite trees, wild shrubs, and weeds, and appeared to be relatively flat.

Based on the topographic elevations obtained from a hand held, commercially available GPS device, the pond location slopes slightly down from the southeast to the northwest with elevations varying from approximately 3710 feet to 3705 feet above mean sea level (AMSL). Surface utilities, fences, and access roads (on the site) were not observed at the time of drilling. Drainage streams, swales, playa, or other potential issues were not seen. The existing ground surface was cleared of shrubs and vegetation prior to the drilling. The immediate surrounding property was undeveloped.

3.0 PROPOSED DEVELOPMENT

Based on the information provided by 3Bear, the water storage (pond) will measure approximately 812 feet long by 350 feet wide with a maximum depth of thirteen feet and capacity of approximately 279,000 barrels (bbl). The pond will be designed with a double liner and a leak detection system and will be nearly entirely incised or below ground. We understand that 3Bear prefers to balance cut and fill volumes using onsite soil for fill to construct a small earthen berm on the northwest corner of the pond, and other site leveling improvements outside the pond area. The bottom of the pond will be sloped to drain to an installed liquid leak detection sump.

4.0 GEOLOGIC CONDITIONS

Mapping by the Natural Resources Conservation Service (NRCS, 2016) identifies the site soils as the Pyote and Maljamar mapping units (Figure 4). These soils are both described as fine sands.

Review of mapping by the U.S. Geological Survey (Figure 5) indicates that the eolian and alluvial deposits entirely cover the project site. Deposits are typically a distinctive reddish-brown color and soils are weakly developed. Eolian sediments consist of wind-deposited sand and silt, augmented and modified by alluvial processes.

Our findings of the geotechnical study are consistent with this characterization within the depths explored.

5.0 EXPLORATORY SOIL BORINGS

Tetra Tech drilled five (5) exploratory soil borings (B-1 through B-5) between September 20th and 22nd, 2017 to identify subsurface conditions at the site. In addition, a composite bulk sample (TP-1) from a depth of approximately 3 feet was collected on October 2nd. The boring locations were selected by a representative from Tetra Tech using a Google Earth map, proposed site development layout and actual property corners provided by RRC representative. The proposed pond footprint was overlaid on the satellite image, and GPS coordinates were obtained for each boring location. The boring locations were marked in the field by Tetra Tech using these coordinates and a commercially available handheld GPS unit. The boring locations were cleared for drilling by comparing the proposed locations to buried utility locations marked by New Mexico 811 utility locating services. In addition, Tetra Tech cleared the boring locations using hand-held pipeline locating instruments.

The borings were drilled by White Drilling Company from Clyde, Texas using a truck-mounted drilling rig. The ground surface was mostly stable for the drilling rig to access the boring locations and limited access issues other than going around obstacles (shrubs, bushes) and one use of sand mats in a loose sand area. Tetra Tech's representative was on site to observe site conditions and the drilling.

Air Rotary drilling equipment was used to complete the borings. Borings B-1 to B-4 were drilled to a depth of approximately 40 feet below the existing ground surface (bgs). Boring B-5 was drilled to an approximate depth of 100 feet bgs to investigate the presence or absence of groundwater. Water was not encountered in the borings while drilling or immediately afterwards. The boreholes were backfilled with the excavated soils following competition of drilling and water level measurements. Soils from all five borings were sampled and delivered to an environmental laboratory for purposes of analyzing for TPH, Chlorides and RCRA metals. The results of the environmental analysis is provided under separate cover.

New Mexico Oil Conservation Division rule 19.15.17.10 states that a permanent pit shall not be located where ground water is less than 50 feet below the bottom of the pit.

Soil samples were collected at depths of 1.5, 3.5, 6, 8.5, 13.5, 18.5, 23.5, 28.5, 33.5 (B-1, B-4) 38.5, 48.5 (B-5 only) and 58.5 (B-5 only) feet. A 140-pound weight falling 30 inches was used to drive the sampler into the undisturbed soils and bedrock. After "seating" the sampler into undisturbed soil, the number of blows required to drive the sampler in sequential 6-inch intervals was recorded similar to the Standard Penetration Test (SPT) (ASTM D 1586). The number of blows for each 12-inch interval (N-value) was recorded on the logs and was used to categorize the consistency of the soil. The N-values were corrected for the larger diameter of the sample barrel when a "California style" sampler was used. A thin walled "Shelby tube" sample was also collected at a depth of 10 feet in all the borings except for B-3.

After drilling and sampling activities were complete the borings were backfilled with soil cuttings. The soil boring logs are presented in Appendix A, and approximate locations of the borings are shown in Figure 3.

6.0 SUBSURFACE CONDITIONS

The information from the borings indicates the subsurface conditions were relatively consistent within the area where the borings were drilled. Beneath minimal vegetation and topsoil, all five (5) borings encountered predominantly medium dense to very dense silty to clayey sand. At various depths, slight cementation of soils was observed.

The in-situ moisture content of the samples ranged from 6.3 to 9.5 percent and the in-situ dry density ranged from 105.6 pounds per cubic foot (pcf) to 117.8 pcf. Laboratory tests showed the fines content (percent passing the #200 sieve) for all samples ranged from 12 to 37 percent indicating a coarse grained (silty/clayey sand) soil according to the Unified Soil Classification System (USCS). The fines content generally decreased with depth except for the clayey sand layer encountered in B-2. Atterberg limits testing of the sandy soils indicated a liquid limit of 21 in B-2 at 6 feet bgs, 36 in B-2 at 14 feet bgs and 29 in B-4 at 4.5 feet bgs. Samples from B-1 at 29.5, B-3 at 14, B-4 at 24 and B-5 at 10 feet bgs were non-plastic. The plasticity index was 3 in B-2 at 6 feet bgs, 23 in B-2 at 14 feet bgs and 16 in B-4 at 4.5 feet bgs.

Consolidation testing of the specimen from B-2 at 14 feet bgs indicated a swell of 0.7 percent with a swell pressure of 2000 pounds per square foot (psf) when inundated with water under a load similar to the existing overburden pressure. The compression index (Cc) was calculated to be 0.11 and the swell index (Cs) was calculated to be 0.028. Consolidation testing on the specimen from B-4 at 4.5 feet indicated a consolidation of 0.22 percent when inundated with water under a load similar to the existing overburden pressure. The Cc and Cs were calculated to be 0.17 and 0.029 respectively.

The bulk sample (TP-1) from the depth of approximately 3 feet had an optimum moisture content of 12.3 percent and a maximum dry density of 107.9 pounds per cubic foot (pcf) determined by standard Proctor test (ASTM D698).

7.0 ENGINEERING ANALYSES AND RECOMMENDATIONS

7.1 Primary Geotechnical Considerations

The primary concerns that could impact the proposed development are the presence of strongly cemented soil causing excavation difficulty, degradation of subgrade or recompacted soils under construction equipment traffic, and the potential for significant reductions in soil volume on compaction. These are discussed in greater detail below.

Strongly cemented soil was not observed in the widely spaced borings drilled by Tetra Tech; however, the degree of cementation in the site soils varies significantly over short distances across the site as evidenced by subsurface information presented in a report of subsurface exploration for the adjacent area (Olsson 2017). If such soils are encountered, excavation will be difficult due to the high energy required to excavate and eventually pulverize the cemented soil into a soil consistency that can be used as fill as described below. Where not cemented, the on-site soils are generally susceptible to degradation under construction equipment traffic, especially when exposed to high moisture levels. Excessive pumping and rutting may occur during construction operations, especially under repeated traffic loads. Necessary precautions should be made to avoid excessive degradation of the subgrade soils including using lightly loaded track mounted equipment in lieu of heavy rubber tired equipment. Temporary stabilization techniques may be required depending on weather events (Olsson 2017).

Laboratory testing indicates that volume changes due to compaction of the existing soils (so called shrink/swell) will be on the order of 5 percent or less. However, practical experience in the area suggests that the difference is closer to 20 percent. Variability in site soils over short distances may result in the greater volume reduction between in situ soil volume and the volume of compacted soils. Based on local experience, we suggest using a volume reduction of 20 percent in construction budget calculations.

Water was not encountered in the borings to a depth of 100 feet. Based on those results we do not anticipate that groundwater will significantly affect the construction. However it must be recognized that our water level measurements occurred over a limited time period. Changes in the ground water conditions may occur seasonally or from year to year.

7.2 Site Preparation

To prepare the site for pond construction, an area larger than the proposed footprint by at least 10 feet in plan dimension on all sides should be stripped of vegetation, roots, organic material, existing construction materials, debris, and other unsuitable materials. A typical stripping depth is approximately 6 inches; however, the actual depth will vary and should be based on field conditions and observations. After stripping, we anticipate a moderately stable surface for support of construction equipment. Unsuitable areas (such as those with loose, wet, soft, yielding, and/or pumping subgrade) should be corrected before construction proceeds.

Obstructions that could hinder preparation of the site should also be removed, with special attention given to unknown or un-documented below ground appurtenances and any existing above and below ground flow lines. Care should be taken not to damage any existing buried utilities located within the footprint of the proposed construction. Any resulting utility trenches/excavations due to replacement or relocation of utilities should be backfilled as discussed in the Fill Placement and Compaction section of this report.

7.3 Excavation and Embankment Slopes

Based on the subsurface data, sandy soil with varying degrees of cementation is present to depths of at least 100 feet below the existing grade. Conventional construction equipment can be used to excavate the ground. However, excavation into the cemented soils will be more difficult and additional effort or large, heavy duty equipment may be necessary. Heavy duty rock ripping equipment like a ripper mounted on a Caterpillar D8 bulldozer or equivalent may be required.

The earthwork contractor should review the subsurface conditions and appropriately select excavation equipment and initial slope of the excavation to minimize potential sloughing and to remain in compliance with OSHA Regulations 1926.651 and 1926.652 on excavation safety. Wetting of the exposed excavation sides to a moisture content near or slightly above optimum may be necessary to stabilize and maintain the slopes during construction.

During construction, the excavation slopes should be observed for safety purposes. Excavation slopes specified by OSHA are dependent on types of soil and groundwater conditions encountered. Based on our investigation the on-site soil is classified as Type C, and the cemented soils can be considered to be Type B according to OSHA 1926, Subpart P, Appendix A. The contractor's "competent person" should identify the soils encountered in the excavation and refer to OSHA 1926.651 and 1926.652 to verify the conditions and classifications from our investigation and determine appropriate slopes. If deemed unstable, the excavation sides should be flattened or benched to remain in compliance. Stockpiles of soils and equipment should not be placed within a horizontal distance equal to one-half the excavation depth, from the edge of the excavation. Excavations deeper than 20 feet should be designed by a Professional Engineer as recommended by OSHA.

Embankment slopes must be constructed slopes flat enough to prevent slope failures. Soil and embankment fill design parameters are presented in Table 1 below. Recommended values are in lieu of design parameters based on shear strength testing.

Parameter / Layer	Unit Weight (γ)	Internal Friction Angle		Cohesion	
		Effective (ϕ')	Total (ϕ)	Effective (c')	Total (c)
Compacted/Improved Subgrade	100 pcf	31°	33°	45 psf	30 psf
Silty/Clayey Sand	110 pcf	31°	36°	30 psf	15 psf
Claystone	120 pcf	0°	0°	5,000 psf	5,000 psf

Table 1. Soil and Compacted Fill Design Parameters

The pond will be lined and we have assumed the liner system will function to prevent development of a phreatic surface within the embankment. We understand that side slopes will be designed at 3 horizontal to 1 vertical (3H:1V), which is consistent with NMAC 19.15.36.17, which states that the maximum allowed pond embankment slope is 3H:1V for exterior slopes and 2H:1V for interior slopes. The slope stability analysis was performed using commercially available SLOPE/W software and results are presented in the Table 2, below. Design slopes of 3H:1V were used in all analysis.

Load Case	FoS
End of construction, Static, Total Stress	2.4
End of construction, Pseudostatic, Total Stress	2.2
Freeboard, Static, Effective Stress	2.1
Freeboard, Pseudostatic, Effective Stress	1.7
Crest, Static, Effective Stress	2.5
Crest, Pseudostatic, Effective Stress	1.9
Rapid Drawdown, Static, Effective Stress	1.1
Rapid Drawdown, Static, Total Stress	1.1

Table 2. Slope Stability Analysis Results

The analyses show that the proposed 3H:1V slopes exceed minimum acceptable factors of safety. We recommend 3H:1V based on consideration of other issues such as constructability, liner stability, and seepage. If 3Bear would like to consider construction of slopes steeper than the 3H:1V recommended above, Tetra Tech is available to conduct additional slope stability analysis to evaluate the feasibility of steeper slopes and liner system performance on those slopes. This analysis would be supported by slope stability modeling and hand calculations to present to the NMOCD in a variance request.

7.4 Fill Placement and Compaction

On-site soils free of rocks greater than 1 inch in diameter, organics, and debris are suitable for use as structural fill or backfill. The cemented soils will likely require additional processing beyond ripping to achieve a soil consistency and meet the maximum particle size dimension in the construction specifications. Fill and backfill should not be placed on organics or other deleterious materials such as soil or rock with soluble components such as gypsum. If additional fill is needed for construction of the embankment, imported fill should be a well-graded clayey sand (SC) or low plasticity clay (CL), or imported soils with engineering properties that are similar to on-site soils (depending on the intended use of the fill). For structural support, a uniform, granular material having 100 percent passing the 1 inch sieve, 30 to 70 percent passing the No. 4 sieve, and 3 to 15 percent passing the number 200 sieve is recommended. Prior to importation, samples of soils being considered as fill should be examined and evaluated by a geotechnical engineer for engineering properties to determine the suitability of the material for its intended use.

The bases of fills in soil should be scarified at least 8 inches deep, moisture-conditioned or dried to within 2 percent of optimum moisture content (12.3 %), processed to a uniform condition, and then compacted to at least 95 percent of maximum dry density (107.9 pcf) determined by standard Proctor (ASTM D698). For on-site and imported fill and backfill, moisture should be adjusted to within minus 1 to 3 percent above optimum moisture content as determined by standard Proctor and the soils thoroughly mixed prior to placement and compaction to provide uniform water content throughout the fill.

Fill and backfill should be placed in uniform lifts of 8 inches or less in loose thickness and compacted to at least 95 percent of standard Proctor maximum dry density (ASTM D 698). Fill should be compacted using the heavy vibratory equipment. In areas with limited space for heavy equipment, appropriate compaction equipment such as a jumping jack or other hand tools should be used. Where smaller compacting equipment or hand tools are used, the fill lifts should be 6 inches or less in loose thickness. The contractor should select the equipment type based upon the fill soil conditions.

Placement and compaction of fill should be observed and tested by a qualified geotechnical engineer or their qualified representative during construction. Each vertical foot of compacted fill placed should be tested for compaction comparison to standard Proctor results. A minimum of one moisture/density verification test should be performed for every 5,000-square-feet of compacted area, or for every 150-lineal feet of utility trench backfill. For smaller areas, a minimum

of 3 verification tests should be conducted for every lift. Subsequent lifts should not be placed until the exposed lift has been tested to confirm compliance with the specified moisture and density. Lifts failing to meet the moisture and density requirements should be reworked to meet the required specifications prior to subsequent lifts being placed. Density and moisture verification testing is recommended to provide an indication that adequate earthwork is being performed. However, the quality of the fill and compaction is the sole responsibility of the contractor. Satisfactory verification testing is not a guarantee of the quality of the contractor's earthwork operations.

The specified moisture content must be maintained until compaction of the overlying lift, or until the cushioning sand layer or geotextile fabric and geomembrane liner are installed. Failure to maintain the specified moisture content could result in excessive soil movement resulting in embankment failure. The contractor must provide some means of controlling the moisture content (such as water hoses, water trucks, etc.). Maintaining subgrade moisture is always critical, but will require the most effort during warm, windy and/or sunny conditions.

7.5 Proof Rolling

Proof rolling of the subgrade prior to fill placement and liner installation should be used to detect areas of soft and/or pumping soil. Proof rolling should be conducted using a heavy, rubber-tired vehicle weighing at least 25 tons, with the tires inflated to the manufacturer's specified operating pressure. The entire area should be proof rolled, with each succeeding pass offset by not greater than one tire width. The geotechnical engineer or an experienced soils technician should be present during proof rolling activities to assist with the identification of unsuitable soil. Unsuitable soil should be undercut and reworked, or otherwise improved in a manner that is suitable to the design and approved by the geotechnical engineer.

7.6 Geomembrane Liner Protection

Where the exposed surface is rough, rock protrusions and sharp edges can potentially damage the geomembrane liner. Additionally an irregular foundation with voids can create localized stress points on the geomembrane liner. The subsurface conditions at this site indicate sandy soils to a depth of 100 feet deep. However, the pond bottom might be underlain by areas of cemented soil with rock-like protrusions and surface irregularities. If the protrusions are greater than $^1/_4$-inch or if voids greater than 2 inches deep will exist below the liner, a cushion, such as a fine grained sand layer, approximately 6 inches thick or a properly designed cushion geotextile should be used to reduce the risk of damage to the liner. Liner requirements must meet those presented in the New Mexico Administrative Code (NMAC) 19.15.36.17.

7.8 Freeboard

An important aspect of embankment stability and performance is maintaining the appropriate freeboard (the vertical distance from the water surface to the crest of the embankment). If the freeboard is insufficient, the embankment could overtop, leading to excessive erosion and possible failure. The NMAC 19.15.36.17 regulations and MCBU General Standards require a minimum freeboard of three feet which must be maintained at all times.

7.9 Settlement of Subgrade and Embankment Materials

Settlement of embankment material is another important aspect of embankment stability and total fluid storage potential over time. It is anticipated that the embankments will be constructed of fill consisting of on-site material or imported fill. The on-site sandy soils have a relatively low potential for post-construction settlement. Construction recommendations from above for subgrade proof rolling, subgrade improvements, and fill placement will reduce the amount of settlement. Due to the sandy nature of the soils and the limited embankment height, most of the anticipated or potential settlement within the embankments and under the embankments should occur during construction.

7.10 Permitting

If applicable, a permit application should be filed with the NMOCD in accordance with NMAC regulations prior to construction. Construction and installation in accordance with NMOCD regulations found in the NMAC and the design drawings and construction specifications is recommended. The NMOCD may require notification prior to construction and prior to operation of the pond.

8.0 CONCLUSIONS

Our investigation identified cemented soil as a potential issue that should be considered before development of the proposed pond. Strongly cemented soil was not observed in the widely spaced borings drilled by Tetra Tech; however, the degree of cementation in the site soils varies significantly over short distances across the site as evidenced by subsurface information presented in a report of subsurface exploration for the adjacent area (Olsson 2017). Excavation in cemented soils will be more difficult and additional effort or large, heavy duty equipment may be necessary.

We recommend designing the side slopes at and inclination of 3 horizontal to 1 vertical (3H:1V), which is consistent with NMAC 19.15.36.17, which states that the maximum allowed pond embankment slope is 3H:1V for exterior slopes and 2H:1V for interior slopes.

If the protrusions greater than $^1/_4$-inch or voids greater than 2 inches deep below the liner, a cushion, such as a fine grained sand layer, approximately 6 inches thick or a properly designed cushion geotextile should be used to reduce the risk of damage to the liner. Liner requirements must meet those presented in the New Mexico Administrative Code (NMAC) 19.15.36.17.

The NMAC 19.15.36.17 regulations and MCBU General Standards require a minimum freeboard of three feet which must be maintained at all times.

9.0 REFERENCES

Olsson Associates (September 2017), Geotechnical Engineering Report, Libby Gas Plant, Lea County, New Mexico

U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS, 2016). Web Soil Survey. http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. Accessed October 10, 2017.

United States Geological Survey (USGS, 2005). Preliminary Integrated Geologic Map for the United States Central States. Open-File Report 2005-1351

10.0 LIMITATIONS

This report was prepared from data developed during our field exploration, laboratory testing, and engineering judgment. Our design recommendations were based on subsurface data and our experience with similar projects and subsurface conditions. Our borings were located to obtain a reasonable interpretation of subsurface conditions. It should be noted that the borings were widely spaced and variation in the subsoils between borings is likely.

A qualified, experienced geotechnical engineer or their designated representative should observe the construction to look for evidence that would indicate differences in subsurface conditions from those described in this report. If any information becomes available that would alter our assumptions, conclusions or recommendations, the opinions presented in this report should be considered invalid until we have been contacted to review our recommendations based on the new information. The geotechnical engineer should review plans and specifications during the design. Placement and compaction of engineered fill, backfill, subgrade and other fills should be observed and tested by a representative of a Construction Materials Testing (CMT) firm during construction, and Tetra Tech should be retained to review these data.

We believe this study was conducted in a manner consistent with that level of skill and care ordinarily used by members of the profession currently practicing under similar conditions in the locality of this project. No warranty, express or implied, is made. If we can be of further service in discussing the contents of this report or in the analysis of the planned project from the geotechnical point of view, please contact us.

APPENDIX A

EXPLORATORY BORING LOGS

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-1

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DATE(S) OF DRILLING: 09/21/2017 **GROUND ELEVATION: NA** **METHOD: HSA/Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.544889 N** **LOGGED BY: Don Grahlherr and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 103.528333 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blowcounts are corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	67	5-7-11				Medium Dense, Tan Red, Cemented, Very Fine Grained, **SILTY SAND**, Dry
5	MC 2	78	10-8-10	MC = 7.2% DD = 107.7 pcf Eff. Phi = 31.6 Eff. C = 32 psf Tot. Phi = 17.1 Tot. C = 34 psf			
	MC 3	100	19-23-14				6.0 Dense, Tan White, Fine Grained, **SILTY SAND**, Dry 7.5
10	MC 4	100	4-6-8				Medium Dense to Very Dense, Tan Red, Some Cementation, Fine Grained, **SILTY SAND**, Dry, Some Limestones, at 35 Ft River Gravel in Shoe (1" dia.)
	ST 1	100					
15	MC 5	0	6-9-10				
20	MC 6	100	5-8-12				
25	MC 7	0	14-50/4"				
30	MC 8	0	50/5"	MC = 6.3% LL = NP PL = NP PI = NP Fines = 21.5%	SM		
35	MC 9	22	50/5"				
40	MC 10	0	50/4"				40.0

Borehole terminated at 40.0 ft.

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-2

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DATE(S) OF DRILLING: 09/21/2017 **GROUND ELEVATION: NA** **METHOD: HSA/Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.544889 N** **LOGGED BY: Don Grahlherr and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 103.525361 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blowcounts are corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	89	6-12-13				Medium Dense to Dense, Tan Red, Some Cementation, Fine Grained **SILTY SAND**, Slighty Moist
5	MC 2	89	13-16-20				
	MC 3	100	10-14-19	LL = 21 PL = 18 PI = 3 Fines = 23.0%	SM		
7.5							
10	MC 4	78	29-50/4"				Very Dense, Tan White, Cemented, Fine Grained **CLAYEY SAND**, Slighty Moist
	ST 1	100					
15	MC 5	100	23-27-50/5"	MC = 9.5% DD = 117.8 pcf LL = 36 PL = 13 PI = 23 Fines = 34.5%	SC		
20	MC 6	50	12-16-50/5"				
20.0							
25	MC 7	0	29-50/5"				Very Dense, Tan White, Some Cementation, Fine Grained **SILTY SAND**, Slighty Moist
30	MC 8	0	14-50/5"				
30.0							
35							Very Dense, Tan Red, Some Cementation, Fine Grained **SILTY SAND**, Slighty Moist, Some River Gravel
40	MC 9	0	50/4"				
40.0							

Borehole terminated at 40.0 ft.

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-3

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DATE(S) OF DRILLING: 09/22/2017 **GROUND ELEVATION: NA** **METHOD: HSA/Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.543860 N** **LOGGED BY: Don Grahlherr and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 103.525333 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blowcounts are corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							Dense to Medium Dense, Red, Very Fine Grained **SILTY SAND**, Moist, Becomes Dry and Cemented at 5 ft
	MC 1	100	8-14-17				
5	MC 2	89	10-12-12				
	MC 3	56	10-14-18				
7.0							
	MC 4	56	23-50/5"				Dense to Very Dense, Tan White, Very Fine Grained **SILTY SAND**, Dry, Becomes Less Cemented at 13 ft to not Cemented at 15ft, at 35 ft Some River Gravel in Cuttings (1" dia.)
10							
				MC = 7.1% DD = 113.4 pcf LL = NP PL = NP PI = NP Fines = 12.0%			
15	MC 5	100	10-13-16		SM		
20	MC 6	94	5-7-10				
25	MC 7	0	14-19-20				
30	MC 8	0	50/2"				
35							
40	MC 9	0	50/1"				
40.0							

Borehole terminated at 40.0 ft.

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-4

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DATE(S) OF DRILLING: 09/21/2017 **GROUND ELEVATION: NA** **METHOD: HSA/Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.543861 N** **LOGGED BY: Don Grahlherr and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 103.528361 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blowcounts are corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	100	5-8-11	MC = 7.3% DD = 105.6 pcf LL = 29 PL = 13 PI = 16 Fines = 26.7%			Medium Dense, Tan Red, Fine Grained **SILTY SAND**, Slightly Moist
3.0							
5	MC 2	78	8-9-10		SC		Medium Dense, Tan White, Very Fine Grained **CLAYEY SAND**, Dry, Some Cementation
5.5							
	MC 3	100	18-20-17				Dense, Tan Red, Very Fine Grained **SILTY SAND**, Dry, More Cementation, at 17ft becomes Less Cemented
10	MC 4	0	3-4-5				
	ST 1	63					
15	MC 5	0	50/5"				
20	MC 6	33	13-18-23				
20.0							
				LL = NP PL = NP PI = NP Fines = 20.0%	SM		Very Dense, Tan Red, Very Fine Grained **SILTY SAND**, Dry, More Cementation, at 30-35 ft Some Gray River Gravel
25	MC 7	0	15-27-50/4"				
30	MC 8	11	50/4"				
35	MC 9	33	31-50/1"				
40	MC 10	0	50/2"				
40.0							

Borehole terminated at 40.0 ft.

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-5

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DATE(S) OF DRILLING: 09/21/2017 **GROUND ELEVATION: NA** **METHOD: HSA/Air Rotary**

CONSULTANT: Tetra Tech, Inc. **LATITUDE: 32.544389 N** **LOGGED BY: Don Grahlherr and Kasia Kuk**

DRILLING CONTRACTOR: White Drilling **LONGITUDE: 103.526861 W** **DRILLED BY: Dallas Rader**

Notes: No groundwater encountered. Blowcounts are corrected for sampler diameter.

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0							
	MC 1	100	6-7-10				Medium Dense, Tan Red, Fine Grained **SILTY SAND**, Moist, Some Cementation
3.0							
5	MC 2	100	8-9-16				Dense, Tan White, Very Fine Grained **SILTY SAND**, Dry, More Cementation
	MC 3	89	17-22-23				
8.0							
10	MC 4	100	13-23-24				Dense to Very Dense, Tan Red, Very Fine Grained **SILTY SAND**, Dry, More Cementation at 18ft, Trace of Gray River Gravel at 38-50 ft
	ST 1	100		LL = NP PL = NP PI = NP Fines = 37.3%	SM		
15	MC 5	89	9-12-19				
20	MC 6	100	9-15-18				
25	MC 7	89	25-29-50/6"				
30	MC 8	0	50/4"				
35							
40	MC 9	0	50/4"				

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-5

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
40							Dense to Very Dense, Tan Red, Very Fine Grained **SILTY SAND**, Dry, More Cementation at 18ft, Trace of Gray River Gravel at 38-50 ft *(continued)*
45							
50	MC 10	0	*50/2"*				50.0
55							Very Dense, Red, Very Fine Grained **SILTY SAND**, Dry
60	MC 11	17	*50/3"*				58.0 Very Dense, Red, Very Fine Grained **SILTY CLAYEY SAND**, Slightly Moist, Trace of Gray River Gravel 60.0
65							Very Dense, Red, Very Fine Grained **SILTY CLAYEY SAND**, Dry, Trace of Gray River Gravel at 70 ft
70							
75							
80							
85							

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

(Continued Next Page)

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
Midland, TX, 79705
Telephone: 432-682-4559
Fax: 432-682-3946

BOREHOLE ID: B-5

CLIENT 3 Bear Energy **PROJECT NAME** Libby Site Impoundment

PROJECT NUMBER 212C-MD-00980 **PROJECT LOCATION** Lea County, New Mexico

DEPTH (ft)	SAMPLE TYPE	RECOVERY %	BLOW COUNTS	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
90							Very Dense, Red, Very Fine Grained **SILTY CLAYEY SAND**, Dry, Trace of Gray River Gravel at 70 ft *(continued)*
95							
100							100.0
							Borehole terminated at 100.0 ft.

BOREHOLE/TP/WELL - TT 3 BEAR LIBBY LEA CO.GPJ LAB SUMMARY.GDT 10/19/17

APPENDIX B

LABORATORY SUMMARY

TETRA TECH
Tetra Tech Inc.
4000 N. Big Spring, Suite 401
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Telephone: 432-682-4559
Fax: 432-682-3946

SUMMARY OF LABORATORY RESULTS

CLIENT 3 Bear Energy

PROJECT NAME Libby Site Impoundment

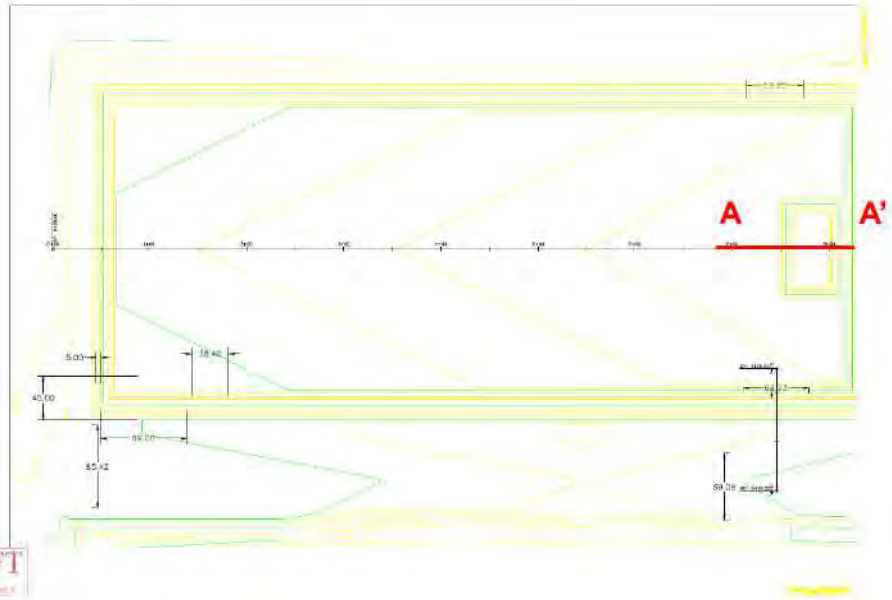
PROJECT NUMBER 212C-MD-00980

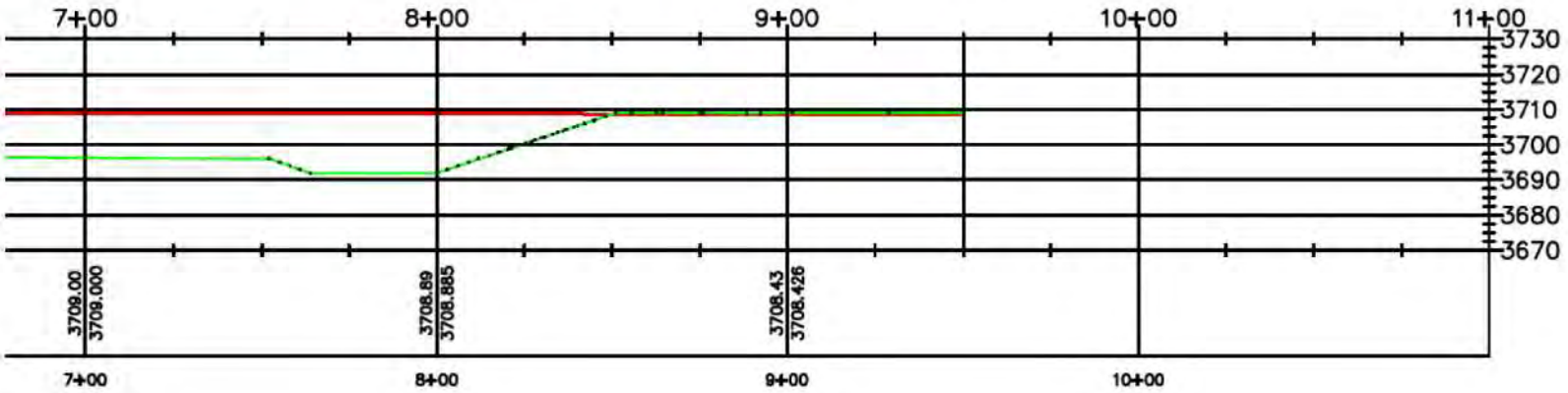
PROJECT LOCATION Lea County, New Mexico

Borehole Identification	Depth	Water Content (%)	Dry Density (pcf)	Atterberg's Limits (LL/PL/PI)	Max Dry Density (pcf)/ OMC(%)	Fines Content (%)	USCS Classi-fication	Swell (%), Swell pressure (psf)	Cc, Cs	Permeability (cm/s)	Group Index	AASHTO Classifi-cation	Triaxial Shear Strength c'(psf), phi'	Specific Gravity, Degree of Saturation
B-1	3.5	7.2	107.7	29/17/12		32	SC				0	A-2-6	32,31.6	
B-1	29.5	6.3		NP		22	SM				0	A-2-4		
B-2	6.0			21/18/3		23	SM				0	A-2-4		
B-2	14.0	9.5	117.8	36/13/23		35	SC	0.7,2000	0.11,0.028		2	A-2-6		
B-3	14.0	7.1	113.4	NP		12	SM				0	A-2-4		
B-4	4.5	7.3	105.6	29/13/16		27	SC	-0.22	0.17,0.029		1	A-2-6		
B-4	24.0			NP		20	SM				0	A-2-4		
B-5	10.0			NP		37	SM				0	A-4		
TP-1 Bulk	2.0			24/19/5	107.9/12.3									
TP-1 Remolded Perm.	2.0	1.9	109.4							0.00138				
TP-1 Remolded Triax.	2.0	12.3	102.5										47,32.7	

APPENDIX C

SLOPE STABILITY ANALYSIS RESULTS

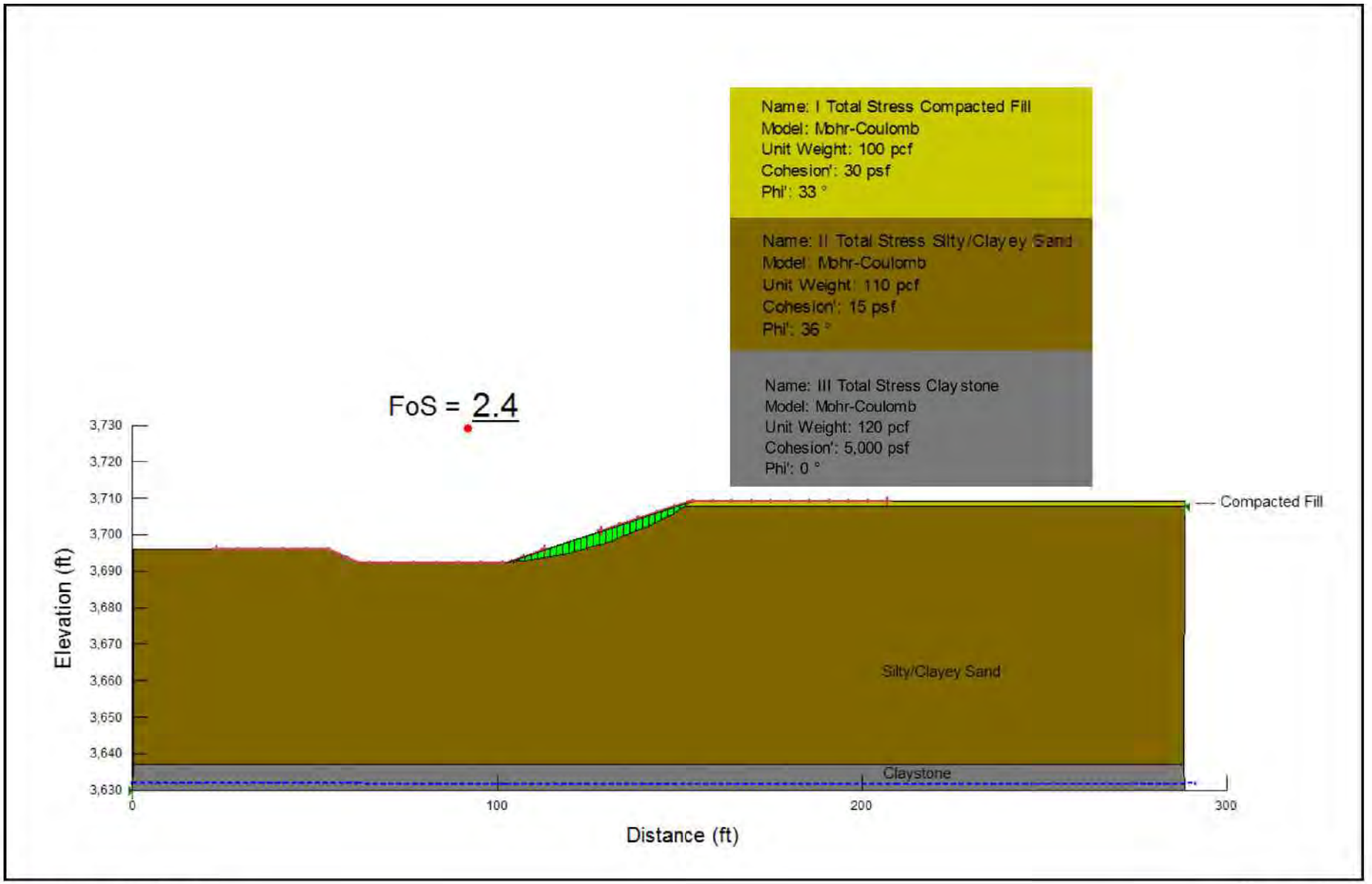




Project No: 212C-MD-00980

November 2017

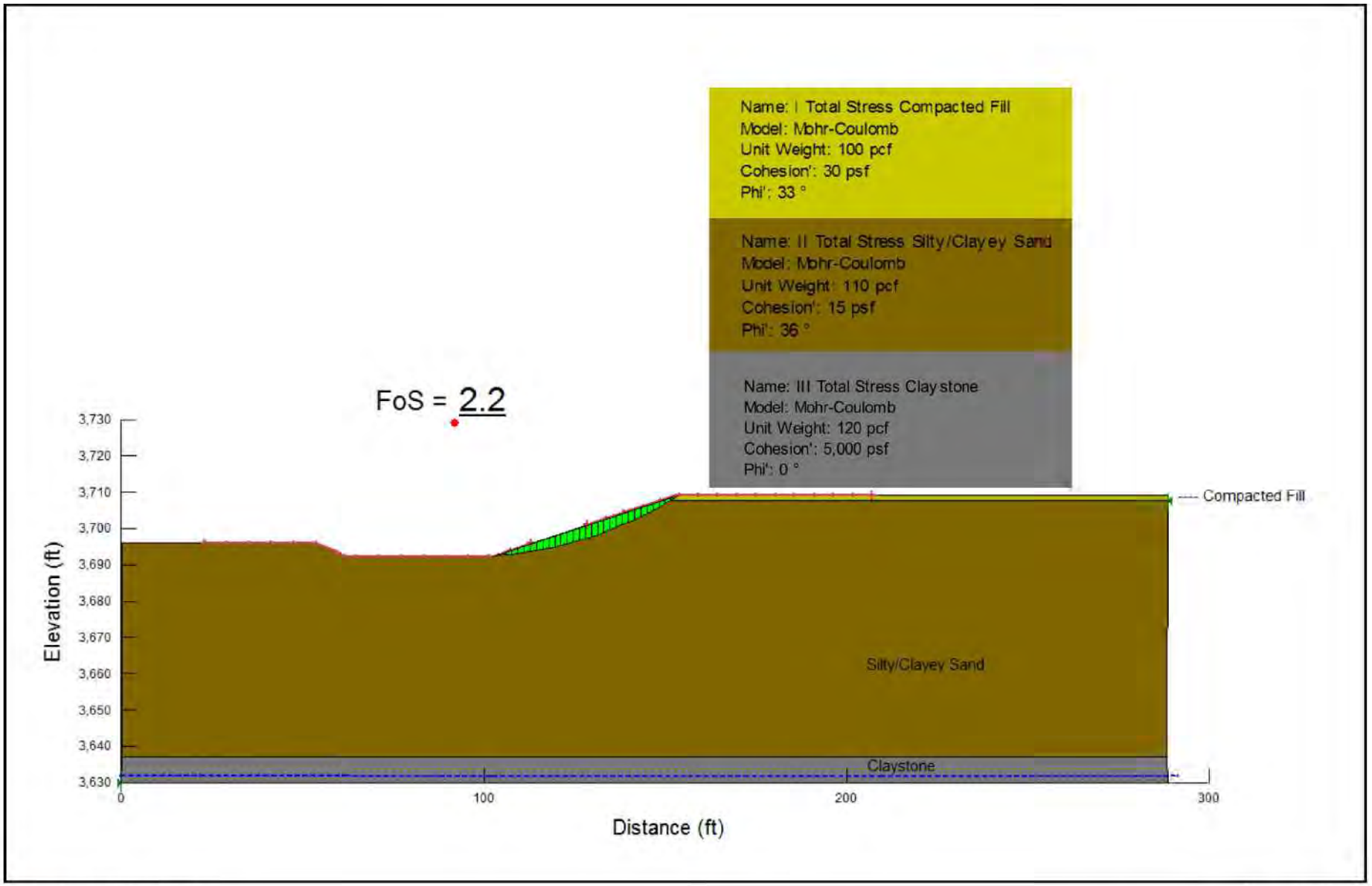
Libby Site Impoundment
Section A-A' Layout



Project No: 212C-MD-00980

November 2017

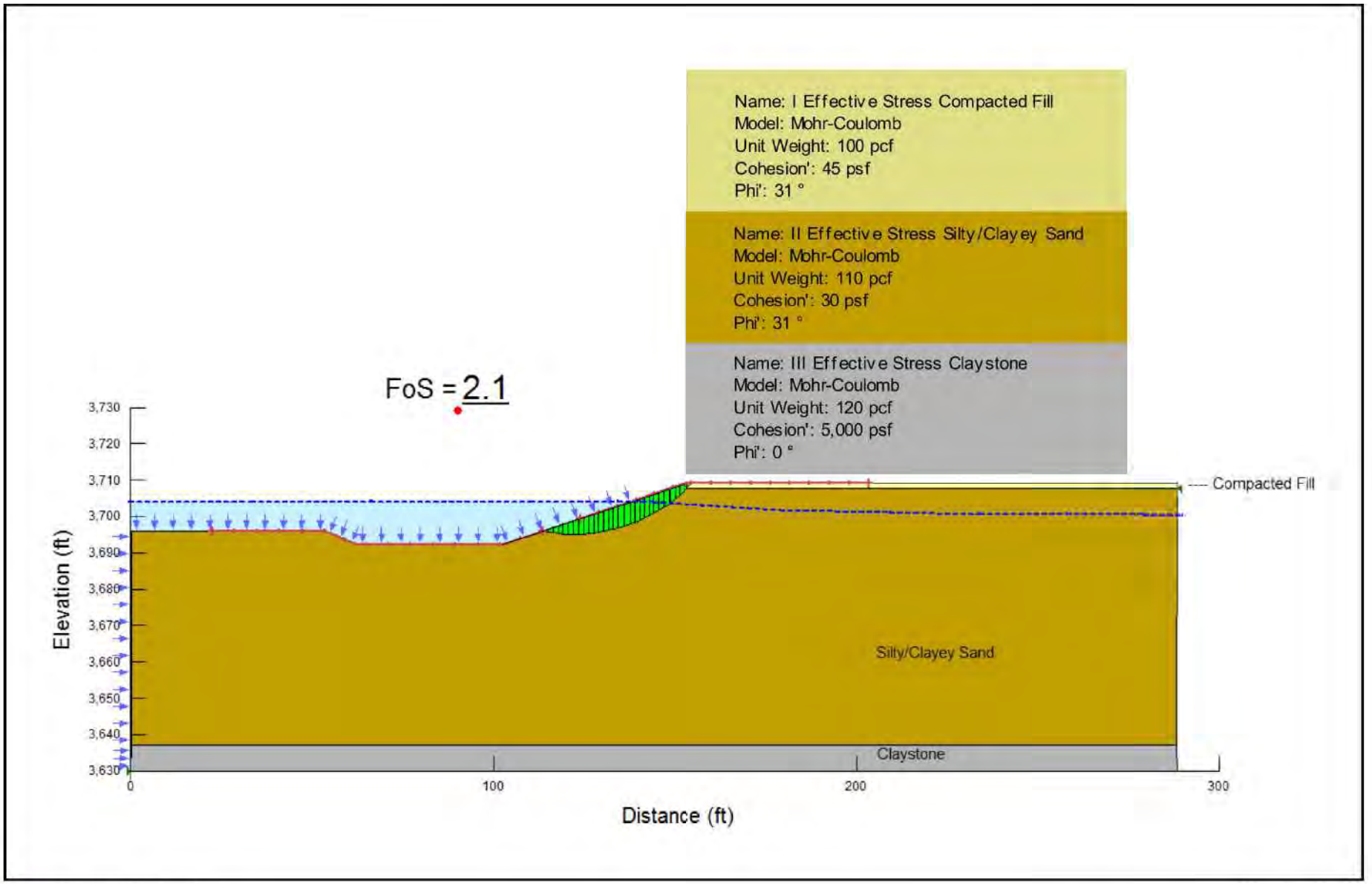
Libby Site Impoundment
Section A-A': Slope Stability Analysis
End of construction, Static, Total Stress



Project No: 212C-MD-00980

November 2017

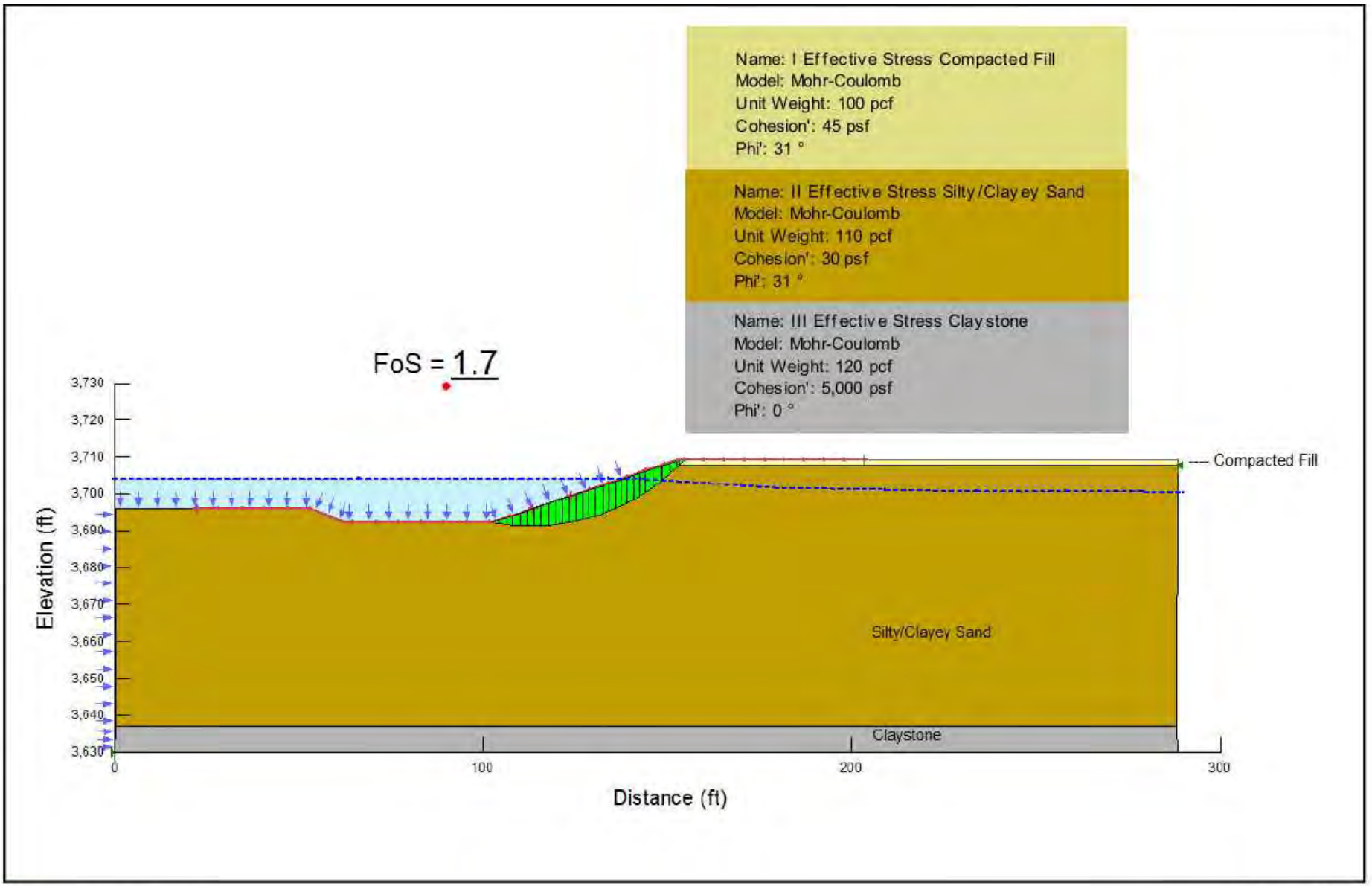
Libby Site Impoundment
Section A-A': Slope Stability Analysis
End of construction, Pseudostatic, Total Stress



Project No: 212C-MD-00980

November 2017

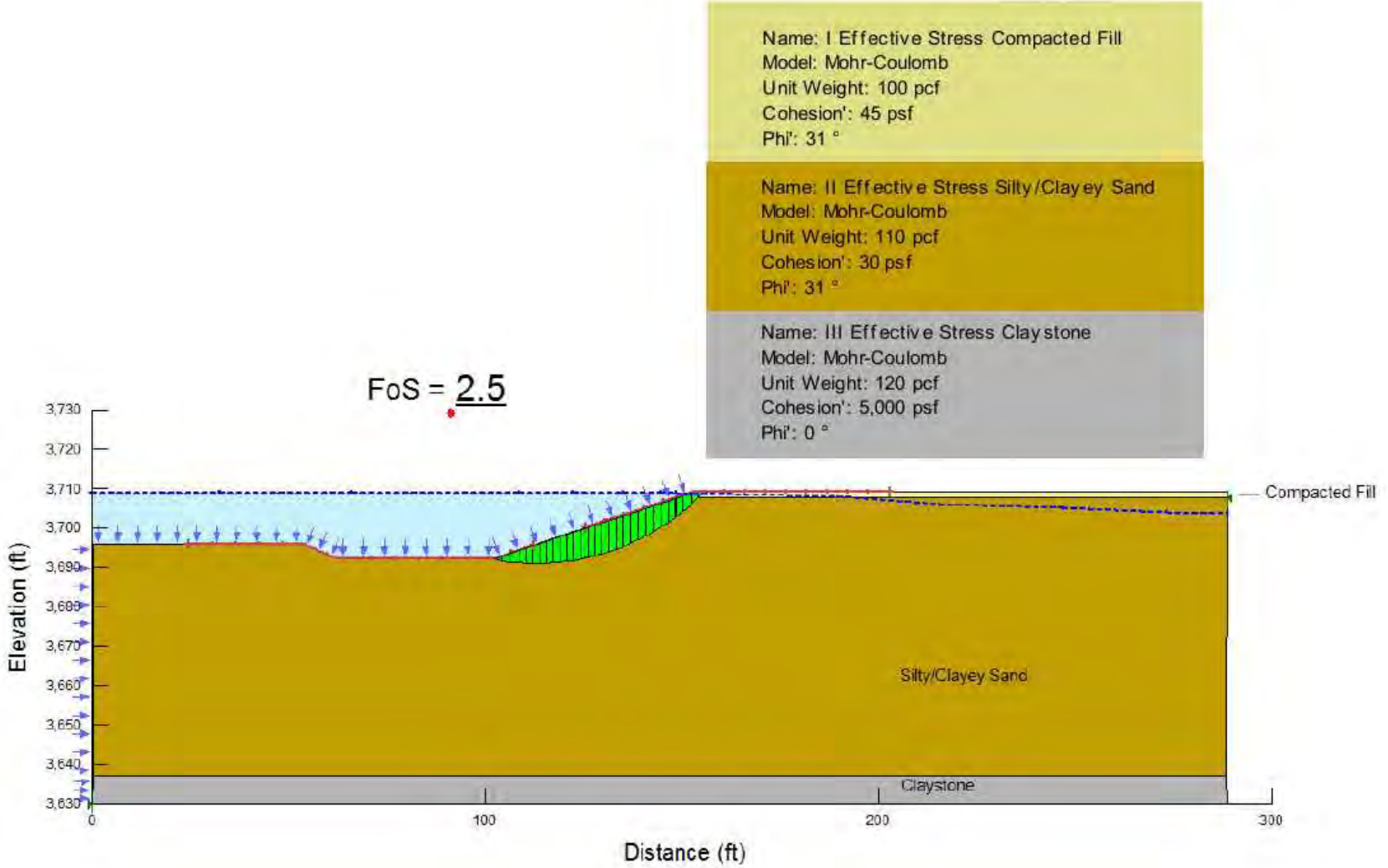
Libby Site Impoundment
Section A-A': Slope Stability Analysis
Freeboard, Static, Effective Stress



Project No: 212C-MD-00980

November 2017

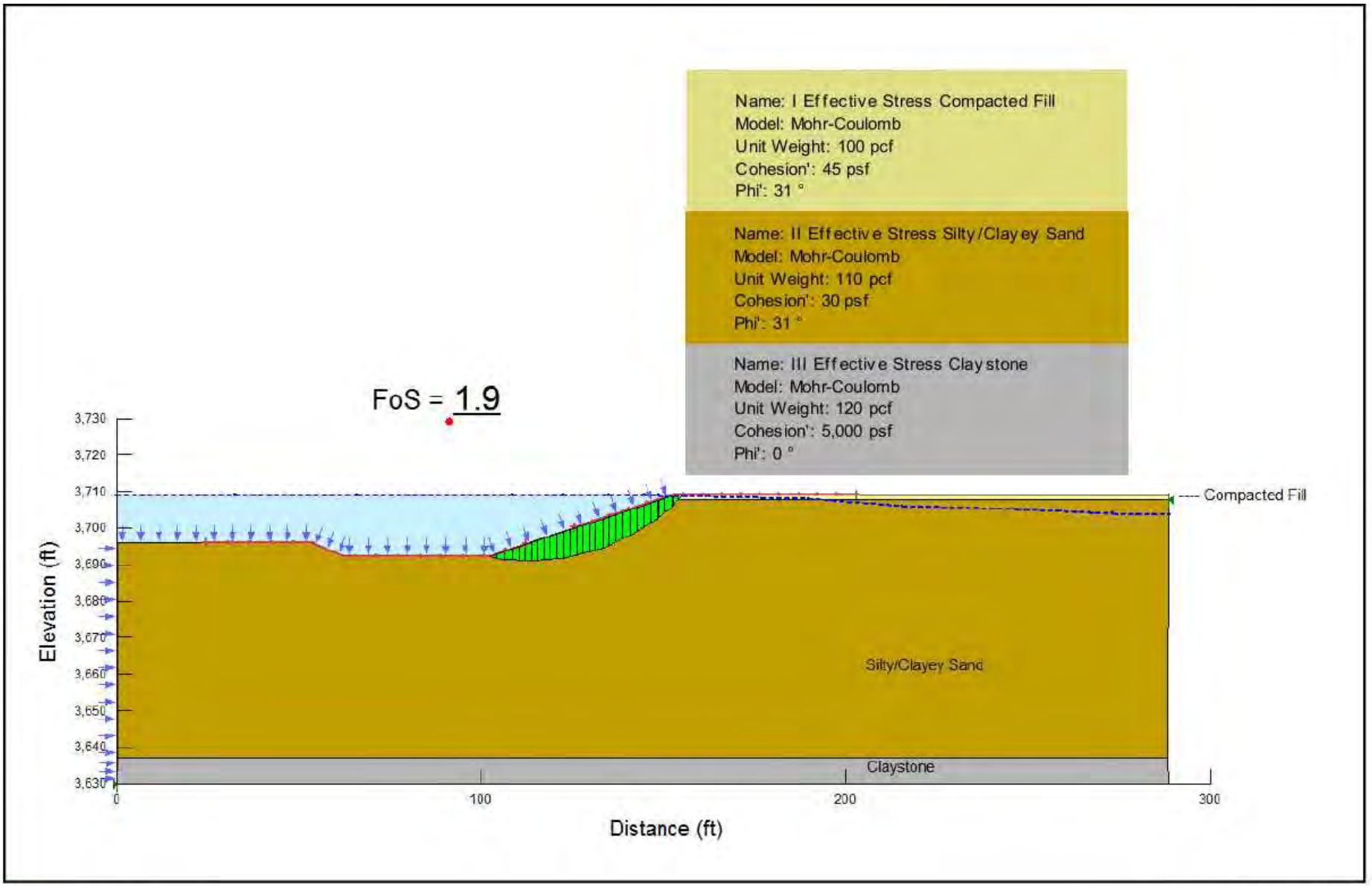
Libby Site Impoundment
Section A-A': Slope Stability Analysis
Freeboard, Pseudostatic, Effective Stress



Project No: 212C-MD-00980

November 2017

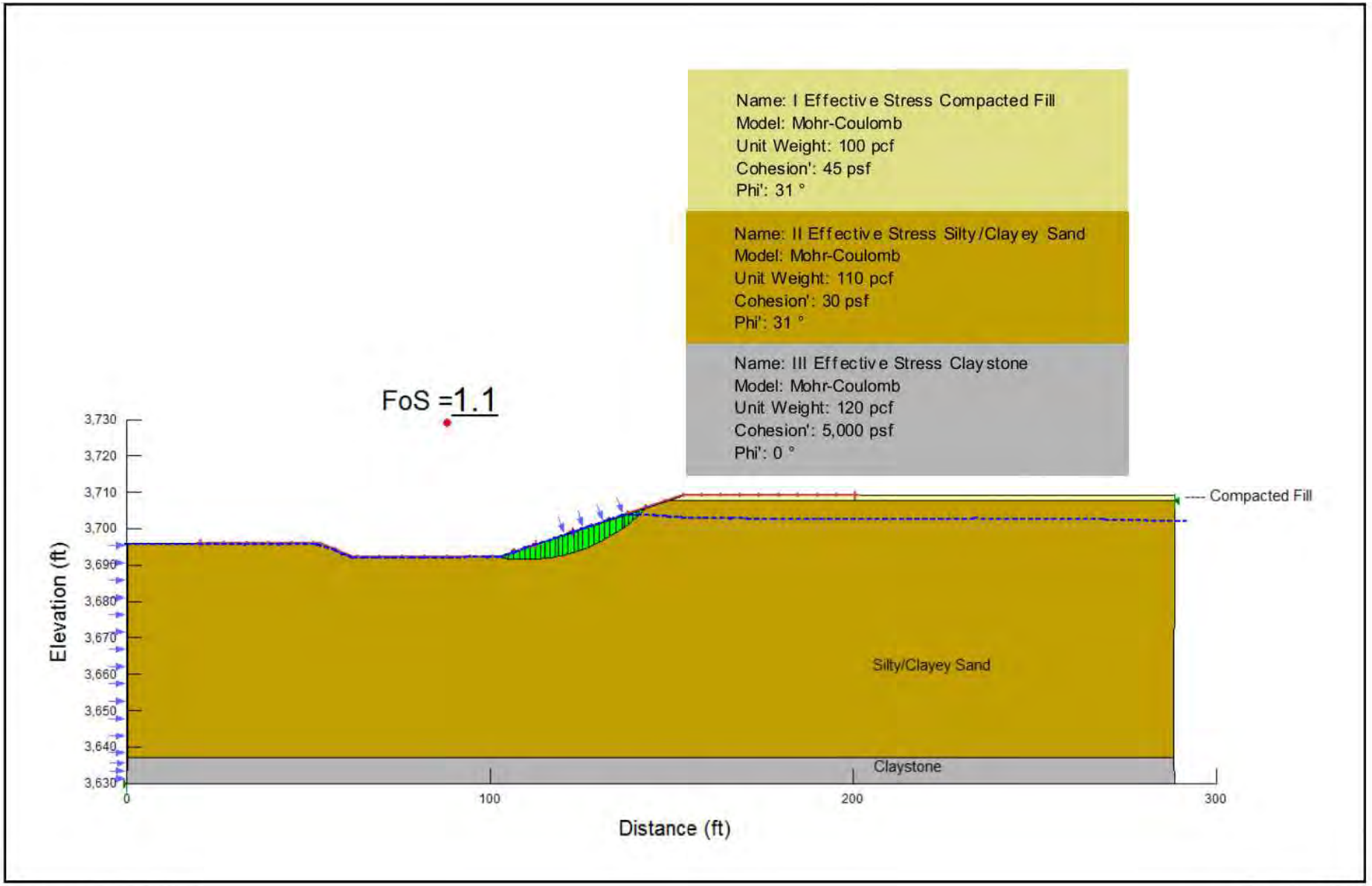
Libby Site Impoundment
Section A-A': Slope Stability Analysis
Crest, Static, Effective Stress



Project No: 212C-MD-00980

November 2017

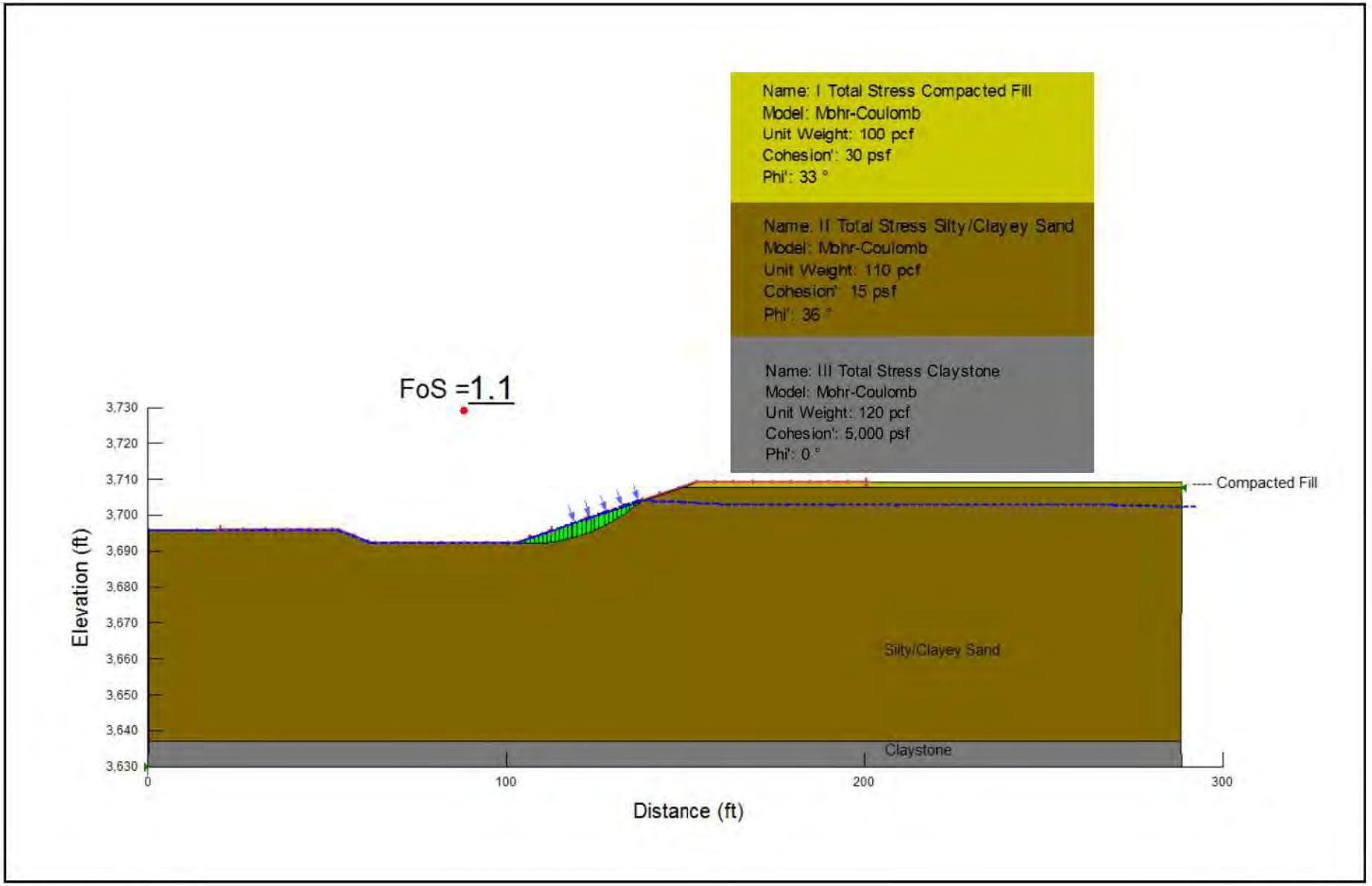
Libby Site Impoundment
Section A-A': Slope Stability Analysis
Crest, Pseudostatic, Effective Stress



Project No: 212C-MD-00980

November 2017

Libby Site Impoundment
Section A-A': Slope Stability Analysis
Rapid Drawdown, Static, Effective Stress



Project No: 212C-MD-00980

November 2017

Libby Site Impoundment
Section A-A': Slope Stability Analysis
Rapid Drawdown, Static, Total Stress

APPENDIX D – Libby Water Recycling and Containment Facility - Supporting Design and Geosynthetics Materials Documentation

PRODUCT DATA SHEET

GSE HD Smooth Geomembrane

Nominal

GSE HD is a smooth high density polyethylene (HDPE) geomembrane manufactured with the highest quality resin specifically formulated for flexible geomembranes. This product is used in applications that require excellent chemical resistance and endurance properties.

[*]

AT THE CORE:

An HDPE geomembrane used in applications that require excellent chemical resistance and endurance properties.

Product Specifications

Tested Property	Test Method	Frequency	Nominal Value					
			30 mil	40 mil	60 mil	80 mil	100 mil	120 mil
Thickness (minimum average), mil	ASTM D 5199	every roll	27	36	54	72	90	108
Density, g/cm³	ASTM D 1505	200,000 lb	0.940	0.940	0.940	0.940	0.94	0.94
Tensile Properties (each direction) Strength at Break, lb/in-width Strength at Yield, lb/in-width Elongation at Break, % Elongation at Yield, %	ASTM D 6693, Type IV Dumbbell, 2 ipm G.L. 2.0 in G.L. 1.3 in	20,000 lb	 114 63 700 12	 152 84 700 12	 228 126 700 12	 304 168 700 12	 380 210 700 12	 456 252 700 12
Tear Resistance, lb	ASTM D 1004	45,000 lb	21	28	42	56	70	84
Puncture Resistance, lb	ASTM D 4833	45,000 lb	54	72	108	144	180	216
Carbon Black Content, % (Range)	ASTM D 1603*/4218	20,000 lb	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0 - 3.0	2.0-3.0
Carbon Black Dispersion	ASTM D 5596	45,000 lb	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)	Note(1)
Notched Constant Tensile Load, hr	ASTM D 5397, Appendix	200,000 lb	500	500	500	500	500	500
Oxidative Induction Time, mins	ASTM D 3895, 200°C; O_2, 1 atm	200,000 lb	>100	>100	>100	>100	>100	>100
TYPICAL ROLL DIMENSIONS								
Roll Length(2), ft			1,240	940	630	470	370	280
Roll Width(2), ft			22.5	22.5	22.5	22.5	22.5	22.5
Roll Area, ft²			27,900	21,150	14,175	10,575	8,325	6,300

NOTES:

- (1)Dispersion only applies to mear spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.
- (2)Roll lengths and widths have a tolerance of ±l%.
- GSE HD is available in rolls weighing approximately 3,900 lb.
- All GSE geomembranes have dimensional stability of ±2% when tested according to ASTM D 1204 and LTB of <-77°C when tested according to ASTM D 746.
- *Modified.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP]

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

PRODUCT DATA SHEET

GSE HyperNet Geonet 150 - 225 mil

GSE HyperNet geonet is a synthetic drainage material manufactured from a premium grade high density polyethylene (HDPE) resin. The structure of the GSE HyperNet geonet is formed specifically to transmit fluids uniformly under a variety of field conditions. The geonet is formulated to be resistant to ultraviolet light for a period of time necessary to complete the installation.

AT THE CORE:

A synthetic geonet engineered specifically to transmit fluids consistently under a variety of field conditions.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Roll Value			
			150 mil	175 mil	200 mil	225 mil
Geonet Thickness, mil	ASTM D 5199	1/50,000 ft²	150	175	200	225
Transmissivity, gal/min/ft (m²/sec)	ASTM D 4716	1/540,000 ft²	15 (3.1×10^{-3}) [1]	20 (4.1×10^{-3}) [1]	9.6 (2×10^{-3}) [2]	12 (2.5×10^{-3}) [2]
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94	0.94
Tensile Strength (MD), lb/in	ASTM D 5035/7179	1/50,000 ft²	35	40	45	50
Carbon Black Content, %	ASTM D 4218	1/50,000 ft²	2.0	2.0	2.0	2.0
NOMINAL ROLL DIMENSIONS						
Roll Width[3], ft			14.5	15	15	15
Roll Length[3], ft			400	350	330	290
Roll Area, ft²			5,800	5,250	4,950	4,350

NOTES:

- [1]Gradient of 0.1, normal load of 1,000 psf, water at 70° F, between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [2]Gradient of 0.1, normal load of 10,000 psf, water at 70° F, between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3]Roll widths and lengths have a tolerance of ±1%

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

DURABILITY RUNS DEEP

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

PRODUCT DATA SHEET

GSE FabriNet 200 mil Geocomposite

GSE FabriNet geocomposite consists of a 200 mil thick GSE HyperNet geonet heat-laminated on one or both sides with a GSE nonwoven needle-punched geotextile. The geotextile is available in mass per unit area range of 6 oz/yd² to 16 oz/yd². The geocomposite is designed and formulated to perform drainage function under a range of anticipated site loads, gradients and boundary conditions.

AT THE CORE:

A 200 mil thick HyperNet geonet heat-laminated on one or both sides with a nonwoven needlepunched geotextile.

Product Specifications

Tested Property	Test Method	Frequency	Minimum Average Roll Value[1]		
Geocomposite			6 oz/yd²	8 oz/yd²	10 oz/yd²
Transmissivity[2], gal/min/ft, (m²/sec) ~~Double-Sided Composite~~ Single-Sided Composite	ASTM D 4716	1/540,000 ft²	 ~~0.5 (1x10⁻⁴)~~ 4.8 (1x10⁻³)	 ~~0.5 (1x10⁻⁴)~~ 4.8 (1x10⁻³)	 ~~0.4 (9x10⁻⁵)~~ 4.3 (9x10⁻⁴)
Ply Adhesion, lb/in	ASTM D 7005	1/50,000 ft²	1.0	1.0	1.0
Geonet Core[1,3] – GSE HyperNet					
Geonet Core Thickness, mil	ASTM D 5199	1/50,000 ft²	200	200	200
Transmissivity[2], gal/min/ft (m²/sec)	ASTM D 4716		9.6 (2 x 10⁻³)	9.6 (2 x 10⁻³)	9.6 (2 x 10⁻³)
Density, g/cm³	ASTM D 1505	1/50,000 ft²	0.94	0.94	0.94
Tensile Strength (MD), lb/in	ASTM D 7179	1/50,000 ft²	45	45	45
Carbon Black Content, %	ASTM D 4218	1/50,000 ft²	2.0	2.0	2.0
Geotextile[1,3]					
Mass per Unit Area, oz/yd²	ASTM D 5261	1/90,000 ft²	6	8	10
Grab Tensile Strength, lb	ASTM D 4632	1/90,000 ft²	160	220	260
Grab Elongation	ASTM D 4632	1/90,000 ft²	50%	50%	50%
CBR Puncture Strength, lb	ASTM D 6241	1/540,000 ft²	435	575	725
Trapezoidal Tear Strength, lb	ASTM D 4533	1/90,000 ft²	65	90	100
AOS, US sieve[1], (mm)	ASTM D 4751	1/540,000 ft²	70 (0.212)	80 (0.180)	100 (0.150)
Permittivity, sec⁻¹	ASTM D 4491	1/540,000 ft²	1.5	1.3	1.0
Water Flow Rate, gpm/ft²	ASTM D 4491	1/540,000 ft²	110	95	75
UV Resistance, % retained	ASTM D 4355 (after 500 hours)	per formulation	70	70	70
NOMINAL ROLL DIMENSIONS[4]					
Roll Width, ft			14.75	14.75	14.75
Roll Length, ft	Double-Sided Composite Single-Sided Composite		270 300	260 300	230 290
Roll Area, ft²	Double-Sided Composite Single-Sided Composite		3,982 4,425	3,835 4,425	3,392 4,277

NOTES:

- [1] All geotextile properties are minimum average roll values except AOS which is maximum average roll value and UV resistance is typical value. Geonet core thickness is nominal value.
- [2] Gradient of 0.1, normal load of 10,000 psf, water at 70˚F between steel plates for 15 minutes. Contact GSE for performance transmissivity value for use in design.
- [3] Component properties prior to lamination.
- [4] Roll widths and lengths have a tolerance of ±1%.

GSE is a leading manufacturer and marketer of geosynthetic lining products and services. We've built a reputation of reliability through our dedication to providing consistency of product, price and protection to our global customers.

Our commitment to innovation, our focus on quality and our industry expertise allow us the flexibility to collaborate with our clients to develop a custom, purpose-fit solution.

GSE ENVIRONMENTAL™

[DURABILITY RUNS DEEP]

For more information on this product and others, please visit us at GSEworld.com, call 800.435.2008 or contact your local sales office.

Mega Blaster PRO

Our most powerful sonic bird control system uses intermittent distress calls to create a "danger zone" that frightens infesting birds away for good.

- Two high-output amplifiers with specially-designed 20-speaker tower
- Comes with four different configurations for common bird infestations
- Customizable settings
- Covers up to 30 acres (12 hectares)

This unit is capable of sound output up to 125 decibels.
HEARING PROTECTION IS RECOMMENDED.

SKU: MEGA

CATEGORY: SONIC BIRD CONTROL (HTTPS://BIRD-X.COM/PRODUCT-CATEGORY/SONIC-BIRD-CONTROL/)

DETAILS APPLICATIONS BENEFITS ADD & COMBINE SPECS REVIEWS (1)

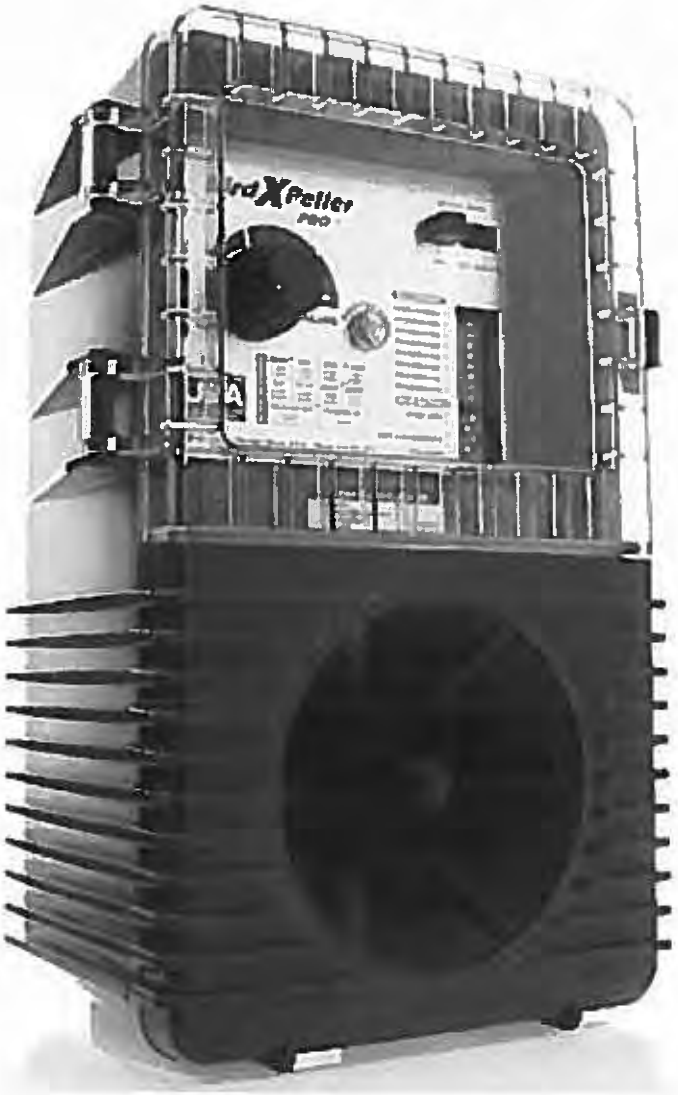
- Coverage: Up to 30 acres from single unit
- Box dimensions: Box 1: 23" x 18" x 16" (23 lbs, unit & speaker), Box 2: 32" x 24" x 5" (17 lbs, solar panel)
- Power Input: 12vDC (3 amps) via solar panel and battery
- Sound Pressure: up to 125 decibels
- Frequency: 2,000-10,000 Hz
- Compliance: UL & CE listed
- EPA Est. 075310-OR-001
- Included: Generating unit with two built-in high-output amplifiers, 20-speaker tower with audio cables, 40 watt solar panel, battery clips, & all mounting hardware.
- Proudly made in the USA

Download Mega Blaster PRO Instructions (https://bird-x.com/wp-content/uploads/Mega-Blaster-Instructions.pdf)

RELATED PRODUCTS

(https://bird-x.com/bird-products/electronic/sonic/critter-blaster-pro/)

Critter Blaster PRO (https://bird-x.com/bird-products/electronic/sonic/critter-blaster-pro/)
★★★★★
$670.00 – $690.00



(https://bird-x.com/bird-products/electronic/sonic/woodpecker-pro/)

Woodpecker PRO (https://bird-x.com/bird-products/electronic/sonic/woodpecker-pro/)
★★★★★
$280.15 – $299.95

(https://bird-x.com/bird-products/electronic/sonic/goosebuster/)

GooseBuster (https://bird-x.com/bird-products/electronic/sonic/goosebuster/)
★★★★★
$956.00 – $976.00

(https://bird-x.com/bird-products/electronic/sonic/airport-bird-control-system/)

Airport Bird Control System (https://bird-x.com/bird-products/electronic/sonic/airport-bird-control-system/)

Contact (Https://Bird-X.com/Contact/)

Customer Service (Https://Bird-X.com/Customer-Service/)

FAQs (Https://Bird-X.com/Faqs/)

Problem Solver (Https://Bird-X.com/Interactive-Problem-Solver/)

Environmental Issues (Https://Bird-X.com/Environmental-Issues/)

Blog (Https://Bird-X.com/Blog/)

Case Studies (Https://Bird-X.com/Case-Studies/)

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GSA (Https://Bird-X.com/Gsa/)

Architects (Https://Bird-X.com/Architects/)

Products For Retailers (Https://Bird-X.com/Products-For-Retailers/)

Products For PCO Installers (Https://Bird-X.com/Products-For-Pco-Installers/)

Installer Catalog (Https://Bird-X.com/Wp-Content/Uploads/Installer-Catalog-V3.0-APRIL-2017-FINAL-Print.pdf)

Full Catalog (Https://Bird-X.com/Wp-Content/Uploads/Bird-X_CATALOG_All.pdf)

Select Language Powered by Google Translate (https://translate.google.com)

APPENDIX E – Copy of NMOCD FORM C-101 for Libby Berry Fee SWD well application

District I
1625 N. French Dr., Hobbs, NM 88240
Phone: (575) 393-6161 Fax: (575) 393-0720
District II
811 S. First St., Artesia, NM 88210
Phone: (575) 748-1283 Fax: (575) 748-9720
District III
1000 Rio Brazos Road, Aztec, NM 87410
Phone: (505) 334-6178 Fax: (505) 334-6170
District IV
1220 S St. Francis Dr., Santa Fe, NM 87505
Phone: (505) 476-3460 Fax: (505) 476-3462

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

Form C-101
Revised July 18, 2013

☐ AMENDED REPORT

APPLICATION FOR PERMIT TO DRILL, RE-ENTER, DEEPEN, PLUGBACK, OR ADD A ZONE

1. Operator Name and Address	2. OGRID Number
3Bear Field Services, LLC	372603
	3. API Number

4. Property Code	5. Property Name	6. Well No.
	Libby Berry Fee SWD	#1

7. Surface Location

UL - Lot	Section	Township	Range	Lot Idn	Feet from	N/S Line	Feet From	E/W Line	County
	26	20S	34E		2507	FNL	709	FEL	Lea20S

8. Proposed Bottom Hole Location

UL - Lot	Section	Township	Range	Lot Idn	Feet from	N/S Line	Feet From	E/W Line	County
	26	20S	34E		2507	FNL	709	FEL	Lea

9. Pool Information

Pool Name	Pool Code
SWD; Miss-Devonian	

Additional Well Information

11. Work Type	12. Well Type	13. Cable/Rotary	14. Lease Type	15. Ground Level Elevation
N	S	R	P	3620
16. Multiple	**17. Proposed Depth**	**18. Formation**	**19. Contractor**	**20. Spud Date**
Yes	14,600	Miss-Devonian	Silver Oak Drilling	December 15, 2017

Depth to Ground water	Distance from nearest fresh water well	Distance to nearest surface water

☐ **We will be using a closed-loop system in lieu of lined pits**

21. Proposed Casing and Cement Program

Type	Hole Size	Casing Size	Casing Weight/ft	Setting Depth	Sacks of Cement	Estimated TOC
Please see attached Addendum to Drilling Permit						

Casing/Cement Program: Additional Comments

Please see attached Addendum to Drilling Permit

22. Proposed Blowout Prevention Program

Type	Working Pressure	Test Pressure	Manufacturer
Please see attached Addendum to Driling Permit			

23. I hereby certify that the information given above is true and complete to the best of my knowledge and belief. **I further certify that I have complied with 19.15.14.9 (A) NMAC ☐ and/or 19.15.14.9 (B) NMAC ☐, if applicable.** Signature: Sample waiting on legal description	OIL CONSERVATION DIVISION
	Approved By:
Printed name: Rory McMinn	Title:
Title: Advisor	Approved Date: / Expiration Date:
E-mail Address: rory@rmcminn.com	
Date: November 13, 2017 Phone: 575/626-7100	Conditions of Approval Attached

ADDENDUM
to
APPLICATION TO DRILL
Libby Berry Fee SWD #1
3Bear Field Services, LLC
Unit Letter , Section 26
T20S, R34E, N.M.P.M Survey
Lea County, NM

This attachment is a continuation of responses to the questions asked within the NM OCD Form C-101 Application to Drill.

1. Location: SHL 2507 FNL & 709 FEL
   BHL 2507 FNL & 709 FEL

2. Elevation above Sea Level at Ground Reference: 3660'

3. Geologic name of surface formation: Quaternary Alluvium Deposits

4. Drilling tools and associated equipment: Conventional rotary drilling rig utilizing a managed fluid as the circulating medium for well control and for solids removal.

5. Proposed drilling depth: MD 14600' TVD 14600'

6. Estimated tops of geological markers:

   0' to 140' Surface Red Bed, Red Sandstone, Conglomerates & FW Sands
   140'-399' Rustler-Anhydrite
   399'-1897' Salado-Salt, Anhydrite, Dolomite stringers @ base Sand stringers & Limestone
   1897'-1941' Lamar-Limestone
   1941'-5458' Delaware section-Bell (Sand & Limestone stringers), Cherry & Brushy (Sand)
   5458'-8611' Bone Spring section-BS (Limestone), 1st through 3rd (Limestone & Sand stringers)
   8611'-10977' Wolfcamp-Limestone and Sand stringers
   10977'-11185' Strawn-Limestone, Sand & possible shale
   11185'-12481' Atoka/Morrow-Limestone, Shale & Sand
   12481'-13299' Mississippian-Limestone, Shale Stringers
   13299'-14600' Devonian-Cherty Limestone

7. Potential mineral bearing formations:
   Yates, Seven Rivers, Queen, Glorieta, Yeso, Penn, Morrow – Oil

8. Proposed Mud Circulating System:

Depth	Type Mud	Mud Weight	Mud Viscosity	pH	Cl-ppm	% Soilds
0-300	SPUD	8.4-9.7	32-38	10.0	1-6K	3%-8%
300-1950	BRINE	10.0	28.0	10.0	186K	.75%-1.0%
1,950-8,000	CB	9.3-9.4	28.0	10.0	120-160K	.5%-.75%
8,000-8,400	CB	9.3-9.6	28.0	10.0	120-160K	.75%-1.0%
8,400-10,850	BR/POLY	10.0-10.5	38-45	10.0	186K	3.0%-6.0%
10,850-13,350	BR/POLY	10.5-12.0	40-50	10.0	186K	5.0%-7.0%
13,350-14,600	CB	8.9-9.0	28.0	10.0	3-6K	.5%-.75%

Sufficient mud materials will be kept on location at all times in order to combat lost circulation or pressure. Mud viscosity and water loss may be adjusted from the above referenced table in order to run open-hole logs and casing.

9. Casing and Cementing Program:

DRILLING:							
Description	Process	Bottom of Pipe	Size of Drill Hole	Size of Pipe	Weight per Foot	API Grade	Thread Type
Conductor	Spud well	300	26	20	94	H-40	Buttress
Surface	Intermediate	1950	17-1/2	13-3/8	54.5	J-55	8rd ST&C
Production	Production	8400	12.25	9.625	43.5	HCL-80	8rd LT&C
Production	Production Liner	13350	8.75	7	29	HCP-110	8rd LT&C
COMPLETION:							
Disposal	Tubing	13300		4 1/2	12.75	P-110	CS Hydrill/PH6 W/Teflon Ring

10. Cementing:

CEMENT PROGRAM:						
Description	Bottom of Pipe	Size of Drill Hole	Size of Pipe	Cement Type & Additives	Cement Volume	Top of Cement
Conductor	300	26	20	Class C w/2% KCL	675 Sacks	Surface
Surface	1950	17-1/2	13-3/8	LEAD: Class C w/2% KCL + Celloflake+Bentonite Extender	900 Sacks	Surface
				TAIL: Class C w/1% PF1 Calcium	200 Sacks	Surface
Production	8400	12.25	9 5/8	LEAD: 50/50 P/H _ 5% BWOW & Salt + 10% Bentonite Gel + Celloflake	1400 Sacks	Surface
				TAIL: Class 50/50 P/H + 2% PF20 Gel + 3% Fluid Loss	300 Sacks	Surface
Production	13350	8.75	7	Class H 50/50 +2% Bentonite Gel + 5% Fluid Loss	940 Sacks	Top of Liner

According to Rancher, Danny Berry-former owner of site, very low volume potable groundwater can be found at 100' to 200' from surface. The closest producing water well is ¾ mile to 1 mile to the southeast of well site. This well produces from 1200' from surface.

11. Pressure Control Equipment;

Exhibit E. A 13-3/8" 5000 PSI working pressure BOP system tested to 3000 PSI consisting of one set of blind rams and on set of pipe rams and a 5000 PSI annular preventer. A choke manifold and 120 gallon accumulator with floor and remote operating stations and auxiliary power system. Rotating head as needed. A Kelly cock will be installed and maintained in operable condition and a drill string safety valve in the open position will be available on the rig floor. Mud gas separator will be available if drilling into H2S areas.

BOP unit will be hydraulically operated. BOP will be nippled up and operated at least once per day while drilling and the blind rams will be operated when out of the hole during trips. No abnormal pressure or temperature is anticipated. From the base of the 13-3/8"casing through the running of the production liner, the well will be equipped with a 5000 PSI BOP system tested to 3000 PSI.

BOPS will be tested by an independent service company to 250 PSI low and 3000 PSI high. Schaffer will be tested to 250 PSI low and 1500 PSI high.

Libby Berry Fee SWD #1 Op
3Bear Field Services, LLC
Berry Plant Site
SWD
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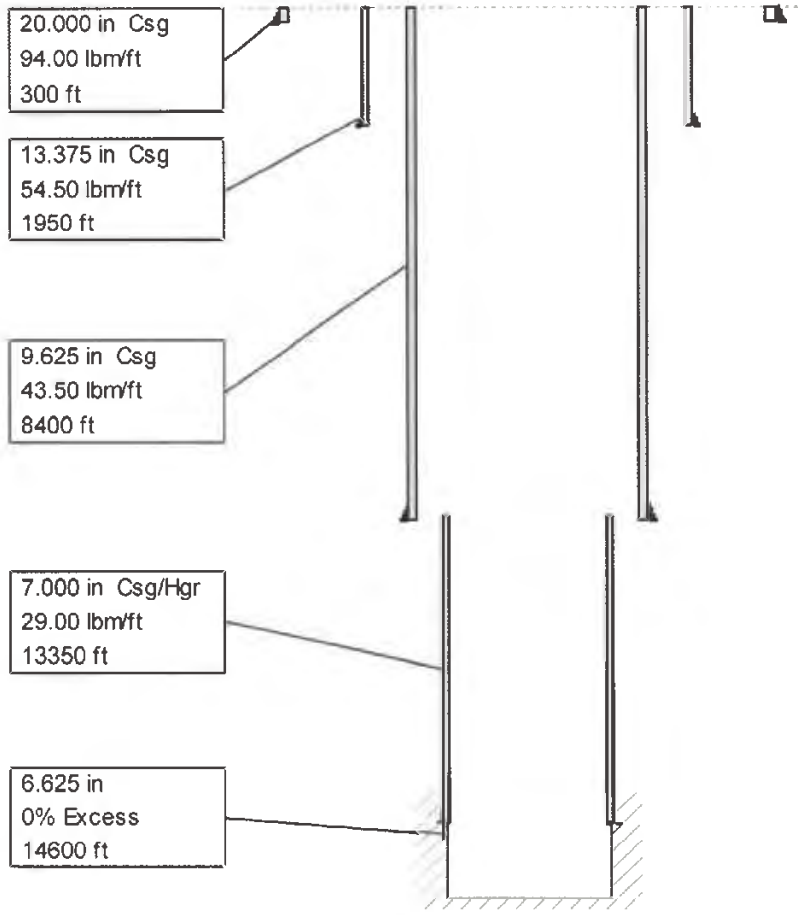
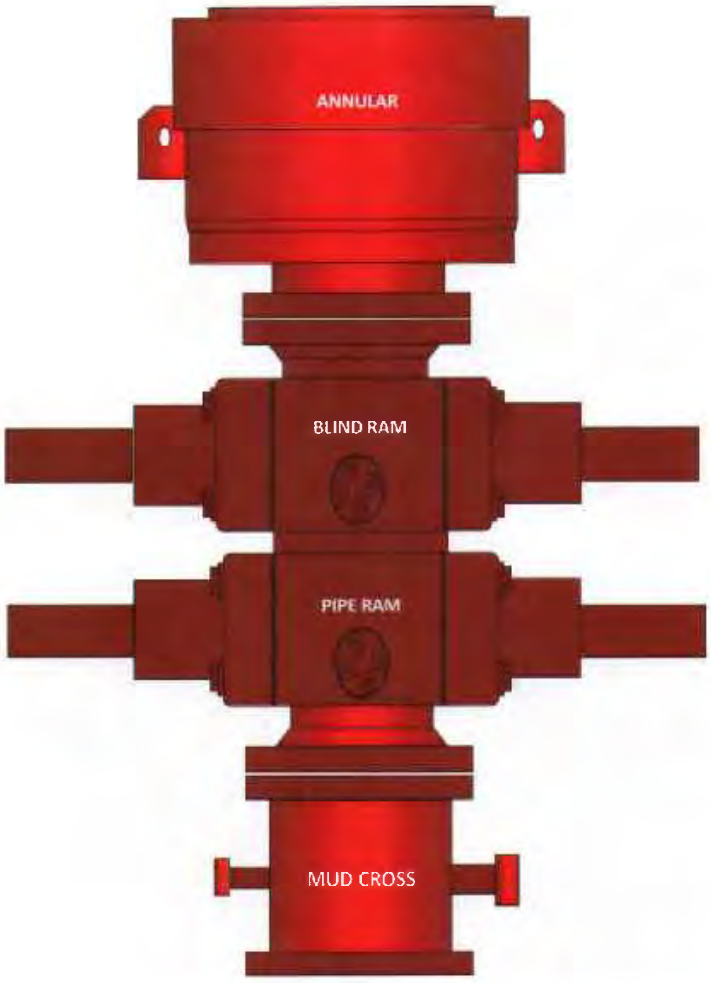


5M BOPE SCHEMATIC

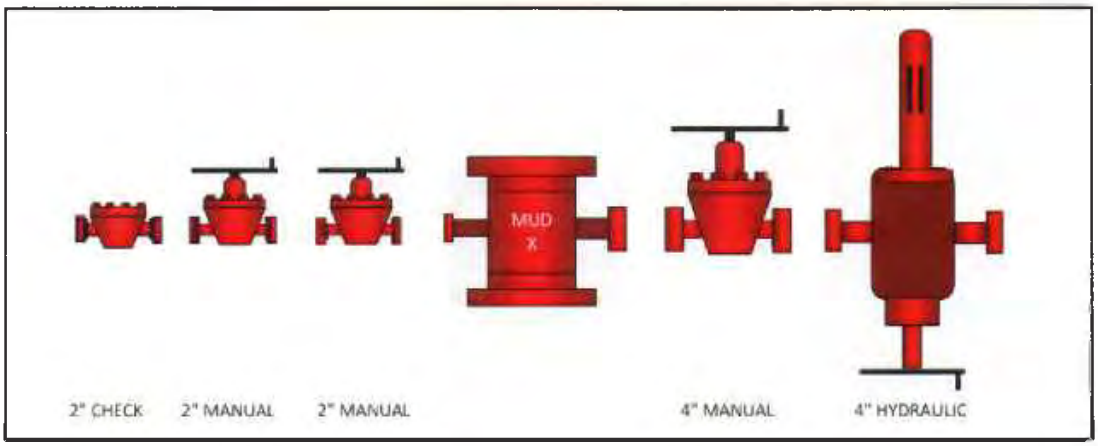
RIG #1



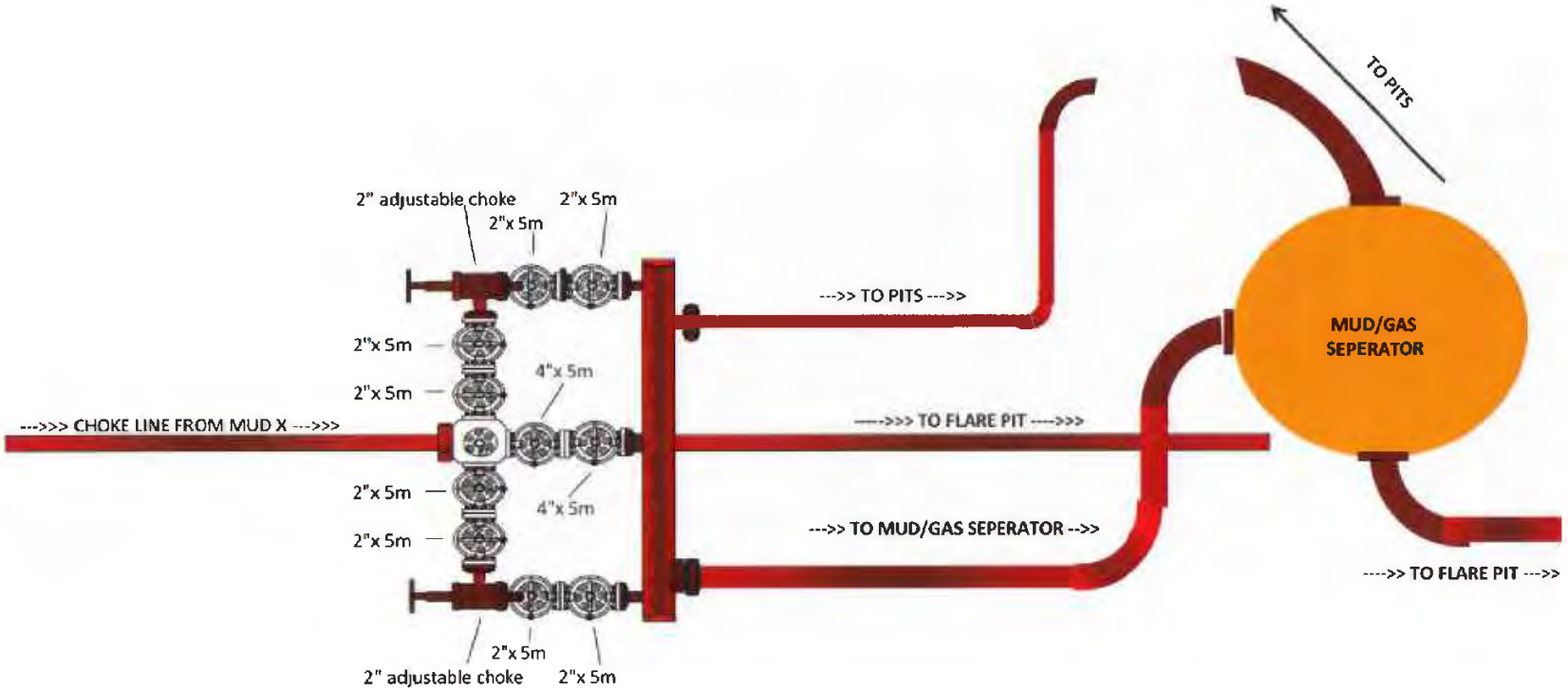
ANNULAR
STYLE: SHAFFER
BORE: 13 5/8" **PRESSURE:** 5,000
HEIGHT: 45 1/2" **WEIGHT:** 13,650

DOUBLE RAM
STYLE: SHAFFER LWS
BORE: 13 5/8" **PRESSURE:** 5,000
RAMS: TOP: BLIND BTM: 4 1/2" PIPE
HEIGHT: 50 1/2" **WEIGHT:** 13,800

MUD CROSS
LENGTH: 24"
OUTLETS: 2" x 5M 4" x 5M
FLANGES: 13 5/8" 5M **X** 13 5/8" 5M



5M CHOKE MANIFOLD ARRANGEMENT



HYDROGEN SULFIDE DRILLING OPERATIONS PLAN
Libby Berry Fee SWD #1
Unit , Section 26
T20S, R34E, Lea County, NM

1. All personnel admitted to drilling location must be H2S certified:
   All Company and Contract personnel admitted on location must be trained by a qualified H2S instructor to the following:
   A. Characteristics of H2S
   B. Physical effects and hazards
   C. Proper use of safety equipment and life support systems
   D. Principle and operation of H2S detectors, warning system and briefing areas
   E. Evacuation procedure, routes and first aid
   F. Proper use of 30 minute pressure demand pack

2. H2S Detection and Alarm Systems:
   A. H2S detectors and audio alarm system to be located at bell nipple, end of flowline (mud pit) and on derrick floor or doghouse.

3. Windsocks and wind streamers:
   A. Windsock at mud pit should be high enough to be readily visible
   B. Windsock at briefing area should be high enough to be readily visible

4. Condition Flags and Signs:
   A. Warning signs on access road to location
   B. Flags to be displayed on sign at entrance to location.
      a. Green flag indicates normal safe condition.
      b. Yellow flag indicates potential pressure and danger.
      c. Red flag indicates danger (H2S present in dangerous concentration). Only emergency personnel admitted to location
5. Well control equipment:
   A. See Exhibit E

6. Communication:
   A. While working under masks, chalkboards will be used for communication
   B. Hand signals will be used where chalkboard is inappropriate
   C. Two way radio will be used to communicate off location in case emergency help is required. In most cases cellular telephones will be available at drilling foreman's trailer or living quarters.

7. Drillstem Testing:
   A. No DST's nor cores are planned for this drilling program

8. Metallurgical effect of H2S:
   A. Drilling contractor shall be required to be familiar with the effects of H2S on tubular goods and other mechanical equipment

9. Mud system changes to control H2S:
   A. Should H2S be encountered, the mud system will be altered as necessary to maintain control of the formation. A mud gas separator will be placed in service along with H2S

scavengers as needed.

Emergency Procedures

In the event of a release of gas containing H2S, the first responders must:

- Isolate the area and prevent entry by other persons into the area;
- Evacuate any public places encompassed by the release area;
- Be equipped with H2S monitors and air packs in order to control the release;
- Use the "buddy system" to ensure that no injuries occur during the response;
- Take precautions to avoid personal injury during this operation;
- Contact operator and/or local officials to aid in the operation – a list of safety contact numbers is attached;
- Have received training in the:
  Detection of H2S, and
  Become trained in the measures for protection against the gas, and
  Become trained in the use of the equipment used for protection and emergency response.

Ignition of the Gas Source

Should control of the well deteriorate or be considered lost and ignition is a possibility or is being considered, take care to protect against exposure to Sulphur Dioxide (SO2). Intentional ignition must be coordinated with the NMOCD, the operator, and both the State and Local officials. Once the State Police become involved, they shall be the Incident Command on scene. Take care to protect downwind during the release and during the ignition phase.

Characteristics of H2s and SO2

Common Name	Chemical Formula	Specific Gravity	Threshold Limit	Hazardous Limit	Lethal Concentration
Hydrogen Sulfide	H2S	1.189 Air=1	10 ppm	100 ppm/hr	600 ppm
Sulphur Dioxide	SO2	2.21 Air=1	2 ppm	N/A	1000 ppm

H2S Contingency Plan and Emergency Contacts

Libby Berry Fee SWD #1

3Bear Field Service, LLC

Unit , Section 26, T20S, R34E

Company Office:		Office	Direct	Mobile
3Bear Energy, LLC		303/626-8290		
Key Personnel				
Name	Title	Office	Direct	Mobile
Scott Spicher	VP/CEO	303/626-8290	303/862-3962	720/202-2824
Mike Solomon	VP/COO	303/626-8290	303/862-3960	303/921-9117
Rory McMinn	Advisor			575/626-7100
Eunice, NM				
Ambulance		911		
State Police				
City Police				
Sheriff's Office				
Fire Department				
Local Emergency Planning				
Hobbs, NM				
Ambulance		911		
State Police				
City Police				
Sheriff's Office				
Fire Department				
Local Emergency Planning				
New Mexico Oil Conservation Division				
Carlsbad, NM				
Ambulance		911		
State Police		575/885-3137		
City Police		575/885-2111		
Sheriff's Office		575/887-7551		
Fire Department		575/887-3798		
Local Emergency Planning		575/887-6544		
Santa Fe, NM				
New Mexico Emergency Response Commission		505/476-9600		
New Mexico Emergency Response Commission 24 hrs		505/827-9126		
New Mexico Emergency Operations Center		505/476-9635		
National				
National Emergency Response Center, Wash, DC		800/424-8802		
Medical				
Flight for Life - 4000 24th St., Lubbock, TX		806/743-9911		
Aerocare - R3, Box 49C, Lubbock, TX		806/747-8923		
Med Flight Air Amb - 2301 Yale Blvd. SE #D3, Albuquerque, NM		505-842-4433		
SB Air Med Service - 2505 Clark Carr Loop S.E., Albuquerque, NM		505/842-4949		
Other				
Boots & Coots IWC		800/256-9688		
Elite Well Service				
Cudd Pressure Control		432/699-0139		
Halliburton		575/746-2757		