

NOTES:

1. INSTALLER TO SIGN SUBGRADE ACCEPTANCE FORM (PROVIDED BY OWNER REPRESENTATIVE) DAILY PRIOR TO INSTALLATION.
2. CONTRACTOR TO PROVIDE SUBMITTAL OF LINER PANEL LAYOUT.
3. A 3" DIAMETER MINIMUM PIECE OF 40 MIL LINER SHALL BE EXTRUDED WELDED WHERE THE PIE SHAPED CORNER SECTIONS MEET FOR SEAM REINFORCEMENT.
4. INSTALL A FULL DOUBLE WITH SECTION OF BLACK 60 MIL TEXTURED HOPE GEOTEXTILE OVER THE SEAM. THE SEAM SHALL BE REINFORCED WITH A 3" DIAMETER MINIMUM PIECE OF 40 MIL LINER. THE SEAM SHALL BE REINFORCED WITH A 3" DIAMETER MINIMUM PIECE OF 40 MIL LINER. THE SEAM SHALL BE REINFORCED WITH A 3" DIAMETER MINIMUM PIECE OF 40 MIL LINER.
5. CONTRACTOR SHALL PLACE SANDBAGS ON LINER DURING INSTALLATION AS REQUIRED TO PREVENT PNEUMATIC PUMP FROM PULLING LINER OFF OF SUBGRADE.
6. CONTRACTOR SHALL PLACE SANDBAGS ON LINER DURING INSTALLATION AS REQUIRED TO PREVENT PNEUMATIC PUMP FROM PULLING LINER OFF OF SUBGRADE.
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13. CONTRACTOR SHALL PLACE SANDBAGS ON LINER DURING INSTALLATION AS REQUIRED TO PREVENT PNEUMATIC PUMP FROM PULLING LINER OFF OF SUBGRADE.
14. CONTRACTOR SHALL PLACE SANDBAGS ON LINER DURING INSTALLATION AS REQUIRED TO PREVENT PNEUMATIC PUMP FROM PULLING LINER OFF OF SUBGRADE.

PROJECT NO. 5000-218002  
FILE NAME: C00451PL.DWG  
SHEET NO. C-4

PROPOSED LINER PANEL LAYOUT  
1,000,000 BBL RECYCLING CONTAINMENT  
BORCO, LP  
MIDLAND TEXAS  
PLU CENTRAL 2

DESIGNED BY: J. MOORE  
DRAWN BY: M. WANNING  
CHECKED BY: M. WANNING  
APPROVED BY: M. WANNING  
DATE: AUGUST 2013

REVISIONS  
REV. DATE DRAWN CHKD  
1. 08/13/13 M. WANNING M. WANNING

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SEALANT SHALL BE THE SAME ORIENTATION FOR BOTH LAYERS. GEOMETRIC SEAMS SHALL BE ORIENTED PERPENDICULAR TO THE LINER SEAMS.

SEE NOTE 4

SEE NOTE 5

SEE NOTE 6

SEE NOTE 7

SEE NOTE 8

SEE NOTE 9

SEE NOTE 10

SEE NOTE 11

SEE NOTE 12

SEE NOTE 13

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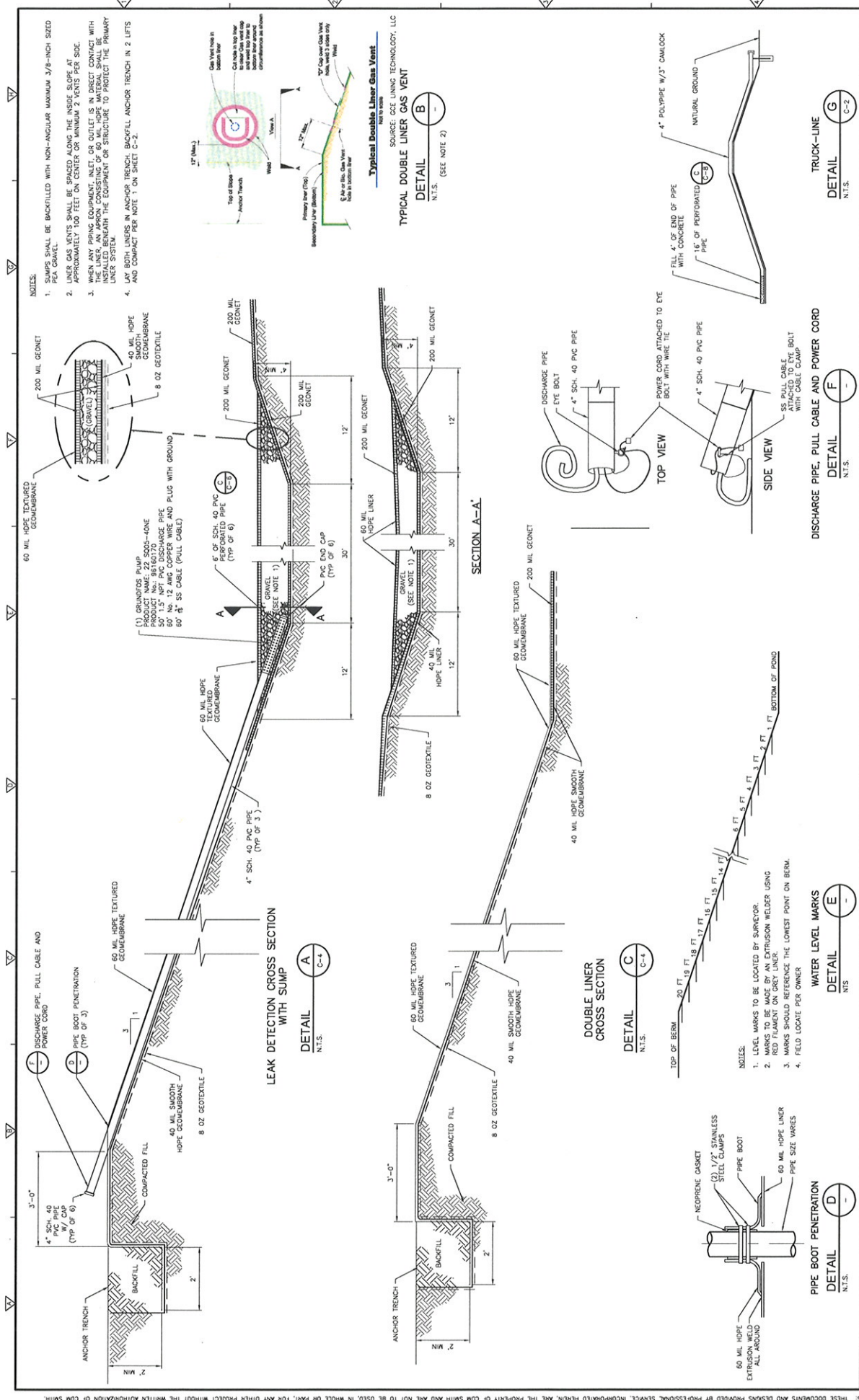
SEE NOTE 97

SEE NOTE 98

SEE NOTE 99

SEE NOTE 100

PRELIMINARY DRAWINGS - NOT FOR CONSTRUCTION



NOTES:  
1. RUMPS SHALL BE BACKFILLED WITH NON-ANGULAR MAXIMUM 3/8-INCH SIZED  
2. LINER GAS VENTS SHALL BE SPACED ALONG THE INSIDE SLOPE AT  
APPROXIMATELY 100 FEET ON CENTER ON MINIMUM 2 VENTS PER SLOPE  
3. WHEN ANY PUMPING EQUIPMENT INLET OR OUTLET IS IN DIRECT CONTACT WITH  
THE LINER, AN APPROXIMATELY 60 MIL HDPE MATERIAL SHALL BE  
INSTALLED BENEATH THE EQUIPMENT OR STRUCTURE TO PROTECT THE PRIMARY  
LINER SYSTEM.  
4. LINER SYSTEMS SHALL BE ANCHORED TO THE TRENCH BACKFILL ANCHOR TRENCH IN 2 LIFTS  
AND COMPACT PER NOTE 1 ON SHEET C-2.

ANCHOR TRENCH  
BACKFILL  
2' MIN  
2' MIN  
3'-0"  
4" SCH. 40  
W/ CUP  
(TYP OF 6)  
DISCHARGE PIPE, PULL CABLE AND  
POWER CORD  
PIPE BOOT PENETRATION  
(TYP OF 3)  
60 MIL HOPE TEXTURED  
GEOMEMBRANE  
40 MIL SMOOTH  
HOPE GEOMEMBRANE  
8 OZ GEOTEXTILE  
COMPACTED FILL  
2' MIN  
2' MIN  
3'-0"  
ANCHOR TRENCH  
BACKFILL  
2' MIN  
2' MIN  
3'-0"  
4" SCH. 40  
W/ CUP  
(TYP OF 6)  
DISCHARGE PIPE, PULL CABLE AND  
POWER CORD  
PIPE BOOT PENETRATION  
(TYP OF 3)  
60 MIL HOPE TEXTURED  
GEOMEMBRANE  
40 MIL SMOOTH  
HOPE GEOMEMBRANE  
8 OZ GEOTEXTILE  
COMPACTED FILL  
2' MIN  
2' MIN  
3'-0"

PROJECT NO. 5000-218602  
FILE NAME: C0050107.DWG  
SHEET NO. C-5

DOUBLE LINER AND LEAK  
DETECTION DETAILS

1,000,000 BBL RECYCLING CONTAINMENT  
PLU CENTRAL 2  
BOPCO, LP  
MIDLAND, TEXAS

PRELIMINARY DRAWINGS - NOT FOR CONSTRUCTION

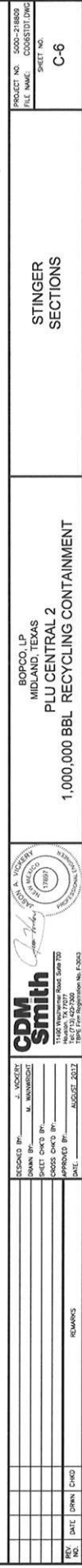
DESIGNED BY: J. JOHNSON  
DRAWN BY: M. MINNEMANN  
CHECKED BY: J. JOHNSON  
DATE: AUGUST 2017

CDM  
Smith

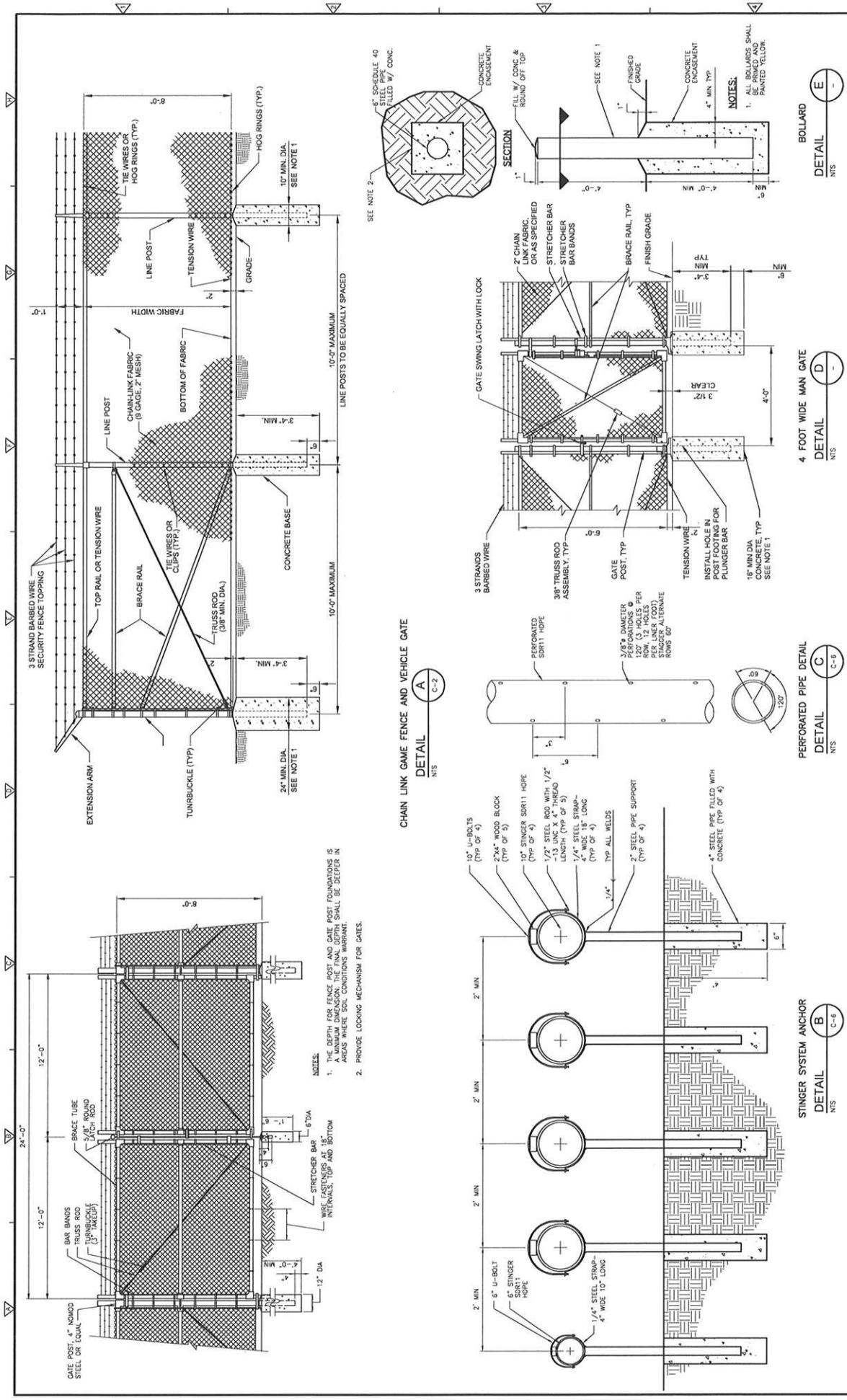
11000 Westview Road, Suite 700  
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REMARKS

NO. DATE DRAWN CHECK



PRELIMINARY DRAWINGS - NOT FOR CONSTRUCTION



PROJECT NO. 5000-218009 FILE NAME: C:\00PST\DWG SHEET NO. C-7		STINGER AND FENCING DETAILS	
BOPCO, LP MIDLAND, TEXAS PLU CENTRAL 2 1,000,000 BBL RECYCLING CONTAINMENT		PRELIMINARY DRAWINGS - NOT FOR CONSTRUCTION	
DESIGNED BY: J. VICKERT DRAWN BY: M. WANNING SHEET CHECK BY: M. WANNING CHECKED BY: M. WANNING DATE: AUGUST 2017		CDM Smith 1500 Westwood Road, Suite 700 Fort Worth, Texas 76104 Tel: 817.432.2500 Email: csm@cdm.com	
REV	DATE	DESCRIPTION	REMARKS



# Appendix H

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## Specifications

**SECTION 02100**  
**SITE PREPARATION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

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

**1.2 DEFINITIONS**

- A. Clearing: Clearing shall consist of removal of all vegetation and the satisfactory disposal of brush, rubbish, and any other vegetation.
- B. Grubbing: Grubbing shall consist of the removal and disposal of roots, root mats, stumps, logs, peat, and other objectionable matter which could adversely affect the quality of the subgrade or borrow materials.
- C. Topsoil: Topsoil is the upper soil horizon which is characterized by a significant organic content.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION**

**3.1 AREAS TO BE CLEARED AND GRUBBED**

- A. Perform clearing and grubbing only in areas identified by the ENGINEER OR OWNER. Clear and grub all areas where WORK is to take place.
- B. Clear and grub all borrow areas to the extent necessary to provide fill materials free of all objectionable matter described above.
- C. Vegetation located outside the construction limits shall not be damaged.

**3.2 DISPOSAL OF CLEARED AND GRUBBED MATERIALS**

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

### **3.3 EXCAVATING, STOCKPILING, AND WASTING TOPSOIL**

- A. If present, excavate topsoil from areas designated for project grading or construction, as encountered. In addition, excavate topsoil from areas designated for use as waste locations for earth subsoil material.
- B. Remove lumped soil, vegetative material, boulders, and rocks from the excavated topsoil to be stockpiled.
- C. Stockpile, if available, sufficient topsoil material on-site for use as vegetative cover for future reclamation purposes. Protect stockpile from erosion and grade to prevent ponding of water. Organic soils shall be segregated from soil materials that may be suitable for other uses described in these SPECIFICATIONS and shown on the DRAWINGS.
- D. Dispose of excess topsoil and waste topsoil not intended for reuse in a location selected by the OWNER. Disposal and handling of this material shall be performed following the requirements of the appropriate government agencies.

END OF SECTION 02100

**SECTION 02200**  
**EXCAVATION, BACKFILL AND COMPACTION**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The section describes the following:
  - 1. All excavation required to reach planned grades and contours, install project components, and to construct temporary run-on and run-off conveyance systems.
  - 2. Placement of various fill materials:
    - a. Compacted embankment fill
    - b. Drainage Aggregate (Drain Rock)
  - 3. Material placement and compaction
  - 4. Site grading
  - 5. Foundation preparation
  - 6. Construction of fills and backfills
  - 7. Compaction requirements
  - 8. Site grading
- B. The WORK shall be done in accordance with the SPECIFICATIONS and as shown on the DRAWINGS.
- C. The WORK includes furnishing all labor, tools, materials, equipment, and supervision necessary to construct the project as described in the contract documents.

**1.2 TOLERANCES**

- A. All excavations shall be constructed within the tolerance as shown in these SPECIFICATIONS except where dimensions or grades are shown or specified as minimum or maximum in the DRAWINGS. All grading shall be performed to maintain slopes and drainages as shown in the DRAWINGS.
- B. Excavate to within a horizontal and vertical tolerance of  $\pm 0.1$  -foot on all slopes flatter than 10% and within a vertical tolerance of  $\pm 0.2$  -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  $\pm 0.1$  -ft, regardless of the steepness of the slope.

**1.3 SUBSURFACE CONDITIONS**

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



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

#### **1.4 SUBMITTALS**

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

#### **1.5 REFERENCES**

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

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

1. ASTM D422 – Standard Test Method for Particle Size Analysis of Soils.
2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kN-m/m<sup>3</sup>)).
3. ASTM D854 – Standard for Test Method for Specific Gravity of Soil Solids by Water Pycnometer.
4. ASTM D1140 – Standard Test Method for Amount of Material in Soils Finer than the Number 200 (75 micrometer) Sieve.
5. ASTM D1556 – Standard Test Method for Density and Limit Weight of Soil in Place by the Sand Cone Method.
6. ASTM D2216 – Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
7. ASTM D2434 – Test Method for Permeability of Granular Soils
8. ASTM D2487 – Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).
9. ASTM D2488 – Standard Practice for Description and Identification of Soils (Visual Manual Procedure).
10. ASTM D2922 – Standard Test Method for Density of Soil and Soil Aggregate in Place by Nuclear Methods (Shallow Depth).
11. ASTM D2937 – Standard Test Method for Density of Soil in Place by Drive-Cylinder Method.

12. ASTM D3017 – Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
13. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils
14. ASTM D6913 – Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
15. ASTM D6938 – Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

B. Geotechnical Data Report for the proposed PLU Central 2Containment Site.

## **1.6 QUALITY ASSURANCE**

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

## **PART 2 - PRODUCTS**

### **2.1 ENGINEERED FILL**

- A. Engineered Fill is defined as material obtained from excavations associated with the WORK or designated on-site borrow sources, approved by the ENGINEER, that meet the requirements of the SPECIFICATIONS.
- B. Engineered Fill material shall be free of debris, organics, oversized material (clods or rocks greater than 1 inch in diameter), frozen material, ice, snow, deleterious, or other unsuitable materials.
- C. The aggregate for the fill material should conform to the requirements as shown in Table 1 Grade 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for Grade 1. Do not use additives such as, but not limited to lime, cement, or fly ash, to modify aggregate to meet requirement of Table 1. As per the geotechnical study, the on-site material meets these requirements and are suitable as Engineered Fill.
- D. The CONTRACTOR will provide laboratory testing results to the OWNER for all fill material used in construction for verification of material compliance as required for the project.
- E. Based on the results of the geotechnical investigation, native soils at the PLU Central 2Containment site are suitable for use as “Engineered Fill” as described in this Section.

### **2.2 ENGINEERED FILL MATERIAL USED IN SUBGRADE PREPARATION**

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

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

### 2.3 DRAINAGE AGGREGATE (DRAIN ROCK)

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

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

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

- C. Drain Rock Aggregate shall be free of organic material, frozen material, ice, snow, or excess moisture.
- D. Drain Rock Aggregate material must be hard, durable, and not subject to grain crushing. Individual rock fragments shall be dense, sound, and resistant to abrasion and shall be free from cracks, seams, and other defects that would tend to increase their destruction from water and frost actions. Drain Rock Aggregate shall be less than 5 percent carbonate.
- E. Material shall be poorly-graded within the SPECIFICATION limits with a uniform grading of coarse to fine particles. No gap-graded material, as determined by the ENGINEER, shall be acceptable.
- F. Verify that all necessary pre-construction submittals such as conformance testing of the Drain Rock Aggregate have been performed prior to placement or importing.

## PART 3 - EXECUTION

### 3.1 PREPARATION, EXAMINATION, AND PROTECTION OF EARTHWORK

- A. Provide construction staking and grade control. Establish and set required lines, levels, grade, contours, and datum by construction staking.
- B. Provide for dust control in accordance with site requirements and OWNER'S direction.

- C. Provide for dewatering as necessary for finish excavation and fill placement.
- D. Locate, identify, and protect all utilities and existing structures from damage (including overhead and suspended utilities).
- E. Protect temporary or permanent bench marks, survey stakes, settlement monuments, existing structures, fences and existing WORK from damage or displacement by construction equipment and vehicular traffic.
- F. Coordinate traffic control, operations, and haul routes with the OWNER and LINER CONTRACTOR.
- G. Note that topography shown on DRAWINGS may differ from topography at time of construction.
- H. Protect the exposed surfaces of compacted lifts from drying and cracking due to excessive heat, or softening due to excessive moisture, until overlying fill material is placed and compacted.
- I. Any earthen surface upon which the liner is installed shall be prepared and compacted in accordance with the project SPECIFICATIONS. The surface shall be smooth, firm, and unyielding. The top six-inches of fill beneath the surface shall be free of:
  - 1. Vegetation/Roots/Sticks
  - 2. Construction debris
  - 3. Sharp, angular rocks
  - 4. Rocks larger than 1 inch in diameter
  - 5. Void spaces
  - 6. Abrupt elevation changes
  - 7. Standing water
  - 8. Cracks larger than six millimeters in width
  - 9. Any other foreign matter that could contact the liner
- J. Immediately prior to liner deployment, LINER CONTRACTOR shall arrange for the subgrade to be final-graded by the EARTHWORK CONTRACTOR to fill in all voids or cracks, then smooth-rolled to provide the best practicable surface for the liner. At completion of this activity, no wheel ruts, footprints or other irregularities in the subgrade are permissible. Furthermore, all protrusions extending more than 0.5-inches from the surface shall be removed, crushed, or pushed into the surface with a smooth-drum roller compactor.
- K. On a continuing basis, the OWNER's REPRESENTATIVE shall examine the subgrade for suitability before liner placement.
- L. It shall be the CONTRACTOR'S responsibility to indicate to the OWNER or ENGINEER any change in the condition of the subgrade that could cause the subgrade to be non-compliance with any SPECIFICATION requirement. If the CONTRACTOR has not notified the OWNER or ENGINEER of changes that cause the subgrade to be non-compliant and installs the liner, then the CONTRACTOR has determined and assumes responsibility that the subgrade is acceptable for liner installation.
- M. At the crest of the embankments, an anchor trench for the liner shall be constructed by the EARTHWORK CONTRACTOR as detailed on the DRAWINGS. Any deviation from the anchor trench details shown on the DRAWINGS requires review and approval by the ENGINEER. No loose soil shall be allowed at the bottom of the trench, and no sharp corners or protrusions shall exist anywhere within the trench.

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

### 3.2 EXCAVATION

- A. Excavate material shown on the DRAWINGS and as necessary to complete the WORK. Excavation carried below the grade lines shown on the drawings shall be repaired as specified by the OWNER unless previously approved by the OWNER. Correction of all over-excavated areas shall be at the CONTRACTOR's sole expense.
- B. All necessary precautions shall be taken to preserve the material below and beyond the established lines of all excavation in the soundest possible condition. Any damage to the WORK beyond the required excavation lines due to wetting, drying, or the CONTRACTOR'S operations shall be repaired at the CONTRACTOR'S sole expense.
- C. Excavation, shaping, and any other work related to material removal, shall be carried out by the method(s) considered most suitable, provided it meets the design intent as determined by the ENGINEER.
- D. Limits of excavation to accomplish the WORK safely shall be determined by the CONTRACTOR. Any minimum excavation limits shown on the DRAWINGS are for material identification only and do not necessarily represent safe limits. All excavations shall be free of overhangs, and the sidewalls shall be kept free of loose material. As a minimum, the CONTRACTOR shall slope, bench and shore all excavations as necessary to prevent any unsafe conditions as required by OSHA 29 CFR 1926.651 and 1926.652.
- E. Accurate trimming of the slopes of excavations to be filled will not be required, but such excavations shall conform as closely as practical to the established lines and grades.
- F. For pipe trench excavations, grade trench bottom to provide uniform bearing for the entire length of pipe to be installed. Fill in voids, gaps, low points ("dips" or "bellies") and bridging areas within trench bottom and along the entire length of pipe.
- G. Subsoil not to be used in the construction of earth fills or reclamation shall be stockpiled in areas designated by OWNER and in accordance with applicable laws, rules, and regulations.
- H. Permanently stockpiled earth material shall be graded to drain and blended seamlessly into the natural landscape.
- I. Provide and operate equipment adequate to keep all excavations and trenches free of water.
- J. Excavate unsuitable areas of the subgrade and replace with approved fill materials. Compact to density equal to requirements for subsequent fill material.
- K. The subgrade of each pond shall be proof-rolled and compacted in place prior to fill placement or grading.
- L. Grade top perimeter of excavation to prevent surface water from draining into excavation.

### 3.3 MISCELLANEOUS EXCAVATION

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

### 3.4 FILL PLACEMENT

#### A. General

1. Transport, process, place, spread, compact, and complete fill using the appropriate equipment to achieve lift thickness, design lines and grades and compaction specified in the DRAWINGS and SPECIFICATIONS.
2. To the extent practicable, fill shall be placed by routing the hauling and spreading units approximately parallel to the axis of the embankment.
3. Hauling equipment shall be routed in such a manner that they do not follow in the same paths but spread their traveled routes evenly over the surface of the fill.
4. Protect installed measurement instrumentation, structures, and utilities from damage.
5. Care shall be taken at all times to avoid segregation of material being placed, and all pockets of segregated or undesirable material shall be removed and replaced with material matching the surrounding material.
6. Each zone shall be constructed with materials meeting the specified requirements and shall be free from lenses, pockets, and layers of materials that are substantially different in gradation from surrounding material in the same zone.
7. No material shall be placed on material that is too soft, smooth, wet, or dry, or that has been damaged by drying, cracking, frost, runoff, or construction activities. Previously completed portions of the subgrade that are deemed unsuitable for construction shall be repaired until approved by the ENGINEER. **The top 8 inches of the foundation surface shall be scarified, moisture conditioned (as necessary), and compacted so fill material will bond firmly to surfaces of excavation.** Remove standing water prior to placement of all fill material.
8. To the extent practicable, fill materials shall be brought to the placement area at the recommended moisture content.
9. Moisture conditioning is the operation required to increase or decrease the moisture content of material to within the specified limits for proper material placement and compaction. If moisture conditioning is necessary, it may be carried out by whatever method CONTRACTOR deems suitable, provided it produces the moisture content specified in the SPECIFICATIONS.

### 3.5 TRENCH BACKFILL

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



1. Sand bedding material shall be placed around the lower half of the pipe, culvert or box and thoroughly rodded and tamped to fill all voids and provide uniform support. Material shall be thoroughly compacted by machine tamping in 6-inch thick layers as required to provide 95% of the Modified Proctor maximum dry density per ASTM D1557.
2. Common fill shall be placed around the upper half of the pipe, culvert or box and to a minimum depth of 12-inches over the top of the pipe, culvert or box. Common Fill shall be thoroughly compacted by machine tamping in 6-inch thick layers as required to provide 95% of the Modified Proctor maximum dry density per ASTM D1557.
3. The remainder of the trench shall be backfilled with Common Fill in loose layers not to exceed 8-inches in thickness and thoroughly compacted by machine tamping as required to provide 95% of the Modified Proctor maximum dry density per ASTM D1557.
4. Backfilling under haunches shall be performed manually by tamping rods or similar hand equipment to eliminate voids underneath.
5. The minimum frequency of Moisture Content ASTM D3017 and In Place Density ASTM D2922 testing shall be 1 test per lift per 50 linear feet of trench for all material types.

### **3.6 ROAD SUBGRADE**

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

### **3.7 MOISTURE CONTROL**

- A. Prior to and during all compacting operations, maintain moisture content within the limits recommended herein. Maintain uniform moisture content throughout the lift. To the extent practicable, add water to materials that are too dry at the site of excavation. Supplement, if necessary, by sprinkling and mixing water into the fill material prior to compaction. The moisture content shall be at or no more than 2 percent above the optimum moisture content in accordance with ASTM D2216.
- B. Do not attempt to compact fill material containing excessive moisture. Aerate material by blading, disk, harrowing, or other methods, to dry the material to acceptable moisture content.

### **3.8 LIFT THICKNESS REQUIREMENTS**

- A. Berm Fill:
  1. Placement lift thickness for Engineered Fill shall not exceed 6 inches prior to compaction with hand-operated compaction equipment and should not exceed 8 inches with heavy machine operated compaction equipment. It is the CONTACTOR's responsibility to ensure that the compaction achieved meets the specifications.
  2. Fill placement for anchor trenches shall not exceed 6 inches in loose lift thickness for each lift.
- B. Drain Rock Aggregate:
  1. Drain Rock Aggregate shall be placed and spread in lifts not exceeding 8 inches in thickness.

### 3.9 COMPACTION AND MOISTURE CONTENT REQUIREMENTS

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

**Table 2: Compaction and Moisture Content Requirements**

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

### 3.10 COMPACTION EQUIPMENT

- A. Compaction equipment shall be maintained in good working condition at all times to ensure that the amount of compaction obtained is the maximum for the equipment.
- B. Compactor:
1. The fill is required to be compacted with a heavy vibratory-optional roller and a maximum roller speed of approximately 2 mph.
  2. The compactor shall be of self-propelled design to develop 10,000 pounds in weight per linear foot of width at rest on level ground or equivalent as approved by the ENGINEER.
- C. Special Compactors:
1. Special compactors shall be used to compact materials that, in the opinion of the ENGINEER, cannot be compacted properly by the specified roller because of location or accessibility.
  2. Special compaction measures shall be adopted, such as hand-held compactors, smooth drum rollers, or other methods approved by the ENGINEER, to compact fill material in trenches, around structures, around geomembrane, and in other confined areas that are not accessible to the Compactor. The final surface on which the geomembrane will be placed shall be compacted with a smooth drum roller.
  3. Anchor trenches shall be compacted with a hand-operated compaction machine.

### 3.11 COMPACTION TESTING OF ENGINEERED FILL

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

### **3.12 SITE GRADING**

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

END OF SECTION 02200

SECTION 02776  
HIGH DENSITY POLYETHYLENE (HDPE) GEOMEMBRANE

**PART 1 - GENERAL**

**1.1 SUMMARY**

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

**1.2 SUBMITTALS**

- A. The CONTRACTOR shall submit a Subgrade Acceptance Letter to the ENGINEER prior to installation of the geomembrane stating the subgrade is acceptable and does not void the warranty.
- B. The CONTRACTOR shall submit the following product data to the ENGINEER:
  - 1. Resin Data:
    - a. Certification stating that the resin meets the SPECIFICATION requirements.
  - 2. Geomembrane Roll:
    - a. Statement certifying no recycled polymer and no more than 10% rework of the same type of material is added to the resin.
- C. Pre-Construction Submittals: Submit the following within 10 days of Notice to Proceed. Pre-Construction materials shall be submitted to the OWNER and ENGINEER.
  - 1. The MANUFACTURER'S Information
    - a. The MANUFACTURER'S name and address and primary contact.
    - b. The manufacturing plant name and address where the geomembrane for this project will be produced.
    - c. The MANUFACTURER'S qualifications including:
      - 1) Evidence of production of at least 10 million square feet of geomembrane that meets the specifications.
      - 2) Certification that the MANUFACTURER has sufficient capacity to provide the required material in the given timeframe.
      - 3) A list of at least 10 projects for which geomembrane has been supplied by the MANUFACTURER, three of which shall have been for projects of similar size.
    - d. Product name and the MANUFACTURER'S description of the proposed geomembrane and five (5) representative samples of the product proposed for use on this project.
    - e. The MANUFACTURER'S material properties sheets (cut sheets) of proposed geosynthetic products meeting the requirements of the specification.
    - f. The MANUFACTURER'S Quality Control (MQC) Plan, including examples of geomembrane certification documents, name and address of the quality control testing laboratory, quality control laboratory certification, examples of retesting notification, and documentation.