



**TECHNICAL SPECIFICATIONS
PHASE II LFGCCS EXPANSION**

**CENTRAL COUNTY SOLID WASTE
DISPOSAL COMPLEX
SARASOTA COUNTY, FLORIDA**

Prepared for:

Sarasota County Solid Waste Operations



4000 Knights Trail Road
Nokomis, FL 34275
FDEP Permit No. 0130542-022-SO/01
WACS ID No. 51614

Prepared by:

SCS Engineers
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(813) 621-0080

Florida Board of Professional Engineers
Certificate Number 00004892

March 6, 2017
File No. 09216113.03

Offices Nationwide
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PHASE II LFGCCS EXPANSION
SARASOTA COUNTY, FLORIDA**

Submitted to:

Florida Department of Environmental Protection
Division of Waste Management
2600 Blairstone Road, MS 4565
Tallahassee FL, 32399

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Daniel R. Cooper 3-6-17
Daniel R. Cooper, P.E.
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SECTION 02 41 16

REFUSE HANDLING, STORAGE, AND DISPOSAL

PART 1 - GENERAL

1.01 NOTIFICATION

- A. The CONTRACTOR shall notify the COUNTY in advance of planned excavation of landfill refuse.
- B. No excavated materials shall be removed from the site or disposed of by the CONTRACTOR except as specified below and approved by the COUNTY.

PART 2 - REFUSE HANDLING AND DISPOSAL

2.01 REQUIREMENT

- A. The CONTRACTOR will be required to setup an account with the landfill scale house and pre-load the account with monies to pay the required current waste disposal tipping fee. The CONTRACTOR will submit receipts and reports with each pay application for those periods when waste is taken to the landfill for disposal for the tonnage of waste taken to the landfill working face and the value will be paid from the Waste Disposal Allowance, Bid Item No. XX.
- B. The CONTRACTOR may do the following to determine the tons of waste removed and disposed in the landfill.
 - 1. The CONTRACTOR may use on-road dump trucks to haul each load of waste from the excavation to the scales located at the site for weight and determination of tipping payment, and then haul the waste from the scales to the working face of the landfill for disposal.
 - 2. Alternatively, if the CONTRACTOR would prefer to use off-road dump trucks, or another vehicle, to haul the excavated waste directly to the working face without taking each load to the scale, the CONTRACTOR may use the average weight of three fully loaded on-road dump trucks, no off-road dump trucks will be allowed on the scales, that shall be weighed on the scales at the start of the excavation activities. The number of on-road dump truck loads in an off-road truck will be estimated during operations. Loads will then be counted and the average weight used for determining waste hauled and allowed for billing.
- C. In the event that refuse is excavated and cannot be immediately taken to the working face the refuse may be stored adjacent to the excavation until it can be taken to the working face before the end of the same working day, unless rain is forecast in the day, in which case the refuse must be immediately taken to the

working face to avoid production of leachate due to rainfall on the waste. Refuse shall remain within close proximity to the location from which it was removed. All refuse must be removed from all locations at the end of each working day.

- D. The CONTRACTOR shall include all costs for the determination of tonnage, removal and all other costs for hauling the waste to the working face in CONTRACTOR in Bid Item No. XX on Bid Form. Only the value of the tipping fee to the landfill will be paid from the allowance in Bid Item No. XX on the Bid Form.

PART 3 – EXECUTION (Not Used)

END OF SECTION



SARASOTA COUNTY

"Dedicated to Quality Service"

March 22, 2013

Mr. Steve G. Morgan
Florida Department of Environmental Protection
Southwest District
Solid Waste Program
13051 North Telecom Parkway
Tampa, FL 33637-0926

RE: Submittal of Minor Permit Modifications to Project Documents
CCSWDC Phase I Class I Landfill Closure and Landfill Gas Collection System
FDEP Construction Permit No. 130542-014-SF/01 (Phase I Closure)
Sarasota County, FL

Dear Mr. Morgan:

Please find attached to this letter a Minor Permit Modification to Permit Nos. 130542-014-SF/01 for the CCSWDC Phase I Class I Landfill Closure and Gas Collection System located in Sarasota County, Florida. The Minor Permit Modification was prepared by HDR Engineering, Inc. (HDR) to reflect revisions made to the Technical Specifications and Drawings during construction of the Phase I Closure.

Attached is a check in the amount of \$250, for the Minor Permit Modification processing fee.

Also attached to this letter is the Certification of Construction Completion Report for the Phase I Closure which was constructed in accordance with the revisions stated in the Minor Permit Modification.

I am aware of the statements made in the attached Minor Permit Modification and the supporting information. I certify that the information in the Minor Permit Modification is true, correct, and complete to the best of my knowledge and belief. Further, I agree to comply with the provisions of Chapter 403, Florida Statutes, and all rules and regulations of the Department.

Sincerely,

Lois Rose
Manager Solid Waste Operations

cc: Alex Boudreau, P.E., Sarasota County
Gary Bennett, Sarasota County
Jason Timmons, P.E., Sarasota County

SECTION 02771
TPO GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes the scrim reinforced Thermoplastic Polyolefin (TPO) geomembrane components used in the exposed geomembrane temporary cover. The scrim reinforced TPO is 60 mil UltraPly™ TPO as manufactured by Firestone Building Products or equivalent.
- B. Related Sections:
 - 1. Section 02200 –Earthwork - Landfill.
Section 02778 - Geotextile.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. ASTM D751– Standard Test Methods for Coated Fabrics
 - b. ASTM D6878– Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing
 - c. ASTM D5261– Test Method for Measuring Mass per Unit Area of Geotextiles
 - d. ASTM D4885– Standard Test Method for Determining Performance Strength of Geomembranes by the Wide Strip Tensile Method
 - e. ASTM D5884– Standard Test Method for Determining Tearing Strength of Internally Reinforced Geomembranes
 - f. ASTM D2137 – Standard Test Methods for Rubber Property-Brittleness Point of Flexible Polymers and Coated Fabrics
 - g. ASTM D1204– Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
 - h. ASTM D1149– Standard Test Methods for Rubber Deterioration; Cracking in an Ozone Controlled Environment
 - i. FTM 101 C– Test Method for Puncture Resistance and Elongation Test
 - j. ASTM D471– Standard Test Method for Rubber Properties—Effect of Liquids (Water Absorption)
 - k. ASTM G 151 – Practice for Exposing Non-Metallic Materials in Accelerated Test Devices that use Laboratory Light Sources
 - l. ASTM G 155 – Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials
 - 2. The Geosynthetic Research Institute (GRI).
 - a. GRI/G 16 – Observation of Surface Cracking of Geomembranes
- B. Qualifications:
 - 1. Each manufacturing and fabricating firm shall demonstrate 5 years continuous experience with a minimum of 10,000,000 SF of TPO geomembranes.
 - 2. Installer:
 - a. Demonstrate 5 years continuous experience with a minimum 10,000,000 SF of geomembranes.
 - b. Trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).
 - c. Geomembrane Installer Personnel Qualifications:
 - 1) Installation Superintendent shall have worked in a similar capacity on at least five geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.

- 2) The Master Welder shall have completed a minimum of 5,000,000 sf geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
 - 3) Other welders shall have seamed a minimum of 1,000,000 sf geomembrane.
3. CQC Testing Laboratory shall demonstrate 3 years of continuous experience in similar geosynthetic materials testing.
- C. Quality Assurance / Control:
1. The Owner or Engineer's representative will conduct independent testing to support construction quality assurance (CQA) program and to provide documentation of such to appropriate regulatory agencies.
 2. Unless specifically superseded by these contract documents or approved plans submitted by the Contractor, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA/600/R-93/182 and EPA/530/SW-91/051.
 - a. This specifically includes:
 - 1) Material Composition.
 - 2) Manufacturing.
 - 3) Handling and Packaging.
 - 4) Shipment.
 - 5) Storage (Manufacturer and Site).
 - 6) Placement:
 - a) Seaming and Joining.
 - b) Destructive and Non Destructive Testing.
 - c) Protection, Backfilling and Covering.
 - 7) Conformance Testing.
 - 8) Anchoring and Anchor Trenches.
 - 9) Access Roads/Ramps.
- D. CQA Plan Implementation: Construction Quality Control will be performed in accordance with the CQA Plan prepared for this project. The Contractor and Geomembrane Installer should familiarize themselves with the CQA Plan.
- E. Installer's construction quality control programs to include, but not be limited to, product acceptance testing, installation testing, including both nondestructive and destructive quality control field testing of the sheets and seams during installation of the geomembrane, proposed methods of testing geosynthetic joints and connections at appurtenances for continuity, documentation and changes, alterations, repairs, retests, and acceptance.
- F. Geomembrane Installer's installation manual to include:
1. Ambient temperature at which the seams are made
 2. Control of panel lift up by wind
 3. Acceptable condition of the subsurface beneath the geomembrane
 4. Quality and consistency of the welding material
 5. Proper preparation of the liner surfaces to be joined
 6. Cleanliness of the seam interface (e.g., the amount of airborne dust and debris present)
 7. Proposed details for connecting the TPO liner to appurtenances, i.e. penetrations of the containment facilities.
 8. A complete description of seaming by hot-air welding and hot-wedge welding.
 9. Requirements of the Manufacturer's Installation Manual unless exceptions are noted and approved by the Engineer.

1.3 DEFINITIONS AND RESPONSIBILITIES

- A. Geomembrane Manufacturer: Manufacturer of geomembranes producing geomembrane sheets from resin and additives. The manufacturer is responsible for producing geomembrane sheet which complies with these Specifications. These responsibilities include but are not limited to:
1. Acceptance of the resin and additives from chemical formulators. Testing of the raw resin and additives to ensure compliance with the manufacturer's specifications and with this Specification.

2. Formulation of the resin and additives into geomembrane sheeting using mixing and extrusion equipment.
 3. Testing of the geomembrane sheet to ensure compliance with manufacturer's specification and this Specification.
 4. Shipping of the geomembrane sheet to installer designated facilities.
 5. Certification of the raw materials and finished geomembrane sheet to comply with this Specification.
 6. Certification of installer's training, experience, and methods for welding and inspection of geomembrane installations in compliance with manufacturer's standards.
- B. Geomembrane Installer. Installer of geomembranes are responsible for handling, fitting, welding, and testing of geomembrane sheets or blankets in the field. These responsibilities include but are not limited to:
1. Acceptance (in writing) of the geomembrane from the manufacturer.
 2. Acceptance (in writing) of the surface which will serve as a base for the geomembrane. This acceptance shall precede installation of the geomembrane, and shall state that the installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of geomembrane liners. The written acceptance shall explicitly state any and all exceptions to acceptance.
 3. Handling, welding, testing, and repair geomembrane liners in compliance with this Specification and the Geomembrane Installer's Installation Procedures Manual.
 4. Performance of QC testing and record keeping as required by the approved Geomembrane Installer's Field Installation Procedures Manual.
 5. Repair or replacement of defects in the geomembrane as required by the Installer's CQC Consultant or the CQA Inspector.
- C. CQA Inspector:
1. Inspectors of TPO geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the Manufacturer, Installer, CQA Engineer, and Owner with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the Manufacturer or Installer.
- D. CQA Testing Laboratory shall:
1. Perform destructive testing of the TPO geomembrane.
 2. Perform conformance testing of TPO geomembrane.
- E. Installer's CQC Consultant: Responsible for observing field installation of the geomembrane and performance of material conformance and CQC testing to provide the Contractor with verbal and written documentation of the compliance of the installation with these Specifications.
- F. CQA Engineer: Responsible for implementing CQA Plan including overview of material conformance testing, field installation of the geomembrane, and CQC activities, and to perform limited CQA conformance testing to provide Owner with verbal and written documentation of the compliance of the installation with these Specifications. The CQA Engineer will use the written results of the CQC program and the CQA program in the preparation of the facility Certification Document. The CQA Engineer reports to the Owner and is not part of this contract.
- G. Refer to the accompanying CQA Plan for additional definitions.

1.4 SUBMITTALS

- A. Shop Drawings:
1. Submit for Engineer's approval Shop Drawings, including:
 - a. Manufacturer's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties.
 - 1) Original certificates are required.
 - b. Manufacturer/Fabricator/Installer quality control requirements.
 - c. Qualifications and experience of key personnel per 1.2 B of this section.

- d. Manufacturer's written acceptance of Geomembrane Installer's qualifications for installation of the TPO geomembrane.
 - e. TPO Geomembrane layout plan with proposed size, number, position and sequencing of liner panels and showing the location and direction of all field or factory joints.
 - 1) Proposed details for connecting the geosynthetic materials to appurtenances.
 - 2) Proposed methods of welding, seaming or jointing geosynthetic materials.
 - 3) Proposed method of testing TPO geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
 - 4) Location and configuration of haul roads and access points.
 - 5) Proposed details for anchor trench if different than included in Contract Documents.
- B. Miscellaneous:
- 1. Test results:
 - a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
 - 1) Results shall include or bracket the rolls delivered for use in the Work.
 - b. Daily test seam results.
 - c. Daily results of production seam testing.
 - 2. Warranties as described below.
 - 3. Submit written certifications that:
 - a. Utilize certification forms approved for use on this project by the Owner and Engineer. Make appropriate number of copies, as required.
 - b. The TPO geomembrane material delivered to site meets the requirements of this Specification.
 - c. The TPO geomembrane was received and accepted in undamaged condition from shipper.
 - d. The TPO geomembrane liner was installed in accordance with this Specification and with approved Shop Drawings.
 - e. The TPO geomembrane joints were inspected, tested for strength and continuity, and passed all inspections and tests.
 - 1) All test and inspection data shall be incorporated into this certification.
 - 4. Manufacturer/Installer's Field Installation Procedures Manual shall clearly identify any exceptions taken to the specified execution of the Work.
 - 5. Record Drawings: Submit reproducible drawings of record showing changes from the approved installation drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.
- C. Provide all submittals in a single coordinated transmittal. Partial submittals will not be accepted. All submittals must be submitted prior to the Geomembrane Preconstruction Meeting and a minimum of four weeks prior to installation.
- D. The acceptable color of the material will be a shade of green. The proposed color and a sample of material and color shall be submitted for acceptance and approval by the Owner and Engineer.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. The TPO geomembrane should be protected from punctures, abrasions, vandalism, excessive heat or cold or other damaging conditions
- B. The TPO geomembrane shall be delivered to the project site intact and free from any tears, abrasion, or damage. Store TPO geomembrane rolls in a dry area off the ground on 4 rails with each rail being a minimum of 3.5 inches wide, and protected from the direct heat of the sun, where possible, and accessories in original containers in a dry area protected from the elements.
- C. Each roll shall be labeled with the manufacturers name, type, lot number, roll number, and roll dimensions (length, width, gross weight).

1. TPO geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
 2. TPO geomembrane shall not be exposed to temperatures in excess of 60 Deg C (140 Deg F) or less if recommended by the Manufacturer.
- D. No hooks, tongs or other sharp instruments shall be used for handling the TPO geomembrane.
1. Rolls shall not be lifted by use of cables or chains in contact with the TPO geomembrane.
 2. TPO geomembrane shall not be dragged along the ground.

1.6 PROJECT CONDITIONS

- A. When the weather is of such a nature as to endanger the integrity and quality of the installation, whether this is due to rain, high winds, cold temperatures, or other weather elements, the installation of the geomembrane shall be halted at the direction of, or with the concurrence of, the Owner until the weather conditions are satisfactory.
- B. The contractor shall ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on geosynthetic surfaces which hamper the efficient field seaming of geosynthetic panels or performance.
- C. Maintain natural surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.
- D. All materials shall be placed and spread with low ground pressure equipment (10 psi ground pressure or less) as approved by the CQA Engineer to reduce potential damage to the geosynthetics. The geosynthetics surface shall be off limits to construction traffic. Hard turning of tracked equipment on the protective cover and stone must be avoided.
1. At least 12 inches of separation between the geosynthetics and all low ground pressure equipment shall be maintained.
 2. Stockpiling of materials within the limits of the cell shall be subject to advanced approval by the CQA Inspector. Any hauling equipment (dump trucks, etc.) operating within the cell limits (and including access ramps), shall have a minimum of 4 feet of separation between the vehicle wheels and the geosynthetics.
 3. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.
 4. When damage is suspected, uncover area, repair damage if required, and recover area at no cost to Owner.
 5. Suspect areas may be identified by Owner or Engineer.

1.7 WARRANTIES

- A. Written warranties addressing TPO geomembrane material and installation workmanship shall be furnished by the Contractor and shall be made to the Owner.
- B. Submit material samples and warranties prior to shipment.
- C. Suitability of geosynthetic liner system shall be subject to Owner's approval of warranty.
1. The Manufacturer's warranty shall be against manufacturing defects and workmanship and against deterioration due to ozone, ultra- violet exposure from direct sunlight, and other exposure to the elements, for a period of 20 years on a pro rata basis. The warranty shall be limited to replacement of material, and shall not cover installation of replacement geomembrane.
 2. The Installer's warranty shall state that the materials were properly installed, properly (field and factory) welded, seamed and jointed and will not fail within two years of the date of final acceptance of the Work by the Owner.
 - a. Warranty shall not be prorated.
- D. Warranties shall provide for complete repair/replacement excluding installation costs at no additional cost to the Owner for the warranty period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS AND/OR GEOMEMBRANE INSTALLERS

- A. Subject to compliance with the Contract Documents, the following manufacturers and installers are acceptable:
 - 1. TPO Geomembrane liners manufacturers:
 - a. Firestone Building Products
 - b. Carlisle SynTec
 - 2. TPO Geomembrane Liner Installers:
 - a. Authorized installers of approved manufacturers.
 - b. Other installers may qualify by providing references for a minimum of 10,000,000 SF of TPO liner installations.

2.2 MATERIALS

- A. The membrane will be Firestone UltraPly TPO 60 mil geomembrane or equivalent.
- B. Accessories will be as supplied or approved by geomembrane manufacturer.
- C. Geomembrane meets or exceeds the property values listed in Table 1.
- D. Interface testing of liner and geotextile will be submitted as specified in Table 2.

Table 1: Physical Properties

Description	Test Method	Property
UNAGED PROPERTIES:		
Thickness (min average)	ASTM D751 and D6878	0.060" (1.52 mm, 60 mil) Lowest individual -10%
Thickness Over Scrim	ASTM D 4637 (Optical Method) 0.060" Membrane	0.024" (0.609 mm) ± 10%
Mass per unit area (min)	ASTM D5261	0.3 lb/sf (1.42 Kg/m ²)
Breaking Strength (TD and MD) (min)	ASTM D 4885	150 ppi (26.3 kN/m)
Elongation at Reinforcement break (TD and MD) (min)	ASTM D 4885	30%
Tearing Strength (TD and MD) (min)	ASTM D 751 (8"x8" specimen)	86 lbf (382 N) 55lbf (245 N)
Brittleness Point (max)	ASTM D 2137	-50°F (-46°C) -40°F (-40°C)
Linear Dimension Change (max)	ASTM D 120 (6 hrs @70° C)	4 %
Ozone Resistance	ASTM D 1149	PASS (no cracks)
Factory Seam Strength (min)	ASTM D 4885	150 ppi (26.3 kN/m)
Puncture Resistance (min)	FTM 101C Method 2031	265 lbf (1174 N)
Water Absorption (max, mass)	ASTM D471 166 hrs at 158 ⁰ F	+/- 3%
HEAT AGED PROPERTIES:		
Breaking Strength (TD and MD) (min)	ASTM D 4885	150 ppi (26.3 kN/m)*
Elongation at Reinforcement Break (TD and MD) (min)	ASTM D 4885	30%*
Tearing Strength (TD and MD) (min)	ASTM D 5884 (8"x8" specimen)	86 lbf (382N)*
Weight Change (max) (Membrane)	ASTM D 471	1% (change in mass)
AGED PROPERTIES:		
Ozone Resistance	ASTM D 1149	PASS (No cracks)
Weather resistance (Retained Values)	ASTM G 151/ G 154	
Visual Inspection		PASS
Breaking Strength, (min)		90% retained
Elongation at Reinforcement Break (min)	ASTM D 4885	90% retained
Resistance to Xenon-Arc Weathering	ASTM G 151/ G155	Pass

*ASTM D 6878 requires retained values of 90% for original breaking strength and elongation and 60% for tearing strength

Table 2: Interface Friction Angles

PROPERTIES	QUALIFIERS	UNITS	VALUES	TEST METHOD
Engineering Properties				
Interface friction between geomembrane liner and geotextile material in the anchor trench	minimum	degrees	22 ⁽¹⁾	ASTM D 5321 ⁽²⁾

- (1) Perform testing using normal stress range of 144 lb/sf, 288 lb/sf and 432 lb/sf.
 (2) Wet the geotextile/TPO geomembrane interface prior to testing: perform test using: (i) normal stress indicator above; and (ii) a strain rate calculated in accordance with ASTM D 3080, Sections 9.12 and 9.13, not to exceed 1 mm/min. (0.04 in./min.).

2.3 MANUFACTURING QUALITY CONTROL

A. Rolls:

1. The Manufacturer will continuously monitor the TPO geomembrane sheets during the manufacturing process for inclusions, bubbles, or other defects.
2. No TPO geomembrane will be accepted that exhibits any defects.
3. The Manufacturer will continuously monitor the TPO geomembrane thickness during the manufacturing process.
4. No TPO geomembrane will be accepted that fails to meet the specified minimum thickness.
5. The Manufacturer will sample and test the geomembrane, at a minimum, at the test frequencies specified in Table 3.
 - a. Samples taken from stored rolls will be taken across the entire width of the roll and will not include the first wrapping or outer layer of the roll (about 3.3 feet).
 - b. Samples taken at the time of manufacturing can be obtained from the start/end of the roll.
 - c. Unless otherwise specified, samples will be 2 feet long by the roll width. The Manufacturer will mark the machine direction on the samples with an arrow.
 - d. Manufacturer quality control data shall accompany the geomembrane shipment.

Table 3: Manufacturer Quality Control Requirements

Material Property	Method	Test Frequency
Thickness	ASTM D751	Per roll
Tensile Properties	ASTM D4885	Once per day or 20,000 lb
Tear Resistance	ASTM D751	Once per day or 45,000 lb
Scrim Orientation	Visual	Every Lot or Every Scrim Roll
Mass per Unit Area	ASTM D5261	Once per day or 200,000 lb
Tear Resistance	ASTM D5884	Once per day or 45,000 lb
Thickness over Scrim	ASTM D6878	45,000 lb or Every other lot

6. Any TPO geomembrane sample that does not comply with the Specifications will result in rejection of the roll from which the sample was obtained. Contractor will replace any rejected rolls at no additional cost to Owner.
7. If a TPO geomembrane sample fails to meet the quality control requirements of this Section, the Manufacturer will sample and test each roll manufactured, in the same resin batch, or at the same time, as the failing roll. Sampling and testing of rolls will continue until a pattern of acceptable test results is established.
8. Additional testing may be performed at the Manufacturer’s discretion and expense, to more closely identify the non-complying rolls and/or to qualify individual rolls.

2.4 CONFORMANCE TESTING

- A. At the Geomembrane Manufacturer’s plant or upon delivery of the rolls of geomembrane at the site, the CQA Officer will verify that samples are removed at the specified frequency and forwarded to the Geosynthetics CQA Laboratory for testing to verify conformance to both the design specifications and the list of guaranteed properties. The minimum number of tests to be performed and test procedures will be as indicated in Table 4.
- B. Samples will be taken across the entire width of the roll and will not include the first linear 3 ft. Unless otherwise specified, samples will be 3-ft long by the roll width. The CQA Officer will mark the machine direction on the samples with an arrow. The required minimum sampling frequencies are provided in Table 4.
- C. The CQA Officer will examine the results from laboratory conformance testing and will report non-conformance to the Project Manager.
- D. The following procedure will apply whenever a sample fails a conformance test that is conducted by the Geosynthetics CQA Laboratory:
 - 1. Installer will replace the roll of geomembrane that is in nonconformance with the specifications with a roll that meets specifications;
 - 2. Installer will remove conformance samples for testing by the Geosynthetics CQA Laboratory from the closest numerical roll on both sides of the failed roll.
 - 3. These two samples must both conform to specifications. If either of these samples fail, then every roll of geomembrane on site and every roll delivered subsequently must be tested by the Geosynthetics CQA Laboratory for conformance to the specifications. This additional conformance testing will be at the expense of the Installer.
- E. The CQA Officer will document actions taken in conjunction with conformance test failures.

Table 4: Geomembrane Conformance Testing Requirements

TEST NAME	TEST METHOD	MINIMUM FREQUENCY OF TESTING
Thickness	ASTM D 4637 751	1 test per 100,000 ft ²
Tensile Strength at Break	ASTM D 4885	1 test per 100,000 ft ²
Elongation at Break	ASTM D 4885	1 test per 100,000 ft ²
Tear Strength	ASTM D 5884	1 test per 100,000 ft ²
Puncture Resistance	ASTM D 4833 FTM 101C Method 2031	1 test per 100,000 ft ²
Resistance to Xenon-Arc Weathering	ASTM G 155	Manufacturer’s Certification Only
Ozone Resistance	ASTM D 1149	1 test per 100,000 ft ²

2.5 EQUIPMENT AND ACCESSORIES

- A. Welding and Seaming Equipment:
 - 1. Equipped with gages showing temperatures at the nozzle or at the wedge (wedge welder).
 - 2. Maintained in adequate numbers to avoid delaying work.

3. Supplied by a power source capable of providing constant voltage under a combined-line load.
 4. Electric generator shall not be placed on the TPO geomembrane.
- B. Field Tensiometer:
1. Provide a tensiometer for on-site shear and peel testing of TPO geomembrane seams.
 - a. Tensiometer shall be in good working order.
 - b. Built to ASTM specifications.
 - c. Accompanied by evidence of calibration of equipment and gages within the past six months.
 2. Tension meter:
 - a. Motor driven.
 - b. Jaws capable of traveling a measure rate of 2 IN per minute.
 - c. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
 - d. Digital readout.
- C. Punch Press:
1. Provide a punch press for the onsite preparation of specimens for testing.
 2. Capable of cutting specimens in accordance with ASTM D4437.
- D. Air Lance Test:
1. Provide equipment for air lance test per ASTM D4337.
- E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.
- F. Gages:
1. Calibrated within past six months.
 2. Specified test values reading near mid-range of the gage scale.
- G. Equipment necessary to perform "Non-Destructive Testing of Geomembrane Seams Using The Spark Test" in accordance with ASTM D6365.

PART 3 - EXECUTION

3.1 GEOSYNTHETIC LINER SYSTEM

- A. Geomembrane Subgrade:
1. Protect subgrade at all times from damage until such time as the placement of TPO geomembrane liner and other components of the geosynthetic liner system are complete.
 2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of TPO Geomembrane.
 - a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the TPO Geomembrane or other synthetic liner materials.
 - b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 inch.
 - c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
 - d. During installation, ensure that rutting or ravelling is not caused by installation equipment or weathering.
- B. Anchor Trenches:
1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
 2. Excavation, backfill and compaction shall be in accordance with Section 02200.
- C. TPO Geomembrane:
1. General:
 - a. Installer of TPO geomembranes is responsible for handling, fitting, welding, seaming, jointing and testing of geosynthetic materials sheets or blankets in the field in accordance with the Construction Quality Assurance (CQA) Plan.

- b. These responsibilities include but are not limited to:
 - 1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
 - 2) Acceptance (in writing) of the surface which will serve as a base for the TPO geomembrane.
 - a) This acceptance shall precede installation of the TPO geomembrane.
 - b) Shall state that the Installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of TPO geomembrane liners.
 - c) Shall explicitly state any and all exceptions to acceptance.
 - 3) Handling, welding, seaming, jointing, testing and repair of TPO geomembrane liners and other geosynthetic materials in compliance with this Specification and with written procedures manuals prepared by the Manufacturer or Fabricator.
 - a) Manual shall be submitted to the Engineer together with Shop Drawings showing the layout of TPO geomembrane within the facility.
 - (1) Do not deviate from the procedures included in the manual.
 - b) TPO Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.
 - c) TPO Geomembrane liner materials shall be laid out according to plans previously approved by the Engineer.
 - d) Adjacent rolls of TPO geomembrane shall overlap a minimum of 3 IN.
 - 4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the Owner.
 - 5) Installer and Manufacturer may be the same firm.
- 2. Panel deployment:
 - a. Subgrade Preparation:
 - 1) Prepare subgrade in a manner consistent with proper subgrade preparation techniques for the installation of TPO geomembrane liner.
 - 2) Properly compact the subgrade so as not to settle and cause excessive strains in the TPO geomembrane liner.
 - 3) Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.
 - 4) Subgrade soils proof-rolled with a ten (10) ton drum roller, two (2) passes parallel to slope or as directed by CQA Inspector. The subbase shall be compacted and proof-rolled under observation of the CQA Inspector to assure the maximum practical compaction under the existing field conditions has been achieved. See specification Section 02200 for project specific compaction requirement.
 - 5) Ensure rutting or raveling is not caused by installation equipment or weather.
 - 6) Ensure that lines and grades have been verified by the Contractor and a subgrade acceptance form has been submitted.
 - b. Construct and backfill anchor trenches
 - c. Deploy TPO geomembrane liner in a manner to ensure it is not damaged
 - d. On slopes, anchor the TPO geomembrane liner securely and deploy it down the slope in a controlled manner.
 - e. Weight the TPO geomembrane liner with sandbags or equivalent in the presence of wind.
 - f. Minimize cutting the TPO geomembrane liner. Whenever possible, overlap instead of cutting material. If cutting is required, cut TPO geomembrane liner with a cutter or other approved device. Seal all cut edges, as recommended by Manufacturer.
 - g. Only those panel/sheets that can be seamed in 1 day shall be deployed.
 - h. Place panels with minimal handling.
 - 1) Protect panels from tear, puncture or abrasion.
 - i. Equipment used to deploy the geomembrane shall not damage the TPO geomembrane.
 - j. Minimize foot traffic.
 - 1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.

- 2) Do not allow footwear that may damage the geomembrane.
- k. Ballast with sandbags to prevent wind uplift as recommended by Manufacturer based on local climatic conditions.
 - 1) Remove and replace all wind damaged panels at no additional cost to Owner.
 - 2) If wind causes panels to be displaced, displaced panel may not be reused.
- l. Install TPO geomembrane in stress free, tension free and relaxed condition.
 - 1) Account for temperature and weather-related impacts when deploying and covering.
 - 2) Stretching to fit and folding are not permitted.
- m. Do not allow TPO geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
 - 1) Except as noted on Contract Drawings no folds in TPO geomembrane will be allowed.
- n. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.
- o. Field seaming:
 - 1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane Manufacturer, referenced EPA documents, and this specification.
 - 2) Each piece of seaming equipment and each operator shall perform trial seams at the start of a shift, whenever equipment has broken down or seaming is interrupted for more than 30 minutes, and at other times at the discretion of the Installer and Inspector.
 - 3) Trial seams shall use the same seaming materials and methods to be used in the actual construction.
 - 4) Surfaces to be seamed shall be clean and dry at the time of seaming.
 - a) Precipitation and ponding of water on the TPO geomembrane shall cause termination of seaming operations.
 - b) TPO geomembrane shall not be seamed when ambient temperatures are below 41 DegF or above 104 DegF, without written consent of TPO geomembrane Manufacturer and Engineer.
 - 5) TPO geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
 - a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
 - b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
 - c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
 - 6) All TPO geomembranes shall be seamed by thermal fusion methods as recommended by the TPO geomembrane Manufacturer.
 - a) TPO geomembrane seaming shall be either hot-air or double wedge welded as approved by the Engineer.
 - 7) Manufacturer's seaming instructions shall specifically address seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
 - 8) A copy of Manufacturer's seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the Manufacturer and Engineer.
 - 9) All panels/sheets should be overlapped a minimum of 3 IN.
 - 10) Seaming shall not be conducted in the presence of standing water.
 - a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
 - 11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.

- 12) Tack welds shall conform to manufacturer's seaming techniques and shall not damage underlying membrane.
- p. Patching:
 - 1) Defects in and damage to TPO geomembrane sheets shall be repaired by seaming a patch over the defect.
 - a) The patch material shall consist of an undamaged piece of TPO geomembrane cut to provide a minimum of 6 IN of overlap in all directions from the defect.
 - b) Round corners shall be utilized on all patches. No bead or spot patching will be accepted.
 - c) Torn or permanently twisted TPO geomembrane shall be replaced at no expense to the Owner.
 - 2) Test all patch seams non-destructively using the air lance tests .
 - a) Test patch seams destructively if the seam is greater than 100 feet in contiguous length (i.e. a single seam greater than 100 feet).
 - b) Perform a destructive test for every 100 feet of contiguous seam over 200 total feet of contiguous seam. For example if a patch seam is 340 feet, 2 destructive tests would be required for the seam. Smoking is not permitted while on the geomembrane.
- q. Field Panel Identification: The Installer's CQC Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" consistent with the approved panel layout plan. The location of the label and the color of marker used must be as agreed to in the QA/QC Preconstruction Meeting.
- r. Exposed reinforcement from cut TPO edges must be sealed with a hot-air weld.

3.2 FIELD QUALITY CONTROL

- A. The CQA inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the Manufacturer and Installer.
 1. The CQA inspector's responsibilities include, but are not limited to:
 - a. Inspection of the material and the handling and field installation of the geomembranes. Inspection of all welds, repairs and quality control test results.
 - b. All exceptions to material or installation shall be documented and furnished to the CQA firm in writing within 48 HRS of discovery.
 - c. Inspection and Certification of TPO geomembrane integrity until completion of placement of protective soil cover.
- B. Non-Destructive Testing:
 1. The Geosynthetics Installer will nondestructively test all field seams over their full length using a air lance test (TPO hot air weld), vaccum box (HDPE and LLDPE extrusion weld), or air pressure test (TPO, HDPE and LLDPE double fusion seams). Continuity testing will be carried out as the seaming work progresses, not at the completion of all field seaming. The Installer will complete any required repairs in accordance with specifications. The following procedures will apply to locations where seams cannot be nondestructively tested:
 - a. If the seam is accessible to testing equipment prior to final installation, the seam will be nondestructively tested prior to final installation.
 - b. If the seam cannot be tested prior to final installation, the seaming operations must be observed in their entirety by the CQA Officer for uniformity and completeness.
 2. Air Pressure Testing (For Double Fusion Seams Only):
 - a. The following procedures are applicable to those processes that produce a double seam with an enclosed space.
 - b. The equipment will comprise the following.
 - 1) An air pump (manual or motor driven), equipped with a pressure gauge, capable of generating and sustaining a pressure between 25 and 30 psi, mounted on a cushion to protect the geomembrane.
 - 2) A rubber hose with fittings and connections.
 - 3) A sharp hollow needle, or other approved pressure feed device.
 - c. The following procedures will be followed.

- 1) Seal both ends of the seam to be tested.
 - 2) Insert needle, or other approved pressure feed device, into the channel created by the fusion weld.
 - 3) Insert a protective cushion between the air pump and the geomembrane.
 - 4) Energize the air pump to a pressure between 25 and 30 psi, close valve, allow two minutes for pressure to stabilize, and sustain the pressure for not less than 5 minutes.
 - 5) If loss of pressure exceeds 4 psi, or if the pressure does not stabilize, locate faulty area and repair in accordance with Section 3.3.
 - 6) Cut opposite end to verify continuity of seam, remove needle, or other approved pressure feed device, and repair in accordance with Section 3.3.
3. Air Lance Testing
- a. Mechanical point stressing method (see ASTM D4437, article 4.5) or the air lance test method will be used to verify seam integrity for hot air seams and wedge seams without air channel. Since the mechanical point stressing method cannot evaluate the bond over its entire width, and since there is a potential for damaging the membrane with the sharp point of the probe, the air lance test method is recommended to verify seam integrity.
- C. Trial Seams
1. Trial seams shall be made prior to production seaming by all seamers and by all equipment to be used during production seaming. The trial seams shall be made on fragment pieces of geomembrane to verify that seaming conditions are adequate. Such trial seams shall be made at the beginning of each seaming period, seaming operation has been suspended for more than 1/2 hour, breakdown of the seaming equipment occurs or at least once each five hours, for each seaming apparatus used that day. Also, each seamer shall make at least one trial seam each day. Trial seams shall be made under the same conditions as actual seams. The trial seam sample shall be at least 5 ft long by 1 ft wide (after seaming) with the seam centered lengthwise. Seam overlap shall be as specified.
 2. Two adjoining specimens, each 1-inch wide for peel and 2-inch wide for shear, shall be cut from the trial seam sample by the Geosynthetics Installer. Fully support the test specimen within the grips across the width of the specimen. The specimens shall be tested in shear and peel, using a field tensiometer, and the specimen shall fail by film tear bond rather than in the seam. The minimum requirements for the seams strengths shall be as specified in Table 5. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus or seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved.
- D. After completion of the above-described tests, the remaining portion of the trial seam sample can be discarded. If a trial seam sample fails a test, then a destructive test seam sample shall be taken from the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the CQA Consultant and, if they fail the tests, the procedure indicated in Paragraph 3.3 of this section shall apply. The conditions of this paragraph shall be considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam
- E. Destructive Testing:
- F. Destructive Seam Testing:
1. A minimum of one destructive test per 500 LF of seam, and as many other samples as CQA firm determines appropriate, shall be obtained at locations specified by the CQA firm.
 - a. Sample locations shall not be identified prior to seaming.
 - b. The samples shall be a minimum of 12 IN wide by 48 IN long with the seam centered lengthwise.
 - c. Each sample shall be cut into three equal pieces with one piece retained by the Installer, one piece given to a CQA Testing Laboratory, and the remaining piece given to the CQA Engineer for quality assurance testing and/or permanent record.
 - d. Each sample shall be numbered and recorded on the final panel layout record drawing, and cross-referenced to a field log which identifies:

- 1) Panel/sheet number.
 - 2) Seam number.
 - 3) Top sheet.
 - 4) Date and time cut.
 - 5) Ambient temperature.
 - 6) Seaming unit designation.
 - 7) Name of seamer.
 - 8) Seaming apparatus temperature and pressures (where applicable).
2. A minimum of four 1 IN wide replicate specimens shall be cut from the Installer's sample.
 - a. A minimum of 2 specimens shall be tested for shear strength and 2 for peel adhesion using an approved field quantitative tensiometer. Jaw separation speed shall be 2 IN per minute.
 - b. To be acceptable, all field test specimens must meet the specified seam strength requirements and all must fail as Film Tear Bond.
 - c. If all field tests pass, 5 specimens shall be tested at the CQA Testing Laboratory for shear strength and 5 for peel adhesion in accordance with ASTM D4437.
 - d. To be acceptable, 4 out of 5 replicate test specimens must meet the specified seam strength requirements and fifth sample must meet 80% required strength and fail at Film Tear Bond.
 - e. Shear elongation and Peel separation shall not exceed values given in GRI GM19

Table 5: Seam Strength and Related Properties of Thermally Bonded TPO Geomembrane per ASTM D 4437/GM 19

Geomembrane Nominal Thickness	60 mils
Hot Wedge Seams ⁽¹⁾	
Shear strength ⁽²⁾ , lb/in	150
Peel strength ⁽²⁾ , lb/in	20
Hot-air Seams	
Shear strength ⁽²⁾ , lb/in	150 125
Peel strength ⁽²⁾ , lb/in	20

Notes:

1. Also for hot air seaming methods
2. Value listed for shear and peel strengths are for 4 out of 5 test specimens; the 5th specimen can be as low as 80% of the listed values.
3. For destructive samples which have failed the passing criterion, the Contractor will reconstruct all the field seams between any two previous passed seam locations which include the failed seam or will go on both sides of the failed seam location (10 feet minimum), take another sample each side and test both. If both pass, the Contractor may patch or cap strip the seam between the passed samples. If either fails, the Contractor will remove and replace the entire seam. In all cases, acceptable field seams must be bounded by two passed test locations. The decision of the CQA Engineer will be final.
 - a. In addition, all destructive seam sample holes shall be repaired the same day as cut.
 - b. Certified test results on all field seams shall be submitted to and approved by the CQA Engineer prior to acceptance of the seam.
4. All repaired areas shall be non-destructively tested and destructively tested as described in Part 3.1B.2.p (2) of this specification.
5. Destructive testing shall be performed by a CQA Testing Laboratory not employed by the Installer.
6. A map showing the locations, number and type of all patches shall be prepared and provided to the Owner.

7. Documentation: The following documentation must be maintained at the project site for review by the CQA Engineer or Inspector.
 - a. Geomembrane Installer's Documentation:
 - 1) Daily Log: daily record that summarizes panels deployed, seams completed, seam testing, seam repair, personnel on site, weather conditions, and equipment on site.
 - 2) Material Conformance: maintain original conformance certificate(s) from geomembrane manufacturer.
 - 3) Subgrade Acceptance Log: maintained originals of subgrade acceptance forms for each panel and signed by the Geomembrane Installer.
 - 4) Panel Log: provides geomembrane roll number used and subgrade acceptance for each panel deployed.
 - 5) Seam Testing Log: provides a complete record of all nondestructive and destructive seam tests performed as part of the Geomembrane Installer's QC program.
 - 6) Seam/Panel Repair Log: provides a complete record of all repairs and vacuum box testing of repairs made to defective seams or panels.
 - 7) As-Built Drawing: maintain an as-built drawing updated on a weekly basis.

3.3 DEFECTS AND REPAIRS

- A. All seams and non-seam areas of the geomembrane will be examined by the CQA Officer for evidence of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be swept or washed by the Geosynthetics Installer if surface contamination inhibits examination. The Geosynthetics Installer shall ensure that this examination of the geomembrane precedes any seaming of that section.
- B. Each suspect location, both in seam and non-seam areas, shall be nondestructively tested using the methods described, as appropriate. Each location that fails nondestructive testing shall be marked by the CQA Consultant and repaired by the Geosynthetics Installer. Work shall not proceed with any materials that will cover repaired locations until laboratory test results with passing values are available.
- C. When seaming of a geomembrane is completed (or when seaming of a large area of a geomembrane is completed) and prior to placing overlying materials, the CQA Consultant shall identify excessive geomembrane wrinkles. The Geosynthetics Installer shall cut and reseam all wrinkles so identified. The seams thus produced shall be tested like any other seams.
- D. Repair Procedures:
 1. Any portion of the geomembrane exhibiting a flaw, or failing a destructive or nondestructive test, shall be repaired by the Geosynthetics Installer. Several repair procedures are specified below. The final decision as to the appropriate repair procedure shall be agreed upon between the CQA Consultant and the Geosynthetics Installer. The procedures available include:
 - a. patching - used to repair large holes, tears, undispersed raw materials, and contamination by foreign matter;
 - b. abrading and reseaming - used to repair small sections of extruded seams;
 - c. spot seaming - used to repair small tears, pinholes, or other minor, localized flaws;
 - d. capping - used to repair long lengths of failed seams; and
 - e. removing bad seam and replacing with a strip of new material seamed into place (used with long lengths of fusion seams).
 2. In addition, the following shall be satisfied:
 - a. surfaces of the geomembrane that are to be repaired shall be abraded no more than one hour prior to the repair;
 - b. all surfaces must be clean and dry at the time of repair;
 - c. all seaming equipment used in repair procedures must be approved by Engineer;
 - d. the repair procedures, materials, and techniques shall be approved in advance, for the specific repair, by the CQA Consultant and Geosynthetics Installer;

- e. patches or caps shall extend at least 6 inches beyond the edge of the defect, and all corners of patches shall be rounded with a radius of at least 3 inches.; and
 - f. the geomembrane below large caps shall be appropriately cut to avoid water or gas collection between the two sheets.
- E. Each repair shall be numbered and logged and shall be nondestructively tested using the methods described in this section, as appropriate. Repairs that pass the nondestructive test shall be taken as an indication of an adequate repair. Failed tests will require the repair to be redone and retested until a passing test result is achieved. At the discretion of the CQA Consultant, destructive testing may be required on large caps at no additional cost to OWNER.

3.4 DOCUMENTATION

- A. The following documentation must be maintained at the project site for review by the CQA Engineer or Inspector as the Geomembrane Installer's Documentation:
- 1. Daily Log: daily record that summarizes panels deployed, seams completed, seam testing, seam repair, personnel on site, weather conditions, and equipment on site.
 - 2. Material Conformance: maintain original conformance certificate(s) from geomembrane manufacturer.
 - 3. Subgrade Acceptance Log: maintained originals of subgrade acceptance forms for each panel and signed by the Geomembrane Installer.
 - 4. Panel Log: provides geomembrane roll number used and subgrade acceptance for each panel deployed.
 - 5. Seam Testing Log: provides a complete record of all nondestructive and destructive seam tests performed as part of the Geomembrane Installer's QC program.
 - 6. Seam/Panel Repair Log: provides a complete record of all repairs and air lance testing of repairs made to defective seams or panels.
 - 7. As-Built Drawing: maintain an as-built drawing updated on a weekly basis.

3.5 GEOSYNTHETIC LINER SYSTEM ACCEPTANCE

- A. Contractor shall retain all ownership and responsibility for the geosynthetic liner system until final acceptance by the Owner.
- 1. Owner will accept the geosynthetic liner system installation when the installation is finished and all required warranties, test results, and documentation from the Contractor, Manufacturer, Inspector and Installer have been received and approved, and verification of the adequacy of all field seams and repairs, including associated testing, is complete.

END OF SECTION

SECTION 31 20 00

EXCAVATING, TRENCHING, BACKFILLING, AND GRADING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope: CONTRACTOR shall provide all labor, materials, and incidentals to excavate and trench designated areas, install pipe and appurtenances, haul (on-site) and install bedding and backfill material, compact backfill, and regrade disturbed areas as shown on the Drawings, and described in this Section.
- B. The WORK specified in this Section includes the trenching and trench backfilling activities associated with installation of modifications to the LFG extraction wells, LFG lateral and header pipe, horizontal collectors, air supply pipe, dewatering discharge line, and any other Work requiring drilling, excavation, trenching, trench backfilling, or grading.
- C. WORK under this Section includes trenching and grading activities inside of municipal solid waste (MSW) landfill areas.
- D. No classification of type of excavated materials will be made. Excavation includes all soil and refuse materials regardless of type, character, composition, moisture, or condition thereof.
- E. Any damage to existing features shall be repaired as directed by the ENGINEER, at the CONTRACTOR's expense.

1.02 PROJECT CONDITIONS

- A. Existing project conditions are shown on the Drawings or otherwise described herein.
- B. Site information has been obtained from existing records. It is not guaranteed to be correct or complete and is shown for the convenience of the CONTRACTOR. The CONTRACTOR shall explore ahead of the required excavation to determine the exact location of all structures, utilities, etc.
- C. Structures shall be supported and protected from damage by the CONTRACTOR. If structures are broken or damaged, CONTRACTOR shall restore structures, utilities, etc. to their original condition at no additional cost to the COUNTY. Repair of damaged features or structures shall be approved by the ENGINEER and COUNTY.

1.03 SITE ACCESS

WORK shall be performed so as to not block or hinder site access, except as authorized by the PROJECT MANAGER.

1.04 SAFETY

- A. All WORK shall be performed in strict accordance with the Health and Safety requirements set forth in the General Conditions of the Contract Documents.
- B. All WORK shall be performed in strict accordance with all local, State, U.S. Occupational Safety and Health Administration (OSHA) and other applicable Federal regulations regarding trenching operations and trench safety.
- C. Excavation may be made without sheeting and bracing within the limitations and requirements of the governmental agencies having jurisdiction. Failure of the ENGINEER to order the use of bracing or sheeting and shoring or direct changes to systems in place, shall not in any way or to any extent relieve the CONTRACTOR of any responsibility concerning the condition of excavations or of his obligations under the Contract. The CONTRACTOR shall be responsible for the condition of all excavations. All slides and caves shall be removed without extra compensation, at whatever time and under whatever circumstances that they may occur.
- D. All excavation shall comply with the applicable requirements as stated in the following:
 - 1. OSHA excavation safety standards 29 CFR, 1926-650, subpart P.
 - 2. State (Trench Safety Act Section 553.60-553.64 Florida Statutes) and COUNTY construction safety regulations.
 - 3. Trench safety guidelines as specified by the Landfill Gas Division of the Solid Waste Association of North America (SWANA).
- E. The CONTRACTOR shall include for any excavation, temporary controls for stormwater runoff and erosion control in full conformance with all existing facility permits and/or applicable regulations. Facility's current permits will be supplied at pre-construction meeting.

1.05 SUBMITTALS

- A. Health and Safety Plan.
- B. Results of sieve analysis and calcium carbonate test for No. 4 stone.
- C. Pipe slope calculations and survey notes for pre-construction layout, including lateral route, and air supply/dewatering discharge lines.

- D. Pipe survey notes for installed pipe pursuant to Part 3.06 of this Section.
- E. Proposed stationing and pipeline identification procedures. Prior to the start of any pipe installation, CONTRACTOR shall supply an example layout drawing showing how the header and laterals will be marked with stations for the conformance surveys. The example layout drawing and stations must be consistent with the requirements of Sections 01 30 10, 01 70 30, and 33 51 10 of the Contract Documents.
- F. CONTRACTOR daily logs detailing length of trench excavated and backfilled, with reference to pipe stationing and details sufficient to properly describe the WORK completed to date.
- G. The CONTRACTOR shall notify the ENGINEER in writing of the material source for each of the soils specified within Part 2 of this Section at least 14 calendar days prior to the date of anticipated use of such material. Notification shall include:
 - 1. Supplier's name.
 - 2. Borrow location.
 - 3. Documentation confirming adequate quantities are available to complete the WORK.
 - 4. Soil field-moisture, laboratory proctor-density tests, and field compaction test results as required within Part 2 of this Section.
 - 5. Certification that the soil is not petroleum-contaminated or contaminated with other chemicals or compounds that may be deemed hazardous or harmful to human health or the environment.

PART 2 - PRODUCTS

2.01 SAND BEDDING MATERIAL

- A. Clean dry sand shall be used for pipe bedding and backfill to at least 6 inches above the top of the installed pipe. Sand shall be coarse-grained and conform to the following gradation unless otherwise approved by the ENGINEER in writing.

<u>Sieve Size</u>	<u>% Passing (by weight)</u>
3/8"-inch	100
No. 4	95
No. 200	5

Sand shall be free of sticks, roots, vegetation, organic matter, and stones larger than 1-inch in any dimension.

2.02 NON-CALCAREOUS STONE

- A. Stone backfill shall be hard, durable non-calcareous rock. Stone shall be washed as a component of the manufacturing process and be free of organics, lumps or balls of clay, and other deleterious materials.

Stone shall be FDOT No. 4 and conform to the following gradation requirements:

<u>Sieve Size</u>	<u>% Passing (by Weight)</u>
2-inch	100
1½-inch	90
1-inch	35
¾-inch	5
⅜-inch	0

2.03 CLEAN SOIL BACKFILL MATERIALS

- A. Soil material may be reused for clean soil backfill provided it is free of sticks, roots, organic matter, MSW, and stones larger than 1-inch in any dimension. Remove any material that cannot be made to compact readily and replace with suitable material. If new material must be imported for use as clean soil backfill it must meet the criteria of this Specification and the testing requirements below.
- B. Material shall be well-graded (SW), poorly graded (SP) or clayey sands (SC) as classified by the Unified Soil Classification System (USCS), or other soil as approved by the ENGINEER.
- C. General Fill shall be used in the following areas of work and as shown on the Drawings:
1. Above the final cover system to ground surface in all trenches, unless specified otherwise on the Drawings.
 2. Any location on Drawings that calls for “general fill” or “clean soil backfill” if excavated material is waste or is otherwise not suitable for reuse.
- D. Clean soil backfill will be provided by COUNTY from onsite borrow pit to be loaded and transported to work area by CONTRACTOR.

2.04 SUBGRADE SOIL MATERIALS

- A. Subgrade soils are natural, in-place materials. Soils shall be well-drained and reasonably free of sticks, roots, debris, organic matter, and MSW. CONTRACTOR shall remove material that cannot be made to compact readily and replace with ENGINEER-approved soil.

- B. Soils which yield or exhibit pumping due to excessive moisture shall be excavated and replaced with general fill or materials as approved by the ENGINEER.

2.05 TOPSOIL

- A. Material shall be fertile, natural soil, typical of the locality, free from MSW, stones (exceeding 2-inch in any dimension), roots or sticks (exceeding 1-inch diameter), clay, and weeds, and obtained from naturally well drained areas. It shall not be excessively acid or alkaline nor contain material harmful to plant growth. The material shall comply with the requirements of FDOT's Standard Specifications for Road and Bridge Construction (2017), Section 987, prepared soil layer materials.

PART 3 – EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours and datum locations.
- B. Locate, identify and protect utilities from damage.
- C. Protect benchmarks, survey control points, monitoring wells, existing structures and fences from excavating equipment and vehicular traffic.

3.02 PRE-CONSTRUCTION LAYOUT

- A. Prior to trenching and pipe installation, CONTRACTOR and CONTRACTOR's surveyor shall stake out the entire proposed trench alignment. The proposed alignment must be approved by the ENGINEER and PROJECT MANAGER prior to the CONTRACTOR beginning excavation activities. This pipeline route staking for both header and lateral pipes must meet the minimum pipe slopes listed in this Section and on the Drawings.
- B. Survey notes with proposed pipe slope calculations shall be submitted to the ENGINEER for approval prior to pipe installation. Notes of pre-construction survey shall identify conflicts between the proposed WORK and existing features.

3.03 EXCAVATION

- A. Refuse materials shall be handled as directed in Section 02 41 16, Refuse Handling, Storage, and Disposal.
- B. Excavate to lines, grades and dimensions necessary to complete the WORK.
- C. Trenching Tolerances:

1. Excavate to install pipes in straight runs at a uniform grade, without sags or humps, between vertical and horizontal control points in accordance with the Contract Drawings.
 2. Minimum trench width shall be as shown on the Drawings.
 3. Maintain thickness of soil cover over the top of the pipe, as shown on the Drawings, or approved by the ENGINEER.
- D. CONTRACTOR may not excavate more trench daily than can be completely backfilled after installation of the pipe the same day. Excavations shall not be left open overnight. In the event that a trench must be left open overnight the CONTRACTOR must get permission from the COUNTY to leave trench open and trench must be encircled in safety/warning tape attached to stakes placed along the perimeter on all edges of the trench. In the event that the trench has exposed refuse, all refuse must be covered with a tarp that is secured on all corners and along its perimeter.
- E. CONTRACTOR shall use appropriate survey/level instrumentation during excavation to ensure proper trench slope. Verification of installed pipe slope shall be as specified in Part 3.06.
- F. Minimum trench slopes shall be at least 5 percent as shown on the Drawings or approved by the ENGINEER.

3.04 DEWATERING

- A. Water that enters excavations into refuse shall be considered landfill leachate and shall not be discharged to the ground or other means that are typical for stormwater. Water in trench excavations into refuse shall be pumped into sealed tanks, hauled to the main leachate pump station, or as directed by the PROJECT MANAGER, and discharged into the pump station. The CONTRACTOR must notify the COUNTY prior to dewatering, and allow the COUNTY to witness the dewatering and discharge to the leachate sump.
- B. The CONTRACTOR shall at all times during construction provide and maintain proper equipment and facilities to remove water entering excavations. CONTRACTOR shall keep such excavations dry so as to obtain a satisfactory foundation condition for all WORK.
- C. Do not allow water to accumulate in excavations. Remove water to prevent softening of foundation bottom, and soil changes detrimental to stability of subgrades and foundations. Subgrade soils which become soft, loose, "quick", or otherwise unsatisfactory for support of structure as a result of inadequate dewatering or other construction methods shall be removed and replaced by crushed stone or gravel as required by the ENGINEER at the CONTRACTOR's expense. The bottom of excavations shall be firm and without standing water

before placing structures or pipes. Provide and maintain pumps, well points, sumps, suction and discharge lines, and other dewatering system components necessary to convey water away from excavations.

D. Disposal of Water Removed by Dewatering System:

1. Water conveyed away from excavations which has not contacted refuse materials shall be discharged to areas approved by the ENGINEER.
2. Dispose of water by procedures approved by the ENGINEER in such a manner as to cause no inconvenience to the COUNTY, the ENGINEER, or others involved in work about the site.
3. Water conveyed away from excavations which has contacted refuse materials shall be pumped into spill-proof containers and discharged into the leachate sump as directed by the PROJECT MANAGER.

E. If pipe trench becomes watered-in after placement of pipe, but before backfilling, CONTRACTOR shall dewater the trench, demonstrate that the pipe bedding and pipe slope remain satisfactory, and upon approval by the ENGINEER, backfill the pipe with clean dry soil in accordance with Part 2.01 of this Section.

3.05 ROAD CROSSINGS

- A. CONTRACTOR shall schedule and coordinate all road crossings with the COUNTY to minimize disruption of the COUNTY's operations.
- B. HDPE pipes shall be encased in a larger diameter casing for protection. The inner diameter of the casing shall be a minimum of six (6) inches larger than the cumulative outside diameters of the HDPE pipes encased. Outer casing shall be N-12 pipe as manufactured by Advanced Drainage Systems, Inc. (800) 821-6710 or approved equivalent. See Drawings for road crossing details as applicable.

3.06 PIPE SURVEY

- A. CONTRACTOR shall verify that pipe slope meets the requirements specified in this Section and on the Drawings at 10-foot intervals along LFG laterals and header and record such information in the project notes. Station numbering shall be used and marked on the pipe, as approved by the ENGINEER.
 1. CONTRACTOR shall measure each length of installed pipe and mark the 10-foot stations. Stationing of laterals shall begin with 0+00 at the header, ending at the riser for the well.
 2. Stationing of the header shall begin with 0+00 at a location approved by the ENGINEER. Station numbering for pipe installed each day shall be consecutive with pipe installed on previous days. The CONTRACTOR

shall not restart station numbering at 0+00 for any header segment without advance approval from the ENGINEER.

3. Survey equipment shall be used to measure the change in relative elevation between each 10-foot station prior to burial of any pipe.
 4. The surveyed elevations and calculated change in elevation and slope for each 10-foot section shall be recorded in the CONTRACTOR's project notes.
 5. A trench laser will not be considered acceptable survey equipment for the purpose of verifying pipe slope.
- B. The project notes detailing the required pipe slope confirmation shall be provided daily to the ENGINEER.
- C. An as-built survey shall be conducted on all installed pipe prior to backfilling the trench.
1. The survey shall document the horizontal and vertical location of the top of the landfill gas laterals, air supply lines, condensate discharge line and drain line pipes at minimum 50-foot intervals and at each change in pipe direction, ground surface grade break, change in pipe grade, fitting, connection, pipe crossover, and tie-in along the entire pipeline routes.
 2. If a run of pipe is 100 feet or less in length, CONTRACTOR shall provide survey shots at a 20-foot interval or less. For a run of pipe of 50 feet or less, CONTRACTOR shall provide survey shots at a 10-foot interval or less to document the pipe as-built conditions.
 3. The survey shall also document the type of pipe, location (horizontal and vertical coordinate) of structures and appurtenances such as, but not limited to road crossing casing, pipe crossing, and tie-ins.
 4. This surveying shall be sealed by a Florida Licensed Land Surveyor as described in Section 01 70 30, Project Record Documents.

3.07 BACKFILLING

- A. Backfill materials shall be as described in Part 2 of this Section.
- B. CONTRACTOR shall notify the ENGINEER prior to beginning backfilling. The ENGINEER shall inspect all pipe, fittings and connections prior to approving backfilling. If CONTRACTOR backfills pipe without inspection of the pipe while pipe is installed in the open trench, CONTRACTOR shall uncover all uninspected buried pipe so that it may be properly inspected. This shall be done at no additional cost to the COUNTY or ENGINEER.

- C. Place bedding material in trench to the lines and grades shown on the Drawings.
- D. Bedding material (sand) shall be placed in the trench ensuring material is placed under the haunch of the pipe. The bedding shall be poured into place, not pushed, and shall be raked by hand and then compacted, using a mechanical compaction device such as walk-behind vibratory compactor, in a loose lift not to exceed six (6) inches above the top of the pipe.
- E. Backfilling procedures shall be modified as necessary as approved by the ENGINEER in order to not displace (either horizontally or vertically) piping installed in the trench during backfill or bedding placement.
- F. Place soil backfill in maximum 6 inch lifts above pipe bedding to the existing grade. CONTRACTOR shall compact soil backfill in 6-inch lifts with mechanical compaction such as a walk-behind vibratory compactor or excavator bucket. Compaction shall be to a density where subsequent passes with the mechanical compaction device will not reduce the surface elevation of the bedding material by more than three-quarters of an inch.

3.08 REFUSE DISPOSAL

The CONTRACTOR shall be responsible for loading and transporting refuse to the working face as specified in Section 02 41 16. No excavated waste shall be left overnight at any excavation at any time.

3.09 GRADING DISTURBED AREAS

CONTRACTOR shall regrade and return to their original condition, as determined by the PROJECT MANAGER and ENGINEER, all areas disturbed by CONTRACTOR's work. This includes, but is not limited to ruts caused by construction equipment, soil stockpile areas, and landfill benches and terraces used for access.

3.10 TESTING REQUIREMENTS DURING PLACEMENT

- A. The CONTRACTOR shall place backfill and fill materials to achieve an equal or "higher" degree of compaction than undisturbed materials adjacent to the work; however, in no case shall the degree of compaction fall below minimum compaction specified in this Section.
- B. Where laboratory or field testing is specified herein to verify that the constructed, in-place WORK meets the specifications and quality control requirements herein, the CONTRACTOR shall employ and bear the expense for an independent testing laboratory to conduct such tests. The CONTRACTOR shall pay for the costs of all retests required due to the initial testing not passing the requirements herein. Laboratory shall be on the approved vendors list of the COUNTY.

Where laboratory testing is specified to verify that any individual material of

construction or product meets certain quality control requirements (i.e. size, gradation, mix formula, hardness, shape, inherent strength, etc.), the CONTRACTOR shall employ and bear all expenses for an independent testing laboratory to sample the material or product and to conduct such tests and retests if necessary or required by the COUNTY.

END OF SECTION

SECTION 33 21 70

LFG EXTRACTION WELLS AND WELLHEADS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The CONTRACTOR shall provide all labor, equipment, materials, and appurtenances necessary to drill, install and make ready landfill gas (LFG) extraction wells and wellheads as specified herein and as indicated on the Drawings.
- B. The perforated pipe, gravel stone, geotextile, bentonite, and soil backfill shall be set at depths and thicknesses shown on the Drawings or as designated in the field by the ENGINEER. It is expected that combustible and asphixiant gases will be venting from boreholes drilled in to waste within the footprint of the landfill. The CONTRACTOR's bid price shall include provision for all equipment and procedures necessary to safely install wells and borings under this condition. All Work shall be performed by qualified workers in accordance with the best standards and practices available.
- C. Upon completion of each new extraction well or boring, CONTRACTOR shall dispose of all construction and drilling refuse materials as specified in Section 02 41 16 or as directed by the PROJECT MANAGER.
- D. Related Work Described Elsewhere:
 - 1. Section 02 41 16: Refuse Handling, Storage, and Disposal
 - 2. Section 31 20 00: Excavating, Trenching, Backfilling and Grading
 - 3. Section 31 51 10: Pipe and Pipe Fittings

1.02 REFERENCES

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) STANDARD TEST METHODS/PRACTICE

ASTM D 420-98	Standard Guide to Site Characterization for Engineering, Design, and Construction Purposes
ASTM D 422-63	Standard Method for Particle-Size Analysis of Soils
ASTM D 1452-80	Standard Practice for Soil Investigation and Sampling by Auger Borings

ASTM D 2487-00 Standard Classification of Soils for Engineering
Purposes (Unified Classification System)

ASTM D 2488-00 Standard Practice for Description and Identification
of Soils (Visual-Manual Procedure)

1.03 SUBMITTALS

- A. The CONTRACTOR shall prepare and submit to the ENGINEER, for review and approval, Certificates of Compliance on materials furnished, and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, and inspection of pipe and appurtenances furnished as described in Contractor Submittals.
- B. The CONTRACTOR shall prepare and submit to the ENGINEER for review and approval, Shop Drawings showing dimensions, materials, and manufacturer's information for pipe, pipe perforations, fittings, bentonite, and wellhead components.
- C. One week prior to well drilling, CONTRACTOR shall submit an example well boring log and construction log. The example log shall be completed with all of the required descriptions and pertinent information required under Part 3.04 of this Section.
- D. At least two weeks prior to construction, the CONTRACTOR shall submit to the ENGINEER for review and approval, results of the sieve analysis for the soil backfill, samples of all well backfill materials (if requested), the name of the vendor(s), and source of backfill materials furnished.
- E. At the end of each day, CONTRACTOR shall provide copies of the handwritten well boring and completion logs for each well drilled on that day. Information to be included on the well logs is listed in Part 3.04 of this Section.
- F. Final boring logs based on field information shall be typewritten and submitted with the Record Documents. Description of the boring and excavated material shall be according to the attached well boring log template at the end of this Section.

1.04 QUALITY ASSURANCE

- A. A professional experienced in installation of LFG wells shall be responsible for observing and documenting information related to all boring and installation activities. The OWNER will contract with the quality assurance professional that will oversee and observe the extraction well installation.
- B. Inspect well materials for cleanliness, deformations, and imperfections, and ensure conformance with Specifications prior to use.

PART 2 - PRODUCTS

2.01 SOIL

Soil backfill material shall be granular material free of clay, sticks, roots organic material from an off-site source, as specified in Section 31 20 00.

2.02 STONE

Stone shall be FDOT No. 4 stone as specified in Section 31 20 00 Part 2.02

2.03 BENTONITE

- A. “Bentonite Plug” as used in the Drawings, shall refer to a well seal comprised of hydrated sodium bentonite pellets or chips of a thickness as indicated on the Drawings. Bentonite material shall consist of clay greater than 85% sodium montmorillonite, without additives.
- B. Bentonite shall be hydrated per manufacturer’s instructions prior to backfilling with soil. Bentonite shall be hydrated in 6-inch lifts as per Paragraph 3.05 B of this Section.
- C. Under no circumstances will the use of granular bentonite be permitted for the vertical extraction wells.

2.04 HDPE PIPE

- A. Pipe for extraction wells shall be 8-inch Standard Dimension Ration (SDR) 9 High Density Polyethylene (HDPE) pipe as shown on the Drawings and conforming to the requirements of Section 33 51 10 Part 2.02
- B. The perforations in the extraction well piping shall be as specified on the Drawings.

2.05 WELLHEAD MATERIALS

- A. Wellheads shall be Precision Quick-Change™ orifice plate wellheads provided by QED Environmental.

2.06 MONITORING PORTS

- A. Monitoring ports shall be Easy Port™ ¼ inch male NPT screw-capped “long” barb fittings as supplied by QED Environmental, model no. 40987.

2.07 WELL IDENTIFICATION

- A. Upon completion of well drilling, CONTRACTOR shall paint the well identification number on the well casing using 3-inch tall stenciled letters and white or yellow paint. Lettering any other means shall not be permitted.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION SERVICES

- A. The CONTRACTOR shall survey and stake the well boring locations prior to drilling. Pre-construction layout surveying shall be done by a Florida Licensed Professional Surveyor.
- B. CONTRACTOR shall supply surveyed ground elevations of the proposed new extraction wells to the ENGINEER so that the design well depths may be confirmed at least one week prior to drilling.
- C. Extraction well and boring locations must be approved and may be adjusted by the ENGINEER prior to beginning drilling.

3.02 DRILLING

- A. The CONTRACTOR shall coordinate the start of drilling with the ENGINEER and PROJECT MANAGER.
- B. The CONTRACTOR shall provide at all times a thoroughly experienced, competent driller during all operations at the drill site.
- C. The CONTRACTOR must use dry drilling equipment.
- D. Wells are to be drilled to the depth and diameter as shown on the Drawings. The boring depths shown on the Drawings may be adjusted in the field by the ENGINEER. Under no circumstances are the drilling depths from the well schedule on the Drawings to be exceeded unless approved by the ENGINEER in advance.
 - 1. Wet Borings:
 - a. The PROJECT MANAGER and ENGINEER shall be notified of wet boring conditions.
 - b. If water is encountered in a boring, the CONTRACTOR may be directed by the PROJECT MANAGER and ENGINEER to drill beyond the point at which it was encountered. If wet conditions remain, at the direction of the PROJECT MANAGER and ENGINEER, the boring may be terminated (after driller has attempted to advance boring for 2 hours) and the length of perforated pipe adjusted by the ENGINEER. If wet conditions

cease (e.g., due to a perched water layer), then drilling will continue to the design depth.

- c. If water is encountered in a boring at a shallow depth, the ENGINEER may decrease the well depth and length of perforated pipe, or relocate the well.

2. Abandoned Borings:

- a. If, in the opinion of the PROJECT MANAGER and ENGINEER, the borehole has not reached a sufficient depth to function as an effective extraction well, the CONTRACTOR shall abandon this borehole by backfilling it with cuttings removed during drilling. Soil shall be backfilled and compacted to ground surface. CONTRACTOR shall supply additional soil backfill to refill any settlement within the abandoned borehole, as approved by the ENGINEER.
- b. If cuttings are unsuitable as backfill (for example, box springs, tires, etc.) the CONTRACTOR shall use soil backfill material.
- c. Compensation for abandoned borings shall be at the unit price for boring refusal.

E. The bore for the well shall be straight and the well pipe shall be installed in the center of the borehole.

- 1. The CONTRACTOR shall take all necessary precautions to maintain the well pipe vertically plumb during the entire backfill operation of the borehole to the satisfaction of the ENGINEER.
- 2. The grate over the borehole that is used to keep the well casing plumb shall not be removed until the borehole is backfilled to within 2 feet of ground surface.
- 3. If the pipe is installed out of plumb, as determined by the ENGINEER, the CONTRACTOR, at his own expense, shall correct the alignment.
- 4. The well casing shall extend above ground surface as shown on the drawing. No pipe couplings shall be installed above grade or within 10 feet of ground surface below grade.

3.03 WELL LOGS

- A. CONTRACTOR shall keep detailed well logs for all wells drilled. Information recorded on the well logs shall include the following:
1. Total depth of well.
 2. Visual description of refuse at 5-foot intervals:
 - a. Type of refuse encountered including the estimated percentage of the following components (by volume) on visual inspection:
 - Paper/Cardboard
 - Plastic
 - Yard refuse
 - Construction debris
 - Textiles
 - Tires
 - Sludge
 - Dirt
 - b. Moisture content (in percentages) based on the guidelines attached to the end of this Section.
 - c. State of decomposition based on the guidelines attached to the end of this Section.
 - d. Temperature of excavated refuse
 3. Occurrence, depth, and thickness of water-bearing zones
 4. Length of slotted pipe and solid pipe below grade.
 5. Thickness, description and depth from ground surface of backfill layers.
 6. Length of above ground riser stick-up pipe.
- B. CONTRACTOR shall use the well borings description sheet provided at the end of this Section as a guideline for describing excavated materials.
- C. Field copies of the well logs shall be provided to the ENGINEER. If the CONTRACTOR fails to provide field copies of well logs to the PROJECT MANAGER at the end of each day, the CONTRACTOR will not be allowed to conduct any further drilling activities until the logs have been submitted and reviewed by the ENGINEER.
- D. Typed final copies of the well logs shall be submitted with the Record Drawings in accordance with Section 01 70 00. Handwritten logs will not be acceptable for submittal with the Record Drawings.

3.04 JOINING OF PIPES

- A. Pipes shall be joined as specified in Section 33 51 10, Pipe and Pipe Fittings, Section 3.04 Part B.
 - 1. Heat fusion joints shall be made in accordance with manufacturer's step-by-step procedures and recommendations.
 - 2. Mechanical joining shall be accomplished with HDPE flange adapters, neoprene gaskets, and ductile iron back-up flanges, and shall be used only where shown on the Drawings.
- B. At the end of each day, CONTRACTOR shall cap the ends of all joined pipes longer than 20 feet to prevent entry by animals and debris.

3.05 BACKFILLING

- A. Backfilling of the well shall commence immediately after well drilling is completed and the well piping has been installed in the borehole.
 - 1. Backfill materials shall be placed carefully within the wells to the dimensions shown on the Drawings and as approved by the ENGINEER.
 - 2. Tire chip and soil backfill containing foreign material may be rejected by the PROJECT MANAGER or ENGINEER on the basis of a visual examination.
 - 3. Both well piping and backfill shall be installed with a safety grate installed over the boring. The safety grate shall remain in place until backfill is within 2 feet of existing ground surface.
- B. Bentonite Plug shall be backfilled and hydrated in 6-inch lifts. The CONTRACTOR shall soak each lift according to the manufacturer's instructions prior to filling the next one. A minimum of 6 bags of bentonite shall be poured into the center of the borehole per 6-inch lift.
- C. Soil backfill shall be rodded in the boring to provide even distribution and compaction.

3.06 REFUSE DISPOSAL

The CONTRACTOR shall dispose of excavated refuse as specified in Section 02 41 16- Refuse Handling, Storage, and Disposal.

3.07 TEMPORARY CAP

The CONTRACTOR shall temporarily cap the riser pipe of the vertical extraction well immediately after well pipe installation to prevent venting of LFG into the atmosphere. The CONTRACTOR shall remove this cap during the installation of the wellheads. Lag screws may be necessary due to the internal gas pressure within the well.

3.08 WELLHEAD INSTALLATION

- A. Vertical extraction well and horizontal collector wellheads shall be installed in accordance with manufacturer's recommendations. PVC pipe sections of the wellhead shall be air-tight. Any leaks shall be repaired by CONTRACTOR at no additional cost to the COUNTY.
- B. Install flexible Kanaflex hose on all wells so that hose has no sags, as shown on the Drawings. However, flexible hose shall not be taut. Provide enough slack to accommodate minor pipe settlement, as approved by the ENGINEER.

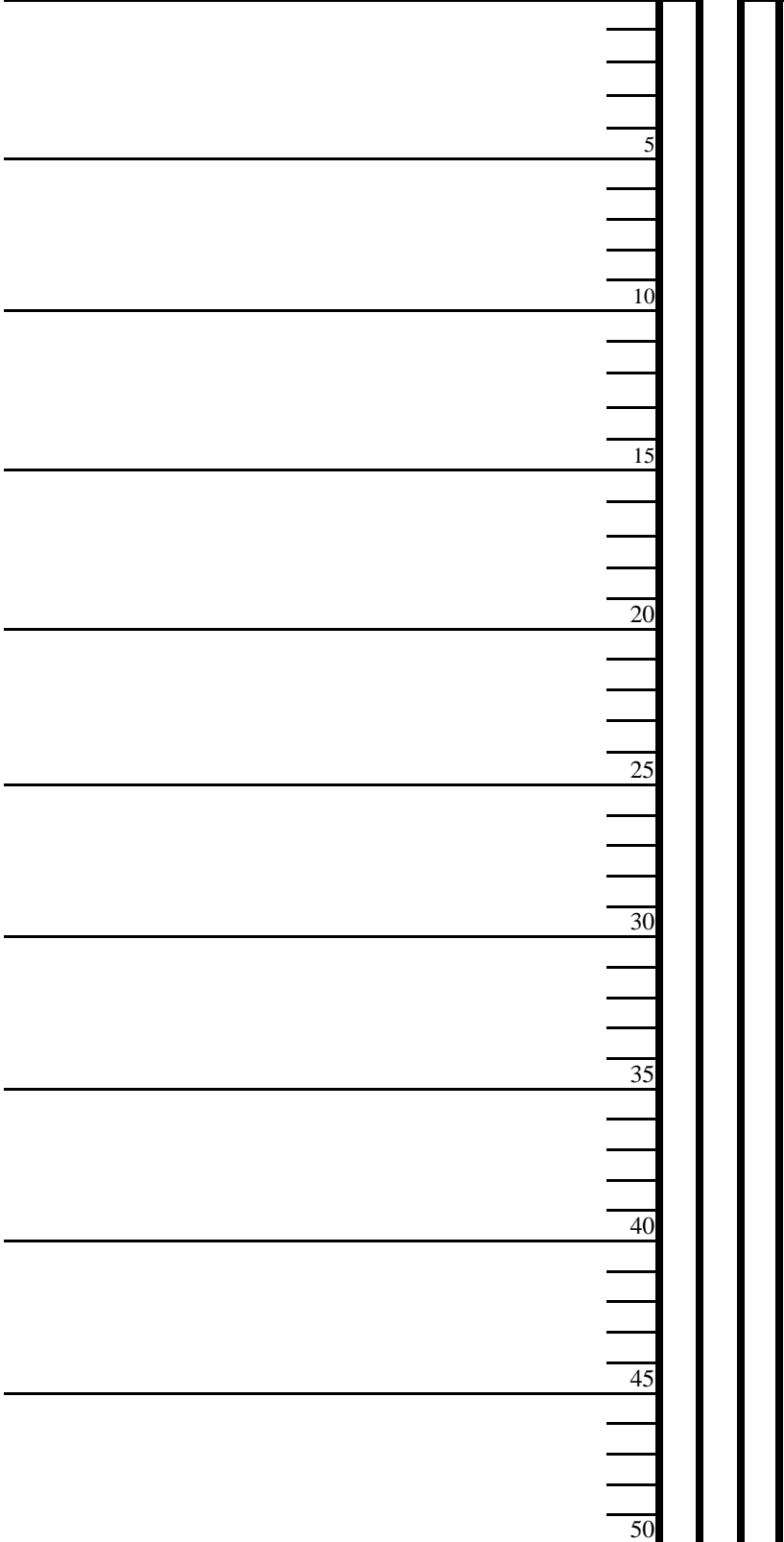
ATTACHMENT 33 21 70 - 1 Well Boring Log Template

END OF SECTION

Well Log - SCS Engineers

Site Name: _____ Well Number: _____
 Project #: 09206066.10 Coordinates: _____
 Start Date: _____ Surface Elevation: _____
 Completed: _____ Top of Casing Elevation: _____

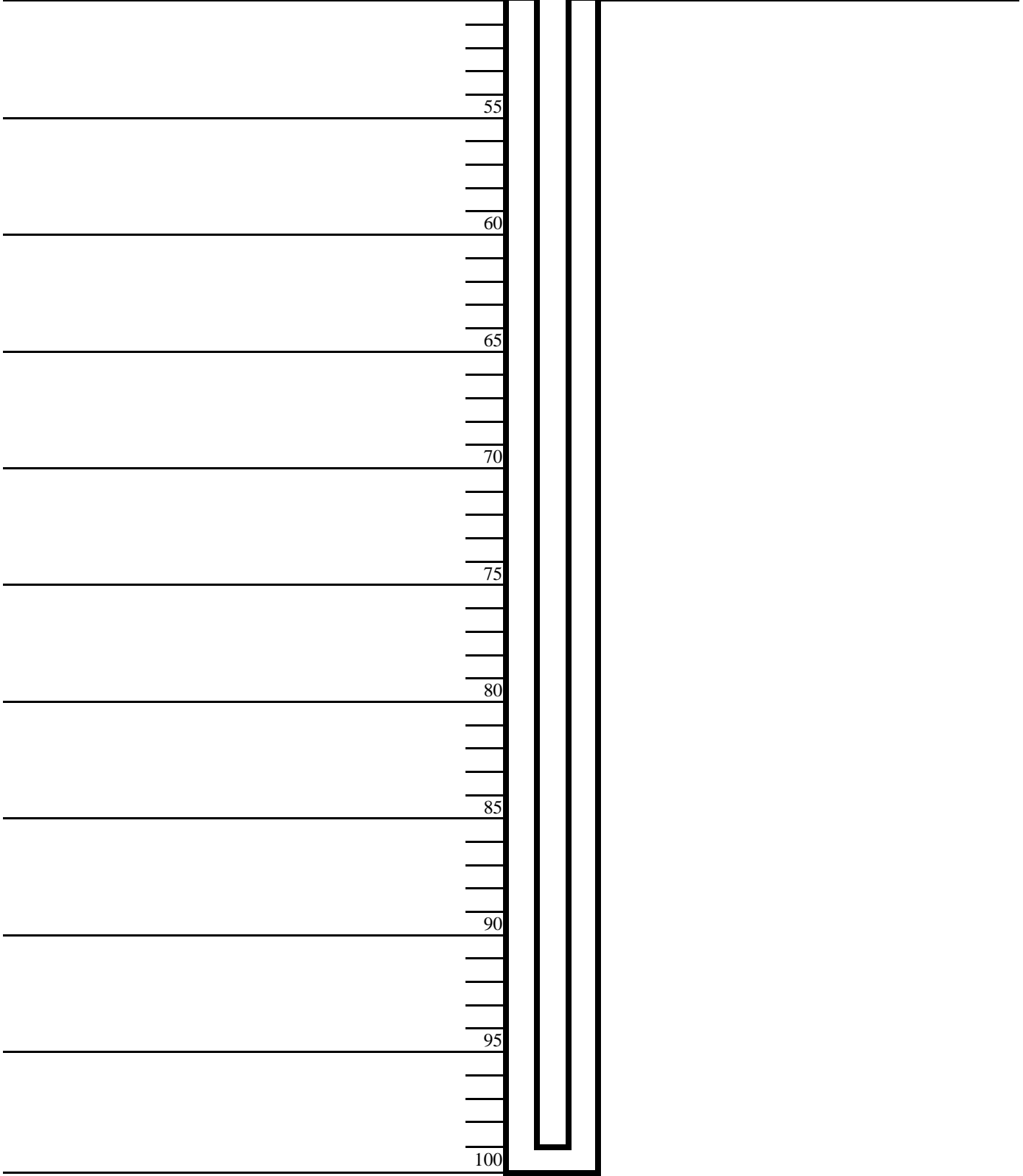
Contractor: _____ Boring Diameter: _____
 Inspector: _____ Pipe Material Diameter: _____
 Driller: _____ Total Depth Drilled: _____
 Completion: _____



COMPLETION LOG	
RISER STICK UP	
RISER BELOW	
PERF. PIPE	
BACKFILL	
BENTONITE #1	
SILICA SAND 20/30	
BENTONITE #2	
BACKFILL	
GRAVEL PACK	
BACKFILL LOG	
Stone	
Structural fill	
Bentonite fill	
MATERIALS LIST	
TOP CAP	
SOLID PIPE	
PERF PIPE	
BOTTOM CAP	
BENTONITE	
BACKFILL	
STONE	

Well Log - SCS Engineers

Site Name:	Well Number:
Project #: 09206066.10	Coordinates:
Start Date:	Surface Elevation:
Completed:	Top of Casing Elevation:
Contractor:	Boring Diameter:
Inspector:	Pipe Material Diameter:
Driller:	Total Depth Drilled:
	Completion:



SECTION 33 21 70

LANDFILL BOREHOLE AND WELL LOGGING GUIDANCE – REFUSE

Moisture Content Scale

15% Dry Refuse	20-25% Normal	25-35% Damp	35-50% Wet	50% Saturated
Rock, dirt, etc; no trace of moisture paper will be fuzzed up	Newspaper, etc; still not noticeably wet but normal moisture	Paper shows dampness lawn clippings, tree branches, stiff & hold together	Paper saturated but no free water, just getting sloppy; water emanates when squeezed	Mud or free water present

Decomposition Scale

Little	Some	Moderate	Much	Severe
Newspaper readable; refuse looks new		Newspaper not legible; branches intact		Newspaper not legible; crumble; black/brown mucky material

Log the following (in 5' intervals):

- Note apparent Intermediate cover thickness and presence of intermediate cell cover
- Ratio of refuse to cover soil
- Degree of compaction (i.e., loose, moderate, tight)
- Composition description (i.e., household, garden, commercial, demolition, sludge, medical, or other)
- Percent of refuse components (plastic, metal, yard waste, etc.)
- Note color and unusual odors or appearances
- Degree of decomposition
- Percent of moisture
- Approximate dates of refuse as an indicator (only) of dates of placement (i.e., newspaper, etc.)
- Refuse temperature
- Gas presence and relative pressure and temperature
- Presence of perched or free liquid
- Note elevations and observations of changes in refuse/soil/liquid conditions

SECTION 33 21 80

LANDFILL GAS COLLECTION SYSTEM APPURTENANCES

PART 1 - GENERAL

1.01 GENERAL

- A. The CONTRACTOR shall furnish all labor, materials, equipment and incidentals necessary to perform all work and services for complete installation of landfill gas collection system appurtenances as shown on the drawings and as specified, in accordance with provisions of the Contract Documents.
- B. The WORK shall include, but not necessarily be limited to construction of LFG extraction wells, installation of pneumatic pumps, valves, valve vaults, condensate trap assemblies, sumps, access risers, blind flanges, installation of pipe, fittings, and connections, bentonite/soil seal, and gravel, as specified and as shown on the drawings.

1.02 SUBMITTALS

- A. Materials shall not be incorporated in construction until approved by the COUNTY and ENGINEER.
- B. The CONTRACTOR shall notify the COUNTY of the source of all materials and shall furnish a representative sample for approval, at least ten calendar days prior to the date of anticipated use of such material.

PART 2 - PRODUCTS

2.01 PNEUMATIC PUMPS

- A. The pneumatic pumps shall be QED AutoPump bottom inlet model Short AP4⁺B. The pump shall have screens, casings and fittings, and a hose and hardware package with 1-inch discharge hoses and ¾ inch air hoses.

2.02 WELL CAPS

- A. The well caps shall be QED 8-inch well diameter wellheads without fittings, model number GWC82.

2.03 HIGH LEVEL INDICATOR

- A. The high liquid level indicator shall be QED supplied Easy Level™ Liquid Level Indicator, model number 40363 with QED supplied bubbler tubing model number 40360.

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 33 51 10

PIPE AND PIPE FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The CONTRACTOR shall supply all materials, equipment, and labor needed to install complete and make ready for use all pipe, pipe fittings, and valves as specified herein and as indicated on the Drawings.
- B. Related Work Described Elsewhere
 - 1. Section 31 20 00 - Excavating, Trenching, Backfilling and Grading
 - 2. Section 33 21 70 - LFG Extraction Wells and Wellheads
 - 3. Section 44 42 60 - Condensate Management System

1.02 SUBMITTALS

- A. The CONTRACTOR shall prepare and submit to the ENGINEER, for review and approval prior to commencement of construction, certificates of compliance on materials furnished and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, inspection, maintenance, and repair of each type of pipe, pipe fitting, and valve furnished.
- B. The CONTRACTOR shall prepare and submit Shop Drawings to the ENGINEER for review and approval. The Shop Drawings shall show the following:
 - 1. All dimensions, slopes, and invert elevations at connections to existing pipes.
 - 2. All tie-ins to the existing leachate collection system shall be field-verified and shown on the Shop Drawings. This shall include pipe size and burial depth at a minimum.
 - 3. Pipe Dimensions for each pipe size used:
 - a. Average outside diameter.
 - b. Average inside diameter.
 - c. Minimum average wall thickness.
 - 4. Each pipe and fitting size to be used.

1.03 REFERENCE

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only. Use of the most recent version is required.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 1248	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
ASTM D 1784	Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
ASTM D 1785	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
ASTM D 2321	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and other gravity-flow applications.
ASTM D 2467	Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D 2513	Standard Specification for Thermoplastic Gas Pressure Pipe Tubing and Fittings
ASTM D 2564	Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems
ASTM D 2774	Standard Practice for Underground Installation of Thermoplastic Pressure Piping
ASTM D 2855	Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings
ASTM D 3261	Butt Head Fusion Polyethylene (PE) Plastic Fittings for Polyethylene Plastic Pipe and Tubing
ASTM D 3350	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

AMERICAN NATIONAL STANDARD INSTITUTE (ANSI)

ANSI B 31.8	Code for Pressure Piping, Appendix N
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PART 2 - PRODUCTS

2.01 FLEXIBLE PVC PIPE ON WELLHEADS

- A. Flexible PVC pipe shall be UV-Resistant Solarguard™ Flexible Hose supplied by QED Environmental, model number 40946.
- B. Fasteners for flexible PVC pipe shall be high strength stainless steel banding kits supplied by QED Environmental, model number 40979.

2.02 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. General:
 - 1. All HDPE pipe and fittings 4-inch diameter and greater as indicated on the Drawings shall be Standard Dimension Ratio (SDR) 17 high density polyethylene pipe using a 3608 type resin or approved equal. HDPE pipe and fittings for landfill gas or condensate flow that are 2-inch diameter and less shall be SDR 11 or as indicated on the Drawings.
 - 2. Air supply pipes and fittings shall be 2-inch diameter SDR 9 with yellow striping.
 - 3. Pipe shall be extruded from a Type III, Class C, Category 5, Grade P36 compound as described in ASTM D 1248. It shall be classified as cell 345464C according to ASTM D 3350 and have the material designation of PE 3408. The pipe shall be manufactured to meet the requirements of ASTM D 2513. Manufacturer's literature shall be adhered to when "manufacturer's recommendations" are specified. All pipe and fittings shall be provided by one manufacturer. Acceptable manufacturers include Performance Pipe (800-527-0662), or approved equal.
- B. HDPE Fittings
 - 1. Fittings shall be manufactured from polyethylene compound having cell classification equal to or exceeding the compound used in the pipe.
 - 2. All fittings 12 inches and smaller shall be molded, unless approved by the ENGINEER.
- C. All pipe and fittings must be supplied by the same manufacturer.

2.03 FLANGES FOR HDPE PIPE

- A. Flanges for HDPE pipe shall be convoluted ductile iron back-up rings with a minimum thickness of 1-inch, as manufactured by Improved Piping Products, Inc. (800) 969-0962, of Orinda, California or approved equal. Hardware and fittings shall be stainless steel, finished with blue primer, and epoxy coated.

- B. The studs, nuts, and washers for the flanges shall be stainless steel. All below grade studs, nuts, and washers shall be thoroughly coated with Polyken Technologies 1027 Primer, or rubberized emulsion undercoating spray, or approved substitute, with no gaps in coverage. Below grade flanges shall be wrapped in 5-mil polyethylene sheeting just after installation and prior to backfilling to help prevent corrosion.
- C. Flange gaskets shall be full-face Neoprene.

2.04 PIPE MARKINGS

All PVC and HDPE pipe shall be stamped by the manufacturer with the following information at five foot intervals:

- A. Manufacturer name or trademark
- B. Nominal pipe size
- C. Type of plastic (e.g., PE 3608)
- D. Standard dimension ration (SDR) or Schedule (SCH) value
- E. ASTM designations (i.e., ASTM D 2513)

2.05 VALVES

- A. All valves shall be complete with all necessary operators and other accessories or appurtenances which are required for the proper completion of the WORK. Operators and other accessories shall be sized and furnished by the valve supplier and factory mounted.
- B. Valves and operators shall be suitable for the exposure they are subject to, e.g., buried and landfill gas. Valves shall have all safety features required by OSHA.
- C. Unless otherwise shown, valves shall be the same size as the adjoining pipe.
- D. Valve position indicators shall be installed correctly to properly identify the valve position.
- E. Valve spacers shall be used for all valves 6 inches and larger.

2.06 PIPELINE LOCATOR/WARNING TAPE

- A. For LFG header and laterals as shown on the Drawings, tape shall be a standard locator/warning tape imprinted with the words "Caution Gas Line Buried Below," as supplied by Reef Industries, Inc. (800-231-6074), or approved equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Pipe shall be stored or stacked so as to prevent damage by marring, crushing, or piercing. Maximum stacking height shall be limited to 6 feet.
- B. Pipe and pipe fittings shall be handled carefully in loading and unloading. They shall be lifted by hoists and lowered on skidways in such a manner as to avoid shock. Derricks, ropes, or other suitable equipment shall be used for lowering the pipe into the extraction well borings. Pipe and pipe fittings shall not be dropped or dumped.

3.02 FIELD QUALITY CONTROL

- A. Pipe may be rejected for failure to conform to the Specifications or for the following reasons:
 - 1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 inches in length at either end of the pipe which could be cut off and discarded. Pipes within one shipment shall be rejected if defects exist in more than 5 percent of shipment or delivery.
 - 2. Cracks sufficient to impair strength, durability or serviceability of pipe.
 - 3. Defects indicating improper proportioning, mixing, or molding.
 - 4. Damaged ends, where such damage prevents making a satisfactory joint.
 - 5. Scratches or gouges of depth greater than 10 percent of pipe wall thickness.
- B. Acceptance of fittings, stubs, or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation of conformance to these Specifications.
- C. The ENGINEER shall be notified by CONTRACTOR prior to burial of pipe.
- D. The PROJECT MANAGER and ENGINEER reserve the right to require destructive testing of any fusion weld on HDPE pipe.

3.03 FLEXIBLE PVC PIPE CONNECTIONS

Connections to pipe shall be made with clamps in accordance with manufacturer's step-by-step procedures and recommendations, and as approved by the ENGINEER.

3.04 HDPE PIPE HANDLING

- A. HDPE pipe shall not be bent more than the minimum radius recommended by the manufacturer for type, grade, and SDR. Care shall be taken to avoid imposing strains that will overstress or buckle the HDPE piping or impose excessive stress on the joints.
- B. Joining HDPE Pipe:
 - 1. Only two methods shall be utilized to join HDPE pipe: heat fusion and mechanical joining.
 - a. Mechanical Joining shall be accomplished with HDPE flange adapters, neoprene gaskets, and ductile iron back-up flanges, and shall be used only where shown on the Drawings. Refer also to Part 3.09.
 - b. Heat Fusion joints shall be made in accordance with manufacturer's step-by-step procedures and recommendations.
 - 1) Fusion equipment and a trained operator shall be provided by the CONTRACTOR. Pipe fusion equipment shall be of the size and nature to adequately weld all pipe sizes and fittings necessary to complete the project (refer to Part 2.10).
 - 2) Branch saddle fusions shall be made in accordance with manufacturer's recommendations and step-by-step procedures. Branch saddle fusion equipment shall be of the size to facilitate saddle fusion within the pipe trench.
 - 3) Heat fusion shall be performed outside of the trench whenever practical.
 - 4) Before heat fusing pipe, each length shall be inspected for the presence of dirt, sand, mud, shavings, and other debris, and any foreign material shall be completely removed.
 - 5) At the end of each day, all open ends of fused pipe shall be capped or otherwise covered to prevent entry by animals or debris.
 - c. As per the manufacturer's instructions, no fusion shall be performed in precipitation unless a shelter is provided.

3.05 HDPE PIPE INSTALLATION

- A. Pipe installation shall comply with the requirements of ASTM D 2321, PPI TR-31/9-79, and the manufacturer's recommendations.
- B. Lengths of fused pipe to be handled as one segment shall not exceed 500 feet.
- C. The PROJECT MANAGER or the ENGINEER shall be notified prior to any pipe being installed in the trench in order to have an opportunity to inspect the following items:
 - 1. All butt and saddle fusions.
 - 2. Pipe integrity.
 - 3. Trench excavation and bedding material for rocks and foreign material.
 - 4. Proper trench slope.
 - 5. Trench contour to ensure the pipe will have uniform and continuous support.
 - 6. Proposed backfill sand and soil.
- D. Any irregularities found by the ENGINEER during this inspection must be corrected before lowering the pipe into the trench. Pipe shall be allowed sufficient time to adjust to trench temperature prior to any testing, segment tie-ins, and/or backfilling.
- E. Tie-ins shall be made out of the trench whenever possible. When tie-ins are to be made in a trench, a bell hole shall be excavated large enough to ensure an adequate and safe work area.
- F. Below grade piping shall be marked with warning tape to be buried in the trench above the pipe as indicated on the Drawings.
- G. CONTRACTOR shall collect all pipe shavings and discard in a trash receptacle. Shavings shall not be left on the ground.
- H. All installed HDPE pipe shall be marked in 10-foot intervals corresponding to the stationing required for slope confirmation and conformance surveying. For main pipeline, station numbering shall be continuous and sequential. Station numbering shall be referenced in daily logs to document pipe installation progress.

3.06 FLANGED CONNECTIONS

- A. For flanged connections in virgin soil, the CONTRACTOR shall wrap and tape the flanges and bolts in 5 mil polyethylene sheeting prior to backfilling to help protect the assembly from corrosion.

- B. Flanges shall be joined with stainless steel studs and nuts. Stud lengths shall accommodate the required distance between flanges including valve spacers, if necessary.
- C. For flanged connections within the limits of refuse, all below grade back-up rings, studs, nuts and washers shall be thoroughly coated with Polyken Technologies 1027 Primer, or rubberized emulsion undercoating spray, or approved substitute.
- D. The CONTRACTOR shall wrap and tape the flanges and bolts in 5 mil polyethylene sheeting prior to backfilling.

3.07 PIPE SUPPORTS

All piping and valves shall be supported in such a manner as to prevent any stress being transmitted between sections and connected equipment and appurtenances.

3.08 SEGMENT TESTING

- A. The HDPE laterals and connections to LFG header, air supply lines, and condensate discharge line pipelines shall be subjected to pressure tests as described herein to detect any leaks in the piping. Testing shall be performed below grade (inside the trench). The CONTRACTOR shall accept the responsibility for locating, uncovering (if previously backfilled), and repairing any leaks detected during testing.
- B. Polyethylene piping shall be butt welded together into testing segments. Segments shall be connected to a testing apparatus on one end and fitted with fusion-welded caps on all openings.
- C. The segment to be tested shall be allowed time to reach constant and/or ambient temperature before initiating the test.
- D. The test must be performed during a period when the pipe segment will be out of direct sunlight; i.e., early morning, late evening, or cloudy days. This will minimize the pressure changes which will occur during temperature fluctuations. No testing will be allowed during the middle of the day or when pipe segments are exposed to sunlight.
- E. The test pressure for LFG laterals and header shall be 10 psig. The test pressure for air supply and condensate/dewatering pipes shall be 100 psig.
- F. Pressure drop during the test shall not exceed one percent of the testing gauge pressure over a period of one hour. This pressure drop shall be corrected for temperature changes before determining pass or failure. (See Section 3.09 for test failures). The ENGINEER shall sign off on a test form to indicate test compliance.

- G. The ENGINEER and CQA Consultant shall be notified prior to commencement of the testing procedure and shall be present during the test.
- H. All equipment for this testing procedure, including an adequately sized air compressor, fittings, caps/pipe plugs, etc., shall be furnished by the CONTRACTOR. Other necessary equipment includes a flange adaptor with a steel or brass blind flange. Tapped and threaded into the blind flange will be a temperature gauge with a scale of 0 to 100 degrees C with 1-deg. intervals, a pressure gauge with a scale that spans the test pressure range with increments equal to 0.1 percent of the test pressure, an appropriate valve to facilitate an air compressor hose, and a ball valve to release pipe pressure at completion of test. Pipe reducers shall be utilized to adapt test flange to size of pipe being tested.

3.09 TEST FAILURE

- A. The following steps shall be performed when a pipe segment fails the one percent/one hour test described in Part 3.08 F, above.
 - 1. The pipe and all fusions shall be inspected for cracks, pinholes, or perforations.
 - 2. All blocked risers and capped ends shall be inspected for leaks.
 - 3. Leaks shall be located and/or verified by applying a soapy water solution and observing soap bubble formation.
- B. All pipe and fused joint leaks shall be repaired by cutting out the leaking area and refusing the pipe.
- C. After all leaks are repaired, a retest shall be performed in accordance with Part 3.08.

3.10 TEST REPORTING

- A. Each test (pass or failure) shall be reported in writing on the attached pipe testing form or another form approved by the ENGINEER.
- B. If failure occurs, CONTRACTOR shall note the following:
 - 1. Location of failure segment.
 - 2. Nature of leaks.
 - 3. Repairs performed.
 - 4. Results of test.

ATTACHMENT 33 51 10 - 1 Pipe Pressure Test Data Log

END OF SECTION

HDPE PIPE PRESSURE TEST PROCEDURE

This protocol describes the method for testing the installation of HDPE pipelines and components using a low-pressure air test.

PROCEDURE

1. Isolate the section of HDPE pipe to be tested using fusion welded caps. Cap the ends of all branches, laterals, tees, wyes, and stubs included in the test to prevent air leakage. All caps shall be securely braced to prevent blowout.
2. Contractor shall install a temperature gauge, pressure gauge and fittings for connection of an air compressor hose and a ball valve to release the pressure at the completion of the test.
 - Temperature gauge shall have a range of 0 to 100 °C.
 - Pressure gauge shall have increments equal to 1% of the test pressure.

Contractor shall not install new holes in pipeline for the exclusive purpose of performing the air test. However, tapped holes shown on the Plans for items such as header isolation valve monitoring ports may be utilized.

3. Connect the hose to the inlet tap and portable air supply source. Add air slowly to the test section until the pressure inside the pipe reaches the required level as shown below:
 - LFG header, laterals and condensate dewatering discharge lines: 4 psig
 - Air supply line and leachate forcemain: 100 psig
4. Once pressurized and the pressure has stabilized, record the initial temperature (°C) and pressure of the air inside the pipe on the test report form.
5. Begin timing the test. At ten-minute intervals, record the temperature (°C) and pressure of the air inside the pipe on the test report form. Record this data for 6 intervals, until the total time equals 60 minutes.
6. For pipe segments that include an isolation valve, the pressure test must be performed to demonstrate the integrity of the valve. Contractor shall close the valve and perform pressure tests on the header segments on both sides of the valve. This will serve to identify if the valve is airtight.

CALCULATIONS

In order to determine if the section of pipe tested is acceptable, the following calculations must be made.

1. Calculate the final theoretical pressure.

$$P_{\text{final, theoretical}} (\text{psi}) = \frac{[P_{\text{initial}} (\text{psi}) + 14.7] * [T_{\text{final}} (\text{°C}) + 273]}{T_{\text{initial}} (\text{°C}) + 273}$$

where,

$P_{\text{final, theoretical}} (\text{psi})$ = the theoretical acceptable gauge air pressure in the pipe at the end of the 10 min. interval

$P_{\text{initial}} (\text{psi})$ = the gauge air pressure in the pipe at the start of the 10 min. interval

$T_{\text{initial}} (\text{°C})$ = the air temperature in the pipe at the beginning of the 10 min. interval

$T_{\text{final}} (\text{°C})$ = the air temperature in the pipe at the end of the 10 min. interval

2. Calculate the gauge pressure (P_c) corrected for the temperature at the end of the 10-minute interval using the following equation and the value for $P_{\text{final, theoretical}}$ calculated above:

$$P_c = P_{\text{final, theol}} (\text{psi}) - 14.7 \text{ psi}$$

3. Calculate the actual Percent Pressure Drop using the following equation:

$$\text{Percent Pressure Drop} = \frac{P_c - P_{f, \text{actual}}}{P_c} * 100\%$$

where,

$P_{f, \text{actual}}$ = the final gauge pressure in the pipe at the end of the interval

4. If the percent pressure drop is less than or equal to 1%, the pipe segment passes for that particular interval. If the percent pressure drop is greater than 1%, then the following steps shall be performed.

- a) All blocked risers and capped ends shall be inspected for leaks.

- b) The pipe and all fusions in the section tested shall be inspected for cracks, pinholes, or perforations.
 - c) Air pressure leaks shall be located and/or verified by applying a soapy water solution and observing soap bubble formation.
 - d) All confirmed pipe and joint leaks shall be repaired by cutting out the leaking area and rewelding the pipe.
 - e) After all leaks are repaired, a retest shall be performed. This process shall be repeated until a successful test is achieved.
5. Each test (passed or failed) shall be reported in writing.
6. For each test failure, Inspector shall note the following:
- a) Location of failure segment
 - b) nature of leaks
 - c) Repairs performed
 - d) Results of test

Upon completion of the test, open the ball valve and allow air to escape. Caps must not be removed until air pressure in all of the test sections has been reduced to atmospheric pressure.

DATA LOG

DATE: _____

PROJECT NAME/NO: _____

TIME: _____

CONTRACTOR: _____

PERSON PERFORMING TEST: _____

OWNER REPRESENTATIVE: _____

DESCRIPTION/LOCATION OF TEST SEGMENT: _____

Interval #	Time (min)	T _{initial} (°C)	T _{final} (°C)	P _{g, initial} (in-H ₂ O)	P _{i, absolute} (in-H ₂ O)	P _{theoretical} * (in-H ₂ O)	P _c * (in-H ₂ O)	P _{f, actual} (in-H ₂ O)	% Pressure Drop*	Retest?
1	10									
2	20									
3	30									
4	40									
5	50									
6	60									

* See equations in procedure

PIPE SIZE: _____

SDR: _____

LENGTH: _____

DESCRIPTION/NATURE OF LEAKS & REPAIRS OF RETEST SEGMENT:

SECTION 33 51 20

LFG HEADER ISOLATION VALVES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Scope of Work: The CONTRACTOR shall provide all materials, equipment, and labor needed to install complete and ready-for-use all header isolation valves as specified herein and as indicated on the Plans.
- B. Related Work Described Elsewhere
 - 1. Section 33 51 10: Pipe and Pipe Fittings

1.02 SUBMITTALS

The CONTRACTOR shall prepare and submit to the ENGINEER, for review and approval, certificates of compliance on materials furnished and manufacturer's brochures containing complete information and instructions pertaining to the storage, handling, installation, inspection, maintenance, operation, and repair of each type of valve furnished. Shop drawings shall be submitted for butterfly valve assemblies requiring spacers per paragraph 3.01 B of this Section.

PART 2 - MATERIALS

2.01 BUTTERFLY VALVES

- A. All valves shall be complete with all necessary operators, actuators, handwheels, extension stems, worm gear operators, operating nuts, wrenches, and other accessories or appurtenances which are required for the proper completion of the Work. Operators and other accessories shall be sized and furnished by the valve supplier and factory mounted.
- B. Valves shall be suitable for the intended service. Renewable parts including discs, packing, and seats shall be of types recommended by valve manufacturer for intended service, but not of a lower quality than specified herein.
- C. Valves and operators shall be suitable for burial within a landfill.
- D. Unless otherwise shown, valves shall be the same size as the adjoining pipe.
- E. Header isolation valves shall be butterfly bubble tight, wafer design, with a PVC body, polypropylene disc, nitrile seats and seals, 316 SS valve stem, and compatible with a flat face flange. Valves shall be Asahi-America Type 56 series (12-inch) and Type 75 series (18-inch).

- F. Stem extensions shall be stainless steel in an epoxy coated carbon steel outer housing with a diecast aluminum alloy gear box assembly mounted on top and equipped with a removable manual operating wheel.

2.02 MONITORING PORTS AT VALVES

Monitoring ports shall be installed at each isolation valve and shall include the following items, or approved substitutes. Monitoring hose shall be stainless steel with outer braid Swagelok (407-894-7191) flexible metal hose, part no. SS-FM4PM4PF4, of adequate length to extend above grade as shown on the Plans. The male NPT end shall be threaded into the top of the header. Sampling end shall be Easy Port™ ¼ inch male NPT screw-capped long barb fittings as supplied by QED Environmental, model no. 40987. The hose shall be secured to the valve stem inner boring by stainless steel brackets.

2.03 IDENTIFICATION TAGS

- A. CONTRACTOR shall supply and affix to each valve an adhesive sticker marked with pre-printed letters designating the valve number (e.g., V-3, V-4, V-5, etc.). Tags shall not be marked with pen or marker.
- B. Tags shall be yellow adhesive sticker with black lettering. The sticker shall contain the following information: valve point ID, and the word “CCSWDC”.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Valves shall be installed in accordance with the manufacturer’s recommendations and the following:
 - 1. Butterfly valves shall be installed between two flanges as shown on the Drawings; care shall be taken to avoid stripping studs when tightening.
 - 2. Flanges shall be joined with stainless steel studs and nuts. Stud lengths shall accommodate the required distance between flanges including spacers, if necessary.
 - 3. All below grade back-up rings, studs, nuts and washers shall be thoroughly coated with Polyken Technologies 1027 Primer (508-261-6200).
 - 4. The CONTRACTOR shall wrap and tape the valve, flanges, and bolts in 5 mil polyethylene sheeting prior to backfilling.
- B. Flanged butterfly valves may require spacers between the flange adapters and the valve body in order to allow full travel of the internal disk. If spacers are necessary for any butterfly valve, the CONTRACTOR shall install valve spacers subject to approval by the ENGINEER.

END OF SECTION

SECTION 44 42 60

CONDENSATE MANAGEMENT SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide all materials, equipment, labor, and incidentals needed to install the condensate sumps, condensate traps, pneumatic pumps and appurtenances in accordance with the Drawings and manufacturer's instructions.
- B. Related Work Described Elsewhere
 - 1. Section 31 20 00 – Trenching, Excavating, Backfilling and Grading
 - 2. Section 33 51 10 – Pipe and Pipe Fittings

1.02 SUBMITTALS

- A. The CONTRACTOR shall prepare and submit to the ENGINEER for review and approval manufacturer's literature, shop drawings, or other information pertaining to the assembly, operation, adjustments, and other maintenance and repairs of equipment to be installed under this Section, together with detailed parts lists, Drawings, dimensions, and/or photographs.
- B. At start-up, CONTRACTOR shall submit Operations and Maintenance (O&M) manuals.

PART 2 - MATERIALS

2.01 CONDENSATE SUMP

- A. The condensate sump system shall be capable of handling a flow rate of 7.5 gallons per minute (gpm) with a total dynamic head of 60 feet.
- B. The sump shall be a welded, single-walled HDPE assembly. The reservoir shall be fabricated from SDR 17 pipe and designed to withstand a vacuum of 120 inches-w.c. and a pressure of 5 PSIG at 130 degrees F.
- C. The condensate pump shall have level controls. The pump shall pump condensate to a discharge line. Discharge piping from the sump to the condensate discharge line shall be of a size and material recommended by the manufacturer such that the pneumatic pump can deliver the anticipated condensate load.

2.02 CONDENSATE TRAP

The trap shall be a welded, single-walled HDPE assembly. The reservoir shall be fabricated from SDR 17 pipe and designed to withstand a vacuum of 120 inches-w.c. and a pressure of 5 PSIG at 130 degrees F.

2.03 ACCESS PORT

Port shall be 1¹/₂- inch diameter black polypropylene quick connect coupling consisting of two parts: a male pipe threaded adapter and cap with steel cam locking levers.

2.04 MONITORING PORT

Monitoring ports shall be QED supplied Easy Port™ capped long barb fittings, model number 40987.

2.05 PNEUMATIC PUMP

- A. Pump shall be submersible air displacement pump, internally controlled and designed for leachate and condensate systems. Pump shall be bottom-loading with fiberglass body. Major metal components shall be stainless steel, this shall include the pump head assembly, center dip tube, discharge check valve assembly, chain support harness, 3.5 inch extended inlet screen, and bottom check collar. Plastic components shall be PVDF (kynar) or UHMWPE.
- B. The pneumatic pumps shall be QED AutoPump bottom inlet Model Short AP4⁺B.
- C. Pump installed in condensate sump shall include the following components:
 - 1. Air filter/regulator
 - 2. Air inlet supply pressure gauge
 - 3. Pump cycle counter
 - 4. High liquid level indicator
- D. Pump shall have a minimum pumping capacity of 7.5 gallons per minute at 20 feet total dynamic head and an air supply pressure of 60 pounds per square inch, gauge (psig).
- E. Pump accessories to include are 4 inch vacuum fit cap and hose set, including the discharge hose (3/4-inch I.D. Nylon Tube) from the pneumatic pump to the HDPE forcemain and the 150 psig rated, 1/4-inch I.D. air hose to the HDPE air supply line.
- F. Air and discharge hose lengths outside the sump/wells shall be field determined and approved by the ENGINEER.
- G. Each pump will include a 1/2 inch nylon support rope from pump to sealing cap. A stainless steel quick link connector will be used to attach the rope to the pump support harness.

2.06 AIR SUPPLY LINE

The air supply line from the compressor shall be as specified in Section 33 51 10 and on the Drawings.

2.07 CONDENSATE DISCHARGE LINE/DRAINAGE LINE

The condensate discharge line shall be 2-inch diameter HDPE SDR 11 pipe as specified in Section 33 51 10 and shown on the Drawings.

PART 3 - EXECUTION

3.01 AIR SUPPLY LINE

The air supply line from the compressor to the pneumatic pumps shall be 2-inch diameter SDR 9 HDPE pipe with yellow stripe as specified in Section 33 51 10. Air supply line shall be located in the same trench as the header/lateral piping (where possible) at a minimum depth as shown on the Drawings.

3.02 CONDENSATE SUMP INSTALLATION

- A. CONTRACTOR shall install condensate sump in the location and to the lines shown on the Drawings. Sump shall be installed vertically plumb.
- B. HDPE pipe connections shall be in accordance with Section 33 51 10, Pipe and Pipe Fittings.
- C. Caution shall be exercised when backfilling around the sump to prevent damaging air and discharge lines.

3.03 PUMP INSTALLATION

- A. Pump shall be installed in accordance with manufacturer's recommendations. Pump vent line shall be installed to discharge inside the sump.
- B. Install pump so that bottom of pump is suspended off the bottom of the sump as shown on the Drawings and recommended by the manufacturer and approved by the ENGINEER.

3.04 TESTING

- A. Upon completion of the installation, tests shall be performed by the CONTRACTOR with the assistance of the manufacturer's representative, in the presence of the ENGINEER. These tests shall demonstrate condensate pump, startup, shutdown, operation, and maintenance. Test shall demonstrate the pumping of water from the sump for the full drawdown of the pump. Equipment and other requirements necessary to perform the tests shall be furnished by the CONTRACTOR.

END OF SECTION