

PART IV
SPECIFICATIONS

**Technical Specifications and
Construction Quality Assurance Plan
For**

Increment 1 Buildout

**For
Landfill Facility**

**Seminole Electric Cooperative, Inc.
Seminole Generating Station
Putnam County, Florida**



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SPECIFICATIONS

SECTION 1 INTENT

These Specifications present the minimum standards for the required materials and construction quality to ensure proper construction of a lined disposal area associated with Increment 1 Buildout of the existing landfill at the Seminole Electric Cooperative, Inc. ("SECI") Seminole Generating Station ("SGS") in Putnam County, Florida. They also specify the construction, field inspection, sampling, quality assurance testing and maintenance procedures for Site preparation, earthen dike construction, earthwork excavation and grading, geosynthetic clay liner and geomembrane liner installation, leachate collection and detection system construction, leachate gravity pipe to Pond 8 and all other work associated with construction of the proposed lined disposal area and storm water pond.

Responsibilities of the parties involved and the minimum qualifications of each party to fulfill their identified responsibilities are included in these Specifications. During the construction Work for this Project, the following documents should be referred to: (i) the construction Specifications, (ii) the construction drawings (Drawings), (iii) applicable Manufacturer's quality control/assurance manuals, (iv) Contractor's quality control plan, (v) applicable Florida Department of Environmental Protection (FDEP) regulations, (vi) applicable safety regulations, and (vii) applicable ASTM International (ASTM), Federal Testing Method, Geosynthetic Research Institute (GRI), and Florida Department of Transportation (FDOT) standards.

The Work covered by these Specifications includes all or parts of the following:

- Construction of a double-lined landfill over the Increment 1 Buildout area and a single geomembrane on the side slope of the existing landfill facility.
- Construction of the lined disposal area will require construction of an earthen perimeter dike, and installation of a liner system on the inside slope of the perimeter dike and the side slope surface of the existing landfill. In ascending order, the Increment 1 Buildout liner will consist of the following:
 - Geosynthetic clay liner (GCL) will be placed on a compacted 6 inch soil sub base.
 - 60-mil thick lower textured HDPE geomembrane liner for the secondary leakage barrier.
 - HDPE geocomposite drainage net (CDN) that serves as the leak detection layer.
 - 60-mil thick upper textured HDPE geomembrane liner for the primary leakage barrier.
 - HDPE geocomposite drainage net for the leachate collection system.

- 2-foot thick drainage sand layer will be placed over the geocomposite drainage net. This sand serves as the upper portion of the leachate collection and removal system and as a protective layer for the upper HDPE geomembrane.
- Leachate collection piping will be installed in trenches to collect leachate from the geocomposite drainage nets and convey it to the leachate gravity pipe. The liners, leak detection, and leachate collection systems will be installed to the lines, grades, and locations shown on the Drawings.
- Leachate gravity pipe to Pond #8 for treatment and reuse or disposal.
- Construction of the stormwater pond dike, under drain system, control structure, pipe and discharge structure.
- Seeding the outside slope of the landfill perimeter dike, stormwater pond invert and dike and all disturbed areas.
- Relocation of an existing leachate force main and electrical service
- Fill will come from either an on-site or off-site borrow pit

Other Work covered by the Specifications includes but is not limited to: (i) surveying; (ii) Site preparation and stripping of designated areas; (iii) demolition and the incidental removal of debris or foreign objects from within the limits of construction; (iv) access road construction and maintenance; (v) repair to any SECI facilities, equipment or property damaged by the Contractor; (vi) hauling and spraying water to control dusting; (vii) dewatering and control of surface water runoff; (viii) maintenance of completed Work until accepted by the Owner; and (ix) Site clean-up.

SPECIFICATIONS

SECTION 2

DESCRIPTION OF WORK, DEFINITIONS, AND GENERAL CONDITIONS

2.1 General Description of Work

The Work for this Project as described in Section 1 involves construction of the Increment 1 Buildout for the existing landfill. The landfill is used for disposal of fly ash and miscellaneous waste from the Seminole Generating Station. The existing landfill has a base area of approximately 80 acres. Disposal will continue at the landfill during construction of Increment 1 Buildout in a lined area at the top of the existing landfill.

The Contractor shall furnish all the materials, equipment, supplies, tools, labor, and supervision necessary to perform the Work covered by these Specifications and as shown on the Drawings. All Work is to be performed and construction completed in accordance with the alignments, lines, grades, and dimensions defined in these Specifications and as shown on the Drawings. The Owner and the Engineer reserve the right to modify the design grade as well as any design elements during construction to maintain cut and fill balance and to expedite construction activities.

2.2 Definitions

Specific items and parties or individuals that are involved with the construction of Increment 1 Buildout are defined as follows:

- “Contractor” or “Bidder” means the person, firm or corporation with whom Owner has entered into the Contract to perform the Work.
- “Engineer” means the Engineer employed by the Owner, to provide engineering services for the Project and said Engineer's duly authorized assistants and representatives. For this Project, “Engineer” means PBS&J, its subsidiaries, officers, directors and employees.
- “Liner Manufacturer” or “Manufacturer” refers to the organization(s) that will manufacture and supply the geosynthetic clay liner (GCL), geocomposite drainage net, and/or HDPE geomembrane liner to the Contractor.
- “Liner Installer” or “Installer” refers to the organization(s) that will be retained by the Contractor for installation of the GCL, geocomposite drainage net, and HDPE geomembrane liners. The “Liner Installer” can be the same firm as the “Contractor.”
- “Owner” means Seminole Electric Cooperative, Inc., also referred to as “SECI”.
- “Regulatory Agency” or “Agency” refers to the Florida Department of Environmental Protection (FDEP), which has the authority to review this Project. However, per the Conditions of Certification for Units 1 and 2, no additional permitting is required for

construction and operation of a landfill within the footprint of the existing landfill. However, FDEP reviews are being requested.

2.3 Responsibility and Authority

The principal organizations involved in the design and construction Work associated with the proposed Increment 1 Buildout, as defined herein, will have the following responsibilities and authorities in construction quality assurance or herein "CQA". Delineation of these responsibilities and authorities will establish the necessary lines of communication that will facilitate an effective decision making process during construction.

2.3.1 Owner

The Owner will oversee, manage, and approve the execution of all Work associated with the landfill construction. To accomplish the above overall task, the Owner will hire/engage, as necessary, the parties as defined herein. The Owner also has the responsibility to ensure that the approved CQA plan is adhered to during construction. The Owner has the authority to select and dismiss the Engineer, the Contractor(s), the Liner Installer and/or the Liner Manufacturer. The Owner also has the authority to accept or reject design plans and Specifications, recommendations of the Engineer, the materials supplied, and workmanship of the Contractor(s) and the Liner Installer(s).

2.3.2 Engineer

The Engineer is responsible for the design and construction Specifications and quality assurance activities as specified in this CQA plan.

The specific responsibilities of the Engineer shall include:

- (i) reviewing design criteria, plans, specifications and CQA plan,
- (ii) providing and educating the inspection personnel on the CQA requirements and procedures,
- (iii) reviewing Contractor's quality control plan to ensure that it conforms to the CQA plan, scheduling, directing, and coordinating the CQA activities, and providing the results of the CQA activities to the Owner on a regular basis and at the end of the Project. Additional responsibilities delegated to the Engineer by the Owner may include periodic review of CQA documentation and specifying corrective measures in case non-conformance with Project Specifications is detected.

The inspection personnel provided by the Engineer shall have the following specific responsibilities:

- (i) performing independent inspection of the Work in progress to verify compliance with the design and construction criteria, Drawings, and Specifications,
- (ii) verifying that all testing equipment used meet the test requirements and that the tests are conducted in accordance with standard procedures specified in the CQA plan, and reporting to the Engineer the results of all inspections including the Work that is not of acceptable quality and/or fails to meet the specification requirements.

2.3.3 Contractor

The responsibility of the Contractor is to perform all the construction activities in accordance with the design and construction criteria, the Drawings, and Specifications. The Contractor is responsible for delivery of all materials FOB the SGS, productivity of the Installers, and the overall schedule of the Project. The Contractor shall submit all the Shop Drawings and other necessary documents for approval by the Engineer. The Contractor is also responsible for cooperating with the Engineer to help conduct all CQA inspection and testing activities.

2.3.4 Liner Installer(s)

The responsibility of the Liner Installer(s) is to install the geosynthetic clay liner, geomembrane liners, and geocomposite drainage nets in accordance with the Drawings and Specifications. The Installer(s) shall submit all the Shop Drawings and other necessary documents for approval by the Engineer. The Installer is also responsible for cooperating with the Engineer to help conduct all CQA inspection and testing activities.

2.3.5 Regulatory Agency

The Regulatory Agency (i.e., FDEP) has the responsibility and authority to review all CQA documentation during and/or after the completion of construction to confirm that the CQA plan was adhered to during construction and that the construction procedures and quality conformed to the Specifications.

2.4 Qualifications

2.4.1 Engineer

The CQA Engineer and testing laboratory shall have the following minimum qualifications:

- The Engineer and the testing laboratory must have at least 5 continuous years of experience in similar projects immediately prior to the date of this Project.
- The Engineer must have inspected and tested a minimum of five liner projects consisting of at least 5,000,000 square feet of geomembrane liner.
- The Engineer shall be familiar with the ASTM, GRI, and other applicable testing standards. The testing laboratory shall possess testing equipment capable of testing geomembrane liner seams for peel and shear in accordance with ASTM D6392. The laboratory shall have performed at least 5,000 sets of peel and shear tests on geomembrane liner seams.
- The Engineer shall be capable of providing qualified technicians to perform the required tests on geomembrane liner and able to provide test results within 48 hours of receipt of Samples requiring laboratory testing. The Engineer shall also be capable of providing technicians to perform full-time inspection and testing during Site preparation, earthwork construction, geosynthetic products placement, and drain installation.

- The Engineer must be a full-time registered Professional Engineer in the state of Florida and be able to sign, seal, and certify that the Project was constructed in accordance with the requirements stipulated in the Specifications.

2.4.2 Contractor

To be considered qualified for this Project, the Contractor and all subcontractors must be well experienced in earthwork construction with soil, pipe installation, and placement and compaction of soil below synthetic liners. The Contractor must also be well experienced in project management, construction of embankments, earthwork excavation and grading, drain and culvert installation, dewatering, earthwork restoration, slope dressing, and fine grading of the liner sub grade.

The Contractor must at a minimum, demonstrate the successful completion of at least three projects over the past 5 years similar in size and scope to this Project.

For each project submitted to document the Contractor's experience, the following information on the completed facility must be provided with the bid package:

- i. the name and purpose of the facility, and location and date of construction;
- ii. the name of the facility owner and design engineer, and the name and telephone number of a contact person at the facility who can discuss the project; and
- iii. description of the project, scope of Work, and construction methods used.

The Contractor shall provide and maintain, continually on the Site of the Work during its progress, adequate and competent superintendence of all operations for and in connection with the Work under the Specifications. The Contractor shall either personally superintend his work or shall cause it to be done by a capable superintendent acceptable to the Owner, and such representative shall be authorized to receive instructions from the Owner. Said superintendent shall have authority to see that the Work is carried out in accordance with the CQA Plan, Drawings, and Specifications in a first-class, thorough, and competent manner in every respect.

2.4.3 Liner Manufacturer

To be qualified by the Owner, the Manufacturer of the geosynthetic clay liner (GCL) shall provide documentation to the Owner of previously demonstrated ability to produce the specified liner by having successfully manufactured a minimum of 10 million square feet of GCL with at least 8 million square feet installed in similar applications.

The Manufacturer must provide the Owner with a written commitment that sufficient commercial quantities of GCL will be made available for this Project at the time of construction.

To be qualified by the Owner, the Manufacturer of HDPE liners shall provide documentation to the Owner of previously demonstrated ability to produce the specified liner by having successfully manufactured a minimum of 15 million square feet of HDPE liner installed in

similar applications. The Manufacturer shall also provide documentation that he has satisfactorily produced "textured" HDPE liners, and that such production has been on-line for at least 6 months. The Manufacturer shall submit to the Owner, the Manufacturer's Quality Assurance - Quality Control Plan for review by the Owner. Continuous spark testing of all liner manufactured for this Project at the production facility is required prior to delivery of the liner rolls to the Project Site.

The Manufacturer(s) must provide the Owner with a written commitment that sufficient commercial quantities of the textured HDPE liners, geocomposites, geotextiles, and GCL will be made available for this Project at the time of construction. The Manufacturer(s) shall also submit specification sheets detailing minimum physical and chemical properties of the proposed geosynthetic products, field seaming methods and properties, and certificates confirming compliance with the Specifications for this Project.

2.4.4 Liner Installer

To be considered qualified for this Project, the Installer and all subcontractors must be well experienced in the installation of HDPE liners and connections to associated structures. The Installer shall be the Manufacturer of the HDPE liner or an approved Installer trained and/or licensed to install the HDPE liner supplied by one of the approved liner manufacturers. If the Installer is not the Manufacturer, then the Installer must submit with the Bid a written certification, or license to install, provided by an approved Liner Manufacturer.

The Liner Installer shall have installed HDPE liner in similar applications, for a period of not less than 2 years. The Installer shall submit to the Owner a list of at least ten completed facilities, totaling a minimum of 4 million square feet, for which the Installer has installed an HDPE synthetic liner of the same type as specified in these Specifications. For each installation, the following information shall be provided:

- Name and purpose of facility, location, and date of installation.
- Name of Owner and Engineer, liner Manufacturer, and name and telephone number of contact at the facility who can discuss the project.
- Type and thickness of HDPE liner installed, and surface area covered.
- Type of field seaming performed, and names of the Installation Supervisor and Master Seamer representing the Installer.
- Crew size and typical daily production per crew.

The Installer shall also submit to the Owner through the Contractor a copy of the Manufacturer's standard specifications for liner handling and installation and any Quality Assurance/Quality Control Plans for approval by the Engineer. Moreover, the Liner Installer must submit qualification résumés for the HDPE liner Installation Supervisor(s) and Master Seamer(s) to be assigned to, and will be present on Site for this Project, including documentation that each has

similar experience on completed facilities totaling a minimum of 4 million square feet of HDPE liner installation.

All other seamers and quality control/testing technicians representing the Installer who will be involved in the installation shall have a minimum of 1.5 million square feet of related HDPE liner installation experience.

2.5 Reports and Documentation

2.5.1 Contractor

Throughout the construction period, the Contractor shall maintain a careful record of any changes on the Drawings during actual construction. Any changes, in addition to the Contractor's field construction notes, shall be neatly and legibly prepared. The Contractor shall submit two (2) copies of the notes and marked Drawings to the Engineer, on a monthly basis, or more frequently if requested by the Engineer.

Upon completion of the Work, and prior to acceptance by the Engineer, the Contractor shall file with the Engineer two (2) sets of complete Drawings with all changes and the Contractor's field construction notes neatly and legibly recorded thereon.

Such information will be used by the Engineer to prepare record Drawings for the Owner. Drawings may not be materially changed, except with the written approval of the Engineer, and the Work cannot be considered as having been completed until the Engineer has approved the same in writing.

2.5.2 CQA Engineer and Technician

Documentation of the CQA activities during construction shall consist of the following: (i) daily field reports, (ii) inspection and test data sheets and photographs, (iii) acceptance reports for completed components, and (iv) final report.

A daily field report shall be prepared by the lead CQA technician to document the CQA activities of the day. At a minimum, the daily field report shall include the following information: (i) date, Project name, location and any other Project identification, (ii) description of weather condition, (iii) description of work locations for the day, (iv) description of equipment and personnel being worked on the day, (v) description of Work performed and CQA activities, (vi) description of materials received, (vii) any equipment calibrations, (viii) any approval of completed Work and/or rejection of Work that did not meet the Project Specifications, (ix) any supporting inspection data sheets, (x) reports of any meetings held and their results, (xi) description of any problems and suggested corrective measures, and (xii) signature of the CQA personnel. The CQA technician shall work under the supervision of the Engineer and consult daily with the Engineer on CQA activities and any associated problems.

Inspection and test data sheets used to document various CQA inspection and testing activities shall include the following information: (i) date, Project name, location and any other Project identification, (ii) description of inspection activity or test, (iii) location of inspection activity or

test sample, (iv) result of inspection/test and comparison with Project Specifications, (v) personnel involved in the inspection/testing activity, and (vi) signature of the CQA personnel.

Photographs shall be taken as necessary to keep pictorial records of completed Work, Work in progress, problems and/or corrective measures. The photographic data sheets shall contain the following information: (i) date, Project name, location and any other Project identification, (ii) location and description of Work, (iii) purpose of the photograph, and (iv) signature of the CQA personnel.

Upon acceptance of a completed component of Work by the CQA inspector, appropriate acceptance forms shall be filled out and signed by the CQA inspector and the Contractor's or Installer's representative. At a minimum, the acceptance report shall contain the following information: (i) date, Project name, location and any other Project identification, and (ii) location and description of the accepted component.

At the completion of the Project, the Engineer shall submit a final report that summarizes the results of the CQA inspection and testing activities for the Project. This document shall be signed and sealed by the Engineer and will form a part of the CQA plan documentation.

The final report shall be submitted within 30 days of Substantial Completion of all construction associated with the Project, as outlined within the scope of services and approved by the Owner.

2.6 Project Meetings

Weekly Project meetings shall be conducted by the PBS&J who will arrange for the meetings, record minutes, and distribute copies to the participants and those affected by the decisions made at the meetings. The Project meetings shall consist of pre-construction CQA meeting, progress meetings, and problems or Work deficiency meetings.

The pre-construction CQA meeting shall be attended by the Owner, the Engineer, the Contractor and the Liner Installer(s). Each participating organization will be provided with all relevant CQA documents and the following items shall be discussed at the meeting: (i) the role and responsibility of each organization in carrying out the CQA plan, (ii) the authority and lines of communication for each organization, (iii) procedures for inspection, sampling, and testing, (iv) procedures for handling construction deficiencies, repairs, and re-testing, (v) methods for documenting and reporting inspection data, (vi) methods for distributing documents and reports, (vii) work area safety and security protocol, and (viii) storage and protection of construction materials. Following the pre-construction meeting, a Site tour shall be conducted for visual observation of the Site conditions by various organizations in relation to the above CQA plan items.

Progress meetings shall be conducted weekly at a time determined at the pre-construction meeting. The progress meeting shall be attended by the Owner, the Engineer, the Contractor, and/or the Liner Installer(s). The following items shall be discussed in the progress meeting: (i) activities and accomplishments of the previous week, (ii) overall progress of the Project in relation to the Project schedule, (iii) activities and goals for the week, and (iv) any construction problems/deficiencies.

Special meetings shall be conducted when problems and/or deficiencies occur or are likely to occur. These meetings shall be attended by the parties involved, which may include the Owner, the Engineer, the Contractor, and the Liner Installer(s). In these meetings, the problems or deficiencies shall be defined, discussed, and resolved.

2.7 Scheduling and Coordination

All scheduling and coordination of the Work outlined herein shall be undertaken through the Owner's Project Manager assigned to the Work. **The Contractor must submit a revised Project Schedule to the Owner at the pre-construction meeting for approval.** The schedule shall be in the form of a Gantt chart showing all construction activities, and shall be updated weekly and provided to the Owner as the Work progresses.

The Contractor and Liner Installer(s) shall closely coordinate all planned and ongoing construction activities on a weekly basis (minimum) with the Owner's Project Manager and/or the other contractors to facilitate timely completion of all Work at the Project Site.

2.8 Access, Inspection, and Testing

All materials furnished by the Contractor shall be subject to the examination and approval of the Owner, or his representative, at all times during the progress of the Work and until the completion of the same. As soon as the materials are examined and tested, the Contractor shall immediately remove all rejected materials from the Work to an on-Site location designated by the Owner. No material shall be used before being examined and approved by the Owner or his representative, but the failure on the part of the Owner or his representative to condemn or reject inferior materials or Work shall not be construed to imply an acceptance of the same should their inferiority become evident at any time prior to final acceptance of the Work.

The Contractor shall make necessary arrangements so that the Engineer may secure Samples of materials on the job for testing to ascertain whether any material to be included in the Work meets the requirements of these Specifications.

The Owner and his representative shall have free access to the Work at all times. The Contractor shall furnish them with equipment, as needed, for ascertaining whether the Work being performed, or the Work which has been completed, is in accordance with the requirements of these Specifications, even to the extent of uncovering, testing, or removing portions of finished Work, if such is necessary.

The Owner may order the Contractor to suspend any Work that may be affected, damaged, or endangered by climatic conditions. Further, the Owner may suspend any Work at any time when acceptable results as defined by these Specifications cannot be obtained due to inclement weather or other unsatisfactory field conditions.

2.9 Survey Control

The Owner will establish reference points for horizontal and vertical control near the construction area. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to complete the Work to the location, lines, and grades shown on the Drawings or as otherwise revised or approved by the Owner. It is the responsibility of the Contractor to verify all dimensions prior to fabrication, installation, and/or construction of any item of Work. The Contractor shall maintain the survey control system, and shall provide all his alignment and grade control surveying of whatsoever nature.

2.10 Precedents and Discrepancies

Work indicated on the Drawings and not mentioned in the Specifications, or vice-versa, shall be performed as though fully set forth in both. Work not particularly detailed, marked, or specified, shall be performed in the same manner as similar Work that is detailed, marked, or specified. In Work drawings, the precedent shall be drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions, and noted material over graphic indications.

In the event of a discrepancy between the Drawings and the Specifications, or within either, the discrepancy shall immediately be brought to the attention of the Engineer and the Owner. The Engineer will specify the correct interpretation upon the Owner's approval.

2.11 Superintendence

The Contractor shall provide and maintain, continually on the Site of the Work during its progress, adequate and competent superintendence of all operations for and in connection with the Work under these Specifications. The Contractor shall either personally superintend his work or shall cause it to be done by a capable superintendent acceptable to the Owner. Such representative shall be able to read, write, and speak English fluently and shall be authorized to receive instruction from the Owner. The superintendent shall have the responsibility to see that the Work is carried out in accordance with the Specifications and Drawings.

2.12 Contractor's Staging Area

The designated staging area for the Contractor is shown on the Drawings. The Contractor shall be responsible for electrical connections and other utilities, as needed and approved by the Owner. The Owner will provide reasonable quantities of water required for construction. However, it shall be the responsibility of the Contractor to transport or convey the water from the designated sources, and to meter the quantity of water used for construction. Owner will not be responsible for the supply of water needed for seeding, maintaining seeding and/or dust control unless written approval is provided by the Owner.

2.13 Contractor Safety

The Contractor, contractor employees, subcontractors, and subcontractor employees shall comply with the regulations of the Owner, the U.S. Department of Labor Occupational Safety and Health Administration (OSHA), and/or other applicable agencies. The Contractor shall show evidence for each employee, including employees of subcontractors, of Owner required Site-specific safety training. The regular on-Site safety meetings shall be documented and the minutes of the meetings need to be submitted to the Owner.

2.14 Environmental Protection

The Contractor shall comply with all applicable regulations set forth by the Owner and the following agencies:

1. U.S. Environmental Protection Agency (EPA)
2. Florida Department of Environmental Protection (FDEP)
3. Putnam County, Florida
4. St. Johns River Water Management District (SJRWMD)
5. U.S. Army Corps of Engineers
6. Occupational Safety and Health Administration (OSHA).

The Contractor shall provide and maintain, during the life of the contract, environmental protection as defined herein. The Contractor shall provide environmental protective measures as required to control pollution that develops during normal construction practice and provide environmental protective measures required to correct conditions that develop during the construction of permanent or temporary environmental features associated with the Project. The Contractor shall comply with all federal, state, and local regulations pertaining to water, air, and noise pollution.

2.15 Protection of Natural Resources

Limits of Work: The natural resources outside the limits of permanent Work performed under this contract shall be preserved in their existing condition or restored to an equivalent or improved condition upon completion of the Work. The Contractor shall confine construction activities to areas defined by the scope of Work, Drawings, and Specifications.

Land Resources: Except in those areas indicated on the construction plans to be cleared, the Contractor shall not remove, cut, deface, injure, or destroy trees or shrubs without permission from the Owner.

Temporary Facilities: The Contractor shall eliminate all signs of temporary construction facilities such as Work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and all other vestiges of construction except for access roads. All other areas are to be restored to their original condition.

Water Resources: The Contractor shall perform all Work in such a manner that any adverse environmental impact on water resources is reduced to a level acceptable to Putnam County,

EPA, and FDEP. Work must be performed in accordance with the applicable permit requirements. If water quality is compromised, all construction activities will cease until the problem is remedied and the contractor receives notification to proceed from the Owner.

Oily Substances: The Contractor shall take whatever measures necessary to prevent oily or other potentially hazardous substances from entering the ground, drainage areas, or local bodies of water. All temporary fuel oil, petroleum, or liquid chemical storage tanks shall be protected with a temporary high density polyethylene (HDPE) lined earthen berm and secondary containment area of sufficient size and strength to contain the contents of the tanks in the event of content leakage or spillage. At the request of the Contractor, other forms of containment with impervious liner will be considered. If any spill occurs, the Contractor is responsible for all cleanup expenses and notifying the Owner.

Fish and Wildlife Resources: The Contractor shall take all necessary steps, as required, to prevent interference or disturbance to fish and wildlife. The Contractor shall not alter water flows or otherwise significantly disturb native habitat, adjacent to the Project area, which are critical to fish and wildlife, except as approved by the Owner. The contractor shall note that harming or harassing of the indigo snake, gopher tortoise, or other protected species is prohibited.

Fines: Any fines levied against the Contractor, or against the Owner that arise because of the Contractor's Work during the life of this contract will be borne by the Contractor.

Protection of Erodible Soils: All earthwork brought to a final grade shall be immediately finished as indicated or specified. The Contractor shall protect side slopes and back slopes upon completion of rough grading.

2.16 Protection of Existing Facilities

The Contractor is responsible, at no additional cost to the Owner, for timely repair or replacement of structures, equipment, pipelines, power lines, power poles, monitor wells, piezometers, pumps, or any Owner's facilities damaged by the Contractor's operations and/or personnel during construction. All repairs and/or replacements shall be performed in a manner approved by the Owner.

2.17 Daily and Final Clean-Up

The Contractor shall clean up the Work Site and shall install all barricades as needed at the end of each workday to maintain the Site in a clean and safe condition as required by the Owner safety regulations. The Contractor shall fully comply with the requirements set forth in this section and in Sections 2.15 and 2.16 pertaining to Site maintenance.

Upon completion of the Work, the Contractor shall remove and dispose of all trash, debris, unused materials, etc., resulting from operations during the construction of the lined landfill area. Remaining unused clean soils shall be stockpiled in areas designated by the Owner. Soil surfaces disturbed because of construction activities shall be regraded to their existing condition as directed by the Owner.

Waste oil, antifreeze, fuels, grease, or any other hazardous materials shall be disposed of, off-Site, in accordance with applicable regulations, and shall not be dumped on the ground. The Contractor shall furnish proper records documenting the disposition of any such waste materials to the Owner.

2.18 Final Inspection, Acceptance and Contract Closeout

Upon completing all clean-up operations, the Contractor shall advise the Owner that he is ready for final inspection. Per the Project Schedule, the Owner will then set a specific time for the final inspection. The Owner, the Contractor, and the Engineer will jointly inspect the Project area to verify that all Work has been completed in accordance with the Drawings and Specifications. Any Work found lacking in any way shall be corrected and re-inspected.

The Contractor shall provide certified As-Built drawings per the schedule (see Section 15, 15.1) to the Engineer, who will review and finalize the drawings and provide them to the Owner. The As-Built drawings shall include, but not be limited to, earthwork, liners, piping, and other items constructed by the Contractor. Upon all final Submittals being submitted and approved by the Engineer and Owner and acceptance of all Work per the Specifications and Drawings, Owner shall initiate the RUS closeout process per Part II, Section 18.

2.19 Applicable Specifications, Codes, and Standards

All Work shall be performed in compliance with these Specifications unless otherwise approved in writing by the Engineer. In the event of a conflict between these Specifications and the referenced standards, these Specifications shall govern.

2.20 Engineering Data

The lined landfill is to be constructed adjacent to the landfill and over the side slope of the existing fly ash and FGD sludge landfill. Subsurface information is provided in the Geotechnical Report, which contains the results of test borings previously performed on top of the existing landfill and in Increment 1 Buildout. It is strongly emphasized that the subsurface information and conditions are made available to the Contractor without a guarantee or obligation of any kind whatsoever on the part of the Owner. The Owner does not guarantee the correctness of the designations of any materials shown on the Drawings, nor any interpretations, deductions, or conclusions shown on any drawings or other documents relative to subsurface conditions. Conditions affecting the Contractor's performance and schedule may differ from those indicated or described. Bidders will be deemed to have inspected the Job Site and satisfied themselves on all matters affecting the Contract and Specifications. Bidders may, at their own expense and with the approval of the Owner, make additional investigations if they so desire. The Bidders and Contractor must assume all responsibility for deductions and conclusions as to the nature or condition of soil and other materials to be excavated, the difficulties of performing and maintaining the required excavations, filling, dewatering, and of doing other Work affected by the existing conditions, geology, and geometry of the Job Site.

SPECIFICATIONS

SECTION 3 SITE PREPARATION AND EARTHWORK CONSTRUCTION

3.1 Site Preparation and Maintenance

3.1.1 Layout of Work

The Owner will establish reference points for horizontal and vertical controls near the construction area. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to complete the Work to the location, lines, and grades shown on the Drawings or as otherwise revised or approved by the Owner. It is the responsibility of the Contractor to verify all dimensions prior to fabrication, installation, and/or construction of any item of Work.

3.1.2 Site Access

The Contractor shall, by his own inspection and by careful examination, fully convince himself as to the accessibility of the Job Site for performing the Work. The Contractor shall be responsible for modifying or preparing any access roads. Any modifications to the existing topography of the Site (i.e., cut and/or fill) required for access during construction shall be submitted to the Owner for approval prior to actual construction.

There is an existing road for access to Increment 1 Buildout. The Contractor shall maintain the existing roads used for his work, repair any damage caused to existing roads by his work and return the roads to original or better condition at the end of the project. Any additional fill material required for Job Site access shall be obtained from on-Site or near-Site borrow areas designated and/or approved by the Owner. This may include the expanded borrow area approved as part of the site certification process for Unit 3. Fill for temporary access ramps and roads shall consist of fine sands, slightly silty, silty, and clayey sands free of deleterious materials (organic matter, roots, wood, trash, debris, particles greater than 6 inches in size, etc.), and classifying as SP, SP-SM, SM, and SC-type soils in accordance with ASTM D2487. Subject to the approval of the Owner, bottom ash from the Seminole Generating Station may also be used for access road construction.

All areas disturbed by the Contractor in constructing temporary access roads and ramps shall be re-graded and restored to pre-construction condition, or as otherwise approved by the Owner.

3.1.3 Site Dewatering

The construction of the lined landfill area will be near the existing ground surface and above the anticipated ground water. The Contractor shall be responsible for transferring any standing stormwater within the designated construction area to permit construction in the dry. Stormwater that has not come into contact with fly ash or other waste materials may be discharged as

stormwater. Any stormwater that has been in contact with fly ash or other waste materials is considered leachate and shall be disposed of in Pond 3, 7 or 8 containment areas. No water shall be released off-Site or into adjacent ditches or streams without the Owner's permission and appropriate discharge permits.

3.1.4 Clearing, Grubbing, and Stripping

The Work shall consist of furnishing all tools, labor, materials, and equipment required for all clearing, grubbing, and stripping operations within the limits of construction. The Work will generally be performed in all areas designated for the on-Site borrow areas, and dike and general earthwork construction.

The Contractor shall remove/re-locate any debris, piping, concrete structures, etc., within the designated construction area. If required for disposal, these items shall be disposed of on-Site at locations designated by the Owner.

Clearing shall consist of cutting, removing, and disposing of all grass, trees, brush, debris, and other objectionable organic material resting on or protruding above ground within the limits of grading as indicated on the Drawings.

Grubbing shall consist of the removal and disposal of stumps, roots, and other objectionable organic material within the limits of grading, as indicated on the Drawings. Stumps shall be removed entirely. Roots and matted roots shall be grubbed to at least 12 inches below the existing grade or proposed final sub grade surface, whichever is greater.

Stripping shall consist of the removal of organic top soils and muck from within the limits of grading, as indicated on the Drawings. Over stripping shall be avoided.

All organic or otherwise objectionable material removed by clearing, grubbing, and stripping shall be disposed of in area(s) designated by the Owner.

3.1.5 Unsuitable Soils/Waste Removal

All organic, highly compressible, and other deleterious soils within the designated construction area, as determined by the Engineer, shall be excavated and removed from the construction area and disposed of on-Site at locations designated by the Owner. All other construction waste shall be removed by the Contractor and disposed of off-site.

The proposed Increment 1 Buildout will be constructed adjacent to the existing landfill and the geomembrane liner will extend over the side slope of the existing waste. The sub grade for the liner system and the perimeter dikes consist predominantly of fly ash and miscellaneous wastes landfilled within pozzocrete berms. The Contractor shall be aware that some of the landfilled materials (e.g., wastewater treatment sludge) may not be suitable as sub grade materials for the liner system. If such materials are encountered, the Contractor shall remove and stockpile or dispose of the materials on-Site at locations designated by the Owner.

3.2 Earthwork for Site Grading

The sub grade for the liner system on the side slope of the existing landfill is 18 inches to 24 inches of intermediate sand cove over predominantly fly ash landfilled within pozzocrete berms. The existing vegetation must be removed and additional clean sand added to a total thickness of 24 inches before placing the geomembrane. The existing grade shall be prepared and compacted to the lines and grades indicated on the Drawings.

3.2.1 Existing and Excavated Base Surfaces

Existing surfaces and those exposed as a result of excavation shall be scarified, wetted, or dried as may be required, and compacted to a dry density of not less than 95 percent of the standard Proctor maximum dry density (ASTM D698) to a depth of not less than 6 inches beneath the finished surface before the placement of any fill materials. This requirement does not apply to pozzocrete berms.

3.2.2 Fill Placement for Site Grading

Fill materials meeting the requirements of Section 3.2.4 and subject to approval by the Engineer shall be wetted or dried, as may be required, homogenized and placed in successive relatively horizontal layers not exceeding 12 inches in loose thickness. After a lift is placed and compacted per these Specifications, its surface shall be scarified just before placement and compaction of the next lift to permit proper bonding between lifts. The base shall be smoothly graded to the lines and grades shown on the Drawings, or as otherwise revised by the Owner.

The operation of Job Site grading shall be suspended at any time when satisfactory results cannot be obtained because of rain, inclement weather, or other unsatisfactory conditions in the field.

3.2.3 Source of Fill Materials

Fill materials for Site grading, and backfill of areas excavated to remove unsuitable material shall be clean fill obtained from on-Site borrow sources designated by the Owner.

3.2.4 Fill Material Requirements

Only clean fill are allowed to be used for Site grading inside the proposed perimeter dikes. If clean fill is used, the materials shall consist of fine sands and slightly silty to silty and slightly clayey to clayey fine sands classifying as SP, SP-SM, SP-SC, SM, or SC-type soils in accordance with ASTM D2487 and free from rocks, stones, and gravel in excess of 6 inches in diameter, and other deleterious materials (organic matter, roots, wood, trash, debris, sharp objects, etc.). Fill materials within the upper 12 inches of the final finished sub grade (i.e., finished grade on which the GCL will be placed) shall not contain particles larger than 1/4-inch in diameter to prevent damage to the geomembrane liner.

3.2.5 Compaction Criteria

Existing surfaces and those exposed by excavation shall be inspected by the Engineer and compacted to a dry density of not less than 95 percent of the standard Proctor maximum dry density (ASTM D698) prior to the placement of any fill materials. Standard Proctor compaction tests (ASTM D698) will be performed by the Engineer on Samples of the borrow soils, as needed, to determine the optimum moisture contents, allowable ranges of placement moisture content, and the relationships between dry density and molding moisture content to be used for compaction control. The Engineer will provide standard Proctor maximum dry densities and moisture contents for the borrow soils.

3.2.6 Dewatering Ditches

The slopes of all temporary dewatering and runoff diversion ditches used during construction shall be cut back to a minimum slope of 3H:1V prior to backfilling. The ditches shall be backfilled and properly compacted when they are no longer needed.

3.2.7 CQA Inspection and Testing

The Engineer, retained by the Owner, will test and inspect the prepared base for compliance with the material and compaction criteria specified herein. The Engineer will perform in situ moisture content and density determinations a minimum of once per 22,500 square feet for compacted existing and excavated base surfaces and a minimum of once per 850 cubic yards of compacted fill using the drive cylinder method (ASTM D2937), or another method approved by the Engineer and deemed equivalent by him/her at his/her sole discretion.

3.2.8 Base Maintenance

It shall be the Contractor's responsibility to maintain, re-grade, and restore, as needed, the condition of the prepared base to the lines, grades, and degree of compaction noted above, and to maintain the surface to be lined smooth and free from deleterious materials.

3.3 Earthen Dike Construction

The earthen perimeter and divider dikes shall be constructed at the locations and to the lines and grades shown on the Drawings. Portions of the existing landfill slopes that will become part of the Increment 1 Buildout shall be re-worked, cut, or filled to the lines, grades and dimensions shown on the drawings.

3.3.1 Source of Fill Materials

Fill materials shall be obtained from on-Site borrow sources or stockpiles designated by the Owner. Alternative borrow sources are subject to prior approval by the Owner. Stockpiling of approved dike fill materials, if required, shall be on-Site in areas designated by the Owner.

3.3.2 Dike Fill Material Requirements

Fill materials used in construction of the perimeter dike shall be classified as clean granular fill. All dike fill materials are subject to approval by the Engineer, and shall be free from wood, roots, trash, rocks, debris, or other deleterious material.

The clean granular fill materials must be obtained from pre-approved, natural ground borrow sources or on-Site stockpiles. The clean granular fill materials shall consist of clean, granular soils, which classify as SW, SP, SW-SM, SW-SC, SP-SM, and SP-SC in accordance with ASTM D2487. The soil shall have not more than 12 percent by dry weight passing the U.S. Standard No. 200 sieve in accordance with ASTM D1140. With prior approval by the Engineer, SC type soils with not more than 25 percent by dry weight passing the U.S. Standard No. 200 sieve size may also be utilized in dike construction.

The fill materials shall not contain any particles larger than 6 inches in diameter, with the exception of the upper 1 foot of the interior dike slope, which shall not contain particles larger than 1/4-inch in diameter to prevent damage to the liner system.

3.3.3 Dike Construction

The earthen dikes shall be constructed upon a prepared sub base meeting the requirements specified in Sections 3.2.1 and 3.2.5. Portions of the prepared base surface that no longer meet the specified compaction criteria shall be scarified, wetted or dried, as needed, and re-compacted prior to placement of dike fill materials. Just prior to placement of the initial lift of dike fill material, the prepared sub base shall be scarified to permit proper bonding between the two surfaces. This requirement does not apply to sub base that consists of the pozzocrete berm.

After a lift is placed and compacted per these Specifications, its surface shall be scarified just before placement and compaction of the next lift to permit proper bonding between the two lifts. At no time shall a new lift of fill be placed over a non-scarified or dried surface. If a dried surface develops, it shall be re-wetted and re-compacted or thoroughly and uniformly mixed with moist underlying soils prior to placement of a new lift of fill.

Dikes shall be constructed by placement and compaction of the selected fill materials in successive horizontal layers of not more than 12 inches in loose, vertical thickness. The fill materials shall be wetted or dried, and homogenized prior to compaction to obtain uniform moisture content in each lift. Each lift shall be compacted by rolling with a tamping roller, heavy rubber tire roller, steel wheel (sheep-foot) power roller, or other suitable compaction equipment. The Contractor shall plan the traffic flow of equipment to provide a thorough and uniform compaction effort on each successive lift of fill.

3.3.4 Compaction Criteria

Earthen dike fill materials shall be compacted to a dry density of not less than 95 percent of the standard Proctor maximum dry density (ASTM D698). The Engineer shall perform Standard

Proctor compaction tests (ASTM D698) on Samples of the borrow or stockpiled soils, as needed, to determine the optimum moisture content and maximum dry density to be used for compaction control.

3.3.5 CQA Inspection and Testing

The Engineer, retained by the Owner, will undertake observations and perform CQA tests to determine compliance of the dike construction with these Specifications. Prior to placement, the Engineer shall observe that the base surface or surface of the previously compacted lift is satisfactorily prepared in accordance with Sections 3.3.3 and 3.3.4. The Engineer shall also verify that the borrow soils used for construction are free of deleterious materials and meet the requirements specified in Section 3.3.2 for the appropriate material classification required for construction of the designated dike types. Fines content determinations (ASTM D1140) shall be performed, as needed, to verify conformance of the clean granular fill with the requirements specified in Section 3.3.2.

During placement, the dike fill materials will be inspected to verify that they have been thoroughly homogenized, uniformly placed and adequately compacted. The Engineer shall make the necessary penetration tests to quantify the uniformity of compaction and probe measurements to verify compliance with the maximum lift thickness specified herein.

After compaction of each lift is complete, the Engineer, retained by the Owner, will perform moisture content determinations and in situ density determinations at a minimum rate of once per 2,000 cubic yards of compacted fill using the drive cylinder method (ASTM D2937), or another method approved by the Engineer and deemed equivalent by him/her at his/her sole discretion. The Engineer shall compare results of these tests to the results of standard Proctor tests to determine compliance with the specified compaction criteria.

3.3.6 Dike Maintenance

The Contractor shall maintain and restore, as needed, the condition of the completed earthen dike such that it conforms to the lines and grades shown on the Drawings and to the compaction criteria specified herein.

3.4 Erosion and Sedimentation Control Features

3.4.1 Description

Erosion and sedimentation control practices shall be employed by the Contractor to minimize erosion and sedimentation during construction until all Work has been accepted by the Owner. Methods, which may be used, include, but are not limited to, vegetation, berms, and silt fences. An erosion control plan outlining the proposed erosion and sedimentation control measures to be undertaken during construction shall be submitted by the Contractor to the Owner for approval prior to construction. All devices for erosion and sedimentation control shall be installed prior to beginning construction in an area. If the Owner determines that erosion or sedimentation is

occurring because of the Contractor's construction activity despite implementation and maintenance of protective measures, the Contractor shall take additional protective measures as directed by the Owner. Upon completion of the Work or upon instruction by the Owner, the Contractor shall dismantle and remove erosion and sedimentation control devices used during construction.

3.4.2 Referenced Standards

Florida Department of Transportation: Standard Specification for Road and Bridge Conditions – Latest Edition.

Florida Department of Transportation: Roadway and Traffic Design Standards.

3.4.3 Submittals

Certifications: Submit copies of a certification from the manufacturer and/or supplier that all materials used in this work meet the appropriate project specification.

3.4.4 Quality Assurance

General: The Contractor shall be responsible for routine inspection of erosion and sedimentation control measures for verification of compliance with the Water Management District permit, Stormwater Pollution Prevention Plan, and FDEP NPDES permit.

3.4.5 Permits

Water Management Permit: Contractor shall comply with all requirements of the Water Management District permit during construction.

Copies: Contractor shall maintain a copy of all permits on-site and available for review by any regulatory agency.

3.4.6 Control of Contractor's Operations Which May Result in Water Pollution

General: Take sufficient precautions to prevent pollution of streams, canals, lakes, and other water impoundments, with fuels, oils, bitumen's, calcium chloride, or other harmful materials. Conduct and schedule operations so as to avoid or otherwise minimize pollution or siltation of such streams, etc. and to avoid interference with movement of migratory fish. Do not dump the residue from dust collectors or washers into any water body.

Construction in Wet Areas: Construction operations in rivers, streams, lakes, canals, and other impoundments shall be restricted to those areas where it is necessary to perform filling or excavation to accomplish the work shown in the Contract Documents and to those areas which must be entered to construct temporary or permanent structures. As soon as conditions permit, promptly clear canals, streams, and impoundments of all obstructions placed therein or caused by construction operations.

Placement of excavated Material: Except as necessary for construction, do not deposit excavated material in streams, canals, or impoundments, or in a position close enough thereto, to be washed away by high water or runoff.

Pumped Discharge: Where pumps are used to remove highly turbid waters from enclosed construction areas such as cofferdams or forms, treat the water prior to discharge into waters of the State. Pump the water into grassed swales, appropriate vegetated areas, or sediment basins, or confine it by an appropriate enclosure such as siltation curtains when other methods are not considered appropriate. Do not contaminate waters of the State.

Limits of Construction: Do not disturb lands or waters outside the limits of construction, except as may be found necessary to complete the work.

3.4.7 Start of Work

Survey: Prior to starting work the Contractor shall, field survey and stake the limits of construction where specific delineations are needed to properly identify the project limits.

Fences: Install all silt fences along the limits of construction as indicated on the Drawings.

Approval: Obtain the Owner's approval of the installed erosion and sedimentation control measures prior to the start of construction activities.

3.4.8 Products

General: Materials used for the construction of the temporary erosion and sedimentation control measures are not to be incorporated into the completed project and therefore may be new or used materials.

Testing: No testing of materials used in construction of temporary erosion control features will be required.

3.4.9 Execution

General: Temporary erosion control features shall consist of, but not be limited to, temporary sodding, sandbagging, slope drains, sediment basins, artificial coverings, berms, floating silt barriers, staked silt barriers and staked silt fences. Design details for some of these items may be found in the Water Quality Section of the applicable edition of the FDOT Roadway and Traffic Design Standards.

Permanent Features: Incorporate permanent erosion control features into the project at the earliest practical time. Correct conditions, using temporary measures that develop during construction to control erosion prior to the time it is practical to construct permanent control features.

Protection of Adjacent Waters: Construct temporary and permanent erosion and sediment control measures to prevent the pollution of adjacent water ways in conformance with the laws, rules and regulations of Federal, State and local agencies.

3.4.10 Installation

Temporary Coverage: This work shall consist of furnishing and placing grass and/or sod.

Sandbagging: This work shall consist of furnishing and placing sandbags in configurations, so as to control erosion and siltation.

Slope Drains: This work shall consist of constructing slope drains, utilizing pipe, filter fabric mats, rubble, cement concrete, asphaltic concrete plastic sheeting, or other acceptable materials, in accordance with the details shown in FDOT's Roadway and Traffic Design Standards or as may be approved as suitable to adequately perform the intended function.

Sediment Basins: Sediment basins shall be constructed in accordance with the details shown in FDOT's Roadway and Traffic Design Standards or as suitable to adequately perform the intended function. Sediment basins shall be cleaned out as often as necessary.

Artificial Coverings: This work shall consist of furnishing and applying fiber mats, netting, plastic sheeting, or other approved covering to the earth surfaces.

Berms: This work shall consist of construction of temporary earth berms to divert the flow of water from an erodible surface.

Temporary Silt Fences and Staked Silt Barriers: This work shall consist of furnishing, installing, maintaining and removing staked turbidity barriers in accordance with the manufacturer's directions, these specifications and the details as shown in FDOT's Roadway and Traffic Design Standards.

Floating Silt Barriers: This work shall consist of installing, maintaining, and removal of floating silt barriers to contain turbidity that may occur as the result of dredging, filling, or other construction activities in waters of the State. The type barrier used, the deployment and maintenance of the barrier will be such as to minimize dispersion of turbid waters from the construction site. Alternate methods or materials may be used provided that compliance with applicable permit conditions and State water quality standards are maintained.

Enviro Fence: This work shall consist of furnishing, installing, maintaining and removing staked geo-grid fence in accordance with these specifications, the Drawings, and the manufacturer's recommendations.

3.4.11 Removal of Temporary Erosion Control Features

Removal: In general, remove or incorporate into the soil any temporary erosion control features existing at the time of construction of the permanent erosion control features in such a manner that there will be no detrimental effect. Removal of such measures shall not occur prior to receipt of approvals from the Owner.

3.4.12 Maintenance of Erosion Control Features

General: Provide continuous routine maintenance of permanent and temporary erosion control features until the project is completed and accepted.

3.4.13 Protection During Suspension of Contract Time

Suspension: In the event that it is necessary that the construction operations be suspended for any appreciable length of time, shape the top of the earthwork in such a manner as to permit runoff of rainwater and construct earth berms along the top edges of embankments to intercept runoff water. Provide temporary slope drains to carry runoff from cuts and embankments which are located in the vicinity of rivers, streams, canals, lakes, and impoundments. Should such preventive measures fail, immediately take such other action as necessary to effectively prevent erosion and siltation.

3.4.14 Surface Water Management, Stormwater Runoff Control and Erosion Control

Storm Water Pollution Prevention Plan: In addition to all other applicable laws, ordinances, codes, rules, regulations, orders and decrees with which Contractor is obligated to comply, the Contractor expressly affirms that it has made itself familiar with, and shall fully comply with, the Storm Water Pollution Prevention Plan (SWPPP) for this Project.

Notice of Intent: The Owner shall submit to USEPA a completed and executed "Notice of Intent" (NOI) for Storm Water Discharges Associated with Construction Activity Under a NPDES General Permit, EPA Form 3510-9, and the Contractor shall submit to the Owner a completed and executed Contractors Certification on a form to be provided by the Owner.

Protection: The Contractor shall be responsible for all runoff control efforts, including without limitation providing protection of areas receiving runoff, in accordance with any applicable regulations, codes, plans and permits.

Temporary Facilities: The Contractor shall furnish, install and maintain, at no additional cost to the Owner, all necessary surface protection such as temporary retention basins, silt screens, diapers, jute mesh, filter fabric, sod, sandbags, etc., for turbidity control and to prevent erosion and surface degradation.

Restoration: The Contractor recognizes and agrees that should any of the ponds, lakes, canals or other bodies of water adjacent to the site become contaminated due to the actions or inactions of the Contractor, the costs to flocculate, clean or remedy such contamination by any means necessary or required, will be borne by the Contractor. The Owner shall take turbidity readings on a regular basis and shall enforce all applicable environmental regulations.

SPECIFICATIONS

SECTION 4 INSTALLATION OF GEOSYNTHETIC CLAY LINER

4.1 Description of Work

The Work covered by this section involves installing a geosynthetic clay liner (GCL) at the base of the landfill to the lines and elevations shown on the Drawings. The GCL shall be installed on the liner soil base and on the side slopes of the perimeter dike constructed in accordance with Section 3 of the Specifications.

4.2 Layout of Work

The Owner will establish reference points for horizontal and vertical controls near the designated construction area for the landfill. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to install the GCL to the lines and grades shown on the Drawings. It is the responsibility of the Contractor to verify all locations and dimensions prior to performance of any Work.

4.3 Referenced Standards

The following ASTM standards are referenced in this Specification:

<u>D4643</u> :	Determination of Water (Moisture) Content of Soil by the Microwave Oven Method
<u>D5084</u> :	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
<u>D5261</u> :	Standard Test Method for Measuring Mass per Unit Area of Geotextiles
<u>D5321</u> :	Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
<u>D5887</u> :	Standard Test Method for Measurement of Index Flux through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter
<u>D5888</u> :	Standard Guide for Storage and Handling of Geosynthetic Clay Liners
<u>D5889</u> :	Standard Practice for Quality Control of Geosynthetic Clay Liners
<u>D5890</u> :	Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners
<u>D5891</u> :	Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners

- D5993: Standard Test Method for Measuring Mass per Unit of Geosynthetic Clay Liners
- D6141: Standard Guide for Screening Clay Portion of Geosynthetic Clay Liner (GCL) for Chemical Compatibility to Liquids
- D6243: Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method
- D6496: Standard Test Method for Determining Average Bonding Peel Strength between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners
- D6768: Standard Test Method for Tensile Strength of Geosynthetic Clay Liners

4.4 Material Property Requirements

The geosynthetic clay liner shall be prefabricated in a manufacturing facility with a uniform layer of natural bentonite sandwiched between two layers of geotextile backing to contain the bentonite. The geosynthetic clay liner shall be a reinforced and needle-punched product. The bentonite shall be continuously adhered to the geotextile backing either with a water-soluble adhesive, by needle punching, or a combination of adhesive and stitch bonding. The geotextile and any adhesives used in the manufacturing of the geosynthetic clay liner shall not interfere with the swelling and self-healing characteristics of the bentonite and with the effectiveness of the bentonite as an impermeable barrier. The selected geosynthetic clay liner shall have been satisfactorily demonstrated by prior use to be suitable and durable for such applications. The GCL shall have a saturated hydraulic conductivity of equal to or less than 1.0×10^{-7} cm/sec when hydrated and permeated with leachate from fly ash.

4.4.1 Bentonite

Bentonite, which is the active ingredient of the geosynthetic clay liner, shall be a premium grade bentonite that comprises at least 90 percent sodium montmorillonite with high swelling characteristics. The bentonite used in all field seams, where specified, shall be identical to the bentonite product used in the manufacturing of the geosynthetic clay liner sheets. The bentonite in the finished product shall have moisture content no greater than 12 percent and shall be uniformly distributed at a minimum rate of 0.75 dry pounds per square foot. The bentonite shall continuously adhere to the geotextile backing materials and shall not be easily displaced when the liner is cut. The bentonite shall have a minimum swell index (ASTM D5890) of 24 mL/2g and a maximum fluid loss (ASTM D5891) of 18 mL.

4.4.2 Geotextile Backing Materials

The geotextile backing materials of the geosynthetic clay liner shall be manufactured from 100 percent polypropylene. The geotextile shall be uniform and homogeneous in appearance and composition, and shall be free from tears, cuts, thin spots or any defects that may affect its serviceability. The geotextile shall be strong enough to help support the normal load and provide

a degree of protection against puncture. The geotextile shall be sufficiently porous to allow bentonite flow-through to create a positive bentonite-to-bentonite seal along the seam between two adjacent liner sheets. Moreover, the geotextile backing materials shall not interfere with the swelling, self healing or low permeability characteristics of the bentonite product.

4.4.3 Adhesive

If an adhesive is used to adhere the bentonite to the geotextile backing fabrics, the adhesive shall be water-soluble, non-toxic glue, and shall not interfere with the swelling, self healing or low permeability characteristics of the bentonite product.

4.4.4 Finished Product

As a finished product, the geosynthetic clay liner shall be comprised of a uniform layer of natural bentonite encapsulated between two layers of geotextile backing and shall meet the following criteria:

Property	Test Method	Criterion
Bentonite Mass per Unit Area (Oven-Dried)	ASTM D5993	$\geq 0.75 \text{ lb/ft}^2$
GCL Grab Strength	ASTM D6768	$\geq 30 \text{ lb/in MARV}^*$
Peel Strength	ASTM D6496	$\geq 2.3 \text{ lb/in}$
Hydraulic Conductivity at 5 psi	ASTM D5084	$\leq 5.0 \times 10^{-9} \text{ cm/sec}$
Effective Stress	ASTM D5887	$\leq 1 \times 10^{-8} \text{ m}^3/\text{m}^2/\text{sec}$
Index Flux	ASTM D6243	500 lb/ft^2
Internal Shear Strength		
*MARV - Minimum average roll value		

A complete description of the geosynthetic clay liner proposed for use by the Contractor that meets or exceeds the requirements specified herein shall be submitted to the Engineer for approval prior to installation.

4.5 Manufacturing and Factory Testing/Inspection

4.5.1 Minimum Sheet Dimensions

The geosynthetic clay liner shall be supplied by the Manufacturer in rolls having a minimum width of 12 feet and a minimum length of 100 feet.

4.5.2 Factory Testing

Standard factory testing reports for raw materials used in manufacturing of the geosynthetic clay liner supplied to this Project shall be submitted to the Engineer for approval before shipment of any liner. Factory quality control certificates for each liner roll shall be provided to the Engineer by the Manufacturer prior to installation. As a minimum, the quality control certificates shall contain the liner roll identification number, date manufactured, roll length and width, and the following test results at the indicated frequencies:

- Free swell of bentonite (Every 50 tons)

- Fluid loss of bentonite (Every 50 tons)
- Bentonite mass/unit area (1 per 40,000 square feet)
- GCL grab strength (1 per 200,000 square feet)
- GCL peel strength (1 per 40,000 square feet)
- Hydraulic conductivity of GCL (Every 30 Rolls)
- Index flux of GCL (Every 30 Rolls)

4.5.3 Factory Inspection

Prior to rolling and shipment, the finished product shall be visually inspected by the Manufacturer over 100 percent of the surface area to detect deficiencies in the uniformity of the bentonite. Regions of the finished product in which a bentonite deficiency is noted shall be removed from the production line and rejected.

4.5.4 Marking and Packaging

The Manufacturer shall provide each sheet or roll with prominent identifying markings indicating proper direction of unrolling to facilitate layout and positioning in the field, and identifying the thickness, length, width, weight, date manufactured and Manufacturer's roll identification number. Further, overlap marks shall be marked longitudinally on the geosynthetic clay liner by the Manufacturer to assist in obtaining the proper overlap.

Each liner roll shall be individually packaged at the factory and protected to prevent damage during shipment. If the liner is not packaged and a roll is damaged during shipment, it shall be rejected. If only the outermost surface of the roll is affected, it shall be peeled back, cut, and wasted, i.e., it shall be treated as if it were the protective packaging for the remainder of the roll. Unrolled liner stock that requires more than one repair patch per 1,000 square feet shall be considered faulty, and shall be rejected and replaced.

The liner rolls shall be completely wrapped and adequately secured with a durable polyethylene protective cover to provide protection from ultraviolet degradation of the geotextile backing materials and excessive moisture loss during shipping and storage.

4.6 Handling and Installation

Installation of the geosynthetic clay liner shall be in compliance with these Specifications and with the Manufacturer's standard guidelines and specifications for liner installation, subject to approval by the Engineer. Items covered by these Specifications include, but are not limited to, handling and Site storage requirements, unrolling of panels and lying of liner sheets, overlapping of adjacent panels, and anchor trench and wind ballast details.

4.6.1 On-Site Storage

The geosynthetic clay liner rolls shall be carefully unloaded by the Contractor upon arrival at the Site, and shall be stored in their original, unopened, wrapped cover in a clean, dry area. On-Site storage shall be as needed to protect the liner rolls from excessive dirt, water, moisture, heat and direct rays of the sun, and from mechanical abrasion, puncture and vehicular traffic. Liner rolls shall be stored off the ground by using 4"x4" lumber, and the liner shall not be stacked more than three rolls high. The liner rolls shall be covered with a heavy, protective tarpaulin or enclosed within a storage facility. Care shall be exercised to keep the liner clean and free from debris prior to installation.

4.6.2 Base Preparation and Maintenance

Installation of the geosynthetic clay liner shall not begin until a soil base has been prepared in accordance with Section 3 of these Specifications, approved by the Engineer, and accepted by the GCL Installer. The prepared surface shall be free from loose soil, exposed rocks larger than ½ inch in diameter, rubble and other foreign matter.

Once liner installation begins, the Contractor shall maintain and restore, as needed, the condition of the soil base. Any damage to the prepared soil base shall be reported immediately to the Engineer so that repair Work can be undertaken immediately. The method of repair shall be approved by the Engineer. The base shall be maintained well drained at all times during liner installation.

4.6.3 Handling and Panel Placement

Appropriate handling equipment shall be used when loading and moving rolled liner sheets from one place to another. Appropriate equipment includes spreader and roll bars for deployment, and cloth chokers and spreader bar for off-loading. Alternatively, a forklift truck can be modified to lift the rolls with a similar steel bar, securely attached to the forklift and inserted into the roll core. The bar shall extend fully into the roll core from one end to the other. At no time shall the rolls be lifted by sliding the forks under the roll.

The geosynthetic clay liner rolls shall be brought to the area to be lined with a front-end loader and support pipes set up such that the geosynthetic clay liner roll is fully supported across its length. A spreader bar or similar device shall be used to prevent the lifting chains or slings from damaging the edges.

The geosynthetic clay liner shall be installed in a relaxed condition and shall be free of tension or stress upon completion of the installation. Stretching of the geosynthetic clay liner to fit will not be allowed. The geosynthetic clay liner shall be straightened to smooth out creases and folds. Dragging of the geosynthetic clay liner panels over the surface shall be minimized. Deployment of the liner shall not be done during precipitation, excessive moisture, wet conditions, high winds, or other adverse climatologic conditions. Panel layout and deployment shall be such that all seams run down the side slopes. All panels used on the side slopes must be needle punched or stitch-bonded. A detailed layout plan and Shop Drawings shall be prepared and submitted by the Contractor to the Engineer for approval prior to delivery of any liner material to the Site.

4.6.4 Seaming

Once the first run has been laid, adjoining runs shall be laid with a 6-inch minimum overlap on the longitudinal seams and 36 inches on the end seams. After the overlying liner is placed, its edge shall be pulled back to expose the overlap zone. Any soil or debris present in the overlap zone shall be removed. A fillet of granular bentonite shall be poured in a continuous manner along the overlap zone at a rate of 0.25 pounds per lineal foot. Seam overlaps shall be placed such that the direction of flow is from the top sheet to the bottom sheet to form a shingle effect.

On side slopes, all runs shall be from crest to toe with the machine direction of the geosynthetic clay liner running perpendicular to the base.

The field seam of the geosynthetic clay liner and that of the geomembrane liner shall be offset by at least 3 feet or as otherwise approved by the Engineer such that the seams of the geomembrane liner do not overlie those of the geosynthetic clay liner.

4.6.5 Anchorage

The geosynthetic clay liner shall be anchored securely in anchor trenches shown on the design drawings. The anchor trench shall be no less than 18 inches in width and 24 inches in depth and the corners of the trench shall be slightly rounded to minimize sharp bends in the liner.

The Contractor shall be responsible for earthwork pertaining to anchorage. After placement of the geomembrane liner, the trench shall be backfilled with random fill compacted to at least 95 percent of the standard Proctor maximum dry density, as determined in accordance with ASTM D698. The random fill for the anchor trench shall be obtained from an on-Site source designated by the Engineer. Care shall be taken not to damage the liner during placement and compaction of the backfill in the anchor trench.

4.6.6 Other Ballast Loading

Adequate loading that will not damage the liner shall be placed by the Contractor over the liner during installation as needed to prevent uplift by wind and by rapid changes in barometric pressure. This ballast loading shall be in addition to the permanent anchor trenches.

Ballast loading may consist of additional wind ballast trenches and/or sand bags, etc. Bags used for containing sand or cement shall be resistant to degradation by ultraviolet rays.

Sufficient temporary ballast loading shall be placed along panel edges, in particular, as needed to minimize the risk of wind flow under the liner panels. Continuous loading shall be provided at all panel edges during days off, at night, and whenever inclement or stormy weather is anticipated.

The Contractor shall submit details of the ballast loading (type, spacing, etc.) it proposes using for review and approval by the Engineer. Approval by the Engineer, however, shall not relieve the Contractor from its responsibility to provide additional ballast loading, as needed, to prevent liner uplift and to prevent erosion below the installed liner.

4.6.7 Repairs

Irregular shapes, cuts or tears in installed liner shall be covered with sufficient liner to provide a 12-inch overlap on all adjoining liners. Granular bentonite shall be placed around the perimeter of the affected area at a rate of 0.50 pounds per lineal foot prior to installing the patch. Patches and repairs shall not be allowed on the side slopes unless they are securely anchored with a water-soluble adhesive or other approved method. The patches should remain secure even after the liner and patch have become fully hydrated. Alternatively, the patches can be placed under the defective liner in order to prevent slippage of the patch.

4.6.8 Liner Protection

No equipment, tools or personnel that can cause damage to the geosynthetic clay liner shall be allowed on the liner during and after installation. Personnel working on the geosynthetic clay liner shall not smoke, wear potentially damaging shoes, dispose of trash or other debris, or engage in any activity that could damage the liner. The passage of construction equipment over any exposed geosynthetic clay liner surface is strictly prohibited. Any damage to the geosynthetic clay liner shall be repaired by the Contractor.

4.6.9 Visual Inspection

The Contractor shall visually inspect the entire GCL surface for any defects including, but not limited to, seam imperfections, tears, rips and punctures. The Contractor shall also identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs shall be made in accordance with these Specifications.

4.7 Cover Material

The geosynthetic clay liner shall be covered the same day with the HDPE geomembrane liner to be installed in accordance with Section 6 of these Specifications. To prevent premature hydration or contraction in hot, arid conditions, only the amount of geosynthetic clay liner that can be anchored, inspected, repaired and covered in the same day shall be installed. Any leading edge or panels of geosynthetic clay liner left unprotected must be covered by the Contractor with a heavy, waterproofing tarp that is adequately secured and protected with sand bags or other ballast to prevent erosion beneath the liner during heavy precipitation.

4.8 Quality Assurance Inspection and Testing

4.8.1 Base Maintenance and Repair During GCL Installation

Prior to and during installation of the GCL, the Contractor shall maintain the sub grade in accordance with Section 3 of the Specifications and to the lines, dimensions and grades shown on the Drawings. The Contractor shall repair any ruts, erosions, cracks, or other discontinuities to provide a smooth base for GCL installation. The Contractor shall not deploy or install any GCL without prior approval of the sub grade by the Engineer.

The Engineer will undertake observations and perform quality assurance tests to determine compliance with these Specifications. The Engineer will perform *in situ* density tests: (i) after

compaction of fill as needed to fine grade, maintain and restore the condition of the sub grade; (ii) after dressing the slopes of dikes; (iii) after compaction of fill in excavations as needed to restore the grade; and (iv) after compaction of backfill in anchor trenches. *In situ* density tests will be performed by the drive cylinder method (ASTM D2937), sand cone method (ASTM D1556) or other methods approved by the Engineer. Penetration test probes may also be performed as needed to verify the uniformity of compaction. The Engineer will perform standard or modified Proctor compaction tests (ASTM D698 or D1557) and/or minimum and maximum density tests (ASTM D4253 and D4254) to determine compliance with compaction requirements.

4.8.2 Field Observation

The quality control documentation shall be reviewed by the Engineer to ensure that the finished geosynthetic clay liner meets or exceeds all of the criteria stipulated in these Specifications. All delivered geosynthetic clay liner rolls shall be visually inspected and approved by the Engineer or his designated field representative prior to installation. Defects or damage from shipping and handling shall be grounds for rejection at the discretion of the Engineer.

The Engineer or his designated field representative shall observe deployment of each geosynthetic clay liner panel to ensure compliance with these Specifications. The inspection shall consist of:

- Recording of each roll number and lot number as panels are deployed along with a general description of the location of each panel.
- Inspection of overlap.
- Visual inspection of geotextile quality, bentonite uniformity and the degree of hydration, if any, on the geosynthetic clay liner. Marking of any areas as appropriate for repair.
- Inspection of anchoring.

4.8.3 Independent Testing

The Contractor shall cut a 1-foot long by roll width sample at a frequency of one per 100,000 square feet of geosynthetic clay liner delivered to the Site and submit to the Engineer for independent testing. Hydraulic conductivity testing, peel strength, and bentonite mass per unit area determinations shall be performed by the Engineer.

SPECIFICATIONS

SECTION 5 GEOMEMBRANE LINER MATERIALS

This Specification covers the material requirements for High Density Polyethylene (HDPE) geomembrane liner, factory inspection and testing requirements, and independent quality control testing. The Geomembrane shall or exceed the specifications in GRI GM 13.

5.1 Referenced Standards

The following ASTM and Federal Test Method (FTM) standards are referenced in this Specification:

- D570: Standard Test Method for Water Absorption of Plastics
- D746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
- D792: Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1004: Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
- D1203: Standard Test Method for Volatile Loss from Plastics Using Activated Carbon Methods
- D1204: Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
- D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603: Standard Test Method for Carbon Black in Olefin Plastics
- D1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics
- D3895: Standard Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis
- D4833: Standard Test Method for Index Puncture Resistance of Geotextiles and Geomembranes

- D4976: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
- D5199: Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
- D5321: Standard Test Method for Determining the Coefficient of Soil and Geosynthetic Or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
- D5397: Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Load Test; Appendix - Procedure to Perform a Single Point Notched Constant Load (Appendix (SP-NCTL) Test
- D5596: Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D5994: Standard Test Method for Measuring Core Thickness of Textured Geomembranes
- D6693: Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
- E96: Standard Test Methods for Water Vapor Transmission of Materials
- FTMS 101B-2065:
Puncture Resistance and Elongation Test (c-inch Radius Probe Method)

5.2 Material Requirements

Two-sided textured geomembrane liner shall consist of unreinforced high density polyethylene (HDPE), designed and manufactured specifically for the purpose of liquid containment.

Product data sheets listing the minimum and nominal liner physical properties shall be provided for each type liner prior to shipment. Product data sheets for the HDPE resin, listing density, melt index, low temperature brittleness and environmental stress crack resistance, shall be provided for each type resin prior to shipment.

5.2.1 Base Resin

The uncolored base resin used to manufacture the liner shall be polyethylene having a minimum density of 0.932 g/cm^3 . The formulated colored resin shall classify as a Type III, Category 4 or 5, Grade P34, Class C High Density Polyethylene in accordance with ASTM D4976. The resin shall contain not less than 97 percent of the base polymer, and not less than 2.0 percent carbon black. Carbon black dispersion in the liner shall be rated as ≥ 9 of 10 views as Category 1 or 2, and ≤ 1 of 10 views as Category 3 classified using ASTM D5596. The variation in carbon black content within each resin batch shall be no greater than ± 5 percent from the average carbon black content. The liner material shall contain no more than 3 percent carbon black, anti-oxidants and

heat stabilizers combined, and no other additives, fillers or extenders. The liner shall be manufactured from virgin resin with no more than 3 percent regrind material. Regrind material, if used, must be of the same formulation as the virgin resin. No post-consumer resin of any type may be used.

Liner sheets shall be manufactured using one of the following base resins unless otherwise approved by the Engineer:

- Mobil HDA 601
- Chevron Phillips 66 HHM TR-400, or K306
- BP Solvay G36-24x1767
- Atofina Finacene M3302
- Petromont HDPE 7000.

Use of any of the approved base resins shall not relieve the Liner Manufacturer from complying with all other Specification criteria. HDPE welding rods shall be manufactured from the same resin used to manufacture the liner.

5.2.2 Physical Appearance of Liner Sheets

All liner sheets shall have good appearance qualities. Texturing on the surface of textured sheets shall be uniform and homogeneously distributed.

All liner sheets shall be free of pinholes, holes, blisters, gels, undispersed ingredients, fish-eye blemishes, any signs of contamination by foreign matter, or any defect that may affect serviceability. The edges of the sheets shall be straight and free from nicks and cuts. Rolled out liner stock that requires more than one patch per 5,000 square feet for repair of blemishes, holes, undispersed ingredients, etc., shall be considered faulty, and shall be rejected and replaced at the Contractor's expense.

5.2.3 Textured Liner Physical Properties

The textured HDPE liner shall be textured on both sides. Textured liner shall have a uniform texturing appearance and shall be free from agglomerated texturing material. The textured liner shall meet the following criteria:

Property	Test Method	Criterion
Minimum Thickness Average Thickness Asperity Height Density (minimum) Melt Index Carbon Black Content Carbon Black Dispersion	ASTM D5994 ASTM D5994 GRI GM13 ASTM D792 or D1505 ASTM D1238, Condition E ASTM D1603 ASTM D5596 (10 views)	≥ 54 mil ≥ 60 mil ≥ 10 mil > 0.940 g/cm ³ † <1.0 g/10 min ≥2.0% & <3.0% Category 1 or 2 (≥9 views) and Category 3 (# 1 view)
Tensile Strength at Yield MARV Tensile Strength at Break MARV Elongation at Yield MARV Elongation at Break MARV Tear Resistance MARV Puncture Resistance MARV	ASTM D6693, Type IV* ASTM D6693, Type IV* ASTM D6693, Type IV* ASTM D6693, Type IV* ASTM D1004 ASTM D4833	>130 lb/in >90 lb/in >13% >150% >42 lb >108 lb
Water Vapor Transmission MARV Dimensional Stability Low Temperature Brittleness Volatile Loss Water Absorption	ASTM E96, Procedure BW ASTM D1204, 100 °C / 1 hr ASTM D746, Procedure B ASTM D1203, Method A ASTM D570	<0.03 g/m ² /24 hr ±2% (max) <-94 °F (<-70 °C) <0.1% <0.1%
Constant Tensile Load Stress Crack Resistance (Single Point at 30% of yield stress) Oxidative Induction Time MARV	ASTM D5397 (SP-NCTL) ASTM D3895 (200 °C & 14.7 lb/in ² O ₂)	> 200 hrs >100 min
MARV - Minimum average roll value † The density of the uncolored base resin shall be greater than 0.932 g/cm ³ . * Tested at a rate of displacement of 2 inches/minute in both machine and transverse directions. Strain at yield shall be calculated using a 1.3" gauge length and strain at break shall be calculated using a 2.0" gauge length.		

All individual test specimens shall meet the minimum or maximum criterion tabulated above, with the following exception:

- The average tensile strength and elongation at break in both the machine and transverse directions, determined as the average of five test specimens in each direction, shall meet the specified criteria tabulated above. All individual test specimen results shall display tensile strengths at break equaling or exceeding 36 lb/in, and elongations at break equaling or exceeding 60 percent.

5.2.4 Frictional Characteristics

The surface roughness of the textured HDPE liner shall be such that the peak interface friction angle is equal to or greater than 12° between the textured HDPE liner and the HDPE geonet in the leak detection system, as well as between the textured HDPE liner and the HDPE geonet

component of the geocomposite in the leachate collection system. For determining compliance with the specified interface friction angle, compliance tests shall be performed by the Engineer using Samples of the textured liner, GCL, and geocomposite provided by the Manufacturers. The interface frictional resistance shall be determined by direct shear tests in general accordance with ASTM D5321 at normal stresses ranging from 20 to 40 lb/in².

5.3 Manufacturing and Factory Inspection and Testing

The Liner Manufacturer shall submit product data sheets and test data for each liner type to the Engineer presenting the liner minimum physical properties for each property listed in Section 5.2.3 and the resin types and properties. Written certification shall be provided by the Liner Manufacturer confirming compliance of the resin and liner sheets with this Specification.

5.3.1 Minimum Sheet Dimensions

The HDPE liner shall be supplied in rolled sheets having a minimum width of 22 feet and minimum length of 400 feet. Variances for shorter roll lengths may be allowed at the discretion of the Engineer.

5.3.2 Marking and Packaging

The Liner Manufacturer shall label each roll with the roll number, thickness, length, width and date manufactured.

Each roll shall be individually packaged at the factory and protected to prevent damage during shipment. If the liner is not packaged and a roll is damaged during shipment, it shall be rejected. If only the outermost surface of the roll is affected, it shall be peeled back, cut, and wasted (i.e., it shall be treated as if it were the protective packaging for the remainder of the roll). Rolled out liner stock that requires more than one repair patch per 5,000 square feet prior to installation shall be considered faulty, and shall be rejected and replaced at the Contractor's expense.

5.3.3 Factory Inspection and Spark Testing

The Liner manufacturer shall inspect all liner sheets at the factory for compliance with the physical appearance requirements listed in Section 5.2.2. The Liner Manufacturer shall continuously spark test all liner sheets during manufacturing. The spark tester shall be capable of detecting defects or pinholes equal to or less than 10 mils (0.25 mm) in diameter. The Liner Manufacturer shall submit a complete description of the spark tester, operating protocols, factory QA/QC plan for operating the system and identifying defective liner, and methods for removing or patching liner with pinholes to the Engineer prior to shipping liner to the Project. All necessary repairs to the liner shall be made by the Liner Manufacturer at the factory before shipment.

The Liner Manufacturer shall provide written certification that all liner rolls delivered to the Project were continuously spark tested and do not contain pinhole defects.

5.3.4 Factory Testing

The Liner Manufacturer shall submit the factory testing QA/QC plan, and factory laboratory quality manual for all liner and resin tests required in this Specification to the Engineer prior to shipping liner to the Project.

5.3.4.1 HDPE Resin

Factory sampling and testing of raw materials shall be in conformance with ASTM standards. Factory test reports for the HDPE resin shall include the proportions of HDPE resin, carbon black and other additives, and test results for melt index, specific gravity, environmental stress crack resistance, low temperature brittleness and oxidative induction time. These reports shall be submitted for approval by the Engineer before installation of any liner material. The following tests and minimum frequency of testing shall be undertaken by the Liner Manufacturer.

Resin Property	Method	Minimum Frequency
Density	ASTM D792	Once per Batch of Resin
Melt Index		
Oxidative Induction Time	ASTM D1238, Condition E	Once per Batch of Resin
	ASTM D3895	Once per Batch of Resin

The resin density and melt index shall be reported for both the unblended resin and the blended resin after adding carbon black and antioxidants. The oxidative induction time shall be reported for the blended resin. Routine testing for low temperature brittleness and environmental stress crack resistance is not required. Certification of these properties, in accordance with the requirements in Section 5.2.3, will be accepted.

5.3.4.2 Liner Rolls

Factory test reports for each roll of liner shall include test results for the following properties: tensile strength and elongation at yield and at break, tear resistance, puncture resistance, minimum and average thickness, density, carbon black content, and carbon black dispersion. These reports shall be submitted to the Owner before installation and prior to acceptance of the liner. Failure of any of the tests shall result in rejection of the corresponding liner rolls.

At the request of the Owner, but not more than once per day during each production run, the Liner Manufacturer shall furnish production line Samples to the Owner who reserves the right to have these Samples tested by the Engineer, at Owner's expense, to evaluate compliance with this Specification. Failure of any of the tests shall result in rejection of the corresponding batch or production run of liner material.

The following tests and minimum frequencies of testing shall be undertaken by the Liner Manufacturer on the liner rolls.

Liner Property	Test Method	Minimum Frequency
Core Thickness (Textured Liner)	ASTM D5994	Every Roll
Tensile Strength at Yield	ASTM D6693	Every Roll
Tensile Strength at Break	ASTM D6693	Every Roll
Elongation at Yield	ASTM D6693	Every Roll
Elongation at Break	ASTM D6693	Every Roll
Tear Resistance	ASTM D004	Every Roll
Puncture Resistance	FTMS 101B (Method 2065); or ASTM D4833	Every Roll
Density	ASTM D792 or D1505	Every 5 Rolls
Carbon Black Content	ASTM D1603	Every 5 Rolls
Carbon Black Dispersion	ASTM D5596	Every 5 Rolls
Notched Constant Load ESCR (Single Point at 30% of Yield Stress)	ASTM D5397 (SP-NCTL)	Every 20 Rolls

Tensile tests (ASTM D6693) and tear resistance tests (ASTM D1004) shall be performed in both the machine and transverse directions. Tensile properties (ASTM D6693), tear resistance (ASTM D1004) and puncture resistance (FTMS 101B-2065 or ASTM D4833) tests may be performed on only one test specimen from each roll of liner (in each direction, where applicable) and the moving average as well as the minimum value from each five consecutive rolls reported to the Engineer. Five test specimens shall be tested in each direction for tensile properties (ASTM D6693) from each of the first 20 rolls of textured liner manufactured for delivery to this Project. Provided all test results comply with Specifications, the number of test specimens may then be reduced as allowed above for smooth liner if approved by the Engineer. All factory testing shall be at the Liner Installer or Liner Manufacturer's expense.

Certification of the liner modulus of elasticity, dimensional stability, environmental stress crack resistance (ASTM D1693, Condition B), volatile loss, water absorption and water vapor transmission shall be provided in accordance with Section 5.2.3 of this Specification.

5.4 Independent Quality Assurance Testing

The Liner Installer shall obtain and secure Samples (coupons) of the liner for destructive testing by the Engineer from locations designated by the Engineer, and shall properly mark all test specimens as needed to identify the liner roll or panel from which the specimen was obtained. Testing by the Engineer will be made for the following liner properties at the following sampling frequencies unless revised otherwise by the Engineer during construction.

Property	Test Method	Sampling Frequency
Thickness	ASTM D5994 (Textured Liner)	2 per acre
Density	ASTM D1505	1 per acre
Carbon Black Content	ASTM D1603	1 per acre
Tear Resistance	ASTM D1004	
Tensile Strength at Yield	ASTM D6693, Type IV, 2 ipm	1 per acre*
Tensile Strength at Break	ASTM D6693, Type IV, 2 ipm	1 per acre*
Elongation at Yield	ASTM D6693, Type IV, 2 ipm	1 per acre*
Elongation at Break	ASTM D6693, Type IV, 2 ipm	1 per acre*
Frictional Characteristics	ASTM D5321	1 per 10 acres
Other Properties	As requested by the Engineer	Up to 2 Samples per acre
*Tested in machine and transverse directions.		

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material or installed liner section from which the sample was collected to the extent designated by the Engineer. If the Liner Installer or Liner Manufacturer can establish to the Engineer, via additional test results, that the failed sample is representative of a smaller section of the liner, then only that portion will be rejected, provided that such additional tests are performed, at the Liner Installer's or Liner Manufacturer's expense, by the Engineer representing the Owner.

5.5 Warranty

A written warranty shall be provided to the Owner from the Manufacturer. This document shall warrant the quality of the liner material for a period of not less than 20 years.

5.6 Submittals

The following submittals are required as part of the requirements of this Specification:

- Product data sheets and test data for each liner type listing the minimum liner physical properties, and the product data sheets for each type resin listing the resin properties (Section 5.2).
- A written certification from the Liner Manufacturer that the resin and liner materials comply with this Specification (Section 5.3).
- Written certification from the Liner Manufacturer that the liner modulus of elasticity, dimensional stability, low temperature brittleness, environmental stress crack resistance, volatile loss, water absorption and water vapor transmission meet the requirements of this Specification. In support of the certification, the Liner Manufacturer shall submit the result of at least one test for each certified property performed within 1 year prior to the date of the certification for each type liner manufactured with the same type resin supplied to the Project (Section 5.2.3).

- Written certification from the Liner Manufacturer that the HDPE resin low temperature brittleness and environmental stress crack resistance meet the requirements of this Specification. In support of the certification, the Liner Manufacturer shall submit the result of at least one test for each certified property performed within 1 year prior to the date of the certification for each type resin used to manufacture the liner supplied to the Project (Section 5.3.4.1).
- Description of the spark testing device, the factory QA/QC plan for operating the system, and written certification that all liner rolls have been factory spark tested and do not contain pinhole defects (Section 5.3.3).
- Factory testing QA/QC plan and factory laboratory quality control manual for all liner and resin tests required in this Specification (Section 5.3.4)
- Factory test reports for each batch of HDPE resin used in the liner sheets including proportions of base polymer and additives, oxidative induction time, melt index and density. The resin manufacturer's certificate of analysis for each batch of resin shall also be provided (Section 5.3.4.1).
- Factory quality control certificates for each liner roll including minimum and average thickness, tensile properties, tear resistance, puncture resistance, density, carbon black content and carbon black dispersion (Section 5.3.4.2).
- Written warranty from the Liner Manufacturer to warrant the quality of the liner material for a period of not less than 20 years (Section 5.5).

SPECIFICATIONS

SECTION 6 HDPE LINER INSTALLATION

6.1 Description of Work

This Specification covers the installation of high density polyethylene (HDPE) geomembrane liner and associated ancillary Work. The HDPE liner shall be installed in accordance with this Specification and as shown on the Drawings. Liner installation includes:

- (i) surface water control during liner installation;
- (ii) maintenance of the prepared soil base for the liner;
- (iii) placement and seaming of 60-mil HDPE liners;
- (iv) excavation and backfilling liner anchor trenches;
- (v) placement of temporary ballast loading;
- (vi) seaming of liner sheets; and
- (vii) liner connections at trenches and sumps.

6.2 Referenced Standards

The following ASTM standards are referenced in this Specification:

- D698: Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))
- D1556: Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
- D2216: Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
- D2937: Standard Test Method for Density of Soil in Place by the Drive Cylinder Method
- D4253: Standard Test Methods for Maximum Index Density and Unit Weight of Soils
- D4254: Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density
- D4437: Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- D4944: Standard Test Method for Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method
- D6392: Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

6.3 Surface Water Control and Base Maintenance

The base of the landfill construction area shall be maintained well drained prior to and during liner installation. Liner Work areas shall be maintained well drained and dry to prevent uplift of the liner after installation. The Contractor's proposed methods for dewatering, surface water control and routing water to either lined containments or surface water drainage shall be submitted to the Owner for approval at least 2 weeks prior to implementation.

The Liner Contractor shall maintain and restore, as needed, the condition of the prepared base prior to and during liner deployment and installation such that the prepared base is maintained in accordance with the Specifications in Sections 3 and 4 at the time of liner deployment.

6.4 Liner Handling and Installation

Installation of the liner shall be in compliance with this Specification and with the Manufacturer's standard guidelines and specifications for liner installation, subject to approval by the Engineer, including, but not limited to: handling and Site storage requirements; unrolling and laying of liner sheets; field welding techniques; anchor trench and temporary ballast details; vent details; and connections to pipes and structures.

6.4.1 On-Site Storage

On-Site storage shall be as needed to protect the liner rolls from excessive accumulations of soil on the liner surfaces, water, heat, mechanical abrasion, puncture and vehicular traffic. Liner rolls shall be stored on a firm, dry, and elevated surface in a protected storage area approved by the Owner. The liner rolls shall not be stacked more than three rolls high or as otherwise recommended by the Manufacturer.

6.4.2 Handling and Panel Placement

Appropriate handling equipment shall be used when loading or moving rolled liner sheets from one place to another. Appropriate equipment includes spreader and roll bars for deployment, and cloth chokers with a spreader bar for off-loading.

The HDPE liner shall be installed at the locations and to the lines, grades and dimensions shown on the Drawings, or as otherwise directed by the Engineer. A detailed layout plan and Shop Drawings shall be prepared and submitted to the Owner for approval by the Engineer at least 2 weeks prior to liner installation.

HDPE liner deployment shall not be performed during precipitation, when excessive moisture or wet conditions exist, or when high winds or other adverse climatological conditions exist. The liner sheets shall be unrolled and deployed in a manner, which minimizes wrinkles and prevents the occurrence of folds and creases.

Panel layout and deployment shall be such that the seams run down the slope of the dikes and are oriented perpendicular to the top of slope of the dikes. This seam orientation shall be maintained for a distance of at least 10 feet from the inside toe of the dikes or as otherwise shown on the

Drawings or approved by the Engineer. The Liner Installer shall submit a panel layout plan indicating the proposed liner panel configuration, and identifying field seams, anchor trenches, vents, structure and pipe connections and other details needed to complete the Work, for approval by the Engineer, at least 2 weeks prior to liner installation.

6.4.3 Field Seams

All liner panels shall be seamed the same day they are deployed. All liner panels shall be ballasted immediately after deployment to prevent uplift by winds. Welding of field seams shall not take place except during suitable ambient weather conditions, after confirmed by field trial test welds.

All liner sheets must be continuously and tightly bonded using continuous extrusion fillet welds or double wedge fusion welds using automated welding equipment approved by the Engineer. Field seaming shall be conducted in the dry, on a compacted smooth surface, and in such a manner to prevent ash, dust, dirt, or other foreign material from being included in the seam.

Adjoining liner sheets shall be overlapped a minimum of 4 inches, and in no case less than 3 inches at any location, by adequately lapping the edges of the sheets. The overlap shall not exceed 6 inches for double-wedge fusion welds. Seam overlaps on the bottom area of the lined disposal area shall be made such that the direction of flow over the lined surface is from the top sheet toward the bottom sheet to form a shingle effect.

The edges to be welded shall be wiped and cleaned thoroughly to remove any ash, dirt, dust, moisture or other foreign materials. All field seams must be uniform in appearance, width and properties, and shall not exhibit warping due to overheating from welding. The peel and shear strengths of the welded seams must comply with the strength criteria in Section 6.4.3.1 of this Specification.

6.4.3.1 Field Seam Strength

All welded field seams shall meet the following criteria:

- (i) When the weld is tested in shear in accordance with ASTM D6392, the specimen shall exhibit a film tear bond failure (FTB), and the strength shall be equal to or greater than 120 lb/in (ppi) for welds in 60-mil liner. The tests shall be performed at a rate of displacement of 2 inches per minute (ipm) until the maximum load is achieved, and the test then continued at a rate of displacement of 20 inches per minute until rupture.
- (ii) When the weld is tested in peel in accordance with ASTM D6392, the specimen shall exhibit a film tear bond failure (FTB) and/or the liner must fail before the weld, and the strength shall be equal to or greater than 83 lb/in (ppi) for welds in 60-mil liner. The peel strength criteria shall apply to both the top and bottom welds of double wedge fusion welds.

6.4.3.2 Pass/Fail Criteria

The following pass/fail criteria shall be used to determine compliance of field seams with the above strength criteria:

- (i) All five seam specimens from a given sample or coupon tested in peel (both top and bottom for double wedge fusion welds) and all five specimens tested in shear shall exhibit the required strengths, and display film-tear bond (FTB) failures (i.e., zero percent strength failures and zero percent non-FTB failures); or
- (ii) All five seam specimens from a given sample or coupon tested in peel and all five specimens tested in shear shall exhibit the required strengths and at least four out of five test specimens, for each type of test, shall exhibit a film tear bond (FTB) failure (i.e., zero percent strength failures and up to 20 percent non-FTB failures); or
- (iii) One seam specimen from a given sample or coupon tested in peel or shear may exhibit a non-FTB failure and a strength no less than 50 percent of the specified strength provided that all five field seam specimens tested from the duplicate (or archive) sample coupon exhibit the required strength and no more than one test specimen out of the five additional specimens exhibits a non-FTB failure (i.e., 10 percent (one out of ten) strength failures and up to 20 percent (two out of ten) non-FTB failures).

If a field seam fails the criteria specified herein, and the Liner Contractor wishes to establish to the Engineer that the failed sample represents a smaller section of the field seam than designated by the Engineer, additional coupons may be obtained at progressively increasing distances from both sides of the failed sample, at locations approved by the Engineer, until two consecutive Samples on each side of the original sample pass the field seam criteria. At that point, the extent of the original defect in both directions along the field seam will be considered isolated and the Liner Contractor may then: (i) either cap, re-weld and re-test the seam up to and including the closest of the two passing Samples, and patch and weld the hole of the furthest passing sample; or (ii) cap, re-weld and re-test the entire length of sampling.

If approved by the Engineer, double-wedge fusion welds may be repaired by extrusion welding the flap of the top sheet to the bottom sheet if the seam non-compliance is due only to a non-FTB failure of the destructive test sample.

Duplicate coupons of additional Samples requested by the Liner Contractor for identifying the extent of a defective seam will not be tested, i.e., the seam shall meet either pass/fail criteria (i) or (ii). The Liner Contractor shall reimburse the Owner for the cost of any such additional tests that he requests and which fail to meet the requirements of this Specification.

6.4.4 Anchor Trenches

The liner shall be anchored in anchor trenches in the crest of the dikes at the locations shown on the Drawings. Field Seams shall be welded continuously through the anchor trench.

Liner anchor trenches shall be no less than 24 inches in width and 24 inches in depth and the corners of the trenches shall be slightly rounded to minimize sharp bends in the liner. After placement of the liner along one side and across the bottom of the trench, the trench shall be backfilled with soil fill meeting the materials requirements specified in Section 3.3.2. Anchor trench backfill shall be compacted to a dry density not less than 95 percent of the Standard

Proctor maximum dry density (ASTM D698 using drying temperature of 40° C). Care shall be taken not to damage the liner during placement and compaction of the backfill.

6.4.5 Temporary Ballast Loading

Adequate loading that will not damage the liner shall be placed by the Liner Installer over the liner during installation as needed to prevent uplift by wind and by rapid changes in barometric pressure. This temporary ballast loading shall be in addition to the anchor trenches and permanent wind ballast trenches. Sufficient temporary ballast loading shall be placed along panel edges, in particular, as needed to minimize the risk of wind flow under the panels. Continuous loading shall be provided at all panel edges during days off, at night, and whenever inclement or stormy weather is anticipated.

Temporary ballast loading may consist of sand filled bags. Bags used for containing sand shall be resistant to degradation by ultraviolet rays, shall contain the selected material without leakage, and shall be approved by the Engineer. No ash or soil fill shall be placed atop the liner, as ballast loading, without it being adequately and completely contained.

Temporary ballast loading shall be maintained as necessary or as otherwise directed by the Engineer. All temporary ballast loading shall be removed by the Liner Installer prior to demobilizing from the Site unless otherwise approved by the Engineer.

The Liner Installer shall submit a complete description and details of the proposed temporary wind ballast at least 2 weeks prior to liner installation. Approval by the Owner or Engineer shall not relieve the Liner Installer from responsibility to provide all temporary wind ballast loading as needed to prevent uplift during construction.

6.4.6 Pipe Penetrations

All pipe penetrations shall be made in accordance with the details shown on the Drawings and following the Liner Manufacturer's recommendations, subject to approval by the Engineer. Pipe penetrations through the HDPE liner shall be made using a specially constructed HDPE boot, which will provide a strong, watertight seal between the liner and the pipe. The pipe penetration boot shall be constructed from the same base resins as the liner. The boot shall be continuously extrusion welded to the liner and the HDPE pipe, as shown on the Drawings.

6.4.7 Repairs

All liner defects (scratches, blisters, rips, punctures, tears, holes, pinholes, creases, folds, etc.) and holes created by removal of Samples or coupons for destructive testing shall be marked and repaired by completely covering the defect or hole with an oval-shaped piece of the corresponding HDPE geomembrane material, and continuously welding the patch to the liner sheet using an extrusion weld. Holes created by removal of Samples or coupons for destructive testing shall be marked, patched and repaired as specified above for liner defects. Liner repairs shall be documented including date, liner panel number, repair location, type of defect, and description of repairs made.

6.4.8 Liner Protection

No equipment, tools or personnel that can readily cause damage to the HDPE liner shall be allowed on the liner during and after installation. Personnel working on the HDPE liner shall not smoke, wear potentially damaging shoes, dispose of trash or other debris, or engage in any activity that could damage the liner.

The passage of construction equipment, other than light rubber-tired equipment approved by the Engineer, over any exposed HDPE liner surface is strictly prohibited. Light rubber-tired equipment exerting a contact stress less than 6 lb/in² will be allowed provided proper care is taken when operating the vehicle to avoid pulling, displacing or damaging the liner.

Any damage to the liner shall be immediately reported to the Engineer, and repaired by the Liner Installer at his expense.

6.4.9 Fuel and Oil Spill Clean-Up

All spills or leaks of fuels or oils from equipment and vehicles on the surface of the liner shall be thoroughly cleaned with soap and water or, at the discretion of the Engineer; the affected liner shall be cut, removed and replaced with new liner material. Sub grade soils contaminated with fuel or oil shall be excavated and replaced to the extent designated by the Engineer. Contaminated soils shall be disposed of on Site in an area designated by the Owner.

6.5 Inspection and Field Testing by Contractor

6.5.1 Initial Qualifying Welds

All master seamers/welders and seamers/welders shall demonstrate their ability to consistently make successful seams prior to installation of the liner. Each seamer or welder shall prepare test strips for each type of seam between different liner types and for either extrusion or double-wedge fusion welds. Each test strip shall have a minimum length of 20 feet. The welds shall be inspected for compliance with the requirements in Section 6.4.3. Six Samples from each test strip shall be cut at locations selected by the Engineer and tested by the Liner Installer in both shear and peel for compliance with the Specification requirements in Section 6.4.3. No seamer/welder shall be allowed to perform any production welds in the liner without first successfully passing these initial field tests.

6.5.2 Daily Qualifying Welds

At the beginning of each working day, after any interruption in power, after any prolonged idle period during the day, and at the request of the Engineer at any other time during the day, each seamer/welder shall prepare a 3-foot (for extrusion welds) to 10-foot (for double-wedge fusion welds) long test strip using the welding apparatus assigned to him. Five Samples from the test strip shall be cut at locations selected by the Engineer and tested by the Liner Installer in both shear and peel for compliance with the specification requirements in Section 6.4.3. The sample weld shall successfully pass the test requirements before either the welder or welding apparatus are allowed to operate on production welds.

6.5.3 Non-Destructive Testing of Welds

The Liner Installer shall continuously test every field weld (i.e., 100 percent of the length of all field seams) including field welds around patches using non-destructive testing techniques. These tests shall be performed in the presence of the Engineer. Extrusion welds shall be tested using a vacuum box and test procedures specified in ASTM D4437. Once the soap solution is uniformly placed over the weld and suction is applied to the seam, any bubble formation must be noted and the corresponding defective area identified, marked, and subsequently repaired.

Double-wedge fusion welds with a continuous air gap between the two welds shall be non-destructively tested by pressurizing the gap between the two welds to a pressure between 25 and 30 lb/in² and monitoring the pressure for any decline with time. After allowing 2 minutes for relaxation, the pressure shall be monitored over a test period of not less than 5 minutes. A weld will be considered satisfactory if either of the following criteria is satisfied:

- (i) the loss in pressure is equal to or less than 2 lb/in² and the pressure stabilizes within the 5-minute test period; or
- (ii) if criteria (i) are not satisfied, the additional pressure drop is equal to or less than 1 lb/in² during an additional test period of 5 minutes (i.e., the total pressure drop is less than or equal to 3 lb/in² over a 10-minute test period), and the pressure stabilizes during the second test period.

The length of welded section tested by air pressure shall not exceed 450 feet, without prior approval by the Engineer. If a non-compliant pressure drop is noted, pressure testing may be repeated in a step fashion each time halving the length of weld being tested until the extent of the defective weld is determined. Vacuum box testing (ASTM D4437) may also be used to locate a defect in the top weld or in the top of the air channel.

Once the defect is found, it shall be clearly identified, marked and repaired. Any defective seam shall be repaired so that it meets or exceeds the minimum requirements specified herein.

6.5.4 Sampling and Destructive Testing

The Liner Installer shall obtain and secure Samples of the liner and field seams for destructive testing by the Engineer at locations designated by the Engineer. Samples shall be obtained at the frequency specified in Section 6.6.3. The Liner Installer shall obtain seam Samples, in triplicate, from the designated location for laboratory testing. One portion of the sample shall be retained by the Liner Installer for testing. If the results of field tests performed by the Liner Installer, in the presence of the Engineer, indicate compliance with the criteria in Section 6.4.3, then the Liner Installer shall provide the second portion of the sample to the Engineer for independent testing, and the third portion will be retained by the Owner for archive storage. If the results of peel and shear tests performed by the Liner Installer in the field do not meet or exceed the requirements specified herein, then the provisions of Section 6.4.3 shall apply for temporarily determining the extent of repairs pending performance of independent quality control tests by the Engineer.

The portions of seam Samples provided to the Engineer for laboratory destructive testing, and provided to the Owner for archive storage, shall each be not less than 12 inches wide by 18 inches long in the direction of the seam. The seam shall be centered along the sample length. Each of the triplicate sample portions shall be properly marked and identified by the Liner Installer. The Liner Installer shall repair all holes created by sampling in accordance with Section 6.4.7.

6.5.5 Visual Inspection

The Liner Installer shall visually inspect the entire liner surface for any defects including, but not limited to, seam imperfections, badly scuffed areas, scratches, blisters, tears, rips, holes, pinholes, and punctures. He shall identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs shall be made in accordance with Section 6.4.7.

6.5.6 Quality Assurance Forms

The Liner Installer shall adopt and use the quality assurance forms prepared by the Engineer, or other forms approved by the Engineer, during all applicable phases of liner installation, inspection and testing. The Liner Installer can request to use his forms. The forms must be submitted to the Engineer at least 2 weeks prior to liner installation for review and approval.

6.5.7 Certification

The Liner Installer's installation supervisor shall observe and check all phases of the liner installation. When the liner is finally accepted by the Owner, the Liner Installer shall submit written certification to the Owner that the installation conforms to the requirements of the Liner Manufacturer.

6.6 Quality Control Inspection and Testing by Engineer

6.6.1 Base Maintenance and Repair During Liner Installation

The Engineer will undertake observations and perform quality control tests to determine compliance with these Specifications. Quality control by the Engineer will include monitoring fill placement to determine the suitability of sub grade materials and adequacy of compaction. The Engineer will perform in situ density tests: (i) after compaction of fill as needed to fine grade, maintain and restore the condition of the prepared base; (ii) after dressing the slopes of dikes; (iii) after compaction of fill in excavations as needed to restore the grade; and (iv) after compaction of backfill in anchor trenches. In situ density tests will be performed by the drive cylinder method (ASTM D2937), sand cone method (ASTM D1556) or other methods approved by the Engineer. Moisture content tests made in the field using a calcium carbide gas pressure moisture tester (ASTM D4944) may be used to provide moisture content information for construction control, but final acceptance of all liner sub grade material will be based upon the ASTM D2216 test method (using a drying temperature of 40°C) unless approved otherwise by the Engineer. Penetration test probes may also be performed as needed to verify the uniformity of compaction.

Testing of the uppermost soil base will be made by the Engineer following final grading and compaction by the Earthwork Contractor before the surfaces are turned over to the Liner Installer. Testing of the uppermost 1 foot of the surfaces to receive the liner will be repeated, as needed, immediately prior to liner placement. Final documentation and results from these tests, however, will not be available prior to liner deployment. Such testing shall not relieve the Liner Installer from his responsibility for restoration or repair of unsuitable areas following liner placement, in the event that such is deemed necessary by the Engineer.

6.6.2 Liner Installation

All aspects of the liner installation will be inspected on a full-time basis by the Engineer. The Engineer will conduct his own inspections and tests in addition to those performed by the Liner Installer. The Engineer will undertake observations and perform quality control tests to determine compliance of the liner installation with these Specifications. Quality control by the Engineer will include monitoring: (i) liner handling and panel deployment; (ii) field welding of liner sheets and non-destructive testing of field welds; (iii) installation of anchor trenches; (iv) placement and maintenance of temporary ballast loading; (v) attachment of the liner to HDPE pipes; and (vi) construction of flap vents. The Engineer will also monitor liner repair Work, and evaluate the adequacy and acceptability of all repair Work.

6.6.3 Destructive Testing

The Liner Installer shall obtain and secure Samples (coupons) of the liner and field seams for destructive testing by the Engineer from locations designated by the Engineer, and shall properly mark all test specimens as needed to identify the particular seam or liner panel from which the specimen was obtained. Testing of the liner materials will be conducted by the Engineer as specified in Section 5.4. Seam Samples will be taken for destructive peel and shear strength testing by the Engineer at a minimum frequency of one sample per 500 feet of field seam.

Duplicate Samples of all HDPE liner material and all field seams tested destructively by the Liner Contractor shall also be secured by the Liner Installer and submitted to the Engineer for independent testing. All Samples shall be properly marked and identified.

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material, installed liner section, or field seam from which the sample was collected to the extent designated by the Engineer. If the Liner Installer can establish to the Engineer, via submittal of additional test results, that the failed sample is representative of a smaller section of the liner or field seam, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Liner Installer shall reimburse the Owner for the cost of any such additional tests that he requests and which fail to meet the requirements of the Specifications.

6.7 Insurance

The Liner Installer shall provide the Owner insurance coverage against blowout or uplift of the liner during installation. The insurance coverage shall remain in effect until the Owner and/or Engineer issues a Letter of Acceptance to the Liner Installer.

The Liner Installer shall agree to provide the Owner with a commitment to re-install or replace any liner that may blowout during the time when the insurance coverage is in effect, at the same rate as required during initial installation, without adversely affecting the rate of progress of Work yet to be performed. Additional material, labor and equipment shall be mobilized to the Site within 2 weeks of a blowout occurrence as needed to comply with this commitment.

6.8 Warranty

A written warranty shall be provided to the Owner by the Liner Installer. This document shall warrant the quality of the workmanship for a period of not less than 2 years beginning on the date of the Letter of Acceptance from the Owner and/or Engineer.

6.9 As-Built Drawings

The Liner Installer shall submit to the Engineer through the Contractor, within 30 days of completion of installation of the liner, an as-built plan in AutoCAD format showing the location and identification of all installed liner panels, anchor trenches, repairs and destructive test Samples.

6.10 Submittals

The following submittals are required from the Liner Installer as part of the requirements of the Specifications:

- The proposed methods for dewatering, surface water control and routing water to containments or the surface water drainage system shall be submitted at least 2 weeks prior to implementation (Section 6.3).
- Shop Drawings showing the proposed liner panel layout and details of the liner installation, including anchor trenches, vents, ballast on top of the liner, and boots for liner penetrations shall be submitted at least 2 weeks prior to liner installation (Section 6.4.2).
- A complete description and details of the proposed temporary wind ballast loading shall be submitted at least 2 weeks prior to liner installation (Section 6.4.5).
- Quality assurance forms proposed for use by the Liner Installer for all phases of liner installation, inspection and testing shall be submitted at least 2 weeks prior to liner installation (Section 6.5.6).
- Certification by the Liner Installer, when the liner is accepted by the Owner, that the liner installation complies with the requirements of the Liner Manufacturer (Section 6.5.7).
- Workmanship warranty for a period of at least 2 years beginning on the date of the Letter of Acceptance from the Owner and/or Engineer (Section 6.8).
- As-built plan of the installed HDPE liner within 30 days of completion of liner installation (Section 6.9).

SPECIFICATIONS

SECTION 7 GEOTEXTILES, HDPE GEOCOMPOSITES, AND HDPE GEONETS

This Specification covers the material requirements and installation of geotextiles, HDPE geocomposites, and geonets as shown on the Drawings.

7.1 Referenced Standards

The following ASTM standards are referenced in this Specification:

- D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603: Standard Test Method for Carbon Black in Olefin Plastics
- D3786: Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
- D4491: Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- D4533: Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- D4632: Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4716: Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- D4751: Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4833: Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- D4884: Standard Test Method for Strength of Sewn or Thermally Bonded Seams in Geotextiles
- D4976: Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
- D5035: Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method)
- D5199: Standard Test Method for Measuring the Nominal Thickness of Geosynthetics

D5261: Standard Test Method for Measuring Mass per Unit Area of Geotextiles

D6241: Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe

D7005: Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites

D7179: Standard Test Method for Determining Geonet Breaking Force

D7406: Standard Test Method for Time-Dependent (Creep) Deformation under Constant Pressure for Geosynthetic Drainage Products

7.2 Material Requirements

The leak detection system between the textured primary and secondary HDPE liners and the geosynthetic drainage layer above the textured primary HDPE liner shall consist of a double-sided geocomposite with non-woven geotextiles heat bonded to both sides of an HDPE geonet.

The geocomposite shall meet applicable requirements in Sections 7.2.1, 7.2.2, and 7.3.3. The geonet shall be manufactured from unreinforced HDPE designed and manufactured for use in drainage geonets. The geotextile around the gravel envelopes in the leachate collection and leak detection systems shall be a 12 oz/yd² geotextile meeting applicable requirements in Section 7.2.2.

7.2.1 Geonet

7.2.1.1 HDPE Resin

The uncolored base resin shall have a density of at least 0.932 g/cm³. The formulated colored resin shall have properties equivalent to ASTM D4976, Type III, Category 4 or 5, and Grade P34. The resin shall contain not less than 97 percent of the base polymer and not less than 2.0 percent carbon black as defined in ASTM D4976 for Class C high-density polyethylene. The geonet shall contain no more than 3 percent carbon black, anti-oxidants and heat stabilizers combined, and no other additives, fillers or extenders. The geonet shall be manufactured from virgin resin; with no, more than 3 percent regrind material. No post-consumer resin of any type shall be used.

7.2.1.2 Physical Appearance

The geonet shall be uniform in appearance and composition and shall be free of tears, cuts, gels, undispersed ingredients, any signs of contamination by foreign matter, or any defect that may affect serviceability.

7.2.1.3 Physical Properties

The HDPE geonet shall meet the following criteria:

Property	Test Method	Criterion
Carbon Black Content	ASTM D1603	$\geq 2.0\%$ & $< 3.0\%$
Density	ASTM D1505	$\geq 0.94 \text{ g/cm}^3$
Thickness	ASTM D5199	$\geq 200 \text{ mil}$
Transmissivity	ASTM D4716	$\geq 1.0 \times 10^{-3} \text{ m}^2/\text{sec}^*$
Tensile Strength	ASTM D7179	$\geq 45 \text{ lb/in}^{**}$
* Machine direction under a compressive load of 5,000 psf and at a gradient of 0.01.		
** Machine direction.		

A complete description of the geonet proposed for use and the Manufacturer's product data sheets shall be submitted to the Engineer for approval at least 2 weeks prior to installation. Certification from the Manufacturer that the geonet complies with this Specification shall also be supplied to the Engineer 2 weeks prior to installation.

7.2.2 Geotextiles

Geotextiles for the geocomposite drainage net and where shown elsewhere on the Drawings shall be a non-woven, needle-punched fabric manufactured from 100 percent polyester or 100 percent polypropylene. The geotextiles shall be uniform and homogeneous in appearance and composition, and free from tears, cuts, thin spots, or any defects that may affect serviceability. The geotextiles shall meet the following criteria.

Property	Test Method	Criterion
Mass per Unit Area	ASTM D5261	$\geq 8 \text{ oz/yd}^2$
Apparent Opening Size	ASTM D4751	$\geq 80^\dagger$
Grab Tensile Strength*	ASTM D4632	$\geq 200 \text{ lb}$
Grab Elongation*	ASTM D4632	$\geq 50 \%$
Trapezoidal Tear Strength*	ASTM D4533	$\geq 50 \text{ lb}$
Puncture Strength	ASTM D4833	$\geq 120 \text{ lb}$
Permeability to Water	ASTM D4491	$\geq 0.2 \text{ cm/sec}$
* Machine and transverse directions.		
† United States standard sieve number.		

A complete description of the geotextiles proposed for use and the Manufacturer's product data sheets shall be submitted to the Engineer for approval at least 2 weeks prior to installation. Certification from the Manufacturers that the geotextiles comply with this Specification shall also be supplied to the Engineer 2 weeks prior to installation.

7.2.2.1 Geocomposite

The geonet and 8-oz/yd^2 geotextile in the geocomposite shall meet the requirements in Sections 7.2.1 and 7.2.2, respectively. The single-sided geocomposite above the textured primary HDPE liner at the base of the lined disposal area shall also meet the following requirements: (i) a

transmissivity equal to or greater than $2.0 \times 10^{-3} \text{ m}^2/\text{sec}$, as determined in accordance with ASTM D4716 using a compressive load of 5,000 psf and a gradient of 0.01; and (ii) the bond between the geotextiles and the geonet shall exhibit an average ply adhesion of equal to or greater than 1.0 lb/in, as determined in accordance with ASTM D7005. The double-sided geocomposites above the textured primary HDPE liner as well as between the textured primary and secondary HDPE liners on the inside slope of the perimeter dike and to a distance of 10 feet from the toe of the inside slope shall also meet the following requirements: (i) a transmissivity equal to or greater than $1.0 \times 10^{-5} \text{ m}^2/\text{sec}$, as determined in accordance with ASTM D4716 using a compressive load of 2,500 psf and a gradient of 0.33; and (ii) the bond between the geotextiles and the geonet shall exhibit an average ply adhesion of equal to or greater than 1.0 lb/in, as determined in accordance with ASTM D7005.

A complete description of the geocomposite proposed for use with a minimum 1 square yard sample and the Manufacturer's product data sheets shall be submitted to the Engineer for approval at least 2 weeks prior to installation. Certification from the Manufacturer that the geocomposite complies with this Specification shall also be supplied to the Engineer at least 2 weeks prior to installation.

7.3 Factory Testing and Inspection

7.3.1 Factory Testing

7.3.1.1 Geonet

Standard factory testing reports for raw materials including melt index and specific gravity or density for each batch of resin used to manufacture the geonet shall be submitted to the Engineer for approval at least 2 weeks prior to installation. The resin Manufacturer's certificate of analysis for each batch of resin shall also be provided to the Engineer at least 2 weeks prior to installation.

Factory quality control certificates for the geonet component of the geocomposite shall be provided to the Engineer by the Manufacturer at least 2 weeks prior to construction. As a minimum, the quality control certificates shall contain the geonet roll identification number, date manufactured, roll width and length, and resin batch number. The following factory quality control tests shall be provided at the indicated frequencies:

Property	Test Method	Frequency
Thickness	ASTM D5199	Every 20 Rolls
Tensile Strength*	ASTM D5035	Every 20 Rolls
Transmissivity**	ASTM D4716	Every 20 Rolls
Carbon Black Content	ASTM D1603	Once per Batch of Resin or Every 20 Rolls
Density	ASTM D1505	Once per Batch of Resin or Every 20 Rolls
* Machine and transverse directions.		

Failure of any of the tests shall result in rejection of the corresponding lot of geonet.

7.3.1.2 Non-Woven Geotextile

Factory quality control certificates for the non-woven geotextiles, including the component of the geocomposite, shall be provided to the Engineer by the Manufacturer at least 2 weeks prior to construction. The quality control certificates shall contain the geotextile roll number, date manufactured, roll length, and width. The Manufacturer shall provide test results to the Engineer for every 5,000 yd² of geotextile or at least one sample per lot of geotextile for mass per unit area, thickness, apparent opening size, permeability to water, and grab tensile strength and elongation in accordance with the test procedures in Section 7.2.2. Failure of any of the tests shall result in rejection of the corresponding lot of geotextile.

7.3.2 Factory Inspection

The geotextiles and geocomposite shall be visually inspected at the factory prior to shipment for compliance with the physical appearance requirements in Sections 7.2.1.2 and 7.3.2. All necessary repairs shall be made by the Manufacturer at the factory prior to shipment.

7.3.3 Marking and Packaging

Each geotextile and geocomposite roll shall be individually packaged at the factory to prevent damage during shipping and handling, and shall be completely wrapped by a protective ultraviolet resistant thin plastic film having a minimum thickness of 2 mils. The Manufacturer shall provide each roll with a label indicating the roll number, product name, length, width and date manufactured.

7.4 Handling and Installation

7.4.1 Storage and Handling

The Contractor shall be responsible for unloading and storing the geotextile and geocomposite rolls. During unloading, the Contractor shall obtain Samples from the ends of rolls for testing by the Engineer at locations selected by the Engineer.

The geotextiles and geocomposites shall remain wrapped in the protective cover and shall be stored, as recommended by the Manufacturer and approved by the Engineer, in an area of the Site that protects the geotextiles from moisture, water, ash, dirt, ultraviolet light and mechanical damage until the time of installation. The rolls shall not be unwrapped more than 1 hour before use. Handling of the rolls shall be in accordance with the Manufacturer's recommendations, and shall be as needed to protect the geotextiles from damage.

7.4.2 Laying and Installation

The geocomposites and geotextiles shall be installed at the locations and to the lines and dimensions shown on the Drawings.

The geocomposite shall be installed in the direction of the slope and in the intended direction of flow unless otherwise specified by the Engineer. The geocomposites and geotextiles shall be installed in a smooth and unwrinkled condition in uniform contact with the underlying materials, and held in place as needed and approved by the Engineer until covered.

The ends of the geocomposite at a joint shall be overlapped 4 inches, and tied together with polyethylene or polypropylene ties recommended by the Manufacturer and approved by the Engineer. Metallic ties shall not be used. A minimum of three ties shall be used at each joint, and the ties shall be of a color to allow easy inspection (e.g., white or yellow) against the black geonet. The geotextiles of the geocomposite at the joint shall be overlapped a minimum of 4 inches, and shall be sewn in accordance with Section 7.4.3.

After installation, the geocomposite shall not be left exposed for more than 48 hours prior to covering.

The exposed edge of the geonet on all cut sides and ends of the geocomposite shall be covered with a piece of the same geotextile as on the composite overlapped 12 inches minimum on the bottom and top of the composite. The edge of the top lap shall be held in-place until covered using spot thermal bonding or black PVC pipe wrapping tape as approved by the Engineer and, if needed, temporary sand bags. The upper and lower geotextiles along the uncut edge of the geocomposite shall be sewn in accordance with Section 7.4.3.

Geotextiles shall be installed where shown on the Drawings in a manner that minimizes seams. The geotextiles shall be cut to the dimensions shown on the Drawings, overlapped if needed, and installed in a smooth unwrinkled condition in contact with the underlying materials. The geotextiles shall be held in place as needed until covered, and shall always be covered within 48 hours of installation.

7.4.3 Geotextile Field Seams

Field seams in geotextiles shall be made using a minimum overlap of 4 inches. The geotextile panels shall be sewn together with a sewing machine using a flat sewn seam with one row of stitches with a minimum of four stitches per inch, or a seam and stitching pattern recommended by the Manufacturer and approved by the Engineer. The thread used to sew the seams shall be 2000 denier minimum, or as recommended by the Manufacturer and approved by the Engineer, and shall have the same composition as the geotextile. The strength of field seams shall not be less than 50 percent of that of the unaged geotextile in any principal direction when tested in accordance with ASTM D4884 at a strain rate of 12 inches/minute. The Contractor shall submit details of the proposed sewing method (type of stitch, number of stitches per inch, number of stitching rows, distance from the edge of the geotextile to the stitches, weight and type of thread, etc.) and a minimum 3 feet long sample of the sewn seam for approval by the Engineer at least 1 week prior to installation.

7.4.4 Geotextile Repairs

All tears, punctures, thinly stretched sections, or any other defect that may, as determined by the Engineer, render the geotextile unsuitable, shall be repaired by the Contractor. Repairs shall be made by overlaying a patch of geotextile over the damaged area with a 12-inch minimum lap all

around. The patch shall be sewn to the geotextile, as specified in Section 7.4.3, all around the patch perimeter. Patches on geotextiles on the geocomposite shall be held in place by thermal bonding or 2-inch wide black PVC pipe wrapping tape, and sewn in accordance with Section 7.4.3 of this Specification where directed by the Engineer. Geotextile and geocomposite that require more than one repair to the geotextile per roll shall be rejected and replaced.

7.5 Sampling and Inspection by Contractor

7.5.1 Sampling

The Contractor shall obtain and secure Samples of the geotextile, and geocomposite for destructive testing by the Engineer when the rolls are delivered to the Site or subsequently during installation as requested by the Engineer. The Samples shall be obtained from locations designated by the Engineer. All Samples shall be properly marked and identified by the Contractor. The Contractor shall repair all openings created by sampling in accordance with Section 7.4.4 or completely remove the full width of the roll at the sampling location.

7.5.2 Visual Inspection

The Contractor shall visually inspect the surfaces of the installed geotextiles and geocomposites for any defects including, but not limited to, rips, tears, punctures and defective seams. The Contractor shall identify, mark, and repair all noted defects, as well as defects designated by the Engineer. Repairs to geotextiles shall be made in accordance with Section 7.4.4. Geocomposite with damage to both geotextile surfaces at any location shall be removed and replaced.

The Contractor shall visually inspect the surfaces for soil, ash, dust or debris that could result in clogging of the geonets or geotextiles. If soil, ash, dust or debris is entrapped in the geonets, it shall be removed and replaced or the surfaces cleaned as approved by the Engineer.

7.6 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance of the materials and Work with this Specification. Quality assurance by the Engineer will include monitoring and/or inspecting: (i) geotextile handling, installation, overlapping and field seaming; (ii) geocomposite handling, installation, overlapping and field joining; (iii) the geotextile and geonet for damage; and (iv) geotextile and geonet for excessive entrapped soil, ash, dust or debris that could reduce the transmissivity of the composite.

Laboratory quality assurance tests will be performed by the Engineer on the geocomposite material at the following minimum indicated frequencies.

Material	Property	Test Method	Minimum Testing Frequency
Geonet Component	Thickness Density Carbon Black Content Tensile Strength	ASTM D5199 ASTM D1505 ASTM D1603 ASTM D7179	Once per 50,000 square feet
	Transmissivity	ASTM D4716	Once per 100,000 square feet
Geotextile Component	Mass Per Unit Area Grab Strength & Elongation	ASTM D3776 ASTM D4632	Once per 50,000 square feet
	Apparent Opening Size Permeability	ASTM D4751 ASTM D4491	Once per 100,000 square feet
	Field Seam Strength	ASTM D4884	Once per 200 feet of field seam
Geonet/Geotextile Composite	Transmissivity	ASTM D4716	Once per 100,000 square feet
	Ply Adhesion	ASTM D7005	Once per 50,000 square feet

Failure of any sample to meet or exceed the requirements specified herein shall be considered cause for rejection of the material or installed section from which the sample was collected to the extent designated by the Engineer. If the Contractor can establish to the Engineer, via additional tests performed by the Engineer, that the failed sample is representative of a smaller section of the installed material than the entire lot represented by the original test sample, then only that portion will be rejected, provided, however, that the additional tests are performed by the Engineer representing the Owner. The Contractor shall also reimburse the Owner for any such test that fails to meet the requirements specified herein.

7.7 Submittals

The following submittals are required from the Contractor as part of the requirements of this Specification.

- A complete description of each non-woven geotextile, the Manufacturer's product data sheets for each, and the Manufacturer's certification that the geotextiles meet the requirements of this Specification.
- A minimum 1 square yard sample of each proposed non-woven geotextile.
- Factory quality control certificates for each roll of non-woven geotextile, HDPE geonet, and geocomposite.
- Proposed sewing method for field seaming the non-woven geotextiles and a minimum 3 feet long sample of sewn seam.

- A complete description of the HDPE geocomposite, a minimum 1 square yard sample of the composite and 1 square yard sample of the non-woven geotextile used on the composite, the Manufacturer's product data sheets, and the Manufacturer's certification that the geocomposite meets the requirements of this Specification.

SPECIFICATIONS

SECTION 8 PRESSURE-RATED HDPE PIPE AND FITTINGS

This Specification covers the material requirements and installation of pressure-rated HDPE pipe and fittings shown on the Drawings.

8.1 Referenced Standards

The following ASTM standards are referenced in this Specification:

- D638: Standard Test Method for Tensile Properties of Plastics
- D695: Standard Test Method for Compressive Properties of Rigid Plastics
- D696: Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics
- D790: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- D792: Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1238: Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505: Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603: Standard Test Method for Carbon Black in Olefin Plastics
- D1693: Standard Test Method for Environmental Stress Cracking of Ethylene Plastics
- D2240: Standard Test Method for Rubber Property - Durometer Hardness
- D2412: Standard Test Method for External Loading Properties of Plastic Pipe by Parallel-Plate Loading
- D2513: Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing and Fittings
- D2837: Standard Specification for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials
- D3261: Standard Specification for Butt Heat Fusion Polyethylene Plastic Pipe and Tubing
- D3350: Standard Specification for Polyethylene Plastics Pipe and Fittings Materials

F714: Standard Specification for Polyethylene Plastic Pipe Based on Outside Diameter

8.2 Material Requirements

8.2.1 Base Resin

The base resin shall be high density, high molecular weight polyethylene (HDPE) with properties equivalent to ASTM D3350 cell classification PE345444C or PE345464C. The pipe and fittings shall be manufactured from virgin resin with no regrind material. The resin shall contain not less than 97 percent of the base resin, and not less than 2.0 percent carbon black. The pipe material shall contain no more than 3 percent carbon black, anti-oxidants and heat stabilizers combined, and no other additives, fillers or extenders.

8.2.2 Physical Appearance

All pipes and fittings shall have good appearance qualities. The pipe and fittings shall be homogeneous throughout, and the surfaces shall be smooth and uniform with no visible defects. The pipes shall be free of holes, cracks, nicks, cuts, gouges, scratches, blisters, gels, undispersed ingredients, any signs of contamination by foreign inclusions, or any defect that may affect serviceability.

8.2.3 Physical Properties

Pipe and fitting dimensions, workmanship, standard dimension ratio (SDR) and corresponding pressure rating shall be in accordance with the requirements of ASTM F 714. Pipes shall be furnished in Standard 40-foot lengths. The pipe material shall meet the following criteria:

Property	Test Method	Criterion
Density	ASTM D1505	>0.945 g/cc
Melt Index	ASTM D1238	<0.15 g/10
Carbon Black Content	ASTM D1603	minutes
Flexural Modulus	ASTM D790	≥2.0% & <3.0%
Tensile Strength at Yield	ASTM D638, Type IV*	>125,000 psi
Elongation at Yield	ASTM D638, Type IV*	>3,000 psi
Modulus of Elasticity	ASTM D638, Type IV*	>8%
Environmental Stress Crack Resistance	ASTM D1693, Condition C	>100,000 psi
Hardness	ASTM D2240	>5,000 hrs
Compressive Strength at Yield	ASTM D695	>60 Shore "D"
Hydrostatic Design Basis	ASTM D2837	>1,600 psi
Low Temperature Brittleness	ASTM D746	>1,600 psi
Thermal Expansion Coefficient	ASTM D696	<-118°C
*Type IV Specimen tested at a rate of strain of 2 inches/minute		

The Contractor or Supplier shall submit a complete description of the HDPE pipe and fittings proposed for use to the Engineer for approval at least 2 weeks prior to pipe installation. The Manufacturer's product data sheets and certification from the Manufacturer that the pipe and fittings comply with this Specification shall also be supplied to the Engineer at least 2 weeks prior to installation.

8.2.4 Pipe Sizes

Both solid and slotted HDPE pipe shall have the nominal diameters and Standard Dimension Ratios (SDR) shown on the Drawings. Dimensions, workmanship, SDR and corresponding pressure rating shall be in accordance with ASTM F714.

8.2.5 Slotted Pipe

Where slotted pipe is specified on the Drawings, the slots shall be cleanly cut, identical in geometry, and evenly spaced. The slot length shall be located perpendicular to the longitudinal axis of the pipe. Slots shall be located in two straight rows along the length of the pipe. The rows of slots shall be spaced 180° on centers around the circumference of the pipe, and shall not be staggered. The slots shall satisfy the following criteria:

Dimension or Area	Criteria
Slot Width (inches)	>0.09 and <0.12
Slot Length Measured Along Outer Pipe Circumference (inches)	>1.50 and <2.50
Slotted Area (in ² /foot of pipe)	>2.0 (outer wall) >1.0 (inner wall)
Spacing Between Slots Along Pipe Length (c/c, inches)	>1.0 and <3.0

The Contractor shall submit a 3-foot long sample of slotted pipe for each SDR rating shown on the Drawings at least 2 weeks prior to construction. Slotted pipe shall not be delivered to the Site without first receiving approval from the Owner.

8.2.6 Fabricated Fittings

Fabricated fittings made by butt fusing cut segments of pipe shall be used where shown on the Drawings. Fabricated fittings shall be made using pipe segments meeting the base resin, physical appearance and physical property requirements specified in Sections 8.2.1, 8.2.2, and 8.2.3 of this Specification. Shop Drawings for fabricated fittings shall be submitted to the Engineer for approval at least 2 weeks prior to fabrication.

8.2.7 Approved Manufacturers

The following manufacturers and corresponding pipe series designations are approved for use:

- Chevron Phillips DriscoPlex PE 3408 Pipe Series
- Poly Pipe PE 3408 Pipe Series

Other manufacturers producing equivalent pipes may be approved provided product data sheets and resin certificates are submitted to the Engineer to confirm compliance with this Specification.

The Manufacturer's product data sheets, resin certificates, and certification from the Manufacturer that the pipe and fittings comply with the Specifications shall be submitted to the Engineer for approval at least 2 weeks prior to installation.

8.2.8 Marking and Packaging

The pipe Manufacturer shall mark each pipe length and each fitting with the Manufacturer's name or trademark, pipe series designation, size, and SDR.

Packaging, handling and shipment shall be in accordance with the pipe Manufacturer's standards, instructions and recommendations.

8.2.9 Molded Fittings

Molded fittings shall meet the requirements of Sections 8.2.1, 8.2.2, and 8.2.3 of this Specification, and the requirements of ASTM D2513 and D3261.

8.3 Joint Requirements

The HDPE pipe, and the pipe and fittings, shall be joined using butt, heat fusion welds. All joints shall be made in compliance with the Manufacturer's recommended practice for heater surface temperature, heating time, applied pressure and cooling time, subject to the Engineer's approval. All joints shall be made by trained technicians qualified by the Manufacturer and using equipment and controlled procedures approved by the Manufacturer.

All pipe joints shall be stronger than the pipe itself under both tension and hydrostatic loading conditions. The joints shall be leak-tight, homogeneous and uniform throughout. The Contractor shall submit written documentation certifying compliance with the Manufacturer's standard specifications and Quality Assurance/Quality Control plan for the butt, heat fusion technique. Bend back tests shall be performed at least once per day for each pipe diameter and SDR to demonstrate the integrity of the fusion welds.

8.4 Storage and Handling

The Contractor shall comply with the pipe Manufacturer's recommendations for handling and storing pipe and fittings. The pipe shall be stored on clean, level ground to prevent undue scratching or gouging and as needed to protect the pipe from being covered with excessive dirt and/or ash, from water and moisture, and from mechanical abrasion. Care shall be taken to minimize the amount of soil or ash collected inside the pipe while handling and installing. The handling of the pipe shall be in such a manner that the pipe is not damaged by dragging it over sharp objects, and care shall be exercised during installation not to damage the pipes and fittings.

Any pipe section, fitting or joint, which becomes broken, cracked, crushed, cut, scratched, gouged or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor. Scratches greater than 6 inches in length and gouges exhibiting a depth in excess of 8 percent of the wall thickness of the pipe shall be cause for rejection of pipe or fittings to the extent designated by the Engineer.

8.5 Installation

8.5.1 HDPE Pipe and Fittings

The installation of the pipes and fittings shall be made by the Contractor coordinating his work with the pipe supplier for delivery of materials and field welding, and with the Liner Installer for installation of the pipe boots, where applicable. The installation methods and handling shall be in accordance with the Manufacturer's recommendations as approved by the Engineer.

Pipe sections shall be joined adjacent to the trench, prior to placing the pipe on the pipe bedding. Care shall be taken not to drop the pipe while moving it, and to avoid excess stress or strain during installation. When pulling the pipe, either a pulling head or a suitable wraparound sleeve with rubber protective cover shall be used to prevent the pulling cables from damaging the pipe. The maximum pulling length shall be limited to 500 feet.

Pipe installation and placement of backfill around pipes shall be performed when the pipe is in a contracted state, i.e., during the cool of morning, at night, or during periods of over-cast skies.

Immediately after placement, the pipe shall be thoroughly and completely embedded, supported, and covered, and the backfill compacted, in accordance with Section 3 of the Specifications, and the details shown on the Drawings.

8.6 Protection and Repairs

Care shall be exercised during construction not to damage the pipes and fittings. Construction equipment shall not be allowed to pass over any pipe culvert until a minimum of 2 feet of compacted cover is placed above the crown of the pipe.

Any pipe section, fitting or joint, which becomes broken, cracked, crushed, cut, scratched, gouged or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor. Scratches greater than 6 inches in length and gouges exhibiting a depth in excess of 8 percent of the wall thickness of the pipe or fitting shall be cause for rejection of a pipe section or fitting to the extent designated by the Engineer.

8.7 Quality Assurance Inspection and Testing

The Engineer, representing the Owner, will undertake observations and inspections to determine compliance of the materials and Work with this Specification. Quality assurance by the Engineer will include monitoring and/or inspecting: (i) the HDPE pipe and fittings for correct size, SDR rating workmanship, and fabrication; (ii) damage during installation; and (iii) the installation, alignment and welding of all pipe, fittings and seep shields.

8.8 Submittals

The following submittals are required from the Contractor as part of the requirements of Section 8 of the Specifications.

- A complete description of the HDPE pipe and fittings with the Manufacturer's product data sheets, description of the HDPE resin, Manufacturer's certificate of analysis for the HDPE resin, and Manufacturer's certification that the pipe and fittings satisfy the requirements of this Specification.
- Shop Drawings for each fabricated HDPE pipe fitting.

SPECIFICATIONS

SECTION 9 INSTALLATION OF LEACHATE COLLECTION AND LEAK DETECTION SYSTEMS

9.1 Description of Work

The Work covered by this specification involves installing a leachate collection and leak detection systems at the bottom of the lined disposal area. The leachate collection and leak detection systems shall be placed directly above the upper HDPE geomembrane liner installed in accordance with Section 6 of the Specifications.

9.2 Layout of Work

The Owner will establish reference points for horizontal and vertical controls near the designated construction area. From these reference points, the Contractor shall provide all horizontal and vertical controls necessary to install the leachate collection and leak detection systems to the lines and grades shown on the Construction Drawings. It is the responsibility of the Contractor to verify all locations and dimensions prior to performance of any Work.

9.3 Material Requirements

9.3.1 Solid HDPE Pipe and Fittings

The pipes used for removal of leachate and leakage from the lined disposal area shall consist of 6-inch diameter SDR 17 pipes. The leachate collection and leak detection discharge pipes shall be solid. The solid pipes used for the clean-outs of the leachate collection and leak detection pipes shall consist of 6-inch diameter SDR 17 pipe.

Solid HDPE pipes and fittings shall meet the requirements of Section 8 of the Specifications.

9.3.2 Slotted HDPE Pipes and Fittings

The leachate collection and leak detection pipes shall consist of 8-inch diameter SDR 17 slotted HDPE pipe. Slotted HDPE pipes and fittings shall meet the requirements of Section 8 of the Specifications including the slot dimensions and spacing specified in Section 8.2.5.

9.3.3 Joining and Joint Requirements

All HDPE pipe joints shall meet the requirements of Section 8.3 of the Specifications.

9.3.3.1. Filter Fabric

The gravel for the leachate collection and leak detection systems shall be completely wrapped on all faces with a 12 oz/yd² non-woven, needle-punched polypropylene or polyester filter fabric to preclude the migration of the drainage sand into the gravel.

The filter fabric shall be uniform and homogeneous in appearance and composition, and free from tears, cuts, thin spots or any defects that may affect serviceability. The filter fabric shall be supplied in rolls having a minimum width of 15 feet and minimum length of 300 feet, and shall meet the following material requirements:

Property	Test Method	Criterion
Mass per Unit Area		±12 oz/yd ²
Apparent Opening Size	ASTM D5261	±80 U.S. Standard Sieve
Grab Tensile Strength*	ASTM D4751	±275 lb
Grab Elongation*	ASTM D4632	±50%
Trapezoidal Tear*	ASTM D4533	±110 lb
Puncture Resistance	ASTM D4833	±150 lb
Permeability to Water	ASTM D4491	±0.20 cm/sec
* Machine and transverse directions.		

A complete description of the filter fabric proposed for use by the Contractor that meets or exceeds the specified requirements shall be submitted to the Engineer for approval at least 1 week prior to delivery of the material to the Job Site.

9.3.4 Gravel

The gravel used for construction of the leachate collection and leak detection systems shall consist of clean, washed, rounded, sub-rounded to sub-angular particle shape, silica classifying as a GP-type poorly graded fine gravel, as determined in accordance with ASTM D2487. Gravel consisting of predominantly angular or otherwise sharp-edged particles shall not be used.

The gravel shall be free of any trash or debris, and shall meet the following gradation requirements, as determined using ASTM D421 and D422:

<u>U.S. Standard Sieve Size</u>	Percent Passing (Dry Weight Basis)
2-inch	100
1½-inch	90-100
1-inch	40-60
¾-inch	15-40
⅝-inch	0-5

A complete description of the proposed gravel material, including its chemical composition and the gradation test results, shall be submitted by the Contractor to the Engineer for approval at least 1 week prior to delivery of the material to the Job Site to confirm compliance with these Specifications.

9.3.5 Drainage Sand/Protective Cover

The sand used for construction of the drainage sand/protective cover layer shall meet the following requirements:

- The material shall have no particle retained on a U.S. ¼-inch standard sieve.
- The material shall have a plasticity index of 0 percent (ASTM D4318).
- The material shall have carbonate content no greater than 10 percent (ASTM D4373), and an organic content no greater than 5 percent (ASTM D2974).
- The material shall classify as a fine sand or slightly silty fine sand with a SP or SP-SM designation in accordance with ASTM D2487.
- The material shall have a fines content equal to or less than 12 percent, as determined by ASTM D1140.
- The material shall be relatively uniform in character and, after compaction, shall be able to achieve an in place saturated hydraulic conductivity equal to or greater than 1.0×10^{-3} cm/sec.

9.4 Installation of Drain System

Proper tools and equipment shall be used by the Contractor for installation of the drain system at the base of the landfill. The geocomposite drainage nets and HDPE pipes shall be installed at the locations and along the lines and grades shown on the Drawings. The geocomposite drainage net of the leachate collection system shall be installed prior to placement of the drainage sand/protective cover layer.

Prior to installation of the drain system, the Contractor shall carefully examine all geocomposites and HDPE pipe and fittings for any damage and defects. All defective materials shall be rejected and replaced. The Contractor shall also carefully inspect the base of the landfill and make sure that it is free of foreign objects or obstacles that may affect installation of the drain system. If water is present in the pipe trench or sump area, it shall be dewatered prior to placement of the filter fabric, gravel and HDPE pipes.

The filter fabric used in the gravel trench drain shall remain wrapped and protected from moisture and ultraviolet light until the time of installation. Storage at the Site shall be in a suitable area protected from sunlight and moisture. After installation, the filter fabric shall not

be left exposed for more than 48 hours before being covered with drainage sand or the upper liner.

During installation, the filter fabric shall be loosely laid with the long direction of the filter fabric roll placed along the alignment of the trenches upon the liner or geocomposite surface, as shown on the Construction Drawings. The liner or geocomposite surface shall be free from debris or objects that could damage the filter fabric. The filter fabric shall be in contact with the liner or geocomposite without excessive wrinkles or gaps. Field joints, where necessary, shall be made using a minimum lap length of 6 inches and flat sewn or thermal bonded seams in accordance with the Manufacturer's recommendations, subject to approval by the Engineer. The thread used to sew the seams shall be of the same material as the filter fabric.

At the ends of the leachate collection and leak detection systems, the 6-inch diameter HDPE pipes penetrate the filter fabric. At the penetrations, the filter fabric shall be cut to fit tightly around the pipe's circumference.

Tears, punctures, thinly stretched sections, or any other damaged filter fabric resulting from construction activities or as received from the Manufacturer which could allow the migration of the drainage sand or fine filter gravel through the fabric shall be overlain by another section or patch of filter fabric with a 6-inch lap all around the damaged area. The patch shall be field sewn or thermally bonded to the filter fabric all around the patch perimeter.

Care shall be exercised in handling and placing the HDPE pipes to avoid any damage. Under no circumstances shall the pipes be dropped or dumped into the trench. As each section of the pipe is placed in the trenches, the joints shall be assembled and the pipes shall be brought to the lines and grades shown on the Construction Drawings. After the pipes are in place, additional gravel shall be placed around and over the drainage pipes, as shown on the Construction Drawings. The filter fabric shall then be wrapped around the gravel with a minimum overlap of 6 inches at all seams. At times when pipe laying is not in progress, the open ends of the drainage pipes shall be closed using a watertight plug or other means approved by the Engineer.

To prevent crushing of the geocomposite and HDPE pipes, sufficient backfill shall be placed over the drainage nets and pipes according to the Manufacturer's specifications before construction equipment is allowed to pass over the drainage net or the drainage pipes. Any geocomposite or pipe that is broken, cracked or otherwise rendered unsuitable, as determined by the Engineer, shall be removed and replaced by the Contractor.

9.5 Pre-Construction Testing of Drainage Sand/Protective Cover

The Contractor may assume that the on-Site borrow source designated by the Owner for the drainage sand/protective cover (less all deleterious materials such as organic matter, roots, wood, trash, debris, etc.) can meet the material requirements listed in Section 9.3.8. For the purpose of determining the hydraulic conductivity for compliance with the specification requirement, laboratory hydraulic conductivity tests have been performed by the Engineer on representative

sample(s) of the proposed borrow source using specimens compacted to 95 percent of the standard Proctor maximum dry density (ASTM D698).

9.6 Placement and Compaction Criteria for Drainage Sand/Protective Cover

The drainage sand/protective cover shall be wetted or dried, as may be required, homogenized and placed in one single 24-inch thick lift above the HDPE geomembrane liner. Placement of the drainage sand/protective cover on the side slopes shall begin at the base of the landfill liner system and progress upslope to the crest of the perimeter dike. Placement of the drainage sand directly over the geomembrane liner or geocomposite drainage net shall be performed by light track-mounted equipment (e.g., low ground pressure D-4 or D-5 dozers) and traveling on a minimum of 18 inches of sand. Care shall be exercised during placement so as not to damage the liner with the blade or tracks of the placement equipment. The drainage sand shall also be placed in such a manner to avoid pushing, pulling, or otherwise stretching the liner.

The drainage sand/protective cover shall be compacted to 90 to 95 percent of the standard Proctor maximum dry density. Standard Proctor compaction tests (ASTM D698) will be performed by the Engineer on Samples of the drainage sand/protective cover, as needed, to determine the maximum dry density for compaction control.

9.7 Construction Quality Assurance Inspection and Testing

9.7.1 Field Construction Quality Assurance Testing

A field representative of the Engineer will be present at the Site during installation of the leachate collection and leak detection systems to:

- Ascertain that the materials are free of deleterious materials and that construction materials and procedures are in conformance with these Specifications, particularly filter fabric seams, geocomposite drainage net joints and seams, HDPE pipe joints and seams, and placement of the drainage sand layer without damage to the geocomposite drainage net and liner.
- Perform *in situ* density tests in the drainage sand layer after compaction and compare the results to the standard Proctor compaction test (ASTM D698). Testing will be performed by the nuclear density method (ASTM D2922) or any other appropriate procedures. Field *in situ* density measurements will be made at a minimum frequency of one test per acre.
- Perform thickness measurements of the drainage sand layer after placement and compaction. Thickness measurements will be made at a minimum frequency of four tests per acre.

- Recover Samples for laboratory hydraulic conductivity testing. Samples will be selected randomly by a field representative of the Engineer at a minimum frequency of one test per acre.

9.7.2 Laboratory Construction Quality Assurance Testing

Laboratory falling head hydraulic conductivity tests will be conducted by the Engineer on specimens remolded to 95 percent of the standard Proctor maximum dry density. If the hydraulic conductivity documented from a sample within drainage sand/protective cover layer section does not meet the requirement of the Specifications, that drainage sand/protective cover section shall be replaced. If the sand has to be removed above the HDPE liner, extreme care shall be exercised to prevent damage to the HDPE liner.

SPECIFICATIONS

SECTION 10 CONCRETE AND REINFORCING STEEL

This Specification covers the requirements for reinforced cast-in place concrete.

10.1 Referenced Standards

The following ASTM standards are referenced in this Specification:

- A82: Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement
- A185: Specifications for Welded Steel Wire Fabric for Concrete Reinforcement
- A615: Specifications for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
- C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
- C33: Standard Specification for Concrete Aggregates
- C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
- C94: Standard Specification for Ready-Mixed Concrete
- C143: Standard Test Method for Slump of Hydraulic Cement Concrete
- C50: Standard Specification for Portland Cement
- C171: Standard Specification for Sheet Materials for Curing Concrete
- C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
- C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

The following American Concrete Institute (ACI) standards are referenced in this Specification:

- ACI 301: Specifications for Structural Concrete

ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete

ACI 305: Recommended Practice for Hot Weather Concreting

ACI 306: Recommended Practice for Cold Weather Concreting

ACI 347: Recommended Practice for Concrete Formwork

ACI SP-66: Recommended Practice for Placing Reinforcing Bars

10.2 General Requirements

10.2.1 Product Handling

The Contractor shall use all means necessary to protect materials before, during and after installation and to protect any other completed Work. In the event of damage, the Contractor shall immediately make all repairs and replacements specified by the Engineer at no additional cost.

Concrete reinforcement shall be stored in a manner to prevent excessive rusting and fouling with dirt, grease and other bond-breaking coatings. Precautions shall be taken to maintain reinforcing steel identification after the bundles are broken.

10.2.2 Formwork

Formwork, where required, shall comply with all pertinent codes and regulations, and all pertinent recommendations contained in ACI 347. If the provisions of pertinent codes and standards conflict with the requirements of this section of this Specification, the more stringent provisions shall govern.

All form lumber in contact with exposed concrete shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic, or other acceptable material capable of producing the desired finish. No selected form facing materials shall be specified for rough form finish surfaces. Form sealers shall be first quality of their respective kinds and subject to approval by the Engineer.

Form ties shall be a type which do not leave an open hole through the concrete and which permit neat and solid patching at every hole. Wire ties and wood spreaders shall not be used. When forms are removed, no metal shall be less than 2-inches from the surface. Alternate forming systems may be used subject to approval by the Engineer.

All other materials not specifically described but required for proper completion of concrete formwork, shall be as selected by the Contractor subject to approval by the Engineer.

10.2.3 Design and Construction of Forms

Design and construction of all forms, where required, shall be sufficiently tight to prevent

leakage of mortar, and able to prevent excessive deflection when filled with wet concrete. Design loads and pressures shall conform to those stipulated in ACI 347.

All required cast-in-place concrete shall be formed, where needed, to the shapes, sizes, lines, and dimensions indicated on the Drawings. The Contractor shall exercise care in the layout of forms to avoid the necessity for cutting of concrete after it is in place. Proper provisions shall be made for all openings, offsets, recesses, anchorage, blockings, and other features of the Work as shown on the Drawings or as required. Reinforcement and other such items required to be anchored in the concrete shall be set before the concrete is placed. Reinforcement shall not be used to support forms or keyways.

The forms shall be braced and tied together to maintain position and shape and to ensure safety to personnel. Bracing and supporting members of ample size and strength shall be constructed to carry safely, without excessive deflection, all dead and live loads to which they may be subjected. The Contractor shall provide metal spreader ties that give positive tying and accurate spreading. Forms shall be constructed straight, true, plumb, and square within a tolerance horizontally of 1 in 400 and a tolerance vertically of 1 in 500. Forms shall be sufficiently wetted to prevent joints from opening up before concrete is placed.

10.2.4 Removal of Forms

Side forms of footings and foundations may be removed, with Engineer's approval, 24 hours after placement of concrete, but the time may be extended if deemed necessary. The Contractor shall use all means necessary to protect workers, the installed Work and materials, and ensure the complete safety of the Work. Nails and tie wires or form ties shall be cut off flush, and all surfaces left smooth and clean. Metal spreader ties on exposed concrete shall be removed by snapping off inside the wall surface, and pointing up and rubbing the resulting pockets to match the surrounding areas. Holes resulting from the use of the spreader rods and sleeve nuts shall be flushed using water and then solidly packed throughout the wall thickness with cement grout applied under pressure by means of a grouting gun. Grout shall be one (1) part Portland cement to two and one-half (2½) parts sand. Grout shall be applied immediately after removing forms.

10.3 Reinforcing Steel

The Contractor shall comply with all pertinent codes and regulations, the pertinent recommendations contained in ACI SP-66 and "Recommended Practice for Placing Reinforcing Bars" of the Concrete Reinforcing Steel Institute. If the provisions of pertinent codes and standards conflict with the requirements of this section of the Specification, the more stringent provisions shall govern.

The Contractor shall submit Shop Drawings he has reviewed and approved for each cast-in-place concrete structure to the Engineer for approval. Submittals shall include bending diagrams, assembly diagrams, splicing and laps of rebar, and shapes, dimensions and details of bar reinforcing and accessories.

All concrete reinforcement materials shall be new, free from rust, and comply with the following standards:

- Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement (ASTM A615, Grade 60).
- Specifications for Cold-Drawn Steel Wire for Concrete Reinforcement (ASTM A82).
- Specifications for Welded Steel Wire Fabric for Concrete Reinforcement (ASTM A185).

All materials shall be stored in a manner to prevent excessive rusting and fouling with dirt, ash, grease, and other bond-weakening coatings. All other materials not specifically described but required for a complete and proper installation of concrete reinforcement, shall be as selected by the Contractor subject to approval by the Engineer.

Reinforcement shall be fabricated in strict accordance with the approved Shop Drawings. The Contractor shall not use bars with kinks or bends not shown on the Drawings or on the accepted Shop Drawings. Bending or straightening steel, which has been partially embedded in hardened concrete or in any other manner that will injure the material will not be permitted. Any bending shall be done cold. Bends for stirrups and ties shall be made around a pin having a diameter not less than four times the minimum thickness of the bar. Bends for other bars, including hooks, shall be made around a pin having a diameter not less than six times the minimum thickness of the bar for bars up to 1 inch in diameter and eight times the minimum thickness of the bar for bars over 1 inch in diameter.

All concrete reinforcement shall be accurately placed, secured and supported with metal chairs, spacers or hangers before the start of concrete placement. The clear space between bars shall not be less than the nominal diameter of round bars. In no case shall the clear distance be less than 1 inch nor less than one and one-third times the maximum size of aggregate. The Contractor shall provide the following minimum concrete covering of reinforcement:

- Concrete placed against soil or ash: 3 inches.
- Concrete cover over all reinforcing steel: 3 inches.

10.4 Cast-In-Place Concrete

10.4.1 General

The Contractor shall comply with all pertinent codes and regulations, and all pertinent recommendations of ACI 301 and ACI 304. If the provisions of pertinent codes and standards conflict with this Specification, the more stringent provisions shall govern.

10.4.2 Documentation

Before any concrete is delivered, the Contractor shall furnish to the Engineer for approval, a concrete mix design for each class of concrete to be used. The design mixes shall be proven by compression test cylinders, tested by a recognized testing laboratory or by certification and test results of a standard mix of the transit-mix concrete supplier in accordance with ACI 301. All material used in the design mixes shall be that proposed for this Project. Tests shall be in

accordance with ASTM C39. The slump of the concrete used in these test cylinders shall not be less than the maximum slump specified.

The Contractor shall keep a record at the Job-Site showing time and location of each placement of concrete, together with transit-mix delivery slips certifying contents of the pour per ASTM C94. The record shall be made available to the Engineer for his use upon request. Upon completion of this portion of the Work, the Contractor shall deliver the record and the delivery slips to the Engineer.

10.4.3 Concrete

All concrete, unless otherwise specifically permitted by the Engineer, shall be transit-mixed in accordance with ASTM C94. The control of concrete production and all tests of cement, aggregates, and water shall be by a recognized testing laboratory, approved by the Engineer.

Concrete shall be air entrained and shall conform to the following requirements:

Minimum Compressive Strength at 28 days (psi):	3000
Minimum Cement Content (sacks per cubic yard):	5.5
Maximum Water to Cement Ratio:	0.45
Percent Air by Volume:	4 to 6
Slump (inches):	4 to 5

Cement shall be Portland cement conforming to ASTM C150, modified Type II, Low C3A (5 percent maximum), or equivalent approved by the Engineer.

Aggregates shall be non-reactive aggregates consisting of at least 95 percent silica (dry weight basis) and containing less than 1.0 percent total carbonates (dry weight basis) determined in accordance with ASTM D4373 on specimens ground to pass the U.S. Standard No. 60 sieve.

10.4.4 Preparation

The Contractor shall remove all debris from the areas in which concrete will be placed. To ensure proper placement and bonding of concrete, the area shall be thoroughly cleaned. Forms, if required, shall be thoroughly wet (except in freezing weather) or sprayed or brushed with a releasing agent and all standing water removed. All transporting and handling equipment shall be thoroughly cleaned. The Engineer shall be notified at least 24 hours before concrete is placed. Concrete shall not be placed until all forms, reinforcing steel and other items to be embedded within the concrete have been observed and approved by the Engineer.

10.4.5 Placing Concrete

Concrete shall be placed in conformance with ACI 304. Concrete shall be conveyed from mixer to place of final deposit by methods that will prevent separation and loss of materials. For chuting, pumping, and pneumatically conveying concrete, only equipment of such size and design as to ensure a practically continuous flow of concrete at the delivery end without loss or separation of materials shall be used. Concrete shall be deposited as nearly as possible in its final position to avoid segregation due to re-handling and flowing. Concrete shall be placed as

dry as possible consistent with good workmanship, never exceeding the maximum specified slump. Concrete shall be placed in a manner that will avoid splashing forms or reinforcing bars and shall not be dropped freely more than 4 feet. Aluminum pump lines or tools shall not be allowed for concrete pumping and placement.

Concrete shall be placed at such a rate that it is at all times plastic and flows readily between bare bars. Once concrete placement is started, it shall be a continuous operation until placement is complete. When stoppage of concrete operations occurs for any reason, construction joints shall be placed as required. Construction joints shall be provided with shear key, and/or dowels, to resist shear and moment as specified by the Engineer.

All Concrete shall be thoroughly consolidated by mechanical vibration or other suitable means during placement, working it around all embedded fixtures and into corners of forms. A vibrator shall be inserted at many locations, from 5 to 15 seconds, until vibration is sufficient to bring a continuous film or mortar to the surface. Vibration shall stop before any segregation of the concrete occurs.

Concrete batches delivered to the Job-Site shall be kept as uniform as possible in consistency and strength. Each of the following shall be considered a basis for the rejection of the concrete delivered to the Site.

- Evidence that the concrete has been re-tempered.
- Concrete that has been contaminated with foreign material.
- Slump exceeding maximum specified.
- Percent of entrained air not within specified limits.
- Discharge from truck not within the 1.5-hour limitation of ASTM C94.

10.4.6 Finishing

After concrete has been screeded to grade, it shall be floated with a metal or wooden float followed by a steel trowel finish. Unless otherwise indicated on the Drawings, the Contractor shall finish all concrete to an even and uniform appearance and, where no slope is required, level within plus or minus 1/8 inch in 10 feet.

10.4.7 Curing

All concrete shall be cured regardless of temperature, weather, or season, to protect it from premature drying, excessively hot or cold temperatures, and mechanical injury. Immediately upon finishing the concrete or removing formwork, curing procedures shall be initiated. Curing shall be continued for at least seven days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70 percent of the specified strength. The curing procedure is used initially, may be replaced by any other procedures at any

time after the concrete is one day old provided the concrete is not permitted to become surface dry during the transition.

Optional curing methods include:

1. Continuous sprinkling with fresh water.
2. Waterproof sheet materials conforming to ASTM C171:
 - A. Immediately upon finishing an area, an acceptable curing membrane shall be applied.
 - B. Lap and securely join all joints.
 - C. Weight membrane down to prevent wind damage.
3. Curing Compound conforming to ASTM C309:
 - A. Immediately upon finishing an area, an acceptable curing compound shall be applied to the entire area.
 - B. The compound shall be applied in strict conformance to the recommendations of the Manufacturer.

Moisture loss from surfaces placed against wooden or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the time prescribed by one of the methods noted above. No traffic shall be allowed on concrete until it has been sufficiently cured.

10.4.8 Hot Weather Requirements

Concrete placement in hot weather shall be in accordance with ACI 305. Concrete with a placement temperature that will cause loss of slump, flash set or cold joints shall not be used. A concrete temperature during placement of less than 90°F shall be maintained. All means necessary to avoid drying the concrete prior to finishing operations shall be used. All required windbreaks, sunshades, fog sprays, evaporation retardants and other devices to protect the concrete shall be provided and used by the Contractor.

10.4.9 Cold Weather Requirements

Concrete placement in cold weather shall be in accordance with ACI 306. Concrete shall be placed with the mix temperature between 50°F and 70°F. When the mean daily outdoor temperature is at or below 40°F, the concrete shall be maintained between 50°F and 70°F for the required curing period of Section 10.4.7 of this Specification. Concrete shall not be placed against or on frozen material.

The Contractor shall provide and use all required framework, cover, heating apparatus, and other devices to protect the concrete. Concrete and/or aggregates shall be protected during batching, transit and mixing, and before and after placing.

10.4.10 Defective Work

The Contractor shall inspect all concrete surfaces and patch all pour joints, voids, rock pockets, form tie holes, and other imperfections before the concrete is thoroughly dry. Defective areas shall not be patched until the concrete has been observed by the Engineer. If the defects are serious or affect the strength of the structure, or if patching does not satisfactorily restore the quality and appearance of the surface, the Engineer may require the concrete be completely removed and replaced in accordance with the provisions of this section, all at no additional cost.

10.5 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance of the materials and Work with this Specification. Quality assurance by the Engineer will include monitoring and/or inspecting: (i) reinforcing steel placement; (ii) concrete placement, finishing and curing; and (iii) sampling and testing of the concrete for compliance with this Specification including Samples for testing in accordance with ASTM C31, ASTM C39, and ASTM C143.

10.6 Submittals

The following submittals are required from the Contractor as part of the requirements of this Specification: (i) Shop Drawings for reinforcing steel; (ii) concrete mix design; and (iii) transit-mix delivery slips.

SPECIFICATIONS

SECTION 11 CONCRETE UNIFORM SECTION MAT

This Section covers the material requirements and installation of concrete uniform section mats.

11.1 Referenced Standards

The following ASTM standards are referenced in this Specification:

C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field

C33: Standard Specification for Concrete Aggregates

C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

C150: Standard Specification for Portland Cement

C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete

11.2 Material Requirements

The concrete uniform section mats (with thicknesses as shown on the Drawings) shall consist of concrete-filled Fabriform-type facing, with weep holes, underlain by non-woven geotextile filter fabric.

11.2.1 Fabric

The fabric forms shall consist of 100 percent woven polyester or polypropylene with a mass per unit area of no less than 6 oz/yd² and with a double-layer mass per unit area of no less than 12 oz/yd². The fabric forms shall consist of multiple panels of double-layer fabric joined in such a manner as to provide an average thickness as shown on the Drawings. Individual width panels shall be cut to suitable lengths and the two layers of fabric separately joined edge to edge by means of a heavy thread, double stitched. The tensile strength of stitch joints shall be not less than 100 pounds per inch.

11.2.2 Grout

Grout shall consist of a mixture of Portland cement, fine aggregate and water so proportioned and mixed as to provide a pumpable slurry. Pozzolan and grout fluidizers conforming to the Specifications may be used at the option of the Contractor. The mix shall obtain a minimum compressive strength of 2000 psi at 28 days when tested in accordance with ASTM C31 and ASTM C39. The grout mix design shall be submitted to the Engineer for approval at least 2 weeks prior to installation of the mats.

Portland cement shall conform to ASTM C150. Pozzolan, if used, shall conform to ASTM C618. Only clean fresh water shall be used. Aggregate shall meet the requirements of ASTM C33, except as to grading. Aggregate grading shall be reasonably consistent and shall be well graded from the maximum size, which can be handled with available pumping equipment.

11.2.3 Weep Holes

The mat shall contain weep holes at the specific locations shown on the Drawings. The weep holes, where specified, shall consist of 7/8-inch inside diameter polyethylene tubes through the mat on a 60-inch center-to-center spacing. The weep holes shall not protrude past the bottom surface of the mat to avoid damaging the HDPE liner.

11.3 Installation Procedures

Prior to placement of the fabric form panels, a layer of 12 oz/yd² non-woven geotextile, meeting the requirements of Section 7 of the Specifications, shall be placed on the prepared sub grade to the lines and dimensions shown on the Drawings.

Prior to grout injection, the fabric form panels shall be positioned to the locations, lines and grades shown on the Drawings. Panels of fabric may be factory assembled in predetermined sizes and joined side-by side at the Site by field sewing or by means of zipper closures attached to the upper and lower layers of fabric. Simple butt joints shall not be permitted.

Expansion joints shall be used at the locations shown on the Drawings.

Only approved grout mixing, pumping and agitating equipment shall be used in preparation and handling of the grout. All oil and other rust inhibitors shall be removed from the pumps and mixers. All materials shall be accurately measured by volume or weight as they are fed into the mixer or delivered to the pump. The quantity of water shall be such as to produce a grout having a pumpable consistency. Time of mixing shall be not less than 1 minute. If agitated continuously, the grout may be held in the mixer or agitator for a period not exceeding 2.5 hours in temperatures below 70° F and for a period not exceeding 2 hours at higher temperatures. If there is a lapse in a pumping operation, the grout shall be re-circulated through the pump or through the mixer drum (or agitator) and pump.

Grout shall be introduced into the space between the layers of fabric and shall be injected in such a way that excessive pressure on the fabric envelope is avoided. The injection pipe shall be wrapped tightly at the point of injection with a strip of burlap and the burlap pushed into the slit as the injection pipe is withdrawn in order to minimize spillage of grout.

The thickness of the mat shall be measured by survey or other appropriate methods, approved by the Engineer. Measurement of thickness shall not be made by inserting anything through the mat that could damage the HDPE liner. Any mat measuring less than 90 percent of the average of all thickness measurements shall be re-injected with grout until the average thickness has been attained.

Foot traffic shall not be permitted on the freshly pumped mat when such traffic will cause permanent indentations in the mat surface. Walk boards shall be used where necessary.

11.4 Quality Assurance Inspection and Testing

The Engineer will undertake observations and perform quality assurance tests to determine compliance with this Specification. Quality assurance by the Engineer will include checking layout and measuring dimensions of the fabric forms, placement and spacing of weep holes, placement of expansion joints, measuring the thickness of the mat, and taking field Samples of the grout for compressive strength tests in accordance with ASTM C31 and ASTM C39.

11.5 Submittals

The Contractor shall submit a complete description of the concrete uniform section mat, weep holes and proposed grout mixture to the Engineer for approval at least 2 weeks prior to installation of the mat.

SPECIFICATIONS

SECTION 12 SEEDING AND MULCHING

12.1 General

Seeding and mulching shall be completed on all disturbed soil covered areas from the outside edge of the finished perimeter dike crest to the limits of construction, including all landfill slopes, lay down areas, and other areas disturbed by the Contractor, within 30 days after completion of grading activities. All seeding operations shall be performed in accordance with these Specifications.

Seeding operations, including fertilizing, seeding, and mulching, will not be permitted when wind velocities exceed 15 miles per hour. Seed shall be sown only when the soil is moist and in proper condition to induce growth. No seeding shall be done when the ground is unduly wet or otherwise not in a tillable condition.

The Contractor shall be responsible for furnishing all labor, material, and equipment required to perform seeding and mulching activities, including ground preparation, placement of approved seed, mulching, and spreading of approved commercial fertilizer.

12.2 Ground Preparation and Fertilizer Application

All operations in connection with grassing shall be performed as soon as practicable after finish grade has been established. Prior to grading and tillage operations, the ground surface shall be cleared of all heavy vegetation, roots, rubbish, grade stakes, and other material which might hinder proper grading, tillage, or subsequent maintenance operations. Grades on areas to be seeded shall be maintained in a true and even condition, preventing the formation of depressions where water will stand.

The ground over which the seed is to be sown shall be prepared by disk harrowing and thoroughly pulverizing the soil to a depth of 6 inches. The prepared soil shall be loose and reasonably smooth. Harrows will not be allowed.

Fertilizer shall be spread uniformly over all areas to be seeded. A commercial fertilizer satisfying the requirements of Section 982 of the Standard Specifications for Road and Bridge Construction, Florida Department of Transportation, latest revision, or as specified by the Owner, shall be used and spread at a rate of 500 pounds per acre or as specified by the Owner. The device for spreading fertilizer shall be capable of uniformly distributing the material at the specified rate. Immediately after the fertilizer is spread, it shall be mixed into the soil, to a depth of approximately 6 inches.

12.3 Seeding

While the soil is still loose, the seed shall be distributed uniformly over the grassing area and immediately mixed into the seedbed to a depth of one-half inch. The seed spreader shall be an approved mechanical type of spreader. Seed shall be sown only when the soil is moist, but not

too wet and in proper condition to induce growth. The Contractor shall water the surface, if needed, prior to seeding.

Permanent type grass seed shall be 30 pounds of common Bermuda seed and 50 pounds of Pensacola Bahia seed per acre. Quick-growing type grass seed, such as rye or millet, shall be a species that will provide an early ground cover during the particular season when planting is done and will not later compete with permanent grass. The rate of sowing quick-growing grass seed shall be 50 pounds per acre. The separate types of seed used shall be thoroughly dry-mixed immediately before sowing. Seed that has become wet shall not be used.

All seed shall meet the requirements of the Florida Department of Agriculture and Consumer Services and all applicable State laws, and shall be approved by the Engineer before being sown. The seed shall have been harvested from the previous year's crop.

Each of the species or varieties of seed shall be furnished and delivered to the Site in separate labeled bags. During handling and storing, the seed shall be cared for in such a manner that it will be protected from damage by heat, moisture, rodents, and other causes. All permanent and temporary grass seed shall have been tested within a period of six months of the date of planting, and shall have a minimum percent of purity and germination as follows:

- Bahia grass seed shall have a minimum pure seed content of 98 percent with a minimum total germination of 85 percent.
- Bermuda grass seed shall be of common variety with a minimum pure seed content of 95 percent with a minimum total germination of 85 percent.
- Annual quick growing Rye grass seed (for planting between September 1 and January 31) shall have a minimum pure seed content of 95 percent with a minimum total germination of 90 percent.
- Quick-growing Millet seed (for planting between March 16 and August 31) shall be of the Brown Top variety with a minimum pure seed content of 90 percent with a minimum total germination of 85 percent.

12.4 Mulching

Two tons per acre of dry hay mulch material satisfying the requirements of Section 981 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction shall be applied uniformly over the seeded area, and the mulch material cut into the soil. The mulching equipment shall be of a type capable of cutting the specified materials uniformly into the soil and to the required depth. Care shall be exercised that the materials are not cut too deeply into the soil. Only undeteriorated mulch that can be readily cut into the soil shall be used.

Immediately after completion of the seeding and mulching operation, the seeded area shall be rolled thoroughly with a cultipacker or other equipment approved by the Engineer. At least two trips over the entire area will be required. The mulch shall be anchored to the ground as needed to minimize loss by wind and rain, by a V-type wheel land packer or similar equipment, and in

accordance with Section 570 of the Florida Department of Transportation Standard Specifications for Road and Bridge Construction.

12.5 Watering

Newly seeded areas shall be watered as required to prevent the grass from drying out, and to maintain the necessary soil moisture for a period of 60 days following planting or as otherwise approved by the Owner. The moistened condition shall extend to the full depth of the rooting zone. All seeded areas shall be watered, as needed and directed by the Owner, and maintained by the Contractor for a period of 60 days following planting until final acceptance of the Work by the Owner. The irrigation water shall be obtained from locations designated by the Owner.

SPECIFICATIONS

SECTION 13 SITE LIMITATIONS

13.1 Owner's Activities and Other Construction

Landfilling of fly ash and other miscellaneous wastes as well as maintenance and operation activities by the Owner will occur on and around the designated construction area for the Increment 1 Buildout. The Owner will continue to place waste in the lined disposal area on top of FGD sludge landfill throughout the entire period of construction.

The Owner will designate an access road for construction equipment to the top and to the side slope of the landfill. The Contractor shall be aware that the access road will have to be shared with the Owner or other contractors working on top of the landfill. All Contractors' activities must be coordinated with the Owner to avoid conflicts with the Owner's activities.

13.2 Contact With Stormwater Runoff and Leachate from the Landfill

Rainwater that comes in contact with fly ash and pozzocrete in the existing landfill and in surface water ponds is considered leachate and is characterized by a pH as high as 12 and elevated dissolved solids concentrations. Appropriate personal protective equipment (PPE) must be used by all personnel in contact with fly ash, waste, or leachate during construction activities.

13.3 Existing Facilities

Any damage to existing facilities by the Contractor shall be repaired by the Contractor at his expense and as directed by the Owner.

13.4 Relocation of Existing Force Main and Electrical Service

The Contractor shall install the relocated force main and electrical service prior to removal of the existing system.

SPECIFICATIONS

SECTION 14 GENERAL PROVISIONS

This Specification presents general provisions covering Work performed for Increment 1 Buildout.

14.1 General

14.1.1 Scheduling and Coordination

The Contractor shall keep the Owner informed daily of the times and places at which he intends to do Work. All Work shall be scheduled and coordinated with the Owner as outlined in Section 15 of these Specifications.

14.1.2 Monthly Submittal of Worked Hours

The Contractor shall keep records of the hours worked during each week. A report summarizing all Work hours must be submitted to the Owner's Engineer by the following workday (Monday).

14.1.3 Inspection and Sampling of Materials

All materials furnished by the Contractor shall be subject to the examination and approval of the Owner or the Owner's Engineer at all times during the progress of the Work until completion of the Project. As soon as the materials are examined and/ or tested and approved, the Contractor shall immediately remove all rejected materials from the Job Site, as directed by the Owner or Owner's Engineer. No material shall be used before being examined and/or tested and approved by the Owner or the Owner's Engineer. Failure on the part of the Owner, or the Engineer, to condemn or reject inferior materials or Work shall not be construed to imply an acceptance of the same should their inferiority become evident at any time prior to final acceptance of the Work.

The Contractor shall make necessary arrangements so that the Engineer may secure Samples of materials on the job for testing to ascertain whether materials included, or to be included, in the Work meet the requirements of the Specifications.

14.1.4 Access To Work

The Owner and Engineer shall have free access to the Work at all times. The Contractor shall furnish the Owner and the Engineer with tools, equipment, labor and Samples, as needed, for ascertaining whether the Work being performed, or the Work which has been completed, is in accordance with the requirements of the Specifications, even to the extent of uncovering, testing, or removing portions of finished Work, if such is necessary.

14.1.5 Suspension of Work

The Owner may order the Contractor to suspend any or all Work that may be affected, damaged, or endangered by climatic conditions. Further, the Owner may suspend any Work at any time when acceptable results as defined in the Specifications cannot be obtained due to inclement weather or other unsatisfactory field conditions.

14.1.6 Utilities and Contractor's Facilities

Utilities are not available at the Increment 1 Buildout. Utilities, electricity, and fuel as may be required for construction and other purposes shall be secured and purchased by the Contractor. The Owner will make space available for Contractor's facilities for storage and for trailers. Fresh water (for non-potable use) shall be provided at a location selected by the Owner.

14.2 Drawings and Specifications

The Drawings and Specifications are intended to be coordinated. Anything shown on the Drawings but not mentioned in the Specifications, or vice-versa, or anything not expressly set forth in either, but which is reasonably implied, shall be furnished as though specifically shown and mentioned in both without any extra charge. Should anything be omitted from the Drawings, which is the subject of the Contract between the Owner and the Contractor, it shall be the duty of the Contractor so to notify the Owner before signing the Contract. The Contractor shall furnish such detailed plans and drawings as may be required for the execution of the Work and which are not included in the Drawings furnished by the Engineer on behalf of the Owner; these shall include shop details.

Shop Drawings for the HDPE geomembrane liner, the geonet, the geocomposite drainage net, and the GCL shall be prepared and submitted to the Engineer at least 2 weeks prior to installation, for approval. Shop Drawings prepared by a subcontractor or supplier shall first be checked by the Contractor for compliance with the Specifications, and shall be initialed by the Contractor, prior to submittal to the Engineer for review and approval.

The Contractor shall submit all drawings and schedules with the supporting information at the time of the Bid and shall again do so sufficiently in advance of construction activities to allow ample time for engineer's review, recommendations and changes if any; applying the recommendations and changes of the engineer and resubmitting them before final approval. No claim by the Contractor for delays, arising from his failure in this respect, shall be allowed.

All drawings submitted by the Contractor must bear the stamp of approval by the Contractor as evidence that the drawings have been checked by the Contractor. The approval by the Engineer of drawings submitted by the Contractor shall be only for conformance with the design of the Project and shall not relieve the Contractor from the responsibility for adherence to the Contract, nor shall it relieve him of the responsibility for any error, which may exist.

14.3 Engineering/Topographic Data

The topographic information provided on the Drawings is for informational purposes only, and shall be reviewed in conjunction with the notes on the Drawings. The Contractor shall examine

the Site and may perform additional survey, if necessary, to determine whether there are significant changes in sub grade elevations compared to those shown on the Drawings.

The Contractor must form his own opinion of the character of the Work and of the fly ash and waste materials, and must satisfy himself with his own investigations, explorations, tests or studies, of the conditions affecting the Work to be done. The Contractor shall assume all responsibility for deductions and conclusions as to the nature or condition of the in-place ash, soil, borrow materials, subsurface condition, the difficulties of making and maintaining the Work area dewatered, and doing any Work affected by the existing conditions in the proposed landfill vertical expansion area and the slopes of the existing landfill.

14.4 Right To Change Location and Drawings

When additional information regarding the topography, subsurface, or other conditions becomes available from excavation, testing, data, or other work, the Engineer may find it desirable to change alignment, dimensions, or design of a portion of the Work to conform to the newly discovered conditions. Toward this end, the Owner reserves the right to make any such reasonable changes and the Contractor's operations shall be conducted to accommodate reasonable changes without additional expense.

14.5 As-Built Drawings

The Contractor shall maintain one set of prints of drawings issued for construction on the Job Site at all times for the preparation of As-Built Drawings. This set will be in addition to any sets needed and used in the actual construction operation. The As-Built Drawings are to be kept up to date by the Contractor, as approved by the Owner, on a daily basis. The plans shall show the actual as-built condition. **Final As-built Drawings shall be submitted to the Owner per the schedule as noted in Section 15.1. The survey for the liner sub-grade shall be at a minimum 50-foot grade with additional elevations determined at slopes breaks as necessary. The CQA Engineer must review and approve the survey notes prior to placing the GCL.**

SPECIFICATIONS

SECTION 15 CONSTRUCTION SCHEDULE

15.1. Project Milestone Schedule Summary:

Expected Award Date: To Be Determined
Project Kickoff Meeting Date at the SGS:
Revised Project Schedule Due:
Commencement Date:
Site Mobilization Date:
Increment 1 Buildout Complete:
Project - Substantial Completion Date:
Final Drawings ("As Builts") Submittals due to Engineer (2 sets):
All other required Submittals due Engineer/Owner
Final CQA Inspection and Testing Reports Due (Section 2.5)
Final Inspection and Acceptance by Engineer and Owner
RUS Closeout Procedure to begin (see Part II, Section 18)

15.2. Work Hours

Unless otherwise directed by the Owner, the Contractor shall perform construction operations a minimum of 8 hours per day, 5 days per week. The Contractor shall schedule work shifts to conform to working hours normally observed at the Seminole Generating Station.

15.3 Submission of Schedule

The Contractor shall submit with the supporting information for the bid and again at the first construction meeting, a detailed Project construction schedule (to be attached hereto as Exhibit 9) for the Project in the form of a bar chart. The schedule shall be submitted using Microsoft Project scheduling software, software that is 100 percent compatible with Microsoft Project, or other software approved by the Owner. The schedule shall include the specific period of each Work task. In addition, the schedule shall include submittals requiring Owner or Engineer approval before delivery to the Site (e.g., Shop Drawings, Manufacturer's product specification sheets and conformance test results) and delivery of construction materials.

15.4. Construction Duration

Time is of the essence and the Contractor's proposed Project Schedule (attached hereto as Exhibit 9) will be considered in the bid evaluation.

SPECIFICATIONS

SECTION 16 FINAL INSPECTION AND ACCEPTANCE

16.1 Final Inspection

Upon completing all clean-up operations, the Contractor shall advise the Owner he is ready for final inspection. The Owner will then set a specific date and time for the final inspection. The Owner, Engineer, and Contractor will jointly inspect the Project area to verify that all Work has been completed in accordance with the Drawings and Specifications. Any Work found lacking in any way should be corrected by the Contractor at Contractor's expense and re-inspected.

16.2 Acceptance and Contract Closeout

The Owner shall issue the appropriate RUS closeout forms (See Part II, Section 18) to the Contractor once all Work has been satisfactorily completed, inspected and accepted by the Engineer and Owner.

Additionally Contractor shall submit all appropriate Release of Liens (See Exhibit 7).

Final payment can be requested by the Contractor after completion of Units of Property requirements, completion of all drawings and document submittals, and all required RUS closeout documents.

16.3 Material and Workmanship Warranties

Warranties for HDPE liner, geocomposite, geonet, and GCL material and workmanship shall take effect from the completion date of the Contract as noted on the RUS Form 187 – Certificate of Completion.

SPECIFICATIONS

SECTION 17 SCHEDULING AND COORDINATION

All scheduling and coordination of the Work shall be undertaken through the Owner's Project Manager, listed in Section 17.2, assigned to the Work.

17.1 Pre-Construction Coordination Meeting

There will be at least one coordination meeting with all contractors and subcontractors, the Engineer, and the Owner after the Work is awarded and before construction begins.

The Contractor shall submit a revised Project Schedule for the Owner's approval at the first coordination meeting. The schedule shall be in the form of a Gantt chart using Microsoft Project 2003 showing all construction activities, and shall be updated weekly and provided to the Owner as the Work progresses. Each contractor shall also designate a project manager at the first coordination meeting. The Contractor's designated Site supervisor shall also attend the coordination meeting.

17.2 Correspondence With Owner

All correspondence with the Owner shall be directed to the following address:

Mailing Address: Seminole Electric Cooperative, Inc
16313 North Dale Mabry Highway
Tampa, FL 33618-1427

Attention: TO BE DETERMINED
Telephone:
Fax:
E-mail:

17.3 Correspondence With Engineer

All questions and correspondence regarding the Drawings and Specifications shall be directed through the Owner to the Engineer, PBS&J at the following address:

Mailing Address: PBS&J
482 South Keller Road
Orlando, Florida 32810

Attention:	Mr. Joe Miller, P.E.	Mr. Dave Deans, P.E.
Telephone:	407-806-4153 (office)	407-806-4104 (office)
Fax:	407-647-0624	407-647-0624
E-mail:	jlmiller@pbsj.com	dedeans@pbsj.com

17.4 Coordination With Other Contractors and Suppliers

Construction by other contractors may be ongoing through the period of construction. The schedule and activities of each contractor shall be approved by and coordinated with the Owner to avoid conflicts. No contractor will be allowed additional payment for any delays in his work not coordinated through and approved by the Owner.

SPECIFICATIONS

SECTION 18 UNITS OF PROPERTY ACCOUNTING AND REPORTING

Owner's financial and tax reporting needs require detailed and accurate property records. Therefore, the new or replacement structures and/or equipment to be constructed, installed and/or provided under this Project shall be broken down into specific Units of Property. A Unit of Property is defined as a distinct item having a "fully-loaded" installed cost (including Owner's Costs) of not less than \$5,000, or a group of like or related items having a "fully-loaded" installed cost of not less than \$5,000, which could reasonably be expected to be replaced as a unit at one time. In addition, certain structural items (such as foundations, superstructures, roofing, and paving, to name a few) must be shown as separate Units of Property. Although it is not likely that such items will be replaced, the costs for such items must not be included in other structure or equipment items and thus overstate the costs of those items. Contractor must clearly identify and allocate appropriate equipment, engineering, design, installation and other labor, contract overheads, escalation, testing, and any other direct or indirect costs allocable to each defined Unit of Property.

Costs to remove existing structures or equipment shall not be allocated to new or replacement Units of Property but shall be separately accumulated. Contractor shall deliver to Owner a Report in MS Excel format, using the template shown in Exhibit ____ (Excel filename *UOP Retired Template.xls*), to report all existing items retired under this Project and appropriate removal costs allocated to each. Owner will provide to Contractor extractions of relevant sections of the existing property records from which Contractor will identify all existing items retired under this Project. This Report shall include: (i) the previously existing Units of Property measured by "each" that were totally or almost totally replaced (i.e., at least 80%); (ii) for Units of Property measured in bulk (for example, in linear feet, square feet, cubic yards, etc.), only those where at least 10% of the original item was replaced, along with the ratio actually replaced (for example, 100/500 sq. ft. replaced). There should be no other costs shown on this Report (it is not necessary to show the original cost of the removed item).

In addition to the Report for new or replacement Units of Property (discussed in detail below) and the Report showing existing Units of Property removed under the Project (see previous paragraph), a third Report must be provided to show Project costs (NOT original asset costs) related to: (i) partial replacements of previously existing Units of Property (i.e., less than 80% replacements of items measured by "each" and less than 10% replacements of items measured in bulk); and (ii) repairs, cleaning, relocation, etc. of existing items. All of these costs will be expensed, not added to Units of Property. This Report must be in MS Excel and must follow the format shown in Exhibit ____ (Excel filename *Project Costs Expensed Template.xls*).

With respect to new or replacement Units of Property, Contractor must deliver to Owner a Report as described below. The Report must be in MS Excel and must follow the format shown in Exhibit ____ (Excel filename *Units of Property SGS Project Template.xls*). [NOTE: The columns with green headings in the Exhibit require input from Owner, whereas the columns with yellow headings should be completed solely by Contractor.] Owner must receive the Report via electronic mail and, upon completion of the Project, in CD form. The Report must be capable of further refinement by Owner, if necessary. A draft version of the Report shall be submitted to

Owner for review within 60 days after the Contract Date. The Report will not contain cost amounts at this time but should list all known Units of Property. Recommendations and alterations agreed upon by Owner and Contractor shall be incorporated into the Report on an ongoing basis. As Work progresses on the Project, Contractor shall provide an updated draft of the Report to the Owner on a monthly basis. Owner reserves the right to require reasonable modifications of and adjustments to the Report. Owner shall provide to Contractor total Owner's Costs to be included in the Units of Property upon completion of the Project. Contractor shall provide a final Report to Owner within 30 days after completion of the Project.

Each Unit of Property's item number must be unique, and the structure of this number is as follows:

Title

RUSCODE

SUBCODE

CATEGORY

ITEM

GENERATING UNIT

GENERATIONAL LEVEL

DIFFERENTIATING DIGIT

Number of Digits

3

2

2

2

1

1

1

Significance

RUS Account

Major Plant System

Plant Subsystem

Unit of Property

1, 2 or 3 (Unit 1, Unit 2, Common)

‘A’ for Original Item; ‘B’ for First Replacement, etc.

Optional alphabetic character used to differentiate among multiple similar items.

The Unit of Property number's components are not only for proper identification of each item but are also used for subtotaling related items in a hierarchy fashion in the Report.

The RUSCODES are the Rural Utilities Service accounts assigned by that USDA agency. Typical accounts used at this facility are as follows:

311 – Steam Production Plant Structures and Improvements

312 – Boiler Plant Equipment

314 – Turbogenerator Units

315 – Accessory Electrical Equipment

316 – Miscellaneous Power Plant Equipment

352 – Switchyard Structures and Improvements

353 – Switchyard Station Equipment

Generally, most Units of Property constructed or installed in this Project should fall under RUS account **312, Boiler Plant Equipment FGD Landfill** (and related) Equipment. The SUBCODES represent major systems. CATEGORIES are sequentially numbered within each SUBCODE, beginning with 01; ITEMS are numbered similarly within CATEGORIES. The GENERATING UNIT is either ‘1’ (Unit 1), ‘2’ (Unit 2) or ‘3’ (Common Facilities).

It is imperative that new Unit of Property item numbers be consistent with those of existing Units of Property, and that there is a seamless meshing of the new items into the property records. Owner will provide to Contractor extractions of relevant sections of the existing property records.

Data shown for each Unit of Property shall be of sufficient detail to allow accounting for retirement, replacement or modification of all or part thereof without having to go back to Contractor progress reports and invoices.

- a. **Emboldened Sub-Headings.** The appropriate RUSCODE, SUBCODE and CATEGORY in both numeric and verbal forms shall be used to categorize the Units of Property.
- b. **Item Numbers.** These unique Units of Property identifying numbers shall be listed in column A under their appropriate subheadings.
- c. **Descriptions, Units of Measure, and Quantities.** Items shall be reasonable demarcations of plant and equipment, and main descriptions shall include the following identification where applicable: type, size, manufacturer, model and serial number, totaling up to 50 characters in length. Additional descriptions shall be added as necessary to further explain configurations, styles, usages, etc. Contractor shall use reasonable units of measure appropriate to each Unit of Property (e.g., each, assembly, linear feet, cubic yards, etc.). Nonspecific measurements such as "lot" are generally **not** acceptable.
- d. **Pollution Control Equipment.** Owner shall provide to Contractor the Florida statutes and rules defining pollution control equipment for property tax purposes. Based on this information, Contractor shall determine the percentages and amounts of each appropriate item which should be considered pollution control equipment and shall so indicate on the Report.
- e. **Florida Sales Tax Status.** Owner and Contractor shall confer on the nature of the Units of Property to be provided under the Project and shall jointly determine how items should be categorized for Florida sales tax purposes once installed. Items identified as **Exempt** property (pursuant to Section 212.08(5)(c), FS, or any other statutory exemption provision) shall be designated with an 'E,' those identified as **Real** property shall be designated with an 'R,' and those items determined to be **Taxable** shall be designated with a 'T' on the Report.
- f. **IRC § 1245/1250 Tax Status.** Contractor shall specifically identify Units of Property determined to be § 1250 property according to the Internal Revenue Code and Regulations. All items not so identified will be assumed to be § 1245 property.
- g. **Owner's Costs.** This amount shall be provided by Owner to Contractor upon completion of the Project, in a lump sum. Contractor shall apportion it to each Unit of Property according to Total Contract Cost.
- h. **Subtotals and Totals.** The Report shall contain subtotals for each of the amount columns, appropriate to the headings and subheadings as delineated in subparagraph a, above. The Report shall be grand totaled.
- i. **Other.** The Report shall contain headers and footers as shown in Exhibit 10, including proper pagination and dates.

SPECIFICATIONS

SECTION 19 DRAWINGS AND ATTACHMENTS

Made a part of this Contract is the following Project Drawing package entitled
"Construction Drawings for Increment 1 Buildout - Seminole Generating Station Putnam
County, Florida" dated July 2010.

<u>Drawing #</u>	<u>Title</u>
1	Cover
2	Site Plan
3	Existing Grade – October 20, 2009
4	Liner Sub-grade – Grading Plan
5	Landfill Geometry
6	Cross Section A-A
7	Cross Section B-B
8	Cross section C-C
9	Liner - Typical Sections and Details
10	Leachate Collection Piping System - Sheet 1 of 3
11	Leachate Collection Piping System – Sheet 2 of 3
12	Leachate Collection Piping System – Sheet 3 of 3
13	Stormwater Pond B - Final Grading Plan
14	Stormwater Pond B - Sections and Details
15	Stormwater Pond B - Geometry Plan 1
16	Stormwater Pond B - Geometry Plan 2
17	Erosion Control Details

Attachments:

Report entitled: "Geotechnical Investigation of Increment 1 Landfill Buildout" prepared
by Andreyev Engineering, Inc. July 2010.