



Gibbons Creek Environmental Redevelopment Group, LLC

Site A and Site F Landfill Closure

Construction Documents Project Manual

Issued for Construction

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Prepared by HDR

HDR Project No. 10290148

Texas Firm Registration No. F-754



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The following specifications were prepared under my direction:

Division 01, Division 31, Division 32 and Division 33.



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HDR ENGINEERING, INC.
TEXAS REGISTERED ENGINEERING FIRM F-754

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SECTION 01 30 00 SPECIAL CONDITIONS

PART 1 - GENERAL

1.1 CONDITIONS SPECIFIC TO THIS PROJECT

- A. DANGER – A concentration of H₂S poisonous gas may be present near discharge drains, leachate equipment or low-lying areas. Detection equipment is required when working in areas where H₂S may be present.
- B. DANGER – Some leachate and/or CCR contact water may be acidic. Contractor to take any necessary precautions while working with leachate water.
- C. CQC/CQA Duties: The CQA Consultant may conduct all required testing and certify the project. If utilized, the CQC Consultant will provide all documentation to the CQA Consultant for review and inclusion in the certification to TCEQ. Refer to the CQA Plan.
- D. The CONTRACTOR is responsible for construction/maintenance of any additional access/haul roads as approved by the OWNER.
- E. The CONTRACTOR is responsible for maintaining the Erosion and Sediment Control measures.
- F. CONTRACTOR is to obtain all soil material from on-site. Stockpiling of soil material shall be as indicated or as approved by Engineer and Owner.
- G. Hours of Construction shall be as agreed by the OWNER. Construction may occur on Legal Holidays with permission from the OWNER. The OWNER may allow the CONTRACTOR to extend the Hours of Construction provided there are not complaints from the community and the OWNER approves of the extension. If the OWNER receives any complaints, then the OWNER may revoke the extended hours of construction.
- H. Testing:
 - 1. CQA Consultant will be responsible for Soil and Concrete Testing;
 - 2. The Contractor will be responsible for payment of failed soils and concrete tests and any corrective actions necessary to get passing results.
 - 3. Other testing: Required testing, testing procedures, reports, certificates, and costs associated with all phases of securing required satisfactory test information which may be required by individual sections of Specifications or Drawings are the full responsibility of the Contractor.
 - 4. Testing results: Contractor shall provide Owner and Engineer copies of all test results.
 - a. Test results may be submitted to Owner and Engineer in electronic pdf format.

1.2 DEFINITIONS

The following terms and definitions shall be used unless defined differently in other specifications.

- Engineer – Consultant responsible for design of specific portions of project.
- CQA Consultant – Engineer hired by Owner to provide construction materials testing.
- Owner – Gibbons Creek Environmental Redevelopment Group (GCERG)
- GCSES – Gibbons Creek Steam Electric Station
- APs – Ash Ponds (A, B, and C)
- CoY – Coal Yard
- FGD Complex – Flue Gas Desulfurization Complex
- PCP – Plant Collection Pond
- SSP – Scrubber Sludge Pond
- SFL – Site F Landfill
- SAL – Site A Landfill

1.3 PROJECT MEETINGS

- A. A preconstruction conference shall be held at the site with the ENGINEER, CONTRACTOR's Project Manager and Project Superintendent and CONTRACTOR's Subcontractor Representatives. The purpose is to review sequence of work and communication procedures.
- B. Pre-Installation Conferences:
 - 1. Coordinate and schedule with Resident Project Representative and ENGINEER for each material, product or system specified. Conferences to be held prior to initiating installation, but not more than two (2) weeks before scheduled initiation of installation.
 - a. Conferences may be combined if installation schedule of multiple components occurs within the same two (2) week interval.
 - b. Review manufacturers recommendations and Contract Documents Specifications.
 - 2. CONTRACTOR's Superintendent and individual who will actually act as foreman of the installation crew (installer), if other than the Superintendent, shall attend.
- C. Construction Meetings:
 - 1. The ENGINEER will conduct construction meetings involving:
 - a. CONTRACTOR's project manager.
 - b. CONTRACTOR's project superintendent.
 - c. OWNER's designated representative(s).
 - d. ENGINEER's designated representative(s).
 - e. CONTRACTOR's subcontractors as appropriate to the work in progress.
 - f. ENGINEER'S Construction Quality Consultant(s).
 - 2. Frequency of meetings to be as agreed upon at the Pre-Construction Meeting.
 - 3. The ENGINEER will take meeting minutes and submit copies of meeting minutes to participants and designated recipients identified at the Preconstruction Conference. Corrections, additions or deletions to the minutes shall be noted and addressed at the following meeting.
 - 4. The CONTRACTOR shall have available at each meeting up-to-date record drawings

1.4 DATA AND MEASUREMENTS

- A. The data given in the Specifications and shown on the Drawings is believed to be accurate but the accuracy is not guaranteed. The Contractor must take all levels, locations, measurements, and verify all dimensions of the job site prior to construction and must adapt his work into the exact construction. Larger scale Drawings take precedence over smaller scale Drawings, and approved shop drawings take precedence over all others.
- B. All surveys shall be sealed by a Texas registered land surveyor and submitted to the Engineer. The Contractor shall provide the Engineer with an electronic version of the sealed survey in AutoCAD readable format. Provide unique layers for 1 FT contours, index contours, text, water, vegetation, buildings, roads, etc. Utilize Texas State Plane coordinate system (Central Zone, NAD 83) and locate all features in x, y, and z dimensions.
- C. Initial survey shall include the following:
 - 1. Topography of the Scrubber Sludge Pond, Ash Ponds, Site A Landfill, Site F Landfill, and Soil Borrow Area(s).
 - 2. Topography of the stockpile areas.
 - 3. Topography within limits of construction including:
 - a. Topography of all leachate collection and storm water ponds.
 - b. Location of existing channels.
 - c. Location of structures.
 - d. Inverts of pipe, size, and pipe location.
- D. Final as-built survey shall include the following, for example:
 - 1. Topography of the entire area within limits of construction.
 - 2. Limits of landfill cap placement.

3. Topography of the stockpile areas and all other disturbed areas.
 4. Location of roads.
 5. Location of channels.
 6. Topography of all stormwater control enhancements and associated outlet structures.
 7. Culverts (invert, size, locations).
 8. Other areas or items that were a part of the Work as directed by the Engineer.
 9. Locations of leachate pipes, toe drain pipes, down chutes, valves, sumps, and ponds.
- E. During construction, the contractor shall submit to the Engineer for review preliminary surveys that depict thickness verification of the soil layers.
- F. Thickness verification may be done with a table or by electronic comparison of drawing files. The method shall be agreed to by the CQA and ENGINEER prior to construction. If the table method is selected, the same point on each soil layer must be used. The thickness is to be measured perpendicular to the slope. Refer to the soil specifications for frequency of points.
- G. Contractor shall preserve and protect all reference points and pay for replacement of any destroyed referenced points.
- H. Additional requirements are set forth in the CQA Plan.

1.5 SPECIAL CONSIDERATIONS

- A. CONTRACTOR shall be responsible for negotiations of any waivers or alternate arrangements required to enable transportation of materials to the site.
- B. Maintain conditions of access road to site such that access is not hindered as the result of construction related deterioration.
- C. Safety:
1. The CONTRACTOR alone shall be solely and completely responsible for conditions of the job site in connection with his work, including safety of all persons and property, preparatory to and during performance of the work. This requirement shall apply continuously and not be limited to normal working hours.
 2. The Construction Documents and the construction hereby contemplated, are to be governed, at all times, by applicable provisions of local and state laws and regulations, and federal laws, including, but not limited to, the latest amendments of the following: Department of Labor, Bureau of Labor Standards Safety and Health Regulations for Construction, and Williams and Steiger Occupational Safety and Health Act of 1970, including rules and regulations pursuant thereto, applicable to the Work and performance of the Contract. (OSHA).
 3. The duty of the ENGINEER to conduct construction review of the CONTRACTOR's performance is not intended to include review of the adequacy of the CONTRACTOR's safety measures in, on, or near the construction site.
 4. No explosives are permitted for this project.
- D. Inspections by Federal and State Agencies: Authorized representative and agents of the state and federal government shall be permitted to inspect all work, materials, records of personnel, invoices of materials, and other relevant data and records.
- E. Water:
1. CONTRACTOR is responsible for all water necessary for the completion of the Work. Water used on the project shall be fresh and of drinkable quality. The CONTRACTOR shall make arrangements to obtain fresh water for his drinking.
 2. Water for other uses such as dust control and moisture control of fill may be obtained from storm water basins as approved by the Engineer/CQA Consultant and Owner. The CONTRACTOR shall obtain any required permits.
 3. CONTRACTOR is responsible for coordinating use of, and all costs associated with use of, water from local sources.

- F. The CONTRACTOR shall provide sanitary facilities during construction.
- G. Order of Construction: The CONTRACTOR will schedule construction operations to allow the other contractors access to the site.

1.6 HISTORICAL AND ARCHAEOLOGICAL

- A. If during the course of construction, evidence of deposits of historical or archeological interest is found, the CONTRACTOR shall cease operations affecting the find and shall notify OWNER. No further disturbance of the deposits shall ensue until the CONTRACTOR has been notified by OWNER that CONTRACTOR may proceed. OWNER will issue a notice to proceed after appropriate authorities have surveyed the find and made a determination to OWNER. Compensation to the CONTRACTOR, if any, for lost time or changes in construction resulting from the find, shall be determined in accordance with changed or extra work provisions of the Contract Documents. The site has been previously investigated and has no known history of historical or archaeological finds.

1.7 DRAWINGS AND CONTRACT DOCUMENTS FOR CONTRACTOR USE

- A. Contractor shall be provided electronic copies in pdf format of the construction plans and specifications for their reproduction and use.

1.8 ORDER OF CONSTRUCTION AND CONSTRUCTION SCHEDULE

- A. At no time shall Contractor or his employees modify operation of the existing facilities or start construction modifications without approval of the Owner except in an emergency to prevent or minimize damage.
- B. Submit a critical path type schedule for approval. Account for schedule of Subcontracts. Include proper sequence of construction, various crafts, purchasing time, shop drawing approval, material delivery, equipment fabrication, startup, demonstration, and similar time consuming factors. Show on schedule at a minimum, earliest starting, earliest completion, latest starting, latest finish, and free and total float for each task or item.
- C. Evaluate schedule no less than once every two weeks. Update, correct, and rerun schedule and submit to Engineer in triplicate with pay application to show rescheduling necessary to reflect true job conditions. When shortening of various time intervals is necessary to correct for behind schedule conditions, indicate actions to implement to accomplish work in shorter duration. Information shall be submitted before implementation to Engineer in writing with revised schedule.
- D. If Contractor does not take necessary action to accomplish work according to schedule, Contractor may be ordered by Owner in writing to take necessary and timely action to improve work progress. Order may require increased work forces, extra equipment, extra shifts or other action as necessary. Should Contractor refuse or neglect to take such action authorized, under provisions of this contract, Owner may take necessary actions including, but not necessarily limited to, withholding of payment and termination of contract.
- E. Upon receipt of approved "Work Schedule," within 10 days, submit to Engineer an estimated payment schedule by each month of project duration. Include a composite curve to show estimated value of work complete and stored materials less specified retainage. During the course of work, update with new composite curves at key months or whenever variation is expected to be more than plus or minus 10 percent.

1.9 SPECIAL CONSIDERATIONS

- A. Contractor, Contractor's employees and Subcontractors must abide by Owner's site rules and regulations at all times. Owner's safety training will be required of all Contractor, Subcontractors and employees who will be working on site on this project. Contractor and his Sub-contractor's activities must not interfere with other decommissioning activities at the GCSES. Owner's Site Representative must be contacted in advance when impending

interference with Owner's decommissioning activities is anticipated by Contractor or his Subcontractors.

- B. Contractor shall be responsible for negotiations of any waivers or alternate arrangements required to enable transportation of materials to the site and at the contractor's expense.
- C. Maintain conditions of access road to site such that access is not hindered as the result of construction related deterioration.

1.10 CONTRACTOR'S FIELD OFFICE

- A. Establish at the Site the Contractor's field office, structurally sound and in accordance with Laws and Regulations, sufficient for Contractor's needs at the Site.
- B. Equipment: Telephone, copier/scanner, and (as deemed necessary by Contractor) appropriate computer equipment.
- C. Contractor's personnel will be reasonably present at Contractor's office during working days.
- D. At Contractor's field office, maintain complete file of the Contract Documents, Submittals approved or accepted (as applicable) by Engineer, interpretations and clarifications issued by Engineer, copies of Contractor's daily field reports, all necessary and required safety data sheets, copies of documents comprising Contractor's safety program, record documents required by the Contract Documents and other files of field operations deemed appropriate by Contractor and as required by the Contract Documents.
- E. Remove field office from Site following Substantial Completion of all the Work and prior to final inspection of the completed Work.

1.11 PROJECT PHOTOGRAPHIC DOCUMENTATION

- A. Contractor shall furnish photographic documentation as required and as directed by Engineer or Construction Manager. Required under this Article is "still" photographs only.
- B. Construction Photography - General:
 - 1. Obtain required photographic documentation using a digital camera of not less than 16 megapixel resolution.
 - 2. Photographs shall be digital and submitted to Engineer electronically with the monthly application for payment. Each photograph shall be JPG, TIFF, or PNG files. Each electronic file of a photograph shall be titled with the date and brief description of the view; for example: "2021-10-25 - SSP Geomembrane Excavation..jpg".
 - 3. All photographs shall be in color, properly lit and illuminated, and adequately framed to fully illustrate the subject of the photograph.
 - 4. Schedule and coordinate photographer with Engineer, Construction Manager, or Owner, as applicable. Locations at which photographs are taken and view shall be mutually agreeable to Contractor and Engineer, Construction Manager, or Owner as applicable.

1.12 ADJACENT PROPERTIES AND FACILITIES

- A. Contractor shall obtain and pay for any and all waivers or alternate arrangements necessary for transporting materials and equipment to the Site.
- B. Access, Traffic Control, and Parking:
 - 1. Maintain conditions of access road to site such that access is not hindered as the result of construction related deterioration.
 - 2. Do not permit driving across or transporting materials or equipment across areas outside the construction limits shown on the Drawings.
 - 3. Provide traffic control devices and personnel necessary to ensure a safe interface of construction traffic with traffic to and from adjacent sites.
 - 4. Provide access routes for emergency vehicles at all times.
 - 5. Provide daily sweeping of hard-surface roadways to remove soils tracked onto roadway.

- 6. Provide on-site parking for all staff to limit interference with adjacent properties and businesses.
- C. Borrow Soil Area has been identified onsite as the Skinner Mountain area as depicted on the plans. Earthwork calculations indicate all required clay and topsoil needed for closure of the Site A and Site F Landfills will be supported by this borrow source.

PART 2 - PRODUCTS

2.1 INTERFACE FRICTION TESTS

- A. Laboratory friction tests shall be conducted, on behalf of the OWNER by the CQA Consultant, with representative samples of the materials selected by the CONTRACTOR for use in the Work. The CQA Consultant must approve the testing laboratory used for these tests. The CONTRACTOR is responsible for shipping materials to the testing laboratory. The initial set of testing and subsequent conformance tests (if any) shall be paid for by the CQA Consultant. If any interface doesn't meet the requirements, or if the CONTRACTOR changes geosynthetic materials, then the additional cost to qualify those materials shall be borne by the CONTRACTOR.
- B. Cap System
 - 1. Testing will include the interfaces between the following adjacent materials with a minimum peak friction angle of 26 degrees and minimum peak adhesion of 100 psf is required for each interface.

MATERIAL	SPECIFICATION SECTION
Drainage Soil	N/A
Drainage Composite	31 32 18
60 Mil HDPE (textured)	31 35 26.17
Soil Barrier	31 38 40
Ash	---

- C. Testing shall be performed in accordance with ASTM D6243. The cap system materials shall be tested at normal stressed of 500, 1,000, and 1,500 psf. Displacement rates shall be in accordance with ASTM D6243 Procedure A for geosynthetic to geosynthetic interfaces and Procedure B for soil to geosynthetic interfaces. Soil components shall be compacted to the same moisture-density requirements specified for full-scale field placement and saturated prior to shear for 24 hours. All geosynthetic interfaces shall be tested in a wet condition. Geosynthetics shall be oriented such that the shear force is parallel to the downslope orientation of these components in the field. The testing laboratory shall confirm these criteria with the CQA firm prior to performing the tests.
- D. Report results in accordance with ASTM D6243 provide complete test data, including plots of shear force versus horizontal displacement and a plot of peak shear stress versus normal stress for the tests conducted. Test results must be satisfactory for material shop drawings to be approved.

END OF SECTION

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SECTION 01 33 00

SUBMITTALS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Mechanics and administration of the submittal process for:
 - a. Shop Drawings.
 - b. Samples.
 - c. Informational submittals.
 - 2. General content requirements for Shop Drawings.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Technical Specification Sections identifying required submittals.

1.2 DEFINITIONS

- A. Action Submittals:
 - 1. Action Submittals require an explicit, written approval or other appropriate action by Engineer before Contractor may release the associated item(s) for raw materials procurement, fabrication, production, and shipment.
 - 2. Unless otherwise indicated in the Contract Documents, Action Submittals include the following:
 - a. Shop Drawings.
 - b. Product data.
 - c. Samples.
 - d. Testing plans for quality control activities required by the Contract Documents.
 - e. Delegated Designs: Design drawings, design specifications, calculations, reports, and other instruments of service sealed and signed by design professional retained by Contractor, Subcontractor, or Supplier for a portion of the completed Work as part of the completed Project. Engineer's approval or other appropriate action on such delegated design Submittals will be only for the limited purposes set forth in the General Conditions.
- B. Informational Submittals:
 - 1. Informational Submittals are Submittals, other than Action Submittals, required by the Contract Documents. Explicit response from Engineer is not required when such Submittal is acceptable and Engineer's acceptance thereof will be indicated in the Engineer's Submittals log. When Informational Submittal does not indicate full compliance with the Contract Documents, Engineer will indicate the non-compliance in a written response to Contractor.
 - 2. Representative types of informational submittal items include but are not limited to:
 - a. Concrete compressive strength and in-place moisture density soil test reports.
 - b. Installed equipment and systems performance test reports.
 - c. Manufacturer's installation instructions.
 - d. Manufacturer's installation certification letters.
 - e. Instrumentation and control commissioning reports.
 - f. Warranties.
 - g. Service agreements.
 - h. Construction photographs.
 - i. Survey data.
 - j. Work plans.

- k. Shop Drawings, product data, Samples, and testing plans, submitted as a requirement of for delegated designs, bearing the Submittal approval stamp of associated design professional retained by Contractor, Subcontractor, or Supplier.
- 3. For-Information-Only submittals upon which the Engineer is not expected to conduct review or take responsive action may be so identified in the Contract Documents.

1.3 SUBMITTAL SCHEDULE

- A. Schedule of Shop Drawings:
 - 1. Submitted and approved within 20 days of receipt of Notice to Proceed.
 - 2. Account for multiple transmittals under any specification section where partial submittals will be transmitted.
- B. Shop Drawings: Submittal and approval prior to 30 percent completion of project.
- C. Informational Submittals:
 - 1. Reports and installation certifications submitted within seven days of conducting testing, installation, or examination.
 - 2. Submittals showing compliance with required qualifications submitted 20 days prior to any work beginning using the subject qualifications.
- D. The submittal schedule shall include the following columns as a minimum:

Submittal Section	Submittal Description	Planned Submittal Date	Submittal Need Date	Actual Submittal Date	Actual Return Date	Disposition

1.4 PREPARATION OF SUBMITTALS

- A. General:
 - 1. All submittals and all pages of all copies of a submittal shall be completely legible.
 - 2. Submittals which, in the Engineer’s sole opinion, are illegible will be returned without review.
 - 3. Minimize extraneous information for equipment and products not relevant to the submittal.
 - 4. Contractors or vendors written comments on the submittal drawings shall be in green
- B. Shop Drawings, Product Data, and Samples:
 - 1. Scope of any submittal and letter of transmittal:
 - a. Limited to one Specification Section.
 - b. Submittals with more than one Specification section included will be rejected.
 - c. Do not submit under any Specification Section entitled (in part) "Basic Requirements" unless the product or material submitted is specified, in total, in a "Basic Requirements" Specification Section.
 - 2. Numbering letter of transmittal:
 - a. Include as prefix the Specification Section number followed by a series number, "-xx", beginning with "01" and increasing sequentially with each additional transmittal for that Specification Section.
 - b. If more than one submittal under any Specification Section, assign consecutive series numbers to subsequent transmittal letters.
 - 3. Describing transmittal contents:
 - a. Provide listing of each component or item in submittal capable of receiving an independent review action.
 - b. Identify for each item:
 - 1) Manufacturer and Manufacturer's Drawing or data number.
 - 2) Contract Document tag number(s).
 - 3) Unique page numbers for each page of each separate item.

- c. When submitting "or-equal" items that are not the products of named manufacturers, include the words "or-equal" in the item description.
- 4. Contractor certification of review and approval:
 - a. Contractor's review and approval certification stamp shall be applied either to the letter of transmittal or a separate sheet preceding each independent item in the submittal.
 - 1) Stamp may be either a wet ink stamp or electronically embedded.
 - 2) Clearly identify the person who reviewed the submittal and the date it was reviewed.
 - 3) Shop Drawing submittal stamp shall read "(Contractor's Name) has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval as stipulated in the General Conditions."
 - b. Submittals containing multiple independent items shall be prepared with each item listed on the letter of transmittal or on an index sheet for all items listing the discrete page numbers for each page of each item, which shall be stamped with the Contractor's review and approval stamp.
 - 1) Each independent item shall have a cover sheet with the transmittal number and item number recorded.
 - a) Provide clear space of 3 IN SQ for Engineer stamping.
 - 2) Individual pages or sheets of independent items shall be numbered in a manner that permits the entire contents of a particular item to be readily recognized and associated with Contractor's certification.
- 5. Resubmittals:
 - a. Number with original Specification Section and series number with a suffix letter starting with "A" on a (new) duplicate transmittal form.
 - b. Do not increase the scope of any prior transmittal.
 - c. Provide cover letter indicating how each "B", "C", or "D" Action from previous submittal was addressed and where the correction is found in the resubmittal.
 - d. Account for all components of prior transmittal.
 - 1) If items in prior transmittal received "A" or "B" Action code, list them and indicate "A" or "B" as appropriate.
 - a) Do not include submittal information for items listed with prior "A" or "B" Action in resubmittal.
 - 2) Indicate "Outstanding-To Be Resubmitted At a Later Date" for any prior "C" or "D" Action item not included in resubmittal.
 - a) Obtain Engineer's approval to exclude items.
- 6. For 8-1/2 x 11 IN, 8-1/2 x 14 IN, and 11 x 17 IN size sheets, provide five copies of each submittal for Engineer plus the number required by the Contractor.
 - a. The number of copies required by the Contractor will be defined at the Preconstruction Conference, but shall not exceed three.
 - b. All other size sheets:
 - 1) Submit one reproducible transparency or high resolution print and one additional print of each Drawing until approval is obtained.
 - 2) Utilize mailing tube; do not fold.
 - 3) The Engineer will mark and return the reproducible to the Contractor for reproduction and distribution.
- 7. Do not use red color for marks on transmittals.
 - a. Duplicate all marks on all copies transmitted, and ensure marks are photocopy reproducible.
 - b. Engineer will use red marks or enclose marks in a cloud.
- 8. Transmittal contents:
 - a. Coordinate and identify Shop Drawing contents so that all items can be easily verified by the Engineer.
 - b. Provide submittal information or marks defining specific equipment or materials utilized on the Project.

- 1) Generalized product information, not clearly defining specific equipment or materials to be provided, will be rejected.
 - c. Identify equipment or material project use, tag number, Drawing detail reference, weight, and other Project specific information.
 - d. Provide sufficient information together with technical cuts and technical data to allow an evaluation to be made to determine that the item submitted is in compliance with the Contract Documents.
 - e. Do not modify the manufacturer's documentation or data except as specified herein.
 - f. Submit items such as equipment brochures, cuts of fixtures, product data sheets or catalog sheets not exceeding 11 x 17 IN pages.
 - 1) Indicate exact item or model and all options proposed by arrow and leader.
 - g. When a Shop Drawing submittal is called for in any Specification Section, include as appropriate, scaled details, sizes, dimensions, performance characteristics, capacities, test data, anchoring details, installation instructions, storage and handling instructions, color charts, layout Drawings, rough-in diagrams, wiring diagrams, controls, weights and other pertinent data in addition to information specifically stipulated in the Specification Section.
 - 1) Arrange data and performance information in format similar to that provided in Contract Documents.
 - 2) Provide, at minimum, the detail specified in the Contract Documents.
 - h. If proposed equipment or materials deviate from the Contract Drawings or Specifications in any way, clearly note the deviation and justify the said deviation in detail in a separate letter immediately following transmittal sheet. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.
9. Samples:
- a. Identification:
 - 1) Identify sample as to transmittal number, manufacturer, item, use, type, project designation, tag number, Specification Section or Drawing detail reference, color, range, texture, finish and other pertinent data.
 - 2) If identifying information cannot be marked directly on sample without defacing or adversely altering samples, provide a durable tag with identifying information securely attached to the sample.
 - b. Include application specific brochures, and installation instructions.
 - c. Provide Contractor's review and approval certification stamp or Contractor's Submittal Certification form as indication of Contractor's checking and verification of dimensions and coordination with interrelated work.
 - d. Resubmit revised samples of rejected items.
- C. Informational Submittals:
- 1. Prepare in the format and detail specified in Specification requiring the informational submittal.

1.5 TRANSMITTAL OF SUBMITTALS

- A. Shop Drawings and Samples:
 - 1. Transmit all submittals to:

HDR
 17111 Preston Road
 Suite 300
 Dallas, TX 75248
 Attn: Dave Vogt

2. Utilize two copies of attached Exhibit A to transmit all Shop Drawings and samples.
 3. All submittals must be from Contractor.
 - a. Submittals will not be received from or returned to subcontractors.
- B. Informational Submittals:
1. Transmit under Contractor's standard letter of transmittal or letterhead.
 2. Submit in triplicate or as specified in individual Specification Section.
 3. Transmit to:

HDR
17111 Preston Road
Suite 300
Dallas, TX 75248
Attn: Dave Vogt
- C. Electronic Transmission of Submittals:
1. Transmittals may be made electronically.
 - a. Use email.
 - b. Transmit to david.vogt@hdrinc.com
 2. Provide documents in Adobe Acrobat Portable Document Format (PDF), latest version.
 3. Do not password protect or lock the PDF document.
 4. Drawings or other graphics must be converted to PDF file format from the original drawing file format and made part of the PDF document.
 - a. Scanning of drawings is to be used only where actual file conversion is not possible and drawings must be scanned at a resolution of 300 DPI or greater.
 - b. Required signatures may be applied prior to scanning for transmittal.
 5. Electronic drawings shall be formatted to be at full-scale (or half-scale when printed to 11x17).
 - a. Do not reduce drawings by more than 50 percent in size.
 - b. Reduced drawings shall be clearly marked "HALF-SIZE" and shall scale accurately at that size.
 6. Rotate sheets that are normally viewed in landscape mode so that when the PDF file is opened the sheet is in the appropriate position for viewing.
 7. Create bookmarks in the bookmarks panel for the cover, the Table of Contents, and each major section of the document.
 8. Using Adobe Acrobat Standard or Adobe Acrobat Professional, set the PDF document properties, initial view as follows:
 - a. Select File → Properties → Initial View.
 - b. Select the Navigation tab: Bookmarks Panel and Page.
 - c. Select the Page layout: Single Page.
 - d. Select the Magnification: Fit Page.
 - e. Select Open to page: 1.
 - f. Set the file to open to the cover page with bookmarks to the left, and the first bookmark linked to the cover page.
 9. Set the PDF file "Fast Web View" option to open the first several pages of the document while the rest of the document continues to load.
 - a. To do this:
 - 1) Select Edit → Preferences → Documents → Save Settings.
 - 2) Check the Save As optimizes for Fast Web View box.
 10. File naming conventions:
 - a. File names shall use the convention (XXXXXX-YY-Z.PDF) where XXXXXX is the Specification Section number, YY is the Shop Drawing Root number and Z is an ID number used to designate the associated volume.
 11. Labeling:
 - a. As a minimum, include the following labeling on all electronic media:

- 1) Project Name.
 - 2) Equipment Name and Project Tag Number.
 - 3) Project Specification Section.
 - 4) Manufacturer Name.
 - 5) Vendor Name.
12. Binding:
- a. Include labeled electronic media in a protective case.
 - 1) Bind protective case in three-ring binder, inserted at the front of the Final paper copy submittal.
 - 2) Protective case(s) to have means for securing electronic media to prevent loss (e.g., zip case, flap and strap, or equivalent).

1.6 ENGINEER'S REVIEW ACTION

A. Shop Drawings and Samples:

1. Items within transmittals will be reviewed for overall design intent and will receive one of the following actions:
 - a. A - FURNISH AS SUBMITTED.
 - b. B - FURNISH AS NOTED (BY ENGINEER).
 - c. C - REVISE AND RESUBMIT.
 - d. D - REJECTED.
 - e. E - ENGINEER'S REVIEW NOT REQUIRED.
2. Submittals received will be initially reviewed to ascertain inclusion of Contractor's approval stamp.
 - a. Submittals not stamped by the Contractor or stamped with a stamp containing language other than that specified herein will not be reviewed for technical content and will be returned rejected.
3. In relying on the representation on the Contractor's review and approval stamp, Owner and Engineer reserve the right to review and process poorly organized and poorly described submittals as follows:
 - a. Submittals transmitted with a description identifying a single item and found to contain multiple independent items:
 - 1) Review and approval will be limited to the single item described on the transmittal letter.
 - 2) Other items identified in the submittal will:
 - a) Not be logged as received by the Engineer.
 - b) Be removed from the submittal package and returned without review and comment to the Contractor for coordination, description and stamping.
 - c) Be submitted by the Contractor as a new series number, not as a re-submittal number.
 - b. Engineer, at Engineer's discretion, may revise the transmittal letter item list and descriptions, and conduct review.
 - 1) Unless Contractor notifies Engineer in writing that the Engineer's revision of the transmittal letter item list and descriptions was in error, Contractor's review and approval stamp will be deemed to have applied to the entire contents of the submittal package.
4. Submittals returned with Action "A" or "B" are considered ready for fabrication and installation.
 - a. If for any reason a submittal that has an "A" or "B" Action is resubmitted, it must be accompanied by a letter defining the changes that have been made and the reason for the resubmittal.
 - b. Destroy or conspicuously mark "SUPERSEDED" all documents having previously received "A" or "B" Action that are superseded by a resubmittal.
5. Submittals with Action "A" or "B" combined with Action "C" (Revise and Resubmit) or "D" (Rejected) will be individually analyzed giving consideration as follows:

- a. The portion of the submittal given "C" or "D" will not be distributed (unless previously agreed to otherwise at the Preconstruction Conference).
 - 1) One copy or the one transparency of the "C" or "D" Drawings will be marked up and returned to the Contractor.
 - a) Correct and resubmit items so marked.
- b. Items marked "A" or "B" will be fully distributed.
- c. If a portion of the items or system proposed are acceptable, however, the major part of the individual Drawings or documents are incomplete or require revision, the entire submittal may be given "C" or "D" Action.
 - 1) This is at the sole discretion of the Engineer.
 - 2) In this case, some Drawings may contain relatively few or no comments or the statement, "Resubmit to maintain a complete package."
 - 3) Distribution to the Owner and field will not be made (unless previously agreed to otherwise).
6. Failure to include any specific information specified under the submittal paragraphs of the Specifications will result in the submittal being returned to the Contractor with "C" or "D" Action.
7. Calculations required in individual Specification Sections will be received for information purposes only, as evidence calculations have been stamped by the professional as defined in the specifications and for limited purpose of checking conformance with given performance and design criteria. The Engineer is not responsible for checking the accuracy of the calculations and the calculations will be returned stamped "E. Engineer's Review Not Required" to acknowledge receipt.
8. Furnish required submittals with sufficient information and accuracy to obtain required approval of an item with no more than three submittals. Engineer will record Engineer's time for reviewing a fourth or subsequent submittal of a Shop Drawings, sample, or other item requiring approval, and Contractor shall be responsible for Engineer's charges to Owner for such time. Owner may impose a set-off against payments due to Contractor to secure reimbursement for such charges.
9. Transmittals of submittals which the Engineer considers as "Not Required" submittal information, which is supplemental to but not essential to prior submitted information, or items of information in a transmittal which have been reviewed and received "A" or "B" action in a prior submittal, will be returned with action "E. Engineer's Review Not Required."
10. Samples may be retained for comparison purposes.
 - a. Remove samples when directed.
 - b. Include in bid all costs of furnishing and removing samples.
11. Approved samples submitted or constructed, constitute criteria for judging completed work.
 - a. Finished work or items not equal to samples will be rejected.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION

EXHIBIT A Shop Drawing Transmittal No.

(Spec Section) (Series)

Project Name:		Date Received:
Project Owner:		Checked By:
Contractor:	HDR Engineering, Inc.	Log Page:
Address:	Address:	HDR No.:
		Spec Section:
		Drawing/Detail No.:
Attn:	Attn:	1st. Sub ReSub.
Date Transmitted:	Previous Transmittal Date:	

Item No.	No. Copies	Description	Manufacturer	Mfr/Vendor Dwg or Data No.	Action Taken*

Remarks:

* The Action designated above is in accordance with the following legend:

<p>A - Furnish as Submitted</p> <p>B - Furnish as Noted</p> <p>C - Revise and Submit</p> <ol style="list-style-type: none"> 1. Not enough information for review. 2. No reproducibles submitted. 3. Copies illegible. 4. Not enough copies submitted. 5. Wrong sequence number. 6. Wrong resubmittal number. 7. Wrong spec. section. 8. Wrong form used. 9. See comments. <p>D - Rejected</p>	<p>E - Engineer's review not required</p> <ol style="list-style-type: none"> 1. Submittal not required. 2. Supplemental Information. Submittal retained for informational purposes only. 3. Information reviewed and approved on prior submittal. 4. See comments. <p>Engineer's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. Any deviation from plans or specifications not depicted in the submittal or included but not clearly noted by the Contractor may not have been reviewed. Review by the Engineer shall not serve to relieve the Contractor of the contractual responsibility for any error or deviation from contract requirements.</p>
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Comments:

	By		Date	
--	----	--	------	--

Distribution: Contractor | File | Field | Owner | Other |

Contractor's Submittal Certification

Shop Drawing Transmittal No.:

Contract/Project Name:

Company Name:

has

1. reviewed and coordinated this Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents;
2. determined and verified all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;
3. determined and verified the suitability of all materials offered with respect to the indicated application, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work; and
4. determined and verified all information relative to Contractor's responsibilities for means, methods, techniques, sequences, and procedures of construction, and safety precautions and programs incident thereto.

This Submittal **does not** contain any variations from the requirements of the Contract Documents.

This Submittal **does** contain variations from the requirements of the Contract Documents. A separate description of said variations and a justification for them is provided in an attachment hereto identified as:

"Shop Drawing Transmittal No. _____ Variation and Justification Documentation"

Insert picture file or electronic signature of Authorized Representative

Authorized Representative

Date

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SECTION 01 35 05
ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Minimizing the pollution of air, water, or land; control of noise, the disposal of solid waste materials, and protection of deposits of historical or archaeological interest.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Prior to the start of any construction activities submit:
 - a. A detailed proposal of all methods of control and preventive measures to be utilized for environmental protection.
 - b. A drawing of the work area, haul routes, storage areas, access routes and current land conditions including trees and vegetation.
 - c. A copy of the NPDES permit for storm water discharges from construction activities.
 - d. A copy of the approved pollution prevention plan.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Employ and utilize environmental protection methods, obtain all necessary permits, and fully observe all local, state, and federal regulations.
- B. Land Protection:
 - 1. Except for any work or storage area and access routes specifically assigned for the use of the Contractor, the land areas outside the limits of construction shall be preserved in their present condition.
 - a. Confine construction activities to areas defined for work within the Contract Documents.
 - 2. Manage and control all borrow areas, work or storage areas, access routes and embankments to prevent sediment from entering nearby water or land adjacent to the work site.
 - 3. Restore all disturbed areas including borrow and haul areas and establish permanent type of locally adaptable vegetative cover.
 - 4. Unless earthwork is immediately paved or surfaced, protect all side slopes and backslopes immediately upon completion of final grading.
 - 5. Plan and execute earthwork in a manner to minimize duration of exposure of unprotected soils.
 - 6. Except for areas designated by the Contract Documents to be cleared and grubbed, do not deface, injure or destroy trees and vegetation, nor remove, cut, or disturb them without approval of the Engineer.

- a. Any damage caused by the Contractor's equipment or operations shall be restored as nearly as possible to its original condition at no additional cost to the Owner.
- C. Surface Water Protection:
1. Prepare pollution prevention plan.
 2. Utilize, as necessary, erosion control methods to protect side and backslopes, minimize and the discharge of sediment to the surface water leaving the construction site as soon as rough grading is complete.
 - a. These controls shall be maintained until the site is ready for final grading and landscaping or until they are no longer warranted and concurrence is received from the Engineer.
 - b. Physically retard the rate and volume of run-on and runoff by:
 - 1) Implementing structural practices such as diversion swales, terraces, straw bales, silt fences, berms, storm drain inlet protection, rockered outlet protection, sediment traps and temporary basins.
 - 2) Implementing vegetative practices such as temporary seeding, permanent seeding, mulching, sod stabilization, vegetative buffers, hydroseeding, anchored erosion control blankets, sodding, vegetated swales or a combination of these methods.
 - 3) Providing Construction sites with graveled or rockered access entrance and exit drives and parking areas to reduce the tracking of sediment onto public or private roads.
 3. Discharges from the construction site shall not contain pollutants at concentrations that produce objectionable films, colors, turbidity, deposits or noxious odors in the receiving stream or waterway.
- D. Solid Waste Disposal:
1. Collect solid waste on a daily basis.
 2. Provide disposal of degradable solid waste to an approved solid waste disposal site.
 3. Provide disposal of nondegradable solid waste to an approved solid waste disposal site or in an alternate manner approved by Engineer and regulatory agencies.
 4. No building materials wastes or unused building materials shall be buried, dumped, or disposed of on the site.
- E. CCR Waste Disposal
1. Dispose CCR waste at the Site F Landfill's Active Waste Disposal Area at a location pre-approved by the Owner.
- F. Fuel and Chemical Handling:
1. Store and dispose of chemical wastes in a manner approved by regulatory agencies.
 2. Take special measures to prevent chemicals, fuels, oils, greases, herbicides, and insecticides from entering drainage ways.
 3. Do not allow water used in onsite material processing, concrete curing, cleanup, and other waste waters to enter a drainage way(s) or stream.
 4. Provide containment around fueling and chemical storage areas to ensure that spills in these areas do not reach waters of the state.
- G. Control of Dust:
1. The control of dust shall mean that no construction activity shall take place without applying all such reasonable measures as may be required to prevent particulate matter from becoming airborne so that it remains visible beyond the limits of construction.
 2. Utilize methods and practices of construction to eliminate dust in full observance of agency regulations.
 3. The Engineer will determine the effectiveness of the dust control program and may request the Contractor to provide additional measures, at no additional cost to Owner.
- H. Burning:
1. Do not burn material on the site without Owner's approval.

2. If the Contractor elects to dispose of waste materials by burning, make arrangements with Owner for an approved burning area and conform to all local and agency notification requirements and regulations.
- I. Control of Noise:
 1. Control noise by fitting equipment with appropriate mufflers.
 - J. Completion of Work:
 1. Upon completion of work, leave area in a clean, natural looking condition.
 2. Ensure all signs of temporary construction and activities incidental to construction of required permanent work are removed.
 3. Grade, fill and seed all disturbed areas.

END OF SECTION

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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish labor, materials, tools, equipment, and services for Construction Facilities, Temporary Controls and Utilities, as indicated, in accordance with provisions of Contract Documents.
- B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

- A. Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to following:
 - 1. NFPA 241 Standard for Safeguarding Construction, Alteration, and Demolition Operations.
 - 2. International Building Code, Chapter 33, Safeguards During Construction.
 - 3. Local building codes.
 - 4. Health and safety regulations.
 - 5. Utility company regulations.
 - 6. Police, fire and rescue rules.
 - 7. Environmental protection regulations.
 - 8. Local agencies requirements and regulations.
- B. Maintain required exits, existing structural elements, fire protection devices and sanitary safeguards during remodeling, alterations, repairs or additions to any building or structure, except; make adequate substitute provisions when such required elements or devices are being remodeled, altered or repaired, or when existing building is not occupied.
- C. Arrange for authorities having jurisdiction to inspect and test each temporary utility before use.
- D. Obtain certifications, permits for temporary utilities, fees, labor and materials for necessary services.
- E. Locate facilities to serve Project adequately and result in minimum interference with performance of Work.
- F. Relocate and modify facilities as required.

1.3 TEMPORARY UTILITIES - GENERAL

- A. Provide fees, labor, and materials, including temporary equipment and connection thereof, required to provide temporary utility services necessary for maintaining existing services and for execution of Work, and tests required in various sections of Specifications at Contractor's expense, except where otherwise specified.
- B. Maintain temporary services and facilities clean and neat in appearance, including those furnished or provided by Owner for Contractor's use.
- C. Coordinate with Owner to relocate temporary services and facilities as Work progresses.
- D. Do not overload facilities or permit them to interfere with progress.
- E. Take necessary fire prevention measures.
- F. Preclude hazardous, dangerous, or unsanitary conditions, or public nuisances to develop or persist on site.
- G. Prepare schedule indicating dates for implementation, shut downs, tie-ins and termination of each temporary utility and coordinate with Owner.

- H. At earliest possible time, when acceptable to Owner, change over from use of temporary service to use of permanent service.
- I. Remove temporary equipment and connections, and leave premises and existing permanent apparatus in an equivalent condition as existed prior to making temporary connections.
 - 1. Service utility connections shall be discontinued and capped in accordance with the approved rules and the requirements of the authority having jurisdiction.
 - 2. At completion of Work, remove and replace damaged parts of permanent systems.
- J. Extend warranty or guarantee period on permanent systems used during construction period so they commence on date of Substantial Completion.

1.4 TEMPORARY ELECTRICITY AND LIGHTING

- A. Provide equipment, poles, meter, wiring, switches, outlets, to provide 480V, 3 phase power and necessary step down transformers for 208V and 120V power for construction lighting and power requirements.
 - 1. Provide generator if no electrical service to site.
 - 2. Permanent building power distribution system may be used with Owner approval.
 - 3. Remove temporary electrical equipment when no longer needed.
- B. Provide adequate lighting with local switching for safe access and egress, security, and for providing adequate illumination for construction operations.
 - 1. Turn off lighting in areas at end of work day to conserve energy.
 - 2. Re-lamp permanent light fixtures used during construction with new lamps at Substantial Completion.
- C. Temporary electrical power used will be paid for by Contractor until Substantial Completion.
- D. Provide own extension cords and electrical safety devices.
- E. Provide any additional electrical power required for installer's operation, exceeding available power.

1.5 TEMPORARY WATER

- A. Make arrangements; provide equipment, piping, and outlets for an adequate supply of clean water for construction purposes.
 - 1. Existing water distribution system may be used for temporary service.
 - 2. Provide temporary meters and pay costs of installation and use.
 - 3. Provide pressure backflow preventer at each connection.
 - 4. Disinfect temporary piping before use.
- B. Contractor is responsible to pay for water used until Substantial Completion.
- C. Furnish drinking water for those connected with the Work.

1.6 TEMPORARY SANITARY FACILITIES

- A. Provide temporary sanitary facilities for use of construction workers during construction, remodeling or demolition activities.
- B. Do not use existing toilet facilities in occupied areas or new toilet facilities in construction area without Owner's written consent.
- C. Provide facilities complying with local, State and Federal sanitary laws and regulations.
- D. Maintain and service in clean and sanitary condition.
- E. Provide adequate supplies of toilet paper, cleaning and other required items.

1.7 CONTRACTOR'S FIELD OFFICE (OPTIONAL)

- A. Provide field office for Contractor's use.

- B. Telephone, Internet, and Copier:
 - 1. Provide telephones, answering machine telephone service in field office.
 - 2. Provide broadband service with wireless internet connection for use by Owner and Architect.
 - 3. Provide commercial grade photocopy machine with document scanning capability.
 - 4. Contractor pay service and use charges.

1.8 PROTECTION OF ADJOINING PROPERTY

- A. Protect adjoining public and private property from damage during construction, remodeling and demolition work.
 - 1. Protect footings, foundations, party walls, chimneys, skylights and roofs.
 - 2. Control water runoff and erosion during construction or demolition activities.
 - 3. Provide written notice to owners of adjoining properties advising of construction plans and excavations to be undertaken 10 days prior to the scheduled date of excavation.
 - 4. Minimize noise in construction operation, employing reasonable noise control measures during operations, in accordance with local ordinances or safety and health regulations.

1.9 TEMPORARY STORAGE AND STAGING AREAS

- A. Store and place construction equipment and materials so as not to endanger public, workers or adjoining property for duration of Project.
- B. Comply with provisions of authority having jurisdiction for temporary use of streets or public property for storage or handling of materials or of equipment required for construction or demolition, and the protection provided to the public.
- C. Construction materials and equipment shall not be placed or stored so as to obstruct access to fire hydrants, standpipes, fire or police alarm boxes, catch basins or manholes, nor shall such material or equipment be located within 20 FT of a street intersection, or placed so as to obstruct normal observations of traffic signals or to hinder the use of public transit loading platforms.
- D. Building materials, fences, sheds or obstruction of any kind shall not be placed so as to obstruct free approach to any fire hydrant, fire department connection, utility pole, manhole, fire alarm box or catch basin, or so as to interfere with the passage of water in gutter. Protection against damage shall be provided to such utility fixtures during the progress of Work, but sight of them shall not be obstructed.
- E. Prior to start of Work, meet with installers to arrange and prepare plot plan defining staging, storage, field office and traffic areas.
 - 1. Obtain Owner's approval of plan.
 - 2. Except as specifically provided, working and storing outside these areas will not be permitted.
 - 3. Arrange and locate temporary structures and storage to avoid interfering with construction.
- F. Within area designated for Contractor and Subcontractor's use, Contractor and Subcontractors provide suitable and sufficient enclosed and covered spaces, with raised flooring, to protect materials and equipment from damage by weather or construction work.
 - 1. Maintain storage and working areas in clean and orderly condition.

1.10 TEMPORARY FIRE EXTINGUISHERS

- A. Structures under construction, alteration or demolition shall be provided with not less than one approved portable fire extinguisher and sized for not less than ordinary hazard as follows:
 - 1. At each storage, construction shed and temporary construction office.
 - 2. Provide additional portable fire extinguishers where special hazards exist, such as storage and use of flammable and combustible liquids.
- B. Strictly observe provisions of codes to safeguard against fire hazards attendant upon construction operations.

1.11 TEMPORARY FENCES AND BARRICADES

- A. Furnish, install and maintain temporary fences, barricades, trench and hole covers, warning lights and safety devices necessary to prevent injury to persons and damage to property.
 - 1. Provide padlocks manufactured by Knox keyed to the Fire Department keying system to the construction areas.
 - 2. Provide 24 FT wide gates to facilitate Fire Department access.
 - 3. Fire Department apparatus shall be able to turn into construction site in one turn.
- B. Contractor is responsible to design construction barricades and fences with proper sizes of members and with adequate supports to protect public from injuries or accidents, arising from construction Work.

1.12 TEMPORARY ACCESS

- A. Contractor's access to construction area will be permitted only through designated approaches in such a manner that traffic will not interfere with Owner's activities.

1.13 TEMPORARY PROTECTION

- A. Protect Work in progress and adjoining materials in place, during handling and installation.
- B. Supervise construction operation to assure that Work, completed or in progress, is not subject to harmful, dangerous, damaging or otherwise harmful exposure throughout construction period.
 - 1. Prevent accumulation of water on site:
 - a. Remove standing water.
 - b. Pump or direct away from site and adjoining property.
 - 2. Prevent accumulation of water on slabs, adjacent to building or foundations, or in utility trenches.
 - 3. Prevent damage to structural members.
- C. Apply protective covering to assure protection of Work from damage or deterioration.
 - 1. Remove coverings at Substantial Completion.
- D. Adjust, lubricate and maintain operable components to assure operability without damaging effects throughout construction period.

1.14 SECURITY

- A. Provide security and facilities to protect Work and existing facilities and Owner's operations from unauthorized entry, vandalism or theft.
- B. Coordinate with Owner's security program..

1.15 TEMPORARY ACCESS ROADS

- A. Provide access on construction site as required to perform Work.
- B. Maintain construction site access roads free of obstruction.
- C. Clean up debris, materials, etc., that falls from vehicles in route to and from site.
- D. Do not block access to Owner's facilities.
- E. When this access is no longer required, restore to its original condition.
- F. Provide means of removing mud from vehicle wheels before leaving site and entering public streets or Owner's roads.

1.16 TEMPORARY PARKING

- A. Contractor Parking will be at the areas designated by Owner.
- B. Provide transportation for Contractor's employees from parking area to job site.

1.17 TRAFFIC CONTROL

- A. Provide traffic control necessary to effect smooth Owner operations.
- B. Provide and maintain adequate traffic control and flagmen's services at points where transporting of equipment and materials engaged on Work, enters and exits from Project site and on site.

1.18 WASTE MANAGEMENT FACILITIES

- A. Maintain facilities for separate collection of construction wastes and materials.

1.19 COMPLETION OF WORK

- A. Upon completion of Work or as progress of work dictates or sooner if directed by Owner or Architect, remove temporary facilities, and return improvements on or about site and adjacent property which are not shown to be altered, removed or otherwise changed; to condition which existed previous to starting Work.

END OF SECTION

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SECTION 01 65 50
PRODUCT DELIVERY, STORAGE, AND HANDLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Scheduling of product delivery.
 - 2. Packaging of products for delivery.
 - 3. Protection of products against damage from:
 - a. Handling.
 - b. Exposure to elements or harsh environments.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
- C. Payment:
 - 1. No payment will be made to Contractor for equipment or materials not properly stored and insured or without approved Shop Drawings.
 - a. Previous payments for items will be deducted from subsequent progress estimate(s) if proper storage procedures are not observed.

1.2 DELIVERY

- A. Scheduling: Schedule delivery of products or equipment as required to allow timely installation and to avoid prolonged storage.
- B. Packaging: Deliver products or equipment in manufacturer's original unbroken cartons or other containers designed and constructed to protect the contents from physical or environmental damage.
- C. Identification: Clearly and fully mark and identify as to manufacturer, item, and installation location.
- D. Protection and Handling: Provide manufacturer's instructions for storage and handling.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PROTECTION, STORAGE AND HANDLING

- A. Manufacturer's Instruction:
 - 1. Protect all products or equipment in accordance with manufacturer's written directions.
 - a. Store products or equipment in location to avoid physical damage to items while in storage.
 - b. Handle products or equipment in accordance with manufacturer's recommendations and instructions.
 - 2. Protect equipment from exposure to elements and keep thoroughly dry.
 - 3. When space heaters are provided in equipment, connect and operate heaters during storage until equipment is placed in service.

3.2 FIELD QUALITY CONTROL

- A. Inspect Deliveries:
 - 1. Inspect all products or equipment delivered to the site prior to unloading.

- a. Reject all products or equipment that are damaged, used, or in any other way unsatisfactory for use on Project.
- B. Monitor Storage Area: Monitor storage area to ensure suitable temperature and moisture conditions are maintained as required by manufacturer or as appropriate for particular items.

END OF SECTION

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SECTION 31 10 00 SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Site clearing, tree protection, stripping topsoil and demolition.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.
 - 4. Section 31 25 00 - Soil Erosion and Sediment Control.
 - 5. Section 32 91 13 - Topsoiling and Finished Grading.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect existing trees and other vegetation to remain against damage.
 - 1. Do not smother trees by stockpiling construction materials or excavated materials within drip line.
 - 2. Avoid foot or vehicular traffic or parking of vehicles within drip line.
 - 3. Provide temporary protection as required.
- B. Repair or replace trees and vegetation damaged by construction operations.
 - 1. Repair to be performed by a qualified tree surgeon/licensed arborist.
 - 2. Remove trees which cannot be repaired and restored to full-growth status.
 - 3. Replace with new trees of minimum 4 IN caliper or as required by local tree ordinance.
- C. Owner will obtain authority for removal and alteration work on adjoining property, as applicable.

3.2 SITE CLEARING

- A. Topsoil Removal:
 - 1. Strip topsoil to depths encountered or as specified within the soils report, 4 IN minimum.
 - a. Remove heavy growths of grass before stripping.
 - b. Stop topsoil stripping sufficient distance from such trees to prevent damage to main root system.
 - c. Separate from underlying subsoil or objectionable material.
 - 2. Stockpile topsoil where directed by Engineer.
 - a. Construct storage piles to freely drain surface water.
 - b. Seed or cover storage piles to prevent erosion.
 - 3. Do not strip topsoil in wooded areas where no change in grade occurs.
 - 4. Borrow topsoil: Reasonably free of subsoil, objects over 2 IN DIA, weeds and roots.
- B. Clearing and Grubbing:
 - 1. Clear from within limits of construction all trees not marked to remain.
 - a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.

2. Grub (remove) from within limits of construction all stumps, roots, root mats, logs and debris encountered.
- C. Disposal of Waste Materials:
1. Do not burn combustible materials on site without Owner's approval.
 2. Remove all waste materials from site.
 3. Do not bury organic matter on site.

END OF SECTION

SECTION 31 23 00

EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Earthwork - excavation, backfilling, grading, compaction, disposal of waste and surplus materials, placing crushed stone, construction of berms, sheeting, bracing, dewatering and other Earthwork related work.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 33 - Trenching, Backfilling and Compacting for Utilities.
 - 4. Section 31 25 00 - Soil Erosion and Sediment Control.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. C33/C33M, Standard Specification for Concrete Aggregates.
 - b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³).
 - c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT³(2,700 kN-M/M³)).
 - d. D1586, Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils.
 - e. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - f. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
 - g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - h. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
 - i. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - 2. Occupational Safety and Health Administration (OSHA):
 - a. 29 CFR Part 1926.650, Safety and Health Regulations for Construction - Excavations, referred to herein as OSHA Standards.

1.3 DEFINITIONS

- A. Excavation:
 - 1. Consists of removal of material encountered to subgrade elevations required or indicated.
 - 2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.
- B. Geotechnical Engineer: JBS Engineering and Environmental, Inc., an independent geotechnical specialist providing field quality control for the project.
- C. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.
- D. Subgrade: The earth or soil layer immediately below the compacted clay barrier, foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

- E. Unauthorized Excavation:
 - 1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Engineer.
 - a. Unauthorized excavation, as well as associated remedial work as directed by Engineer or Geotechnical Engineer, shall be at Contractor's expense.
 - 2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.
- F. CCR Material:
 - 1. Material derived from the combustion of coal to generate power. This material is typically fly ash, bottom ash, economizer ash, scrubber sludge, and other by products of combustion.
 - 2. This material is considered as waste material. Care must be taken to prevent comingling of soils material used for subgrade material, clay barrier material, infiltration layer material, or topsoil with CCR material. CCR comingled soils material will be considered as waste and shall be disposed of in the landfill.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Certifications.
- B. Samples:
 - 1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.
 - 2. Test reports.

1.5 PROJECT CONDITIONS

- A. Salvageable Items: Carefully remove items to be salvaged, and store on Owner's premises unless otherwise directed.
- B. Disposal of permitted waste materials shall be at the Site F Landfill. Dispose non-permitted waste materials, legally, off site.
 - 1. Burning, as a means of waste disposal, is not permitted without Owner's permission.
- C. Site Information:
 - 1. Data in subsurface investigation reports was used for the basis of the design.
 - a. Conditions are not intended as representations or warranties of accuracy or continuity between soil borings.
 - b. The Owner or Engineer will not be responsible for interpretations or conclusions drawn from this data by Contractor.
 - 2. Additional test borings and other exploratory operations may be performed by Contractor, at the Contractor's option; however, no change in the Contract Sum will be authorized for such additional exploration.
 - 3. Site data provided is not contractual and shall be considered "for information only."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fill and Backfill:
 - 1. Selected material approved by Geotechnical Engineer from site excavation or from off site borrow.

2. Structural Fill:
 - a. May be low volume change cohesive or granular soil at Contractor's option.
 - b. Free of organic matter, frozen material and debris.
 - c. Low volume change cohesive soil:
 - 1) ASTM D2487 classification: CL-ML or CL.
 - 2) Liquid limit: Less than 45.
 - 3) Maximum plasticity index: 20.
 - d. Granular soil:
 - 1) ASTM D2487 classification: GW, GP, GM, GC, SW, SP, SM or SC.
 3. Non-Structural Fill:
 - a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
 - b. Liquid limit: Less than 45.
 - c. Maximum plasticity index: 20.
- B. Granular Fill Under Equipment Pads (i.e., water treatment or evaporation):
1. Per equipment manufacturer's recommendation.
 2. Absent recommendation, provide:
 - a. Clean, granular material.
 - b. Less than 5 PCT fines passing the No. 200 sieve.
 - c. ASTM C33/C33M gradation size No. 67, 3/4 IN to No. 4 or other material acceptable to Geotechnical Engineer.
- C. Drainage Course: Free draining stone such as #57 stone or #67 stone meeting the requirements of ASTM C33/C33M specifications.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Erosion Control:
1. See Specification Section 31 25 00.
 2. Clean paved roadways daily of any spillage of dirt, rocks or debris from vehicles and equipment entering or leaving site.
 3. Conduct work to minimize erosion of site. Remove eroded material washed off site.
 - a. If necessary or requested by Engineer, construct stilling areas to settle and detain eroded material.
- B. Protect existing surface and subsurface features on-site and adjacent to site as follows:
1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
 2. Protect and maintain bench marks, monuments or other established reference points and property corners.
 - a. If disturbed or destroyed, replace at own expense to full satisfaction of Owner and controlling agency.
 3. Verify location of utilities, toe drains, and leachate collection lines.
 - a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
 - b. Secure and examine local utility records for location data.
 - c. Take necessary precautions to protect existing utilities from damage due to any construction activity.
 - 1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
 - 2) Do not interrupt existing utilities serving facilities occupied by Owner or others, during occupied hours, except when permitted in writing by Owner and then only after acceptable temporary utility services have been provided.
 - 3) Obtain Owner's approval prior to disconnecting any utility service.
 - d. Repair damages to utility items at own expense.

- e. In case of damage, notify Engineer at once so required protective measures may be taken.
- 4. Maintain free of damage, existing sidewalks, structures, and pavement, not indicated to be removed.
 - a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
 - b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
 - c. All repairs to be made and paid for by Contractor.
- 5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
- 6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
- 7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.

3.2 SITE EXCAVATION AND GRADING

- A. The site excavation and grading work includes the onsite disposal or offsite disposition of all material:
 - 1. That exceed quantities required for earthwork on the project.
 - 2. That the Geotechnical engineer classifies as unclassified excavation.
 - 3. That the Geotechnical engineer classifies as unacceptable.
 - 4. That the Geotechnical engineer classifies as potentially contaminated.
- B. Excavation and Grading:
 - 1. Perform as required by the Contract Drawings.
 - 2. Contract Drawings may indicate both existing grade and finished grade required for construction of Project.
 - a. Stake all units, structures, piping, and roads and establish their elevations.
 - b. Perform other layout work required.
 - c. Replace property corner markers to original location if disturbed or destroyed.
 - 3. Preparation of ground surface for embankments or fills:
 - a. Before fill is started, scarify to a minimum depth of 6 IN in all proposed embankment and fill areas.
 - b. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface.
 - 4. Protection of finish grade:
 - a. During construction, shape and drain embankment and excavations.
 - b. Maintain ditches and drains to provide drainage at all times.
 - c. Protect graded areas against action of elements prior to acceptance of work.
 - d. Reestablish grade where settlement or erosion occurs.
- C. Borrow:
 - 1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
 - 2. Fill material to be approved by Geotechnical Engineer prior to placement.
- D. Construct embankments and fills as required by the Contract Drawings:
 - 1. Construct embankments and fills at locations and to lines of grade indicated.
 - a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
 - 2. Provide approved fill material which is free from roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
 - a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.

- b. Do not place material in layers greater than 8 IN loose thickness.
- c. Place layers horizontally and compact each layer prior to placing additional fill.
- 3. Compact soils as required to obtain specified density. Selection of appropriate equipment is the Contractor's responsibility.
 - a. In general, compact cohesive soils by sheepsfoot, and granular soils by pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
 - b. Control moisture for each layer necessary to meet requirements of compaction.

E. Grading Tolerances: 0.1 FT.

3.3 USE OF EXPLOSIVES

A. Blasting with any type of explosive is prohibited.

3.4 COMPACTION DENSITY REQUIREMENTS

- A. Obtain approval from Geotechnical Engineer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.
- B. Provide dewatering system necessary to successfully complete compaction and construction requirements.
- C. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Geotechnical Engineer.
- D. Stabilize subgrade with well graded granular materials as directed by Geotechnical Engineer.
- E. Assure by results of testing that compaction densities comply with the following requirements:
 - 1. Sitework:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under Piping:		
Cohesive soils	95 PCT per ASTM D698	-2 to +3 PCT of optimum
Cohesionless soils	75 PCT relative density per ASTM D4253 and ASTM D4254	
Unpaved Areas:		
Cohesive soils	90 PCT of ASTM D698	-2 to +3 PCT of optimum
Cohesionless soils	65 PCT relative density per ASTM D4253 and ASTM D4254	

2. Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under equipment support pads and scarified existing subgrade under fill material	98 PCT per ASTM D698	-2 to +3 PCT of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	92 PCT per ASTM D698	-2 to +3 PCT of optimum

3. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Subgrade, Infiltration Layer and Topsoil	95 PCT per ASTM D698	-2 to +3 PCT of optimum
CCR Material	Smooth Rolled and without unstable or soft spots as determined by geotechnical inspector.	

3.5 EXCAVATION, FILLING, AND BACKFILLING

A. General:

1. In general, work includes, but is not necessarily limited to, excavation, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
2. Obtain fill and backfill material necessary to produce grades required.
 - a. Materials and source to be approved by Geotechnical Engineer.
 - b. Excavated material approved by Geotechnical Engineer may also be used for fill and backfill.
3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements:

1. General:
 - a. Do not commence excavation for landfill cap until Geotechnical Engineer approves:
 - 1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
 - 2) Density and moisture content of site area compacted fill material meets requirements of specifications.
 - 3) Site surcharge or mass fill material can be removed from entire construction site or portion thereof.
 - 4) Surcharge or mass fill material has been removed from construction area or portions thereof.
 - b. Engineer grants approval to begin excavations.
2. Dimensions:
 - a. Excavate to elevations and dimensions indicated or specified.
 - b. Allow additional space as required for construction operations and inspection.
 - c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
 - d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, CCR material, industrial waste, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Contract Drawings.
 - a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Geotechnical Engineer.
 - b. When excavation has reached required subgrade elevations, notify Geotechnical Engineer, who will make an inspection of conditions.
4. Proof-roll all subgrades to receive fill after subgrade has been scarified and compacted.
5. Level off bottoms of excavations to receive equipment support pads or compacted fill.
 - a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.

- b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 6 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
 - c. Do not carry excavations lower than shown for foundations except as directed by Geotechnical Engineer or Engineer.
 - d. If any part of excavations is carried below required depth without authorization, notify Engineer and correct unauthorized excavation as directed. Corrections may include:
 - 1) Backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Geotechnical Engineer.
 - 2) No extra compensation will be made to Contractor for correcting unauthorized excavations.
6. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
7. Notify Geotechnical Engineer and Engineer as soon as excavation is completed in order that subgrades may be inspected.
- a. Do not commence further construction until subgrade under compacted clay barrier or geomembrane has been inspected and approved by the Geotechnical Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the landfill cap system.
 - b. Contractor shall certify in writing the geomembrane's subgrade meets the manufacturer's requirements prior to geomembrane installation.
 - c. Geotechnical Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
 - d. Before compacted clay barrier material or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
8. Dewatering:
- a. Where groundwater is or is expected to be encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade to allow fill material to be placed in the dry and to maintain a stable excavation side slope.
 - b. Groundwater shall be maintained at least 3 FT below the bottom of any excavation.
 - c. Review Geotechnical investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
 - d. Employ dewatering specialist for selecting and operating dewatering system.
 - e. Keep dewatering system in operation until dead load of final cap system exceeds possible buoyant uplift force on the system.
 - f. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
 - 1) Install groundwater monitoring wells as necessary.
 - g. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.
9. Subgrade stabilization:
- a. If subgrade under foundations, fill material, compacted clay barrier, geomembrane, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Geotechnical Engineer.
 - b. Provide compaction density of replacement material as stated in this Specification Section.
 - c. Loose, wet, or soft materials, when approved by Geotechnical Engineer, may be stabilized by a compacted working mat of well graded crushed stone.
 - d. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.
 - e. Remove and replace frozen materials as directed by Geotechnical Engineer.

- f. Method of stabilization shall be performed as directed by Geotechnical Engineer.
 - g. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Geotechnical Engineer.
10. Protection of structures:
- a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.
 - b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
11. Shoring:
- a. Shore, slope, or brace excavations as required to prevent them from collapsing.
 - b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
 - c. Construct shoring that is required to retain water as part of the dewatering system, using non-permeable details such as interlock sealant for sheet piles.
12. Drainage:
- a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
 - b. Maintain excavations where equipment support pads or fill material are to be placed free of water.
 - c. Provide pumping required to keep excavated spaces clear of water during construction.
 - d. Should any water be encountered in the excavation, notify Engineer and Geotechnical Engineer.
 - e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.
13. Frost protection:
- a. Do not place equipment support pads or fill material on frozen ground.
 - b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless equipment support pads or fill material can be placed immediately after excavation has been completed and approved.
 - c. Protect excavation from frost if placing of concrete or fill is delayed.
 - d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Owner.
 - e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DEGF.
- C. Fill and Backfill Inside of Structure and Below Foundations, Equipment Support Pads and Piping:
1. General:
- a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Geotechnical Engineer and scarified to a depth of 6 IN and compacted to density specified herein.
 - b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2 PCT.
 - c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Geotechnical Engineer as being free of undesirable material and compacted to specified density.
2. Obtain approval of fill and backfill material and source from Geotechnical Engineer prior to placing the material.
3. Fill and backfill placement:
- a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Geotechnical Engineer.
 - b. Place fill and backfill material in 6 IN lifts.

- c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
- d. Use hand operated equipment for filling and backfilling within 5 FT of walls and less than 3 FT above pipes.
 - 1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
 - 2) Contractor is responsible for method of compaction so as not to damage wall.
- e. Use hand operated equipment for filling and backfilling next to walls.
- f. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
- g. Use vibratory equipment to compact granular material; do not use water.
- 4. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.

3.6 FIELD QUALITY CONTROL

- A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA Standards, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.
- B. Contractor provides sufficient notification and access so inspection and testing can be accomplished.
- C. Contractor pays for retesting of failed tests and for additional testing required when defects are discovered.
- D. Responsibilities of CQA Inspector:
 - 1. Review proposed materials for fill and backfill around structures.
 - 2. All testing, observation and work indicated as being performed by the Geotechnical Engineer or CQC/CQA Consultant in the Final Cover Quality Control Plan and this specification.
 - 3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 - 4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
 - 5. Extent of compaction testing will be as necessary to assure compliance with specifications.
 - 6. Make at least one field density test on subgrade and each compacted fill layer for every 8,000 SQFT.
 - 7. Make at least one field density test per every 8,000 SQFT, or less, of surface area of compacted clay barrier for each 6 inches of depth (but no less than 3 density tests per 6-inch lift). For horizontal lifts, one test will be conducted for each 100 lineal feet for each 12 inches of thickness. The test locations will be evenly distributed across each lift being tested. Any area appearing to be of questionable quality will be tested instead of, or in addition to, the area previously planned for testing.
 - 8. Bulk samples will be collected for analysis to determine the Atterberg limits and the percent passing the No. 40 and No. 200 sieves for material used to construct the compacted clay barrier. For parallel lifts, a minimum of one test sample will be conducted for each 100,000 SQFT of surface per lift, or major fraction thereof, but no less than one test per 6 inch lift of parallel liner. For horizontal lifts, a minimum of one test will be conducted per 2,000 lineal feet per 12 inches of horizontal liner.
 - 9. Make at least one permeability test per every 100,000 SQFT of surface per lift, or major fraction thereof, and no less than one test per 6-inch lift of compacted clay barrier. For horizontal lifts, a minimum of one test per 2,000 lineal feet per 12-inches horizontal liner will be performed.
 - 10. Prepare and submit inspection and test reports to Engineer.

- a. Coordinate such work with other CQA Inspectors.
- 11. Test reports to include the following:
 - a. Report and certification of aggregate fill and drainage fill.
 - b. Test reports on borrow material.
 - c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
 - d. Field reports; in-place soil density and moisture tests.
 - e. One optimum moisture-maximum density curve for each type of soil encountered.
 - f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
 - g. Other documentation necessary for Geotechnical Engineer to approve earthwork.
 - h. Assist Engineer to determine corrective measures necessary for defective work.
- E. Give minimum of 24 HR advance notice to Geotechnical Engineer when ready for compaction or subgrade testing and inspection.
- F. Should any compaction density test or subgrade inspection fail to meet specification requirements, perform corrective work as necessary, at no additional expense to Owner.
- G. Pay for all costs associated with corrective work and retesting resulting from failing compaction density tests.
- H. Responsibilities of Testing Agency for Site Excavation and Grading:
 - 1. All testing, observation and work indicated as being performed by the Geotechnical Engineer in other than Article 3.6 of this Specification Section.
 - 2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
 - 3. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
 - 4. Extent of compaction testing will be as necessary to assure compliance with specifications.
- I. Inspector shall not be a part of the geomembrane installation program and shall not serve as a substitute for performing the duties or certification required of the Fabricator and Installer.

END OF SECTION

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SECTION 31 23 33
TRENCHING, BACKFILLING, AND COMPACTING FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Excavation, trenching, backfilling and compacting for all underground utilities.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³ (600 kN-M/M³)).
 - b. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
 - c. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
- B. Qualifications: Hire an independent soils laboratory to conduct in-place moisture-density tests for backfilling to assure that all work complies with this Specification Section.

1.3 DEFINITIONS

- A. Excavation: All excavation will be defined as unclassified.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - 3. Submit respective pipe or conduit manufacturer's data regarding bedding methods of installation and general recommendations.
 - 4. Submit sieve analysis reports on all granular materials.
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Trench shield (trench box) certification if employed:
 - a. Specific to Project conditions.
 - b. Re-certified if members become distressed.
 - c. Certification by registered professional structural engineer, registered in the state where the Project is located.
 - d. Engineer is not responsible to, and will not, review and approve.

1.5 SITE CONDITIONS

- A. Avoid overloading or surcharge a sufficient distance back from edge of excavation to prevent slides or caving.

1. Maintain and trim excavated materials in such manner to be as little inconvenience as possible to public and adjoining property owners.
- B. Provide full access to public and private premises and fire hydrants, at street crossings, sidewalks and other points as designated by Owner to prevent serious interruption of travel.
- C. Protect and maintain bench marks, monuments or other established points and reference points and if disturbed or destroyed, replace items to full satisfaction of Owner and controlling agency.
- D. Verify location of existing underground utilities

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Backfill Material:
 1. As approved by Engineer.
 - a. Free of rock cobbles, roots, sod or other organic matter, and frozen material.
 - b. Moisture content at time of placement: ± 3 PCT of optimum moisture content as specified in accordance with ASTM D698.
 2. Gravel trench backfill materials:
 - a. Uniformly graded 3/8 IN pea gravel.
- B. Bedding Materials:
 1. As approved by the Geotechnical Engineer.
 2. Granular bedding materials:
 - a. ASTM D2321 Class 1B.
 - 1) Well-graded crushed stone.
 3. Flowable fill:
 - a. Description: Flowable fill shall be a mixture of cement, fly ash, fine sand, water, and air having a consistency which will flow under a very low head.
 - b. Material characteristics:
 - 1) The approximate quantities of each component per cubic yard of mixed material shall be as follows:
 - a) Cement (Type I or II): 50 LBS.
 - b) Fly ash: 200 LBS.
 - c) Fine sand: 2,700 LBS.
 - d) Water: 420 LBS.
 - e) Air content: 10 PCT.
 - 2) Actual quantities shall be adjusted to provide a yield of 1 cubic yard with the materials used.
 - 3) Approximate compressive strength should be 85 to 175 PSI.
 - 4) Fine sand shall be an evenly graded material having not less than 95 PCT passing the No. 4 sieve and not more than 5 PCT passing the No. 200 sieve.

PART 3 - EXECUTION

3.1 GENERAL

- A. Remove and dispose of unsuitable materials as directed by Geotechnical Engineer to landfill.

3.2 EXCAVATION

- A. Unclassified Excavation: Remove rock excavation, clay, silt, gravel, hard pan, loose shale, and loose stone as directed by Geotechnical Engineer.
- B. Excavation for Appurtenances:
 1. 12 IN (minimum) clear distance between outer surface and embankment.

C. Groundwater Dewatering:

1. Where groundwater is, or is expected to be, encountered during excavation, install a dewatering system to prevent softening and disturbance of subgrade to allow pipe, bedding and backfill material to be placed in the dry, and to maintain a stable trench wall or side slope.
2. Groundwater shall be drawn down and maintained at least 2 FT below the bottom of any trench or manhole excavation prior to excavation.
3. Review soils investigation before beginning excavation and determine where groundwater is likely to be encountered during excavation.
 - a. Employ dewatering specialist for selecting and operating dewatering system.
4. Keep dewatering system in operation until dead load of pipe, structure and backfill exceeds possible buoyant uplift force on pipe or structure.
5. Dispose of groundwater to an area which will not interfere with construction operations or damage existing construction.
6. Install groundwater monitoring wells as necessary.
7. Shut off dewatering system at such a rate to prevent a quick upsurge of water that might weaken the subgrade.

D. Trench Excavation:

1. Excavate trenches by open cut method to depth shown on Drawings and necessary to accommodate work.
 - a. Support existing utility lines and yard piping where proposed work crosses at a lower elevation.
 - 1) Stabilize excavation to prevent undermining of existing utility and yard piping.
2. Open trench outside buildings, units, landfill, and structures:
 - a. No more than the distance between structures, units, or 300 LF, whichever is less.
 - b. Field adjust limitations as weather conditions dictate.
3. Trenching within landfill:
 - a. No more than 100 LF at any one time.
4. Any trench or portion of trench, which is opened and remains idle for seven calendar days, or longer, as determined by the Owner, may be directed to be immediately refilled, without completion of work, at no additional cost to Owner.
 - a. Said trench may not be reopened until Owner is satisfied that work associated with trench will be prosecuted with dispatch.
5. Observe following trenching criteria:
 - a. Trench size:
 - 1) Excavate width to accommodate free working space.
 - 2) Maximum trench width at top of pipe or conduit may not exceed outside diameter of utility service by more than the following dimensions:

OVERALL DIAMETER OF UTILITY SERVICE	EXCESS DIMENSION
33 IN and less	18 IN
more than 33 IN	24 IN

- 3) Cut trench walls vertically from bottom of trench to 1 FT above top of pipe, conduit, or utility service.
- 4) Keep trenches free of surface water runoff.
 - a) Include cost in Bid.
 - b) No separate payment for surface water runoff pumping will be made.

E. Trenching for Electrical Installations:

1. Observe the preceding Trench Excavation paragraph in PART 3 of this Specification Section.
2. Modify for electrical installations as follows:

- a. Open no more than 600 LF of trench in exterior locations for trenches more than 12 IN but not more than 30 IN wide.
 - b. Any length of trench may be opened in exterior locations for trenches which are 12 IN wide or less.
 - c. Do not over excavate trench.
 - d. Cut trenches for electrical runs with minimum 30 IN cover, unless otherwise specified or shown on Drawings.
 - e. See Division 26 for additional requirements.
- F. Flowable Fill:
- 1. Flowable fill shall be:
 - a. Discharged from a mixer by any means acceptable to the Engineer into the area to be filled.
 - b. Placed in 4 FT maximum lifts to the elevations indicated.
 - 1) Allow 12 HR set-up time before placing next lift or as approved by the Engineer.
 - 2) Place flowable fill lifts in such a manner as to prevent flotation of the pipe.
 - 2. Flowable fill shall not be placed on frozen ground.
 - 3. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
 - 4. Conform to appropriate requirements of Specification Section 31 23 00.
 - 5. Flowable fill batching, mixing, and placing may be started if weather conditions are favorable, and the air temperature is 34 DEGF and rising.
 - 6. At the time of placement, flowable fill must have a temperature of at least 40 DEGF.
 - 7. Mixing and placing shall stop when the air temperature is 38 DEGF or less and falling.
 - 8. Each filling stage shall be as continuous an operation as is practicable.
 - 9. Prevent traffic contact with flowable fill for at least 24 HRS after placement or until flowable fill is hard enough to prevent rutting by construction equipment.
 - 10. Flowable fill shall not be placed until water has been controlled or groundwater level has been lowered in conformance with the requirements of the preceding Groundwater Dewatering paragraph in PART 3 of this Specification Section.

3.3 PREPARATION OF FOUNDATION FOR PIPE LAYING

- A. Over-Excavation:
- 1. Backfill and compact to 90 PCT of maximum dry density per ASTM D698.
 - 2. Backfill with granular bedding material as option.
- B. Rock Excavation:
- 1. Excavate minimum of 6 IN below bottom exterior surface of the pipe or conduit.
 - 2. Backfill to grade with suitable earth or granular material.
 - 3. Form bell holes in trench bottom.
- C. Subgrade Stabilization:
- 1. Stabilize the subgrade when directed by the Owner.
 - 2. Observe the following requirements when unstable trench bottom materials are encountered.
 - a. Notify Owner when unstable materials are encountered.
 - 1) Define by drawing station locations and limits.
 - b. Remove unstable trench bottom caused by Contractor failure to dewater, rainfall, or Contractor operations.
 - 1) Replace with subgrade stabilization with no additional compensation.

3.4 BACKFILLING METHODS

- A. Do not backfill until tests to be performed on system show system is in full compliance with specified requirements.
- B. Carefully Compacted Backfill:
- 1. Furnish where indicated on Drawings, specified for trench embedment conditions and for compacted backfill conditions up to 12 IN above top of pipe or conduit.

2. Comply with the following:
 - a. Place backfill in lifts not exceeding 8 IN (loose thickness).
 - b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
 - c. Observe specific manufacturer's recommendations regarding backfilling and compaction.
 - d. Compact each lift to specified requirements.
- C. Common Trench Backfill:
 1. Perform in accordance with the following:
 - a. Place backfill in lift thicknesses capable of being compacted to densities specified.
 - b. Observe specific manufacturer's recommendations regarding backfilling and compaction.
 - c. Avoid displacing joints and appurtenances or causing any horizontal or vertical misalignment, separation, or distortion.
- D. Water flushing for consolidation is not permitted.
- E. Backfilling for Electrical Installations:
 1. Observe the preceding Carefully Compacted Backfill paragraph or Common Trench Backfill paragraph in PART 3 of this Specification Section or when approved by the Engineer.
 2. Modify for electrical installation as follows:
 - a. Observe notes and details on electrical drawings for fill in immediate vicinity of direct burial cables.

3.5 COMPACTION

- A. General:
 1. Place and assure bedding, backfill, and fill materials achieve an equal or higher degree of compaction than undisturbed materials adjacent to the work.
 2. In no case shall degree of compaction below minimum compactions specified be accepted.
- B. Compaction Requirements:
 1. Unless noted otherwise on Drawings or more stringently by other Specification Sections, comply with following minimum trench compaction criteria.
 - a. Bedding material:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	75 PCT relative density by ASTM D4253 and ASTM D4254

- b. Carefully compacted backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All applicable areas	Cohesive soils	95 PCT of maximum dry density by ASTM D698
	Cohesionless soils	75 PCT relative density by ASTM D4253 and ASTM D4254

- c. Toe drain bedding and backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
All locations	Cohesionless soils	60 PCT relative density by ASTM D4253 and ASTM D4254

- d. Common trench backfill:

LOCATION	SOIL TYPE	COMPACTION DENSITY
Under pavements, roadways, surfaces within highway right-of-ways	Cohesive soils	95 PCT of maximum dry density by ASTM D698
	Cohesionless soils	60 PCT of relative density by ASTM D4253 and ASTM D4254
Under turfed, sodded, plant seeded, nontraffic areas	Cohesive soils	85 PCT of maximum dry density by ATM D698
	Cohesionless soils	40 PCT of relative density by ASTM D4253 and ASTM D4254

3.6 FIELD QUALITY CONTROL

A. Testing:

1. Perform in-place moisture-density tests as directed by the Owner.
2. Perform tests through recognized testing laboratory approved by Owner.
3. Costs of "Passing" tests paid by Owner.
4. Perform additional tests as directed until compaction meets or exceeds requirements.
5. Cost associated with "Failing" tests shall be paid by Contractor.
6. Reference to Engineer in this Specification Section will imply Geotechnical Engineer when employed by Owner and directed by Engineer to undertake necessary inspections as approvals as necessary.
7. Assure Owner has immediate access for testing of all soils related work.
8. Ensure excavations are safe for testing personnel.

END OF SECTION

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Soil erosion and sediment control.
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Reference Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T88, Standard Specification for Particle Size Analysis of Soils.
 - b. T180, Standard Specification for Moisture-Density Relations of Soils Using a 4.54 KG (10 LB) Rammer and a 457 MM (18 IN) Drop.
 - 2. American Concrete Institute (ACI):
 - a. 301, Specifications for Structural Concrete.
 - 3. ASTM International (ASTM):
 - a. C127, Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
 - b. D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT³ (600 kN-M/M<sup>3 - c. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/FT³ (2,700 kN-M/M<sup>3 - d. D2922, Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - e. D3017, Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).</sup></sup>
 - 4. Precast/Prestressed Concrete Institute (PCI):
 - a. MNL-116S, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
- B. Perform Work in accordance with Texas Department of Transportation 2014 Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

1.3 SITE CONDITIONS

- A. The Contractor shall protect all streams, creeks, and drainage features from sediment laden runoff.
- B. All erosion and sediment control practices shall conform to the Gibbons Creek SES Storm Water Pollution Prevention Plan (SW3P), latest revision.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stone for Stone Filter: Per TxDOT specifications.
- B. Grass Seed: Refer to Section 32 92 00, Seeding.

- C. Silt Fence: Premanufactured or constructed on site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prior to Generally Stripping Topsoil, Tree Clearing, and Excavating:
 - 1. Install silt fence, ditches, and channels.
 - 2. Excavate and shape sediment basins and traps.
 - 3. Construct pipe spillways and install stone filter where required.
 - 4. Machine compact all berms, dikes, and embankments for basins and traps.
 - 5. Refer to the construction sequence on the plans for further detail.
- B. Temporarily seed basin slopes and stockpiles:
 - 1. Rate: See Section 32 92 00 - Seeding.
 - 2. Reseed as required until good stand of grass is achieved.

3.2 DURING CONSTRUCTION PERIOD

- A. Maintain Basins, Dikes, Traps, Stone Filters, Straw Bales, Etc.:
 - 1. Inspect regularly especially after rainstorms.
 - 2. Repair or replace damaged or missing items.
- B. After rough grading, sow temporary grass cover over all exposed earth areas not draining into sediment basin or trap.
- C. Provide necessary swales and dikes to direct all water towards and into sediment basins and traps.
- D. Do not disturb existing vegetation (grass and trees).
- E. Excavate sediment out of basins and traps when capacity has been reduced by 50 percent.
- F. Topsoil and Fine Grade Slopes and Swales, Etc.:
 - 1. Seed and mulch as soon as areas become ready.
- G. Clean streets and roads daily of any spillage of dirt, rocks, or debris from equipment entering or leaving the site.

3.3 NEAR COMPLETION OF CONSTRUCTION

- A. Grade to finished or existing grades.
- B. Fine grade all remaining earth areas, then seed and mulch.

END OF SECTION

SECTION 31 32 18

GEOCOMPOSITE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Bonded geotextile-geonet drainage composite.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 32 19 - Geotextiles.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D413, Standard Test Methods for Rubber Property - Adhesion to Flexible Substrate.
 - b. D1238, Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
 - c. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
 - d. D1603, Standard Test Method for Carbon Black in Olefin Plastics.
 - e. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
- B. Qualifications:
 - 1. Each manufacturing and fabricating firm shall demonstrate five years continuous experience, including a minimum of 5,000,000 SQFT of drainage composite production in the past three years.
 - 2. Installer shall attend pre-installation conference.

1.3 DEFINITIONS

- A. Manufacturer: Manufacturer producing drainage composites from geonet cores and geotextiles.
- B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Manufacturer's documentation that raw materials and roll materials comply with required drainage composite physical properties.
 - 3. Manufacturer and Installer quality control manuals.
 - 4. Original test results for resins and roll material at frequency specified in respective quality control manuals.
 - a. Include or bracket the rolls delivered for use in the Work.
 - 5. Layout plan with proposed size, number, position and sequencing of drainage composite rolls and direction of all field seams.
 - 6. Proposed details of anchor trench if different than included in Contract Documents.
- B. Informational Submittals:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Qualification documentation specified in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Label, handle, and store drainage composites in accordance with ASTM D4873 and as specified herein.
- B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
 1. Do not remove the plastic wrapping until deployment.
- C. Label each roll with the manufacturer's name, drainage composite type, lot number, roll number, and roll dimensions (length, width, gross weight).
- D. Repair or replace, as directed by the Engineer, drainage composite or plastic wrapping damaged as a result of storage or handling.
- E. Do not expose drainage composite to temperatures in excess of 71 DEGC (160 DEGF) or below 0 DEGC (32 DEGF) unless recommended by the Manufacturer.
- F. Do not use hooks, tongs or other sharp instruments for handling the drainage composite.
- G. Do not lift rolls by use of cables or chains in contact with the drainage composite.
- H. Do not drag drainage composite along the ground or across textured geomembranes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. National Seal Company.
 2. Tensar Earth Technologies.
 3. Fluid Systems.
 4. Solmax.

2.2 MATERIALS AND MANUFACTURE

- A. Geonet Core:
 1. Use nonthermally degraded polyethylene polymer which is clean and free of any foreign contaminants.
 2. Manufactured geonet to conform to the property requirements listed in Table 1 and be free of defects including tears, nodules or other manufacturing defects which may affect its serviceability.

TABLE 1 - GEONET PROPERTIES		
PROPERTY	TEST METHOD	TEST VALUE
Polymer Density	ASTM D1505	>0.93 g/cc
Polymer Melt Index	ASTM D1238	<1.1 g/10 min.
Carbon Black Content	ASTM D1603	2-3 PCT

- B. Geotextile:
 1. Cover geonet core on both sides with a geotextile complying with requirements specified in Specification Section 31 32 19, Type 2.
- C. Drainage Composite:
 1. Create a composite by heat bonding geotextiles to the geonet.

- a. The bond between the geotextile and the geonet shall exhibit a minimum peel strength of 1 LBS/IN when tested in accordance with ASTM D413.
2. Transmissivity equals 5×10^{-4} square meters per second.

2.3 SOURCE QUALITY CONTROL

- A. Transmissivity Testing:
 1. Measure transmissivity using water at 68 DEGF with a maximum gradient of 0.10 under a normal pressure of 1,000 LBS/SQFT.
 2. Attach geotextiles to the geonet in the same configuration as will be used in the field for transmissivity testing.
 3. Sandwich the drainage net between rigid platens on the bottom and on the top.
 4. Use a minimum seating period of 15 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to placement of the drainage composite, clean the surface of the geomembrane of all soil, rock, and other materials which could damage the composite.

3.2 INSTALLATION

- A. Deploy the drainage composite ensuring that the drainage composite and underlying materials are not damaged.
 1. Replace or repair faulty or damaged drainage composite as directed by Engineer.
- B. Unroll drainage composite downslope keeping in slight tension to minimize wrinkles and folds.
- C. Maintain free of dirt, mud, or any other foreign materials at all times during construction.
 1. Clean or replace rolls which are contaminated.
- D. Place adequate loading (e.g., sandbags) to prevent uplift by wind.
- E. Overlap adjacent rolls a minimum of 6 IN.
 1. Overlap new drainage composite over existing as shown on the Drawings.
- F. Use manufacturer's fasteners to join adjacent rolls.
 1. Metallic fasteners will not be allowed.
 2. Space fasteners a maximum of 5 FT along downslope roll overlaps and a maximum of 2 FT along cross slope roll overlaps.
 3. Use fasteners of contrasting color from the drainage composite to facilitate visual inspection.
 4. Do not weld drainage composite to geomembranes.
- G. Heat tack overlap of the upper geotextile to the upper geotextile of the adjacent rolls.
- H. Repairs holes or tears in the drainage composite by placing a patch of drainage composite extending a minimum of 2 FT beyond the edges of the hole or tear.
 1. Use approved fasteners, spaced every 6 IN around the patch, to fasten the patch to the original roll.
- I. Penetration details shall be as recommended by the Manufacturer and as approved by the Engineer.

3.3 FIELD QUALITY CONTROL

- A. Provide as-constructed drawing showing roll number; layout; joint locations; and repair and patch locations.

END OF SECTION

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SECTION 31 32 19

GEOTEXTILES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Nonwoven geotextile material.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 01 - General Requirements.
 - 2. Section 31 23 00 - Earthwork.
 - 3. Section 31 32 18 - Drainage Geocomposite.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway Transportation Officials (AASHTO):
 - a. M288, Standard Specification for Geotextile Specification for Highway Applications.
 - 2. ASTM International (ASTM):
 - a. D3786, Standard Test Method for Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
 - b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
 - c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - e. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - f. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - g. D4759, Standard Practice for Determining the Specification Conformance of Geosynthetics.
 - h. D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
 - i. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
 - j. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
- B. Qualifications:
 - 1. Each manufacturing, fabricating firm shall demonstrate five years continuous experience, including a minimum of 10,000,000 SQFT of geotextile installation in the past three years.
 - 2. Installing firm shall demonstrate that the site Superintendent or Foreman has had responsible charge for installation of a minimum of 1,000,000 SQFT of geotextile.
 - 3. Installer shall attend pre-installation conference.

1.3 DEFINITIONS

- A. Manufacturer: Manufacturer producing geotextile sheets from resin and additives.
- B. Installer: The Installers are the individuals actually performing the hands-on work in the field.

1.4 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Manufacturer's documentation that raw materials and roll materials comply with required geotextile physical properties.
 - 3. Manufacturer and Installer quality control manuals.

4. Original test results for resins, roll material and factory seam tests at frequency specified in respective quality control manuals.
 - a. Results shall include or bracket the rolls delivered for use in the Work.
 5. Geotextile layout plan with proposed size, number, position and sequencing of geotextile rolls and direction of all field seams.
 6. Proposed details of anchoring and overlapping if different than included in Contract Documents.
- B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 2. For needle punched geotextiles, the manufacturer shall certify that the geotextile has been continuously inspected using permanent on-line full-width metal detectors and does not contain any needles which could damage other geosynthetic layers.
 3. Qualification documentation specified in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Label, handle, and store geotextiles in accordance with ASTM D4873 and as specified herein.
- B. Wrap each roll in an opaque and waterproof layer of plastic during shipment and storage.
 1. Do not remove the plastic wrapping until deployment.
- C. Label each roll with the manufacturer's name, geotextile type, lot number, roll number, and roll dimensions (length, width, gross weight).
- D. Repair or replace geotextile or plastic wrapping damaged as a result of storage or handling, as directed.
- E. Do not expose geotextile to temperatures in excess of 71 DEGC (160 DEGF) or less than 0 DEGC (32 DEGF) unless recommended by the manufacturer.
- F. Do not use hooks, tongs or other sharp instruments for handling geotextile.
 1. Do not lift rolls lifted by use of cables or chains in contact with the geotextile.
 2. Do not drag geotextile along the ground.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 1. Solmax.
 2. Propex Geosynthetics.
 3. SKAPS Industries.
 4. TenCate Mirafi.
 5. Tenax.

2.2 MATERIALS AND MANUFACTURE

- A. Geotextile:
 1. Nonwoven pervious sheet of polymeric material.
 2. Geotextile fibers:
 - a. Long-chain synthetic polymer composed of at least 85 PCT by weight polyolefins, polyesters, or polyamides.
 - b. Filaments resistant to deterioration by ultraviolet light, oxidation, and heat exposure.
 - c. Do not as reclaimed or recycled fibers or polymer to the formulation.
 3. Form geotextile into a network such that the filaments or yarns retain dimensional stability relative to each other, including the selvages.

4. The geotextile physical properties shall equal or exceed the minimum average roll values listed below.
 - a. Values shown are for the weaker principal direction.
 - b. Acceptance of geotextile shall be in accordance with ASTM D4759.
 - c. Type I Geotextile: AASHTO M288 Class 2, for use in demolition fill.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Mass per Unit Area, OZ/SY	ASTM D5261	=10
AOS, U.S. Standard Sieve	ASTM D4751	70-100
Permittivity, SEC-1	ASTM D4491	=0.5
Puncture, LBS	ASTM D4833	=90
Grab Tensile, LBS	ASTM D4632	=250
Trapezoidal Tear, LBS	ASTM D4533	=90
Burst Strength, PSI	ASTM D3786	=190
Ultraviolet Degradation % retained @ 500 HRS	ASTM D4355	=50
Sewn Seam Strength, LBS	ASTM D4632	=220

- d. Type 2 Geotextile: AASHTO M288 Class 2, for use in drainage composite and other areas shown on the Drawings.

PROPERTY	TEST METHOD	MINIMUM AVERAGE ROLL VALUE
Mass per Unit Area, OZ/SY	ASTM D5261	=8
AOS, U.S. Standard Sieve	ASTM D4751	70-100
Permittivity, SEC-1	ASTM D4491	=0.5
Puncture, LBS	ASTM D4833	=90
Grab Tensile, LBS	ASTM D4632	=250
Trapezoidal Tear, LBS	ASTM D4533	=90
Burst Strength, PSI	ASTM D3786	=190
Ultraviolet Degradation % retained @ 500 HRS	ASTM D4355	=50
Sewn Seam Strength, LBS	ASTM D4632	=220

- B. Thread:
 1. High-strength polyester, nylon, or other approved thread type.
 2. Equivalent chemical compatibility and ultraviolet light stability as the geotextile.
 3. Contrasting color with the geotextile.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Construct the surface underlying the geotextiles smooth and free of ruts or protrusions which could damage the geotextiles.

3.2 INSTALLATION

- A. Install geotextiles in accordance with manufacturer's written recommendations.
- B. Hand place geotextile.
 - 1. No equipment will be permitted to traffic in direct contact with the geotextile.
- C. Lay geotextile smooth so as to be free of tensile stresses, folds, and wrinkles.
- D. Seam Construction:
 - 1. Sew all Type I geotextile seams.
 - 2. Broom clean existing geotextile and cut off to provide a clean area for seaming with the new geotextile.
 - 3. Sew seams continuously using an SSA flat seam with one row of a two-thread 401 chain stitch unless otherwise recommended by the manufacturer.
 - 4. Minimum distance from the geotextile edge to the stitch line nearest to that edge: 2 IN unless otherwise recommended by the manufacturer.
 - 5. Test seams at the frequency specified in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
 - 6. Tie off thread at the end of each seam to prevent unraveling.
 - 7. Construct seams on the top side of the geotextile to allow inspection.
 - 8. Sew skipped stitches or discontinuities with an extra line of stitching with 18 IN of overlap.
 - 9. Type 2 geotextile seams may be sewn or overlapped.
 - a. Construct overlapped seams in accordance with manufacturer's recommendations or as shown on Drawings.
- E. Heat tack the geotextile overlaps as shown on the Drawings.
- F. Backfill anchor trenches in accordance with Specification Section 31 23 00.
- G. Place cover soil in accordance with Specification Section 31 23 00.
- H. Protect geotextiles from clogging, tears, and other damage during installation.
- I. Geotextile Repair:
 - 1. Place a patch of the same type of geotextile which extends a minimum of 12 IN beyond the edge of the damage or defect.
 - 2. Fasten patches continuously using a sewn seam or other approved method.
 - 3. Align machine direction of the patch with the machine direction of the geotextile being repaired.
 - 4. Replace geotextile which cannot be repaired.
- J. Use adequate ballast (e.g., sand bags) to prevent uplift by wind.
- K. Do not use staples or pins to hold the geotextile in place.
- L. Do not leave geotextile uncovered for more than 14 days.

3.3 FIELD QUALITY CONTROL

- A. Conduct destructive seam testing at locations identified by Owner.
 - 1. Minimum testing will be at a frequency of one test per 2,000 linear feet of seam.
- B. Provide as-constructed drawing showing roll number; layout; joint locations; and destructive sample repair, and patch locations.

END OF SECTION

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31 35 26.17

GEOMEMBRANE CONTAINMENT BARRIERS FOR LANDFILLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Furnishing, installation, quality control, and testing of a Linear Low Density Polyethylene (LLDPE) geomembrane.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.
 - 4. Final Cover Quality Control Plan.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. ASTM International (ASTM):
 - a. D413, Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
 - b. D638, Standard Test Method for Tensile Properties of Plastics.
 - c. D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - d. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
 - e. D 1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
 - f. D 1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
 - g. D 1505 Test Method for Density of Plastics by the Density-Gradient Technique
 - h. D 1603 Test Method for Carbon Black in Olefin Plastics
 - i. D 3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
 - j. D 4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
 - k. D 4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
 - l. D4873/D4873M, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
 - m. D 5199 Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
 - n. D 5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
 - o. D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
 - p. D 5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber
 - q. D 5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
 - r. D 5994 Standard Test Method for Measuring Core Thickness of Textured Geomembranes
 - s. D 6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
 - t. D 6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes
 - 2. Environmental Protection Agency (EPA):

- a. 530/SW-91/051, Inspection Techniques for the Fabrication of Geomembrane Field Seams.
 - b. 600/R-93/182, Quality Assurance and Quality Control for Waste Containment Facilities.
3. Geosynthetic Research Institute (GRI):
 - a. GM6, Pressurized Air Channel Test for Dual Sound Geomembranes.
 - b. GM14, Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.
 - c. GM17, Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
 - d. GM19, Seam Strength and Related Properties of Thermally Bonded Polyolefin GeomembranesGM20, Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts.
- B. Quality Assurance:
1. The Owner or Engineer's representative will conduct independent testing to support construction quality assurance program and to provide documentation of such to appropriate regulatory agencies.
 - a. Facilitate and provide opportunities as required.
 2. Unless specifically superseded by these Contract Documents or approved plans submitted by the Contractor, the geosynthetic materials shall be manufactured, stored, placed, seamed, tested and protected as described in EPA 600/R-93/182 and EPA 530/SW-91/051.
 - a. This specifically includes:
 - 1) Material Composition.
 - 2) Manufacturing.
 - 3) Handling and Packaging.
 - 4) Shipment.
 - 5) Storage (Manufacturer and Site).
 - 6) Placement:
 - a) Seaming and Joining.
 - b) Destructive and Nondestructive Testing.
 - c) Protection, Backfilling and Covering.
 - 7) Conformance Testing.
 - 8) Anchoring and Anchor Trenches.
 - 9) Access Roads/Ramps.
- C. Qualifications:
1. Each manufacturing and fabricating firm shall demonstrate five years continuous experience with a minimum of 10,000,000 SQFT of LLDPE geomembranes.
 2. Installer:
 - a. Demonstrate five years continuous experience with a minimum 10,000,000 SQFT of LLDPE geomembranes.
 - b. Trained and certified by at least one of the named manufacturers in this Specification (not necessarily the manufacturer supplying materials for this Project).
 - c. Geomembrane Installer Personnel:
 - 1) Installation Superintendent shall have worked in a similar capacity on at least five LLDPE geomembrane liner jobs similar in size and complexity to the project described in the Contract Documents.
 - 2) The Master Welder shall have completed a minimum of 5,000,000 SQFT of LLDPE geomembrane seaming work using the type of seaming apparatus proposed for use on this Project.
 - 3) Other welders shall have seamed a minimum of 1,000,000 SQFT of LLDPE geomembrane.
 3. Inspectors:
 - a. Demonstrate three years continuous experience with a minimum 5,000,000 SQFT in similar geosynthetic materials installation.

- b. Remain on the project throughout the entire construction and covering of the LLDPE geomembrane.
 - 4. Independent Testing Laboratory shall demonstrate three years of continuous experience in similar geosynthetic materials testing.
- D. Certifications:
- 1. Certifications are required for various aspects of the project related to the LLDPE geomembrane system construction.

1.3 DEFINITIONS

- A. Manufacturer:
- 1. Manufacturer producing geomembrane sheets from resin and additives.
- B. Installer:
- 1. The Installers is the party responsible for field handling, transporting, storing, deploying, seaming, and testing of the geomembrane seams.
- C. Inspector:
- 1. Inspectors of LLDPE geomembrane are the individuals responsible for observing field installation of the geosynthetic materials and providing the Manufacturer, Fabricator, Installer and Owner with verbal and written documentation of the compliance of the installation with this specification and with written procedures manuals prepared by the Manufacturer or Installer.
- D. Independent Testing Laboratory:
- 1. The firm hired to perform destructive testing of the LLDPE geomembrane.
 - 2. Firm shall be acceptable to Engineer and Owner.
- E. Panel:
- 1. Unit area of a geomembrane that will be seamed in the field that is larger than 100 ft².
- F. Patch:
- 1. Unit area of a geomembrane that will be seamed in the field that is less than 100 ft².
- G. Subgrade Surface:
- 1. Soil layer surface which immediately underlies the geosynthetic material(s).
- H. Lot:
- 1. A quantity of resin (usually the capacity of one rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.
- I. Construction Quality Assurance Consultant (CONSULTANT):
- 1. Party, independent from MANUFACTURER and INSTALLER that is responsible for observing and documenting activities related to quality assurance during the lining system construction.
- J. ENGINEER:
- 1. The individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications.

1.4 SUBMITTALS

- A. Shop Drawings:
- 1. Submit for Engineer's approval Shop Drawings, including:
 - a. Manufacturer's certification that raw materials and sheet materials comply with required materials, mil thickness, and material properties.
 - 1) Original certificates are required.
 - b. Manufacturer/Fabricator/Installer quality control requirements.
 - c. Qualifications and experience of key personnel involved in installation/inspection of the geosynthetic materials and geosynthetic system.

- d. LLDPE Geomembrane layout plan with proposed size, number, position and sequencing of panels and showing the location and direction of all field or factory joints.
 - 1) Proposed details for connecting the geosynthetic materials to appurtenances.
 - 2) Proposed methods of welding, seaming or jointing geosynthetic materials.
 - 3) Proposed method and sequencing for placement of drainage layer on top of the LLDPE geomembrane.
 - 4) Proposed method of testing LLDPE geomembrane and other geosynthetic materials, joints and connections at appurtenances for continuity.
 - 5) Location and configuration of haul roads and access points.
 - 6) Proposed details for anchor trench if different than included in Contract Documents.

B. Informational Submittals:

1. Test results:
 - a. Resin test, tests of sheet material and factory seam tests at frequency specified in respective quality control manuals.
 - 1) Results shall include or bracket the rolls delivered for use in the Work.
 - b. Daily test seam results.
 - c. Daily results of production seam testing.
2. Warranties
3. Submit written certifications that:
 - a. The LLDPE geomembrane material delivered to site meets the requirements of this Specification.
 - b. The LLDPE geomembrane were received and accepted in undamaged condition from shipper.
 - c. The subgrade has been properly prepared and acceptable for the placement of the LLDPE geomembrane.
 - d. The LLDPE geomembrane was installed in accordance with this Specification and with approved Shop Drawings.
 - e. The LLDPE geomembrane joints were inspected, tested for strength and continuity, and passed all inspections, tests, or retests.
 - 1) Incorporate all test and inspection data into this certification.
 - f. The drainage layer, geotextiles and protective soil cover layer on top of the LLDPE geomembrane was placed properly and carefully.
4. Manufacturer/Installer's Field Installation Procedures Manual shall clearly identify and exceptions take to the specified execution of the Work.
5. Record Drawings: Submit reproducible drawings of record showing changes from the approved installation drawings. The record drawings shall include the identity and location of each repair, cap strip, penetration, boot, and sample taken from the installed geosynthetic for testing. The record drawings shall show locations of each type of material, anchor trenches and the construction baseline.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store LLDPE geomembrane shall be stored in accordance with the manufacturer's recommendations and ASTM D4873.
- B. Label each roll with the manufacturer's name, type, lot number, roll number, and roll dimensions (length, width, gross weight).
 1. LLDPE geomembrane or plastic wrapping damaged as a result of storage or handling shall be repaired or replaced, as directed.
 2. LLDPE geomembrane shall not be exposed to temperatures in excess of 60 DEGC (140 DEGF) or less if recommended by the Manufacturer.
- C. No hooks, tongs or other sharp instruments shall be used for handling the LLDPE geomembrane.
 1. Rolls shall not be lifted by use of cables or chains in contact with the LLDPE geomembrane.

2. LLDPE geomembrane shall not be dragged along the ground.
- D. Storage - The on-site storage location for geomembrane material, provided by the INSTALLER to protect the geomembrane from punctures, abrasions and excessive dirt and moisture should have the following characteristics:
1. level (no wooden pallets)
 2. smooth
 3. dry
 4. protected from theft and vandalism
 5. adjacent to the area being lined
 6. other recommendations by the Manufacturer

1.6 PROJECT/SITE CONDITIONS

- A. When the weather is of such a nature as to endanger the integrity and quality of the installation whether this is due to rain, high winds, cold temperatures, or other weather elements, the installation shall be halted until the weather conditions are satisfactory.
- B. Ensure that adequate dust control methods are in effect to prevent the unnecessary accumulation of dust and dirt on surfaces which hamper efficient field seaming or performance.
- C. Maintain surface water drainage diversions around the work area and provide for the disposal of water which may collect in the work area directly from precipitation falling within the area or from inadequate diversion structures or practices.
- D. Coordinate the installation of leachate collection lines which shall be in accordance with LLDPE geomembrane Manufacturer's recommendation and as specified in the Contract Documents and shown on the Drawings.
- E. Vehicles, other than those specifically approved, will not be allowed on LLDPE membrane unless at least 18 IN of protective soil cover have been placed over these materials.
 1. No vehicle shall access the completed Work unless it can be demonstrated that its weight, movement or activities will not damage the Work.
 2. When damage is suspected, uncover area, repair damage if required, and recover area at no cost to Owner.
 3. Suspect areas may be identified by Owner or Engineer.

1.7 WARRANTY

- A. Written warranties addressing LLDPE geomembrane material and installation workmanship shall be furnished by the Contractor and shall be made to the Owner.
- B. Submit material samples and warranties prior to shipment.
- C. Suitability of geosynthetic system shall be subject to Owner approval of warranty.
- A. Standard Warranty: The special warranty specified in this Article shall not deprive Owner of other rights or remedies Owner may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under the Contract Documents. The obligations of Contractor under the Contract Documents shall not be limited in any way by the provisions of the specified standard warranty and special warranty.
- B. Special Warranty on geomembrane:
 1. Furnish manufacturer's written warranty, running to benefit of Owner, agreeing to correct, or at option of warranty beneficiary, replace materials and equipment indicated in this Specifications section found to be defective during a period of three years after the date of Substantial Completion certified by Engineer.
 2. The Installer's warranty shall state that the materials were properly installed, properly (field and factory) welded, seamed and jointed and will not fail within two years of the installation under similar conditions.

- a. Warranty shall not be prorated.

1.8 QUALITY ASSURANCE

- A. The OWNER will engage and pay for the services of a Geosynthetic Quality Assurance Consultant and Laboratory to monitor geomembrane installation.
- B. Manufacturing and installation of the geomembranes will be monitored and tested by the CQA Consultant as outlined in the CQA Plan.
- C. Installed material that does not conform to these specifications, whether tested by CONTRACTOR or the CQA Consultant, shall be rejected and shall be replaced or repaired and tested by CONTRACTOR at no cost to OWNER.
- D. CONTRACTOR and Geosynthetics Installer shall be aware of the activities in the CQA Plan and shall account for these CQA activities in the installation schedule.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
 - 1. LLDPE Geomembrane:
 - a. Solmax, 19103 Gundle Rd., Houston, Texas 77073.

2.2 MATERIALS

- A. LLDPE Geomembrane:
 - 1. Consist of unreinforced polyethylene textured on both sides.
 - a. Thickness: 40 MILS.
 - b. Manufactured from virgin, first quality resin designed and formulated specifically for liquid containment in hydraulic structures.
 - c. Reclaimed polymer shall not be added to the resin; except use of polymer recycled during the manufacturing process shall be allowed provided that recycled polymer shall be clean and shall not exceed 2 PCT by weight. No additives or fillers may be added to the resin prior to or during manufacture of the LLDPE geomembrane.
 - 2. Manufactured to be free of holes, blisters, undispersed raw materials, or any sign of contamination by foreign matter.
 - a. Any such defects shall be cause for rejection of the material.
 - b. Minor defects may be repaired in accordance with Manufacturer's recommendations if approved by the Engineer.
 - 3. Manufactured as seamless rolls or as prefabricated panels.
 - a. Minimum width: 15 FT as delivered to the site.
 - b. All factory seams shall be inspected and tested for strength and continuity prior to delivery to the site.
 - 4. Specifications:
 - a. Textured LLDPE geomembrane shall possess properties which meet or exceed the following minimum requirements (per GRI GM17):

PROPERTY	TEST METHOD	FREQUENCY	TEST VALUE
Thickness (min ave.) - lowest average - lowest indiv. for any of the 10 values	ASTM D5994	1/lot and 1/200,000 lb	40mils nom. (-5 PCT) 38.0 34.0
Asperity Height (min. ave.)	ASTM D7466	Every Other Roll	10 MIL
Density (min. ave.)	ASTM D1505	1/lot and 1/200,000 lb	<0.939 G/cc
Tensile Properties (min. ave.) ⁽¹⁾ Type IV - break stress - break elongation	ASTM D6693	1/20,000 lb	60 LB/IN 250 PCT
Tear Resistance (min. ave.)	ASTM D1004	1/45,000 lb	22 LB
Puncture Resistance (min. ave.)	ASTM D4833	1/45,000 lb	44 LBS
Carbon Black Content (range)	ASTM D4218	1/45,000 lb	2.0-3.0 PCT
Carbon Black Dispersion	ASTM D5596	1/45,000 lb	note ⁽³⁾
Oxidative Induction time (OIT) (min. ave.) ⁽⁴⁾ (a) Standard OIT or (b) High Pressure OIT	ASTM D3895 ASTM D5885	1/lot and 1/200,000 lb	100 min 400 min
Oven Aging at 85 DEGC ^{(4), (5)} (a) Standard OIT (min. ave.) or (b) High Pressure OIT (min. ave.) PCT retained after 90 days	ASTM D5721 ASTM D3895 ASTM D5885	1/lot and 1/200,000 lb	35 PCT 60 PCT

- (1) Machine direction (MD) and cross machine direction (XMD) average values shall be on the basis of 5 test specimens each direction:
 - (a) Yield elongation is calculated using a gage length of 1.3 IN.
 - (b) Break elongation is calculated using a gage length of 2.0 IN.
- (2) The SP-NCTL test shall be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials.
 - (a) The yield stress used to calculate the applied load for the SP-NCTL test shall be the manufacturer's mean value via MQC testing.
- (3) Carbon black dispersion for 10 different views:
 - (a) Minimum 9 of 10 IN Categories 1 or 2.
 - (b) All 10 IN Categories 1, 2, or 3.
- (4) The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
- (5) It is also recommended to evaluate supplies at 30 and 60 days to compare with the 90 day response.

5. Extrusion rod shall be manufactured from resin identical to that used in geomembrane manufacture. Manufactured extrusion rod shall be tested for carbon black content and dispersion, specific gravity, and melt index at a frequency of not less than one test per batch.

2.3 EQUIPMENT AND ACCESSORIES

A. Welding and Seaming Equipment:

1. Equipped with gages showing temperatures at the nozzle (extrusion welder) or at the wedge (wedge welder).
2. Maintained in adequate numbers to avoid delaying work.

3. Supplied by a power source capable of providing constant voltage under a combined-line load.
 4. Electric generator shall not be placed on the LLDPE geomembrane.
- B. Field Tensiometer:
1. Provide a tensiometer for on-site shear and peel testing of LLDPE geomembrane seams.
 - a. Tensiometer shall be in good working order.
 - b. Built to ASTM specifications.
 - c. Accompanied by evidence of calibration of equipment and gages within the past six months.
 - d. Motor driven.
 - e. Jaws capable of traveling a measure rate of 2 IN per minute.
 - f. Equipped with a gauge that measures the force in unit pounds exerted between the jaws.
 - g. Digital readout.
- C. Punch Press:
1. Provide a punch press for the onsite preparation of specimens for testing.
 2. Capable of cutting specimens in accordance with ASTM D4437.
- D. Vacuum Box:
1. Provide a vacuum box for onsite testing of LLDPE geomembrane seams in accordance with ASTM D5641.
- E. Equipment necessary to perform "Pressurized Air Channel Evaluation of Dual Seamed Geomembranes" in accordance with ASTM D5820.
- F. Gages:
1. Calibrated within past six months.
 2. Specified test values reading near mid-range of the gage scale.

2.4 FABRICATION

- A. Produce geomembrane sheet which complies with this Specification Section.
- B. Provide resin and additive quality control:
1. Test raw resin and additives to ensure compliance with the Manufacturer's specifications and with this Specification Section.
 2. Test sheet material to ensure compliance with Manufacturer's specification and this Specification Section.
 3. Provide certification of the raw materials and finished sheet demonstrating compliance with this Specification Section.
 4. Provide certification of Fabricator's and Installer's training (unless Installer is certified by other acceptable manufacturer list herein), experience and methods for welding, seaming, jointing and inspecting geosynthetic materials installations in compliance with Manufacturer's standards and with Quality Assurance requirements of this Specification Section.
- C. Fabricated Specials:
1. Subject to same level of manufacturer's quality control.
 2. Fabricated from project rolls.
 - a. Provide traceability of resin and roll stock.

PART 3 - EXECUTION

3.1 GEOSYNTHETIC SYSTEM

- A. Geomembrane Subgrade:
1. Protect subgrade at all times from damage until such time as the placement of LLPE geomembrane and other components of the geosynthetic system are complete.

2. The subgrade shall be prepared in a manner consistent with proper subgrade preparation techniques for the installation of LLDPE Geomembrane.
 - a. The subgrade shall be properly compacted so as not to settle and cause excessive strains in the LLDPE Geomembrane or other synthetic materials.
 - b. Prior to installation, ensure a surface free of debris, roots, or angular stones larger than 1/2 IN.
 - c. In addition, ensure that the subgrade has been rolled to provide a uniform surface.
 - d. During installation, ensure that rutting or raveling is not caused by installation equipment or weathering.
- B. Anchor Trenches:
1. Geosynthetic materials placed on side slopes shall be anchored into trenches as detailed on the Contract Drawings.
 2. Excavation, backfill and compaction shall be in accordance with Specification Section 31 23 00.
- C. LLDPE Geomembrane:
1. General:
 - a. Installer of LLDPE geomembranes is responsible for handling, fitting, welding, seaming, jointing and testing of geosynthetic materials sheets or blankets in the field.
 - b. These responsibilities include but are not limited to:
 - 1) Acceptance (in writing) of the geosynthetic materials sheets or blankets from the transporter.
 - 2) Acceptance (in writing) of the soil or geosynthetic clay liner subgrade which will serve as a base for the LLDPE geomembrane.
 - a) This acceptance shall precede installation of the LLDPE geomembrane.
 - b) Shall state that the Installer has inspected the surface, and reviewed the Specifications for material and placement, and finds all conditions acceptable for placement of LLDPE geomembrane.
 - c) Shall explicitly state any and all exceptions to acceptance.
 - 3) Handling, welding, seaming, jointing, testing and repair of LLDPE geomembrane and other geosynthetic materials in compliance with this Specification and with written procedures manuals prepared by the Manufacturer or Fabricator.
 - a) Manual shall be submitted to the Engineer together with Shop Drawings showing the layout of LLDPE geomembrane within the facility.
 - (1) Do not deviate from the procedures included in the manual.
 - b) LLDPE Geomembrane shall not be placed upon frozen foundation, standing water or other conditions which will result in deterioration of the foundation.
 - c) LLDPE Geomembrane materials shall be laid out according to plans previously approved by the Engineer.
 - d) Adjacent rolls of LLDPE geomembrane shall overlap a minimum of 3 IN, provided that greater overlap may be required to allow seaming in accordance with the Manufacturer's instructions.
 - 4) Repair or replacement of defects in the geosynthetic materials as required by the Inspector or the Owner.
 - 5) Installer and Manufacturer may be the same firm.
 2. Panel deployment:
 - a. Only those panel/sheets that can be seamed in one day shall be deployed.
 - b. Place panels with minimal handling.
 - 1) Orient sheets to eliminate or minimize number of horizontal seams on side slopes.
 - 2) Protect panels from tear, puncture or abrasion.
 - 3) No seams will be permitted in the leachate collection trench.
 - c. Equipment used to deploy the geomembrane shall not rut the recompacted clay liner, or damage the Geosynthetic Clay Liner.
 - 1) A rut is defined as a 1/4 IN depression over a 10 FT straight-edged length.
 - d. No vehicular traffic is permitted on unprotected LLDPE geomembrane.

- e. Minimize foot traffic.
 - 1) Do not allow personnel access to wet or slippery liners without adequate safety precautions.
- f. Ballast with sandbags to prevent wind uplift as recommended by Manufacturer and Fabricator and based on local climatic conditions.
 - 1) Remove and replace all wind damaged panels at no additional cost to Owner.
 - 2) If wind causes panels to be displaced, displaced panel may not be reused.
- g. Install LLDPE geomembrane in stress free, tension free and relaxed condition.
 - 1) Account for temperature and weather-related impacts when deploying and covering.
 - 2) Stretching to fit and folding are not permitted.
- h. Do not allow LLDPE geomembrane to bubble, fold, or create ripples as a result of deployment of drainage layer or protective soil cover placement.
 - 1) Except as noted on Contract Drawings no folds in LLDPE geomembrane will be allowed.
- i. Any panel exhibiting stretching caused by placement, covering techniques, or wind shall be removed and may not be incorporated in the final construction.
- j. Field seaming:
 - 1) Field seaming shall be done in accordance with seaming recommendations furnished by the geomembrane Manufacturer and referenced EPA documents.
 - 2) Each piece of seaming equipment and each operator shall perform demonstration seams at the start of a shift, whenever equipment is switched on or seaming is interrupted for more than ten minutes, and at other times at the discretion of the Installer and Inspector.
 - 3) Demonstration seams shall use the same seaming materials and methods to be used in the actual construction.
 - 4) Surfaces to be seamed shall be clean and dry at the time of seaming.
 - a) Precipitation and ponding of water on the LLDPE geomembrane shall cause termination of seaming operations.
 - b) LLDPE geomembrane shall not be seamed when ambient temperatures are below 32 DEGF or above 104 DEGF, without written consent of LLDPE geomembrane Manufacturer or Fabricator, and Engineer.
 - 5) LLDPE geomembrane sheets shall be seamed continuously without fishmouths or breaks in the seam.
 - a) Where fishmouths are unavoidable, the sheet shall be slit to a point such that the sheet lies flat and with no remaining wrinkle.
 - b) The two edges of the slit shall be seamed together provided that the overlap for this seam shall be a minimum of 6 IN.
 - c) Areas of the slit which do not achieve an overlap of 6 IN, including the terminus of the slit, shall be provided with a patch as discussed below.
 - 6) All LLDPE geomembranes shall be seamed by thermal fusion methods as recommended by the LLDPE geomembrane Manufacturer.
 - a) LLDPE geomembrane seaming shall be double wedge weld unless otherwise approved or prohibited by construction.
 - 7) Manufacturer's or Fabricator's seaming instructions shall specifically address subgrade preparation, seaming materials, temporary and permanent jointing, seaming temperatures including temperatures for seaming materials, seam finishing and curing.
 - 8) A copy of Manufacturer's or Fabricator's seaming instructions shall be available on site at all times and shall not be deviated from without written approval of the Manufacturer and Engineer.
 - 9) All panels/sheets should be overlapped a minimum of 3 IN.
 - a) If horizontal seams are required on side slopes, the upper panel should be lapped over the lower panel.

- 10) Seaming shall not be conducted in the presence of standing water and/or soft subgrades.
 - a) The seamed area shall be cleaned of dust, dirt and foreign material prior to and during the seaming operation.
- 11) Seaming shall extend to the outside edge of panels/sheets to be placed in anchor and/or drainage trenches.
- 12) Tack welds shall conform with manufacturers seaming techniques and shall not damage underlying membrane.
- k. Patching:
 - 1) Defects in and damage to LLDPE geomembrane sheets shall be repaired by seaming a patch over the defect.
 - a) The patch material shall consist of an undamaged piece of LLDPE geomembrane cut to provide a minimum of 6 IN of overlap in all directions from the defect.
 - b) Round corners shall be utilized on all patches.
 - (1) No bead or spot patching will be accepted.
 - c) Torn or permanently twisted LLDPE geomembrane shall be replaced at no expense to the Owner.
 - 2) Test all patch seams using one of the following nondestructive tests: Vacuum tests; spark tests; or ultrasonic tests.
 - a) Test patch seams destructively at a frequency of ten percent or a minimum of one test per seaming personnel per day.
 - b) This destructive testing may be accomplished using demonstration seams performed adjacent to the installation.

3.2 FIELD QUALITY CONTROL

- A. Inspector shall not be a part of the installation program and shall not serve as a substitute for performing the duties or certification required of the Fabricator and Installer.
 - 1. Inspector’s responsibilities include, but are not limited to:
 - a. Inspection of the material and the handling and field installation of the geomembranes.
 - 1) Inspection of all welds, repairs and quality control test results.
 - b. All exceptions to material or installation shall be documented and furnished to the Engineer in writing within 48 HRS of discovery.
 - c. Inspection and Certification of LLDPE geomembrane integrity until completion of placement of protective soil cover.
- B. Trial Seam Testing:
 - 1. Trial seams shall be made each half-day prior to production seaming.
 - a. The location of trial seam shall be in an area proposed for the day's production seaming.
 - b. Equipment, methods and personnel shall be the same as proposed for the day's seaming.
 - 2. Samples shall be tested in accordance with ASTM D413 and ASTM D882.
 - a. To be acceptable, five of five replicate test specimens must meet specified seam strength requirements and failures shall be Film Tear Bond.
 - b. If the field tests fail to meet these requirements, the entire operation shall be repeated.
 - 3. If the additional test seams fail, the seaming apparatus or seamer shall not be accepted or used for seaming until the deficiencies are corrected and two consecutive successful test seams are achieved.
 - 4. The minimum required seam strengths:

FAILURE MODE	TEST METHOD	VALUE(LBS/IN)
Shear	ASTM D6392	60
Peel (fusion)	ASTM D6392	50
Peel (extrusion)	ASTM D6392	44

- C. Nondestructive Seam Testing:
1. All field seams shall be nondestructively tested over their full length.
 - a. Seam testing shall be performed as the seaming work progresses, not at the completion of field seaming.
 - b. All testing shall be documented.
 - 1) Any seams which fail shall be repaired and documented.
 2. Nondestructively test all field seams continuously using one of the following nondestructive seam tests: Vacuum box; ultrasonic tests; spark tests; and pressurized air channel test.

- D. Destructive Seam Testing:
1. A minimum of one destructive test sample in each transverse field seam, and as many other samples as Engineer determines appropriate, shall be obtained at locations specified by the Engineer.
 - a. Sample locations shall not be identified prior to seaming.
 - b. The samples shall be a minimum of 12 IN wide by 48 IN long with the seam centered lengthwise.
 - c. Each sample shall be cut into three equal pieces with one piece retained by the Installer, one piece given to an Independent Testing Laboratory, and the remaining piece given to the Engineer for quality assurance testing and/or permanent record.
 - d. Each sample shall be numbered and recorded on the final panel layout record drawing, and cross-referenced to a field log which identifies:
 - 1) Panel/sheet number.
 - 2) Seam number.
 - 3) Top sheet.
 - 4) Date and time cut.
 - 5) Ambient temperature.
 - 6) Seaming unit designation.
 - 7) Name of seamer.
 - 8) Seaming apparatus temperature and pressures (where applicable).
 2. A minimum of four, 1 IN wide replicate specimens shall be cut from the Installer's sample.
 - a. A minimum of two specimens shall be tested for shear strength and two for peel adhesion using an approved field quantitative tensiometer.
 - 1) Jaw separation speed shall be 2 IN per minute.
 - b. To be acceptable, all replicate test specimens must meet the specified seam strength requirements and fail as Film Tear Bond.
 3. If the field tests pass, five specimens shall be tested at the Independent Testing Laboratory for shear strength and five for peel adhesion in accordance with ASTM D4437.
 - a. To be acceptable, four out of five replicate test specimens must meet the specified seam strength requirements and fail as Film Tear Bond.
 4. The minimum required seam strengths:

FAILURE MODE	TEST METHOD	VALUE(LBS/IN)
Shear	ASTM D6392	60
Peel (fusion)	ASTM D6392	50
Peel (extrusion)	ASTM D6392	44

5. If the field or laboratory tests fail, the seam shall be repaired in accordance with the Manufacturer's Quality Control manual.
6. In addition, all destructive seam sample holes shall be repaired the same day as cut.
7. Certified test results on all field seams shall be submitted to and approved by the Engineer prior to acceptance of the seam.

8. Ten percent of all repaired areas shall be destructively tested.
9. All repaired areas shall be nondestructively tested.
10. The Owner may separately conduct destructive testing for quality assurance.
 - a. If samples tested by Owner fail, based on above criteria, seam will be classified as failed.
11. A map showing the locations, number and type of all patches shall be prepared and provided to the Owner.

3.3 GEOSYNTHETIC SYSTEM ACCEPTANCE

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

3.4 SCHEDULE OF CERTIFICATIONS

- A. The schedule of required certifications and signing parties follows the end of this Specification Section.
- B. The certificates following the end of this Specification Section shall be completed and signed by the required parties, and the original certificates delivered to the Engineer's representative as a part of the completion of that particular phase of the geosynthetic system installation.

END OF SECTION

**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

<u>CERTIFICATE</u>	<u>SIGNATURES REQUIRED</u>
1. Certification of Raw and Fabricated Material	Manufacturer Fabricator
2. Certification of Material Acceptance from Shipper	Installer Contractor
3. Certification of Acceptance of Subgrade	Installer Contractor
4. Certification of Material Installation	Installer Contractor
5. Certification of Material Joints	Installer Contractor
6. Certification of Placement of Adjacent Liner Components	Installer Contractor

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**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

CERTIFICATION OF RAW AND FABRICATED MATERIAL
(To Accompany Each Shipment) (Circle Material Type)

DATE: _____

MATERIAL DESCRIPTION: _____

(include lot and roll/panel numbers)

WE THE UNDERSIGNED CERTIFY THAT THE RAW MATERIAL AND FINISHED LLDPE
GEOMEMBRANE MATERIAL, DRAINAGE COMPOSITE, AND GEOTEXTILES FURNISHED FOR
GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT FROUP COMPLY WITH
SPECIFICATIONS FOR CCR UNIT CLOSURE

MANUFACTURER NAME

MANUFACTURER SIGNATURE (Authorized Representative)

FABRICATOR NAME

FABRICATOR SIGNATURE (Authorized Representative, if different from Manufacturer)

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**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

CERTIFICATION OF MATERIAL ACCEPTANCE FROM SHIPPER
(Per shipment; each roll or container) (Circle Material Type)

REPORT NO.: _____ DATE: _____

PANEL, ROLL, AND CONTAINER NUMBER REFERENCES _____

WE THE UNDERSIGNED ACCEPT THE LLDPE GEOMEMBRANE MATERIALS (ROLLS, SHEETS, BLANKETS), DRAINAGE COMPOSITE, AND GEOTEXTILES FROM THE TRANSPORTER. THESE MATERIALS WERE RECEIVED IN UNDAMAGED CONDITION BASED UPON OUR VISUAL INSPECTION.

INSTALLER SIGNATURE

CONTRACTOR SIGNATURE

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**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

**CERTIFICATION OF ACCEPTANCE OF SUBGRADE - Daily Certification
(Circle Material Type)**

REPORT NO.: _____ DATE: _____

AREA REFERENCED: _____

LINER PANEL NUMBERS INSTALLED OVER REFERENCED AREA THIS DATE:

WE THE UNDERSIGNED CERTIFY THAT WE HAVE INSPECTED THE ENTIRE SURFACE, AND HAVE REVIEWED THE SPECIFICATION SECTION 31 35 26.17, FINAL COVER QUALITY CONTROL PLAN, AND RELATED SHOP DRAWINGS FOR MATERIAL AND PLACEMENT, AND FIND ALL CONDITIONS ACCEPTABLE FOR PLACEMENT OF THE LLDPE GEOMEMBRANE LINER.

WE SPECIFICALLY TAKE THE FOLLOWING EXCEPTIONS TO THE ACCEPTANCE OF THE SUBGRADE ON THIS DATE:

(Note: All exceptions shall be approved by Engineer prior to LLDPE Geomembrane Liner deployment)

INSTALLER SIGNATURE

CONTRACTOR SIGNATURE

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**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

**CERTIFICATE OF MATERIAL INSTALLATION - Daily Certification
(Circle Material Type)**

REPORT NO.: _____ DATE: _____

AREA REFERENCED: _____

LINER PANEL NUMBERS INSTALLED THIS DATE: _____

WE THE UNDERSIGNED CERTIFY THAT THE LLDPE GEOMEMBRANE LINER, DRAINAGE COMPOSITE, AND GEOTEXTILES WERE INSTALLED IN ACCORDANCE WITH THE SPECIFICATIOIS AND WITH APPROVED SHOP DRAWINGS.

INSTALLER SIGNATURE

CONTRACTOR SIGNATURE

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**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

**CERTIFICATION OF MATERIAL JOINTS - Daily Certification Per Test
(As Shop Drawings and as a Compiled Report at the end of Project)
(Circle Material Type)**

TEST REPORT NO.: _____ DATE: _____

FIELD LOG NO.: _____

LIST OF ALL DEFICIENCIES AND SUBSEQUENT REPAIRS, COPIES OF ALL FIELD AND FACTORY TESTS AND INSPECTION DATA INCLUDING RECORDS OF ALL NON-DESTRUCTIVE TESTING (FIELD LOGS) AND REPAIRS ARE ATTACHED.

WE THE UNDERSIGNED CERTIFY THAT THE LLDPE GEOMEMBRANE AND ITS JOINTS WERE INSPECTED AND TESTED FOR STRENGTH AND CONTINUITY, DRAINAGE COMPOSITE SEAMS WERE INSPECTED FOR CONTINUITY, AND GEOTEXTILE SEAMS WERE INSPECTED FOR CONTINUITY AND PASSED ALL INSPECTIONS AND TESTS. WHERE FAILING TESTS OR DEFICIENCIES OCCURRED, THE AREA OF FAILURE WAS IDENTIFIED IN ACCORDANCE WITH THE APPROVED QUALITY CONTROL PROGRAM FOR THE PROJECT AND REPAIRED. THE AREAS OF FAILING TESTS, DEFICIENCIES AND THE SUBSEQUENT RETESTS OR TESTS TO DELINEATE THE LIMITS OF FAILURE ARE IDENTIFIED IN THE ATTACHED SEAM TESTS AND INSPECTION DATA.

INSTALLER SIGNATURE

CONTRACTOR SIGNATURE

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**GIBBONS CREEK ENVIRONMENTAL REDEVELOPMENT GROUP
CCR Unit Closure**

**CERTIFICATION OF PLACEMENT OF ADJACENT LINER COMPONENTS –
Daily Certifications; Per Material and Location (Circle Material Type)**

REPORT NO.: _____ DATE: _____

COMPONENT BEING PLACED: _____

SUBSTRATE: _____

LOCATION: _____

WE THE UNDERSIGNED CERTIFY THAT THE LLDPE GEOMEMBRANE, GEOTEXTILE, AND DRAINAGE COMPOSITE ON TOP OF THE LLDPE GEOMEMBRANE, GEOTEXTILE, AND DRAINAGE COMPOSITE, WAS CAREFULLY PLACED UNDER MY DIRECT SUPERVISION/OBSERVATION THIS DATE, AND WITHOUT KNOWINGLY DAMAGING ANY OF THE UNDERLYING OR ADJACENT SUBSTRATE.

INSTALLER SIGNATURE

CONTRACTOR SIGNATURE

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SECTION 31 37 00
CONCRETE REVETMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fabric-formed Concrete Revetment Mat
- B. Related Sections include but are not necessarily limited to:
 - 1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
 - 2. Division 1 - General Requirements.
 - 3. Section 31 23 00 - Earthwork.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Society for Testing and Materials International (ASTM):
 - a. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 - b. C33, Standard Specification for Concrete Aggregates.
 - c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 - d. C150, Standard Specification for Portland Cement.
 - e. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
 - f. C494, Standard Specification for Chemical Admixtures for Concrete.
 - g. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
 - h. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
 - i. D2256, Standard Test Method for Tensile Properties of Yarns by the Single-Strand Method.
 - j. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - k. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - l. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
 - m. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
 - n. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
 - o. D4873, Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
 - p. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
 - q. D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
 - r. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Section 01 33 00.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Material and method of installation and details for completed system.
 - c. Manufacturer's construction and quality control manual.
 - d. Concrete mix design.

3. The Contractor shall submit a manufacturer's certificate that the supplied fabric forms meet the criteria of these Specifications, as measured in full accordance with the test methods and standards referenced herein.
 - a. The certificates shall include the following information about each fabric form delivered:
 - 1) Manufacturer's name and current address,
 - 2) Full product name,
 - 3) Style and product code number,
 - 4) Form number(s),
 - 5) Composition of yarn, and
 - 6) Manufacturer's certification statement.
4. Fabric form layout plan with proposed size, type, number, position, and sequencing of fabric form panels.
 - a. Show the location and direction of all field and factory seams.
 - b. Show proposed details for making field connections of the fabric forms.
 - c. Show proposed details for connecting the fabric forms to appurtenances.
5. Submit all tests and certification in a single coordinated submittal.

1.4 DELIVERY, STORAGE AND HANDLING

- A. See Section 01 65 50.
- B. The fabric forms shall be kept dry and wrapped such that they are protected from the elements during shipping and storage.
- C. If stored outdoors, the fabric forms shall be elevated and protected with a waterproof cover that is opaque to ultraviolet light.
- D. Fabric forms labeling: per ASTM D 4873.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fabric-formed Concrete Revetment Mat:
 1. Subject to compliance with the Specifications, the following are approved fabric-formed concrete revetment mat manufacturers:
 - a. Hydrotex, Atlanta, GA, (800) 253-0561.
 - b. Other approved manufacturer.
 2. The fabric form shall be uniform section lining, with the following typical dimensions and weights:
 - a. Average thickness: 4.0 IN.
 - b. Mass per unit area: 45 LB/FT².
 - c. Drop point spacing: 3 x 4 IN.
 - d. Concrete coverage: 75 FT²/YD³.
 - e. Shear resistance: 18 LB/FT².
 3. The uniform section fabric shall possess properties which meet or exceed the following minimum average roll values:

4.

Property	Test Method	Minimum Average Roll Value
Physical		
Composition of yarns		Nylon or polyester
Mass per unit area (double-layer), oz/yd ²	ASTM D 5261	12
Thickness, mils	ASTM D 5199	25
Mill width, in		76
Mechanical		
Wide-width strip tensile strength, lb/in	ASTM D4595	
- machine		140
- cross		110
Elongation at break, %	ASTM D4595	
- machine		20
- cross		30
Trapezoidal tear strength, lb	ASTM D 4533	
- machine		150
- cross		100
Hydraulic		
Apparent opening size (AOS), U.S. Standard Sieve	ASTM D4751	40
Flow rate, gal/min/ft ²	ASTM D 4491	90

5. The fabric forms shall be composed of synthetic yarns formed into a woven fabric.
 - a. Yarns used in the manufacture of the fabric shall be composed of nylon and/or polyester.
 - b. Forms shall be woven with a minimum of 50% textured yarns (by weight) to improve adhesion to fine aggregate concrete and to improve filtration.
 - c. Partially-oriented, drawn-textured, and/or staple yarns shall not be used in the manufacture of the fabric.
 - d. Each layer of fabric shall conform to the physical, mechanical and hydraulic requirements referenced herein.
 - e. The fabric forms shall be free of defects and flaws that significantly affect their physical, mechanical, or hydraulic properties.
6. Fabric forms shall consist of double-layer woven fabric joined together by spaced, interwoven cords of uniform length to form a concrete lining with a finished average thickness and nominal mass per unit area listed in part 2.1A.2.
 - a. Cord minimum breaking strength: Minimum 160 lb when tested in accordance with ASTM D 2256.
 - b. After the form has been filled with fine aggregate concrete, the cords' drop points shall be spaced as listed in part 2.1A.2.
 - c. The cords shall connect the two layers of fabric to form a comparatively uniform surface appearance.
7. Mill widths of fabric shall be as listed in part 2.1A.3.
 - a. Each selvage edge of the top and bottom layers of fabric shall be reinforced for a width of not less than 1.35 inches by adding a minimum of 6 warp yarns to each selvage construction.

- b. Mill width rolls shall be cut to the length required, and the double-layer fabric separately joined, bottom layer to bottom layer and top layer to top layer, by means of sewing thread, to form multiple mill width panels with sewn seams on not less than 72-inch centers.
- 8. All factory-sewn seams shall be downward facing.
 - a. All seams sewn in the factory: Minimum 90 lb/in when tested in accordance with ASTM D 4884.
 - b. All sewn seams and zipper attachments shall be made using a double line of U.S. Federal Standard Type 401 stitch.
 - c. All stitches shall be sewn simultaneously and be parallel to each other, spaced between 0.25 inches to 0.75 inches apart.
 - d. Each row of stitching shall consist of 4 to 7 stitches per inch.
 - e. Thread used for seaming shall be nylon and/or polyester.
- 9. Baffles shall be installed at predetermined mill width intervals to regulate the distance of lateral flow of fine aggregate concrete.
 - a. The baffle material shall be non-woven filter fabric.
- 10. Whenever plastic weep tubes for the relief of hydrostatic uplift pressure are required, they shall be inserted through the fabric forms at locations specified in the Contract Documents.
 - a. The lower ends of the weep tubes shall be securely covered by filter fabric, or the fabric forms shall be placed over filter fabric.
- 11. Fine aggregate concrete:
 - a. Mix Portland cement, fine aggregate and water to provide a readily pourable slurry.
 - 1) The consistency of the fine aggregate concrete delivered to the concrete pump shall be proportioned and mixed as to have an efflux time of 9 – 12 seconds when passed through the 0.75-inch orifice of the standard flow cone (ASTM C 939).
 - 2) Ready mix from plant which is certified by the National Ready-Mix Concrete Association. Field mixes subject to approval.
 - a) Portland cement: ASTM C150, Type I or Type II.
 - b) Fine aggregate: ASTM C33.
 - c) Water: Clean, free from injurious amounts of oil, acid, salt, alkali, organics or other impurities.
 - d) Pozzolan: ASTM C618, Class F.
 - e) Plasticizing admixture: ASTM C 494, if used.
 - f) Air entraining admixture: ASTM C 260, if used.
 - b. Pozzolan grade fly ash shall be substituted for cement to the maximum percentage allowed by the manufacturer.
 - c. Admixtures may be used with Engineer's approval.
 - d. Hardened fine aggregate concrete compressive strength: Minimum 2000 psi at 28 days when specimens are made and tested in accordance with ASTM C31 and ASTM C39.

2.2 SOURCE QUALITY CONTROL

- A. Perform all tests required to demonstrate source and material specifications are satisfied.
- B. Contractor shall test all Fine Aggregate Concrete delivered to the site for compressive strength and air content, and provide test results to Owner and Engineer.

PART 3 - EXECUTION

3.1 FOUNDATION PREPARATION

- A. General: Areas on which fabric forms are to be placed shall be constructed to the lines and grades shown on the Contract Drawings and to the tolerances specified in the Contract Documents, and approved by the Engineer.
- B. Grading:

1. Grade slope to a smooth plane surface to provide intimate contact between the slope face and the interface surface of the fabric forms.
 - a. All slope deformities, roots, grade stakes and stones which project normal to the local slope face must be regraded or removed.
 - b. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 1 IN in depth normal to the local slope face shall be permitted.
 - c. No grooves or depressions greater than 0.5 IN in depth normal to the local slope face with a dimension exceeding 1 FT in any direction shall be permitted.
2. Correction:
 - a. Defective areas shall be brought to grade by placing nominally compacted homogeneous material.
 - b. The slope and slope face shall be uniformly compacted.
 - c. Depth of layers, homogeneity of soil and amount of compaction shall be as specified in Section 31 23 00.

3.2 INSTALLING FABRIC-FORMED CONCRETE REVETMENT MAT

- A. General: Placed within the specified lines and grades shown on the Contract Drawings.
- B. Placement on adjoining geosynthetic:
 1. Place on the geosynthetic in such a manner as to produce a smooth plane surface in intimate contact with the geosynthetic.
- C. Prior to fine aggregate concrete injection, position the fabric at its approximate design location, making appropriate allowance for the contraction of the fabric in each direction which will occur as a result of fine aggregate concrete injection.
 1. Anchoring of the fabric forms shall be accomplished through the use of anchor trenches.
 2. Panels of fabric are to be factory assembled in predetermined sizes and jointed together side-by-side at the jobsite by means of a sewn seam or zipper closures attached to the upper and lower layers of fabric.
 - a. Avoid field seaming to the extent possible.
 - b. Machine sew seams shall be made with two lines of U.S. Federal Standard Type 101 stitches.
 - c. The two (2) top layers of fabric and the two (2) bottom layers of fabric shall be separately joined so as to ensure full block thickness.
 - d. Grab tensile strength of sewn seams shall be a minimum 100 LBS/IN per ASTM D4632.
 - e. Face all sewn seams downward.
 - f. Field seaming will only be allowed to join factory assembled panels together.
 - g. There shall be no gaps in the seaming.
 3. Place fabric forms immediately following slope preparation.
 4. When conventional joining of fabric forms is impractical or where called for in the Contract Documents, adjacent forms may be overlapped a minimum of three (3) feet to form a lap joint.
 - a. The lap joint shall be constructed as recommended in the manufacturers construction and quality control manual.
 - b. Based on the predominant flow direction, the downstream edge of the form shall overlap the upstream edge of the next form.
 - c. In no case shall simple butt joints between forms be permitted.**
 5. Immediately prior to filling with fine aggregate concrete, the assembled fabric forms shall be inspected by the Engineer.
 - a. No fine aggregate concrete shall be pumped into the fabric forms until their placement has been approved.
 - b. At no time shall the fabric forms be exposed to ultraviolet light (including direct sunlight) for a period exceeding five (5) days.

- D. Following placement and seaming of the fabric, inject fine aggregate concrete between the top and bottom layers of fabric to the specified dimensions.
 - 1. Tightly wrap injection pipe at injection point while pumping.
 - 2. Inject fine aggregate concrete in such a way that the fabric form is fully inflated and excessive pressure on the fabric forms and cold joints are avoided.
 - a. A cold joint is defined as one in which the pumping of the fine aggregate concrete into a given form is discontinued or interrupted for an interval of forty-five (45) minutes or more.
 - b. Repair damage to the fabric form caused by over-inflation to the satisfaction of the Engineer and at no cost to the Owner.
 - 3. After pumping, minimize spillage of the fine aggregate concrete on the surface of the fabric.
 - 4. Sequence injection of fine aggregate concrete such as to insure complete filling of the fabric form to the thickness specified.
 - 5. Holes in the fabric forms left by the removal of the filling pipe shall be temporarily closed by inserting a piece of nonwoven fabric or similar material.
 - a. The nonwoven fabric shall be removed when the concrete is no longer fluid.
 - b. The concrete surface at the hole shall be cleaned and smoothed by hand.
- E. Do not permit foot traffic on the freshly pumped mat when such traffic will cause permanent indentations in the mat surface.
 - 1. Use walk boards where necessary.
 - 2. Clean up excessive fine aggregate concrete that has been inadvertently spilled on the mat surface.
 - 3. Do not permit the use of a water hose to remove spilled fine aggregate concrete from the surface of freshly pumped mat.
- F. The backfilling and compaction of anchor and terminal trenches shall proceed in not less than one hour behind the concrete filling of the fabric formed mat.
 - 1. Backfilling and compaction shall be as specified in Section 31 23 00.
 - 2. Trenches shall be backfilled and compacted to the top of the mat.
 - 3. The trenches of completed sections of mats shall be backfilled and compacted by the end of the work day.
- G. Measure block thickness during fine aggregate concrete injections.
 - 1. Reject any block measuring less than 90 percent of the average of all thickness measurements until acceptable thickness has been attained.
 - a. Average must be 4 IN or greater.

3.3 MANUFACTURER'S REPRESENTATIVE

- A. A manufacturer's representative shall be present for a minimum of 10 percent of the installation of the fabric form unless the Contractor can prove adequate experience in this technology.

END OF SECTION

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SECTION 31 38 40
FINAL SOIL BARRIER

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Soils used in the construction of the barrier component of a landfill cap system.
- B. Related Sections may include but are not necessarily limited to:
 - 1. Division 01 - General Requirements.
 - 2. Section 31 23 00 - Earthwork.
 - 3. Final Cover Quality Control Plan.

1.2 QUALITY STANDARDS

- A. Reference Standards:
 - 1. ASTM International (ASTM):
 - a. D75/D75M, Standard Practice for Sampling Aggregates.
 - b. D422, Standard Test Method for Particle-Size Analysis of Soils (Withdrawn 2016).
 - c. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
 - d. D1140, Standard Test Methods for Determining the Amount of Material Finer than 75- μ m (No. 200) Sieve in Soils by Washing.
 - e. D1556/D1556M, Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - f. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).
 - g. D2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
 - h. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - i. D2488, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
 - j. D2937, Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
 - k. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - l. D4767, Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils.
 - m. D5084, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
 - n. D5321/D5321M, Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear.
 - o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - 2. Environmental Protection Agency (EPA):
 - a. 600/R-93/182, Technical Guidance Document: Quality Assurance and Quality Control for Waste Containment Facilities, September, 1993.
 - 3. American Society of Civil Engineers (ASCE):
 - a. Paper No. 25333, Water Content – Density Criteria for Compacted Soil Liners (Daniel et al, 1990), Published in the ASCE Journal of Geotechnical Engineering.
 - b. Paper No. 23827, In-Site Hydraulic Conductivity for Compacted Clay (Daniel et al, 1989).

1.3 SUBMITTALS

- A. See Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
- B. Shop Drawings:
 - 1. Certification that the proposed material conforms to the Specifications along with copies of the test results (from a qualified commercial testing laboratory).
 - 2. Borrow Source Characterization Study (BSCS) for each material and /or source proposed for the work.
- C. Test Reports:
 - 1. Narrative.
 - 2. Field density test results.
 - 3. Permeability test results.
 - 4. Map of all field test (density, permeability, thickness, etc.) locations.
 - 5. Sealed by a licensed professional.
- D. As-built drawings.
 - 1. Sealed topographic survey of subgrade prior to soil barrier placement.
 - 2. Sealed topographic survey of soil barrier to confirm thickness and record permeability test locations.
- E. Information Submittals:
 - 1. Soil samples for independent testing as requested by Owner's representative.
 - 2. A written certification, by the contractor installing the materials, that lists and states that the work was performed to the specifications and tolerances. This document complements the set of sealed surveys.

1.4 JOB CONDITIONS

- A. Verify conditions of subgrade prior to commencing work.
- B. The work area is on a landfill which may pose risks to personnel. The contractor should be aware of and take precautions to protect personnel from potential safety issues which may include:
 - 1. Hazardous levels of gas (H₂S and other gases),
 - 2. Airborne particulate hazards (coal ash or other dust).
 - 3. Waste sludges.
 - 4. Pathogens.

1.5 TOLERANCES

- A. The barrier soil system must meet the following tolerances:
 - 1. The saturated hydraulic permeability of the barrier soil must be equal to or less than 1E-5 CM/sec, as determined by ASTM D5084.
 - 2. The work should be constructed to lines, grades, and control points indicated on the Drawings, and shall be controlled and documented with survey methods.
 - 3. The thickness of the barrier soil must be equal to or greater than 12 IN, with any excess beyond the grading tolerance located below the design subgrade (on the bottom of the layer).
 - 4. The grading tolerance for the finished surface of barrier soil (including control points and lines) in relation to the design elevation for the completed surface shall be as follows:
 - a. All Areas: 0 to .1 FT above.
- B. Global positioning system (GPS) based survey systems are required for grading.
- C. All field test locations shall be documented by survey, GPS or other approved method demonstrated to be accurate to within 10 FT horizontally.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Materials may be stockpiled on-site in designate areas approved by the Engineer. Each type of material shall be stockpiled separately. Removal and placement of material shall be done in a manner to prevent contaminating stockpiled soils with soils adjacent to and beneath the stockpile that do not meet the specifications.
- B. The bentonite storage sites should be cleared and level. Bentonite material shall be contained and covered to preserve the fitness and quality of the material.

1.7 QUALIFICATIONS

- A. The work shall be managed by personnel that have demonstrated experience in processing and installation of a compacted barrier soil.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All soils must be approved for use by the Engineer prior to use in the Work. See borrow soil characterization study (BSCS) requirements.
- B. Low Permeability Soil - General:
 - 1. Provide natural, fine-grained soil or bentonite amended soil that is capable of being worked to produce a soil layer of thickness shown on the Drawings that meets the hydraulic conductivity requirements.
 - 2. The soil shall be relatively homogeneous in color and texture and shall be free from roots, stones, foreign objects, and other deleterious materials.
 - 3. Some soils not meeting the requirements for Natural Fine-Grained Soil items 1 and 4 below, may be acceptable for use in the Work at the sole discretion of the Engineer. To gain approval for soils not meeting the definition of Natural Fine-Grained Soil, the Contractor must submit data on soils for the Engineer's review. The submittal should contain: A statement signed by a qualified professional engineer that the proposed soils will meet the grain size and hydraulic conductivity requirements and are otherwise suitable for use in the Work; and supporting geotechnical test data and results.
- C. Natural Fine-Grained Soil:
 - 1. Classification: Natural fine-grained soil shall have a classification of SC, SM, CH, CL, MH, or ML as determined by ASTM D2487.
 - 2. Grain sizes shall be within the following gradation:

Sieve Size	Percent Passing by Weight
3/4 IN	100
No. 4	>90
No. 200	>20

- 3. Hydraulic Conductivity: The saturated hydraulic conductivity of the natural fine-grained soil shall meet the stated tolerances, when compacted in accordance with requirements established by the CQC Consultant and Contractor on the basis of the barrier soil test strip as specified herein.
- 4. Other Barrier soil Properties:
 - a. The liquid limit shall be at least 30 as measured by ASTM D4318.
 - b. The plasticity index shall be at least 10 and less than 35 as measured by ASTM D4318.
- D. Bentonite Amended Soil (where applicable):

1. Hydraulic conductivity of constructed bentonite amended soil shall meet the tolerances when compacted in accordance with requirements established by the CQC Consultant on the basis of test results from the barrier soil test strip and the BSCS.
2. Soil used in the bentonite amended soil shall be free from roots, organic matter, debris, particles larger than 3/4 IN, and other deleterious material. All soil used in the bentonite amended soil shall be taken from a borrow area approved by the CQA Consultant and Engineer.
3. Unless approved otherwise by the CQA Consultant, the soil used in the bentonite amended soil shall meet the following washed sieve gradation:

Sieve Size	Percent Passing by Weight
3/4 IN	100
No. 4	55-100
No. 20	45 - 75
No. 200	10 - 40

4. Bentonite:
 - a. Bentonite shall be free-flowing, powdered, high-swelling, sodium montmorillonite clay free of additives.
 - b. Acceptable bentonite manufacturers are:
 - 1) Bentonite Performance Minerals LLC (281) 871-7900.
 - 2) CETCO (847) 851-1800.
 - 3) WYO-BEN, (800) 548-7055.
 - 4) Approved equal.

E. Permeability Test:

1. Laboratory permeability tests (ASTM D5084) shall be conducted in constant head, triaxial type permeameters. The specimens shall be consolidated under an isotropic effective consolidation stress not to exceed 10 PSI. The inflow to and outflow from the specimens shall be monitored with time and the coefficient of permeability calculated for each recorded flow increment. The test shall continue until steady state flow is achieved and relatively constant values of coefficient of permeability are measured.

F. Interface Friction Tests:

1. Test materials using ASTM D5321.
2. This material is part of a system. The entire system must meet the requirements before any component material is deemed acceptable.
3. Any retesting or other additional testing required to demonstrate compliance with the Specifications shall be at no additional cost to the Owner.

2.2 BARRIER SOIL MATERIAL ACCEPTANCE

A. General:

1. Notify the CQA Consultant at least 24 HRS prior to sampling so that they may observe the sampling procedures.
2. All tests necessary for the Contractor to locate and define acceptable sources of materials shall be made by the CQC Consultant.
3. Contractor to furnish samples to CQA/Engineer upon request without charge.
4. All samples required in this Section shall be representative and be clearly marked to show the source of the material and the intended use on the project. Sampling of the material source shall be done by the CQC Consultant in accordance with ASTM D75.
5. Tentative acceptance of the material source shall be based on an inspection of the source by the CQA Consultant and the certified test results of the Borrow Source Characterization

Study (BSCS) as submitted by the Contractor. No imported materials shall be delivered to the site until the proposed source and materials tests have been accepted in writing by the CQA Consultant and or Engineer.

6. Final acceptance of any material will be based on results of tests made on material samples taken from the completed barrier soil test strip, combined with the results of the BSCS. If tests conducted by the CQC Consultant or the CQA Consultant indicate that the material does not meet Specification requirements, material placement will be terminated until corrective measures are taken. Material which does not conform to the Specification requirements and is placed in the work shall be removed and replaced at the Contractor's sole expense.
7. Be solely responsible for obtaining all permits required to obtain acceptable sources of materials for use in the work.

B. Sampling and testing required herein shall be done at the Contractor's sole expense.

C. Borrow Source Characterization Study:

1. CQC Consultant shall complete one BSCS study per source of natural fine-grained soils or of soil that will be used in bentonite amended soils.
2. The Contractor will be responsible for all processing and screening of the barrier soil material at their own cost to meet the requirements of the Specifications. The Contractor will be responsible for the erosion protection of the stockpile and borrow area during his operation. Coordinate all aspects of this operation with the Engineer, CQC Consultant, CQA Consultant, and Project Manager.
3. Conduct tests, including particle size, Atterberg limits, moisture-density, and hydraulic conductivity tests, as necessary to locate an acceptable source of material.
4. Once a potential source of material has been located, the CQC Consultant shall develop and undertake a testing program to demonstrate the acceptability of the proposed material. Certified results of all tests shall be submitted to the CQA Consultant upon completion of tests. Tentative acceptance of the borrow source by the CQA Consultant will be based upon the results of the study. The testing program shall include the following elements, at a minimum:
 - a. An excavation plan for the borrow source indicating proposed surface mining limits and depths of samples to be taken for testing.
 - b. Test pits for borrow source sampling shall be appropriately spaced to reflect site geomorphology and sampled at depth intervals appropriate to the proposed excavation methods.
5. Test Parameters and Reporting:
 - a. Test natural soils from each proposed borrow area.
 - b. Where applicable, test the bentonite amended soil product for acceptance in addition to the borrow area tests.
 - c. Test frequency: a minimum of five samples or one per 20,000 cubic yards of estimated in-place quantity, whichever is greater per location/material.
 - d. Testing:

Parameter	Test Method.
Particle Size (sieve plus hydrometer)	ASTM D422
Atterberg Limits	ASTM D4318
Standard Proctor	ASTM D698
Hydraulic Conductivity ⁽¹⁾	ASTM D5084

(1) Hydraulic conductivity tests shall be performed on recompacted samples of the proposed material compacted according to criteria developed by the CQC Consultant using data from tests conducted in accordance with ASTM D698.

6. Develop an Acceptable Window: Determine an acceptable zone of moisture contents and dry unit weights for which permeabilities are less than or equal to the specified value in general accordance with ASCE paper 25333, which is generally outlined below and other pertinent criteria.
 - a. Compact five or six different specimens in the laboratory; each with modified, standard, and reduced Proctor compaction procedures and plot on a moisture-density curve.
 - b. Permeate compacted specimens to determine their hydraulic conductivity.
 - c. On the graph of dry density vs. moisture content, identify the samples which have hydraulic conductivities less than or equal to 1.0×10^{-5} CM/s.
 - d. Draw an “acceptable zone” of water content and dry density around the samples with hydraulic conductivities less than or equal to the maximum acceptable value.
 - e. Perform Internal Shear Tests (ASTM D4767) and Interface Shear Tests (ASTM D6321) on specimens and plot the friction angles (internal and interface with the textured synthetic liner) as a function of molding water content.
 - f. Modify the acceptable zone based on other considerations e.g. Shear strength, interface friction, shrink/ swell potential and other appropriate considerations.
 - g. Provide the test data and graphs for review.
7. Bentonite Amended Soil Testing (where applicable):
 - a. For acceptance of a source for soils to be used in bentonite amended soils, perform a Design Mix Analysis and submit certifications for the imported bentonite material as described below.
 - b. Design Mix Analysis:
 - 1) Collect two of the coarsest samples of the soil taken from the approved borrow area (based on percent retained on #200 sieve). Soil samples for testing shall be at least 100 LBS each.
 - 2) Trial mix samples shall be prepared by mixing each soil sample with three trial application rates of bentonite. Compact each trial mix sample to a dry density equal to 95 PCT relative compaction and at a moisture content within the range of optimum to optimum plus 3 PCT (ASTM D698) for the unamended soil.
 - 3) Test the hydraulic conductivity of the trial mix samples using ASTM D5084 and report all data to CQA Consultant. Graph measured hydraulic conductivity vs. percent bentonite.
 - 4) Select a minimum bentonite content needed to consistently achieve the required in-place hydraulic conductivity.
 - c. Bentonite: CQC Consultant shall submit certifications from the supplier of the bentonite material that it meets the requirements specified under PART 2 - PRODUCTS.

D. Soils Conformance Testing:

1. Following acceptance of a borrow source for natural fine-grained soils and soils for bentonite amendment, perform the following tests on samples taken from the production material using the methods and at the frequencies indicated below:

Test	Test Method	Minimum Frequency
Percent Fines	ASTM D1140	1 per 10,000 CUYD
Atterberg Limits	ASTM D4318	1 per 10,000 CUYD
Standard Proctor	ASTM D698	1 per 10,000 CUYD

2. When amended soils are used, conduct tests of the mixed bentonite amended soil, after it has been discharged from the pugmill and before this is placed in the work using the methods and at the frequencies indicated below:

Test	Method	Minimum Frequency
Standard Proctor	ASTM D698	1 per 10,000 CUYD

3. The Engineer may increase the frequency if results indicate more than 2 PCT of the material is not compliant to the BSCS criteria.
4. Any failing test by either CQC or CQA, shall be treated as a failure of the material to meet specifications.
5. If tests indicate material does not meet Specification requirements, Terminate material placement until corrective measures are taken.
6. Remove and replace material which does not meet Specification requirements at no additional cost to the Owner.

2.3 EQUIPMENT

A. Compaction Equipment:

1. The compaction equipment shall be of a suitable type, adequate to obtain the permeability specified, that provides a kneading action, such as a wobble-wheeled roller or a sheepsfoot roller having tines as long as the maximum loose lift thickness to ensure proper lift interface compaction free of voids.
2. The CQC Consultant shall confirm compaction equipment adequacy, and recommend changes if required, based on the barrier soil test strip. Such additional equipment will be provided by Contractor at no additional cost.
3. Hand-operated equipment shall be capable of achieving specified soil densities.
4. The finished surface of the final lift shall be rolled with a smooth steel drum roller or rubber-tired roller to eliminate tine or roller marks and provide a smooth, dense surface for geomembrane placement.

B. Moisture Control Equipment:

1. Equipment for applying water shall be of a type and quality adequate for the work, shall not leak, and shall be equipped with a distributor bar or other approved device to assure uniform application.
2. Equipment for mixing and drying out material shall consist of blades, discs, or other equipment defined by the CQC Consultant as approved by the CQA Consultant.
3. Mixing of natural fine-grained soils may also be required to get even distribution of moisture.
4. Allow sufficient time for adjustment of soil water content to fully saturate the lift prior to applying compaction effort, unless otherwise approved by CQA consultant.

C. Bentonite Amended Soil Mixing Equipment (where applicable):

1. Mix, process, and condition the bentonite amended soil in a pugmill prior to placing and compacting the mixture.
2. The pugmill shall have the capability to break up soil clumps and mix material to form a homogeneous blend. The pugmill shall have controls that allow a variable rate of discharge from it, to control the degree of mixing. The pugmill shall have automated controls to control the rate of feed of each material to within an accuracy of 2 PCT by weight.
3. The pugmill discharge shall be equipped with a batching bin having a drop outlet for loading hauling vehicles directly from the pugmill. Pugmill shall be positioned to allow direct discharge to hauling vehicles.
4. Do not store amended soil in a manner or for a length of time that will cause any degradation of the project or amended soil.

PART 3 - EXECUTION

3.1 BARRIER SOIL TEST PAD

A. Installation:

1. Prior to barrier soil production placement, a barrier soil test strip of a dimension no less than 100 FT long by 30 FT wide by the specified thickness shall be constructed by the Contractor over a compacted subgrade within the lined site.
 2. The barrier soil test strip shall be constructed in 6 IN lifts. The final compacted thickness of each lift shall be a maximum of 6 IN. prior to placement of successive lifts, the surface of the lift in place shall be scarified or otherwise conditioned to eliminate lift interfaces.
 3. The barrier soil test strip shall be constructed using the same equipment and construction procedures that are anticipated for use during actual installation.
 4. During test strip installation, the Contractor in coordination with his CQC Consultant shall determine the field procedures that are best suited for his construction equipment to achieve the requirements specified herein. If subsequent testing invalidates the performance of the procedures the CQA Consultant may require that the Contractor establish new procedures.
- B. Testing.
1. The CQC Consultant shall document that the subgrade of the barrier soil test strip is properly compacted to at least 95 PCT of the maximum dry density, as determined using the Standard Proctor test (ASTM D698) at a minimum of three test locations within the test strip area.
 2. A minimum of five random samples of the barrier soil construction materials delivered to the site during test strip installation shall be tested by the CQC Consultant for moisture content (ASTM D2216), soil type (ASTM D2488) sieve analyses with hydrometer (ASTM D422) and Atterberg limits (ASTM D4318).
 3. The CQC Consultant shall conduct at least one standard Proctor (ASTM D698), one modified Proctor (ASTM D1557) compaction test, and one 'reduced Proctor' (std. Proctor with 15 blows per lift) to establish the moisture-density relationship ranges needed to achieve the required hydraulic conductivity (see ASCE Paper No. 23827).
 4. At least five field density measurements shall be performed by the CQC Consultant on each lift of the barrier soil test strip. Conduct field density tests by the same methods that will be used during production. The density measurement if performed by a nuclear gauge shall be verified through performance of one sand cone test (ASTM D1556) or drive tube test (ASTM D2937) at a location selected by the CQA Consultant. The moisture content measurement, if performed by a nuclear gauge shall be verified by recovering at least five samples for oven-dry testing (ASTM D2216) from the test location.
 5. A composite sample will be taken from each lift for recompacted lab permeability (ASTM D5084).
 6. Upon completion of the barrier soil test strip, the CQC Consultant, as observed by the CQA Consultant, shall measure the thickness of the test strip at a minimum of five random locations.
 7. A minimum of one undisturbed sample shall be taken from each lift of the test strip by the CQC Consultant for laboratory hydraulic conductivity testing. The samples shall be taken within a 2 FT radius of the in-situ density and moisture tests. The CQA Consultant will also conduct at least one confirmatory in-situ hydraulic conductivity testing.
- C. Acceptance/Rejection:
1. Upon receipt of the test data from the CQA Consultant and review of the results, the Project Manager shall inform the Contractor if the test strip can remain in-place as part of the barrier soil.
 2. The test strip will be considered acceptable if the measured hydraulic conductivity of the test strip as determined by ASTM D5084 meets the requirements of the Specifications.
 3. If field and laboratory test data indicate that the installed test strip meets the requirements of this Specification, it may be used as part of the barrier soil provided that it is adequately protected by the Installer from drying and equipment damage after installation. The Installer shall scarify the barrier soil material along the edge of the test strip. A minimum 2 FT overlap per lift is required for mixing and compaction between the test strip and the barrier soil.

4. If the test strip fails to achieve the desired results, the soil material of the test strip shall be completely removed, and additional mix designs (if bentonite amended) and/or test strips will be constructed until a test strip meets the requirements. No additional barrier soil may be placed until a test strip has been accepted by the Engineer.
5. The data gathered from the test strip(s) (i.e., field density, moisture, undisturbed samples, and in-situ hydraulic conductivity) shall be used along with the Proctor curves for the soil to modify the range of acceptable moisture and density test values, per ASCE Paper No. 25333 which are likely to be consistent with the required maximum permeability as recommended by ASCE Paper No. 23827. This range of moisture/density values will be established by the CQC Consultant and the CQA Consultant and will be added to the data from the BSCS and utilized as a means to establish Pass/Fail Criteria for the installation of the subject material.

3.2 INSTALLATION

- A. Repair leachate seeps as required.
- B. The subgrade shall be smooth and free of vegetation, sticks, roots, foreign objects, and debris. It shall be the responsibility of the Contractor to keep the receiving surfaces in the accepted condition until complete installation of the barrier soil is accomplished.
- C. The barrier soil shall not be placed over areas deemed unacceptable by either the CQC or CQA Consultants based on proofroll observations or inadequate test results.
- D. The barrier soil shall be installed in 6 IN compacted lifts. The material shall be placed consistent with criteria developed from construction of a satisfactory test strip.
- E. When particles exceeding 1/2 IN are observed at the final lift surface, they shall be removed by the Contractor prior to final rolling of the surface.
- F. For existing barrier soil remaining in place on the landfill, contractor shall scarify, blade, disc, moisture condition, and compact the top 12 IN of material to achieve the hydraulic conductivity specified in section 1.5.
- G. Equipment shall be used such that bonding of the lifts will occur. Equipment shall have cleats or other protrusions of such length necessary to completely penetrate into the loose lift. Compaction shall be performed using appropriately heavy, properly ballasted, penetrating foot compactor making a minimum number of passes as approved by the CQC Consultant and CQA Consultant based on the barrier soil test strip.
- H. Dry, blend, or wet material as required to maintain the barrier soil at suitable moisture content.
- I. If desiccation and crusting of the lift surface occurs prior to placement of the next lift, this area shall be scarified to a minimum depth of 2 IN or until sufficiently moist materials are encountered, whichever is greater. After scarification, the superficial material should be reworked to obtain moisture content at least 2 PCT above optimum moisture content. Alternately, the drier superficial soil may be stripped and mixed with additional moist soil to achieve a moisture content satisfying the project requirements.
- J. No frozen material shall be placed.
- K. Material shall not be placed on a previous lift which is frozen. Frozen in-place material shall be removed prior to placement of additional soil material.
- L. Material which has been subjected to a freeze/thaw cycle(s) shall be disked and recompact prior to placement of subsequent lifts.
- M. During construction, exposed finished lifts of the barrier soil material should be sprinkled with water to minimize desiccation, as necessary. The Contractor is responsible to protect the barrier soil from rain, drying, desiccation, erosion and freezing. All defective areas shall be repaired by the Contractor to the satisfaction of the CQC Consultant at no extra compensation.

- N. At the end of each day's construction activities, completed lifts or sections of the compacted barrier soil should be sealed. Common sealing methods include rolling with a rubber tired or smooth-drum roller, back dragging with a bulldozer, or placement of temporary cover soil over the compacted barrier soil. The compacted barrier soil should be sprinkled with water, as needed.
- O. If testing shows that a lift is significantly thicker than 6 IN, the top of the lift will be shaved off so that the lift is approximately 6 IN thick.

3.3 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

- A. Refer to the CQA Plan and EPA publication 600/R-93/182.
- B. Soil CQC testing will be performed by JBS Engineering and Environmental.
- C. Confirm specified thickness by survey at a frequency of 1 per 5,000 square feet or fraction thereof.
- D. The following field and laboratory quality control tests shall be performed during barrier soil construction:

Test	Method	Minimum Frequency	Acceptable Criteria
Field Density	ASTM D2937	1/10,000 SQFT/lift	≥95 PCT of ASTM D698
Atterberg Limits	ASTM D4318	1/acre/lift	BSCS Criteria
Fines Content	ASTM D1140	1/acre/lift	BSCS Criteria
Hydraulic Conductivity	ASTM D5084	1/acre/lift	≤1x10 ⁻⁵ CM/SEC
Laboratory Moisture Density Relationship	ASTM D698	1/5,000 CUYD of placed material	NA

- E. Testing and results shall conform to criteria above, unless Engineer accepts a modification per Paragraph 3.1.C.5. of Barrier Soil Test Strip.
- F. Test frequencies may be modified by the Engineer. If there are indications of declining or failing test results, frequencies may be increased. If hydraulic conductivity test results are well above acceptable, the frequency for Atterberg limit and fine content testing may be waived by the Engineer.
- G. The acceptable criteria may be modified by the CQA Consultant if supported by the test strip results and approved by the Engineer.
- H. Holes in the compacted barrier soil, such as those created as a result of destructive testing (e.g. thin-walled Shelby tube sampling and nuclear gauge, field density determinations), shall be backfilled and tamped by rod, uniformly in 2 IN thick lifts. The backfill material shall be the same material or hydrated bentonite powder, if approved by the CQA Consultant. On the surface, the backfill material shall extend slightly beyond the holes to make sure that a good tie-in with the surrounding barrier soil is achieved. Repaired areas shall be observed and documented by the CQC Consultant.
- I. Give minimum of 24 HR advance notice to CQA Consultant when ready for soil testing and inspection in completed area of the barrier soil.
- J. For areas not meeting field and laboratory testing criteria, scarify the full depth of the lift or replace the material as needed. The material shall be reworked, moisture conditioned, and compacted to the specified density. Areas not meeting the thickness requirements shall be augmented with additional materials. The added materials shall be reworked with the soil layer to ensure homogeneity and proper bonding. This may be done by scarification of the surface

prior to addition of new material. The repaired area shall be properly documented, and field and laboratory quality control testing shall be performed to ensure the repaired barrier soil section meets the requirements specified herein.

- K. Pay for all costs associated with corrective work and retesting resulting from failing tests. The CQA Consultant shall be informed immediately of all failing tests.
- L. Plot all field density test locations by lift on an electronic drawing and provide engineers or surveyors certification of the accuracy of the locations.
- M. Field density test locations not accurately documented or precisely located may not be counted towards the required testing frequency.

END OF SECTION

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SECTION 32 91 13
TOPSOILING AND FINISHED GRADING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Topsoiling and finished grading.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 10 00 - Site Clearing.
 - 4. Section 31 23 00 - Earthwork.
 - 5. Section 31 25 00 - Soil Erosion and Sediment Control.
 - 6. Section 32 92 00 - Seeding, Sodding and Landscaping.
- C. Location of Work: All areas within limits of grading and all areas outside limits of grading which are disturbed in the course of the work.

1.2 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Project Data: Test reports for furnished topsoil.

1.3 SITE CONDITIONS

- A. Verify amount of topsoil stockpiled and determine amount of additional topsoil, if necessary to complete work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil:
 - 1. Original surface soil typical of the area.
 - 2. Existing topsoil stockpiled under Specification Section 31 10 00.
 - 3. Friable, loamy soil capable of supporting native plant growth.

2.2 TOLERANCES

- A. Finish Grading Tolerance: ± 0.1 FT from required elevations.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Correct, adjust and/or repair rough graded areas.
 - 1. Cut off mounds and ridges.
 - 2. Fill gullies and depressions.
 - 3. Perform other necessary repairs.
 - 4. Bring all sub-grades to specified contours, even and properly compacted.
- B. Loosen surface to depth of 2 IN, minimum.
- C. Remove all stones and debris over 2 IN in any dimension.

3.2 ROUGH GRADE REVIEW

- A. Reviewed by Engineer in Specification Section 31 10 00.

3.3 PLACING TOPSOIL

- A. Do not place when subgrade is wet or frozen enough to cause clodding.
- B. Spread and lightly compact to a depth of 6 IN for all disturbed earth areas.
- C. If topsoil stockpiled is less than amount required for work, furnish additional topsoil at no cost to Owner.
- D. Provide finished surface free of stones, sticks, or other material 1 IN or more in any dimension.
- E. Provide finished surface smooth and true to required grades.
- F. Restore stockpile area to condition of rest of finished work.

3.4 ACCEPTANCE

- A. Upon completion of topsoiling, obtain Engineer's acceptance of grade and surface.
- B. Make test holes where directed to verify proper placement and thickness of topsoil.

END OF SECTION

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SECTION 32 92 00
SEEDING, SODDING AND LANDSCAPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Seeding, sodding and landscape planting:
 - a. Soil preparation.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Nursery and Landscape Association/American National Standards Institute (ANLA/ANSI):
 - a. Z60.1, American Standard for Nursery Stock.
 - 2. AOAC International (AOAC).
 - 3. ASTM International (ASTM):
 - a. D2028, Standard Specification for Cutback Asphalt (Rapid-Curing Type).
 - b. D5276, Standard Test Method for Drop Test of Loaded Containers by Free Fall.
- B. Quality Control:
 - 1. Fertilizer:
 - a. If Engineer determines fertilizer requires sampling and testing to verify quality, testing will be done at Contractor's expense, in accordance with current methods of the AOAC.
 - b. Upon completion of Project, a final check of total quantities of fertilizer used will be made against total area seeded.
 - c. If minimum rates of application have not been met, Contractor will be required to distribute additional quantities to make up minimum application specified.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Layout drawings:
 - a. Scaled site plan (scale 1 IN = 20 FT or equal to scale of Project site plan Drawing) on reproducible Drawing to show:
 - 3. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Manufacturer's installation instructions.
 - c. Signed copies of vendor's statement for seed mixture required, stating botanical and common name, place of origin, strain, percentage of purity, percentage of germination, and amount of Pure Live Seed (PLS) per bag.
 - d. Type of herbicide to be used during first growing season to contain annual weeds and application rate.
 - 4. Certification that each container of seed delivered will be labeled in accordance with Federal and State Seed Laws and equals or exceeds Specification requirements.

1.4 SEQUENCING AND SCHEDULING

- A. Installation Schedule:
 - 1. Show schedule of when lawn type and other grass areas are anticipated to be planted.

2. Indicate anticipated dates Engineer will be required to review installation for initial acceptance and final acceptance.
- B. Pre-installation Meeting:
1. Meet with Engineer and other parties as necessary to discuss schedule and methods, unless otherwise indicated by Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Native Grass Seeding: Certified seed of locally adapted strains.
- B. Application:
1. Broadcast seeding.
 2. Apply as hydro-mulch mixture.
- C. Water:
1. Water free from substances harmful to grass or sod growth.
 2. Provide water from source approved prior to use.
- D. Acceptable seeding rates:
1. Spring: March - September (Combination of Bermuda and Bahia)
 - a. Bahia Seed – 20lb/acre
 - b. Bermuda Seed “hulled” – 25 lb/acre
 - c. Fertilizer – 600 lb/acre
 2. Fall: October – February
 - a. Rye (use in critical areas that require a quick growing time) – 20 lb/acre
 - b. Wheat – 120 lb/acre
 - c. Fertilizer – 400 lb/acre

PART 3 - EXECUTION

3.1 SOIL PREPARATION

- A. General:
1. Limit preparation to areas which will be planted soon after.
 2. Provide facilities to protect and safeguard all persons on or about premises.
 3. Protect existing trees designated to remain.
 4. Verify location and existence of all underground utilities.
 - a. Take necessary precaution to protect existing utilities from damage due to construction activity.
 - b. Repair all damages to utility items at sole expense.
- B. Preparation for Seeding:
1. Loosen surface to minimum depth of 4 IN.
 2. Remove stones over 1 IN in any dimension and sticks, roots, rubbish, and other extraneous matter.
 3. Prior to applying fertilizer, loosen areas to be seeded with a double disc or other suitable device if the soil has become hard or compacted.
 4. Correct any surface irregularities in order to prevent pocket or low areas which will allow water to stand.
 5. Distribute fertilizer uniformly over areas to be seeded according to manufacturer’s directions.
 6. Incorporate fertilizer into soil to a depth of at least 2 IN by disking, harrowing, or other approved methods.
 7. Remove stones or other substances from surface which will interfere with turf development or subsequent mowing operations.

8. Grade to a smooth, even surface with a loose, uniformly fine texture.
 - a. Roll and rake, remove ridges and fill depressions, as required to meet finish grades.
 - b. Limit fine grading to areas which can be planted soon after preparation.
9. Restore areas to specified condition if eroded or otherwise disturbed after fine grading and before planting.

3.2 INSTALLATION

A. Pasture Seeding:

1. Do not use seed which is wet, moldy, or otherwise damaged.
2. Perform seeding work from April 20 to May 15 for spring planting, and August 1 to September 15 for fall planting, unless otherwise approved by Engineer.
3. Employ satisfactory methods of sowing using mechanical power-driven drills or seeders, mechanical hand seeders, or other approved equipment.
4. Distribute seed evenly over entire area with 50 percent sown in one direction, and the remainder at right angles sown to first sowing.
5. Stop work when work extends beyond most favorable planting season for species designated, or when satisfactory results cannot be obtained because of drought, high winds excessive moisture, or other factors.
 - a. Resume work only when favorable conditions develop.
6. Lightly rake seed into soil followed by light rolling or cultipacking.
7. Immediately protect seeded areas against erosion by mulching.
 - a. Spread mulch in continuous blanket using 1-1/2 tons per acre to a depth of 4 or 5 straws. Use a tacking method over the mulched area.
8. Protect seeded slopes against erosion with erosion netting or other methods approved by Engineer.
 - a. Protect seeded areas against traffic or other use by erecting barricades and placing warning signs.

3.3 MAINTENANCE AND REPLACEMENT

A. General:

1. Begin maintenance of planted areas immediately after each portion is planted and continue until final acceptance or for a specific time period as stated below, whichever is the longer.
2. As required provide and maintain temporary piping, hoses, and watering equipment to convey water from water sources and to keep planted areas uniformly moist for proper growth.
3. Protection of new materials:
 - a. Provide barricades, coverings or other types of protection necessary to prevent damage to existing improvements indicated to remain.
 - b. Repair and pay for all damaged items.
4. Replace unacceptable materials with materials and methods identical to the original specifications unless otherwise approved by the Engineer.

B. Seeded Areas:

1. Maintain seeded areas for a minimum of 90 days, minimum, after installation and acceptance of entire project area to be planted.
2. Maintenance period begins at completion of planting and establishment of at least 70% coverage as determined by Engineer.
3. Engineer will review seeded area after installation for initial acceptance.
4. Maintain seeded area by watering, fertilizing, weeding, mowing, trimming, and other operations such as rolling, regrading, and replanting as required to establish a smooth, uniform area, free of weeds and eroded or bare areas.
5. Lay out temporary watering system and arrange watering schedule to avoid walking over muddy and newly seeded areas.
 - a. Use equipment and water to prevent puddling and water erosion and displacement of seed or mulch.

6. Mow seeded area as soon as there is enough top growth to cut with mower set at recommended height for principal species planted.
 - a. Repeat mowing as required to maintain height.
 - b. Do not delay mowing until grass blades bend over and become matted.
 - c. Do not mow when grass is wet.
 - d. Time initial and subsequent mowings as required to maintain a height of 1-1/2 to 2 IN.
 - e. Do not mow lower than 1-1/2 IN.
7. Remulch with new mulch in areas where mulch has been disturbed by wind or maintenance operations until disturbed areas have been sufficiently covered.
 - a. Anchor as required to prevent displacement.
8. Unacceptable plantings are those areas that do not meet the quality of the specified material, produce the specified results, or were not installed to the specified methods.
9. Replant bare areas using same materials specified.
10. Engineer will review final acceptability of installed areas at end of maintenance period.
11. Maintain repaired areas until remainder of maintenance period or approved by Engineer, whichever is the longer period.

END OF SECTION

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SECTION 33 40 00
STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Storm drainage systems.
 - 2. Storm drainage pipe.
 - 3. Inlets, headwalls, flumes and flared end sections.
- B. Related Specification Sections include but are not necessarily limited to:
 - 1. Division 00 - Procurement and Contracting Requirements.
 - 2. Division 01 - General Requirements.
 - 3. Section 31 23 33 - Trenching, Backfilling, and Compacting for Utilities.

1.2 QUALITY ASSURANCE

- A. Referenced Standards:
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. M36, Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760/A760M).
 - b. M190, Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches.
 - 2. ASTM International (ASTM):
 - a. A760/A760M, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
 - b. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
 - c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
 - d. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
 - e. F2510/F2510M, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual- and Triple-Wall Polyethylene and Polypropylene Pipes.
 - f. F2648/F2648M, Standard Specification for 2 to 60 IN (50 to 1500 MM) Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.
 - 3. Texas Department of Transportation Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges 2014:
 - a. Standard Details and Specifications.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
 - 2. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - 3. Certifications.
 - 4. Test reports.
 - 5. Submit all tests and certification in a single coordinated submittal.
 - a. Partial submittals will not be accepted.
- B. Submit schedules and details for structures and joints.

1.4 WARRANTY

- A. Warrant that the infiltration will not exceed the amount specified in the Exfiltration Test paragraph in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section during the one year correction period.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Reinforced Concrete Pipe (RCP):
 - 1. Reinforced concrete culvert, storm drain and sewer pipe: ASTM C76, Classes III, IV, and V.
- B. RCP Joint Sealer:
 - 1. Rubber gasket: ASTM C361.
- C. Flared End Sections:
 - 1. Conform to TxDOT Specifications.
 - 2. Bituminous coated: AASHTO M190, Type A.
 - 3. Jointing: Same as pipe.
- D. Corrugated Metal Pipe (CMP):
 - 1. AASHTO M36 (ASTM A760/A760M), 16 GA.
 - 2. Bituminous coated: AASHTO M190, Type A.
 - 3. Jointing: Connecting bands of same base metal coated as pipe.
- E. High Density Polyethylene Pipe (HDPE):
 - 1. ASTM F2648/F2648M.
 - 2. ASTM F2510/F2510M.
- F. CMP Joint Sealer:
 - 1. Cold applied asphalt joint compound.
 - 2. Preformed flexible pipe joint sealing compound.
 - 3. Rubber gasket: ASTM C361.
- G. Concrete and Reinforcement for Headwalls, and Flumes:
 - 1. Comply with TxDOT specifications, Drawings, and Details.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Comply with Specification Section 31 23 33.

3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Comply with Specification Section 31 23 33.

3.3 FIELD QUALITY CONTROL

- A. Verify and coordinate installation.
- B. In case of conflict, do not relocate piping without prior approval from the Engineer.

END OF SECTION



Final Cover Quality Control Plan (FCQCP)

Gibbons Creek Steam Electric Station

Site A and Site F Landfill Closure

GCERG, Inc.

Grimes County, TX

July 2021



ISSUED FOR CONSTRUCTION

HDR Engineering, Inc.
Firm Registration No. F-754

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Dallas, Texas 75248
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1 General

This Final Cover Quality Control Plan (FCQCP) has been prepared to provide the Owner, Engineer, and Construction Quality Assurance (CQA) Consultant the means to govern the construction quality and to document construction operations in accordance with the engineering drawings.

More specifically, this FCQCP addresses the components required to construct the closure system for the Site A and Site F Landfills. The common components of a closure system often include many of the following layers: soil subgrade, compacted soil liner, geomembrane, a drainage geocomposite, an infiltration layer and topsoil. As many of the components are the same or similar for both landfills, this CQA plan is organized by the components of the work. This plan is intended to be used for both closure systems; therefore it includes material components that may not be used on both projects.

The CQA Plan is divided into the following sections:

- 1 General
- 2 Soil Liner
- 3 Geomembrane Liner
- 4 Drainage Geocomposite
- 5 Earthen Drainage & Protective Components
- 6 Geotextile
- 7 High Density Polyethylene Pipe, Manholes, & Fittings
- 8 Surveying
- 9 Documentation

1.1 Scope of Construction Quality Assurance Plan

The scope of this FCQCP includes the CQA of the soils and geosynthetic components of the landfill closure systems. The CQA for the selection, evaluation, and placement of the soils is included in the scope. This document is intended to be used in concert with the CQC requirements presented in the project specifications.

1.2 Definitions

1.2.1 Construction Quality Assurance

In the context of this plan, construction quality assurance is defined as a planned and systematic program employed by the Owner to assure conformity of the constructed closure system with the design drawings and the project specifications. CQA is provided by the CQA Consultant as a representative of the Owner and is independent from the Contractor and all manufacturers. The CQA program is designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service.

1.2.2 Construction Quality Control

Construction Quality Control refers to actions taken by manufacturers, fabricators, installers, or the Contractor to ensure that the materials and the workmanship meet the requirements of the

design plans and project specifications. For earthen components such as the compacted clay liner, the infiltration layer and topsoil, CQC will be provided by Owner's CQA Consultant. In the case of geosynthetic components, material quality control is provided by manufacturer certifications and the CQC for the installation of the various geosynthetics is provided by the Contractor's CQC Consultant. The manufacturer's specifications and quality control (QC) requirements are included in this CQA Plan by reference only.

1.2.3 Minimum Average Roll Value (MARV)

Geosynthetics are commonly specified on a minimum or maximum average roll value (MARV). The MARV is the value two standard deviations away from the average value for the product.

1.2.4 CQA/CQC Certification Document

At the completion of construction, a certification document will be prepared by the CQA Consultant and be submitted to the state regulatory agency. The certification report will include all QC testing performed by the Geosynthetics Manufacturers, all CQC testing performed by the CQC Consultant, or Geosynthetic Installers, and all CQA conformance testing performed by the CQA Consultant.

1.2.5 Units

In this CQA Plan, all properties and dimensions are expressed in U.S. units.

1.2.6 References

The CQA Plan includes references to the test procedures of the ASTM International (ASTM), and the "Geosynthetic Research Institute" (GRI).

1.3 Governance between Documents

The CQA Plan is intended to be a supporting document to improve the overall documentation of the Work. The CQA Plan is less specific than the project specifications, and conflicts may exist between the documents. The Contractor is instructed to bring all apparent discrepancies or conflicts to the attention of the Engineer or CQA Consultant for resolution. The Engineer has the sole authority to determine resolution of conflicts existing within the Contract Documents. The more stringent requirement shall control the resolution, unless otherwise determined by the Engineer.

1.4 Parties to Construction Quality Assurance

The lines of authority and communications between each of the parties involved in the CQA and CQC are illustrated in Figure 1.

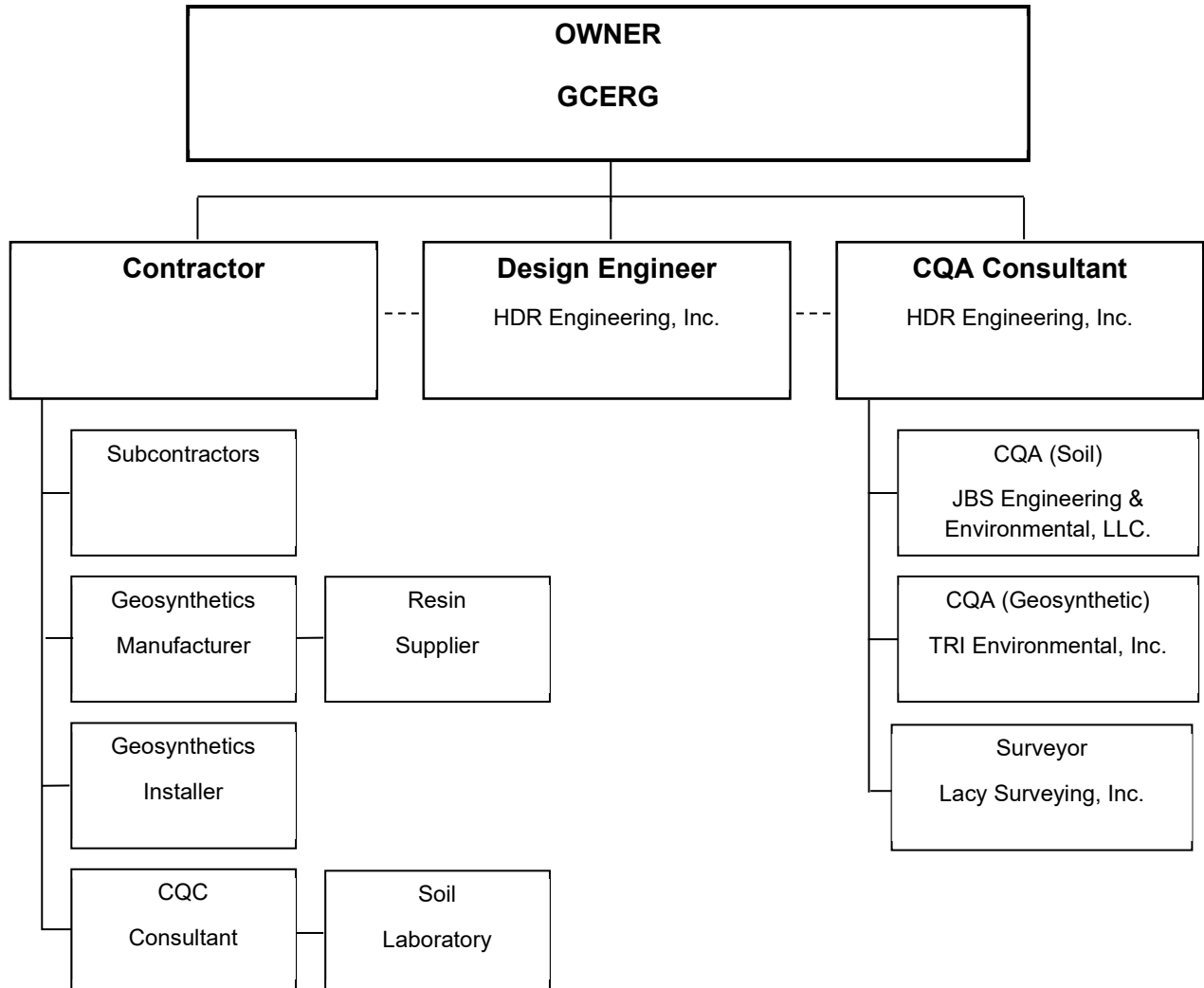


Figure 1 CQA/CQC Lines of Authority and Communication

1.4.1 Owner

The Owner is the Gibbons Creek Environmental Redevelopment Group (GCERG), who owns and/or is responsible for the facility.

1.4.2 Project Manager

The Project Manager is the official representative of the Owner. The Project Manager serves as communications coordinator for the project, initiating the resolution, preconstruction, and construction meetings outlined in this section. The Project Manager shall also be responsible for proper resolution of all quality issues that arise during construction.

1.4.3 Design Engineer

The Design Engineer is responsible for the engineering design, drawings, plans and project specifications for the liner system and protective cover system. The Design Engineer is HDR Engineering, Inc.

1.4.4 Contractor

The Contractor is responsible for the construction of the project and system components in accordance with contract specifications. The Contractor is responsible for all of their subcontractors. The Contractor is responsible for submittal coordination and the overall CQC on the project.

1.4.5 Geosynthetics Manufacturer

The Geosynthetics Manufacturer(s) is (are) responsible for the production of geomembranes, geonets, and geotextiles. The manufacturers are responsible for Quality Control (QC) during manufacture of the geosynthetic components, certification of the properties of the geosynthetic components, and field installation criteria.

1.4.6 Geosynthetics Installer

The Geosynthetics Installer(s) may be the Contractor or a subcontractor to the Contractor and is (are) responsible for field handling, storing, placing, seaming, protection of (against wind, etc.), and other aspects of the geosynthetics installations, including the geomembranes, and geotextiles. The Geosynthetics Installer may also be responsible for transportation of these materials to the site and for the preparation and completion of anchor trenches.

1.4.7 Construction Quality Assurance Consultant

The CQA Consultant, HDR Engineering, Inc., is a representative of the Owner and is responsible for observing, testing, and documenting activities related to the CQC/CQA of the earthworks at the site and the installation of the geosynthetic components of the closure system. The CQA Consultant is also responsible for issuing a facility certification report sealed by a registered professional engineer.

1.4.8 Geosynthetics Construction Quality Assurance Laboratory

The Geosynthetics CQA Laboratory is a party, independent from the Owner, which is responsible for conducting tests on conformance samples of geosynthetics used. The Geosynthetics CQA Laboratory service cannot be provided by any party involved with the manufacture, fabrication, or installation of any of the geosynthetic components. TRI Environmental, Inc. will be the Geosynthetics CQA Laboratory.

1.4.9 Soils Construction Quality Assurance Laboratory

The Soils Construction Quality Assurance Laboratory is a party, independent from the Owner, which is responsible for conducting geotechnical tests on conformance samples of soils used in the closure system. The Soils CQA Laboratory service cannot be provided by any party involved with the Contractor. JBS Engineering, Inc. will be the Soils CQA Consultant.

1.4.10 Construction Quality Control Consultant

The term CQC Consultant shall be used to designate the registered professional engineer in charge of the quality control work. The personnel of the CQC Consultant also include Quality Control Monitors who are also located at the site for construction observation and monitoring. The CQC Consultant is responsible for the timely conveyance of CQC testing results to the CQA Consultant.

1.4.10.1 EARTHWORK AND SOIL QUALITY CONTROL CONSULTANT

The Earthwork and Soil CQC consultant is a representative of the Owner and will be responsible for the earthwork and soil quality control sampling and testing. JBS Engineering, Inc. will be the Soils CQC Consultant.

1.4.10.2 GEOSYNTHETICS CONSTRUCTION QUALITY CONTROL

The Geosynthetics Installer will be responsible for the geosynthetics quality control testing and reporting during the field installation of geosynthetic material.

1.4.10.3 GEOSYNTHETICS CONSTRUCTION QUALITY CONTROL LABORATORY

The Geosynthetics CQC Laboratory is responsible for conducting conformance tests on samples of geosynthetics at the direction of the CQC Consultant.

1.4.10.4 SOILS CONSTRUCTION QUALITY CONTROL LABORATORY

The Soils Construction Quality Control Laboratory is responsible for conducting geotechnical tests on soil samples at the direction of the CQC Consultant.

1.5 Qualifications of the Parties

The following qualifications are required of all parties involved with the manufacture, fabrication, installation, transportation, and CQC/CQA of all materials for the project. Where applicable, these qualifications shall be submitted by the Contractor to the Project Manager for review and approval.

1.5.1 Contractor

Qualifications of the Contractor are specific to the construction contract and independent of this CQA Plan. A complete up to date version of each geosynthetic component manufacturer's QC Plan shall be incorporated into the Contractor's CQC Plan.

1.5.2 Geosynthetics Manufacturers

Each Geosynthetics Manufacturer must satisfy the qualifications presented in the project specifications and must be prequalified and approved by the Project Manager.

The physical properties of each geosynthetic product must be certified by the geosynthetics manufacturer. The properties certified must include, at a minimum, those identified in the project specifications. Manufacturer's certification must be approved by the CQA Consultant before the product is used.

1.5.3 Geosynthetic Installer(s)

The Geosynthetic Installer(s) will be trained and qualified to install the geosynthetics components of the liner system. Each Geosynthetics Installer must meet the requirements of the project specifications and be approved by the Project Manager. The Geomembrane Installer must be approved by the Geomembrane Manufacturer.

1.5.4 Construction Quality Assurance Consultant

The CQA Consultant will act as the Owner's CQA representative and will report to the Project Manager. The CQA Consultant will perform conformance testing to satisfy the requirements of this CQA Plan, will observe the CQC work performed by the CQC Consultant, and will prepare

the certification document incorporating both CQA and CQC test data. The CQA Consultant will have experience in the CQC/CQA aspects of geomembrane system construction and soils testing, and be familiar with ASTM and other related industry standards. The activities of the CQA Consultant will be performed under the supervision of a registered professional engineer.

1.5.5 Construction Quality Control Consultant

The Earthwork and Soil CQC Consultant will be a subcontractor to the CQA Consultant. The Earthwork and Soil CQC Consultant will be experienced with soils, including soil liners, and geosynthetics, including geomembranes, geonets, and geotextiles. The Earthwork and Soil CQC Consultant will satisfy the requirements of the project specifications and be approved by the Project Manager. The activities of the CQC Consultant will be performed under the supervision of a registered professional engineer.

The Geosynthetic Installer will work for the Contractor and be experienced with geosynthetics, including geomembranes, geonets, geocomposites, and geotextiles. The Geosynthetic Installer will satisfy the requirements of the project specifications and be approved by the Contractor.

1.5.6 Geosynthetics Construction Quality Control Laboratory

The Geosynthetics CQC Laboratory is a subcontractor of the CQC Consultant and will have experience in testing geosynthetics and be familiar with ASTM, GRI, and other applicable test standards. The laboratory shall be accredited under the GAI-LAP program for all tests required for the project. The Geosynthetics CQC Laboratory will be capable of providing test results within 24 hours or a reasonable time after, as agreed to at the outset of the project, receipt of samples, and will maintain that standard throughout the installation.

1.6 Site and Project Control

To guarantee a high degree of quality during installation, clear, open channels of communication are essential. To that end, meetings are critical.

1.6.1 CQA/CQC Resolution Meeting

Prior to field mobilization by the Contractor, a Resolution Meeting will be held. This meeting will include all parties then involved, including the Project Manager, the CQA Consultant, the Engineer, the Contractor, and the CQC Consultant.

The purpose of this meeting is to begin planning for coordination of tasks, anticipate any problems which might cause difficulties and delays in construction, and, above all, review the CQA and CQC Plans to all of the parties involved. It is very important that the rules regarding testing, repair, etc., be known and accepted by all.

This meeting should include all of the following activities.

- Provide relevant documents to all involved parties.
- Review critical design details of the project.
- Review the seam layout drawing provided by the Geomembrane/Geosynthetic Installer.
- Review the site-specific CQA and CQC Plans and make any appropriate modifications to the plans to ensure that all necessary testing activities are specified.

- Reach a consensus on the CQA/CQC quality control procedures, especially on methods for determining acceptability of the soils and geosynthetics.
- Review the proposed closure system.
- Select testing equipment and review protocols for testing and placement of general earthwork materials.
- Confirm methods for the soil material selection testing, acceptable zone determinations, and test strip installation.
- Confirm the methods for documenting and reporting, and for distributing documents and reports, and confirm the lines of authority and communication.

The meeting will be documented by the Project Manager and minutes will be transmitted to all parties.

1.6.2 Liner Preconstruction Meeting

A Liner Preconstruction Meeting will be held at the site a minimum of one month prior to placement of the closure system. At a minimum, the meeting will be attended by the Project Manager, Engineer, the CQA Consultant, the Contractor, the CQC Consultant, and the Geosynthetic/Geomembrane Installation Superintendent.

Specific activities considered for this meeting include the following.

- Make any appropriate modifications to the CQA and CQC Plans.
- Review the responsibilities of each party.
- Review lines of authority and communication.
- Review methods for documenting and reporting, and for distributing documents and reports.
- Establish protocols for testing.
- Establish protocols for handling deficiencies, repairs, and retesting.
- Review the time schedule for all operations.
- Establish rules for writing on the geomembrane, i.e., who is authorized to write, what can be written, and in which color.
- Outline procedures for packaging and storing archive samples.
- Review panel layout and numbering systems for panels and seams.
- Establish procedures for use of the extrusion seaming apparatus, if applicable.
- Establish procedures for use of the fusion seaming apparatus, if applicable.
- Finalize field cutout sample sizes.
- Review seam testing procedures.
- Review repair procedures.
- Establish soil stockpiling locations (if any).

The meeting will be documented by the Project Manager and minutes will be transmitted to all parties. The Resolution Meeting and the Preconstruction Meeting may be held as one meeting or separate meetings, depending on the direction of the Project Manager.

1.6.3 Weekly Progress Meetings

A weekly progress meeting will be held between the Project Manager, the CQA Consultant, the Contractor, the CQC Consultant, the Geosynthetic/Geomembrane Installation Superintendent, and representatives from any other involved parties. This meeting will discuss current progress, planned activities for the next week, and any new business or revisions to the work. The CQA Consultant will log any problems, decisions, or questions arising at this meeting in his daily report. Any matter requiring action which is raised in this meeting will be reported to the appropriate parties.

Meeting frequency may be adjusted depending on the schedule of the project and the mutual agreement of all parties involved.

1.6.4 Problem or Work Deficiency Meetings

A special meeting will be held when and if a problem or deficiency is present or likely to occur. At a minimum, the meeting will be attended by all interested parties, the Contractor, the Project Manager, and the CQA Consultant. If the problem requires a design modification, the Engineer should also be present. The purpose of the meeting is to define and resolve the problem or work deficiency as follows:

- define and discuss the problem or deficiency;
- review alternative solutions; and
- implement an action plan to resolve the problem or deficiency.

The meeting will be documented by the Project Manager and minutes will be transmitted to affected parties.

2 CCR Material Removal

Section 2 of the CQA Plan addresses the CQA activities associated with the CCR material removal during the decommissioning of the Scrubber Sludge Pond and Ash Ponds.

2.1 Excavation Monitoring

During the pre-construction meeting the Contractor, the Project Manager, and the CQA Officer will review the CCR excavation plans and specifications to ensure an understanding between all parties on the excavation requirements. The CQA Site Manager or CQA Monitor will observe excavation activities weekly. During periods of CCR excavation, a weekly summary report will be developed noting the following details:

- Map showing area(s) of active excavation
- Review and interpretation of monitoring data collected by the Contractor and actions taken

- Approximate volume of material excavated (truckloads or other approximations)
- General composition of material excavated (CCR, geomembrane, sand, clay, etc.)
- Any excavation problems or difficulties encountered, their location and solution
- Confirm CCR material, rocks and sediment is removed.

Prior to acceptance of the CCR removal as complete, the area will be visually inspected by the CQA Site Manager as exhibiting no visible signs of CCR material in the EAP.

3 Soil Liner

This section of the CQA Plan addresses the soil components of the closure system, and outlines the soils CQA program to be implemented with regard to materials confirmation, laboratory and field confirmation test requirements, overview and interfacing with the Contractor, and resolution of problems. The compacted clay liner will be installed at the Site F Landfill only.

3.1 Soil Liner System

3.1.1 Soil Liner Subgrade

The subgrade material below the soil liner is composed of controlled fill, in situ soils, and/or CCR material. The subgrade shall be placed and compacted in accordance with project specifications. Testing will be conducted by the CQC/CQA Consultant (JBS Engineering & Environmental, LLC). The CQC/CQA Consultant shall conduct field density and moisture tests at the frequency presented in the project specifications.

Prior to the construction of the soil liner, the CQC/CQA Consultant will visually examine the surface of the subgrade to verify that any potentially deleterious materials have been removed.

3.1.2 Compacted Clay Material

The compacted clay material shall be placed and compacted in accordance with the project specifications. The CQC/CQA Consultant shall conduct field density and moisture tests at the frequency presented in the project specifications.

Hydraulic conductivity, Atterberg limits, and percent fines testing of the soil liner material shall be performed by the CQC/CQA Consultant in accordance with the project specifications.

Sealed topographic surveys shall be used to document thickness requirements. Interim thickness measurement shall be conducted in accordance with the project specifications by the CQC/CQA Consultant. Refer to Section 8 for surveying requirements.

3.2 Soils Testing

3.2.1 Test Methods

All testing used to evaluate the suitability or conformance of soils materials will be carried out in accordance with the project specifications.

3.2.2 Soils Testing Requirements

The soil CQC/CQA testing must comply with the minimum frequencies presented in the project specifications.

3.3 Soils Construction Quality Control and Assurance

CQC/CQA will be performed on all soil components of the liner construction. CQA evaluation will consist of: (1) monitoring the work; and (2) performing laboratory and field tests. Laboratory tests will be conducted on samples taken at the borrow source, stockpile, and during the course of the work prior to construction. Field tests will be conducted during the course of the work.

3.3.1 Monitoring

The CQC/CQA Consultant shall monitor and document the construction of all soil components. Monitoring the construction work for the subgrade soil and the soil component of the liner system, includes the following:

- performing CQC testing to determine the water content and other physical properties of the subbase and soil component of the liner system during compaction and compilation of the data;
- monitoring the loose thickness of lifts as placed;
- monitoring the action of the compaction and/or heavy hauling equipment on the construction surface (i.e., penetration, pumping, cracking, etc.); and
- monitoring the number of passes used to compact each lift.

3.3.2 Construction Quality Assurance Judgmental Testing

During construction, the frequency of testing may be increased at the discretion of the CQC/CQA Consultant when visual observations of construction performance indicate a potential problem. Additional testing for suspected areas will be considered when:

- the rollers slip during rolling operation;
- the lift thickness is greater than specified;
- the fill material is at an improper moisture content;
- fewer than the specified number of roller passes are made;
- dirt-clogged rollers are used to compact the material;
- the rollers may not have used optimum ballast;
- the fill materials differ substantially from those specified; or
- the degree of compaction is doubtful.

3.3.3 Perforations in Soil Liner

Perforations that must be filled will include, but not be limited to:

- soil density test locations;
- permeability sampling locations; and/or
- destructive thickness checks.

Unless otherwise noted, or as directed by the Project Manager, all perforations of the subbase by probes or sample tubes will be backfilled with soil in accordance with project specifications or

with bentonite. The CQC/CQA Consultant will observe and confirm that adequate procedures are being employed.

3.3.4 Deficiencies

If a defect is discovered in the earthwork product, the CQC/CQA Consultant will immediately determine the extent and nature of the defect. If the defect is indicated by an unsatisfactory test result, the CQC/CQA Consultant will determine the extent of the deficient area by additional tests, observations, a review of records, or other appropriate means. If the defect is related to adverse site conditions, such as overly wet soils or surface desiccation, the CQC/CQA Consultant will define the limits and nature of the defect.

3.3.4.1 NOTIFICATION

After determining the extent and nature of a defect, the CQC/CQA Consultant will notify the Project Manager and Contractor and schedule appropriate retests when the work deficiency is corrected.

3.3.4.2 REPAIRS AND RETESTING

The Contractor will correct the deficiency to the satisfaction of the CQC/CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQC/CQA Consultant will develop and present suggested solutions to the Project Manager for approval.

The CQC/CQA Consultant must retest all areas represented by failing tests after they have been reworked by the Contractor. All retests performed by the CQC/CQA Consultant must verify that the defect has been corrected before the Contractor proceeds with additional work in the area of the deficiency. The CQC/CQA Consultant will verify that all installation requirements are met and that all submittals are provided.

4 Geomembrane Liner

4.1 Geomembrane Manufacturer's Certification

Compliance testing will be performed by the Geomembrane Manufacturer to demonstrate that the product meets the manufacturers' standards and the project specifications. The manufacturer shall submit a package of certifications and the quality control test results to the Contractor. The Contractor shall distribute the package upon receipt to the CQA consultant prior to the installation of any geomembrane material.

The quality control certificate will be signed by a responsible party employed by the Geomembrane Manufacturer, such as the production manager. In addition to the end product certifications and test results, the package should include the following information.

4.1.1 Raw Material

- Resin Supplier's name and resin production plant.
- Identification (brand name and number), and production date of the resin.
- Copies of the quality control certificates issued by the Resin Supplier.

- Reports on the tests conducted by the Geomembrane Manufacturer to verify the quality of the resin used to manufacture the geomembrane rolls assigned to the project.
- A statement that the percentage of reclaimed polymer added to the resin is in accordance with the project specifications.

4.1.2 Rolls and Sheets

- Roll numbers and identification.
- Property sheets including, at a minimum, all specified properties, measured using test methods indicated in the project technical specifications, or equivalent.
- Sampling procedures and results of testing.

4.2 Conformance Testing

The CQA Consultant may perform additional testing for purposes of conformance evaluation. If the results of the Geomembrane Manufacturer's and the CQA Consultant's testing differ, the testing will be repeated by the CQA Consultant's laboratory, and the Geomembrane Manufacturer will be allowed to monitor this testing. The results of this latter series of tests will prevail, provided that the applicable test methods have been followed.

The CQA Consultant will review the manufacturers' documents and verify that:

- the reported property values certified by the Geomembrane Manufacturer meet all of the project technical specifications; and
- the measurements of properties by the Geomembrane Manufacturer are properly documented and that the test methods used are acceptable.

The CQA Consultant shall report any discrepancies with the above requirements to the Project Manager.

4.3 Handling, and Storage

4.3.1 Handling

The CQA Consultant will verify that:

- handling equipment used on the site is adequate, meets manufacturer's recommendations, and does not pose any risk of damage to the geomembrane; and
- the Geomembrane Installer's personnel handle the geomembranes with care.

Upon delivery at the site, the CQA Consultant will conduct a surface observation of all rolls and sheets for defects and damage. This examination will be conducted without unrolling rolls or unfolding sheets unless defects or damages are found or suspected.

The CQA Consultant will indicate to the Project Manager:

- any rolls or sheets, or portions thereof, that should be rejected and removed from the site because they have severe flaws; and
- any rolls or sheets that have minor repairable flaws.

4.3.2 Storage

The CQA Consultant will document that the Contractor's storage of the geomembrane provides adequate protection against moisture, dirt, shock, and other sources of damage or contamination and is in accordance with the project specifications.

4.4 Geomembrane Installation

4.4.1 Earthwork

4.4.1.1 SURFACE PREPARATION

The Contractor and Geomembrane Installer will certify in writing that the surface on which the geomembrane will be installed meets line and grade, and the surface preparation requirements of the project specifications. The certificate of acceptance will be given to the CQA Consultant prior to commencement of geomembrane installation in the area under consideration. The CQA Consultant will give a copy of this certificate to the Project Manager.

To ensure a timely covering of the soil liner surface, the Project Manager may allow subgrade acceptance in areas as small as one acre. After the supporting soil has been accepted by the Geomembrane Installer, it will be the Geomembrane Installer's responsibility to indicate to the Project Manager of any change in the supporting soil condition that may require repair work. If the CQA Consultant concurs with the Geomembrane Installer, then the Project Manager will ensure that the supporting soil is repaired.

4.4.1.2 ANCHORAGE SYSTEM

The CQA Consultant will verify that anchor trenches have been constructed according to project specifications and design drawings.

4.4.2 Geomembrane Placement

4.4.2.1 FIELD PANEL IDENTIFICATION

The CQA Consultant will document that the Geomembrane Installer labels each field panel with an "identification code" (number or letter-number consistent with the layout plan) agreed upon by the Geomembrane Installer and CQA Consultant at the CQA/CQC Preconstruction Meeting.

The Geomembrane Installer will establish a table or chart showing correspondence between roll numbers and field panel identification codes. This documentation shall be submitted to the CQA Consultant weekly for review and verification. The field panel identification code will be used for all quality control and quality assurance records.

4.4.2.2 FIELD PANEL PLACEMENT

4.4.2.2.1 Location

The CQA Consultant will verify that field panels are installed at the location indicated in the Geomembrane Installer's layout plan, as approved.

4.4.2.2.2 Installation Schedule

The CQA Consultant will evaluate every change in the schedule proposed by the Geomembrane Installer and advise the Project Manager on the acceptability of that change. The

CQA Consultant will verify that the condition of the supporting soil has not changed detrimentally during installation.

The CQA Consultant will record the identification code, location, and date of installation of each field panel.

4.4.2.2.3 Placement of Geomembrane

The CQA Consultant will verify that project specification related restrictions on placement of geomembrane are fulfilled. Additionally, the CQA Consultant will verify that the supporting soil has not been damaged by weather conditions.

Wrinkles and folds shall be prevented to the extent possible and repaired when they are not prevented.

The CQA Consultant will inform the Project Manager if the above conditions are not fulfilled.

4.4.2.2.4 Damage

The Geomembrane Installer's CQC Inspector will visually observe each panel for damage after placement and prior to seaming. The CQC Inspector will advise the CQA Consultant which panels or portion of panels were rejected or marked for repair. Damaged panels, or portions of damaged panels, which have been rejected will be marked and their removal from the work area recorded by the CQA Consultant.

4.4.3 Field Seaming

4.4.3.1 SEAM LAYOUT

The Geomembrane Installer will provide the CQA Consultant with a seam layout drawing, i.e. a drawing of the facility to be lined showing all expected seams. The CQA Consultant and Engineer will review the seam layout drawing and verify that it is consistent with the accepted state of engineering practice and this CQA Plan. In addition, panels not specifically shown on the seam layout drawing may not be used without the Project Manager's prior approval.

A seam numbering system compatible with the panel numbering system will be agreed upon at the Resolution and/or Preconstruction Meeting. An on-going written record of the seams and repair areas shall be maintained by the Geomembrane Installer with weekly review by the CQA Consultant.

4.4.3.2 REQUIREMENTS OF PERSONNEL

The Geomembrane Installer will provide the CQA Consultant with a list of proposed seaming personnel and their experience records. This document will be reviewed by the Project Manager and the CQA Consultant for compliance with project specifications.

4.4.3.3 SEAMING EQUIPMENT AND PRODUCTS

Field seaming processes must comply with project specifications. Proposed alternate processes will be documented and submitted to the CQA Consultant for his approval. Only seaming apparatus which have been specifically approved by make and model will be used.

4.4.3.4 NONDESTRUCTIVE SEAM CONTINUITY TESTING

The Geomembrane Installer will nondestructively test all field seams over their full length using test methods approved by the project specifications. The CQA Consultant shall periodically observe the nondestructive testing to ensure conformance with this CQA Plan and the project specifications.

For approximately 10% of the noncomplying tests, the CQA Consultant will:

- observe continuity testing of the repaired areas performed by the Geomembrane Installer;
- confirm the record location, date, test unit number, name of tester, and compile the record of testing provided by the Geomembrane Installer;
- provide a walkthrough inspection of all impacted seam areas and verify that the areas have been tested in accordance with the CQA Plan and project specifications; and
- verify that the Geomembrane Installer has marked repair areas with the appropriate color-coded marking pencil.

4.4.3.5 DESTRUCTIVE SEAM TESTING

Destructive seam tests will be performed by the Geomembrane Installer's CQC inspector at locations and a frequency in accordance with the project specifications. The CQA Consultant will perform conformance tests on a minimum of 10% of the CQC destructive seam test samples obtained. Additional destructive seam tests may be required at the CQA Consultant's discretion. Selection of such locations may be prompted by suspicion of contamination, excessive grinding, off center and/or offset seams, or any other potential cause of imperfect seaming.

4.4.3.5.1 Geosynthetics CQA Laboratory Testing

Destructive test samples will be packaged and shipped by the CQA Consultant in a manner that will not damage the test sample. The Project Manager will be responsible for storing the archive samples. These procedures will be fully outlined at the Resolution and/or Preconstruction Meeting. Samples will be tested by the Geosynthetics CQA Laboratory.

Conformance testing will include "Seam Strength" and "Peel Adhesion" in accordance with project specifications. All geomembrane destructive test samples that fail to meet project specifications shall be saved and sent to the CQA Consultant for observation.

The Geosynthetics CQA Laboratory will provide preliminary test results no more than 24 hours after they receive the samples. The CQA Consultant will review laboratory test results as soon as they become available.

4.4.3.5.2 Defining Extent of Destructive Seam Test Failure

All defective seam test failures must be bounded by seam tests from which destructive samples passing laboratory tests have been taken. The Geomembrane Installer's CQC Inspector will document repair actions taken in conjunction with all destructive seam test failures.

4.4.4 Defects and Repairs

All seams and non-seam areas of the geomembrane will be examined by the CQA Consultant for identification of defects, holes, blisters, undispersed raw materials, and any sign of

contamination by foreign matter. Each suspected location, both in seam and non-seam areas, will be nondestructively tested using methods in accordance with the project specifications. Each location which fails the nondestructive testing will be marked by the Geomembrane Installer's CQC Inspector and repaired by the Geomembrane Installer. Repair procedures will be in accordance with project specifications or procedures agreed to by the Project Manager in the Preconstruction Meeting. The CQA Consultant will observe all repair procedures and advise the Project Manager of any problems.

4.4.5 Backfilling of Anchor Trench

Anchor trenches will be backfilled and compacted as outlined in the earthwork specifications. The soil used to backfill the anchor trench shall meet the specifications for soil liner and placed in a manner that does not stress or damage the geosynthetics. The CQA Consultant will review the backfilling operation and advise the Project Manager of any problems.

Liner edges that are constructed with run-out instead of anchor trenches (such as construction phase boundaries) will be protected with plywood sheets above the geosynthetics. Subsequent construction must always lap the prior certification limits such that all areas are certified to be in conformance with the plans and specifications. The CQA consultant shall review the procedures to excavate the plywood sheet prior to extending the liner section. The entire length of seam to previously constructed areas shall be thoroughly inspected for conformance. Any liner component (soil and geosynthetic) that is damaged, whether by excavation or other cause, shall be properly repaired and inspected by the CQA consultant. Any deficiencies noted such as, failing seams, shall be addressed to prevent reoccurrence in the new construction.

4.4.6 Materials in Contact with Geomembranes

The quality assurance procedures indicated in this subsection are only intended to assure that the installation of these materials does not damage the geomembrane. Although protective geosynthetics and geotextiles have been incorporated into the liner system, all reasonable measures to protect the geomembrane and provide additional quality assurance procedures are necessary to assure that systems built with these materials will be constructed to ensure proper performance.

4.4.6.1 SOILS

Prior to placement, the CQA Consultant will visually confirm that all soil materials to be placed against the geomembrane comply with project specifications. The Geomembrane Installer will provide the CQA Consultant a written surface acceptance certificate. All soil materials shall be placed and compacted in accordance with project specifications.

4.4.6.2 CONCRETE STRUCTURES AND OTHER APPURTENANCES

The CQA Consultant will review:

- installation of the geomembrane in appurtenance areas, and connection of the geomembrane to appurtenances;
- that extreme care is taken while seaming around appurtenances since neither nondestructive nor destructive testing may be feasible in all of these areas;
- testing is conducted in all areas that are feasible;

- the geomembrane has not been visibly damaged while making connections to appurtenances;
- the installation of the geomembrane shall be exercised so as not to damage sumps; and

The CQA Consultant will inform the Project Manager if the above conditions are not fulfilled or observed to be in accordance with project specifications.

5 Drainage Geocomposite

5.1 Material Requirements

All LLDPE drainage composite shall be manufactured in accordance with the project specifications.

5.2 Manufacturing

The drainage composite manufacturer will provide the Contractor and the CQC Consultant with a written certification, signed by a responsible party, that the drainage composites actually delivered have properties which meet or exceed the specified properties.

The CQA Consultant will examine all manufacturers' certifications to ensure that the property values listed on the certifications meet or exceed the project specifications. Any deviations will be reported to the Project Manager.

5.3 Labeling

The drainage composite manufacturer will identify all rolls of drainage composite in accordance with project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

5.4 Shipment and Storage

Drainage composite cleanliness is essential to its performance; therefore, the shipping and storage of drainage composite must be in accordance with the project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

The CQA Consultant will check that drainage composites are free of dirt and dust just before installation. The CQA Consultant will report the outcome of this review to the Project Manager; and, if the drainage composites are judged dirty or dusty, they will be washed by the drainage composite Installer prior to installation.

Washing operations will be observed by the CQA Consultant and improper washing operations will be reported to the Project Manager.

5.5 Handling and Placement

The drainage composite Installer will handle all drainage composites in a manner in accordance with the project specifications. The CQA Consultant will note any noncompliance and report it to the Project Manager.

5.6 Stacking and Joining

Adjacent drainage composites will be joined according to construction drawings and project specifications. The CQA Consultant will note any noncompliance and report it to the Project Manager.

When several layers of drainage composites are stacked, care should be taken to ensure that stacked drainage composites are placed in the same direction. A stacked drainage composite will never be laid in perpendicular directions to the underlying drainage composite unless otherwise specified by the Engineer. The CQA Consultant will observe the stacking of drainage composites and will note any noncompliance and report it to the Project Manager.

5.7 Repair

Any holes or tears in the drainage composite will be repaired in accordance with project specifications. The CQA Consultant will observe any repair, note any noncompliance with the above requirements, and report them to the Project Manager.

5.8 Placement of Soil Materials

All soil materials placed over the drainage composite should be placed in accordance with project specifications so as to ensure:

- the drainage composite and underlying geomembrane are not damaged;
- wrinkles and folds are prevented to the extent possible and repaired when not prevented;
- minimal slippage of the drainage composite on the underlying geomembrane occurs;
- the material is not exposed for longer than is allowed by the project specifications; and
- no excess tensile stresses occur in the drainage composite.

Any noncompliance will be noted by the CQA Consultant and reported to the Project Manager.

6 Earthen Drainage & Protective Components

6.1 Introduction

This section of the CQA plan addresses the earthen components of a cap system that will be placed above various geosynthetics. For cap systems these components include sand and gravel drains, “infiltrations layers” and topsoil (“erosion layers”). This section outlines the CQA program to be implemented with regard to materials confirmation, laboratory and field test requirements, overview and interfacing with the Contractor, and resolution of problems.

6.2 General Placement

6.2.1 Wrinkles and Folds in Geosynthetics

All earthen materials placed directly above a geosynthetic shall be placed by the contractor in a manner that minimizes wrinkles and folds. The CQA Consultant shall monitor placement and document any areas in which folding occurs so that the Contractor can make repairs to the geosynthetics. It may be necessary to adjust the time of day or the method of placement in order to minimize wrinkling of the geosynthetics. Failure of the Contractor to control wrinkles shall be reported by the CQA consultant to the Project Manager for resolution.

6.2.2 Abrasion and Puncture of Geosynthetics

The CQA consultant shall be aware of activities during the placement of earthen materials above the geosynthetics that may result in abrasion or puncture. The CQA consultant shall investigate any activity that is a cause for concern and shall document all investigations. The documentation shall include a description of the activity that is causing concern; the location; a description of the damage to the geosynthetic (if any); a description of the repair; and preventative measures to be implemented to avoid future incidents of a similar nature.

Activities that may be cause for concern include:

- sharp turns;
- spinning of wheels or tracks;
- digging in placed material; and
- pushing material across a geosynthetic.

6.2.3 Equipment Separation

The CQC consultant shall check that the specified separation between equipment and geosynthetics is maintained. That CQA consultant shall observe and report any problems to the Project Manager.

6.2.4 Exposure

Some geosynthetics, especially geotextiles, degrade when exposed to ultraviolet light. The project specifications may require that these materials be covered within a certain number of days. The CQA consultant shall document when these materials are covered in a timely fashion. If current progress indicates that any materials will not be covered within the time defined in the project specifications the CQA consultant shall report that information to the Project manager and Contractor.

6.3 Soil and Gravel (granular) Drainage Material

The CQC/CQA Consultant will provide testing of the granular material at the frequency specified in the project specifications. The CQC/CQA Consultant will observe that placement of the granular material is done in a manner to protect the geomembrane.

6.4 Infiltration Layer Material

The infiltration layer shall be placed in accordance with the project specifications. The CQC/CQA Consultant will perform gradation and thickness testing of the material at the frequency specified in the project specifications. The CQC/CQA Consultant will observe that placement of the material is accomplished in a manner to protect the geomembrane. The

6.5 Erosion Layer (Topsoil) Material

The erosion layer will consist of topsoil placed in accordance with the project specifications. The CQC/CQA Consultant will provide nutrient and thickness testing of the material at the frequency specified in the project specifications. The CQC/CQA Consultant will observe that placement of the material is accomplished in a manner to protect the erosion layer.

6.6 Materials Testing

6.6.1 Test Methods

All testing used to evaluate the suitability or conformance of earthen materials will be carried out in accordance with the project specifications.

6.6.2 Material Testing Requirements

Laboratory CQA conformance tests may be conducted on samples taken at the borrow source, stockpile, and during the course of work prior to construction. Field conformance tests will be conducted by the CQC/CQA Consultant during the course of the work.

The material CQC testing must comply with the minimum frequencies presented in the project specifications.

6.7 Deficiencies

If a defect is discovered in the earthwork product, the CQC/CQA Consultant will immediately determine the extent and nature of the defect and report it to the CQA Consultant. If the defect is indicated by an unsatisfactory test result, the CQC/CQA Consultant will determine the extent of the deficient area by additional tests, observations, a review of records, or other means that the CQA Consultant deems appropriate.

6.7.1 Notification

After determining the extent and nature of a defect, the CQC/CQA Consultant will notify the Project Manager and Contractor and schedule appropriate retests when the work deficiency is corrected.

6.7.2 Repairs and Retesting

The Contractor will correct the deficiency to the satisfaction of the CQC/CQA Consultant. If a project specification criterion cannot be met, or unusual weather conditions hinder work, then the CQC/CQA Consultant will develop and present to the CQA Consultant and Project Manager suggested solutions for approval.

All retests recommended by the CQC/CQA Consultant must verify that the defect has been corrected before any additional work is performed by the Contractor in the area of the

deficiency. The CQC/CQA Consultant will verify that all installation requirements are met and that all submittals are provided.

7 Geotextile

7.1 Manufacturing

Compliance testing will be performed by the manufacturer to demonstrate that the product meets the manufacturers' standards and the project specifications. The manufacturer shall submit a package of certifications and the quality control test results to the Contractor. The Contractor shall distribute the package upon receipt to the CQA consultant prior to the installation of any material.

The quality control certificate will be signed by a responsible party employed by the Geosynthetics Manufacturer, such as the production manager.

The CQA Consultant will examine all manufacturer certifications to ensure that the property values listed on the certifications meet or exceed those specified for the particular type of geotextile. Any deviations will be reported to the Project Manager.

The inspection methods, handling techniques, and property values identified in the specifications for the filter geotextile shall also apply to geotextile portion of the geocomposite drainage media.

7.2 Labeling

The Geosynthetics Manufacturer will identify all rolls of geotextile in conformance with the project specifications. The CQA Consultant will examine rolls upon delivery and any deviation from the above requirements will be reported to the Project Manager.

7.3 Shipment and Storage

During shipment and storage, the geotextile will be protected as required by the manufacturer's recommendations and the project specifications. The CQA Consultant will observe rolls upon delivery at the site and any deviation from the above requirements will be reported to the Project Manager.

7.4 Handling

The Geosynthetics Installer will handle all geotextiles in such a manner as required by the project specifications. Any noncompliance will be noted by the CQA Consultant and reported to the Project Manager.

7.5 Seams and Overlaps

All geotextiles will be seamed or overlapped in accordance with project specifications or as approved by the CQA Consultant and Engineer. The CQA consultant shall walk the material after placement to confirm that the proper methods have been used.

7.6 Repair

Any holes or tears in the geotextile will be repaired in accordance with the project specifications. The CQA Consultant shall observe any repairs and note any noncompliance with the above requirements and shall report them to the Project Manager.

7.7 Exposure

The CQA consultant shall document the placement time of the material and track the exposure time until the material has been covered. Any material that is exposed to UV radiation longer than the time allowed by the project specifications shall be reported to the Project Manager.

8 Surveying

8.1 Introduction

Lacy Surveying will perform the construction surveys for the purposes of record documentation of the project. The Contractor shall provide their own survey team to survey lines and grades on an ongoing basis during construction.

8.2 Goals

The survey component of the work has two major goals, to construct the work per the plans and specifications and to document the completed work for the CQA report.

8.3 Survey Control

Permanent benchmarks and baseline control points have been established at the site and are as indicated in the project drawings. All surveys should note the horizontal and vertical datums used for control.

8.4 Surveying Personnel

The Contractor's survey crew will consist of a senior surveyor and as many assistants as are required to satisfactorily undertake the work. All surveying personnel will be experienced in the provision of these services including supplying detailed, accurate documentation.

All record documentation surveying will be performed under the direct supervision of a licensed land surveyor (PLS) licensed in the state in which the project is located.

8.5 Precision and Accuracy

A wide variety of survey equipment is available to meet the requirements of this project. The survey instruments used for this work should be sufficiently precise and accurate to meet the needs of the project. All survey instruments should be capable of reading to a precision of 0.01 foot and with a setting accuracy of 20 seconds. (5.6×10^{-3} degrees).

The contour intervals and confidence level of all topographic drawings shall be clearly stated on the drawing and should be appropriate for the tolerances required by the specifications.

8.6 Lines and Grades

The subgrade, top of soil liner with final surfaces shall be surveyed to verify the lines and grades achieved during construction. The survey should at least include the following.

- One or more construction baselines.
- The edges of all surface breaks (ex. toes, crests, ridges and valleys).
- All structures.
- Invert elevation of and location of all HDPE piping at each lateral intersection and endpoint, and at least every 50 feet between the intersections and endpoints.
- Inverts of sumps, manholes and other appurtenances.
- Top/toe of all berms, roads, and channels.
- Location of edge of liner, anchor trenches tie-in seam to adjacent existing liner system (as applicable).
- Major patches of LLDPE liner.

Laser planes or GPS systems are highly recommended for achieving the correct lines and grades during construction of each surface.

8.7 Thickness Measurements

Lacy Surveying, as a representative of the Owner, shall obtain top and bottom elevations of the soil liner and other components as required by the project specifications. Thickness verification may be done with a table or by electronic comparison of drawing files. The procedure for obtaining top and bottom elevations of the soil liner shall be agreed to by the CQA Consultant and Engineer prior to construction. The surveyor shall review the survey information with the Contractor to ensure that the survey demonstrates compliance with the project technical specifications. The Contractor is responsible for repair of any areas of non-compliance evidenced by the survey. The CQA Consultant and Contractor shall review the thickness measurements of the soil liner component prior to placement of the geomembrane liner. The CQA consultant should notify the Project Manager of areas the need to be corrected.

8.7.1 Tabular verification

A thickness verification table may be compiled containing the following information for each point.

- Proposed subgrade elevation.
- Actual subgrade elevation.
- Subgrade deviation.
- Proposed soil liner elevation.
- Actual soil liner elevation.
- Soil liner thickness.
- Elevation deviation.
- Proposed cover elevation.
- Actual cover elevation.
- Cover Thickness.

- Cover Elevation deviation.

Any deviations in elevation or thickness outside the tolerances allowed by specification shall be corrected.

8.7.2 Drawing verification

Electronically compare the surfaces for thickness verification. Supply the Engineer and/or the CQA Consultant with electronic files in agreed upon common format for comparison for review. These files may be for all or a portion of the work. The reviewer shall generate a drawing illustrating the areas of noncompliance and provide it to the Contractor for acquisition of additional data points or corrective action.

8.8 Tolerances

Except for liner components where no minus tolerances are acceptable, the following are maximum tolerances for survey points.

- On surfaces: the maximum tolerances shall be 0.25 foot. This tolerance must be set to the record elevation of the surface below it and not the design elevation.

8.9 Documentation

The results from the field surveys will be documented on a set of survey record (as-built) drawings by Lacy Surveying. The Contractor shall certify to the CQA Consultant and Engineer that the results of the survey demonstrates compliance with the contract documents. Sealed surveys depicting the information gathered shall be supplied to the Engineer and CQA Consultant in sufficient quantities. The surveys shall depict the information in a topographic format and illustrate actual data points.

9 Documentation

An effective CQA plan depends largely on recognition of all construction activities that should be monitored and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of quality assurance activities. The CQA Consultant will document that all quality assurance requirements have been addressed and satisfied.

This CQA plan integrates the testing and inspection performed by the CQC Consultant in accordance with the project specifications with the CQA overview and conformance testing performed by the CQA Consultant in accordance with this CQA Plan.

The CQA Consultant will provide the Project Manager with the CQC Consultant's daily and weekly reports including signed descriptive remarks, data sheets, and logs to verify that all CQC monitoring activities have been carried out. The CQA Consultant will also provide the Project Manager with a weekly report summarizing CQA activities and identifying potential quality assurance problems. The CQA Consultant will also maintain a copy of this CQA plan and a complete file of plans, reports, project specifications, checklists, test procedures, daily logs, and other pertinent documents at the job site.

9.1 Recordkeeping

The CQC Consultant's reporting procedures will include preparation of a daily report which, at a minimum, will consist of:

- a) field notes, including memoranda of meetings and/or discussions with the Contractor;
- b) observation logs and testing data sheets; and
- c) construction problem and solution data sheets.

The daily report must be completed at the end of each CQC Consultant's shift, prior to leaving the site. This information will be submitted weekly to and reviewed by the CQA Consultant.

The CQC Consultant's weekly reports must summarize the major events that occurred during that week. Critical problems that occur shall be communicated verbally to the Project Manager or CQA Consultant immediately as well as being included in the weekly reports. The CQC Consultant's weekly report must be submitted to the CQA Consultant no later than the Monday following the week reported.

The CQA Consultant's weekly report must summarize the CQC Consultant's weekly and daily reports, CQA conformance testing activities, construction problems that occurred, and the resolution of construction problems. The CQA Consultant's weekly report should identify all potential or actual compliance problems outstanding. The CQA Consultant's weekly report must be submitted to the Project Manager on the Wednesday following the week reported.

9.1.1 Memorandum of Discussion with CQC Consultant or Geosynthetic Installer

A report will be prepared summarizing each critical discussion between the CQA Consultant and the CQC Consultant or Geosynthetic Installer. At a minimum, the report will include the following information.

- Date, project name, location, and other identification.
- Name of parties to discussion at the time.
- Relevant subject matter or issues.
- Activities planned and schedule.
- Signature of the CQA Consultant.

9.1.2 CQA Observation Logs and Testing Data Sheets

CQA observation logs and conformance testing data sheets will be prepared by the CQA Consultant on a weekly basis. At a minimum, these logs and data sheets will include the following information.

- An identifying sheet number for cross referencing and document control.
- Date, project name, location, and other identifying information.
- Data on weather conditions.
- A scale site plan showing all proposed work areas and test locations.
- Descriptions and locations of ongoing construction.
- Descriptions and specific locations of areas, or units, of work being tested and/or observed and documented.
- Locations where tests and samples were taken.

- A summary of test results.
- Calibrations of test equipment, and actions taken as a result of recalibration.
- Off-site materials received, including quality verification documentation.
- Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality.
- The CQA Consultant's signature.

9.1.3 CQA Construction Problem and Solution Data Sheets

CQA sheets describing special construction situations will be cross-referenced with specific CQA observation logs and testing data sheets, and must include the following information, where available.

- An identifying sheet number for cross referencing and document control.
- A detailed description of the situation or deficiency.
- The location and probable cause of the situation or deficiency.
- How and when the situation or deficiency was found or located.
- Documentation of the response to the situation or deficiency.
- Final results of any responses.
- Any measures taken to prevent a similar situation from occurring in the future.
- The signature of the CQA Consultant, and signature of the Project Manager indicating concurrence if required by this CQA Plan.

The Project Manager will be made aware of any significant recurring nonconformance with the project specifications. The Project Manager will then determine the cause of the non-conformance and recommend appropriate changes in procedures or specification. When this type of evaluation is made, the results will be documented, and any revision to procedures or project specifications will be approved by the Owner and Engineer.

9.2 CQA Photographic Reporting Data Sheets

Photographic reporting data sheets, where used, will be cross-referenced with CQA observation logs and testing data sheets and/or CQA construction problem and solution data sheets. Digital photographs shall be taken at regular intervals during the construction process and in all areas deemed critical.

These photographs will serve as a pictorial record of work progress, problems, and mitigation activities. The file name for the digital photographs will contain the date and a description of the photograph (i.e. 20210712 Liner Installation Cell 1). These records will be presented to the Project Manager upon completion of the project.

In lieu of photographic documentation, digital video may be used to record work progress, problems, and mitigation activities. The Project Manager may require that a portion of the documentation be recorded by photographic means in conjunction with video.

9.3 Design and/or Project Technical Specification Changes

Design and/or project specification changes may be required during construction. In such cases, the CQA Consultant will notify the Project Manager and the Engineer. The Project Manager will then notify the appropriate agency, if necessary.

Design and/or project specification changes will be made only with the written agreement of the Project Manager and the Engineer, and will take the form of an addendum to the project specifications. All design changes shall include a detail (if necessary) and state which detail it replaces in the plans.

9.4 CQA Progress Reports

The CQA Consultant will prepare a summary progress report each week, or at time intervals established at the pre-construction meeting. As a minimum, this report will include the following information.

- A unique identifying sheet number for cross-referencing and document control.
- The date, project name, location, and other identifying information.
- A summary of work activities during progress reporting period.
- A summary of construction situations, deficiencies, and/or defects occurring during the progress reporting period.
- Summary of all test results, failures and retests, and signature of the CQA Consultant.

9.5 Signature and Final Report

At the completion of each major construction activity at the structural fill unit, the CQA Consultant will certify all required forms, observation logs, field and laboratory testing data sheets including sample location plans, construction problems and solution data sheets. The CQA Consultant will also provide a final report which will certify that the work has been performed in compliance with the plans and project technical specifications, and that the supporting documents provide the necessary information.

The CQA Consultant will also provide summaries of all the data listed above with the report. The Record Drawings will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g., depths, plan dimensions, elevations, soil component thicknesses, etc.). All surveying and base maps required for development of the record drawings will be done by the construction surveyor. These documents will be certified by the Contractor and CQC Consultant and delivered to the CQA Consultant and included as part of the CQA documentation (Certification) report.

It may be necessary to prepare interim certifications, as allowed by the regulatory agency to expedite completion and review.

9.6 Storage of Records

All handwritten data sheet originals, especially those containing signatures, will be stored by the Project Manager in a safe repository on site. Other reports may be stored by any standard



method which will allow for easy access. All written documents will become property of the Owner.