

APPENDIX N TECHNICAL SPECIFICATIONS

DRAFT FINAL DESIGN

TECHNICAL SPECIFICATIONS

CALLAHAN MINE SUPERFUND SITE
BROOKSVILLE, MAINE

Prepared for:

Maine Department of Transportation
16 State House Station
Augusta, Maine 04333

Prepared by:



AMEC Environment & Infrastructure, Inc.
511 Congress Street
Portland, Maine 04101

December 5, 2014

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AMEC Project No. 3612112201.05.01

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OU3 DRAFT FINAL DESIGN
CALLAHAN MINE SUPERFUND SITE
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CALLAHAN MINE SUPERFUND SITE
SPECIFICATIONS

DIVISION 1 – GENERAL REQUIREMENTS

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SECTION 01 11 00

SUMMARY OF WORK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This section is intended to provide a summary of the Project and the various elements of work associated with it. This summary should be used in conjunction with other specification sections, the Drawings and other documentation included with the Contract Documents. This section does not provide technical detail for particular work activities, but describes the work as a whole, providing an overall perspective to the separate tasks and their interrelationships.
- B. Remediation of the Tailings Impoundment (OU3) is part of a larger remedy included in the OU1 Record of Decision (ROD) for the Callahan Mine Superfund Site, Town of Brooksville, Maine. The work is being performed in accordance with the requirements set forth in the Administrative Settlement Agreement and Order of Consent for OU1 ROD and OU2 Early Action between the Environmental Protection Agency (EPA) and the State of Maine (2009). The remediation is being undertaken by the EPA.
- C. The scope of work consists of the Operable Unit 3 (OU3) remediation at the Tailings Impoundment within the Callahan Mine Superfund Site and includes the following:
- Initial dewatering of the Tailings Impoundment will be completed by installation of a horizontal drain, oriented North/South, at an elevation necessary to sufficiently depress the water table and allow for earthwork activities. This single horizontal drain will be installed during the initial phase of the project and will include associated piping, structures, drill-pads, and compost bioreactor ponds to provide necessary treatment prior to releasing groundwater to the downstream Goose Pond Tidal Estuary. It is anticipated that approximately six (6) months of active dewatering will be necessary prior to any additional construction activities.
 - Establish an on-site quarry north of the Tailings Impoundment within the former Mine Operations Area. Quarry operations shall consist of blasting and crushing operations to produce materials for the working surface, haul roads, infiltration barrier cap cover stone, bedding materials and any other aggregates required for the project.
 - A working surface consisting of geosynthetics (i.e., geogrid and geotextile fabric) and crushed stone will be installed in proposed fill areas as shown on the Drawings.
 - EQ Drains will be installed to accelerate the dissipation of pore water pressures generated within the tailings “slimes” as fill placement progresses. The EQ

Drains also provide long-term liquefaction mitigation should zones of the tailings stratum remain saturated or become re-saturated. Discharge from the EQ Drains will be directed to a series of temporary sumps through a crushed stone drainage blanket (a component of the working surface) and pumped to the compost bioreactor ponds.

- Geotechnical instrumentation will be installed following working surface construction and EQ Drain installation and prior to any excavation and/or fill placement operations within the impoundment. Instrumentation will include piezometers (vibrating wire and standpipe), settlement platforms, and inclinometers. The instruments will be monitored during construction, and the monitoring data will be used to adjust the allowable rate of fill placement, as necessary, to maintain stability of the impoundment.
- Upon field verification that groundwater levels have been reduced to adequate elevations to allow for excavation and fill placement, the Tailings Impoundment will be prepared for necessary earthwork operations:
 - Stormwater treatment ponds will be constructed and utilized as temporary sedimentation basins during earthwork activities.
 - Soil Erosion and Sediment Controls shall be implemented utilizing appropriate BMP's as outlined on the Drawings.
 - Waste rock and dewatered tailings along the perimeter of the Tailings Impoundment will be removed to achieve the required subgrade elevations shown on the Drawings. Excavated waste rock may be crushed and reused to develop the working surface beneath the proposed infiltration barrier cap. Excavated dewatered tailings will be reused as subgrade fill within the Tailings Impoundment.
 - The slimes response to subgrade fill placement in central and western portions of the impoundment will be monitored via geotechnical instrumentation, and the rate of fill placement will be governed and regulated by the monitoring data and the ENGINEER, respectively. The placement of fill over the slimes will be required in lifts with wait periods of a minimum of 2 to 4 weeks between lifts to allow for dissipation of excess pore pressures and strength gain in the slimes. These wait periods may be further extended depending on response of the geotechnical instrumentation. The requirements of the geotechnical monitoring plan will ultimately govern the fill placement rate.
 - Prepared subgrade within the Tailings Impoundment will be protected with an infiltration barrier cap. From subgrade upward, the barrier cap will consist of a geocomposite clay liner, a low permeability geomembrane, a geocomposite drainage layer, and a crushed stone protection layer.

- Final surfacing and drainage improvements within the Tailings Impoundment work area and restoration of the quarry area will be completed.
- A deep horizontal drain will be installed along a similar alignment (oriented North/South) as the upper drain to further dewater the impoundment and improve long-term impoundment stability.
- Remaining deep horizontal drains (oriented East/West) depicted in the Drawings may be installed if deemed necessary by the ENGINEER.

1.02 DEFINITIONS

- A. “OWNER” as used in the Contract Documents shall mean the Contracting entity for the work.
- B. “CONTRACTOR” as used in the Contract Documents shall mean the entity performing the work under contract to the OWNER.
- C. “ENGINEER” as used in the Contract Documents shall mean the entity delegated and qualified to act as the engineer during the course of the work.

1.03 WORK COVERED BY THE CONTRACT DOCUMENTS

The work shall primarily consist of, but not necessarily be limited to, the following activities:

- A. Comply with the requirements of all permits, and providing all services, utilities, equipment, and facilities required to perform the work activities in accordance with these Specifications, the Drawings, and the ROD.
- B. CONTRACTOR must accommodate all Federal government (e.g., EPA, USACE) and state (MEDEP and Maine DOT) inspections without change in work schedule. Any local/state inspections and comments should be directed to the OWNER.
- C. CONTRACTOR shall submit a Construction Work Plan for review and acceptance by the OWNER and the ENGINEER, which contains, at a minimum:
 - 1. Proposed sequence, equipment, and methods for the performance of site preparation (e.g., temporary site facilities and controls including utilities; soil erosion and sediment control requirements; etc.);
 - 2. Proposed sequence, equipment, and methods for blasting and crushing;
 - 3. Proposed sequence, equipment, and methods for the construction of the working surface, and the installation of EQ Drains and geotechnical instrumentation;
 - 4. Proposed sequence, equipment, and methods for the excavation, removal, handling and placement of tailings and waste rock materials;
 - 5. Proposed sources and delivery method(s) for any necessary imported materials;
 - 6. Proposed methods of handling, managing, treating, and discharging of impacted stormwater and/or groundwater;

7. Proposed method(s) of handling, stockpiling, and placing of infiltration barrier cap components;
 8. Proposed method(s) of site restoration;
 9. Traffic and Site Access Control Plan. Include the routes, size/load, and frequency of haul trucks providing off-site material to the project site. Delivery of off-site material shall be minimized based on the condition of existing access roads and traffic concerns expressed by local residents.
- D. Pre-Construction Activities
The CONTRACTOR shall prepare, submit, and implement the required plans prior to commencing construction.
- E. Mobilization and Site Preparation
Mobilization and site preparation activities shall include furnishing all labor, material and equipment to provide the following:
1. Equipment and material staging and storage areas;
 2. Personnel decontamination and hygiene facilities as required per the HASP;
 3. Access and site controls (e.g., temporary fencing and barricades) to isolate the work area; and
 4. Temporary collection or by-pass systems for stormwater runoff as needed to perform the Work;
- F. Erosion and Sedimentation Control
Erosion and Sedimentation Control activities shall include furnishing all labor, material and equipment to provide the following:
1. The means and methods required to minimize erosion and sedimentation in accordance with Section 31 25 00 - Erosion and Sedimentation Control and in accordance with State of Maine Standards and Specifications for Erosion Prevention and Sediment Control.
 2. Temporary soil erosion and sedimentation control shall be installed and maintained for the construction activities as shown on the Drawings.
- G. Remedial Construction: The remedial construction shall include the activities described in Item 1.01.C above.
- H. Demobilize from the Site - The work shall include furnishing all labor, equipment, and materials to perform the following:
1. Remove temporary facilities, site/access controls, and erosion and sedimentation controls; and
 2. Clean the Site.

1.04 WORK SEQUENCE

- A. The work shall be planned, scheduled, and performed to complete the work within the requirements of the Contract Documents and the appropriate regulatory agencies and permits. The following summarizes a general sequence of work necessary to complete remediation in accordance with the intended design:

Phase 1 Remedial Construction (Initial Impoundment Dewatering and Instrumentation Installation)

1. Mobilize to Site
2. Install E&SC
3. Establish on-site quarry & crushing operation
4. Construct/improve access road to Impoundment Toe
5. Construct BioReactor Treatment Areas
6. Construct temporary drill pads for horizontal drains
7. Install upper N/S horizontal drain and associated collection piping
8. Construct working surface
9. Install Prefabricated Vertical Drains (PVDs). For purposes of this design, PVDs will be referred to as “EQ Drains”.
10. Install geotechnical instrumentation per GMP (Appendix E)
11. Monitor water levels for 1 year (+/-)

Phase 2 Remedial Construction (Site Re-Grading/Earthworks and Cover System)

1. Install E&SC
2. Install additional horizontal drains (lower N/S drain and/or E/W drains) if necessary (if adequate dewatering has not occurred) to begin construction
3. Staged cut/fill operations. Fill placement rates governed by response of tailings to loading/unloading evidenced by geotechnical instrumentation and monitoring (see GMP)
4. Cut/fill balance and grading adjustments
5. Cover system installation

B. The CONTRACTOR shall select a work sequence that minimizes:

1. Impacts to the surrounding residents.
2. Traffic congestion.

C. Project Startup

1. Project startup shall include the following activities, which are not necessarily in order:
 - a. Attend a Pre-Construction Meeting;
 - b. Develop and submit all required pre-construction submittals for acceptance;
 - c. Complete initial inspections and surveys of work areas as required to verify existing conditions and potential issues that could impact the work;
 - d. Provide required entrance medical examinations for employees designated to work on the project in accordance to the HASP;
 - e. Conduct site-specific safety training in accordance with the HASP; and
 - f. Secure required permits.
2. Begin construction after receipt of and meeting the conditions noted in the Notice to Proceed.

D. Remedial Construction

1. The remedial construction shall include the activities described in Item 1.03 (Work Covered by the Contract Documents) above.

- E. Project Closeout
 - 1. Request a Certificate of Substantial Completion from the OWNER;
 - 2. Perform a Site inspection with the OWNER and ENGINEER to accept work and identify remaining work to be completed (punch list);
 - 3. Complete all remaining work noted in the punch list;
 - 4. Perform a final Site inspection with the OWNER and ENGINEER to verify all work is complete;
 - 5. Submit final record documents including final certification report with record drawings to the OWNER and ENGINEER;
 - 6. Complete final pay requisition with accompanying balancing change order as required; and
 - 7. Achieve Final Completion.

1.05 OTHER GENERAL REQUIREMENTS

- A. Comply with all Project related permits and apply/obtain all CONTRACTOR responsible permits prior to the commencement of work.
- B. Make arrangements for temporary storage of materials and supplies and for timely delivery to the job site.
- C. Assist the OWNER and ENGINEER and State inspectors as required in the review of construction.
- D. Maintain up-to-date records on site.
- E. Maintain the project Site in a neat condition.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 HEALTH AND SAFETY

- A. The CONTRACTOR is advised that the Work will be performed on a Site that may contain hazardous waste. The CONTRACTOR is responsible for developing a Site Specific Health and Safety Plan (HASP) for its operations. The CONTRACTOR shall implement this plan taking precautions as necessary to protect the public and work force personnel from potential hazards. The CONTRACTOR shall utilize personnel with approved hazardous waste training as required.
- B. Several safety hazards to workers, authorized visitors, and trespassers exist at the Callahan Mine Site. In addition, several environmental hazards exist due to presence of waste soil/rock and impacted water within the Tailings Impoundment. The paragraphs

below describe safety and environmental hazards at the Site that will be improved by remedial construction activities.

- C. Remediation of the Tailings Impoundment will reduce the contaminant load to Goose Pond from surface water runoff and groundwater seeps through the waste rock dam. Installation of an infiltration barrier cap will significantly reduce stormwater recharge to the underlying tailings. Deeper horizontal drains will be installed to further assist in lowering the groundwater levels within the Tailings Impoundment which will improve both static and seismic stability and thereby minimize the potential for a slope failure along the perimeter of the impoundment.
- D. Perimeter dams located along the north, south, and east sides of the Tailings Impoundment were constructed with large waste rock boulders obtained from former mining operations. The boulders vary in size with an average diameter of approximately five feet. The perimeter dam was constructed in phases as additional capacity was required within the impoundment, and the rock dam currently ranges from 20 to 60 feet in height. Strategic removal of up to approximately 23 feet of waste rock will be required to achieve design subgrade elevations. Removal of the waste rock will be completed in a manner that avoids risk to construction personnel and equipment and prevents a non-construction-related rock slide at some future date that could compromise completed work and/or pose a risk to site visitors.
- E. Safety zones will be established and controlled in the field to ensure personnel, equipment, or visitors may not access areas that may be subject to tumbling rocks. In addition, protective measures shall be installed to shield monitoring instruments from damage.
- F. PCB impacted soil and ore rock from the forming mine operations area was recently consolidated in an area along the western portion of the impoundment. No EQ Drains or geotechnical instrumentation will be installed in this area.
- G. Quarry operations, including drilling, blasting, and crushing, shall be conducted in accordance with all applicable federal and state regulations as well as the CONTRACTOR's approved HASP and Blasting Plan.
- H. Final restoration shall be completed to establish a competent face free of fragmented rock that could pose a hazard for future visitors at the site. Additional measures, such as rock netting, may be required along the face of the Tailings Impoundment dam to minimize the potential for any localized failure of the waste rock.

3.02 PROTECTION OF PROPERTY AND OPERATIONS

- A. The CONTRACTOR shall utilize every precaution to protect the property from damage during execution of the work. Trees and other structures shall be protected as appropriate. Any damage that the CONTRACTOR may inflict shall be repaired or replaced in a prompt manner as directed by the OWNER or ENGINEER at no additional cost to the OWNER.

- B. Areas for CONTRACTOR staging and storage shall be approved by the OWNER. Suitable areas adjacent to the work are preferred for staging areas as indicated on the drawing.
- C. The CONTRACTOR shall take all measures required to minimize adverse impacts from execution of the work on property abutters and shall not interfere with their operations.
- D. The CONTRACTOR shall coordinate site restrictions and vehicular/pedestrian traffic control plans with the OWNER as appropriate.
- E. CONTRACTOR shall record baseline video and take photos of the Site structures and surrounding residences prior to commencing work. This includes pre-construction as well as construction progress and post construction documentation of all work areas.

3.03 CONTRACTOR'S USE OF PREMISES

- A. The CONTRACTOR shall use only those designated areas of the Site for staging and storage. Staging and storage areas are to be agreed upon and accepted by OWNER.
- B. **NO SMOKING** will be allowed within the Site work areas.
- C. The CONTRACTOR shall assume full responsibility for the protection and safe keeping of products and equipment under this Contract that are stored on-site during the Project construction.

3.04 OTHER REQUIREMENTS

- A. It is the responsibility of the CONTRACTOR to coordinate and provide timely notification to the Owner and operators of underground utilities when construction, excavation, or other work may affect such utilities.
- B. It is the responsibility of the CONTRACTOR to notify the appropriate state or local authority when construction or associated impacts will occur within the road right-of-way and/or may affect roadways or sidewalks.
- C. The CONTRACTOR is responsible for using special care and/or special considerations which may be necessary for proper execution of the Work, but which may not be specifically identified in this section. The CONTRACTOR shall comply with the entire requirements of the Contract Documents and shall exercise special care wherever required for proper execution of the intended work of this contract.
- D. The CONTRACTOR shall comply with all the requirements of any permits, which have been obtained, or applied for by the OWNER or ENGINEER and are included (permit or application) as part of Contract Documents.
- E. Work of others at the Site is not to interfere with CONTRACTOR schedule.

END OF SECTION

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SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Required Submittals are identified in each technical specification section of the Contract Documents. A summary of Submittals is provided at the end of this section. Submittals shall be provided to the OWNER and to the ENGINEER, as required, unless otherwise specified. Submittals may include:
1. Data;
 2. Drawings;
 3. Instructions;
 4. Schedules;
 5. Statements;
 6. Reports;
 7. Plans;
 8. Certificates;
 9. Samples;
 10. Records; and
 11. Operation and Maintenance Manuals.
- B. The CONTRACTOR shall make Submittals as required by the Contract Documents, including the individual specification sections and drawings. Submittal items are summarized in Table 01 33 0-1, which is provided at the end of this section. The CONTRACTOR is responsible for all submittals indicated in the Contract Documents, whether listed in Table 01 33 0-1 or not.
- C. Submittal procedures shall conform to the requirements of applicable Articles and/or Sections of the Contract General Conditions, and as described in this section.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.01 GENERAL

- A. Submittals shall be provided to the OWNER. Additional copies shall be provided to the ENGINEER upon request.

- B. Submittals shall include items such as:
 - 1. Manufacturer's or fabricator's drawings;
 - 2. Descriptive literature including (but not limited to) catalog cuts, diagrams, operating charts or curves;
 - 3. Test reports;
 - 4. Samples;
 - 5. Operation and Maintenance Manuals (including parts list);
 - 6. Certifications;
 - 7. Warranties; and
 - 8. Other pertinent data.

- C. The CONTRACTOR is responsible for providing submittals well in advance of the need for the material or equipment for construction. Consideration shall be given to material lead times, delivery schedules, and time required for submittal review and acceptance by the OWNER.

3.02 SUBMITTAL REQUIREMENTS

- A. Transmittal Form:
 - 1. A Transmittal Form shall accompany all Submittals.
 - 2. The Transmittal Form shall be developed and furnished by the OWNER or the ENGINEER.
 - 3. Transmittals shall include the following information, at a minimum:
 - a. Submittal number in sequence, beginning with 1 (subsequent revised Submittals shall be identified with a number and letter, for example, 1A, 1B, etc.);
 - b. Date;
 - c. Project title and project number;
 - d. CONTRACTOR's name and address;
 - e. Identification of each item submitted under the single Transmittal Form with a separate sequential number (e.g. 1.1, 1.2, etc.). Group only like items in a single Submittal; five items per Submittal maximum;
 - f. Reference to the specification section and sub-part number and/or Contract Drawing sheet and detail number (if applicable) pertinent to the data submitted.
 - g. Notification of any deviations from Contract Documents;
 - h. Return date required by CONTRACTOR; and
 - i. Other pertinent data.

- B. CONTRACTOR Certification: The CONTRACTOR's Certification that the Submittal meets contract requirements shall contain the following:

State of Maine Department of Transportation
Callahan Mine Superfund Site – Brooksville, Maine
OU3 Draft Final Design
Section 01 33 00 – Submittal Procedures

1. CONTRACTOR firm name;
2. Point of contact name, signature, and title;
3. Date; and
4. CONTRACTOR's corrections as noted on Submittal data and/or attached sheets(s).
5. The certification may be provided as part of the Transmittal, on a separate sheet attached to the Transmittal, or as a stamp on the Submittal itself.

C. Procedures:

1. The CONTRACTOR shall schedule submissions at least 14 days before Submittal approvals will be needed, except where different lead time is specified.
2. Submittals shall be delivered electronically. The CONTRACTOR shall provide hardcopies to the OWNER and/or ENGINEER upon request.
3. The CONTRACTOR shall deliver Submittals to the OWNER and to the ENGINEER in electronic form by email. The CONTRACTOR-signed Transmittal shall be scanned and attached to the other electronic Submittal documents. The subject line of the email shall clearly note the project name and Submittal number.
4. The CONTRACTOR shall maintain one copy of the Submittal and Transmittal on site.
5. At the time of each submission, the CONTRACTOR shall call to the OWNER's attention, in writing, any deviations that the Submittal may have from the requirements of the Contract Documents.

D. Submittals shall include:

1. Date and revision dates;
2. Project title and number;
3. The names of:
 - a. OWNER and ENGINEER;
 - b. CONTRACTOR;
 - c. Subcontractor;
 - d. Supplier;
 - e. Manufacturer; and
 - f. Separate detailer when pertinent.
4. Identification of product or material;
5. Field dimensions, clearly identified as such;
6. Specification section and sub-part number and/or Drawing sheet and detail number;
7. Applicable standards, such as ASTM or Federal Specification number;
8. For Submittals which include proposed deviations requested by the CONTRACTOR, "variation" shall be clearly indicated on the Transmittal. The CONTRACTOR shall state the reason for any deviations and annotate such deviations on the Submittal. The OWNER reserves the right to rescind inadvertent acceptance of Submittals containing unnoted deviations.

E. Submittals shall be of standardized sizes.

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1. Approved standard sizes shall be:
 - a. 22 inches by 34 inches;
 - b. 11 inches by 17 inches; and
 - c. 11 inches by 8 1/2 inches.
2. Provision shall be made in preparing Submittals to afford a binding margin on left hand side of sheet.
3. Submittals put forward other than as specified herein may be returned for resubmittal without being reviewed.

SUBMITTAL Table 01 33 00-1: Submittal Summary

No.	Specification Section	Specification Part	Submittal Item	Schedule
1	01 11 00	1.03(C)	Construction Work Plan	Prior to commencement of construction
2	01 11 00	1.04(E)	Record Documents	Project closeout
3	01 11 00	3.01(A)	Contractor Quality Control Plan	Prior to commencement of construction
4	01 45 00	1.03(A)	Personnel Qualifications	Upon Request
5	01 45 00	3.03	Notice of CQC Plan Changes	As Required
6	01 45 00	3.07	CQC Reports	As Required
7	01 46 00	1.03(A)	Field Engineering and Surveying Qualifications	Upon Request
8	01 46 00	1.03(C)	Existing Conditions Verification Survey	Prior to commencement of construction
9	01 46 00	1.04 (F)	Field Verification Surveys for Completed Work	As Required
10	01 56 00	1.03	Qualifications of Personnel	Prior to commencement of construction
11	01 56 00	1.03	Dust Control Plan	Prior to commencement of construction
12	01 78 00	1.04	Project Record Documents	At completion of field operations
13	03 37 13	1.04(A)	Pre-Installation Meeting	1 week prior to commencing work
14	03 37 13	1.04(B)	Product Data, Mix Design, and Test Reports	1 week prior to commencing work
15	31 05 19	1.04	Geogrid and Geotextile Product Data	21 days prior to start of work
16	31 05 19.06	1.04(A)	Liner Material and Manufacturer Data	21 days prior to start of work
17	31 05 19.06	1.04(B)	Panel Layout, Details, and Personnel Qualifications	10 days prior to start of work
18	31 05 19.06	1.05(E)	Geomembrane Quality Control Documentation	Daily during course of work
19	31 23 00	1.04(A)(1)	Soil Material Testing Results	10 days prior to material delivery
20	31 23 00	1.04(A)(2)	In Place Soil Material Testing Results	weekly
21	31 23 00	1.04(B)	Third-Party Soil Testing Service	14 days prior to start of work
22	31 23 00	1.04(C)	Soil Sources	10 days prior to material delivery
23	31 23 10	1.06(A)	Blast Control Specialist Qualifications	1 month prior to start of work
24	31 23 10	1.06(B)	Blasting Plan and Blasting Schedule	1 month prior to start of work
25	31 23 10	1.06 (C)(1)	Licensing, experience and qualifications of the blasters	
26	31 23 10	1.06 (C)(2)	Name and qualifications of the person(s) responsible for designing and directing the blasting	1 month prior to start of work
27	31 23 10	1.06 (C)(3)	Name and qualifications of the person(s) responsible for conducting pre-blast condition surveys	1 month prior to start of work
28	31 23 10	1.06 (C)(4)	Blasting Permit(s)	1 month prior to start of work

01 33 00-5

SUBMITTAL Table 01 33 00-1: Submittal Summary

No.	Specification Section	Specification Part	Submittal Item	Schedule
29	31 23 10	1.06(C)(5)	Pre-blast Condition Survey	1 month prior to start of work
30	31 23 10	1.06(D)	Blasting Complaints	Within 24 hours of receipt of complaint
31	31 23 19	1.03(A)(1)	Qualifications of Dewatering Personnel	10 days prior to start of work
32	31 23 19	1.03(A)(1)	Dewatering Plan	10 days prior to start of work
33	31 23 19	1.03(A)(3)	Water Management Plan	10 days prior to start of work
34	31 23 19	1.03(A)(4)	Product Data	10 days prior to start of work
35	31 25 00	1.03 (C)	Verification with agencies that permits are in place	14 days prior to start of work
36	31 25 13	1.03 (D)	Material submittals for all major components	14 days prior to start of work
37	31 25 13	1.05	Erosion and Sediment Control Plan	1 month prior to start of work
38	31 35 26.15	1.04(A)(1)	Manufacturer's Quality Control Manual	Provide with Contractor Bid Package
39	31 35 26.16	1.04(A)(2)	Manufacture's Project Data Sheet	Provide with Contractor Bid Package
40	31 35 26.16	1.04(A)(3)	Project Reference List for GCL Installer	Provide with Contractor Bid Package
41	31 35 26.16	1.04(A)(4)	A representative sample of proposed GCL	14 days prior to material delivery
42	31 35 26.16	1.04(B)(1)	QC certifications from manufacturer on GCL / Bentonite	14 days prior to material delivery
43	31 35 26.16	1.04(B)(2)	Signed certification by Contractor and CQA Inspector of subgrade acceptance	Prior to installing GCL
44	31 35 26.16	1.04(B)(3a)	Certification by Installer that GCL was installed per project specifications	Upon completion of GCL Installation
45	31 35 26.16	1.04(B)(3b)	Material and Installation Warranties	Upon completion of GCL Installation
46	31 35 26.15	1.04(B)(3c)	As-built drawings showing actual GCL placement	Upon completion of GCL Installation
47	32 92 00	1.04(A)	Topsoil source test results	14 days prior to start of work
48	32 92 00	1.04(B)	Grass see vendor's certificate	14 days prior to start of work
49	32 92 00	1.04(C)	Fertilizer product data	14 days prior to start of work
50	33 05 23	1.2.1	Statement of Qualifications and Records	Provide with Contractor Bid Package
51	33 05 23	1.2.2	As-built drawings of installed drain locations	Upon completion of drain Installation
52	33 05 23	1.2.3	Product Data	14 days prior to start of work
53	33 05 23	1.2.4	Closeout submittal including work logs from drilling	Upon completion of drain Installation
54	33 20 00	1.02(A)	Product Data	14 days prior to start of work
55	33 20 00	1.02(B)	Installation method and proposed sequencing	14 days prior to start of work
56	33 41 00	1.02(A)	Product Data	14 days prior to start of work

SUBMITTAL Table 01 33 00-1: Submittal Summary

No.	Specification Section	Specification Part	Submittal Item	Schedule
57	33 41 00	1.02(B)	As-built drawings of all piping and appurtenant structures	Upon completion of piping installation
58	33 46 16.16	1.06(A)	Manufacturer qualifications	Provide with Contractor Bid Package
59	33 46 16.16	1.06(B)	Installer qualifications	Provide with Contractor Bid Package
60	33 46 16.16	1.06(C)	Quality Control Laboratory (QCL) qualifications	Provide with Contractor Bid Package
61	33 46 16.16	1.06(D)	Product Data and Manufacturer Certifications	21 days prior to start of work
62	33 46 16.16	1.06(E)(1)	Manufacturer Quality Control Certificates	As delivered to the site
63	33 46 16.16	1.06(E)(2)	Contractor Quality Control Results	Weekly
64	33 49 00	1.05(A)	Shop Drawings	21 days prior to start of work
65	33 49 00	1.05(B)	Manufacture's Data	21 days prior to start of work
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SUBMITTAL Table 01 33 00-1: Submittal Summary

No.	Specification Section	Specification Part	Submittal Item	Schedule
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Note: The CONTRACTOR is responsible for all submittals indicated in the Contract Documents, whether listed in Table 01 33 00-1 or not.

END OF SECTION

01 33 00-8

SECTION 01 41 00

REGULATORY REQUIREMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

Comply with local, state, and federal regulations appropriate or applicable to the proposed work.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Section 01 57 20: Environment Protection

1.03 REMEDIAL WORK

Regulations applicable to on-site remedial activities will include but not necessarily be limited to the following governing authorities. A general list is provided below:

- A. Occupational Safety and Health Act (OSHA)
- B. U.S. Environmental Protection Agency (USEPA)
- C. U.S. Army Corps of Engineers (USACE)
- D. Maine Department of Environmental Protection (MEDEP)
- F. Maine Department of Transportation (MEDOT)
- G. Clean Air Act (CAA)
- H. Clean Water Act (CWA)

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

--END OF SECTION--

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SECTION 01 45 00

CONTRACTOR QUALITY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

This Section covers quality control procedures and testing to be completed during Work. Prior to commencement of Work, the CONTRACTOR shall prepare a Contractor Quality Control (CQC) Plan detailing the procedures to be followed and testing to be completed. Quality control testing shall be executed as required in this specification.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Section 01 33 00: Submittal Procedures
Section 01 78 00: Project Record Documents

1.03 SUBMITTALS

- A. SD01 – Pre-construction Submittals
 - 1. Contractor Quality Control (CQC) Plan – shall identify personnel, procedures, instructions, records and forms to be used in carrying out the requirements of this project. The CQC Plan shall provide the CONTRACTOR with a means to provide and maintain effective Quality Control for construction, sampling and testing activities. No work on-site shall be permitted until comments received are adequately addressed by the CONTRACTOR and the CQC Plan is approved by the OWNER.

1.04 CONSTRUCTION QUALITY ASSURANCE

- A. EPA is responsible for providing Construction Quality Assurance (CQA) services during the execution of the Work in accordance with applicable regulations.
- B. The CONTRACTOR's Quality Control procedures shall include coordinating and assisting the OWNER in conducting CQA services as required.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. The quality of all Work shall be the responsibility of the CONTRACTOR.
- B. Perform sufficient inspections and tests of all items of work, on a continuing basis, including that of subcontractors, to ensure conformance to applicable specifications and drawings with respect to the quality of materials, workmanship, construction, and functional performance.
- C. Provide qualified personnel, appropriate facilities, instruments, and testing devices necessary for the performance of the quality control function.
- D. Controls shall be adequate to cover all construction operations, shall be keyed to the proposed construction sequence, and shall be coordinated by the CONTRACTOR's quality control personnel.

3.02 CONTRACTOR QUALITY CONTROL (CQC) PLAN

- A. Prepare and submit a Contractor Quality Control Plan to the OWNER's Representative for approval.
- B. Comments or approval from the OWNER will be submitted to the Contractor within 10 calendar days following receipt of the plan. CONTRACTOR shall adequately respond to comments to the satisfaction of the OWNER within 14 calendar days following receipt of any comments from the OWNER.
- C. No work on-site shall be permitted until the comments received are adequately addressed by the CONTRACTOR and the CQC Plan is approved by the OWNER.
- D. The CQC Plan, at a minimum, shall include the following:
 - 1. A description of the Quality Control Organization, including charts showing lines of internal CONTRACTOR authority, and external Contractor, subcontractor, and OWNER and ENGINEER relationships. The Quality Control Organization shall include the names, qualifications, duties, and responsibilities of each person assigned to a quality control function. The Quality Control Organization chart shall identify a CONTRACTOR's Quality Control Manager whose responsibilities and qualifications are described in the Article entitled "Contractor Quality Control Organization" in this Section.
 - 2. Method of performing, documenting and enforcing quality control operations of both CONTRACTOR and subcontract work including inspection and testing.
 - 3. Inspections as described in the article entitled, "Inspections" in this Section.
 - 4. Provide a list of analytical or testing laboratories to be used by the CONTRACTOR for testing required by these technical specifications.
 - 5. Protocol describing corrective actions to be taken by the CONTRACTOR with specifically defined feedback systems. The OWNER will then decide what further corrective action, if any, shall be taken by the CONTRACTOR. Personnel responsible for initiating and carrying out corrective action shall be indicated in the protocol.
- E. Submit Weekly CQC Reports, Test Reports, Deficiency Reports and Project

Summary as required by this specification.

3.03 NOTIFICATION OF CHANGE

After submittal and approval of the CQC Plan, the OWNER shall be notified in writing of any proposed changes to the CQC Plan.

3.04 CONTRACTOR QUALITY CONTROL ORGANIZATION

A. CQC Manager:

1. Identify an individual, within the CONTRACTOR's organization at the work site, who shall be responsible for overall management of the CQC Plan and have the authority to act in all CQC matters for the CONTRACTOR.
2. The CQC Manager for this contract shall be a qualified construction manager/engineer or comparable individual with a minimum of 2 years of applicable experience, at the Project Manager, Project Engineer, Superintendent or CQC Manager Level, whose responsibility is to ensure compliance with the contract plans and specifications. The CQC Manager shall be independent of the Project Superintendent.
3. The CQC Manager shall be on-site whenever work is in progress so that he/she may be in charge of the CQC Plan for the project.
4. All submittals for approval shall be reviewed and modified or corrected as needed by the CQC Manager the authorized assistants prior to forwarding each submittal to the OWNER.

3.05 INSPECTIONS

A. The CQC Plan shall include the following inspections and tests:

1. The CONTRACTOR shall perform preparatory inspections prior to beginning each feature of work on any on-site construction work conducted by the CONTRACTOR or a subcontractor. Preparatory inspections for the applicable feature of work shall include:
 - a. review of submittal requirements and all other Contract requirements with the performance of the work;
 - b. check to assure that provisions have been made to provide required field work control testing;
 - c. examine the work area to ascertain that all preliminary work has been completed;
 - d. verify all field dimensions and advise the OWNER of any discrepancies;
 - e. perform a physical examination of materials and equipment to assure that they conform to approved shop drawings or submittal data and that all required materials and/or equipment are on hand and comply with the contract requirements.
2. Perform initial inspection as soon as work begins on a representative portion of the particular feature of work, and include examination of the quality of workmanship as well as review of control testing for compliance with

- control requirements.
3. Perform follow-up inspections continuously as any particular feature of work progresses to ensure compliance with Contract requirements, including control testing, until completion of that feature of work.

3.06 TESTING

The CONTRACTOR shall be responsible for all required testing, documentation, and corrective measures. The CONTRACTOR shall perform tests specified or required to verify that control measures are adequate to provide a product which conforms to contract requirements.

3.07 REPORTING

- A. An original and two copies of all inspection and testing results shall be reported daily, weekly, and in project reports unless noted otherwise. All reports shall be prepared and signed by the CQC Manager. All reports shall be legible, literate, complete, and must be submitted on time.
 1. Daily Submittals: Reproduce and fully execute the attached sample "CQC Report" to show all inspections, samples collected and test results (e.g., earthwork, geomembrane) and submit to the OWNER on the first work day following the date covered by the report. Submit an original and two copies of this report. Complete the attached sample "CQC Test Report List" and attach to the CQC Report for submittal to the OWNER.
 2. Deficiency Report: Submit a report to the OWNER of any problems which arise with analysis, instrument calibration or quality control within 48 hours of the occurrence. Include proposed remedial action to be taken to correct the deficiency. A list of ongoing deficiencies to be corrected will be attached to the CQC Report daily. As deficiencies are corrected they are to be acknowledged in the day's CQC Report and deleted from the list.
 3. Project Summary: At the end of the construction, prepare a summary of CQC during the project. The report shall be a consolidation and summary of the CQC daily reports. Submit to the OWNER.

-- END OF SECTION --

CQC REPORT

No. _____ Date

1. Contractor's name and address:

2. Project Title: _____

Location: _____

Contract No.: _____

3. Weather: _____

4. Description and Location of Work (include days of no work and reasons for delay):

5. Follow-up Inspections Performed. Results and Corrective Actions Taken:

6. Job Safety:

7. Miscellaneous Activities and Remarks (Check Appropriate Item):

- A. Preparatory or initial inspection held (see attached minutes)
- B. Testing Performed-See Attached Test Results and/or "CQC Test Report"
- C. Outstanding Deficiencies - See Attached "List"
- D. Verbal Instructions Received (or Comments)
- E. Delivery of Equipment and Materials
- F. Submittal Actions
- G. Misc/Remarks

Use space below to describe checked items as appropriate.

8. Contractor's Verification: The above report and attachments are complete and all supplies, materials, equipment and workmanship incorporated into the work are in full compliance with the contract except as noted.

SIGNED _____

CQC TEST REPORT LIST

CQC REPORT NO. _____ SHEET ___ OF _____
 PROJECT TITLE: _____
 LOCATION: _____

DATE: _____
 CONTRACTOR: _____
 CONTRACT NUMBER: _____

1. SPEC. PARA. OR DWG. REF.	2. TYPE OF TEST	3. DATE PERFORMED	4. RESULTS	5. REMARKS

Notes on Use of This Form: Contractor shall make up a list of tests by filling out Columns 1 and 2, allowing 3 lines for each entry. Contractor shall submit to OWNER’s Representative as part of the Quality Control Plan. As tests are performed the contractor will fill Columns 3, 4 and 5, including name of lab, and submit individual sheets as part of CQC report.

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SECTION 01 46 00

FIELD ENGINEERING AND SURVEY CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Establish survey control points onsite for construction purposes. The CONTRACTOR shall verify locations of survey control points prior to starting Work. The CONTRACTOR shall safeguard all survey control points. Should any of these points be destroyed, the Contractor shall replace the control point at no cost to the OWNER. The CONTRACTOR shall assume the entire expense of rectifying work improperly constructed due to failure to maintain and protect such established survey control points.
- B. The CONTRACTOR shall be responsible for the layout of any additional survey control points, grid coordinate locations, lines, grades, and levels necessary for the proper construction and testing of the Work required in the Contract Documents. Survey control shall include, but not be limited to, maintaining appropriate slopes and specified thickness.
- C. The CONTRACTOR shall employ a surveyor using standard practices and datum for the State of Maine to provide the surveying functions necessary for the proper execution of the Work, and to document and record the completed work.
- D. The CONTRACTOR is responsible for scheduling the surveys to coincide with his construction activities. If the survey documentation shows improper slopes, elevations, locations, or layer thickness, the CONTRACTOR shall correct the deficiency and re-survey the re-work. Phases for survey layout and documentation may include, but not be limited to:
 - 1. Initial field verification survey, see paragraph 1.05.
 - 2. Completed excavation elevations, limits and slopes.
 - 3. Location and elevations of drain features including piping, vaults, discharge structures, manholes (including pipe inverts and top of cover) and appurtenances.
 - 4. Location of installed horizontal drains.
 - 5. Final grade elevations including fill and roadway areas.
 - 6. Utility and storm drain features installed, encountered or relocated as part of the work.
 - 7. Location of cap limits.

1.02 RELATED REQUIREMENTS

- Section 01 11 00: Summary of Work
- Section 01 33 00: Submittal Procedures
- Section 01 45 00: Contractor Quality Control
- Section 01 78 00: Project Record Documents
- Section 31 23 00: Earthwork

Section 33 05 23: Horizontal Directional Drilling

1.03 SUBMITTALS

- A. On request, submit data demonstrating qualifications of persons providing field engineering and survey services.
- B. On request, submit documentation verifying accuracy of survey work.
- C. The CONTRACTOR shall perform a field verification survey as part of the Work prior to the start of construction activities, to verify/establish current conditions. The CONTRACTOR shall then compare the existing condition information shown on the Contract Drawings, to the current conditions determined during the field verification activities. Where discrepancies exist, the Contractor shall submit to the Engineer the results of the field verification survey and results of the comparison with the Contract Drawings. All discrepancies shall be resolved, by the Engineer prior to initiation of construction activities affected by discrepancies.
- D. Maintain complete, accurate log of control and survey work as it progresses. Submit Record Documents specified in Section 01 78 00, “Project Record Documents”.

1.04 FIELD ENGINEERING AND SURVEY REQUIREMENTS

- A. Provide field engineering and survey services using appropriate construction practices. Use skilled persons, trained and experienced in the necessary tasks and techniques for the proper execution of the Work. Locate and layout the Work by survey instrumentation and similar appropriate means.
- B. The CONTRACTOR shall perform layout and document completed construction on Record Drawings of the features list contained in this Specification.
- C. The CONTRACTOR shall establish a grid system (Construction Control Grid) with a maximum spacing of 25 feet with additional grid points as required for grade breaks (toe, top of slopes) over the entire limits of Work. The grid system shall be established for the purpose of determining required excavation and fill thickness, cut and fill quantities as well as locating work and testing by the CONTRACTOR or independent construction quality assurance personnel. Periodically re-establish or verify layout and grid points as required as work progresses.
- D. The CONTRACTOR shall sufficiently establish the existing ground elevations before earthwork is started. Survey constructed grades (subgrade and final) subsequent to excavation and filling existing grades. The Contractor shall sufficiently survey to verify quantities included in requests for payment.
- E. Vertical and horizontal control shall be sufficient to assure work is constructed within 0.1 foot of proposed fill thickness requirements (or proposed grades as indicated where settlement is not a concern) and location.
- F. Verification surveys, surveys for measurement and payment, and Project Record Documentation shall be provided in electronic file format using the current version of AutoCAD at the time of the survey work.

1.05 TECHNICAL REQUIREMENTS OF SURVEY

- A. Horizontal ground control shall originate and terminate on Maine State Plane NAD 83, East Zone. Vertical control shall be tied to NGVD 29.
- B. Map Accuracy - Ninety percent of the elevations determined from the solid-line contours for the topographic maps shall have accuracy with respect to true elevation of 0.5 contour interval (0.5 foot) or better, and the remaining 10 percent of such elevations shall not be in error by more than one contour interval (1 foot). This accuracy shall apply only to the contours which are on each map. Thus, in each particular area where the intermediate contours have had to be omitted due to the steepness of the ground slopes and only the index contours are not omitted, the accuracies are applicable to the contour interval specified for the topographic maps. In densely wooded areas where the heavy brush or tree cover fully obscures the ground the surveyor shall verify elevations in the field.
- C. Coordinate Grid Lines - The plotted position of each plane-coordinated grid line shall not vary by more than one one-hundredth inch (0.01") on each map manuscript.
- D. Establish a permanent project benchmark for vertical control.
- E. Horizontal Control – Each horizontal control point shall be plotted on the map manuscript within the coordinate grid in which it should lie to an accuracy of one one-hundredth in (0.01") of its true position as expressed by the plane coordinates computed for this point.
- F. Spot Elevations - Survey shall be constructed to provide an accuracy of 0.1 feet vertically. No shots exceeding 25 feet shall be taken. Ninety percent of all spot elevations placed on the maps shall have an accuracy of at least 0.1', and the remaining 10 percent shall not be in error by more than one-half (1/2) the contour interval (0.5').
- G. Accuracy - Accuracies and accuracy tests apply to the stereo compilation scale of the original manuscript (i.e., if the manuscript is compiled at a scale of 1" = 100' and then reduced to 1"=200', then the accuracies will apply to the original 1"=100' scale). This is also true if the manuscript is enlarged to 1"=50' or some larger scale.

1.06 FIELD VERIFICATION SURVEY

The existing conditions depicted on the drawings were interpreted from various sources including:

- A. Aerial Mapping and Supplemental ground survey provided by MEDOT (2012).
- B. As-built survey of PCB Impacted Material placed within the Tailings Impoundment provided by CES, Inc. (2014).

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

-- END OF SECTION --

SECTION 01 56 00

DUST CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The CONTRACTOR shall furnish all labor, equipment, and materials necessary to execute the Work by methods that minimize the generation/raising of airborne dust. Work includes, but is not limited to, the following:
 - 1. Furnishing and applying water for dust control on roadways and/or haul roads, where construction equipment is operating, or in disturbed areas, as required or as directed by the OWNER;
 - 2. Employing standard dust control techniques, such as watering down the site, at a minimum, in areas of heavy equipment traffic; and
 - 3. Providing/storing sufficient volumes of water to provide for continuous application, if necessary.
- B. Dust control shall be implemented as necessary to meet local, state, and/or federal regulations for air emissions and dust.
 - 1. Dust control measures will be such that air quality is in compliance with applicable OSHA regulations, at a minimum.
- C. On-site and/or perimeter air monitoring via respirable dust meters will be performed by others.
 - 1. The CONTRACTOR shall support the air monitoring operations and equipment as follows:
 - a. Maintain continuous power to all air monitoring equipment if necessary.
 - b. Move and reinstall air monitoring stations as necessary to accommodate the work.
 - c. Provide physical protection for all air monitoring equipment.
 - 2. The CONTRACTOR will be notified if dust/particulate levels approach the action levels that are to be established in the perimeter air monitoring plan that is to be implemented by others.
- D. No additional payments will be made due to shutdowns as result of emissions whether exceeding standards or posing a nuisance.
 - 1. If the initial controls are found to be inadequate, the CONTRACTOR shall provide additional measures at no additional cost.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00: Summary of Work
- B. Section 31 23 00: Earthwork

1.03 SUBMITTALS

- A. The names and qualifications of the personnel who will be responsible for performance of the activities under this Section.
- B. A proposed Dust Control Plan for review and approval by OWNER and/or the ENGINEER.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Water:
 - 1. Shall be free from oil, acid, and injurious alkali or vegetable matter, and other deleterious materials or contaminants.
 - 2. Water shall not be brackish or contain salts in concentrations greater than 500 ppm.

2.02 EQUIPMENT

- A. Equipment for dust control shall include appropriate measures (e.g., heat tape, tank heaters) to prevent freezing or impair operation due to temperatures below freezing, as necessary.

PART 3 - EXECUTION

3.01 DUST CONTROL PLAN

- A. The CONTRACTOR shall prepare a Dust Control Plan. The plan shall include, but not be limited to the following:
 - 1. Implementation of dust control measures during all activities that may generate airborne dust emissions, including, but not limited to, surcharging, excavation, truck loading, backfilling, road sweeping, stockpiling of soils. Visible airborne dust will be minimized at all times. Control measures, such as limiting the size of excavations, covering stockpiles, applying water mist, etc. shall be used as necessary.
 - 2. The CONTRACTOR shall be responsible for using effective dust control measures. Such measures include:
 - a. Application of water to the excavation face.
 - b. Use of a spray-on sealer.
 - c. Application of water to backfill surfaces during filling and compaction activities.
 - d. Covering of fill surfaces with final cover material as soon as final subgrades are achieved.

- e. Application of water to roadways, gravel surfaces, and exposed subgrade.
 - f. De-icing materials may be necessary during winter months.
 - g. Install wind screen on perimeter fence.
 - h. Decontaminate all construction equipment before releasing them from the site.
 - i. Provide wheel and chassis wash where trucks pass from unpaved surfaces onto pavement.
- 3. Trucks used to transport materials off-site shall be covered and sealed to control dust emissions. The CONTRACTOR shall specify how dust control will be implemented during loading of trucks.
 - 4. The CONTRACTOR shall identify the dust control measures to be implemented for stockpiles.
- B. The CONTRACTOR shall be required to manage dust control and erosion of the soil and stone stockpiles throughout the earthwork activities.

3.02 SPRINKLING WATER

- A. Apply by approved methods and with equipment including a tank with gauge-equipped pressure pump and a nozzle-equipped spray bar.
- B. Disperse through the nozzle under a minimum pressure of 20 pounds per square inch, gauge pressure.
- C. Apply water until the surface is wet, but avoid ponding, run off, or muddy conditions.

3.03 TESTING

- A. All equipment, if not in regular use, shall be tested as requested by the OWNER.

3.04 IMPLEMENTATION

- A. The CONTRACTOR shall have sufficient, personnel and equipment available to implement the approved Dust Control Plan.
- B. The CONTRACTOR shall inspect the dust control measures daily and maintain the effectiveness of the measures. Observations and maintenance activities shall be documented in the Contractor's Daily Reports.
- C. Environmental air monitoring will be performed by others.

--END OF SECTION--

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SECTION 01 57 20

ENVIRONMENTAL PROTECTION

PART 1 – GENERAL

1.01 DESCRIPTION

- A. CONTRACTOR shall perform the Work minimizing environmental pollution or damage as the result of construction operations. Environmental pollution or damage results from the presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; the unfavorable altering of ecological balances of importance to human life; affecting other species of importance to humankind; or degrading the utility of the environment for aesthetic, cultural and/or historical purposes.
- B. The control of environmental pollution or damage requires consideration of land, water, and air, and includes management of visual aesthetics, noise, solid waste, and dust, as well as other pollutants. The environmental resources within the project Limit of Work and those affected beyond shall be protected during the entire duration of this Contract.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00: Summary of Work
- B. Section 01 56 00: Dust Control
- C. Section 31 23 00: Earthwork
- D. Section 31 25 00: Erosion and Sedimentation Control

1.03 DEFINITIONS

- A. Sediment - soil and other debris that has eroded and has been transported by runoff water or wind.
- B. Heavy Duty Vehicle - on road and off road vehicles powered by a diesel engine with a gross vehicle weight greater than 8,500 pounds.
- C. On Road Vehicle - a motor vehicle powered by a diesel engine that has a gross vehicle weight rating greater than 8,500 pounds and is designed primarily for transporting persons or properties on a street or a highway.
- D. Off Road Vehicle - a motor vehicle, other than an on road vehicle, powered by a diesel engine with a gross vehicle weight greater than 8,500 pounds or having an engine of 50 horsepower or greater.

- E. Gross Vehicle Weight Rating - the value specified by the vehicle manufacturer as the maximum loaded weight of a single or combination vehicle.
- F. Ultra Low Sulfur Diesel - diesel fuel having sulfur content of 0.0015 percent (15 ppm) of sulfur or less.
- G. Best Available Retrofit Technology (BART) – technology verified by the Environmental Protection Agency or California Air Resources Board for reducing the emissions of pollutants that achieves reductions in particulate matter emissions at the highest classification level for diesel emission control strategies that is applicable to the particular engine and application. Such technology shall also, at a reasonable cost, achieve the greatest reduction in emissions of nitrogen oxides at such particulate matter reduction level and shall in no event result in a net increase in the emissions of either particulate matter or nitrogen oxides.
- M. Classification level for diesel emission control strategies – particulate matter reduction classification levels and corresponding particulate matter percent reductions as follows:
 - 1. Particulate matter reduction less than 25%: not verified.
 - 2. Particulate matter reduction greater than or equal 25%: Classification Level 1.
 - 3. Particulate matter reduction greater than or equal 50%: Classification Level 2.
 - 4. Particulate matter reduction greater than or equal 85%: Classification Level 3.

PART 2 - PRODUCTS

Not Applicable

PART 3- EXECUTION

3.01 PROTECTION OF NATURAL RESOURCES

- A. Preserve the natural resources within the Limit of Work and outside the project Limit of Work. Restore to an equivalent or improved condition upon completion of Work. Confine construction activities to within the Limit of Work indicated on the Construction Contract Drawings.
- B. The CONTRACTOR shall provide means, methods, and facilities to prevent contamination of soil, water, and atmosphere from waste discharges due to spills and releases as a result of the CONTRACTOR's operation.
- C. Land Resources:

1. Except in areas to be cleared, do not remove, cut, deface, injure, or destroy trees or shrubs without the OWNER's permission. Do not fasten or attach ropes, cables, or guys to existing trees for anchorages unless authorized by the OWNER's. Where such use of attached ropes, cables, or guys is authorized, the CONTRACTOR shall be responsible for any resultant damage.
 2. Protect existing trees and shrubs which are to remain and which may be injured, bruised, defaced, or otherwise damaged by construction operations. Cut off vegetation to be cleared flush with or as close as practical to the original ground surface in areas to be cleared, except for trees and vegetation indicated or directed to be left standing.
 3. Remove traces of temporary construction facilities such as haul roads, work areas, stockpiles of excess or waste materials, and other signs of construction. Grade temporary roads and similar temporary areas to blend with surrounding conditions.
- D. Water Resources:
1. Mine Wastes (soil and rock) - Prevent mine waste materials from entering drainage areas or adjacent surface water bodies.
 2. Sediments - Prevent sediment migration outside the Limit of Work
- E. Fish and Wildlife Resources - Do not disturb fish and wildlife. Do not alter water flows or otherwise significantly disturb the native habitat adjacent to the project and critical to the survival of fish and wildlife, except as indicated or specified as part of the work. Coordinate work with state regulated spawning periods to minimize disturbances to fisheries.

3.02 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

- A. Carefully protect in-place any historical and archaeological items indicated to remain as directed by the OWNER or human skeletal remains discovered in the course of work and report immediately to the OWNER.
- B. Stop work in the immediate area of the discovery until directed by the OWNER to resume work.
- C. The CONTRACTOR is responsible for protection of resources encountered and shall be responsible for their preservation during the life of the Contract. If during excavation or other construction activities any previously unidentified or unanticipated historical, archaeological, and cultural resources are discovered or found, all activities that may damage or alter such resources may be temporarily suspended. Resources covered by this paragraph include but are not limited to: any human skeletal remains or burials; artifacts; shell, midden, bone, charcoal, or other deposits; rock alignments, pavings, wall, or other constructed features; and any indication of agricultural or other human activities. Upon such discovery or find, immediately notify the OWNER so that the appropriate authorities may be notified and a determination made as to their significance and what, if any, special disposition of the finds should be made. Cease all activities that may result in

impact to or the destruction of these resources. Secure the area and prevent employees or other persons from trespassing on, removing, or otherwise disturbing such resources.

- D. The CONTRACTOR shall coordinate with the state cultural resource specialist during the execution of this project.

3.03 EROSION AND SEDIMENT CONTROL MEASURES

- A. Refer to the Construction Contract Drawings and Section 31 25 00 - Erosion and Sedimentation Control for additional requirements.
- B. Burnoff of the ground cover is not permitted.
- C. Protection of Erodible Soils: Immediately finish the earthwork brought to a final grade, as indicated or specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.
- D. Temporary Protection of Erodible Soils: Use the methods prescribed in Section 31 25 00 - Erosion and Sedimentation Control to prevent erosion and control sediment.

3.04 CONTROL AND DISPOSAL OF WASTES

- A. Liquid waste generated and captured during the course of the project shall be managed and properly disposed or treated in accordance with applicable state and federal regulations.
- B. Pick up Site trash, and place in containers which are regularly emptied. Do not prepare, cook, or dispose of food on the project Site. Prevent contamination of the Site or other areas when handling and disposing of wastes. Upon project completion, leave the Site clean. Control and properly handle and properly dispose of waste in accordance with applicable state and federal regulations.
- C. Temporary sanitary facilities shall be managed in accordance applicable state and federal regulations. Include provisions for pest control and elimination of odors. Upon completion of the work, the facilities shall be removed by the CONTRACTOR from the premises, leaving the premises clean and free from nuisance.

3.05 DUST CONTROL

- A. Provisions shall be taken during all construction activities to keep airborne dust levels low, including during non-working periods. Dust control measures shall be implemented when visible air-borne dust becomes noticeable and is carried out of immediate work/disturbed areas.

B. CONTRACTOR shall treat the soil stockpiles, haul roads, and other areas disturbed areas as directed by the OWNER and in accordance applicable state and federal regulations.

C. Refer to Section 01 56 00 - Dust Control for additional requirements

3.06 NOISE

A. Make the maximum use of low-noise emission equipment according to MEDEP or USEPA regulations.

3.07 OTHER CONTROLS

A. During construction of the project, several other controls to ensure that there are no undesirable discharges from the site will be provided. These controls include BMPs for good housekeeping, equipment and fueling BMPs, and concrete washout facilities.

B. Good Housekeeping: Good housekeeping activities will be conducted to keep the construction site in a clean and orderly condition. Construction materials shall be organized and stored neatly; and where required to prevent contact with stormwater or wind, shall be securely covered.

1. Careful management, containment and disposal of litter, trash and construction wastes shall be provided at all times. Conduct cleanup of trash, litter, debris, or other wastes as need to keep the construction site clean. Disposal bins with covers shall be provided for litter, trash, debris and construction wastes. Segregate municipal trash or waste from construction debris or waste and provided for proper and timely disposal of all waste materials.
2. Use of temporary self-contained sanitary systems provided and maintained by reputable firm in the business.
3. Fertilizer shall be stored under cover in the dry. The fertilizer shall be applied at the appropriate rate and manner for the seeding.
4. Incorporation of the sediment and dust controls outlined in this SWPPP to minimize off-site vehicle tracking of sediments and dust generation.
5. Spill prevention and response materials will be provided by the contractor during construction to address potential vehicle fuel spills.

C. Vehicle and Equipment Fueling: Vehicle equipment fueling procedures and practices will be used to prevent fuel spills and leaks, and reduce or eliminate contamination of stormwater. This will accomplished by using the following BMPs:

1. No bulk fuel storage will be conducted for this project. Fueling of construction vehicles and equipment will occur at offsite facilities or by fuel truck delivery.

2. Fueling will be conducted in designated areas only where drip pans and absorbent spill materials and spill kit will be available. In addition, the fuel truck will also be required to have a spill kit.
 3. The dedicated fueling area will be protected from stormwater run-on and runoff, and will be located on a level grade at least 100 ft away from downstream drainage facilities and watercourses.
 4. Absorbent materials will be on small spills. Hosing down or burying the spills will not be permitted. Adsorbent materials will be removed promptly and dispose of properly.
 5. Fuel procedures will include not “top-off” fuel tanks.
 6. Training of employees and subcontractors in proper fueling and spill control procedures will be conducted. Fueling operations will not be left unattended.
 7. Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips.
- D. Diesel Emissions Reduction: To the extent practical, the CONTRACTOR use heavy duty diesel engine vehicles and equipment shall be powered by ultra low sulfur diesel fuel and shall be retrofitted with the best available retrofit technology (BART) applicable to the particular engine model and vehicle application.
- E. Herbicide:
1. Herbicide Delivery and Storage: Deliver pesticides to the site in the original, unopened containers bearing legible labels indicating the EPA registration number and the manufacturer's registered uses. Store herbicides according to manufacturer's instructions and under lock and key when unattended.
 2. Qualifications: For the application of herbicides, use the services of a Subcontractor whose principal business is pest/weed control. The Subcontractor must be licensed and certified in the state where the work is to be performed.
 3. Herbicide Handling Requirements: Formulate, treat with, and dispose of herbicides and associated containers in accordance with label directions and use the clothing and personal protective equipment specified on the labeling for use during all phases of the application. Furnish Material Safety Data Sheets (MSDS) for all herbicide products.
 4. Application: Apply herbicides in accordance with EPA label restrictions and recommendation. Applicator must wear clothing and personal protective equipment as specified on the herbicide label. The OWNER will designate locations for water used in formulating. Do not allow the equipment to overflow. All equipment must be inspected for leaks, clogging, wear, or damage and repaired prior to application of herbicide.

END OF SECTION

SECTION 01 78 00

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The CONTRACTOR shall furnish all labor, equipment, and materials necessary to keep accurate record documents for additions, substitution of material, variations in Work, and other revisions to the Contract Documents.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00: Summary of Work
- B. Section 01 33 00: Submittal Procedures
- C. Section 01 45 00: Contractor Quality Control
- D. Section 01 46 00: Field Engineering and Survey Control
- E. Section 31 23 00: Earthwork

1.03 MAINTENANCE OF RECORD DOCUMENTS

- A. The CONTRACTOR shall maintain one (1) copy of the following documents at the job site:
 - 1. Contract Drawings.
 - 2. Drawings showing progress of Work.
 - 3. Specifications.
 - 4. Addenda.
 - 5. Reviewed Submittals.
 - 6. Change Orders.
 - 7. Other modifications to the Contract.
 - 8. Safety, Health, and Emergency Response Plan.
 - 9. Contractor generated plans, as required by other Specification Sections or permits.
 - 10. Contractor's certifications.
 - 11. Progress payment quantity field notes and records.
 - 12. Deficiency reports.
 - 13. Contractor's daily reports, including:
 - a. Records of site work.
 - b. Inspection records.
 - c. Reports on emergency response actions.
 - 14. Sampling documentation.
 - 15. Analytical laboratory data packages.
 - 16. Record drawings showing the Site as restored (“As-Built”), including new aboveground and underground utilities, installed piping/conduit, the location

01 78 00-1

of all soil/groundwater samples collected during construction, the final footprint and bottom elevation of all excavations, and the final limits of disturbance/restoration.

17. Remediation photographs.
 18. Manifests and Bills of Lading.
- B. The CONTRACTOR shall provide files and racks for storage of documents. Store documents in a dry, safe place available for inspection by the OWNER and/or the ENGINEER.
- C. The record documents shall not be used for construction purposes.
- D. Pre-Construction, Post-Excavation, and Post-Construction Surveys (required for measurement and payment) and As-Built Drawings shall be submitted to the Engineer in both printed and electronic form (Current AutoCAD version format/compatible). The Surveys and As-Built Drawings shall be completed in accordance with Section 01 46 00 "Field Engineering and survey Control."

1.04 SUBMITTALS

- A. At completion of field operations, the Contractor shall deliver the Project Record Documents to the OWNER.
- B. Accompany the Project Record Documents submittal with a transmittal letter containing:
 1. Date.
 2. Project title, project number, and Honeywell Site number.
 3. Contractor's name and address.
 4. Title and number of each record.
 5. Certification that each document as submitted is complete and accurate.
 6. Signature of Contractor, or his/her authorized representative.
- C. Documents must be submitted to the OWNER upon project completion as a condition of final payment.

1.05 RECORDING

- A. Clearly label each document "PROJECT RECORD".
- B. Keep record documents current.
- C. Do not permanently conceal any Work until required information has been recorded.
- D. Contract Drawings:
 1. Legibly mark to record actual construction as applicable:
 - a. Depths of various elements of structure work in relation to survey datum.
 - b. Horizontal and vertical location of underground utilities and appurtenances referenced to permanent surface improvements.
 - c. Field changes of dimension and detail.
 - d. Changes made by Change Order or Field Order.
 - e. Details not on original Contract Drawings.

- E. Specifications and Addenda shall be legibly marked up to record the Manufacturer, trade name, catalog number, and Supplier of each product; changes made by Change or Field Orders, or other matters not originally specified, shall also be recorded.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

Not applicable.

--END OF SECTION--

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OU3 DRAFT FINAL DESIGN
CALLAHAN MINE SUPERFUND SITE
SPECIFICATIONS

DIVISION 3 – CONCRETE

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SECTION 03 37 13

SHOTCRETE

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes pneumatically applied concrete.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 33 00 – Submittal Procedures
- B. Section 31 23 00 – Earthwork
- C. Section 31 25 00 – Erosion and Sedimentation Control

1.03 REFERENCES

- A. American Concrete Institute:
 - 1. ACI 506.2 – Specification for Shotcrete.
- B. ASTM International:
 - 1. A185/A185M-07 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
 - 2. ASTM A497/A497M – Standard Specification for Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement.
 - 3. ASTM C33 – Standard Specification for Concrete Aggregates.
 - 4. ASTM C150 – Standard Specification for Portland Cement.
 - 5. ASTM C260 – Standard Specification for Air-Entraining Admixtures for Concrete.
 - 6. ASTM C330 – Standard Specification for Lightweight Aggregates for Structural Concrete.
 - 7. ASTM C494/C494M – Standard Specification for Chemical Admixtures for Concrete.

1.04 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Product Data: Submit data on admixtures.
- C. Mix design and test reports.

1.2 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 506.2.

1.3 QUALIFICATIONS

- A. Applicator: Company specializing in performing the Work of this section with a minimum of 10 years documented experience.
- B. Install Work of this section under direct supervision of a superintendent experienced in construction of this type of Work with a minimum of 10 years documented experience.

1.4 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing work of this section.
- B. Submit admixture product data, mix designs, and test reports

1.5 ENVIRONMENTAL REQUIREMENTS

- A. Maintain material and surrounding air temperature at minimum 50 degrees F degrees prior to and during installation, and maintain material at this minimum temperature for 7 days after completion of Work. Furnish equipment and cover to maintain minimum temperature.
- B. Suspend shotcrete operations during high winds, rainy weather, or near freezing temperatures when Work cannot be protected.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Cement: ASTM C150, Type I or Type II.
- B. Aggregate: Normal weight, ASTM C33 3/8 maximum size.
- C. Air Entraining Admixture: ASTM C260.
- D. Chemical Admixture: ASTM C494/C494M.
 - 1. Type A - Water Reducing.
 - 2. Type B - Retarding.
 - 3. Type C - Accelerating.
 - 4. Type D - Water Reducing and Retarding.
 - 5. Type E - Water Reducing and Accelerating.
 - 6. Type F - Water Reducing, High Range.
 - 7. Type G - Water Reducing, High Range and Retarding.
- E. Reinforcing Mesh: Welded wire fabric, ASTM A185/A185M, 2 x 2/W0.9 x W0.9.
- F. Water: Clean, potable, and not detrimental to shotcrete.

2.2 SHOTCRETE MIX

- A. Furnish wet or dry mix design that gives good compaction and low percentage of rebound, is stiff enough not to sag, and conforms to following requirements:
 - 1. Compressive Strength (28 day minimum): 3,000.
 - 2. Aggregate Size (maximum): 3/8 inch.
 - 3. Slump (plus or minus 1/2 inch): 1.
- B. Maintain quality control records during production of shotcrete; make records available.

2.3 SOURCE QUALITY CONTROL

- A. Test and analyze shotcrete for conformance to design mix.
- B. Test samples in accordance with ACI 506.2.
- C. Modify mix design as required based on results of testing and inspection.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify conditions are acceptable and are ready to receive work.
- B. Ensure correct placement of reinforcement and sufficient clearance exists around reinforcement to permit complete encasement.
- C. Ensure easy access to shotcrete surfaces for to permit uninterrupted application.

3.2 PREPARATION

- A. Minimize abrupt changes in thickness of repair.
- B. Determine operating procedures for placement in close quarters, extended distances, or around unusual obstructions where placement velocities and mix consistency may be adjusted during application.
- C. Keep application surfaces damp for several hours prior to placement of shotcrete.

3.3 APPLICATION

- A. Use mixing and delivery equipment capable of thoroughly mixing aggregate, cement, and water in sufficient quantity to maintain continuous and uniform placement.
- B. Do not apply shotcrete more than 45minutes after adding Portland cement to mix.
- C. Do not place shotcrete on surfaces that are frozen, spongy, or where there is free water.

- D. Achieve maximum compaction with minimum rebound.
- E. Build-up to required thickness in multiple passes to achieve layering. Encase reinforcement with first pass.
- F. Allow each layer to take initial set before applying succeeding layers.
- G. Do not permit applied shotcrete to sag, slough, or displace.
- H. Maintain shotcrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of shotcrete.
- I. Immediately after placement, protect shotcrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- J. Maintain surfaces damp for minimum of 3 days.

END OF SECTION

OU3 DRAFT FINAL DESIGN
CALLAHAN MINE SUPERFUND SITE
SPECIFICATIONS

DIVISION 31 – EARTHWORK

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SECTION 31 05 19

GEOSYNTHETICS

PART 1 GENERAL

1.01 SUMMARY

- A. This specification includes geotextile and geogrid for subgrade improvement, reinforcement, and separation in the construction of the infiltration barrier cap over waste soils in the Tailings Impoundment. The CONTRACTOR shall furnish the geosynthetics as specified herein. Storing, cutting, and placing geogrid and geotextiles shall be completed in accordance with these specifications and in reasonably close conformity to the lines, grades, and dimensions shown on the Contract Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00: Summary of Work
- B. Section 31 23 00: Earthwork
- C. Section 31 25 00: Erosion and Sedimentation Control
- D. Section 33 49 00: Storm Drainage Structures

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D 3786 - Hydraulic Bursting Strength of Geotextile Fabrics
 - 2. ASTM D 4354 - Practice for Sampling of Geosynthetics for Testing
 - 3. ASTM D 4355 - Deterioration of Geotextiles from Exposure to Light, Moisture, and Heat in a Xenon-Arc Type Apparatus
 - 4. ASTM D 4491 - Water Permeability of Geotextiles by Permittivity
 - 5. ASTM D 4533 - Trapezoid Tearing Strength of Geotextiles
 - 6. ASTM D 4632 - Grab Breaking Load and Elongation of Textiles
 - 7. ASTM D 4751 - Determining Apparent Opening Size of a Geotextile
 - 8. ASTM D 4759 - Practice for Determining the Specification Conformance of Geosynthetics
 - 9. ASTM D 4833 - Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
 - 10. ASTM D 4844 - Strength of Sewn or Thermally Bonded Seams of Geotextiles
 - 11. ASTM D 4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
 - 12. ASTM D 5199 - Grab Breaking Load and Elongation of Textiles

13. ASTM D 5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles
 14. ASTM D 5818 - Practice for Obtaining Samples of Geosynthetics from a Test Section for Assessment of Installation Damage.
 15. ASTM D 6241 - Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe
 16. ASTM D 6637 - Standard Test Method for Individual Geogrid Junction Strength
 17. ASTM D 7737 - Standard Test Method for Individual Geogrid Junction Strength
 18. ASTM D 7748 - Standard test Method for Flexural Rigidity of Geogrids, Geotextiles and Related Products.
- B. Geosynthetic Research Institute (GRI)
1. GRI GG9 - Torsional Behavior of Bidirectional Geogrids When Subjected to In-Plane Rotation
- C. U.S. Environmental Protection Agency (EPA)
1. EPA 9090 – Compatibility Test for Wastes and Membrane Liners

1.04 SUBMITTALS

- A. Submit geogrid and geotextile product data sheets and certification, and installation guidelines, from the Manufacturer that the geosynthetic products supplied meet the requirements of Part 2.01 of this Section.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Geogrid and geotextile labeling, shipment, and storage shall follow ASTM D 4873 requirements.
- B. The CONTRACTOR shall check the geogrid and geotextile materials upon delivery to verify that the proper materials have been received. The geogrid and geotextile rolls shall be inspected by the CONTRACTOR to be free of flaws or damage occurring during manufacturing, shipping, or handling.
- C. During all periods of storage and handling, geosynthetics shall be protected from direct sunlight, ultraviolet rays, temperatures greater than 140° F, mud, dirt, dust and debris. To the extent possible, the geosynthetic materials shall be maintained wrapped in a heavy duty protective covering until installed.

PART 2 PRODUCTS

2.01 GEOTEXTILE MATERIALS

- A. **Woven Geotextile Reinforcement Fabric:** Geotextile reinforcement fabric used on the Project shall be a woven geotextile made of 100 % polypropylene slit film yarns satisfying the requirements as outlined in AASHTO M-288-0 6 for Class 1 Stabilization & Separation applications. The woven fabric shall be US 6200 or an approved equal meeting the following minimum physical requirements of Table 1. Geotextile reinforcement fabric shall be installed as part of the waste soil/rock cover system as shown on the drawings.

Table 1. Minimum Physical Properties of Woven Geotextile Reinforcement Fabric

Property	Value	Test Method
Tensile Strength	700 x 700 lbs	ASTM D-4632
Elongation @ Break	20 x 15 percent	ASTM D-4632
Mullen Burst	1350 psi	ASTM D-3786
Puncture Strength	300 lbs	ASTM D-4833
CBR Puncture	1,700 lbs	ASTM D-6241
Trapezoidal Tear	250 x 250 lbs	ASTM D-4533
Apparent Opening Size	80 US Sieve	ASTM D-4751
Permittivity	0.109 Sec ⁻¹	ASTM D-4491
Water Flow Rate	8 gpm/sf	ASTM D-4491
UV Resistance % retained @ 500 Hours	80	ASTM D-4355

- B. **Non-Woven Geotextile :** Non-woven geotextile fabric used on the Project shall be a non-woven polyester or polypropylene fabric. The fabric shall be GSE NW16 or an approved equal, and shall meet the following minimum physical requirements of Table 1. Non-woven geotextile fabric shall be installed to prevent migration of fine tailings particles into the working surface/drainage blanket and into the crushed stone drainage layer surrounding the water collection sumps, as shown on the Drawings.

Table 1. Minimum Physical Properties of Non-Woven Geotextile Fabric

Property	Value	Test Method
Mullen Burst Strength	750 psi	ASTM D 3786
Grab Tensile Strength	390 lb	ASTM D 4632
Grab Tensile Elongation	50 percent	ASTM D 4632
Puncture Strength	240 lb	ASTM D 4833
CBR Puncture Strength	1,125 lb	ASTM D 6241
Water Flow Rate	45 gpm/sf	ASTM D 4491
Permittivity	0.6 sec ⁻¹	ASTM D 4491
Apparent Opening Size	100 Sieve	ASTM D 4751

Table 1. Minimum Physical Properties of Non-Woven Geotextile Fabric

Property	Value	Test Method
Trapezoidal Tear	150 lb	ASTM D 4533
Unit Weight	16 oz/yd ²	ASTM D 5261
UV Resistance % Retained after 500 hrs	70	ASTM D 4355

- C. Geogrid: The geogrid used on the Project shall be Tensar BX 1500, or an approved equal. The geogrid shall be installed to provide working surface and fill embankment reinforcement, as shown on the Drawings. The geogrid shall be integrally formed and deployed as a single layer having the properties listed in the Table 2 (all values are minimum average roll values unless a range or characteristic is indicated):

Table 2. Minimum Physical Properties of Geogrid

Property	Value	Test Method
Aperture Stability Modulus at 20 cm-kg (2.0 m-N)	0.75 m-N/deg	GRI GG9
Rib Shape	Rectangular or Square	Observation
Minimum Rib Thickness	0.07 in (1.78 mm)	Calipered
Nominal Aperture Dimensions	1.0 to 1.2 in (25 to 33 mm)	I.D. Calipered
Junction Efficiency	93 %	ASTM D 7737-11
Flexural Stiffness	2,000,000 mg-cm	ASTM D 7748-12
Ultimate Tensile Strength	--	ASTM D 6637-10 Method A
- MD	1,850 lb/ft (27.0 kN/m)	ASTM D 6637-10 Method A
- XMD	2,050 lb/ft (30.0 kN/m)	ASTM D 6637-10 Method A
Tensile Strength at 2% Strain	--	ASTM D 6637-10 Method A
- MD	580 lb/ft (8.5 kN/m)	ASTM D 6637-10 Method A
- XMD	690 lb/ft (10.0 kN/m)	ASTM D 6637-10 Method A
Tensile Strength at 5% Strain		ASTM D 6637-10 Method A
- MD	1,200 lb/ft (17.5 kN/m)	ASTM D 6637-10 Method A

- XMD	1,370 lb/ft (20.0 kN/m)	ASTM D 6637-10 Method A
Resistance to Long Term Degradation	100%	EPA 9090
Resistance to UV Degradation	100%	ASTM D4355-05
Resistance to Installation Damage	95%SC / 93%SW / 90%GP	ASTM D5818; ASTM D 6637

PART 3 EXECUTION

3.01 PREPARATION

- A. Subgrade surface grading shall be constructed to the lines, grades and cross sections indicated on the Drawings and shall be graded relatively smooth and free of protrusions that could damage the geosynthetics, as directed by the ENGINEER. The ENGINEER reserves the right to increase or decrease the grade elevations or make such other changes in the grading as may be deemed necessary.
- B. The CONTRACTOR shall not commence geogrid and geotextile installation or cover material placement until the ENGINEER has inspected and accepted the subgrade preparation.
- C. Construction of a working surface will be required to allow for equipment loading atop the tailings to maintain stability of the impoundment. Methodology for installing geogrid, non-woven geotextile, and the working platform shall be described in the CONTRACTOR's Work Plan.

3.02 GEOTEXTILE INSTALLATION

- A. The CONTRACTOR shall adhere to the manufacturer's recommendations and these specifications during installation of the geotextile fabrics. The surface of the prepared subgrade material shall be sufficiently smooth before placing the geotextile fabric. The geotextile fabric shall be adequately supported on the subgrade material and shall not tear or degrade during installation. The CONTRACTOR shall receive approval from the ENGINEER before geotextile fabric installation over the prepared subgrade.
- B. The geotextile shall be laid at the proper elevation and alignment as shown on the Drawings.
- C. The geotextile may be temporarily secured in place with ties, staples, pins, sand bags in accordance with Manufacturer's recommendations, or subgrade fill as

required by fill properties, fill placement procedures or weather conditions or as directed by the ENGINEER.

- D. Fill material shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geotextile and/or movement of the geotextile.
- E. A minimum loose fill thickness of 12 inches is required prior to operation of tracked vehicles over the geotextile. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geotextile. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geotextile reinforcement at slow speeds (less than 10 mph).
- F. Seams: Seams for geotextile fabric placed on slopes flatter than 4H:1V shall have a non-sewn, minimum overlap of eighteen (18) inches. The Manufacturer's recommendations for overlap requirements shall apply if they are more stringent.

3.03 GEOGRID INSTALLATION

- A. The geogrid shall be laid at the proper elevation and alignment as shown on the Drawings.
- B. The geogrid shall be installed in accordance with the Manufacturer's installation guidelines provided by the Manufacturer or as directed by the ENGINEER.
- C. The geogrid may be temporarily secured in place with ties, staples, pins, sand bags or subgrade fill as required by fill properties, fill placement procedures or weather conditions or as directed by the ENGINEER.
- D. Fill material shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid.
- E. The geogrid shall be installed above and below the working surface and at 2-foot vertical spacing within the subgrade fill embankment, as shown on the Drawings.
- F. A minimum loose fill thickness of 12 inches is required prior to operation of tracked vehicles over the geogrid. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and damaging the geogrid. When underlying substrate is trafficable with minimal rutting, rubber-tired equipment may pass over the geogrid reinforcement at slow speeds (less than 10 mph) when integrally-formed geogrids are used.
- G. Joints: Joints for geogrids shall have a minimum overlap of 3 feet. The manufacturer's recommendations for overlap requirements shall apply if they are more stringent.

3.04 INSPECTION

- A. The ENGINEER may randomly inspect geosynthetic before, during and after installation.
- B. Any damaged or defective geosynthetic material (i.e. frayed coating, separated junctions, separated layers, tears, punctures, rips, etc.) will be repaired/replaced in accordance with Section 3.05.

3.05 REPAIR

- A. Removal and Replacement: Any damage during installation, placement of materials or failure to cover geosynthetic materials within the specified time, shall warrant removal and replacement of the geosynthetic material by the CONTRACTOR at no additional cost to the OWNER.
- B. Proper replacement shall consist of replacing the affected area adding 3 feet (1m) of geogrid or geotextile patch to either side of the affected area. Geogrid patch shall be tied in accordance with manufacturer recommendations and geotextile patch shall be secured via heat bonding or sewing.

3.06 PROTECTION

- A. Place fill in a manner that prevents soil from entering the geotextile overlap zone, prevents tensile stress from being mobilized in the geosynthetics, and prevents wrinkles from folding over onto themselves. On slopes, fill shall be placed from the bottom of the slope upward. Fill shall not be dropped onto the geosynthetics from a height greater than 3 feet. No equipment shall be operated directly on top of the geosynthetics. Use equipment with ground pressures less than 5 psi over the geosynthetics. A minimum of 12 inches of soil shall be maintained between full-scale construction equipment and the geosynthetics.
- B. Protection from Damage: The geosynthetic materials shall be protected at all times during construction. The Work shall be scheduled such that the covering of the geosynthetic materials with a layer of the specified material is accomplished within seven (7) calendar days or as specified by the Manufacturer after placement of the geosynthetic materials.

END OF SECTION

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SECTION 31 05 19.16

CAP GEOMEMBRANE LINER

PART 1 - GENERAL

1.01 DESCRIPTION

Work provided in this Section includes furnishing labor, materials, equipment and incidentals required to install a 60-mil textured (both sides) Linear Low Density Polyethylene (LLDPE) geomembrane as part of the multi-layer cap construction as shown on the Drawings and as specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 3300: Submittal Procedures
- B. Section 31 23 00: Earthwork
- C. Section 33 46 16.16: Geocomposite Drainage Layer
- D. Section 31 35 26.15: Geosynthetic Clay Liner

1.03 REFERENCES

The publications listed below, latest edition unless otherwise noted, form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM D 1004	Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting
ASTM D 1238	Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1603	Standard Test Method for Carbon Black in Olefin Plastics
ASTM D 3895	Standard Test Method for Oxidative-Induction Time of Polyolefins By Differential Scanning Calorimetry

ASTM D 4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique

ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geotextile, Geomembranes and Related Products

ASTM D 5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

ASTM D 5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics

ASTM D 5617 Standard Test Method for Multi-Axial Tension Test for Geosynthetics

ASTM D 5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes

ASTM D 5885 Standard Test method for Oxidative Induction Time of Polyolefin Geosynthetics By High-Pressure Differential Scanning Calorimetry

ASTM D 5994 Standard Test Method for Measuring the Core Thickness of Textured Geomembrane

ASTM D 6392 Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods

ASTM D6693 Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes

GEOSYNTHETIC RESEARCH INSTITUTE (GRI) STANDARDS

GRI GM12 Measurement of the Asperity Height of Textured Geomembranes Using a Depth Gage

GRI GM17 Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes

1.04 SUBMITTALS

Submit the following in accordance with Section 01 33 00, “Submittal Procedures”.

- A. Submittals relating to liner Manufacturer and liner material:
1. Manufacturing:
 - a. List of material properties of the liner proposed for the project meeting the requirements herein with attached certified test results.
 - b. Manufacturer's quality control program and manual including description of in-house laboratory facilities.
 - c. A list of ten completed facilities totaling a minimum of ten million square feet, for which the Manufacturer has manufactured LLDPE geomembrane. The following information shall be provided for each facility.
 1. Name and purpose of facility, its location and date of installation.
 2. Name of Owner, Project Manager, Design Engineer and Installer.
 3. Geomembrane thickness and surface area.
 - d. Qualifications statement in accordance with Section 1.06 "Qualifications".
 - e. Manufacturer's recommendations for geomembrane installation procedures.
 2. The origin of the resin to be used in the manufacturing of geomembrane used on-site including the suppliers name and production plant, as well as brand name and tracking number.
 3. Copy of quality control certificates in conformance with Section 2.01. Certifications that the LLDPE geomembrane and extrudate produced for this project have compatible properties. Quality control reports for the time period materials were produced for this project.
 4. A "Sample Warranty" in accordance with Section 1.08.
 5. Prior to shipment of liner material to the site, provide 5 samples (roll width by 3 feet) from 5 random rolls to be provided. Only ship to site material that is approved by the Contractor.
Submittals relating to the Installer:
 6. Installation Capabilities:
 - a. Information on equipment and personnel.
 - b. Anticipated average daily production.
 - c. Number of crews employed and number available for this work.
 - d. Qualifications in accordance with Section 1.06 "Qualifications".
 7. A list of five completed facilities totaling 2 million square feet for which the Installer has installed LLDPE geomembrane. The following information shall be provided for each facility:
 - a. Name and purpose of facility, its location and date of installation.
 - b. Name of Owner, Design Engineer, Manufacturer and name and telephone number of Manufacturer's Representative at the facility who can discuss the project.
 - c. Surface area of the installed LLDPE geomembrane.
 - d. Type of seaming, patching and tacking equipment.
 - e. A copy of the Manufacturer's certification or approval letter.

8. As-built drawings reflecting the actual installation of geomembrane liner, including the location of seams, the location of destructive samples, and the location of repair work.
- B. Within 10 days prior to liner installation submit the following:
 1. Shop Drawings:
 - a. Proposed panel layout showing the installation layout identifying field seams as well as any variance or additional details which deviate from the Drawings.
 - b. Details of seaming the geomembrane, anchoring, connections, penetrations and other construction details, which deviate from these specifications.
 2. Installation Quality Control:
 - a. A quality control manual that specifically defines the quality control program during installation for this project. The manual shall include daily procedures, welding techniques, field testing procedures, lab testing procedures, specific steps that are to be taken in the event of a failure or defect, personnel requirements, levels of authority and other information necessary to ensure a high quality geomembrane installation consistent with Manufacturer recommendations and these specifications.
 - b. Resume of the Installation Supervisor to be assigned to and on-site during the project.
 - c. Resume of the Master Seamer to be assigned to and on-site during the project.
 - d. A list of personnel performing field seaming operations along with pertinent experience information.

1.05 QUALITY CONTROL

- A. In addition to Manufacturer and Installer requirements for qualifications and certification specified in Paragraph 1.06, Quality Control consists of conformance testing of the material prior to delivery to the site and field quality control during installation.
- B. Manufacturer conformance testing requirements are specified in Paragraph 2.02. The purpose of conformance testing is to verify that the supplied material conforms to the Specifications and to the Manufacturer's quality control certificates.
- C. Field quality control testing requirements are specified in Paragraph 3.06 and 3.07. The purpose of field quality control procedures is to verify that the geomembrane has been installed in accordance with the specifications and Manufacturer's recommendations.
- D. Field Quality Control Forms:
The forms in attached Appendix A shall be used for field installation documentation. Alternative forms may be used for documentation as submitted and approved by the Contractor and Engineer.
- E. Geomembrane Quality Control Documentation:
 1. Project Files:

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- b. Two duplicate project files shall be maintained. One shall be maintained by the QC Inspector and the other shall be maintained by the Installer. The Installer shall provide the QC Inspector with complete daily documentation by the end of the following work day. At the end of each work week, the Contractor and Installer will update and check the files to assure that copies of pertinent project information are included in each file.
- c. Blank copies of the project forms shall be available onsite throughout the duration of the project and are included in attached Appendix A.

1.06 QUALIFICATIONS

- A. **Manufacturer:**
The Manufacturer of the lining material described hereunder shall have previously demonstrated its ability to produce this geomembrane by having at least 5 years continuous experience in the manufacturing of LLDPE geomembrane and successfully manufactured a minimum of 10 million square feet of similar material for hydraulic liner installations.
- B. **Installer:**
The Installer shall be the Manufacturer or a Manufacturer approved Installer trained to install the Manufacturer's geomembrane. Installation shall be performed under the constant direction of a single Installation Supervisor who shall remain on site and be in responsible charge, through the subgrade approval, geomembrane installation, for geomembrane layout, seaming, patching, testing, repairs and other site activities required by the Installer. The Installer shall also provide a Master Seamer (who may also be the Installation Supervisor). The Installation Supervisor/Master Seamer shall have installed or supervised the installation and seaming of a minimum of two million square feet of LLDPE geomembrane liner.
- C. **QA Inspector:**
The QA inspector is the person or corporation hired by the Contractor, who is responsible for monitoring and documenting activities related to the QA/QC of the geomembrane from manufacturing through installation. The QA inspector shall have provided QA/QC inspection during installation of the proposed geomembrane material for at least 5 completed projects having a total minimum area of 2 million square feet.
- D. **QC Laboratory:**
The QC laboratory shall have provided QC and/or QA testing of the proposed geomembrane and geomembrane seams for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.07 DELIVERY, STORAGE AND HANDLING

- A. The geomembrane rolls shall be packaged and shipped by appropriate means to prevent damage of the geomembrane rolls. Off-loading, handling, and storage of

the geomembrane are the responsibility of the Installer. The Installer shall be responsible for replacing any damaged or unacceptable material at no additional cost to the Contractor.

- B. Roll Identification:
The Manufacturer shall provide geomembrane rolls marked or tagged with the following information:
1. Manufacturer's name;
 2. Product identification;
 3. Thickness;
 4. Roll dimensions;
 5. Manufacturer's roll and lot number; and
 6. Date of manufacture.
- C Damage during off-loading shall be documented by the Contractor. Damaged rolls must be separated from the undamaged rolls and removed by the Manufacturer.
- D. The geomembrane rolls shall be stored so as to be protected from puncture, dirt, grease, water, mud, mechanical abrasions and excessive heat or cold that may damage the geomembrane material. The rolls shall be stored on a prepared surface (not wooden pallets or hard abrasive surfaces) and shall not be stacked more than two rolls high.

1.08 MATERIAL WARRANTY

The LLDPE geomembrane Manufacturer shall warrant the geomembrane against manufacturing defects and material degradation under outdoor exposure for a period of 5 years on a prorated basis from the date of final payment and acceptance. The Manufacturer shall repair or replace, including material and labor, at no expense to Owner, any material which fails from the above causes within the warranty period. The Manufacturer shall furnish a written warranty covering the requirements of this Paragraph.

1.09 GUARANTEE

The Installer shall guarantee the LLDPE geomembrane against defects in installation and workmanship for the period of 1 year commencing with the date of final payment and acceptance by the Contractor. The guarantee shall include the services of qualified personnel, all materials required for the repairs and testing at no expense to the Contractor.

1.10 DEFINITIONS AND RESPONSIBILITIES

- A. Contractor:
The Contractor is the firm or corporation with whom Owner has entered into agreement to construct the project. The Contractor is responsible for review of submittals by the Manufacturer and the Installer as required by the Specifications. The Contractor is also responsible for scheduling and coordination of the required work with the Manufacturer and the Installer to complete the project.
- C. Engineer:

The Engineer shall be the individual or firm responsible for the design and preparation of the project's Contract Drawings and Specifications and shall provide technical guidance and review when required.

D. Manufacturer:

The Manufacturer is the firm or corporation contracted by the Contractor for production of the geomembrane material to be used in the project. The Manufacturer shall produce a consistent product meeting or exceeding the project specifications and shall provide quality control documentation for the product specified herein.

E. Installer:

The Installer is the firm or corporation contracted by the Contractor for installation of the geomembrane. The Installer shall be the Manufacturer or a Manufacturer approved Installer trained and certified to install the Manufacturer's geomembrane. The Installer shall be responsible for field handling, storing, placing, seaming, sampling, testing, protecting and other aspects of the geomembrane installation.

F. Quality Control Laboratory:

An independent Quality Control Laboratory (QCL) hired by the Contractor to perform conformance testing of the liner material with demonstrated qualifications for conducting required testing.

G. Quality Assurance (QA):

QA inspections will be conducted by an Independent Third Party specializing in Geomembrane QC/QA. The QA inspector will collect samples and conduct independent QA testing.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General:

1. The resin from which the geomembrane is made shall generally be in the density range of 0.926 g/cc or lower, and have a melt index value per ASTM D 1238 of less than 1.0 g/10 min. Formulated sheet density shall be 0.939 g/cc or lower.
2. The blended resin shall contain two to three percent carbon black, anti-oxidants and heat stabilizer, but no fillers or extenders. The resin shall be virgin material, with no more than ten (10) percent rework. If rework is used, it must be of the same formulation as the parent material. No post-consumer resin of any type shall be added to the formulation.
3. The geomembrane material shall be so produced as to be free of holes, blisters, thin areas, inconsistent texturing, undispersed raw materials, or any sign of contamination by foreign matter.
4. The sheets shall be manufactured in a minimum 15-ft seamless width.

B. Properties:

1. The geomembrane rolls shall be textured LLDPE and shall meet the specified physical, mechanical, and chemical property requirements listed in attached Table 02372-2. Manufacturing Quality Control testing shall be

conducted at the frequencies recommended in GRI GM 17 unless otherwise noted.

2. Interface Strength Requirements: In addition to the general material properties requirements, the Manufacturer shall provide geomembrane material meeting the following minimum project-specific interface strength requirements when required:

For Use on 5% (or less) Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Geocomposite Drainage Layer (GDL) / Geomembrane	8 degrees	7 degrees
Geomembrane / Geocomposite Clay Liner (GCL)	8 degrees	7 degrees

For Use on 20% Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Geocomposite Drainage Layer (GDL) / Geomembrane	16.5 degrees	15 degrees
Geomembrane / Geocomposite Clay Liner (GCL)	16.5 degrees	15 degrees

For Use on 33% Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Geocomposite Drainage Layer (GDL) / Geomembrane	23.5 degrees	21.5 degrees
Geomembrane / Geocomposite Clay Liner (GCL)	23.5 degrees	21.5 degrees

- C. Other Materials:
 1. Extrudate welding rods (for fusion welds) shall be compatible and similar to the geomembrane and supplied by the Manufacturer and shall be delivered in the original sealed containers. Each container shall have a label bearing the brand name, Manufacturer's lot number and complete directions as to proper storage.
 2. Boots and shrouds for pipe penetration shall fit snugly around the pipe. Prefabricated material shall be designed to fit site specific conditions for

the intended slope and size of pipe and be made of compatible and identical materials as the geomembrane.

2.02 CONFORMANCE TESTING

A. Tests:

Conformance testing shall be performed by the independent Quality Control Laboratory (QCL) provided and paid for by the Contractor. The Manufacturer shall obtain the samples from the roll, mark the machine direction and identification number and ship the samples to the QCL. The following conformance tests shall be conducted at the laboratory prior to shipment to the site:

1. Thickness
2. Density
3. Tensile properties
4. Tear resistance
5. Puncture resistance
6. Carbon black content
7. Carbon black dispersion
8. Asperity height
9. Interface Strength

B. Frequency:

These conformance tests shall be performed in accordance with Tables 02372-1 and 02372-2 unless otherwise noted or approved by the Contractor.

C. Acceptance or Rejection:

Conformance test results shall be reviewed by the Contractor and accepted or rejected, prior to shipment of the geomembrane. Test results shall meet, or exceed, the property values listed in Tables 02372-1 and 02372-2. The course of action implemented for retesting failing tests shall be approved by the Contractor. In case of failing test results, the Manufacturer may request that another sample be retested by the independent laboratory with Manufacturer's technical representative present during the testing procedures. This retesting shall be paid for by the Manufacturer. The Manufacturer may also have the sample retested at two different laboratories approved by the Contractor, paid for by the Manufacturer. If both laboratories report passing results, the material shall be accepted. If both laboratories do not report passing results, geomembrane material from the lot or bracketed square footage representing the failing sample will be considered out of specification and rejected.

2.03 SITE-SPECIFIC REQUIREMENTS

- A. Conduct interface friction testing using site-specific materials. The test methods and required results shall be as outlined in Table 02372-1.

TABLE 02372-1

Geomembrane Site-Specific Properties^(a)

Property	Test Method	Minimum Value
Interface – GDL/Geomembrane ^{(b)(c)}	ASTM D 5321	See Paragraph 2.03.B.2 ^(d)
Interface – Geomembrane/GCL ^{(b)(c)}	ASTM D 5321	

Table 02372-1 notes:

- (a) Site-specific testing shall be conducted at the frequency of 1 test/75,000 square feet (minimum 3 tests) unless otherwise noted.
- (b) Perform interface tests at normal stresses of 1, 2, and 4 psi with a displacement rate of 0.04 in/min, under non-inundated conditions, report peak and residual values.
- (c) The Contractor and/or Manufacturer shall provide site-specific GDL, Geomembrane, and GCL to the QCL.
- (d) For cohesion/adhesion intercept = 0 psf. Interface friction values less than those specified but containing cohesion/adhesion will be evaluated for acceptance by the Engineer.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATION

- A. Preparation of the subgrade for GCL and geomembrane shall be as specified in Section 31 23 00, “Earthwork”.
- B. The surface of the subgrade shall be smooth, uniform, relatively free from abrupt changes in grade, rocks and stones greater than 1/2-inch, sharp objects, debris and deleterious materials. During actual placing and seaming of the geomembrane, the subgrade surface shall be kept free of standing water. Before the geomembrane installation begins, the Contractor and Installer shall verify and sign off that the surface area to be lined has been properly prepared.

3.02 ANCHOR TRENCH

- A. The anchor trench shall be constructed as shown on the Drawings and/or as specified herein.
- B. The anchor trench shall be adequately drained to prevent water ponding and softening of adjacent soils. The anchor trench shall be backfilled and compacted.
- C. Geosynthetic material in the anchor trench shall be temporarily anchored with sandbags or other suitable materials until final approvals are obtained.
- D. Backfilling of the anchor trench shall be conducted when the geomembrane is in its most contracted (taut) state.
- E. Care shall be taken when backfilling and compacting the trenches to prevent any damage to the lining materials.

3.03 GEOMEMBRANE PLACEMENT

- A. Weather Conditions:
 Geomembrane placement shall not proceed at an ambient temperature below 32 degrees F or above 104 degrees F unless otherwise authorized, in writing, by the

Contractor. Geomembrane placement shall not be performed during precipitation, excessive moisture, in an area of ponded water, or excessive winds that adversely affect the geomembrane placement.

B. Method of Placement:

1. Each panel of the geomembrane shall be rolled out and installed in accordance with the approved shop drawings prepared by the Installer. The layout shall be designed to keep field seams of the LLDPE geomembrane liner to a minimum and consistent with proper methods of LLDPE geomembrane installation. Panel layout and deployment shall be such that seams run down slope (i.e., perpendicular to top of slope). End seams across slopes greater than 4:1 (4 horizontal and 1 vertical) shall be avoided. See additional seam requirements in Section 3.04.
2. Geomembrane rolls shall be placed in a manner to prevent the material from being stretched during deployment.
3. The Contractor shall inspect each panel, after placement and prior to seaming, for damage and/or defects. Also, inspect geomembrane prior to geocomposite drainage layer installation. Defective or damaged panels shall be replaced or repaired, in accordance with Section 3.07.G of the specifications.
4. The Installer shall avoid dragging the geomembrane sheets on rough soil subgrade.
5. Geomembrane shall be anchored as shown on the Drawings and/or consistent with Manufacturer's recommendations.
6. Personnel working on the geomembrane shall not smoke, wear damaging shoes or involve themselves in any activity that may damage the geomembrane.
7. Edges and large exposed areas of the geomembrane shall be properly weighted to avoid uplift due to wind and to prevent lateral movement of the geomembrane.
8. Vehicular traffic except for proper installation vehicles (ATVs) across the geomembrane shall not be allowed. Any vehicle used prior to or after liner placement shall be first approved by the Contractor.
9. Repaired areas and destructive sample locations shall be recorded and indicated on the as-built drawings.
10. When tying into previously installed geomembrane, excavation, if required, adjacent to installed liner shall be performed by hand to prevent damage.
11. The geomembrane shall be kept free of debris, unnecessary tools and materials. In general, the geomembrane area shall remain neat in appearance.
12. Equipment necessary to perform the installation (generators, compressors, etc) at a minimum shall have a scrap geomembrane sheet placed underneath to protect the installed geomembrane from possible damage.
13. No welder or testing equipment shall be allowed to remain on top of the installed geomembrane overnight. Equipment must be removed and stored off the installed geomembrane.

14. No fueling of equipment will be allowed on top of the installed geomembrane. No fuel containers shall be allowed on the geomembrane.
- C. Liner Boots (Penetrations):
1. LLDPE boots or shrouds for liner penetrations shall be furnished and installed where indicated on the Drawings. Prefabricated material shall be designed to fit site specific conditions for the intended slope and size of pipe and be made of compatible and similar materials as the geomembrane.
 2. The geomembrane end of the boots shall terminate in a skirt section suitable for welding to the geomembrane liner. The overlap between the boot and the geomembrane shall be approximately 18-in. The boot shall be welded to the geomembrane as specified herein.
 3. Boots and shrouds shall fit snugly around the pipe, pole, wells or vaults.
 4. A neoprene rubber gasket and/or silicone caulking shall be used between the boot or shroud and the penetration structure and secured with a 1-in wide stainless steel clamp. An LLDPE sacrificial sheet shall be used between the boot or shroud and the clamp for protection.
 5. For pipes, poles, wells, vaults larger than 4-in diameter, a second clamp shall be used. The fastener of the second clamp shall be located on the opposite side from the first clamp, to compensate for uneven pressure and elongation.

3.04 FIELD SEAMS

- A. Individual panels of geomembrane shall be laid out and overlapped by a minimum of 4-inches for fusion welding and 6 inches for extrusion welding prior to welding. The area to be welded shall be cleaned and prepared in accordance with the quality control welding procedures approved by the Contractor.
- B. Double track hot wedge fusion welds shall be used for straight long seams to the maximum extent possible.
- C. Extrusion welds shall be used in areas inaccessible for double track hot wedge fusion welding, including patches, repairs and penetration boots.
- D. The welding equipment used shall be capable of continuously monitoring and controlling the temperatures in the zone of contact where the machine is actually fusing the geomembrane material so as to ensure that changes in environmental conditions will not affect the integrity of the weld.
- E. No "fish mouths" or wrinkles will be allowed within the seam area. Where "fish mouths" or wrinkles occur, the material shall be cut, overlapped and an extrusion weld patch shall be applied. Welds upon completion of the work shall be tightly bonded. Any geomembrane area showing injury due to excessive scuffing, puncture, or distress from any cause shall be replaced or repaired with an additional piece of geomembrane. The number of patches per 100-ft length of seam length shall not exceed five. If more than five patches per 100-ft length are necessary, then the entire 100-ft length of seam shall be removed. Further welding will cease at this time and the Contractor shall be notified.
- F. Seams shall have a seam number that corresponds with the panel layout numbers. The numbering system shall be used in the development of the as-built drawings. Seam numbers shall be derived from the combination of the two panel numbers

- that are to be welded together. Patches, boots and repairs shall be numbered using a system that includes the panel number where the patch, boot or repair is located.
- G. Fusion welded "T" seams (i.e., the result of the geomembrane panels placed perpendicular to each other) shall be double welded where possible. The extrusion process shall be used for the second weld.
 - H. Extrudate shall be free of dirt, dry and protected from damage.
 - I. If an extrusion welder is stopped for longer than one minute, it shall be purged to remove heat degraded extrudate. Purged extrudate shall not be placed on the installed geomembrane.
 - J. Seams constructed on sloped surfaces shall be perpendicular to the top and toe of the slope (vertical seams).
 - K. Panels placed on sloped surfaces (steeper than 4:1) shall extend a minimum of 5-ft inward (on the flat) from the top of slope or edge of trench.
 - L. End seams shall be staggered a minimum of 5-ft in length between contiguous panels. No end seams are allowed on slopes 4:1 (4 horizontal and 1 vertical) or greater, unless otherwise approved by the Contractor.
 - M. To prevent moisture buildup during fusion welding, it may be necessary to place a movable protective layer of plastic (skid sheet) directly below each overlap of geomembrane that is to be seamed.
 - N. Seam welds shall extend the full extent into the anchor trench.
 - O. Factory seams, field seams and repair welds shall meet seam strength requirements specified in Table 02372-3.
 - P. Seams shall be "shingled" or "rain-lapped."

3.05 SEAMING WEATHER CONDITIONS

- A. Normal Weather Conditions:
 - 1. The normal required weather conditions for seaming are:
 - a. Ambient temperature higher than 32 degrees F and lower than 104 degrees F.
 - b. No precipitation or other excessive moisture, such as fog or dew.
 - c. No excessive winds.
 - 2. These weather conditions shall be fulfilled during seaming process.
- B. Cold Weather Conditions:
 - 1. If the ambient air temperature is below 32 degrees F seaming activity is to be avoided. If necessary, Contractor shall provide separate plan for approval.
- C. Warm Weather Conditions:
 - 1. If the ambient air temperature is above 104 degrees F, no seaming of geomembrane shall be permitted unless the Installer can demonstrate, to the satisfaction of the Contractor, that geomembrane seam quality is not adversely impacted.
 - 2. Test seams shall be performed under similar ambient air temperature conditions as the actual seams.
 - 3. Additional destructive tests shall be taken at the discretion of the Contractor.

3.06 FIELD QUALITY CONTROL

A. Start-up Testing:

1. A test weld 3-ft long from each welding machine shall be run upon the beginning of each shift and every five hours thereafter, under the same conditions as exist for the geomembrane welding. The test weld shall be marked with date, time of day, Seamer's initials, temperature and speed settings (for fusion welds) or temperature and preheat settings (for extrusion welds), and machine number. The Installer shall provide a calibrated tensiometer, on-site before and during geomembrane installation for the purpose of testing samples. Six 1-in wide specimens shall be cut from each test weld and tested on-site in the presence of the Contractor's field representative (three for peel and three for shear strength) in accordance with Table 02372-3. To account for minor variations in conditions, the Seamer may reduce the weld speed by a maximum of 15% without the need to perform additional test welds.
2. Test seams shall be performed under the same conditions as the actual seams and shall be at least 3-ft long and 1-ft wide after seaming. Material for test seams shall be cut out of the approved geomembrane rolls.

B. Nondestructive Seam Testing:

1. The Installer shall perform a nondestructive test on field seams over their full length. The purpose of this test is to assure continuity and integrity of the seams. Vacuum and air pressure tests shall be used for nondestructive testing. The vacuum test shall be used for extrusion welds. The air pressure test shall be used for double track fusion welds.
2. Vacuum Testing:
 - a. Equipment for testing extrusion seams shall be comprised of the following:
 1. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly and a vacuum gauge.
 2. A vacuum tank and pump assembly equipped with a pressure controller and pipe connections.
 3. A rubber pressure/vacuum hose with fittings and connections.
 4. A plastic bucket and wide paint brush or mop.
 5. A soapy solution.
 - b. The following procedures shall be followed by the Installer:
 1. Excess sheet overlap shall be trimmed away.
 2. Clean the window, gasket surfaces and check for leaks.
 3. Energize the vacuum pump and reduce the tank pressure to approximately 5 psi.
 4. Wet a strip of geomembrane approximately 12-in by 48-in (length of box) with the soapy solution.
 5. Place the box over the wetted area and compress.
 6. Close the bleed valve and open the vacuum valve.

7. Ensure that a leak-tight seal is created.
 8. For a minimum period of 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
 9. If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum of 3-in overlap and repeat the process.
 10. Areas where soap bubbles appear shall be marked and repaired in accordance with Paragraph 3.07.G and then retested.
- c. If the seam is not accessible to vacuum box equipment and cannot be tested prior to final installation, the seaming operations shall be observed by the Contractor for uniformity and completeness.
3. Air Pressure Testing (for double track fusion seams only):
- a. The following procedures are applicable to those processes which produce a double seam with an enclosed space.
 - b. Equipment for testing double fusion seams shall be comprised of the following:
 1. An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi and mounted on a cushion to protect the geomembrane.
 2. A manometer equipped with a sharp hollow needle, or other approved pressure feed device.
 - c. The following procedures shall be followed by the Installer:
 1. Seal both ends of the seam to be tested. The length of seam shall not exceed 500-ft without approval by the Contractor.
 2. Insert needle or other approved pressure feed device into the tunnel created by the double wedge fusion weld.
 3. Energize the air pump to a pressure between 25 and 30 psi. After allowing two minutes for relaxation, the pressure shall be monitored over a test period not less than five minutes.
 4. If the loss of pressure exceeds 4-psi or the pressure does not stabilize, the weld shall be considered faulty (unless the Installer can demonstrate that monitoring for an additional five minutes does not cause an additional loss in pressure in excess of 1 psi, and that the pressure stabilizes within the second monitoring period). Locate the faulty area, repair in accordance with Paragraph 3.07.G and retest.
 5. If the pressure loss is less than 4 psi after five minutes, cut the air channel on the opposite end the pressure device to confirm there is no blockage and verify the length of the

seam tested. Remove needle or other approved pressure feed device and seal penetrations with extrusion weld.

3.07 DESTRUCTIVE SEAM TESTING

A. Purpose:

The purpose of the destructive testing is to evaluate seam strength properties. An initial minimum sampling interval of one test per 500-ft of performed seam length shall be used for a minimum start-up batch of 25 samples. With 0 to 1 failures out of 25 samples, the sampling interval may be increased to a maximum of one test per 1500-ft of seam length with the approval of the Contractor. With more than 2 failures out of 25 samples, the sampling interval may be decreased as determined by the Contractor. The location of samples shall be determined by the Contractor. Selection of such locations may be prompted by suspicion of overheating, contamination, or other potential cause that may adversely impact the welds. Location of samples shall not be revealed to Installer in advance. Sampling shall be performed by the Installer. Testing of field samples shall be performed by the Contractor's QCL.

B. Sampling Procedures:

1. Samples shall be cut by the Installer at locations chosen by the Contractor as the seaming progresses.
2. The seams shall not be covered by another material before they have been tested and accepted by Contractor.
3. Upon obtaining each sample, assign a number to the sample and mark it accordingly.
4. Record sample location on layout drawing.
5. Record purpose of the sample, statistical routine or suspicious weld area.
6. Holes in the geomembrane resulting from destructive seam testing shall be immediately repaired in accordance with Paragraph 3.07.G.

C. Size and Disposition of Samples:

1. Two samples, 12-inch wide by 6-inch shall be taken for field testing. Each of these samples shall be cut with a 1-in wide die, with the seam centered parallel to the width. The distance between these two samples shall be 36-in. If all samples pass the field test described in Paragraph 3.07.D, a sample for laboratory testing shall be taken from the 36-inch portion.
2. The laboratory sample shall be cut into three parts and distributed as follows:
 - a. One portion to the Installer for optional laboratory testing, 12-in by 12-in.
 - b. One portion for QCL testing, 12-in by 12-in.
 - c. One portion to the Contractor for archive storage, 12-in by 12-in.

D. Field Testing:

1. The following shall be performed by the Installer in the presence of the Contractor:
 - a. The Installer shall cut six 1-in wide replicate specimens from the field testing samples to be tested for shear and peel strength, in accordance with the criteria set in Table 02372-3.

- b. The Installer shall test three specimens for shear seam strength and three for peel strength. Replicate test specimens shall pass for the seam to be acceptable.
 - c. Samples shall be tested with a tensiometer equipped with a drive/pull apparatus adjusted to a pull rate of 20 inches per minute for both peel and sheer testing in accordance with ASTM D 6392. Each sample shall be tested until film tearing bond (FTB) is achieved. At a minimum, the required pass criteria for peel shall be as specified in Appendix A.
(Note: The machine shall be capable of pulling the geomembrane seams at either 2 or 20 inches per minute. If the results are similar, both numerically and visually, the specified test speed shall be 20 inches per minute for all field and laboratory destructive seam tests. If it appears that the faster speed may be affecting the testing results, then the specified speed shall be 2 inches per minute for all field and laboratory destructive seam testing.)
 - d. Any specimen that fails through the weld or through the fusion at the weld sheet interface is a non-FTB break and shall be considered a failure even if it achieves the acceptable strengths.
 - e. A specimen that does not break at the full extent of the test apparatus will be considered a passing test.
 - f. Alternate testing to evaluate both sides of dual wedge welds.
- E. Quality Control Laboratory Testing:
- 1. The Installer shall package and ship destructive test samples to the Contractor's independent Quality Control Laboratory (QCL) as directed by the Contractor by overnight delivery service. Shipping costs and destructive tests are to be paid by the Contractor.
 - 2. Laboratory testing shall include shear and peel strength tests performed in accordance with ASTM D 6392. The minimum acceptable values obtained in these tests shall be in accordance with Table 02372-3.
 - 3. At least five specimens shall be tested each for shear and peel strength. A passing test shall meet the minimum required values in the five specimens tested for each method.
 - 4. The QCL shall provide verbal test results to the Contractor no more than 24 hours after they receive the samples. The Contractor shall review the laboratory results as soon as they become available.
- F. Procedures for Destructive Test Failure:
- 1. The following procedures shall apply whenever a sample fails a destructive test, whether that test is conducted in the field or by the QCL. The Installer has two options:
 - a. The Installer can repair the seam between (1/2 distance or as directed by the Contractor's field representative) any two passing test locations in accordance with Paragraph 3.07.G.
 - b. The Installer can retrace the welding path to an intermediate location a minimum of 10-ft on each side of the failed sample. The sample shall be tested in the field. Subsequent failure of test

- samples shall cause the testing to move further down the seam until the extent of faulty seam has been determined.
2. Acceptable repaired seams shall be bound by two passing locations on each side of the original sample. In cases where repaired seam exceeds 150-ft, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Paragraph 3.07.G.
 3. The Contractor's field representative shall document all actions taken in conjunction with destructive test failures.
- G. Repair Procedures:
1. Any portion of the geomembrane exhibiting signs of any kind of defect, or failing a destructive or a nondestructive test, shall be repaired. Several procedures exist for the repair of these areas. The final decision as to the appropriate repair procedure shall be made by the Contractor
 2. The repair procedures available include:
 - a. Patching, used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.
 - b. Spot welding or seaming, used to repair small tears, pinholes, or other minor, localized defects.
 - c. Capping, is used to repair large lengths of failed seams.
 - d. Removing bad seam and replacing with a strip of new material welded in place.
 3. For any repair method, the following provisions shall be satisfied:
 - a. Surfaces of the geomembrane which are to be repaired using extrusion methods shall be abraded no more than one hour prior to the repair.
 - b. Surfaces shall be clean and dry at the time of the repair.
 - c. Seaming equipment used in repairing procedures shall be qualified.
 - d. Patches and caps shall extend at least 4-inches beyond the edge of the defect.
 - e. Patches shall have rounded corners.
- H. Repair Verification:
- Each repair shall be numbered and logged by the Installer. Each repair shall be nondestructively tested using the methods described in Paragraph 3.6 as appropriate. Repairs which pass the nondestructive test shall be taken as an indication of an adequate repair. Repairs more than 150-ft long may be of sufficient length to require destructive test sampling, at the discretion of the Contractor. A failed test of the repaired section indicates that the repair shall be redone and retested until passing test results are achieved. The Contractor shall observe nondestructive testing of repairs. The Installer shall record the number of each repair, date and test outcome.

- I. Wrinkles:
Large wrinkles that remain in the sheet as result of temperature expansion or uneven surface preparation may need removal as determined by the Contractor in consideration of applied loads on the wrinkle. Should the wrinkle need removing, the lower down-slope edge of the wrinkle shall be cut, overlapped and repaired as described in 3.7.G. Both ends of the wrinkle repair shall be patched. Caution must be taken in removing any wrinkles.
- J. Sufficient slack shall be placed in the geomembrane to compensate for the coldest temperatures envisioned so that no tensile stresses are generated in the geomembrane or in its seams either during installation or subsequently after the geomembrane is covered.
- K. The geomembrane shall have adequate slack such that it does not lift up off the subgrade or substrate material at any location within the facility, i.e., no “trampolining” of the geomembrane shall be allowed to occur at any time.
- L. The geomembrane shall not have excessive slack to the point where creases fold over upon themselves either during placement and seaming, or when the protective soil or drainage materials are placed on the geomembrane.
- M. Permanent (fold-over type) creases in the covered geomembrane should not be permitted at any time.

The amount of slack to be added to the deployed and seamed geomembrane should be carefully considered and calculated, taking into account the type of geomembrane and the geomembrane’s temperature during installation versus its final temperature in the completed installation.

3.08 DISPOSAL OF WASTE MATERIAL

Upon completion of installation, the Installer shall properly remove and dispose of all trash, waste material, tools, and equipment used in connection with the performed work and shall leave the premises in a neat and acceptable condition.

3.09 AS-BUILT DRAWINGS AND INSTALLATION DOCUMENTATION

The Installer shall prepare and submit to the Contractor an as-built drawing reflecting the actual installation of geomembrane liner, including the location of seams, the location of destructive samples, and the location of repair work. The as-built drawing shall be submitted to the Contractor within seven days of the completion of the geomembrane. In addition, a copy of the complete installation documentation package will accompany the as-built drawing.

3.10 COVER MATERIAL

Following QC approvals, geosynthetic drainage layer will be placed directly over the liner. The GDL will be placed in accordance with section 33 46 16.16, “Geocomposite Drainage Layer” of the specifications.

State of Maine Department of Transportation
Callahan Mine Superfund Site – Brooksville, Maine
OU3 Draft Final Design
Section 31 05 19.16 – Cap Geomembrane Liner

TABLE 02372-2
MATERIAL PROPERTIES
LINEAR LOW DENSITY POLYETHYLENE (LLDPE) GEOMEMBRANE
TEXTURED (Both Sides) SHEET

Property	Unit	Test Method	Value	Frequency
Thickness – specified	Mils	ASTM D 5994	60	
Thickness – min average.	Mils	ASTM D 5994	57	
• lowest individual for 8 of 10 values	Mils	ASTM D 5994	54	Per Roll
• lowest individual for any 10 values	Mils	ASTM D 5994	51	
Asperity height (min. avg.) ^(1, 2)	Mils	GRI GM12	10	Every second roll
Tensile Properties (min. avg.) ⁽³⁾		ASTM D 6693 (Type IV)		
1. Break Strength	lb/in		90	20,000 lbs
2. Break Elongation	%		250	
Tear Resistance (min. avg.)	lb	ASTM D 1004	33	45,000 lbs
Puncture Resistance (min. avg.)	lb	ASTM D 4833	66	45,000 lbs
Density (max.)	g/cc	ASTM D 1505/D 792	0.92	200,000 lbs
Carbon Black Content (range)	%	ASTM D 1603 ⁽⁴⁾	2.0 to 3.0	20,000 lbs
Carbon Black Dispersion	N/A	ASTM D 5596	Note 5	45,000 lbs
Oxidative Induction Time (OIT) (min. avg.) ⁽⁶⁾				
- Standard OIT		ASTM D 3895	100	100,000 lbs
or				
- High Pressure OIT		ASTM D 5885	400	
Axi-Symmetric Break				

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Property	Unit	Test Method	Value	Frequency
Resistance Strain (min.)	%	ASTM D 5617	30	
Oven Aging at 85° C - retained after 90 days (min. ave.) ⁽⁹⁾		ASTM D 5721		
- Standard OIT	%	ASTM D 3895	35	
- High Pressure OIT	%	ASTM D 5885	60	
UV Resistance – High Pressure OIT – retained after 1600 hrs (min. ave.) ⁽⁷⁾⁽⁸⁾	%	ASTM D 5885	35	

Table 02372-2 Notes:

1. Of 10 readings, 8 of 10 must be ≥ 7 mils, and the lowest individual reading must be ≥ 5 mils.
2. Alternate the measurement side for double sided textured sheet.
3. Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of 5 test specimens each direction. Break elongation is calculated using a gage length of 2.0 inches at 2.0 in./min.
4. Other methods such as ASTM D 4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to ASTM D 1603 (tube furnace) can be established.
5. Carbon black dispersion (only near spherical agglomerates) for 10 different views: 9 in Categories 1 or 2 and 1 in Category 3.
6. The manufacturer has the option to select either one of the OIT methods listed to evaluate the antioxidant content in the geomembrane.
7. The condition of the test should be 20 hr. UV cycle at 75° C followed by 4 hr. condensation at 60° C.
8. UV resistance is based on percent retained value regardless of the original HP-OIT value.
9. It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.

The above tests shall be performed by the manufacturer of the LLDPE geomembrane for identification of the manufacturer's product. The above test results shall be submitted to the Contractor for approval of the product. The geomembrane to be supplied for the project shall meet these properties.

TABLE 02372-3

SEAM PROPERTIES
 LINEAR LOW DENSITY POLYETHYLENE (LLDPE) GEOMEMBRANE
 TEXTURED (Both Sides) SHEET

Property	Unit	Test Method	60-mil Value
Shear Strength (min. avg.)	lb/in	ASTM 6392	D 90
Peel Strength (extrusion) (min. avg.)	lb/in	ASTM 6392	D 66 & FTB
Peel Strength (hot wedge) (min. avg.)	lb/in	ASTM 6392	D 75 & FTB

-- END OF SECTION --

SECTION 02372 - APPENDIX A

PROJECT FORMS
FOR
INSTALLATION OF
LINEAR LOW DENSITY POLYETHYLENE (LLDPE) GEOMEMBRANE

31 05 19.16-24

Draft Final Design

December 2014

Geosynthetics Inventory and Certification Log

Sheet # _____

Project Name		Material Desc.						
Project No.		Layer	Primary		Secondary		Tertiary	
Owner/Contr.		Material Type	HDPE	GN	GT	GC	GCL	OTHER
QA Monitor		Texture:	Smooth		Thickness:		Width:	

Roll Number	Lot/Batch Number	Roll Length	Roll Area	Date Roll Received	Date Cert.'s Received	Date Roll Approved
-------------	------------------	-------------	-----------	--------------------	-----------------------	--------------------

1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
	Total		-	-		
	Running Total		-			

Notes, Observations, Comments:

MACTEC Representative _____ Date _____

Owner Representative _____ Date _____

CQA Form 001

31 05 19.16-25

Daily Panel As-Built

Sheet # _____

Project Name	Material Desc.	Primary	Secondary	Tertiary
Project No.	Layer	HDPE	GN	GT
Owner/Contr.	Material Type	GC	GCL	OTHER
QA Monitor	CELL No:			

Scale:	Adjacent Sheet No. _____	Indicate North
Vertical		
Horizontal		
Adjacent Sheet No. _____		Adjacent Sheet No. _____
	Adjacent Sheet No. _____	

MACTEC Representative _____ Date _____

Owner Representative _____ Date _____

CQA Form 005

31 05 19.16-29

Draft Final Design

December 2014

Trial Weld Log

Sheet # _____

Project Name	Material Desc. 60 mil Texture
Project No.	Layer Primary Secondary Tertiary
Owner/Contr.	Material Type HDPE GN GT GC OTHER
QA Monitor	CELL No:

Date & Time	Weather/ Winds/ Temp.	Machine/ Operator	Machine Settings		Peel (ppi)	Shear (ppi)	Result (P/F)	FTB (Y/N)	Test Number	Comments/ Observations
			Fusion	Extrusion						
							P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
							P F	Y N		
			Fusion	Extrusion			P F	Y N		
Notes, Observations, Comments:										

MACTEC Representative _____ Date _____

Owner Representative _____ Date _____

CQA Form 006

31 05 19.16-30

Destructive Seam Field Test

Sheet # _____

Project Name	Material Desc.	Primary	Secondary	Tertiary
Project No.	Layer			
Owner/Contr.	Sheet Thickness	Top		Fusion
QA Monitor		Bottom		Extrusion

Seam Location	Temp. @ Test	Sample Size	1x4'
---------------	--------------	-------------	------

Sample ID	Date Welded	Seam No.
Cumulative Weld Total	Date Tested	Welder ID
Number of Destruct's	Test Location	QC Tester ID

Reason for Test	Destructive Sampling Requirements
-----------------	-----------------------------------

Coupon No.	Peel				Shear	
	Inside Track		Outside Track		Load (ppi)	Failure Mode
	Load (ppi)	Failure Mode	Load (ppi)	Failure Mode		

P1						
P2						
P3						
P4						
P5						

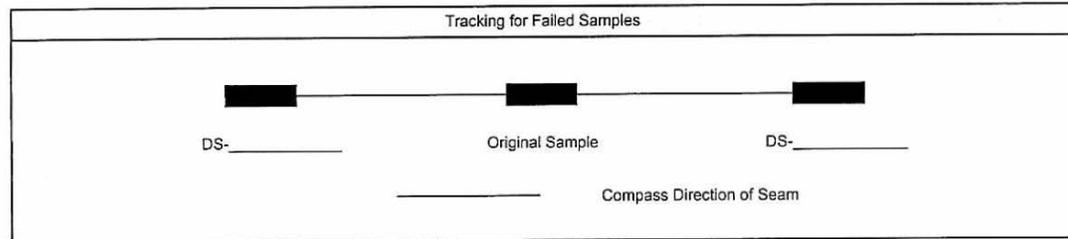
Average				
---------	--	--	--	--

Tensiometer Gauge No.
ST-033

Pass	Fail
------	------

Material Strength Specifications		
Material Description	Peel (ppi)	Shear (ppi)
60 mil Smooth	78	120
60 mil Textured	78	120

Notes, Observations, Comments:



MACTEC Representative _____ Date _____

Owner Representative _____ Date _____

CQA Form 007

Certificate of Soil Surface

Sheet # _____

Project Name	Material Desc.			
Project No.	General Desc.	Subgrade	Operations	LCRS
Owner/Contr.	CELL No.			
QA Monitor	Date			

Description of Soil Surface to be lined:

I hereby certify that the above surface area is suitable for the installation of geosynthetics, and I shall be responsible for its integrity and suitability in accordance with the specifications from this date to the completion of the installation.

CQA Monitor
Name:
Date:
Title:
Representing:
Signature:

Installer Representative
Name:
Date:
Title:
Representing:
Signature:

Owner Representative
Name:
Date:
Title:
Representing:
Signature:

Notes, Observations, Comments:

CQA Form 008

Certificate of Completion

Sheet # _____

Project Name	Material Desc.			
Project No.	Layer	Primary	Secondary	Tertiary
Owner/Contr.	Type	Partial	Substantial	Final
QA Monitor	Date			

Description and Area of Work Being Certified:

I hereby certify that the above identified work has been inspected and it has been properly installed. I further certify all required testing has been completed and the results are acceptable to the CQA Officer. The liner system is suitable for its intended use.

CQA Monitor
Name:
Date:
Title:
Representing:
Signature:

Installer Representative
Name:
Date:
Title:
Representing:
Signature:

Owner Representative
Name:
Date:
Title:
Representing:
Signature:

Notes, Observations, Comments:

CQA Form 009

Daily Inspection Report

Page 1 of 2

Sheet # _____

General Project Information		Site Condition	
Project Name		Weather	
Project No.		Type Precip. / Amount	
Owner/Contr.		Wind Speed / Direction	
Engineer		Liner Temperature	Max. Min.
Sub-Contractor		Site Conditions	
QA Monitor			
Project Schedule		Meetings	
Date		Purpose	
Original Comp. Date			
Revised Comp. Date			
Construction Day	Working Day's Remaining	Attendees	
Contracted Working Days	Revised No. of Working Days		
Construction Activities			
Activities Started/Completed (by Contractor)			
Extra Works, Potential Change Orders			
Materials Delivered to Site			
Permanent Materials Installed			
Contractor and Crew Size			
Site Visitor's			
Additional Comments			
DUDEK Personnel Activity			
	Hours Onsite	Arrive Depart	Hours Offsite Total Hours
	Hours Onsite	Arrive Depart	Hours Offsite Total Hours
List Daily QA Documents			
Sheet #'s	Comment	Sheet #'s	Comment
Inventory Log- CQA Form 001.		DS Tracking Summary- CQA Form 011.	
Defect Log- CQA Form 002.		Photo Log- CQA Form 012.	
Seam Control- CQA Form 003.		NC / Corrective Action- CQA Form 013.	
Panel Placement Log- CQA Form 004.		Laboratory Test Results	
Daily Panel As-Built- CQA Form 004.		List Other:	
Trial Welds- CQA Form 006.			
Destructive Field Sample- CQA Form 007.			
Subgrade Surface- CQA Form 008.			
Completion Certification- CQA Form 009.			

CQA Form 010

31 05 19.16-34

In-Use Construction Equipment (Include machine numbers and data) by Subcontractor	

Summary of Construction Activities	

MACTEC Representative _____ Date _____

Owner Representative _____ Date _____

CQA Form 010

Notice of Non-Compliance and Corrective Action

Sheet # _____

General Project Information	
Project Name	Date
Project No.	Contractor in NC
Owner/Contr.	Non-Compliance No.
QA Monitor	Notes:
Reference	
Item	Drawing No.
Specification Sec. No.	Other:
Description of Non-Compliance	
Cross Reference (QA Inspection Form & Sheet No.):	
Contractor's Response	
Follow Up Action Required	
Recommended by:	
DUDEK Representative _____	Date _____
Approved by:	
Owner Representative _____	Date _____
Follow Up Action Taken	
Cross Reference (QA Inspection Form & Sheet No.):	

MACTEC Representative _____ Date _____

Owner Representative _____ Date _____

CQA Form 013

31 05 19.16-38

SEAM TESTING CHAIN OF CUSTODY FORM

SEND YOUR SEAMS TO

PROJECT NAME / PROJECT NUMBER: _____

PROJECT LOCATION: _____

No.	Seam ID <i>(include seam ID, panel ID, welder, etc.)</i>	MATERIAL DESCRIPTION	FUSION	EXTRUSION	Solvent Weld
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

TEST METHOD
(Please check which test method is applicable)

<input type="radio"/>	<input type="radio"/>
SHEAR - ASTM D4437 PEEL - ASTM D4437	SHEAR - ASTM D6214 PEEL - ASTM D6214
<input type="radio"/>	<input type="radio"/>
SHEAR - ASTM D4437 NSF Modified Crosshead Speed = 2"/min PEEL - ASTM D4437 NSF Modified Crosshead Speed = 2"/min	SHEAR - ASTM D4437 NSF Modified Crosshead Speed = 20"/min PEE - ASTM D4437 NSF Modified Crosshead Speed = 20"/min
<input type="radio"/>	<input type="radio"/>
SHEAR - ASTM D6392 PEEL - ASTM D6392 HDPE	SHEAR - ASTM D3083 Crosshead Speed = 20"/min PEEL - ASTM D413 Crosshead Speed = 2"/min
<input type="radio"/>	<input type="radio"/>
SHEAR - ASTM D6392 PEEL - ASTM D6392 LLDPE/PVC	SHEAR - ASTM D751 PEEL - ASTM D413 Crosshead Speed = 2"/min

SPECIFICATIONS/NOTES:
OPEN on SATURDAYS for SEAM TESTING.
 To ensure that your package is delivered/received on Saturdays; please fax, e-mail or call to let us know the AIRBILL # of your package. This helps us track for SATURDAY DELIVERY.

Thickness required? Yes NO
SOLVENT WELD
 Curing Time: _____ Curing Temp: _____

REPORT TO:
 NAME: _____
 COMPANY: _____
 ADDRESS: _____

 TEL NO: _____
 FAX NO: _____
 E-MAIL: _____

FIELD CONTACT:
 NAME: _____
 Pager: _____
 Mobil: _____
 Phone: _____
 FAX: _____
 E-mail: _____

RELEASED BY:
 NAME: _____
 COMPANY: _____
 DATE/TIME: _____

RECEIVED BY:
 NAME: _____
Precision Geosynthetic Labs
 DATE/TIME: _____

Shipped Via

Fedex
 UPS
 Airborne
 DHL
 US Mail
 Hand Carry
 Others

white- REPORT/SAMPLE, yellow- LAB, pink- CLIENT

CONFORMANCE TEST CHAIN OF CUSTODY FORM

Page ____ of ____

PROJECT NAME / PROJECT NUMBER: _____
 PROJECT LOCATION: _____

GEOMEMBRANE TESTING

SAMPLE ID	Thickness ASTM D5199 or D5984	Density ASTM D1505 or D792	Carbon Black Content ASTM D1603	Carbon Dispersion D3016 / D6596	Tensile ASTM D638 GM13 / NSF54	Tear Resistance ASTM D1004 (Die C)	Puncture D4833 /101CN2065	Melt Flow Index ASTM D1238, cond. E	Dimensional Stability ASTM D1204	Low Temp Brilliance D7467 / D1790	NCTL ASTM D6397 Hours	Other ASTM

NONWOVEN OR WOVEN GEOTEXTILE TESTING

SAMPLE ID	Thickness ASTM D5199 or D1777	Mass Per Area ASTM D5261 or D3776	Grab Tensile ASTM D4632	Trapezoid Tear ASTM D4633	Puncture Resistance ASTM D4833	Mullen Burst ASTM D3776	Permittivity ASTM D4491	AOS ASTM D4751	Wide Width Tensile ASTM D4595	LW (hrs ASTM D4655	Other ASTM	Other ASTM

GEOCOMPOSITE / GEONET / GEOGRID TESTING

SAMPLE ID	Thickness ASTM D5199 or D1777	Density ASTM D1505 or D792	Carbon Black Content ASTM D1603	Mass Per Area ASTM D5261 or D3776	Melt Flow Index ASTM D1238, cond. E	Peel ASTM D413, F904 or GRI-GC7	Transmissivity * ASTM D4716	Compression ASTM D1621	Tensile Strength ASTM D1682 or D5035	Wide Width Tensile ASTM D4595	Rib Tensile Strength GRI-GG1	Junction Strength GRI-GG2

* Transmissivity Test Parameters: Normal Load: _____, Gradient: _____, Seating Time: _____, Boundary Condition: _____

GCL TESTING

SAMPLE ID	Thickness ASTM D5199	Mass Per Area ASTM D5988	Grab Tensile ASTM D4632	Peel Strength ASTM D6166	Moisture Content ASTM D4643 or D2216	Hydraulic Conductivity ASTM D5084	Index Flux ASTM D5887	Swell Index ASTM D5890	Fluid Loss ASTM D5891	Internal Strength ASTM D6243	Other ASTM	Other ASTM

SEND REPORT TO:

Name: _____
 Company: _____
 Address: _____
 Phone: _____
 Fax: _____
 e-mail: _____

FIELD CONTACT:

Name: _____
 Pager: _____
 Mobil: _____
 Phone: _____
 Fax: _____
 e-mail: _____

Released by:

Name: _____
 Date/Time: _____
Received by:
 Name: _____
 PGL _____
 Date/Time: _____

Shipped Via:

Fedex
 UPS
 Airborne
 DHL
 US Mail
 Others

SECTION 31 11 00

CLEARING AND GRUBBING

PART 1 – GENERAL

1.01 DESCRIPTION

- A. Work Included:
 - 1. Clearing includes cutting at the ground surface trees and general woody growth including shrubs, bushes, vines, and general brush.
 - 2. Grubbing includes removal of vegetative cover with root systems, stumps with root systems, and other organic matter surficial or buried within the top layer of soil (topsoil).
- B. Limit of Work:
 - 1. Perform clearing within the limit of work as shown on the Construction Contract Drawings.
 - 2. Prior to beginning remediation construction, perform grubbing as required within the limit of grading and additional areas as necessary to install the construction temporary facilities and controls.
- C. Clearing performed outside the defined limit of work shall not be permitted without permission of the OWNER's Representative or ENGINEER.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 23 00 – Earthwork
- B. Section 31 25 00 – Erosion and Sedimentation Control
- C. Section 32 71 00 – Site Restoration and Wetland Construction

1.03 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies:
 - 1. Dispose of combustible material by burning only when permitted by and in accordance with all applicable local and state laws, ordinances, and code requirements.
- B. Remove and dispose of non-salvageable structures and material in accordance with all applicable local and state laws, ordinances, and code requirements.

PART 2 – PRODUCTS

Not Used

PART 3 – EXECUTION

3.01 PROTECTION

- A. Verify existing conditions before starting work.
- B. Coordinate clearing limits and existing plant life to remain with the OWNER's Representative and clearly flag for protection. Protect trees, plant growth, and features designated to remain, as final landscaping.
- C. Install and maintain perimeter erosion control measures down gradient from areas to be grubbed.
- D. Coordinate with the OWNER's Representative for the location of onsite temporary stockpiles and/or permanent waste or disposal areas and salvaged topsoil stockpiles.
- E. Locate, identify, and protect structures or features indicated to remain. Protect bench marks, survey control points, and existing structures to remain from damage or displacement.

3.02 PERFORMANCE

- A. Layout and Marking:
 - 1. The CONTRACTOR shall procure the services of a qualified surveyor to field locate and mark the limits of work and clearing.
 - 2. Flag the clearing limit as for work areas as delineated on the Construction Contract Drawings.
- B. Clearing:
 - 1. Remove trees, shrubs, and brush above the ground surface within the limit of work.
 - 2. Segregate clearing debris, as required if on-site chipping is proposed.
 - 3. Cleared material may be stockpiled within the limit of work until on or offsite disposal is conducted.
- C. Grubbing:
 - 1. Remove all stumps, roots over 2 inches in diameter, matted roots, and vegetative matter including grasses and weeds within the limit of grading.
 - 2. Segregate grubblings (e.g. stumps) greater than 6 inches in diameter from other grubbed materials.

2. Grubbed material shall be stockpiled within the limit of work until on or offsite disposal is conducted and shall be covered if necessary to prevent wind-blown dust.

D. Disposal:

1. Reuse large woody debris (stumps and logs obtained from tree clearing and grubbing) as part of habitat creation during restoration and wetland mitigation activities. Density and location of placement will be field determined based on available woody materials. Refer to Section 32 71 00, “Site Restoration.”
2. If not reused as outlined in item 1 above, cleared vegetation shall be removed from the Site and legally disposed, or alternatively cleared material may be chipped and used as mulch or disposed on-site in a location approved by OWNER’s Representative.
3. If not reused as outlined in item 1 above, grubbed materials, including roots and stumps, shall be removed from the Site and legally disposed, or alternatively grubbed material may be chipped and used as mulch or disposed on-site in a location approved by OWNER’s Representative.
4. Burning of Materials: Burning of removed vegetation shall be allowed provided required permits are obtained and is conducted in accordance with permit and local authority requirements. Do not bury materials on Site unless approved by OWNER’s Representative. Leave site in clean condition.

3.03 RESTORATION

- A. Restore any items damaged by this work to their original condition.

END OF SECTION

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SECTION 31 23 00

EARTHWORK

PART 1 GENERAL

1.01 DESCRIPTION

- A. This section provides the requirements for earth excavation and filling activities for remediation of the Tailings Impoundment, including: excavation of tailings/waste rock materials; rock removal; trench excavation and backfilling; protection with sheeting and shoring as required; subgrade fill placement; compaction; and construction quality control testing.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittal Procedures
- C. Section 01 45 00 – Contractor Quality Control
- D. Section 31 05 19 - Geosynthetics
- E. Section 31 11 00 – Clearing and Grubbing
- F. Section 31 25 00 – Erosion and Sedimentation Control
- G. Section 31 23 10 – Controlled Blasting
- H. Section 32 37 00 - Site Restoration
- I. Section 32 92 00 - Seeding
- J. Section 33 41 00 – Storm Culvert Piping
- K. Section 33 49 00 – Storm Drainage Structures
- L. Geotechnical Monitoring Plan

1.03 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Unless otherwise noted, the latest edition of the publications shall be used. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D 1557	Standard Test Methods for Laboratory Compaction Characteristi of Soil Using Modified Effort (56,000 ft-lbf/ft ³)
ASTM D 2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
ASTM D 2487	Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D 3740	Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
ASTM D 4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D 5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D 6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
MEDOT SS	Maine Department of Transportation Standard Specifications

1.04 SUBMITTALS

- A. Soil Material Testing Results:
1. Soil material testing results as specified in Part 2 of this Section.
 2. In-place soil material testing results as specified in Part 3 of this Section. Submit daily logs kept by the CONTRACTOR and described in the Article entitled Field Quality Control in Part 3 of this Section. Completed daily logs shall be submitted on a weekly basis. Maintain drawings showing in place testing locations.
- B. Third-Party Soil Testing Service:
The name and qualifications of the third-party soil testing service to be used for soil material in-place testing.
- C. Soil Sources:
List of any off-site soil sources, including contact information and addresses; 10 business days (minimum) prior to material delivery.

1.05 QUALITY ASSURANCE/QUALITY CONTROL

- A. Codes and Standards:
Perform excavation work in compliance with applicable requirements of governing authorities having jurisdiction.
- B. CONTRACTOR Provided Third-Party Soil Testing Service:
The third-party soil testing service must demonstrate geotechnical testing experience and shall have sufficient facilities to perform the required quantity of tests at a rate commensurate with the proposed work schedule and meet the requirements of ASTM D

3740. The soil testing service shall provide access to the Contracting Officer for observation of the facilities and methods used in the geotechnical testing, if requested.

C. CONTRACTOR Provided Surveyor:

The CONTRACTOR is responsible for providing all construction layout. Surveys for construction elevations and locations of the Work shall be performed by or under the supervision of a qualified surveyor.

1.06 FIELD MEASUREMENTS

- A. Existing condition survey shall be completed prior to construction activities to verify features and elevations as shown on the Drawings.

1.07 JOB CONDITIONS

A. Protection:

1. Should uncharted piping or other utilities be encountered during excavation, consult the ENGINEER immediately for direction.
2. Barricade and/or install warning signs or lights as required for protection from open excavations occurring as part of this Work. If warning lights are used, operate warning lights during hours from dusk to dawn each day and as otherwise required.

B. Dust Control:

1. Use means necessary to control dust on and near the Work and on and near all borrow areas if such dust is caused by operations during performance of the Work.
2. Thoroughly treat all surfaces as required to prevent dust from being a nuisance or health risk to the workers, public, neighbors, and concurrent performance of other work on the site.
3. Conduct air monitoring as required in work plans and/or work permits.

C. Groundwater and Surface Water Runoff Control:

1. The CONTRACTOR shall provide adequate pumping and drainage facilities to maintain excavated or fill areas sufficiently dry from groundwater and/or surface water runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The drainage of all water resulting from pumping shall be managed so as not to cause physical or environmental damage to adjacent areas.
2. The CONTRACTOR's pumping and dewatering operations shall be carried out in such a manner as to prevent damage to the Work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous, as required, to protect the work and/or to maintain satisfactory progress in the Work.
3. Water from trenches, excavations and drainage operations shall be disposed of or treated in such a manner as to avoid public nuisance, injury to worker safety, public health or the environment, damage to public or private property, or damage to the Work completed or in progress.
4. The CONTRACTOR shall control the grading in the areas surrounding all excavations

so that the surface of the ground will be properly sloped to prevent water from running into the excavated area.

5. Control sediments to minimize impact of Work to off-site surface water bodies or drainage systems. Refer to Section 31 25 00, “Erosion and Sedimentation Control.”

PART 2 PRODUCTS

2.01 DEFINITIONS

- A. Cohesionless Soil Materials: Gravels, sand-gravel mixtures, sands, and gravelly-sands.
- B. Cohesive Soil Materials: Clayey gravels, and sand-clay mixtures, clayey sands, and clays.
- C. Unsatisfactory Soil Materials: Peat, highly organic soils, frozen and thawed soils, and soils which when left in place are too wet or dry to compact.
- D. Satisfactory Material: Material meeting the requirements specified below and used in areas as shown on the construction drawings.
- E. Waste rock and soil: Existing rock and soil material exposed or deposited at the Site from the former mine activities containing sulfide minerals that cause acid rock drainage (ARD) that could contaminate receiving waters with acid and heavy metals.

2.02 SOIL MATERIALS

- A. Common Borrow: Common Borrow shall be used as subgrade fill, backfilling excavations and trenches, and other miscellaneous fill or backfill as required to complete the work. Common Borrow shall be well graded, stable material suitable for embankment construction with a maximum 6-inch stone size and a maximum of 50% passing the 200 sieve. Common borrow shall be free of trash, ice, snow, tree stumps, and other organic and deleterious materials. It shall be of such a nature and character that it can be compacted to the specified dry density of 90% (measured as a percentage of the max. dry density as determined by ASTM D 1557) or greater with a reasonable compaction effort. Satisfactory onsite excavated materials that meet this requirement shall be used as Common Borrow.
- B. Tailings Material: Tailings material consists of “Coarse Tailings” (consisting of fine silty sand and trace amounts clay, that was deposited generally at the perimeter of the as a waste product from former mining operations. The central portion of the Tailings Impoundment consists of extremely soft soils referred to as “slimes” which are primarily silt and clay size particles and soft to very soft. The coarse tailings will be excavated and placed above the slimes area as required to develop the subgrade elevations as shown on the Drawings.
- C. Protection Layer: Protection Layer shall be a crushed stone material and placed over the infiltration barrier cap and provide the final cover within the Tailings Impoundment. This crushed stone material will be produced at the on-site quarry through drilling, blasting, and

crushing of virgin bedrock located west of the former mining operations area. The protection layer stone shall have a D₅₀ Size of 4-inches and meet the following gradation requirements:

<u>Sieve Designation</u>	<u>Percent by Weight Passing</u>
6 inch	100
4 inch	40-60
No. 4	0-5

- D. Working Surface: Working Surface material shall be a crushed stone material to create a stabilized work area across fill areas to allow equipment access. The bottom one-foot of the Working Surface will act as a drainage blanket for transporting the EQ Drain discharge to the water collection sumps (the same material shall be used to backfill around the bottom 4 feet of the water collection sumps). The Working Surface material will be produced at the on-site quarry and manufactured from virgin bedrock or processed from waste rock boulders scheduled to be removed from the Tailings Impoundment. Contractor may submit a proposed alternate but the following gradations are recommended, from the surface of the Working Surface downward:

<u>Sieve Designation</u>	<u>Percent by Weight Passing</u>
2 inch	100
1-1/2 inch	95-100
3/4 inch	35-70
3/8 inch	10-30
No. 4	0-5

MEDOT 703.02 AA

<u>Sieve Designation</u>	<u>Percent by Weight Passing</u>
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

- E. Crushed Gravel: Crushed Gravel shall be produced at the on-site quarry and manufactured from virgin bedrock. This material shall be used as final surfacing material for the proposed post-remediation gravel access roads and meet the following gradation requirements:

<u>Sieve Designation</u>	<u>Percent by Weight Passing</u>
2 inch	100
1-1/2 inch	95-100
3/4 inch	35-70
3/8 inch	10-30
No. 4	0-5
No. 200	1.5 Max

- F. Underdrain Gravel: Underdrain gravel shall be used for all bedding applications. Underdrain gravel used for bedding material outside the cap limits shall be produced at the on-site quarry and manufactured from virgin bedrock. Underdrain gravel shall meet the following gradation requirements.

MEDOT 703.02 AA	
<u>Sieve Designation</u>	<u>Percent by Weight Passing</u>
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

2.03 BORROW SOURCE TESTING

Borrow source testing shall be conducted for the following soil materials proposed for construction. Testing frequency shall be as listed. The testing requirements for soils obtained from each borrow source(s) are provided below.

<u>Test</u>	<u>Methodology</u>	<u>Frequency</u>
A. Common Borrow, Protection Layer, Working Surface, Crushed gravel, Underdrain Gravel		
Grain Size (to the #200 Sieve)	ASTM D 422	1 test/1000 CY (Min 3)
PART 3 EXECUTION		

3.01 PREPARATION

- A. Examination: Examine the areas and conditions under which excavating, filling, and grading are to be performed and notify the ENGINEER of conditions detrimental to the proper and timely completion of the work.
- B. Clearing and Grubbing: Prior to beginning of excavation, grading, and embankment operations, perform all necessary clearing and grubbing. Refer to Section 31 11 00, "Clearing and Grubbing for requirements.
- C. Groundwater and Surface Water Runoff Control:
1. The CONTRACTOR shall provide adequate drainage and/or pumping facilities to maintain excavated or fill areas sufficiently dry from groundwater and/or surface water runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The drainage of all water resulting from pumping shall be managed so as not to cause physical or environmental damage to adjacent areas.
 2. The CONTRACTOR'S dewatering operations shall be carried out in such a manner as to prevent damage to the Work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Dewatering shall be continuous, as required, to protect the work and/or to maintain satisfactory progress in the work.

3. The CONTRACTOR shall control the grading in the areas surrounding all excavations so that the surface of the ground will be properly sloped to prevent water from running into the excavated area.
4. Control sediments to minimize impact of work to off-site surface water bodies or drainage systems

3.01 LINES AND GRADES

- A. Lay pipes to lines and grades indicated on the construction drawings. The ENGINEER reserves the right to make changes in lines and grades when required for Project conditions.
- B. Maintain grade alignment of pipe using string line parallel with grade line and vertically above centerline of pipe.
 1. Establish string line on level batter boards at intervals of not more than 25 feet.
 2. Install batter boards spanning trench, rigidly anchored to posts driven into ground on both sides of trench.
 3. Set three adjacent batter boards before laying pipe to verify grades and line.
 4. Determine elevation and position of string line from elevation and position of offset points or stakes located along pipe route.
 5. Do not locate pipe using side lines for line or grade.
 6. Alignment and elevations can also be maintained by use of lasers.

3.03 EXCAVATION AND TRENCHING

- A. Excavation and filling operations will be completed within the Tailings Impoundment to prepare the area for installation of the infiltration barrier cap. Tailings and/or waste rock excavated from the eastern side of the impoundment will be placed as fill in central and western portions of the impoundment. The additional fill load placement atop the tailings will result in the generation of excess pore pressures in and settlement/consolidation of the tailings. The tailings response to fill placement will be monitored via geotechnical instrumentation, and the rate of fill placement will be governed and regulated by the monitoring data and the Engineer, respectively.
- B. Excavation stability is the responsibility of the CONTRACTOR. Excavations shall be performed in accordance with local, state, and federal requirements.
- C. Excavate subsoil required for the installation of the piping, manholes, and appurtenances.
- D. Remove lumped subsoil, boulders, and stones up to 6 inches.
- E. Do not advance open trenches more than 150 feet ahead of installed pipe.
- F. Cut excavations or trenches to width indicated on the construction drawings or sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.
- G. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

- H. Excavate to depth indicated on the construction drawings. Provide uniform and continuous bearing and support for bedding material and pipe, vaults, or other appurtenances.
- I. When Project conditions permit, slope side walls of excavation 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.
- J. When subsurface materials at bottom of excavation are loose or soft, excavate to greater depth as directed by the ENGINEER until suitable material is encountered.
- K. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.
- L. Correct areas over excavated areas with compacted backfill as specified.
- M. Remove excess subsoil not intended for reuse from site.
- N. Preserve historic vegetation to maximum extent practicable.

3.04 ROCK REMOVAL

- A. Removal of boulder size waste rock forming the perimeter dam of the Tailings Impoundment will be strategically removed to achieve the subgrade elevations shown on the Drawings. Removed waste rock shall be transported to the on-site quarry area for potential crushing and re-use as Working Surface material.
- B. Waste rock will be removed below the proposed subgrade elevations and the condition of the exposed rock is anticipated to be highly irregular with several surface voids. Contractor shall install a 16 ounce -woven geotextile across the top of the exposed rock and place shotcrete to develop a level surface suitable for soil placement prior to installation of the infiltration barrier cap.

3.05 SHEETING AND SHORING

- A. As required, sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
- B. Support trenches more than 4 feet deep excavated through unstable, loose, or soft material, or slope excavation sides, as appropriate. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
- C. Design sheeting and shoring to be removed at completion of excavation work.
- D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.
- E. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.06 BACKFILLING

- A. Backfill excavations and trenches to contours and elevations with unfrozen fill materials.
- B. Place material in continuous layers as follows:
 - 1. Common Borrow: Maximum 12 inches loose depth2. Tailings Material:
Maximum 12 inches loose depth
 - 3. Protection Layer: Maximum 15 inches compacted depth
 - 4. Working Platform: Maximum 18 inches loose depth
 - 5. Crushed Gravel: Maximum 12 inches loose depth
 - 6. Underdrain Gravel: 12 inches loose depth
- C. Employ placement method that does not disturb or damage utilities in trench or adjacent structures.
- D. Maintain optimum moisture content of fill materials to attain required compaction density.
- E. Do not leave more than 100 feet of trench open at end of working day.
- G. Protect open excavation and trenches to prevent danger to workers, visitors, and the public.
- H. Waste rock removed from the Tailings Impoundment perimeter that is determined unsuitable or not necessary for processing at the on-site quarry shall be transported and stockpiled to a location to be determined.

3.08 COMPACTION

- A. General:
Control soil compaction during construction as specified to achieve the minimum degree of compaction as specified herein.
- B. Preparation:
 - 1. Each layer of subgrade fill or backfill shall be compacted to a firm and unyielding condition, as approved by the ENGINEER. Compaction shall be performed using a steel drum roller capable of providing a 1TSF loading on the soil material. The roller shall be tracked over the soil material until no significant rutting or deformation occurs.
 - 2. Match compaction equipment and methods to the material and location being compacted in order to obtain the specified compaction, with consideration of the following guidelines:
 - a. Vibratory compaction is preferred for dry, granular materials.
 - b. Hand compaction equipment such as impact rammers, plate or small drum vibrators, or pneumatic buttonhead compactors should be used in confined areas and proximate to geotechnical instrumentation.
 - c. Hydraulic compaction by pounding or jetting will not be permitted except in unusual conditions, and then only upon written approval by the ENGINEER

- and after a demonstration of effectiveness.
- d. Backhoe mounted hydraulic or vibratory tampers may be used for compaction of backfill in trenches over 4 feet in depth, provided that the specified density is achieved. The upper 4 feet shall be compacted as detailed above or with hand-guided or self propelled vibratory compactors or static rollers.
- C. Compaction Requirements: There are no specific compaction requirements for all soils except the re-compacted tailings as described below. The crushed stone and working surface materials shall be compacted in lifts with a minimum of 3 passes of a dozer. Each lift of the compacted subgrade shall be inspected by the on-site Engineer for acceptability prior to placement of subsequent lifts.
- D. The CONTRACTOR shall dig test holes and provide access to all backfill areas at no additional compensation when requested by the ENGINEER if an area has been covered without approval or is suspected of not meeting the specifications.
- E. For each test which does not meet the specifications, the CONTRACTOR shall pay for the cost of the test and shall replace all material included in that lift or sector with acceptable material and compact to specification, at no additional compensation.
- G. Moisture Control:
- 1. Where subgrade or a layer of soil material must be moisture conditioned before compaction, uniformly apply water as necessary to surface of subgrade, or layer of soil material, in proper quantities to prevent free water appearing on surface during or subsequent to compaction operations.
 - 2. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - 3. Soil material that has been removed because it is too wet to permit compaction may be stockpiled within the impoundment or spread and allowed to dry. Assist drying by discing, harrowing, or pulverizing until moisture content is reduced to a satisfactory level.
- H. Method:
- 1. Subgrade fill shall be placed in maximum loose lift thicknesses as described in section 3.06, B and compacted with a minimum 3 passes of a static drum roller (1 TSF) or a dozer.
- I. Alternate Methods of Compaction - The CONTRACTOR may employ alternate methods of compaction if the desired degree of compaction can be successfully demonstrated to the satisfaction of the ENGINEER.

- J. Tailings and processed materials shall be graded and compacted to a uniform firm surface and in a manner to minimize large voids.

3.09 FIELD QUALITY CONTROL

- A. Processed Material from On-Site Quarry
1. Perform tests in accordance with the following:

<u>Test</u>	<u>Methodology</u>	<u>Frequency</u>
Grain Size (sieve only)	ASTM D 422	1 test/1000 CY (Min 3)

- B. Tailings Material:
1. Perform Tests in accordance with the following:

<u>Test</u>	<u>Methodology</u>	<u>Frequency</u>
Laboratory Proctor Test	ASTM D 1557	1 test/1000 CY (Min 3)
In-Place Density (92%)	ASTM 6938	1/lift/1000 square feet

- C. When tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest.

3.10 PROTECTION OF FINISHED WORK

- A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

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SECTION 31 23 10

CONTROLLED BLASTING

PART 1 — GENERAL

1.01 DESCRIPTION

A. Section includes:

1. This section describes the controlled blasting of bedrock for the on-site quarry.
2. The work to be done under this section includes furnishing all labor, equipment, materials and services and performing operations required to fragment bedrock and rock utilizing controlled blasting techniques such that: the blasted rock will be of manageable size to allow earthwork equipment to move and spread, damage is prevented to adjacent property and work, and such that resulting ground vibrations and airblast overpressures are consistently maintained below the maximum levels specified in this Section.
3. Protecting the existing adjacent property, workers, ENGINEER, OWNER and the general public from damage or injury from improper handling of explosives, flyrock, excessive ground vibrations and excessive air blast overpressure levels.
4. Furnishing, installing and implementing an audible warning system to indicate impending blasting and familiarizing workers, OWNER's Representative, ENGINEER, OWNER and the general public with the system implemented.

1.02. RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00 – Summary of Work
- B. Section 31 11 00 – Clearing and Grubbing
- C. Section 31 25 00 – Erosion and Sedimentation Control

1.03 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced. Unless otherwise noted, the latest edition of the publications shall be used. The publications are referred to within the text by the basic designation only. Comply with the applicable rules, regulations and standards established by the Regulatory Agencies, codes and professional societies listed herein, including rules and regulations for storage, transportation, and use of explosives.
- B. Whenever blasting operations are in progress, explosives shall be stored, handled and

used as provided in: the Federal Occupational Safety and Health Act of 1970 and the Construction Safety Act of 1969, as amended; Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296, Interim Final Rule; and Organized Crime Control Act of 1970, Title XI, Public Law 91-452, Approved October 15, 1970, as amended; and State of Maine, MRS Title 25, Chapter 318: Explosives and Flammable Liquids.

- C. Ensure that all explosive deliveries to work sites are done in compliance with recent rules and regulations issued by the Department of Transportation (DOT) and the Transportation Security Administration (TSA) on commercial transportation of explosives pursuant to the mandates of the USA PATRIOT ACT of 2001. Under TSA rules, commercial drivers with hazardous materials endorsement shall undergo a personal background records check, training and testing.
- D. Comply with all the applicable provisions of OSHA of 1970, 29 CFR, Section 1910.109.
- E. U.S. Code of Federal Regulations (CFR)
 - 1. CFR 27, U.S. Department of Justice, Alcohol, Tobacco, Firearms and Explosives Division (ATF). 27 CFR Part 555, Implementation of the Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule.
 - 2. Organized Crime Control Act of 1970, Title XI, Public Law 91-452, Approved October 15, 1970, as amended.
 - 3. CFR 49, Parts 100-177 (DOT RSPA); 301-399 (DOT FHA).
 - 4. Federal Occupational Safety and Health Act of 1970, as amended.
 - 5. Construction Safety Act of 1969, as amended.
- F. State Agencies:
 - 1. State of Maine Revised Statutes, MRS Title 25, Chapter 318: Explosives and Flammable Liquids.
- G. Non-regulating Industry Support Organizations:
 - 1. Vibration Subcommittee of the International Society of Explosive Engineers (ISEE), blast monitoring equipment operation standards (1999).
 - 2. IME (Institute of Makers of Explosives) Safety Library Publications (SLPs).
- H. State Agencies
 - 1. State of Maine Department of Transportation Standard Specifications, (MDOT).

1.04 DEFINITIONS

- A. **Blast Consultant:** The Blast Consultant shall be a person with extensive knowledge of noise vibration, and visual impacts of blasting operations, and who is specialized in

the detonation of explosives, particularly in the field of rock quarry operations. The Blast Consultant shall be provided by the CONTRACTOR.

1. The Blast Consultant must have at least 20 years of experience in construction blasting. They must be able to demonstrate involvement in at least five (5) projects with blasting within 200 feet of residential structures. The Blast Consultant must be able to demonstrate attendance in at least ten (10) short courses, seminars, conferences on blasting technology, or engineering class studies during the past 15 years. For the past five (5) years, the Blast Consultant must have derived their primary source of income from providing specialized blasting consulting services.
- B. Blast Control Specialist: Person authorized to act on behalf of the CONTRACTOR and licensed by the state or local regulatory agency to possess, transport, and use explosives.
- C. Blaster-in-Charge or Blasting Supervisor: The single designated and licensed person with complete responsibility and total authority over all decisions involving safe handling, use and site storage of explosives.
- D. Peak Particle Velocity (PPV): The maximum of the three ground vibration velocities measured in the vertical, longitudinal and transverse directions. Velocity units are expressed in inches per second (in/sec).
- E. Air-Overpressure: Temporary changes in ambient air pressure caused by blasting. Air-overpressure is expressed in units of psi or dB or dBL (linear decibel scale). Measurements for blasting are made with microphones having a flat frequency response for over-pressure in the 2 to 200 Hz range. A-weight or C-weight microphones shall not be used for these measurements.
- F. Occupied Building: Structure on or off construction limits that is occupied by humans or livestock.
- G. Residential Building: Includes single and multiple family dwellings, hotels, motels and any other structure containing sleeping quarters.
- H. Scaled Distance: A factor describing relative vibration energy based on distance and charge-per-delay. For ground vibration control and prediction purposes, Scaled Distance (Ds) is obtained by dividing the distance of concern (D) by the square root of the charge-per-delay (W), $D_s = D/(W)^{0.5}$. Minimum scaled distance limits are used to establish charge weights and the units of scaled distance (Ds) are ft-lb-0.5.
- I. Charge-per-Delay: For vibration control, any charges firing within any 8-millisecond time period are considered to have a cumulative effect on vibration and air-overpressure effects. Therefore, the maximum charge-per-delay (W) is the sum of the weight of all charges firing within any 8-millisecond time period. For example, if two 10-lb. Charges fire at 100 ms and one 15-lb charge fires at 105 ms, the maximum charge per delay would be 35 lbs.

- J. Production Holes: Blast holes in the main body of the rock mass being removed by drilling and blasting.
- K. Stemming: Crushed stone, tamped clay or other inert earth material placed in the unloaded collar area of blast holes for the purpose of confining explosive charges and limiting rock movement and air-overpressure (air blast).
- L. Primary Initiation: The method whereby the blaster initiates the blast(s) from a remote and safe location. Primary initiation systems use pneumatic tubing or shock-tubes to convey firing energy from blasters to blast locations.
- M. Sub-drilling: The portion of the blast hole that is drilled below or beyond the desired excavation depth or limit. subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blast holes.
- N. Prohibited Persons: Persons prohibited from handling or possessing explosive materials as defined by the seven categories described in Section 555.11 of 27 CFR (ATF Rules).
- O. Delay: A distinct pause of pre-determined time between detonations of single charges or groups of charges.
- P. Fly Rock: Debris that is ejected or propelled through air by blast.
- Q. Frequency: Ground vibration oscillation at peak event, expressed in Hertz.
- R. Safety zones will be established and clearly delineated in the field. Safety zones are expected to include: an Exclusion Zone, Hazard Zone, Low Hazard Zone, and Safe Zone based potential rock failure planes of 50° or steeper, 40° to 50°, 30° to 40°, and flatter than 30° respectively as measured from the bottom of the South Open Cut Pit Lake.
1. The Exclusion Zone is represented as the area between the pit lake rim and the current 50° rock failure plane where no personnel or equipment would be allowed.
 2. The Hazard Zone is represented as the area between the current 40° to 50° rock failure planes where access is restricted to approved active equipment and workers. Workers would be required to be tethered off within the Safe Zone and shall not work down slope of equipment. Approved equipment would be limited to smaller equipment (less than 3 tons). No equipment or material staging will be permitted in this zone.
 3. The Low Hazard Zone is represented as the area between the current 30° to 40° rock failure planes where access is restricted to approved active equipment and workers. Workers would not be required to be tethered and approved equipment

would be limited to medium equipment (less than 10 tons). No equipment or material staging will be permitted in this zone.

4. The Safe Zone is represented as the area beyond the current 30° rock failure planes where access is not restricted. Equipment or material staging will be permitted in this zone.

1.05 QUALITY ASSURANCE

A. Codes, Permits and Regulations:

1. The CONTRACTOR shall comply with all applicable laws, rules, ordinances and regulations of the Federal Government and the State of Maine governing the transportation, storage, handling and use of explosives. All labor, materials, equipment and services necessary to make the blasting operations comply with such requirements shall be provided without additional cost to the OWNER.
2. The CONTRACTOR shall obtain and pay for all permits and licenses required to complete the work of this section.
 3. In case of conflict between regulations, or between regulations and Specifications, the CONTRACTOR shall comply with the strictest applicable codes, regulations or Specifications.

1.06 SUBMITTALS

- A. Blast Control Specialist: Submit a minimum of one (1) month prior to drilling and blasting the CONTRACTOR's Blast Control Specialist. Blast Control Specialist shall be persons responsible for blasting and pre-blasting services shall be licensed blasters in the State of Maine and shall have had acceptable experience in similar excavations in rock and controlled blasting techniques. The Blast Control Specialist shall have a minimum of ten (10) years experience with blast design and vibration and air-blast monitoring, and significant involvement as the Blast Control Specialist in a minimum of ten (10) previous projects of similar nature. The Blast Control Specialist shall be a licensed blaster in the State of Maine and shall be subject to the approval of the Blast Consultant.
- B. Blasting Plan and Blasting Schedule.
 1. One month prior to commencing drilling and blasting operations, the CONTRACTOR shall submit a Blasting Plan, reviewed and approved by the Blasting Consultant, to the ENGINEER for review. The Blasting Plan shall contain the details of the drilling and blasting patterns and controls proposed for both the controlled and production blasting. The Blasting Plan shall contain the following minimum information:
 - a. Details of the drilling equipment to be used and detailed description of method to safely perform the controlled blasting.

- b. Means and methods to tether and cable off workers/personnel and equipment while working in each safety zone.
 - c. Station limits of proposed shot, the number of blasts, and time of each blast.
 - d. Plan and section views of proposed drill pattern indicating hole size, hole depths and angles, hole pattern and spacing and expected rock types.
 - e. Drill hole diameters (preshear, productions) and depth, including subdrilling depths.
 - f. Drill steel diameter and bit types.
 - g. Stemming length and type of material used for stemming.
 - h. Loading details including trade names, types, sizes of explosives.
 - i. Average bench height.
 - j. Proposed initiation and delay sequence of blast holes.
 - k. Weight of explosives per hole and per delay and powder factors, including weight of explosives per square yard of finished backslope.
 - l. Anticipated vibration levels and peak particle velocities at locations specified by the ENGINEER.
 - m. Anticipated blast decibel level at nearest dwelling.
 - n. Methods of matting or covering of the blast area to prevent flyrock and excessive airblast overpressure.
 - o. Details of an audible advance signal system to be employed at the job site as a means of informing workers, ENGINEER, OWNER and the general public that a blast is about to occur.
2. At any time the CONTRACTOR proposes to change the drilling or blasting methods, the CONTRACTOR shall submit a revised Blasting Plan for the affected Work not later than one (1) week prior to the proposed commencement of the change in the Work.
 3. The Blasting Plan submittal is for quality control and record-keeping purposes. Review of the Blasting Plan by the ENGINEER or Blasting Consultant shall not relieve the CONTRACTOR of their responsibility for the accuracy and adequacy of the plan when implemented in the field.
- C. The CONTRACTOR shall submit the following information to the ENGINEER at least one month prior to commencing drilling and blasting operations:
1. Written evidence of the licensing, experience and qualifications of the blasters who will be directly responsible for the loading of each shot and for firing it.
 2. Name and qualifications of the person(s) responsible for designing and directing the blasting.
 3. Name and qualifications of the person(s) responsible for conducting pre-blast condition surveys.
 4. Submit a copy of the blasting permit(s) obtained to conduct blasting on the site.
 5. Pre-blast condition survey, as described in Paragraph 1.05.A herein.

D. Progress Submittals:

1. The CONTRACTOR shall report to the ENGINEER in writing all blasting complaints received by the CONTRACTOR within 24 hours of receipt. Each blast complaint report shall include the name and address of the complainant, time received, date and time of blast complained about, and a description of the circumstances which led to the complaint.

1.07 PRE-BLAST CONDITION SURVEY

- A. Prior to start of earth/rock excavation or blasting work, the CONTRACTOR shall conduct a pre-blast condition survey of all existing structures within ¼ mile of the site. This survey shall extend to such structures or conditions as may be affected by the CONTRACTOR's construction operations.
 1. Coordinate activities, issue notices, obtain clearances and provide whatever photographic and secretarial assistance is necessary to accomplish the survey.
 2. Give notice in writing, to the owner of the property concerned, tenants of the property and any representative of local authorities required to be present at such survey. Advise in notice the dates on which surveys are to be made so that they may have representatives present during the examination. Provide copies of all notices to the OWNER and ENGINEER.
 3. As a minimum, all buildings within ¼ mile of anticipated rock blasting shall be given detailed examination.
- B. Observations shall be recorded during the survey of the existing conditions for houses, garages, commercial buildings, and other structures which might be affected by the Work of the Contract.
 1. The survey shall consist of a description of the interior and exterior condition of the various structures examined. Descriptions shall locate any cracks, damage, or other defects existing and shall include such information so as to make it possible to determine the effect, if any, of the construction operations on the defect. Where significant cracks or damage exists, or for defects too complicated to describe in words, photographs shall be taken and made part of the record.

2. CONTRACTOR's record of the pre-blast condition survey shall consist of written documentation and photographs of the conditions identified, or a good quality videotape survey, with audio descriptions of defects. Prior to start of Work, the CONTRACTOR's record shall be submitted to the ENGINEER for review.
- C. Upon completion of all earth/rock excavation and blasting work, the CONTRACTOR shall make a similar examination of properties, structures, and conditions where complaints of damage have been received or damage claims have been filed. Give notice to all interested parties so that they may be present during the final examination.

1.08 INDEMNITY

- A. Notwithstanding full compliance with these specifications, approval of blasting plan, and successful limitation to maximum peak particle velocity and airblast overpressure noted herein, the CONTRACTOR shall be solely responsible for any damage, direct or indirect, arising from blasting and shall hold the OWNER, ENGINEER, and their consultants harmless from any costs, liens, charges, claims or suits, including the costs of defense, arising from such damage, real or alleged. The OWNER, the ENGINEER, and their consultants shall be additionally-named insured's on any insurance policy covering blasting carried by the CONTRACTOR, and this requirement shall also be enforced on any subcontractor.

1.09 JOB CONDITIONS

A. Protection:

1. Should uncharted piping or other utilities be encountered during excavation, consult the OWNER and ENGINEER immediately for direction.
2. Barricade and/or install warning signs or lights as required for protection from open excavations occurring as part of this Work. If warning lights are used, operate warning lights during hours from dusk to dawn each day and as otherwise required.

B. Dust Control:

1. Use means necessary to control dust on and near the Work and on and near all borrow areas if such dust is caused by operations during performance of the Work.
2. Thoroughly treat all surfaces as required to prevent dust from being a nuisance or health risk to the workers, public, neighbors, and concurrent performance of other work on the site.
3. Conduct air monitoring as required in work plans and/or work permits.

PART 2 — PRODUCTS

Not used.

PART 3 — EXECUTION

3.01 SAFETY PRECAUTIONS

- A. Clearing the Danger Area Before Blasting: No blasting shall be permitted until all personnel in the danger area have been removed to a place of safety. A loud, audible, warning system, devised and implemented by the CONTRACTOR, shall be sounded before each blast. The CONTRACTOR shall familiarize all personnel on the project, ENGINEER, OWNER, and their consultants and the general public with the implemented system. The danger area shall be patrolled before each blast to make certain that it has been completely cleared and guards shall be stationed to prevent entry until the area has been cleared by the blaster following the blast.
- B. Explosives shall be stored, handled and employed in accordance with Federal, State and local regulations.
- C. No explosives, caps, detonators or fuses shall be stored on the site during non-working hours.
- D. The CONTRACTOR shall be responsible for determining other safety requirements unique to blasting operations on this particular site so as not to endanger life, property, utility services, existing or new construction, or property adjacent to the site.
- E. No requirement of, or omission to require, precautions under this Contract shall be deemed to limit or impair responsibility or obligations assumed by the CONTRACTOR under or in connection with this Contract; and the CONTRACTOR shall at all times maintain adequate protection to safeguard the public and all persons engaged in the work, and shall take such precautions as will accomplish such end, without undue interference to the public. The CONTRACTOR shall be responsible for and pay for damage to adjacent structures resulting from work executed under this Section.

3.02 GENERAL BLASTING PROCEDURES AND RECORDS

- A. Blasting shall be limited to between the hours of 8:00 a.m. and 4:00 p.m., Monday through Friday, unless prior written permission is received from the ENGINEER to blast at other times.
- B. The CONTRACTOR shall notify the ENGINEER at least 48 hours before blasting operations are to commence.
- C. Blasting mats shall be used to cover each blast round in order to prevent the throw of flyrock and minimize airblast overpressure.

- D. The CONTRACTOR shall conduct blasting operations such that damage is prevented to adjacent structures, property and work, and such that peak particle velocity and airblast overpressure levels do not exceed the maximum specified limits at the locations specified.
- E. Keep accurate records of each blast. Blasting records shall be available to the District's Representative at all times and shall contain the following data as a minimum:
1. Blast identification by numerical and chronological sequence.
 2. Location (referenced to pipeline stationing), date and time of blast.
 3. Type of material blasted.
 4. Number of holes, burden and spacing.
 5. Diameter and depth of holes.
 6. Height or length of stemming.
 7. Types of explosives used.
 8. Types of caps and delay periods used.
 9. Total amount of explosives used.
 10. Maximum amount of explosives per delay period of 9 milliseconds or greater.
 11. Powder factor (pounds of explosive per cubic yard of material blasted).
 12. Method of firing and type of circuit.
 13. Weather conditions (including wind direction).
 14. Direction and distance to nearest structure or position of concern.
 15. Type and method of instrumentation.
 16. Location and placement of instruments by plotting numbered locations on scaled maps to within +/- 1 foot where the equipment was placed.
 17. Instrumentation records and calculations for determination of ground motion particle velocity or for charge size based on scaled distance.
 18. An ongoing log-log plot of both vibration and air blast data. The CONTRACTOR or his consultant shall maintain an ongoing log-log plot of both ground vibration and air blast overpressures, and shall submit an updated plot to the District's Representative after each blast, highlighting the newest data.
 19. Measures taken to limit air overpressure and fly rock.
 20. Any unusual circumstances or occurrences during blast.
 21. Name of CONTRACTOR.
 22. Name, license number and signature of responsible Blasting Supervisor.
 23. Summary report of all complaints including complaints regarding blasting-related damage.
 24. Method to notify other CONTRACTORS, personnel on-site of a scheduled blast.
 25. Provide a summary report of all complaints, including complaints regarding blast-related damage.
 26. Within 24 hours after each blast, CONTRACTOR shall

submit to the District's Representative a summary report addressing items 1 through 25 above for compilation in a three-ring binder and have the CONTRACTOR's current blast reports so compiled and available for immediate review by authorities having jurisdiction, including the District and the District's Representative.

3.03. **BLASTING LIMIT CRITERIA:**

1. Peak Particle Velocity Limits:

- a. The CONTRACTOR shall conduct all blasting activity in such a manner that the peak particle velocity of ground vibration does not exceed the following:

<u>Distance from Blast (Ft.)</u>	<u>Maximum Allowable Peak Particle Velocity (in/sec.)</u>
300	2

2. Airblast Overpressure Limit:

The CONTRACTOR shall conduct all blasting activity in such a manner that the peak airblast overpressure measured at the location of the nearest above ground, occupied structure to blasts does not exceed 0.014 psi.

- D. The CONTRACTOR shall be completely responsible for all damages resulting from the blasting operations and shall, as a minimum, take whatever measures are necessary to maintain peak airblast overpressure and peak particle velocities within the specified limits. Modifications to blasting and excavation methods required to meet these requirements shall be undertaken at no additional cost to the OWNER.

END OF SECTION 31 23 10

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SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work for this item includes dewatering wells, well point systems and/or sumps piping, valves, and appurtenances. The CONTRACTOR may elect to supplement the dewatering systems with sumps to accelerate dewatering. The CONTRACTOR should allow for placement of a limited number of sumps in localized areas. The objective is to maintain the groundwater at a minimum of 2 feet below the base of the excavations and subgrade layer to allow for placement and compaction of the backfill in adequately dry conditions.
- B. The dewatering system will discharge to the treatment wetlands in a manner that provides for retention purposes of settlement followed by bag filters to remove solids prior to discharge to the treatment wetlands.
- C. The dewatering system will operate as required. Dewatering is to be conducted in conjunction with the installation the EQ vertical drains, working surface installation, and subgrade filling operations. As subgrade filling occurs, dewatering of the mine tailings will occur through the EQ drains which must be managed through collection sumps to allow for backfilling in dry conditions.
- D. Work for this item includes all labor, materials, and equipment to operate and maintain the Dewatering System.
- E. The CONTRACTOR shall furnish all labor, equipment, and materials necessary for the control and collection of ground and surface water: discharged from EQ drains and entering trenches and/or excavations Work includes, but is not limited to, the following:
 - 1. Design dewatering sump and pumping system required to perform the work;
 - 2. Furnishing, operating, and maintaining dewatering equipment;
 - 2. Temporary on-site storage and containment of all water collected from dewatering operations; and
 - 3. Removal of temporary works.
- B. On-site treatment of all water collected is to occur in treatment wetlands.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00: Summary of Work.
- B. Section 01 33 00: Submittal Procedures.
- C. Section 31 23 00: Earthwork.
- D. Section 31 25 00: Erosion and Sedimentation Control.
- E. Section 33 20 00: Vertical Earthquake Drains

1.03 SUBMITTALS

- A. The following shall be submitted to the ENGINEER (for review) in accordance with Section 01 33 00, “Submittal Procedures”, at least 10 days prior to beginning excavation in areas where dewatering may be required or where required by the ENGINEER due to changed or unforeseen conditions:
 - 1. Qualifications and relevant project experience of proposed dewatering personnel/subcontractor, as applicable.
 - 2. Dewatering plan, including means, methods, equipment, layout plan, discharge location, expected daily volumes, and schedule.
 - 3. Water management plan, including means/methods of collection, pumping, storage, details of the discharge methods(s), and proposed schedule.
 - 4. Product/material information, data, and/or specifications.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The CONTRACTOR will provide, operate, and maintain a dewatering system to remove water from EQ drains, subgrade filling, excavations, and trenches using sumps, pumps, drains, well points, piping, and any other facilities necessary to keep excavations and trenches free of water to the extent that is required to facilitate and complete construction.
 - 1. Have spare units available for immediate use in the event of equipment breakdowns.

2.02 MATERIALS

- A. Dewatering Equipment and Supplies:
 - 1. As necessary, best adapted to site-specific design requirements.
- B. Storage Containers:
 - 1. As necessary, best adapted to site-specific design requirements.
 - 2. In accordance with applicable Federal and State regulations.
- C. Water treatment equipment and plant operation.
- D. Minimum requirements specified on drawings and in permits. CONTRACTOR shall independently verify, and design all system components.

PART 3 - EXECUTION

3.01 PERFORMANCE

A. General:

1. Mechanically retard and control the rate of run-on and runoff at the construction site. This includes construction of diversion ditches, benches, and berms to retard and divert run-on away from the area of work and runoff to protected drainage courses. Stormwater from the site shall be diverted, to the extent practicable, to minimize infiltration into the working surface, subgrade fill, or open excavations and to avoid contact with contaminated materials.
2. Keep excavations and trenches dry until the structures, pipes, and appurtenances to be built therein have been completed to such an extent that they will not be damaged.
3. Perform dewatering work when necessary to keep excavations dry and/or to provide for stability of excavations, including but not limited to the stability of excavation sidewalls; the stability of excavation sheeting, shoring, and/or bracing; the stability of the excavation bottom relative to pumping, heaving, boiling, and/or rutting; and the stability of embankment slopes.
4. Dewater excavations prior to beginning excavation work so as to minimize the moisture content of the excavated materials.
5. Operate the contingent groundwater removal system, as necessary, and if available, to maintain groundwater at acceptable levels during remedy implementation.

B. Damage:

1. All damage resulting from the dewatering operations or the failure of the CONTRACTOR to maintain the work in a suitable dry condition shall be repaired by the CONTRACTOR, at no additional cost to Honeywell.
2. Take all necessary precautions to protect new work and non-work areas from flooding or erosion during storms or from other causes.

3.02 CONSTRUCTION DEWATERING

A. General:

1. Dewater excavations and other parts of the construction site and keep free of standing water or excessively muddy conditions as needed for proper execution of the Work.
2. Furnish, install, operate, and maintain all drains, sumps, pumps, and other equipment needed to perform the dewatering as specified.

B. Diversion Berms:

1. Design, construct, maintain, and remove diversion berms where necessary for diverting runoff away from open excavations and trenches to minimize the generation of waste water

2. Design and construct diversion berms to withstand all imposed loads to prevent injury to adjacent structures or property.
 3. Maintain berms to minimize water ponding, through re-routing or pumping surface water away from bermed areas
- C. Temporary Underdrains:
1. When necessary, lay temporary underdrains in the working surface.
 2. Excavate trenches to suitable dimensions to provide space for the underdrains and surrounding gravel.
 3. Install underdrains a distance of at least 3 inches below the bottom of any pipe or structure.
 4. Temporary underdrain pipe shall be vitrified clay, concrete, ADS, PE, or PVC pipe of standard thickness with open joints wrapped in geotextile fabric to prevent the admission of sand and other soil.
 - a. Sewer pipe of the quality known as “seconds” is acceptable for use as temporary underdrain pipe.
 5. Entirely surround the underdrain pipe and fill the space between the underdrain and the pipe or structure with crushed stone.
 6. Compact the crushed stone and leave the surface suitable for laying the pipe or building the structure.
- D. Cofferdams:
1. Design, construct, maintain, and remove cofferdams where necessary for the dewatering, control, and diversion of water to keep excavations and trenches free of water.
 2. Construct cofferdams to depths to permit a reasonable change in depths of the work, of sufficient height to prevent flooding, and of such dimensions to give sufficient clearance for construction and inspection.
 3. Remove cofferdams after the completion of permanent construction.
- E. Well Points:
1. If required, dewater the excavations via a well point system.
 2. Use well points designed for dewatering work.
 3. Use pumping units designed to be used with well points, capable of maintaining high vacuums, and capable of handling large volumes of air and water at the same time.
- F. EQ Drains:
1. Refer to Section 33 20 00 - Vertical Earthquake Drains for requirements for dewatering using vertical EQ drains.

3.03 TEMPORARY ON-SITE STORAGE/CONTAINMENT

- A. Excavation dewatering waste shall be collected and stored on-site until treatment and discharge can occur. Storage shall be in a suitable enclosed tank such as a Frac, Baker Tank, modutank or equal.

1. On-site storage shall be capable of handling the capacity of the anticipated construction dewatering liquid in addition to other collected liquid wastes including decontamination water, well development water, and contaminated stormwater.
2. Store water in an area as approved by the ENGINEER.
4. CONTRACTOR shall verify storage requirements, based on information provided in permit applications.

3.04 ON-SITE TREATMENT

- A. All water that potentially comes in contact with mine tailings, shall be treated through the on-site wetlands prior to discharge to surface waters.

--END OF SECTION--

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SECTION 31 25 00

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section provides requirements for the preparation and approval of an Erosion and Sediment Control Plan. The Erosion and Sediment Control Plan shall provide measures to be provided and maintained throughout the construction activities in accordance with Maine Erosion and Sediment Control BMPs, the Contract drawings, and other relevant requirements.
- B. This Section provides requirements for furnishing, installing, and the inspection and maintenance of erosion control measures during earth disturbing activities.
- C. Provide materials, equipment, and labor necessary for the installation, inspection, and maintenance of silt and erosion control structures as specified herein or as required to protect surface waters.
- D. At the completion of the remedial construction, provide materials, equipment, and labor necessary for the removal, transport, and disposal of silt and erosion control structures not specified to remain. Remove, transport, and dispose of sediment resulting from erosion control measures collected from disturbed areas by means consistent with the overall intent of this specification and which do not result in additional erosion.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00 – Summary of Work
- B. Section 31 11 00 – Clearing and Grubbing
- C. Section 31 23 00 - Earthwork
- D. Section 32 92 00 – Seeding

1.03 SUBMITTALS

- A. Submit the following for approval by the OWNER or ENGINEER.
- B. Submit an Erosion Prevention and Sediment Control Plan for approval by the OWNER and Maine Department of Environmental Protection (MEDEP).
- C. Verify with regulating agencies that necessary permits are in place prior to commencement of earth disturbing activities. Prepare and submit any additional documentation required for approval.

- D. Provide material submittals for all major components of erosion and sediment control measures, including but not limited to: mulch, soil stabilization blankets, and silt fence.

1.04 STORMWATER EROSION AND SEDIMENT CONTROL GUIDELINES

- A. Maine Erosion and Sediment Control BMPs, by the Bureau of Land Management and Water Quality, Maine Department of Environmental Protection, 2003.
- B. State of Maine Department of Environmental Protection. General Permit for Construction Activity, Maine Pollution Discharge Elimination System, 2006.

1.05 EROSION AND SEDIMENT CONTROL PLAN

- A. The CONTRACTOR shall develop an Erosion and Sediment Control Plan for the Work. The Erosion and Sediment Control Plan shall be approved by the OWNER and approving local/state authority. The Erosion and Sediment Control Plan shall provide measures to be installed and maintained throughout the construction activities in accordance with Maine Erosion and Sediment Control BMPs Standards and Specifications, the contract drawings, and other relevant requirements. The CONTRACTOR shall follow the approved The Erosion and Sediment Control Plan during the execution of the Work.
- B. The CONTRACTOR shall provide erosion and sediment control measures throughout the construction activities as required by Maine Erosion and Sediment Control BMPs Standards and Specifications.
- C. The CONTRACTOR shall notify the OWNER and approving local/state authority if applicable one week prior to the pre-construction conference, one week prior to the commencement of land disturbing activity, and one week prior to the final inspection.
- D. In accordance with the Maine General Permit for Construction Activity and as required by Maine stormwater regulations, during construction runoff from the Site shall not discharge run-off with turbidity exceeding regulatory requirements. The Project involves significant earthwork activities requiring appropriate best management practices (BMPs) to be installed and maintain throughout the construction activities to prevent exceedances of turbidity regulatory requirements.

1.06 REVIEW AND/OR INSPECTION OF EROSION AND SEDIMENTATION CONTROL MEASURES

- A. Construction under this Project may be subject to review and/or inspection by the appropriate local, State, and Federal agencies responsible for ensuring the adequacy of erosion and sedimentation control measures.
- B. If required, allow agents of the local/state authorities onto project work areas for inspection and cooperate with agents in addressing identified erosion and/or sediment issues. The local/state authorities may request additional measures to be provided to

minimize any on-site or off-site erosion and sedimentation control problems observed during construction. All local/state inspections and comments should be directed to the OWNER. Any local/state authority's jurisdiction inspection reports shall be documented and provided to the OWNER.

- C. Daily statements of erosion and sediment control inspections shall be provided in the CONTRACTOR's daily field reports.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Mulch:
 - 1. Straw, hay, or wood cellulose fiber mulch mulches shall meet the requirements of the Maine Erosion and Sediment Control BMPs Standards and Specifications for Mulching.
 - 2. Straw or hay mulch shall consist of late cut, matured, and cured hay or straw that is free from primary noxious weed seeds.
- B. Mulch Anchoring:
 - 1. Provide peg and twine, mulch netting, wood cellulose fiber, or tackifiers in accordance with Maine Erosion and Sediment Control BMPs Standards and Specifications for Mulching.
 - 2. Nettings shall be 100% degradable.
 - 3. Tackifier shall consist of commercially developed products for tacking of hay or straw. Binder shall be free of refuse, physical contaminants, and materials toxic to plant growth.
- C. Seed for Erosion Control:
 - 1. Provide annual ryegrass or winter rye depending on time of year in accordance with Maine Erosion and Sediment Control BMPs Standards and Specifications for Temporary Critical Area Plantings.
- D. Silt Fence:
 - 1. Provide in accordance with Maine Erosion and Sediment Control BMPs Standards and Specifications for Silt Fence.
 - 2. Silt fence shall consist of Envirofence, as manufactured by Mirafi Inc., (or an approved equal) having an equivalent opening size of 30 (or an approved equal).
 - 3. At critical locations, or as indicated or directed by the OWNER, provide hog or chicken wire reinforcing with 6-inch or smaller openings or provide an approved integral silt fence and plastic mesh reinforcing, as necessary.
- E. Fertilizer: Refer to Section 32 92 00 - Seeding.
- F. Lime: Refer to Section 32 92 00 - Seeding.
- G. Permanent Seeding: Refer to Section 32 92 00 - Seeding.

PART 3 - EXECUTION

3.01 PERFORMANCE

A. General:

1. The CONTRACTOR shall implement and maintain erosion and sedimentation control measures which effectively prevent accelerated erosion and sedimentation.
2. Earthmoving activities shall be conducted in such a manner as to prevent accelerated erosion and sedimentation.
3. Land disturbance shall be kept to a minimum.
4. The erosion and sediment control measures shall be constructed in accordance with the Maine Erosion and Sediment Control BMPs Standards and Specifications.
5. Temporary erosion and sediment control measures shall be installed as the first step in construction, shall be continuously maintained, and shall not be removed until permanent cover is completely established and stabilized.
6. Removal of temporary erosion and sediment control measures requires the approval of the OWNER, at a minimum.
7. The following work areas will require erosion and sediment control measures:
 - a. Perimeters of soil excavations, filling, and/or grading areas;
 - b. Pipe trenching;
 - c. Drainage swales or ditches;
 - c. Constructed wetlands or other re-vegetated areas;
 - d. Temporary stockpile areas; and
 - e. Any other disturbed areas.
8. Furnish and place silt fence, hay bales, etc. as temporary erosion and sedimentation control devices at locations as shown on the Drawings or as conditions warrant to control erosion.
9. Erosion control measures shall be employed to protect the site within the limit of work and any adjacent surface waters, drainage ways, or wetlands.
10. Permanent erosion control measures shall be installed within 7 days of completion of finish grading activities. Areas to be completed with a vegetative cover shall be seeded and mulched.

B. Diverting Surface Water:

1. Build, maintain, and operate berms, channels, flumes, sumps, and other temporary diversion and protection works needed to divert surface water through or around the construction site and away from the construction work while construction is in progress.
2. Storm runoff from disturbed areas must discharge through temporary erosion control measures prior to discharge into a natural drainage way.

- C. Erosion Control Provisions (as necessary):
1. Protect areas where existing banks are to be disturbed by constructing straw/hay bale or earth dikes at the top of slope to divert storm runoff from the disturbed area or at the toe of the slope to retain sediments, as conditions permit.
 2. Contain discharge from any necessary pumping operations during dewatering operations with a dike constructed to prevent siltation of down gradient areas. Protect the discharge pipe outlet area against erosion by flowing water through a rock or timber apron.
 3. Prior to removal of sediment barriers, remove retained silt or other materials at no additional cost to the contract.
- D. Seed for Erosion Control:
1. Temporary Seeding: Minimum application rate shall be in accordance with Maine Erosion and Sediment Control BMPs Standards and Specifications for Temporary Critical Area Plantings, based seed mix and on seeding dates.
- E. Mulching:
1. Apply Straw or hay mulch shall at 2 ton/acre (90 lbs/1000sq.ft.) or such that over 90% surface coverage is provided.
 2. Straw or hay mulch shall be anchored with 100% biodegradable methods:
 - a. Wood cellulose fiber: Apply with hydroseeder immediately after mulching. Use 500 to 750 lbs (11 to 17 lbs/1000sq.ft.) wood fiber per acre.
 - b. Mulch Netting: Staple the light-weight paper, jute, wood fiber, or plastic nettings to soil surface according to manufacturer's recommendations. Must be biodegradable and suitable for foot traffic. To avoid wildlife entanglement, netting with fused joints is not approved.
 - c. Peg and Twine: After mulching, divide areas into blocks approximately 1 sq. yd. in size. Drive 4-6 pegs per block to within 2" to 3" of soil surface. Secure mulch to surface by stretching twine between pegs in crisscross pattern on each block. Secure twine around each peg with 2 or more tight turns. Drive pegs flush with soil.
 - d. Tackifier: Mix and apply polymeric and gum tackifiers according to manufacturer's instructions. Avoid application during rain. A 24-hour curing period and a soil temperature higher than 45 degrees Fahrenheit are required.
- E. Silt Fence: Install down gradient from disturbed locations as shown on the Drawings or as directed by the OWNER. Install per Maine Erosion and Sediment Control BMPs Standards and Specifications for Silt Fence and manufacturer's requirements.
- F. Hay bales for Erosion Control:
1. Place as shown on Drawings or as conditions change and additional controls are needed to provide for temporary control of erosion or pollution or both.
 2. Stake bales with the required stakes.

- G. Other Sediment Barriers: Sediment barriers constructed from berms of erosion control mix, compost/bark, or compost-filled filter socks maybe used at locations suitable for their use and as approved by the OWNER.

3.02 MAINTENANCE

A. General

1. Erosion and sediment control activities shall be conducted in accordance with the approved SESCO.
2. Erosion and sedimentation control measures shall be inspected by the CONTRACTOR on a daily basis, immediately prior to forecasted precipitation events, and at least twice daily during prolonged rainfall events. Repair and/or maintenance of erosion and sedimentation control measures will be made as soon as needed.
3. Maintain the integrity of erosion control measures throughout construction period, including during any shut-down period.
4. All access roads shall be maintained during construction in a smooth and passable condition. Rutting, potholes, displacement of gravel and ditching for drainage shall be maintained in a manner acceptable to the OWNER. At the end of the Project all areas of access roads including shall be returned to acceptable pre-construction condition.

END OF SECTION

SECTION 31 35 26.15

GEOSYNTHETIC CLAY LINER

PART 1 - GENERAL

1.01 SUMMARY

- A. This specification covers the technical requirements for the Manufacturing and Installation of the fabric encased geosynthetic clay liner (GCL). All materials meet or exceed the requirements of this specification, and all work will be performed in accordance with the procedures provided in these project specifications.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
1. ASTM D 4632, "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles"
 2. ASTM D 4643, "Determination of Water (Moisture) Content of Soil by the Microwave Oven Method"
 3. ASTM D 5261, "Standard Test Method for Measuring Mass Per Unit Area of Geotextiles"
 4. ASTM D 5321, "Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method"
 5. ASTM D 5887, "Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter"
 6. ASTM D 5888, "Standard Guide for Storage and Handling of Geosynthetic Clay Liners"
 7. ASTM D 5890, "Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners"
 8. ASTM D 5891, "Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners"
 9. ASTM D 5993, "Standard Test Method for Measuring Mass Per Unit of Geosynthetic Clay Liners"
 10. ASTM D 6102, "Standard Guide for Installation of Geosynthetic Clay Liners"
 11. ASTM D 6243, "Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method"
 12. ASTM D 6496, "Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners"
 13. ASTM D 6768, "Standard Test Method for Tensile Strength of Geosynthetic Clay Liners"

1.03 DEFINITIONS

- A. Geosynthetic Clay Liner (GCL) - A factory manufactured hydraulic barrier consisting of granular sodium bentonite clay, sandwiched between, supported and encapsulated by two geotextiles, held together by needlepunching.
- B. Geotextile - A semi-permeable woven or nonwoven fabric used to contain the bentonite used in a GCL.
- C. Sodium Bentonite - The high swelling clay component of GCLs consisting primarily of the mineral Montmorillonite.
- D. Needlepunching - A GCL manufacturing process whereby boards of barbed needles incorporate the staple fibers from a nonwoven geotextile, through a sodium bentonite clay layer, into the matrix of a second geotextile layer.
- E. Thermal Fusing - A needlepunching enhancement process utilizing heat to bond the needlepunched fibers and more permanently lock them into the second geotextile to increase the internal shear strength characteristics.
- F. Minimum Average Roll Value (MARV) - The minimum average value of the material in a particular lot calculated as the mean of the tested values minus two standard deviations providing a 95% confidence level.

1.04 SUBMITTALS

Submit the following in accordance with Section 01330, “Submittal Procedures”.

- A. Pre-Award
 - 1. Manufacturer’s Quality Control Manual
 - 2. Manufacturer’s Product Datasheet for proposed material
 - 3. Project Reference List for GCL consisting of at least ten projects totaling 10 million square feet in size.
 - 4. A representative sample, approximately 3” x 5” of proposed GCL
- B. Post-Award
 - 1. Prior to shipping material to site
 - a. Certification of quality control tests from manufacturer on GCL product
 - b. Certification of quality control tests from manufacturer on Bentonite
 - 2. Prior to installing GCL
 - a. Certification signed by the CONTRACTOR and CQA Inspector of subgrade acceptance
 - 3. Upon completion of GCL installation
 - a. Certification by Installer that the GCL was installed per project specifications
 - b. Material and Installation Warranties
 - c. As-built drawings showing actual GCL placement

1.05 QUALIFICATIONS

- A. Manufacturer
 - 1. GCL shall be manufactured by the following:
 - a. GSE Lining Technology, Inc.
 - b. CETCO Lining Technologies
 - c. ENGINEER approved equal
 - 2. MANUFACTURER shall have manufactured a minimum of 10 million square feet of GCL during the last year.
- B. Installer
 - 1. Installer shall have experience installing GCLs on at least 5 projects and have installed a minimum of 2 million square feet of GCL materials.
- C. QC Laboratory:
 - 1. The QC laboratory shall have provided QC and/or QA testing of the proposed GCL for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.06 DELIVERY, STORAGE & HANDLING

- A. General: Conform to the MANUFACTURER'S requirements and ASTM D5888 unless otherwise specified.
- B. Delivery:
 - 1. Deliver material to the site only after the CQA Inspector accepts required submittals.
 - 2. Material shall be covered with a waterproof plastic covering resistant to ultraviolet degradation.
 - 3. Ship less than one month prior to scheduled installation unless otherwise approved by the ENGINEER.
 - 4. Each roll shall be marked with the following information:
 - a. manufacturer's name
 - b. product identification
 - c. roll number
- C. Handling:
 - 1. The QCA inspector shall verify that proper handling equipment exists which does not pose any danger to installation personnel or risk of damage or deformation to the liner material itself. Suitable handling equipment is described below:
 - a. Spreader Bar Assembly - A spreader bar assembly shall include both a core pipe or bar and a spreader bar beam. The core pipe shall be used to uniformly support the roll when inserted through the GCL core while the spreader bar beam will prevent chains or straps from chafing the roll edges.
 - b. Stinger - A stinger is a rigid pipe or rod with one end directly connected to a forklift or other handling equipment. If a stinger is used, it should be

fully inserted to its full length into the roll to prevent excessive bending of the roll when lifted.

- c. Roller Cradles - Roller cradles consist of two large diameter rollers spaced approximately 3 inches apart, which both support the GCL roll and allows it to freely unroll. The use of roller cradles shall be permitted if the rollers support the entire width of the GCL roll.
- d. Straps – A properly structured and supported pole or “carpet puller” can be used to unload GCL rolls onsite. As an alternative, straps that are appropriately rated can be used as an approved lifting method to unload GCL rolls.

D. Storage:

1. Store rolls in space allocated by CONTRACTOR. Space should be at high ground level or elevated above ground surface.
2. Stack no more than 3 rolls high.
3. Protect rolls from UV, precipitation, other sources of moisture, mud, dirt, dust, puncture, cutting or any other damaging or deleterious conditions.
4. An additional tarpaulin or plastic sheet shall be used over the stacked rolls to provide extra protection for GCL material stored outdoors.
5. Preserve integrity and readability of roll labels.
6. Bagged bentonite material shall be stored and tarped next to GCL rolls unless other more protective measures are available. Bags shall be stored on pallets or other suitably dry surface which will prevent undue prehydration.

E. GCL Inspection upon Delivery:

1. Each roll shall be visually inspected when unloaded to determine if any packaging or material has been damaged during transit.
2. Repairs to damaged GCL shall be performed in accordance with Section 3.07 of this specification.
 - a. Rolls exhibiting damage shall be marked and set aside for closer examination during deployment.
 - b. Minor rips or tears in the plastic packaging shall be repaired with moisture resistant tape prior to being placed in storage to prevent moisture damage.
 - c. GCL rolls delivered to the project site shall be only those indicated on GCL manufacturing quality control certificates.
 - d. For needlepunched GCLs, the presence of free-flowing water within the packaging shall require that roll to be set aside for further examination to ascertain the extent of damage, if any. Free-flowing water within the packaging of unreinforced GCLs shall be cause for rejection of that roll.

1.07 WARRANTY

- A. Material shall be warranted, on a pro-rata basis against Manufacturer’s defects for a period of 5 years from the date of geomembrane installation.
- B. Installation shall be warranted against defects in workmanship for a period of 1 year from the date of geomembrane completion.

PART 2 PRODUCT

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2.01 QUALIFICATIONS

- A. The GCL product supplied to the project shall be in full accordance with the requirements of this section.
- B. The GCL shall be manufactured by mechanically bonding the geotextiles using a needlepunching process as described in Section 1.03 to enhance frictional and internal shear strength characteristics.
- C. The needlepunched GCL shall thermally heat set the nonwoven fibers where they protrude from the second geotextile (woven or nonwoven depending upon product) to more permanently secure the reinforcement in place. Other means may be used to lock the fibers in place if the process demonstrates similar performance to the thermal heat set process.
- D. In order to maintain these characteristics, no glues, adhesives or other non-mechanical bonding processes shall be used in lieu of the needlepunch process. Their use to enhance the physical properties of the GCL is permitted.

2.02 MATERIALS

- A. Acceptable GCL Products:
 - 1. CETCO Bentomat 200ST
 - 2. GSE BentoLiner NSL
 - 3. ENGINEER approved alternative
- B. Alternative Materials
 - 1. Prior to considering an alternative GCL material, the Contractor shall submit certified test results and statements of quality from the proposed GCL supplier to the ENGINEER, indicating without exception that the proposed GCL meets the requirements of this specification. Submittals shall be delivered to the ENGINEER.
 - 2. In areas where a soil bentonite plug is shown on the inboard site of the hydraulic barrier wall, as shown on the drawings, the following soil bentonite mix will be used to create the plug:
 - a. American Petroleum Institute (API) Standard 200 Mesh Bentonite
90 bbl yield
Premium Na (Sodium) Montmorillonite
 - b. Mix API bentonite specified above with clean sand
 - c. 90% Sand to 10% Bentonite

2.03 GCL PHYSICAL PROPERTIES

- A. The GCL material shall be in accordance with the test methods, test frequencies and material physical properties as listed in Table 1.
- B. Interface Strength Requirements: In addition to the general material properties requirements, the Manufacturer shall provide GCL material meeting the following minimum project-specific interface strength requirements when required:

For Use on 5% (or less) Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Geomembrane / GCL	8 degrees	7 degrees
GCL / Subgrade	8 degrees	7 degrees

For Use on 20% Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Geomembrane / GCL	16.5 degrees	15 degrees
GCL / Subgrade	16.5 degrees	15 degrees

For Use on 33% Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Geomembrane / GCL	23.5 degrees	21.5 degrees
GCL / Subgrade	23.5 degrees	21.5 degrees

- C. Dimensions - The minimum acceptable dimensions for the GCL panels shall be 10 feet wide and 125 feet long.
- D. Overlap_Markings - A minimum overlap guide-line and a construction match-line delineating the overlap zone shall be imprinted with non-toxic ink on both edges of the GCL panel to ensure the accuracy of the seam. These lines shall be used during CQA to ensure the minimum overlap is achieved. The minimum overlap guideline shall indicate where the edge of the panel must be placed in order to achieve the correct overlap for each panel.
- E. The GCL will have seam overlaps a minimum of 6 inches for all woven/nonwoven GCLs. GCL's comprised of a nonwoven/nonwoven geotextiles will have a minimum seam overlap of 6 inches for scrim reinforced and 12 inches minimum for all non-scrim reinforced nonwoven GCLs. End of panel or butt end seams shall be a minimum of 12 inches for all woven/nonwoven GCLs, 12 inches for all scrim-reinforced double nonwoven GCLs, and 24 inches for non-scrim reinforced double nonwoven GCLs.
- F. Accessory Bentonite - Any accessory bentonite used for sealing seams, penetrations, or repairs, shall be the same granular bentonite as used in the production of the GCL itself.

Table 1. GCL Properties

TESTED PROPERTY	TEST METHOD	FREQUENCY	VALUE (ENGLISH)	VALUE
GEOTEXTILE PROPERTY				
Cap Nonwoven, Mass/Unit	ASTM D 5261	1/200,000 ft ² (1/20,000)	6.0 oz/yd ²	200 g/m ² MARV ¹
Carrier Woven, Mass/Unit	ASTM D 5261	1/200,000 ft ² (1/20,000)	3.1 oz/yd ² MARV	105 g/m ² MARV
BENTONITE PROPERTY				
Swell Index	ASTM D 5890	1/100,000 lb (50,000 kg)	24 ml/2 g min	24 ml/2 g min
Moisture Content	ASTM D 4643	1/100,000 lb (50,000 kg)	12% max	12% max
Fluid Loss	ASTM D 5891	1/100,000 lb (50,000 kg)	18 ml max	18 ml max
FINISHED GCL PROPERTY				
Bentonite, Mass/Unit Area ²	ASTM D 5993	1/40,000 ft ² (1/4,000 m ²)	0.75 lb/ft ² MARV	3.66 kg/m ² MARV
Tensile Strength ³	ASTM D 6768	1/40,000 ft ² (1/4,000 m ²)	30 lb/in MARV	5 kN/m MARV
Peel Strength	ASTM D 6496 ASTM D 4632 ⁴	1/40,000 ft ² (1/4,000 m ²)	3.5 lb/in MARV 21 lb MARV	610 N/m 93 N MARV
Hydraulic Conductivity ⁵	ASTM D 5887	1/Week	5 x 10 ⁻⁹ cm/sec	5 x 10 ⁻⁹ cm/sec
Index Flux ⁵	ASTM D 5887	1/Week	1 x 10 ⁻⁸ m ³ /m ² /sec	1 x 10 ⁻⁸ m ³ /m ² /sec
Internal Shear Strength ⁶	ASTM D 6243	Periodically	500 psf Typical	24 kPa Typical
ROLL DIMENSIONS				
Width x Length ⁷	Typical	Every Roll	15.5 ft x 150 ft	4.7 m x 45.7 m
Area per Roll	Typical	Every Roll	2,325 ft ²	216 m ²
Packaged Weight	Typical	Every Roll	2,600 lb	1,179 kg

NOTES:

- ¹Minimum Average Roll Value.
- ²Oven-dried measurement. Equates to 0.84 lb/ft(4.1 kg/m) when indexed to a 12% moisture content.
- ³Tested in machine direction.
- ⁴Modified ASTM D 4632 to use a 4 in (100 mm) wide grip. The maximum peak of five specimens averaged in machine direction.
- ⁵Deaired, deionized water @ 5 psi (34.5 kPa) maximum effective confining stress and 2 psi (13.8 kPa) head pressure.
- ⁶Typical peak value for specimen hydrated for 24 hours and sheared under a 200 psf (9.6 kPa) normal stress.
- ⁷Roll widths and lengths have a tolerance of ±1%.

2.04 SITE-SPECIFIC REQUIREMENTS

- A. Conduct interface friction testing using site-specific materials. The test methods and required results shall be as outlined in Table 2.

TABLE 2

GCL Site-Specific Properties^(a)		
Property	Test Method	Minimum Value
Interface – GCL/Geomembrane ^{(b)(c)}	ASTM D 5321	See Paragraph 2.03.B ^(d)
Interface – GCL/Subgrade ^{(b)(c)}	ASTM D 5321	

Table 2 notes:

- (a) Site-specific testing shall be conducted at the frequency of 1 test/75,000 square feet (minimum 3 tests) unless otherwise noted.
- (b) Perform interface tests at normal stresses of 1, 2, and 4 psi with a displacement rate of 0.04 in/min, under non-inundated conditions, report peak and residual values.
- (c) The Contractor shall provide site-specific soils (subgrade) to the QCL along with the Manufacturer provided site-specific GCL and geomembrane.
- (d) For cohesion/adhesion intercept = 0 psf. Interface friction values less than those specified but containing cohesion/adhesion will be evaluated for acceptance by the Engineer.

PART 3 INSTALLATION

3.01 GENERAL

- A. No butt seams shall be allowed on side slopes.

3.02 SUBGRADE PREPARATION

- A. The subgrade upon which the GCL is to be deployed shall be suitable for the placement of GCL material, subject to the applicable section of this specification.
- B. Subgrade - The surface upon which the Cushion Geotextile and GCL material will be installed shall be inspected by the CQA Inspector and certified by the CONTRACTOR to be in accordance with the requirements of this specification.
- C. The surface upon which the GCL is installed should be smooth and free of wheel ruts, debris, roots, sticks, and rocks larger than 1 inch.
- D. The subgrade surface and preparation should be inspected and certified by the CQA Inspector prior to GCL installation. Upon approval by the CQA inspector, it is the geosynthetic Installer's responsibility to communicate to the CONTRACTOR and ENGINEER of any changes in the condition of the subgrade that might render it out of compliance, with any of the requirements of the Project Specification or ASTM Standard D 6102.

3.03 GCL PLACEMENT

- A. GCL Material shall be placed in general accordance with the procedures specified below, or modified to account for site specific conditions.
 - 1. GCL Orientation - GCL panels are typically placed with the nonwoven side up (heat burnished side down) to maximize the shear strength characteristics. However, the heat burnished side up if it maximizes the shear strength characteristics of a site specific interface. In base or flat areas, the GCL does not require any particular orientation.
 - 2. GCL Panel Position - Where possible, all slope panels should be installed parallel to the maximum slope while panels installed in flat areas require no particular orientation.

3. Panel Deployment - GCL materials shall be installed in general accordance with the procedures set forth in this section, subject to site specific conditions which would necessitate modifications.
 - a. Deployment should proceed from the highest elevation to the lowest to facilitate drainage in the event of precipitation.
 - b. The GCL may be deployed on slopes by pulling the material from a suspended roll, or securing a roll end into an anchor trench and unrolling each panel as the handling equipment slowly moves backwards.
 - c. Deployment on flat areas shall be conducted in the same manner as that for the slopes, however, care should be taken to minimize “dragging” the GCL. Slip-sheet may be used to facilitate positioning of the liner while ensuring the GCL is not damaged from underlying sources.
 - d. The GCL will have seam overlaps a minimum of 6 inches for all woven/nonwoven GCLs. GCL’s comprised of a nonwoven/nonwoven geotextiles will have a minimum seam overlap of 6 inches for scrim reinforced and 12 inches minimum for all non-scrim reinforced nonwoven GCLs. End of panel or butt end seams shall be a minimum of 12 inches for all woven/nonwoven GCLs, 12 inches for all scrim-reinforced double nonwoven GCLs, 24 inches for non-scrim reinforced double nonwoven GCLs, and be free of wrinkles, folds or “fish-mouths”.
 - e. The CONTRACTOR shall only install as much GCL that can be covered at the end of the day. No GCL shall be left exposed overnight. The exposed edge of the GCL shall be covered by a temporary tarpaulin or other such water resistant sheeting until the next working day.

3.05 SEAMING

A. Overlap Line

1. Woven/Nonwoven and Scrim Reinforced Nonwoven GCLs
 - a. A 6-inch lap line and a 9-inch match line for scrim reinforced GCLs shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.
2. Non-Scrim Reinforced Nonwoven GCLs
 - a. A 12-inch lap line and 15-inch match line for non-scrim reinforced GCLs shall be imprinted on both edges of the upper geotextile component of the GCL to assist in installation overlap quality control. Lines shall be printed as continuous dashes in easily observable non-toxic ink.

B. Seams

1. Woven/Nonwoven and Scrim Reinforced Nonwoven GCLs
 - a. Overlap seams shall be a minimum of six inches on panel edges and one foot on panel ends.
2. Non-Scrim Reinforced Nonwoven GCLs
 - a. Overlap seams shall be a minimum of 12 inches on panel edges and 2 foot on panel ends.
3. Loose granular bentonite shall be placed between panel overlaps at a rate of 0.25 pound per lineal foot.

3.06 DETAILING

- A. Detail work, defined as the sealing of the liner to pipe penetrations, concrete structures, and other appurtenances, shall be performed as recommended by the GCL Manufacturer.

3.07 DAMAGE REPAIR

- A. Prior to cover material placement, damage to the GCL shall be identified and repaired by the Installer. Damage is defined as any rips or tears in the geotextiles, delamination of geotextiles or a displaced panel.
- B. Rip and Tear Repair (Flat Surfaces) - Rips or tears may be repaired by completely exposing the affected area, removing all foreign objects or soil, and by then placing a patch cut from unused GCL over the damage (damaged material may be left in place), with a minimum overlap of 12 inches on all edges. Accessory bentonite should be placed between the patch edges and the repaired material at a rate of a quarter pound per lineal foot of edge spread in a continuous six inch fillet.
- C. Rip and Tear Repair (Slopes) - Damaged GCL material on slopes shall be repaired by the same procedures above, however, the edges of the patch should also be adhered to the repaired liner with an adhesive to keep the patch in position during backfill or cover operations.

3.08 DISPLACED PANELS

- A. Displaced panels shall be adjusted to the correct position and orientation. The adjusted panel shall then be inspected for any geotextile damage or bentonite loss. Damage shall be repaired by the above procedure.

3.09 PREMATURE HYDRATION

- A. If the GCL is prematurely hydrated greater than 35% moisture, Installer shall notify the QA/QC technician and project OWNER for a site specific determination as to whether the material is acceptable or if alternative measures must be taken to ensure the quality of the design.

3.10 COVER MATERIAL

- A. The cover material shall be geomembrane. The uncovered edge of GCL panels shall be protected at the end of the working day with either geomembrane or a waterproof sheet which is secured adequately with ballast.
- B. Precautions shall be taken to prevent damage to the GCL by restricting the use of heavy equipment over the liner system.
 - 1. Equipment - Installation of the overlying geosynthetic component can be accomplished through the use of lightweight, rubber-tired equipment such as a 4-wheel all-terrain vehicle (ATV). This vehicle can be driven directly on the GCL, provided the ATV makes no sudden stops, starts, or turns.

--END OF SECTION--

OU3 DRAFT FINAL DESIGN
CALLAHAN MINE SUPERFUND SITE
SPECIFICATIONS

DIVISION 32 – EXTERIOR IMPROVEMENTS

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SECTION 32 92 00

SEEDING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The CONTRACTOR shall furnish all labor, equipment, and materials necessary for topsoiling and seeding for upland areas where indicated on the Drawings or as directed by the OWNER or ENGINEER. Work includes, but is not limited to, the following:
 - 1. Furnishing and placing topsoil, seed, lime, fertilizer, and mulch in the areas indicated on the Drawings or in other areas disturbed during the course of construction.
 - 2. Source testing of Topsoil materials as specified in Section 31 71 00 – Site Restoration and Wetland Construction.
 - 3. Maintaining topsoiled and seeded areas throughout the contract maintenance period.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01 11 00: Summary of Work
- B. Section 31 23 00: Earthwork
- C. Section 31 25 00: Erosion and Sedimentation Control

1.03 REFERENCES

- A. The publications listed below form a part of this specification to the extent referenced and unless otherwise noted, the latest publication shall apply. The publications are referred to in the text by the basic designation only.
 - 1. American Society for Testing and Materials (ASTM)
 - a. ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils
 - b. ASTM D 2974 - Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils
 - c. ASTM D 4972 - Standard Test Method for pH of Soils
 - B. Maine Erosion and Sediment Control BMPs, by the Bureau of Land Management and Water Quality, Maine Department of Environmental Protection.
 - C. State of Maine Department of Transportation Standard Specifications, (MDOT).
 - D. Other applicable Federal, State, and local requirements.

1.04 SUBMITTALS

- A. Topsoil: Topsoil source test results.
- B. Grass Seed Vendor's Certificate: CONTRACTOR shall submit for approval by the OWNER the seed vendor's certified statement for the grass seed mixture required, showing common name, percentage of seed mix by weight, percentages of purity and germination, year of production, date of packaging, and location of packaging.
- C. Fertilizer: CONTRACTOR shall submit for approval by the OWNER the soil test results and the fertilizer manufacturer's product data showing chemical analysis and percent composition.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General: Obtain and retain as part of the Project records, certifications, and/or labels of materials supplied.
- B. Topsoil: Meeting the requirement of Upland Topsoil specified in Section 31 710 00 – Site Restoration and Wetland Construction. Topsoil manufactured from mineral soil and organic compost material to specified requirements is acceptable.
- C. Fertilizer:
 - 1. The soil shall be tested to determine the amounts of amendments needed. Apply ground agricultural limestone to attain a pH of 6.0 in the upper 2 inches of soil. If soil must be fertilized before results of a soil test can be obtained to determine fertilizer needs, apply commercial fertilizer at 600 lbs. per acre of 5-10-10 (i.e., at least 5 percent available nitrogen, 10 percent readily available phosphoric acid and 10 percent total available potash) or equivalent.
 - 2. Supply fertilizer in unopened bags with the weight, contents and guaranteed analysis shown thereon or on a securely attached tag.
 - 3. If manure is used, apply a quantity to meet the nutrients of the above fertilizer. This requires an appropriate manure analysis prior to applying to the site. Do not use manure on sites to be planted with birdsfoot trefoil or in the path of concentrated water flow.
- D. Lime:
 - 1. Agricultural Ground Limestone for planting areas shall be composed of not less than a minimum 85 percent calcium carbonate equivalent; at least 60 percent shall pass a No. 100 mesh screen, 90 percent shall pass a No. 20 mesh screen.
 - 2. Limestone for treatment of existing soil that will remain in place shall consist of ground calcite limestone with a minimum calcium carbonate content of 90 percent; at least 60 percent shall pass a No. 100 mesh screen, 90 percent shall pass a No. 20 mesh screen.
- E. Seed: Shall meet the minimum requirements:

1. Upland seed mix shall consist of Ernst Riparian Buffer Mix (Ernmx-178).. The grass seed mixture shall include no "primary noxious weed seeds."
 2. Furnish in fully-labeled, standard sealed containers.
 3. Percentage and germination of each seed type in the mixture, purity, and weed seed content of the mixture shall be clearly stated on the label.
 4. The weight of pure live seed (PLS) is computed by the labeled purity percent times the labeled germination percent times the weight.
 - a. To illustrate the method of computing to PLS from the tag basis, the following example is given: Required: 20 pounds PLS of a particular variety--stock available is 99.41 percent pure and 92 percent germination--20 divided by the product of 0.9941 and 0.92 equals 21.8 pounds on the tag basis to furnish 20 pounds of PLS.
 5. Subject to the testing provisions of the Association of Official Seed Analysis, with the month and year of test clearly stated on the label.
 6. May be tested after it has been delivered to the project.
 7. Seed which has become wet, moldy, or otherwise damaged will not be acceptable.
 8. Apply seed mix at a rate recommended by seed vendor.
 9. For temporary seeding requirements see Section 31 25 00, "Erosion and Sedimentation Control."
- F. Mulch: See Section 31 25 00, "Erosion and Sedimentation Control."

PART 3 - EXECUTION

3.01 PREPARATION

- A. All Areas to be Seeded:
 1. Shall be worked with a disk, harrow, dragged with a chain, mat or blade, machine-raked, or hand-worked as necessary to provide a reasonably firm but friable seedbed.
 2. Shall meet the specified grades or blend and match existing grades and are free of growth and debris.
 3. Take care to prevent the formation of low places and pockets where water will stand.
- B. Depth of Tillage: 2 inches or as directed by the OWNER or ENGINEER.
- C. Where ryegrass has been planted for temporary erosion control and has not been eliminated prior to the completion of the work, disk at least 4 inches deep and seed to permanent grasses.

3.02 APPLICATION

- A. Topsoil: Topsoil shall consist of good quality friable soil consisting of a sandy loam, loam or silty loam that is free of stones over 1-1/2 inches and meeting the following requirements:
 1. Provide soil material with a minimum 20 percent and a maximum of 80

- percent passing the No. 200 sieve and not more than 15 percent clay and not more than 10 percent gravel by volume.
 2. Reasonably free from subsoil, clay lumps, stones, brush, objectionable stumps, roots, litter, toxic substances, noxious weeds, and other material or substances which may be harmful to plant growth or be a hindrance to grading, planting and maintenance operations.
 3. The pH of the material is recommended to be between 6.0 and 7.5 as guidance.
 4. Topsoil shall have at least 6 percent by weight of fine textured stable organic material, and no greater than 20 percent. Muck soil shall not be considered topsoil.
 5. Topsoil containing soluble salts greater than 500 parts per million shall not be used.
 6. Topsoil manufactured from mineral soil and organic compost material to these specified requirements is acceptable.
- B. Fertilizer and Lime:
1. Apply by means of a mechanical spreader or other acceptable method which is capable of maintaining a uniform rate of application.
 2. Conduct when the soil is in a moist condition and at least 24 hours before sowing the seed.
 3. Fertilizer shall be applied at the rate based on the results of the Nutrient Analysis when conducted or at a rate of 18 pounds per 1000 square feet.
 4. Limestone for areas to be planted shall be applied at rate based on the results of the Nutrient Analysis when conducted to provide a pH of 6 to 7.6 or at a rate of 80 pounds per 1000 square feet.
 5. Limestone for treatment of existing soils prior to topsoil placement, shall be applied at rate of 100 pounds per 1000 square feet
- C. Seeding:
1. Perform erosion control items of work such as seeding and mulching upon completion of a unit or portion of the project.
 2. When immediate protection of newly graded areas is necessary at a time which is outside of the normal seeding season, apply hay mulch with the seeding done at the same time or done later, or both, as ordered.
 3. When immediate seeding is required on areas of the project which are not to be regraded or disturbed, use specified seed mixture.
 4. Areas of the project which are to be left temporarily and which will be regraded or otherwise disturbed later during construction may be ordered to be seeded with temporary seed to obtain temporary control, in accordance with Section 31 25 00, "Erosion and Sedimentation Control."
 5. The OWNER reserves the right to prohibit the use of any equipment that is unsuitable or inadequate for the proper performance of the work; immediately remove all rejected equipment from the Project.
- D. Mulch:
1. Undertake immediately after each area has been properly prepared.

2. Apply mulch at the rate as specified in Section 31 25 00, “Erosion and Sedimentation Control.”
3. Blowing chopped mulch will be permitted when authorized.
4. Authorization will be given when it can be determined that the mulch fibers will be of such length and applied in such a manner that there will be a minimum amount of matting that would retard the growth of plants.
5. Straw or hay mulch should cover the ground enough to shade it, but the mulch should not be so thick that a person standing cannot see ground through the mulch.
6. Remove matted mulch or bunches.
7. When specified, anchor mulch in accordance with Section 31 25 00, “Erosion and Sedimentation Control.”
8. Properly dispose of all baling wire or rope offsite.

3.03 SEEDING SEASONS

- A. Conduct permanent seeding between May 15 and June 30, between August 15 and September 1, or as directed or permitted by the OWNER or ENGINEER.
- B. Do not seed during windy weather or when the ground is frozen, excessively wet, or otherwise untillable.

3.04 SEEDING METHODS

- A. Fertilizer, limestone, mulch material if required, and seed of the type specified may be placed at the locations shown or ordered by one of the following methods, provided an even distribution is obtained. The maximum seeding depth shall be 1/4-inch when using methods other than hydroseeding.
 1. Dry Method:
 - a. Power Equipment: Use mechanical seeders, seed drills, landscape seeders, cultipacker seeders, fertilizer spreaders, or other approved mechanical seeding equipment or attachments when seed, limestone, and fertilizer are to be applied in dry form.
 - b. Manual Equipment: On areas which are inaccessible to power equipment, permission may be given to use hand-operated mechanical equipment when the materials are to be applied in dry form. The use of hand shovels to spread the materials will not be allowed.
 - c. Do not mix limestone and fertilizer together prior to their application, but work into the soil together to the specified depth.
 - d. After seeding, compact the entire area by a suitable roller weighing 60 to 90 pounds per lineal foot.
 - e. Allow at least 24 hours between fertilizing and seeding.
 - f. Unless otherwise ordered, mulch areas covered with seed.

2. Hydraulic Method:
 - a. The application of grass, seed, fertilizer, limestone, and a suitable mulch, if approved, may be accomplished in one operation by the use of an approved spraying machine.
 - b. Mix materials with water in the machine and keep in an agitated state in order that the materials may be uniformly suspended in the water.
 - c. The spraying equipment shall be so designed that when the solution is sprayed over an area, the resulting deposits of limestone, fertilizer, and grass seed are equal in quantity to the required rates.
 - d. Flush and clean hydraulic seeding and fertilizing machine each day before seeding is to be started, and thoroughly flush of all residue after the completion of application on every 10 acres.
 - e. If the results of the spray operations are unsatisfactory, abandon this method and apply the materials by the dry method.
 - f. When inoculum is required, mix with the seed and spray.
 - g. Compaction or rolling not required.
 - h. Unless mulch material required is applied during the seeding operation or within 1/2 hour following the seeding operation, take measures to protect the seed from sunlight and heat such as the use of a light brush dragged over the seeded areas to stir the seed into the soil, taking care not to carry the seed ahead.

3.05 CARE AFTER SEEDING

- A. Protect and care for seeded areas until final acceptance of the work, and repair any damage to seeded areas caused by pedestrian or vehicular traffic or other causes, at the CONTRACTOR's expense.
- B. If necessary, place barricades and suitable signs to protect the seeded areas.
- C. Apply water to maintain proper moisture to promote growth. Use approved water wagons or tanks or other approved devices to apply water in the form of a spray or sprinkle without erosive force. Apply water prior to 10:00 a.m. and after 4:00 p.m. to minimize losses due to evaporation.
- D. Cut back weeds growing in seeded areas to prevent them from dominating the desired grass plants.
- E. Hay mulch to be provided as described on the Drawings.
- F. To be acceptable, a stand of grass shall show a reasonably thick, uniform stand, free from sizable areas of thin or bare spots, with a uniform coverage of at least 90 percent of grass.
- G. Reseed any parts of seeded areas which fail to show a uniform stand until all areas are covered with grass, at the CONTRACTOR's expense.
- H. Maintenance Period:

1. This period shall extend for 60 days or until the turf has been completed and accepted on all areas.
2. Acceptable grass areas shall have coverage of not less than 90 percent of permanent grasses at the termination of the maintenance period.

END OF SECTION

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OU3 DRAFT FINAL DESIGN
CALLAHAN MINE SUPERFUND SITE
SPECIFICATIONS

DIVISION 33 – UTILITIES

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SECTION 33 05 23

HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION
(NARA)

29 CFR 1926.652 Safety and Health Regulations for
Construction; Subpart P, Excavations;
Requirements for Protective Systems

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM D 2513 Thermoplastic Gas Pressure Pipe, Tubing, and Fittings

ASTM D 3261 Butt Heat Fusion Polyethylene (PE) Plastic Fittings for
Polyethylene (PE) Plastic Pipe and Tubing

ASTM D 3350 Polyethylene Plastic Pipe and Fittings Materials

1.2 SUBMITTALS

1.2.1 Preconstruction Submittals

Statement of Qualifications and Records

1.2.2 Shop Drawings

Record Drawings

1.2.3 Product Data

PVC Pipe

Polyethylene Pipe

Grout Mixture

Drilling Fluid Mixture and Additives

Drilling Fluid Material Safety Data Sheets

1.2.4 Closeout Submittals

Complete Work Logs of Guided Horizontal/Directional Drill Operations

1.3 COMMENCEMENT, DELIVERY, STORAGE, AND HANDLING OF MATERIALS

Prior to commencement of the work, submit the following to the OWNER and ENGINEER for review and approval:

- a. PVC Pipe
- b. Material Safety Data Sheets – Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Material Safety Data Sheets.
- c. Statement of Qualifications and Records

Inspect materials delivered to the site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects will be rejected. Remove defective materials from the job site.

1.4 QUALITY ASSURANCE

1.4.1 Qualifications

Ensure that CONTRACTOR and his field supervisor assigned to this project are experienced in work of this nature and have successfully completed similar projects of similar length, pipe type, pipe size, and soil/rock type using horizontal/directional drilling in the last three (3) years. As part of the submission provide a description of such project(s) which include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.4.2 Safety

Include in horizontal/directional drilling equipment machine safety requirements a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. Equip the drill with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

PART 2 PRODUCTS

2.1 EQUIPMENT

2.1.1 Drill Rod

Select the appropriate drill rod to be used. Submit certified statement that the drill rod has been inspected and is in satisfactory condition for its intended use.

2.2 Materials

2.2.1 Steel Casing

Select steel casing to be installed through the waste rock, appropriate in diameter and schedule to protect the well drain pipe to be installed through the casing. Submit certified statement that the casing has been inspected and is in satisfactory condition for its intended use.

2.2.2 Pipe Sleeves

Horizontal/directional drilled pipe sleeves used to facilitate installation of well drain pipe shall be high density polyethylene (HDPE) pipe and of the materials specified below.

High Density Polyethylene (HDPE) Pipe and Fittings:

- a. The polyethylene pipe and fittings used for HDD pipe sleeves shall be smooth wall on the exterior and the interior.
- b. Use HDPE (PE 3408) piping conforming to ASTM D 3350 cell classification 345434C with a standard dimension ratio (SDR) 11 in accordance with ASTM D 2513.
- c. The HDPE pipe used for cleanouts shall be provided with a minimum of 2.5% carbon black to provide protection from UV exposure.

2.2.3 Horizontal Well Drain Pipe

PVC Pipe

- a. Well Screen - Schedule 80, 1.5 inch diameter, 0.010 inch well screen, or other approved by the OWNER and ENGINEER. To be of a length shown on the drawings.
- b. Riser - Schedule 80, 1.5 inch diameter solid riser or other approved by the OWNER and ENGINEER. To be of a length shown on the drawings.

Polyethylene or Fiberglass

- a. Well Screen - To be of a material, schedule and diameter approved by the OWNER and ENGINEER. To be of a length shown on the drawings.
- b. Riser - To be of a material, schedule and diameter approved by the OWNER and ENGINEER. To be of a length shown on the drawings.

2.2.4 Cleanouts

Construction: Complete each horizontal well drain and protective casing with sufficient length exposed from the face of the waste rock to allow construction of the protective vaults around each well head as well as associated valves and fittings.

Plug: Provide an expansion plug of nylon and rubber construction for each cleanout. Plugs shall be watertight and have a lip that ensures they will not fall into the cleanout.

2.2.5 Drilling Fluids

Disposal of fluids is the responsibility of the CONTRACTOR. Dispose of fluids in a manner that is in compliance with all permits and applicable Federal, State, and local regulations. The CONTRACTOR may dispose of the drilling fluids on approved onsite location subject to written approval from the OWNER and ENGINEER.

Use only a high quality bentonite or biodegradable polymer drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Use only fluid with a composition which complies with all Federal, State, and local environmental regulations.

Mix the bentonite drilling fluid with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. The CONTRACTOR is responsible for any required pH adjustments.

Collect drilling fluid returns in the entrance pit or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

2.2.6 Fine Aggregate Grout Mix:

Fine aggregate grout shall consist of a mixture of Portland cement, fine aggregate, and water so proportioned and mixed as to provide a readily flowable grout. Admixtures and/or a pozzolan may be used with the approval of the OWNER and ENGINEER. The hardened fine aggregate concrete shall exhibit a compressive strength of 2,500 psi (17 MPa) at 28 days.

PART 3 EXECUTION

3.1 INSTALLATION

Ensure each and every horizontal well alignment are located and clearly marked prior to start of drilling.

3.1.1 Drill Set-Up

- a. Ensure final placement of drill on drill pads allows for achieving the specified entrance point location, elevation, and angle of each bore
- b. Ensure that the drill set-up layout including support equipment, staging and drilling fluid storage areas allows for safe and efficient execution of the required drilling operations.

3.1.2 Drill Entrance Pit

Provide a drill entrance pit as required for drilling fluid storage. Maintain at minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the site.

Do not allow drilling mud to flow freely on the site or around the entrance pits. Remove spilled mud and restore ground to original condition.

When drilling near wetlands or water courses, provide secondary containment to prevent drilling fluids from entering the wetlands, and secure written approval of secondary containment plan from the OWNER and ENGINEER.

3.1.3 Drill Entrance Angle

Ensure entrance angle and elevation profile of each well boring maintains adequate cover to reduce risk of drilling fluid breakouts or ground exit as specified herein. Ensure that entrance angles generate push forces that do not exceed 20 percent buckling strain on the polyethylene pipe sleeve.

3.1.4 Well Bore/Pilot Hole

The type and size of the well bore or pilot string cutting head and the diameter of the drill pipe is at the CONTRACTOR's discretion.

Drill the well bore/pilot hole along the path shown on the plan and profile drawings, according to the following tolerances:

- a. Entry Point Location: Make pilot hole entry point within plus/minus 12 inches of the location shown on the drawings or as directed by the OWNER and ENGINEER in the field.
- b. Vertical Tolerance: Plus/minus 4 inches from the elevation shown for each well.
- c. Horizontal Tolerance: Plus/minus – 24 inches from the alignment path shown for each well.
- d. Contractor shall provide means of accurately locating the steel casing after complete penetration through the waste rock to verify the alignment complies with the specified tolerances. A new casing may be drilled if the specified tolerances are not achieved based on direction of the OWNER and ENGINEER.

3.1.5 Guidance Systems

- a. Guidance systems shall be used in sufficient numbers and frequency of measurement during advancement of each boring to make a determination as to whether the boring will meet the above tolerances. Such systems may include walkover, gyro, Parjary or a magnetic survey tool locator installed behind the pilot string cutting head and an electric grid (tru-tracker) system.

The CONTRACTOR shall make the results of real time guidance system monitoring available to the OWNER and ENGINEER so that a determination can be made of the acceptability of each boring.

- b. Drain Crossings: At locations of drain crossings as shown on the drawings, the CONTRACTOR shall increase the number and or frequency of guidance systems measurements to clearly document the location of both drains at each crossing and acceptable separations (no less than 42 inches) between drains.

3.1.6 Reaming

Conduct reaming operations at the CONTRACTOR's discretion. Determine the type of back reamer to be utilized by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type is at the CONTRACTOR's discretion.

3.1.7 Well Development

Each completed and accepted horizontal well drain shall be developed by flushing with clean water or other fluid approved by the OWNER and ENGINEER, until fines have been removed from the return water and the turbidity of the flow from each drain is acceptable to the OWNER and ENGINEER.

3.2 FIELD QUALITY CONTROL

Maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at least every 10 feet along the drill path. In addition, keep logs that record, as a minimum the following, every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

- a. Drilling Fluid Pressure
- b. Drilling Fluid Flow Rate
- c. Drill Thrust Pressure
- d. Drill Pullback Pressure
- e. Drill Head Torque

Make all instrumentation, readings, and logs available to the OWNER at all times during operation.

3.3 CLOSEOUT ACTIVITIES

Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service leaving the entire area involved in a neat condition acceptable of the OWNER and ENGINEER.

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and return the surface area to its original condition. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

Submit an electronic copy and three hard copies of the record drawings to the OWNER and ENGINEER within 10 days after completing the well installations. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain and submit upon completion signed complete work logs of guided directional drill operations.

END OF SECTION

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SECTION 33 41 00

DRAIN AND CULVERT PIPING

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install drain and culvert piping, including all incidental work, complete, in strict accordance with the specifications, construction drawings and standard details.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 23 00 – Earthwork

1.02 SUBMITTALS

- A. Product Data: Submit data indicating pipe and pipe accessories.
- B. Project Record Documents: Accurately record actual locations of installed pipe runs, culverts, flow control structures, cleanouts, and invert elevations.

1.04 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO M 252: Standard Specification for Corrugated Polyethylene Drainage Pipe
 - 2. AASHTO M 294: Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM D 2321: Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
 - 2. ASTM D 3212 - Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
 - 3. ASTM F 477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
 - 4. ASTM F 2648 - Standard Specification for 2 to 60 inch Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.
 - 5. ASTM D 3350 - Polyethylene Plastic Pipe and Fittings Materials

PART 2 PRODUCTS

2.01 CULVERT PIPE

- A. Pipe for storm drain culvert pipe shall be of the sizes indicated on the drawings and of the materials specified below.
- B. Corrugated Polyethylene (PE) and Fittings: Use AASHTO M 252-“S” (smooth core) for pipes 3 to 10 inches, AASHTO M 294-“S” for pipes 12 to 24 inches in diameter. Fittings shall be manufacturer's standard type and shall conform to the indicated specification.
 - 1. Joints: Bell & Spigot couplers with “O” ring gasket per ASTM F 477.

2.01 DRAIN PIPE

- A. Pipe for the horizontal drain collection system and treatment wetlands shall be of the sizes indicated on the drawings and of the materials specified below.
- B. High Density Polyethylene (HDPE) Pipe and Fittings:
 - 1. The polyethylene pipe and fittings used for horizontal drain collection system and treatment wetlands shall be smooth wall on the exterior and the interior.
 - 2. Use HDPE (PE 3408) piping conforming to ASTM D 3350 cell classification 345434C with a standard dimension ratio (SDR) 17.
 - 3. The HDPE pipe used for cleanouts shall be provided with a minimum of 2.5% carbon black to provide protection from UV exposure.
- C. Perforated Pipe:
 - 1. Where indicated on the Contract Drawings, provide perforated pipe. Water inlet area shall be a minimum of 1.5 square inch per linear foot. Manufacturer's standard perforated pipe, which essentially meets these requirements, may be substituted with prior approval of the OWNER.
 - 2. The plastic pipe perforations shall be 1/2- inch diameter circular holes cleanly cut and arranged in rows parallel to the longitudinal axis of the pipe. Perforations shall be approximately 6 inches center-to-center along rows. The 4 rows shall be evenly spaced at 30 degree intervals over the lower 180 degrees of circumference (@ 4, 5, 7, and 8 o'clock). The ends of each pipe section shall not be perforated for at least 6 inches to allow for butt fusion, and perforations shall continue at uniform spacing over the entire length of the pipe.

2.03 ACCESSORIES

- A Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps and other configurations required.

2.04 BEDDING AND COVER MATERIALS

- A Stone Bedding: Crushed Stone as specified in Section 31 23 00 – Earthwork and shown on the construction drawings.
- B. Cover: Common Fill as specified in Section 31 23 00 – Earthwork and as shown on the construction drawings.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on construction drawings.

3.2 PREPARATION

- A. Hand trim excavations to required elevations. Correct over excavation with pipe bedding stone.
- B. Remove large stones or other hard matter capable of damaging piping or impeding consistent backfilling or compaction.

3.3 BEDDING

- A. Excavate pipe trench in accordance with Section 31 23 00 – Earthwork for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom, level materials in continuous 6 inch deep layer, compacted depth.

3.4 INSTALLATION - PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D 2321.
- B. Place storm drain pipe within envelope of bedding stone material as specified in Section 31 23 00 – Earthwork and as shown on the construction drawings.
- C. Lay pipe to slope gradients noted on construction drawings. Pipe shall have minimum slope of 0.0050 ft/ft.
- D. Install aggregate at sides and over top of pipe. Install top cover to minimum compacted thickness of 6 inches or as shown on the drawings.
- E. Do not displace or damage pipe when compacting.

3.5 FIELD QUALITY CONTROL

- A. Request inspection prior to and immediately after placing stone bedding material over pipe.
- B. Common Fill backfill over pipe bedding material shall be conducted in accordance with Section 31 23 00 – Earthwork.

- C. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.
 - 1. Take care not to damage or displace installed pipe and joints during backfilling of pipe and other operations.
 - 2. Correct damaged or displaced pipe.

END OF SECTION

SECTION 33 46 16.16

GEOCOMPOSITE DRAINAGE LAYER

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall furnish labor, materials, tools, and equipment and perform operations necessary to furnish, deploy, and install the geocomposite drainage layer (GDL) in the areas indicated on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 01010: Summary of Work.
- B. Section 01330: Submittal Procedures.
- C. Section 01450: Contractor Quality Control.
- D. Section 02315: Earthwork.
- E. Section 02372: Cap Geomembrane Liner.

1.03 REFERENCES

The publications listed below form a part of this Specification to the extent referenced. The reference is made to the most current version/edition of the publication, unless otherwise noted. The publications are referred to in the text by the basic designation only.

- A. ASTM International, Inc. (ASTM):
 - 1. ASTM D1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
 - 2. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
 - 3. ASTM D 1603 Standard Test Method for Carbon Black in Olefin Plastics
 - 4. ASTM D 4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique
 - 5. ASTM D 4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus
 - 6. ASTM D 4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
 - 7. ASTM D 4533 Standard Test Method for Trapezoidal Tearing Strength of Geotextiles
 - 8. ASTM D 4595 Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
 - 9. ASTM D 4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

10. ASTM D 4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
 11. ASTM D 4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
 12. ASTM D 4833 Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
 13. ASTM D 5199 Standard Test Method for Measuring Nominal Thickness of Geosynthetics
 14. ASTM D 5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles
 15. ASTM D 5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method
 16. ASTM F 904 Standard Test Method for Comparison of Bond Strength or Ply Adhesion of Similar laminates Made from Flexible Materials
 17. ASTM G 154 Standard Practice for operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
- B. Geosynthetic Research Institute (GRI):
1. GRI GC-7 Determination of Adhesion and Bond Strength of Geocomposites

1.04 DEFINITIONS

- A. Contractor: The Contractor is the firm or corporation with whom OWNER has entered into agreement to construct the project. The Contractor is responsible for submittals by the Manufacturer and the Installer as required by the Specifications. The Contractor is also responsible for scheduling and coordination of the required work with the Manufacturer and the Installer to complete the project.
- B. Engineer: The individual or firm responsible for the design and preparation of the Drawings and Specifications.
- C. Geocomposite Manufacturer (Manufacturer): The Manufacturer is the firm or corporation contracted by the Contractor for production of the GDL to be used in the project. The Manufacturer shall produce a consistent product meeting the project specifications and shall provide quality control documentation for the product specified herein.
- D. Quality Control Laboratory (QCL): Party independent from the Manufacturer and Installer, hired by the Contractor, responsible for conducting laboratory tests on samples of GDL obtained at the site or during manufacturing. The QAL shall have a GRI certification.
- E. Installer: The Installer is the firm or corporation hired by the Contractor to install the GDL. The Installer shall be the Manufacturer or a Manufacturer-approved Installer trained and certified to install the Manufacturer's product. The Installer shall be responsible for field handling, storing, placing, seaming, sampling, testing, and other aspects of the GDL.

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

1.05 QUALIFICATIONS

- A. Manufacturer: Manufacturer shall have manufactured a minimum of 10,000,000 square feet of GDL during the previous year.
- B. Installer:
 - 1. Installation shall be performed by a Manufacturer-approved Installer. The Installer shall have installed a minimum of 1,000,000 square feet of GDL in the last 3 years.
 - 2. Installer shall have worked in a similar capacity on at least 3 projects similar in complexity to the project described in the Contract Documents.
 - 3. The Installation Supervisor shall have worked in a similar capacity on projects similar in size and complexity to the project described in the Contract Documents.
- C. QC Laboratory:
 - 1. The QC laboratory shall have provided QC and/or QA testing of the proposed GDL for at least five completed projects having a total minimum area of 2 million square feet. The QC laboratory shall be accredited via the Geosynthetic Accreditation Institute's Laboratory Accreditation Program (GAI-LAP) for the tests the QC laboratory will be required to perform.

1.06 SUBMITTALS

The Contractor shall submit the following to the Engineer, at a minimum, in accordance with Section 01330, "Submittal Procedures":

- A. Manufacturer qualifications (see Paragraph 1.5A).
- B. Installer Qualifications (see Paragraph 1.5B).
- C. QCL Qualifications
- D. Prior to transporting the GDL to the Site, the Contractor shall submit the following information to the Engineer:
 - 1. Mill Certificate: Copy of the mill certificate or affidavit signed by a legally authorized official of the Manufacturer attesting that the GDL meets the physical and manufacturing requirements stated in this Section.
 - 2. Sample: One 12" x 12" sample of the GDL product.
 - 3. A copy of the Manufacturer's product specification data sheet listing test methods and property values as listed in this Section.
 - 4. Manufacturer's Quality Control Plan.
 - 5. Manufacturer's recommendations for shipping, handling, and storage of the GDL.
- E. The Contractor shall submit to the Engineer the following information for the GDL delivered to the site:
 - 1. Manufacturing quality control certificates for each shift's production, signed by the responsible parties employed by the Manufacturer.

2. The quality control certificate shall include:
 - a. Roll numbers and identification;
 - b. The results of quality control tests, including identification of the test methods, frequency used. At a minimum, the Manufacturing Quality Control test results and frequency of testing shall be as shown in Table 02374-3 in Paragraph 2.2.

1.07 WARRANTY

- A. Material: Material shall be warranted, on a pro-rated basis against defects for a period of 1-year from the date of substantial completion of work.
- B. Installation: Installation shall be warranted against defects in workmanship for a period of 1-year from the date of substantial completion of work.
- C. Provide copies of warranty certificates to the Engineer.

1.08 MATERIAL LABELING, DELIVERY, STORAGE, AND HANDLING

- A. Labeling: Each roll of GDL delivered to the site shall be wrapped and labeled by the Manufacturer. The label will identify:
 1. Manufacturer's name;
 2. Product identification;
 3. Roll dimensions;
 4. Geotextile type;
 5. Finished product lot; and
 6. Roll number.
- B. Delivery: Rolls of GDL will be prepared to ship by appropriate means to prevent damage to the material and to facilitate off-loading.
- C. Storage and Handling: The Installer shall be responsible for the handling, storage and care of the GDL from the time of delivery to the site until final acceptance of the completed work by the Contractor. Material storage and handling practices shall meet the Manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 GEOCOMPOSITE DRAINAGE LAYER

- A. Geocomposite Drainage Layer:
 1. The GDL shall be manufactured by extruding polyethylene to form a drainage net structure (a geonet) with a non-woven geotextile bonded to both sides.
 2. The locations where the GDL is to be installed are shown on the Drawings.
 3. Provide a material meeting or exceeding the requirements specified in Table 02374-1.
 4. Interface Strength Requirements: In addition to the general material properties requirements, the Manufacturer shall provide GDL material meeting the following minimum project-specific interface strength requirements when required:

For Use on 5% (or less) Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Protection Layer / GDL	8 degrees	7 degrees
GDL / Geomembrane	8 degrees	7 degrees

For Use on 20% Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Protection Layer / GDL	16.5 degrees	15 degrees
GDL / Geomembrane	16.5 degrees	15 degrees

For Use on 33% Slopes

Interface	Peak Shear Strength	Residual Shear Strength
Protection Layer / GDL	23.5 degrees	21.5 degrees
GDL / Geomembrane	23.5 degrees	21.5 degrees

TABLE 02374-1

Geocomposite Drainage Layer		
Property	Test Method	Value^(b)
Geonet Component^(a)		
Thickness, mil	ASTM D 5199	200 (MAV)
Density, g/cm ³	ASTM D 1505	0.94 (MAV)
Tensile Strength (MD), lb/in	ASTM D 4595	45 (MAV)
Carbon Black Content, %	ASTM D 1603/D 4218	2 to 3 (range)
Geotextile Component^(a)		
Mass Per Unit Area, oz/yd ²	ASTM D 5261	6 (MARV)
AOS, US Sieve (mm)	ASTM D 4751	0.25 (MaxARV)
Permittivity, sec ⁻¹	ASTM D 4491 (Falling Head)	0.5 (MARV)
Flow Rate, gpm/ft ²	ASTM D 4491 (Falling Head)	100 (MARV)
Grab Tensile, lbs	ASTM D 4632	158 (MARV)
Sewn Seam Strength, lbs	ASTM D 4632	142 (MARV)
Tear Strength, lbs	ASTM D 4533	57 (MARV)
Puncture Strength, lbs	ASTM D 4833	57 (MARV)
UV Resistance, % retained	ASTM D 4355/G 154 (after 500 hours)	90 (MARV)
Geocomposite		
Ply Adhesion, lb/in	GRI GC-7 or ASTM F 904 (mod.)	0.5 (MAV)
Ultimate Transmissivity ^(c, d) , m ² /sec	ASTM D 4716	(MAV) 8.0x10 ⁻⁴ @ gradient 0.316

Table 02374-1 Notes:

- (a) Component properties prior to lamination.
- (b) Values: minimum average values (MAV); minimum average roll value (MARV) in the weakest principal direction; maximum average roll value (MaxARV).
- (c) The normal compressive load shall be 750 psf at a hydraulic gradient 0.316. Testing boundary conditions shall be steel plate/site-specific protection layer/GDL/steel plate with a minimum seating time of 100 hours.
- (d) The GDL Manufacturer shall provide a recommended creep reduction factor to the Engineer for use in evaluating the allowable transmissivity of the GDL. The recommended value shall be supported by product-specific testing data.

B. Resin:

1. Resin used to manufacture the geonet core shall be new first quality, compounded polyethylene resin. No post-consumer reclaimed polymer shall be added to the resin during the manufacture of the geonet material. Natural resin (without carbon black) shall meet the following additional minimum requirements provided in Table 02374-2.

TABLE 02374-2

Natural Resin		
Property	Test Method	Value
Density (g/cm ³)	ASTM D 1505	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	≤ 1.0

- C. Ties:
1. Ties used to secure adjacent sheets of GDL shall be plastic fasteners or polymer braid.
 2. Metallic ties will not be allowed.
 3. Ties shall be yellow or white to facilitate inspection.
- D. Thread:
1. Thread used to seam the geotextile portion of the GDL shall be polymeric material with chemical resistance properties equal to or exceeding those of the geotextile. The thread shall be a different color than the geotextile to facilitate inspection.

2.2 MANUFACTURING QUALITY CONTROL

- A. The GDL shall be manufactured in accordance with the Manufacturer's Quality Control Plan, as submitted to and approved by the Engineer. The GDL shall be tested according to the test methods and frequencies listed in Table 02374-3:

TABLE 02374-3

Characteristics	Test Method	Units	Frequency
<i>Resin</i>			
Polymer Density	ASTM D 1505	g/cm ³	Once Per Lot
Melt Flow Index	ASTM D 1238	g/10 min	Once Per Lot
<i>Geonet Test</i>			
Thickness	ASTM D 5199	mil	50,000 ft ²
Carbon Black	ASTM D 1603/D4218	%	50,000 ft ²
Tensile Strength, MD	ASTM D 4595	lbs/ft	50,000 ft ²
<i>Geotextile Tests</i>			
Mass per Unit Area	ASTM D 5261	oz/yd ²	Every 100,000 ft ²
Grab Tensile	ASTM D 4632	lbs	Every 100,000 ft ²
Tear	ASTM D 4533	lbs	Every 100,000 ft ²
Puncture	ASTM D 4833	lbs	Every 100,000 ft ²
AOS, US Sieve	ASTM D 4751	mm	Every 500,000 ft ²
Permittivity	ASTM D 4491	sec ⁻¹	Every 500,000 ft ²
UV Resistance	ASTM D 4355/G 154 (after 500 hrs)	%	Once per resin formulation

Characteristics	Test Method	Units	Frequency
Geocomposite Tests			
Ply Adhesion	GRI GC-7 or ASTM F 904 (mod.)	lbs/in.	100,000 ft ²
Transmissivity	ASTM D 4716	m ² /sec	200,000 ft ²

2.3 SITE-SPECIFIC REQUIREMENTS

- A. Conduct interface friction and transmissivity testing using site-specific soils. The test methods and required results shall be as outlined in Table 02374-4.

TABLE 02374-4
GDL Site-Specific Properties^(a)

Property	Test Method	Minimum Value
Interface – GDL/Geomembrane ^{(b)(c)}	ASTM D 5321	See Paragraph 2.1.A.4 ^(d)
Interface – GDL/Protection Layer ^{(b)(c)}	ASTM D 5321	

Table 02374-4 notes:

- (a) Site-specific testing shall be conducted at the frequency of 1 test/75,000 square feet (minimum 3 tests) unless otherwise noted.
- (b) Perform interface tests at normal stresses of 1, 2, and 4 psi with a displacement rate of 0.04 in/min, under non-inundated conditions, report peak and residual values.
- (c) The Contractor shall provide site-specific soils (Protection Layer) to the QCL along with the Manufacturer provided site-specific GDL.
- (d) For cohesion/adhesion intercept = 0 psf. Interface friction values less than those specified but containing cohesion/adhesion will be evaluated for acceptance by the Engineer.

PART 3 - EXECUTION

3.1 FAMILIARIZATION

- A. Prior to installation, the Installer shall carefully inspect the subgrade verify that work is complete to the point where the installation of the GDL may properly commence without adverse impact. If the Installer has any concerns regarding the subgrade, he shall notify the Contractor.

3.2 PROTECTION

- A. Prior to installation, the GDL shall not be placed on the ground and shall be covered in such a manner as to keep it dry and out of direct sunlight.

3.3 INSTALLATION

- A. General:
- The GDL shall be installed in accordance with the Manufacturer's recommendations, as shown on the Drawings, and as specified herein.
- B. Handling and Placement:

1. The Installer shall handle the GDL in such a manner as to ensure it is not damaged.
 2. The predominant flow direction of the GDL is in the machined direction (roll direction) and the GDL shall be installed in the direction of flow (deploying the GDL directly down the slope) unless an alternative drainage path is approved or specified by the Engineer.
 3. The installation shall be conducted by using full length rolls from the top of the slope to the toe.
 4. Minimize dragging of the GDL over the subgrade during installation.
 5. No equipment shall be operated directly on the GDL surface.
 6. At obstructions or penetrations, the GDL shall be cut and/or a penetration formed in a manner to fit around the object without a gap. The bottom geotextile and geonet shall be in close contact with the object. Provide excess upper geotextile material at the penetration to allow the excess material to be tucked back under the GDL to protect the geonet core and prevent soil particles from migrating into the geonet core.
 7. Following deployment, folds or excessive wrinkles shall be removed to the extent practicable.
- C. Seaming Procedures:
1. Horizontal seams shall not be allowed, except as part of a patch. If horizontal seams are required as part of a patch, offset adjacent horizontal seams.
 2. Seams shall be along (running up/down the slope), not across the slope. At a minimum, the following requirements shall be met:
 - a. Adjacent rolls/sheet of GDL shall be overlapped so that the geonet overlaps by 2 to 3 inches and the geotextiles overlap by at least 4 inches.
 - b. Geonet tying shall be at a maximum of every 5 feet along the slope, every 6 inches in the anchor trench.
 - c. Once the geonet is tied, the top geotextile of the GDL be continuously sewn. Thermally bonded seaming may be permitted as approved by the Engineer. Spot sewing or bonding is not allowed. The Installer shall pay particular attention to seams to ensure that no cover soil could be inadvertently inserted beneath the geotextile.
 - d. Sewing shall be done using polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of the geotextile. Sewing shall be done using sewing machines specifically designed for this purpose as recommended by the GDL Manufacturer or as approved in writing by the Engineer.
 - e. Thermally bonded seams, if approved by the Engineer, may be bonded using hot plate, hot knife, or ultrasonic devices. For thermally bonded seams, adjacent geotextile panels shall overlap 6-inches prior to seaming. The geotextile panels shall be completely clean prior to seaming. The geotextile panel edges shall lay flat against each other prior to seaming such that no gaps are formed in the seam. Manual or automatic machine driven seaming devices may be used; however, machine driven seaming

equipment is preferred. Locations where heat bonding has melted through either geotextile panel shall be repaired. Heat seaming shall not be performed during rain or snow. Ambient temperatures for seaming should be above freezing, i.e. 32°F, unless it can be demonstrated that satisfactory seams (comparable to seams conducted a higher temperatures without melt through) can be fabricated at lower temperatures. The use of a seaming board or slip sheet is recommended for some seaming operations. A seaming board or slip sheet may be a wood board or piece of geomembrane which is placed below the geotextile panels at the location of seaming. The board or sheet may be pulled with a rope or strap as seaming progresses. The purpose of the seaming board or slip sheet is to provide a firm, clean surface for seaming.

- f. The bottom layer of geotextile shall be overlapped.
- g. No end seams shall be installed in areas with 3H:1V slopes unless approved by the Engineer. Provide adequate anchorage and/or on run-out prior to placing cover on 3H:1V slopes, to prevent sliding of GDL on the subgrade.

D. Inspection:

- 1. Prior to covering installed GDL with cover soils, all areas shall be inspected by the Contractor and the Installer. During the inspection, the Installer shall repair defect areas identified to the satisfaction of the Contractor. A surface verification form shall be prepared indicating covering of the GDL can be conducted following a successful inspection.

E. Repair:

- 1. Rips, tears, or damaged areas of the GDL shall be removed and patched.
- 2. The patch for damaged geonet shall be secured to the deployed geonet by tying every 6 inches with plastic fasteners or polymeric braid. The patch shall be extended 12 inches beyond the edges of the damaged area.

F. Anchor Trench:

- 1. Where shown on the Drawings, GDL shall be secured in an anchor trench prior to the placement of cover soils. Sand bags or suitable weights may be utilized. The anchor trench shall not be backfilled until the cover soils have been placed and any slack, folds, or wrinkles that have developed in the GDL at the crest of the slope or in the anchor trench have been pulled taut.
- 2. Prevent compaction equipment from coming into direct contact with the GDL during trench backfilling.

G. Protection Layer Placement:

- 1. The guidelines below apply to all soil placed over the GDL..
- 2. See Section 02315, “Earthwork”, for additional requirements.
- 3. When placing material a minimum of 15 inches of loaded material shall be placed under loaded trucks operating over the GDL.
- 4. Protection Layer shall be placed in such a manner as to prevent damaging or unnecessarily stressing the GDL.
- 5. Placement of the Protection Layer is recommended to proceed immediately. If Protection Layer placement cannot be conducted immediately, cover the GDL with a temporary cover (black plastic

- sheeting). The GDL shall not be left exposed to sunlight for more than 2 weeks or as recommended by the GDL Manufacturer.
6. In applying Protection Layer material, no equipment shall drive directly on the GDL.
 7. The specified cover material shall be placed and spread utilizing vehicles with a low ground pressure (LGP). The Protection Layer shall be placed on the GDL from the bottom of the slope proceeding upwards and in a manner which prevents instability of the Protection Layer or damage to the GDL.
 8. Unless otherwise specified by the Engineer, all equipment for spreading fill materials atop the GDL shall comply with the following:
Max. Equipment Ground Pressure (psi) Min. Separation Thickness (inches)

Max 5psi (low ground pressure related)	Min.	12”
Max 10 psi	Min.	18”
Max 40 psi	Min.	24”
Max 80 psi (fully loaded highway truck)	Min.	36”
 9. Compaction of the initial lift of cover soil placed atop the GDL shall be performed in a manner that does not damage the GDL.
 10. In the presence of wind, all geocomposites shall be weighted down with sandbags or the equivalent. Such sandbags shall be used during placement and remain until replaced with cover material.

-- END OF SECTION --

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SECTION 33 49 00

PRECAST CONCRETE STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

Furnish and install all precast structures and all incidental work. Complete in strict accordance with the Specifications Drawings and Standard Details.

1.02 RELATED WORK SPECIFIED ELSEWHERE

Section 01 11 00: Summary of Work
Section 01 33 00: Submittal Procedures
Section 31 23 00: Earthwork

1.03 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only and shall refer to the latest version unless otherwise noted.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION
OFFICIALS (AASHTO)

AASHTO M198 Joints for Circular Concrete Sewer and Culvert Pipe Using
Flexible Watertight Gaskets

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48 Standard Specification for Gray Iron Castings

ASTM A 82 Standard Specification for Steel Wire, Plain, for Concrete
Reinforcement

ASTM A185 Standard Specification for Steel Welded Wire Reinforcement,
Plain, for Concrete

ASTM A 536 Standard Specification for Ductile Iron Castings

ASTM A 615 Standard Specification for deformed and Plain Billet-Steel Bars
for Concrete Reinforcement

33 49 00-1

ASTM C 32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C 33	Standard Specification for Concrete Aggregates
ASTM C 139	Standard Specification for Concrete Masonry Units for Construction of Catch basins and Manholes
ASTM C 150	Standard Specification for Portland Cement
ASTM C 207	Standard Specification for Hydrated lime for Masonry Purposes
ASTM C 443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C 478	Standard Specifications for Underground Precast Concrete Utility Structures
ASTM C 858	Standard Specifications for Precast Reinforced Concrete Manholes Sections
ASTM C 913	Standard Specification for Precast Concrete Water and Wastewater Structures.
ASTM C 923	Standard Specification for Resilient Connectors between Reinforced Concrete Manhole Structures, Pipes and Laterals

1.04 QUALITY ASSURANCE

- A. It is the intention of this Section that the manholes and other structures, including all component parts, have adequate space, strength and leakproof qualities considered necessary for the intended service. Space requirements and configurations shall be as shown on the Drawings.
- B. Structures may be an assembly of precast sections with steel reinforcement, with approved jointing or cast monolithically in place with reinforcement. In any approved structure, the complete structure shall be of such material and quality as to withstand loads of 8 tons (H-20 loading) without failure and prevent leakage in excess of one gallon per day per vertical foot. Any modifications to this requirement shall be approved by the OWNER and/or ENGINEER.

1.05 SUBMITTALS

- A. Shop Drawings of all precast units.
- B. Manufacturer's Information: Joint sealants, gaskets and waterproofing.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Precast Concrete Structures

1. General: Reinforced concrete riser sections and tops conforming to the dimensions indicated on the Drawings.
2. Manufactured in accordance with ASTM C 478 or ASTM C 858.
3. Minimum Compressive Strength of Concrete: 4,000 psi. Provide an air content of 6 percent, plus or minus 2 percent and a minimum wall thickness of 5 inches.
4. The minimum circumferential steel reinforcement for riser pipe sections, cone sections, and base walls: 0.12 square inch per linear foot and shall conform to the latest ASTM A 185 or A 82 specification.
5. Reinforcing shall extend into the tongue and groove of each structure section.
6. Casting methods must assure each unit to be very dense in structure and impervious to water. All manhole sections shall be manufactured by the “wet cast method”. The allowable absorption of water by the concrete shall not exceed 9 percent of the dry weight of the structure.
7. Paint precast structure exterior including the bottom with two coats of a waterproof epoxy sealing compound.
8. Tongue and Groove:
 - a. Formed of concrete so as to receive the round rubber gaskets.
 - b. Sections shall be set so as to be vertical and in true alignment.
 - c. Horizontal joints between sections of precast concrete sections shall be of a type approved by the Engineer and shall, in general, be self-centering and make a watertight joint using a round rubber gasket.
 - d. All inside surfaces of the bell or outside surfaces of the spigot on which the gasket will bear shall be parallel within 1 degree and have an angle of not more than 2 degrees with the longitudinal axis of the structure. The distance from the gasket to the end of the bell or spigot shall be not less than $\frac{3}{4}$ “.
9. All precast structure joints shall be mortared both inside and out.
10. Pipe to Structure Joints: Only as approved by the OWNER and, in general, will depend for watertightness upon a rubber boot either cast-in-place or press-wedged in place. Attachment to the pipe will be by use of two stainless steel bands per pipeline connection. The flexible sleeves shall meet the requirements of ASTM Designation C-923.
11. All precast sections and bases shall have the date of manufacture and the name or trademark of the manufacturer impressed or indelibly marked on the inside wall.
12. Manhole Steps:
 - a. 5/8-inch steel reinforced polypropylene plastic manufactured to ASTM D 246 Type II grade 16906 and ASTM C 478 standards.

- b. Cast into walls of the precast section so as to form a continuous ladder with a distance of 12 inches between steps.
 - c. Constructed to the dimensions as shown on the Contract Drawings.
 13. Provide 2 holes for the purpose of handling and installing. These holes shall be tapered and shall be plugged with mortar after installation.
 14. Precast Base Sections: Cast holes for pipes in the base section so that there is a clear distance of 4 1/2 inches minimum between the inside bottom of the base section and the pipe invert.
 - B. Manhole Frames and Covers
 1. Provide a 24" diameter clear opening.
 2. Provide covers with a non-skid surface and the letters as shown on the design drawings with 2" high letters.
 3. Provide factory machined bearing surfaces to prevent rocking. Any covers found to rattle after installation shall be replaced.
 4. Castings: Good quality, strong, tough, even-grained cast iron, smooth, free from scale, lumps, blisters, sandholes, and defects of every nature which would render them unfit for the service for which they are intended.
 5. Class 30 conforming to the requirements of ASTM A 48.
 - C. Aluminum Access Hatches:
 1. Shall be of the size shown on the drawings.
 2. Made of 1/4" thick diamond pattern aluminum plate.
 3. Reinforced for H2O loading.
 4. Automatic hold-open arm.
 5. Depth of frame as required to match the depth of the precast structure cover.
 6. All hardware including latches, lifting mechanism assemblies, guides, brackets, hinges, pins, hold open arms, and guides shall be made of 316 SS.
 7. Hinges shall be accessible only when the access door is in the open position.
 8. All access hatches shall be provided with recessed padlock hasps covered by a hinged lid that closes flush with the surface of the hatch cover.
 9. Insulate cover with 2-inches of rigid foam board insulation.
 - D. Rigid Foam Board Insulation
 1. As shown on the drawings, insulate precast concrete structures with rigid foam board insulation.
 2. Rigid foam board insulation shall be Type 4 extruded polystyrene especially suited for foundations, slabs, crawl spaces, interior basements, geotechnical and other in-ground insulation applications.
 - E. Brick:
 1. Brick shall be used to bring the cast manhole frame and cover to ground surface.
 2. Sound, hard, and uniformly formed brick, regular and uniform in shape and size, of compact texture, and satisfactory to the Engineer.
 3. Comply with the requirements of ASTM C 32, for Grade SS, hard brick.
 4. Rejected brick shall be immediately removed from the project site.
 - F. Mortar:
 1. Composed of Portland cement, hydrated lime, and sand, in the proportions of 1 part cement to 1/2 part lime to 4 1/2 parts sand, (by volume).

2. The proportion of cement to lime may vary from 1:1/4 for hard brick to 1:3/4 for softer brick, but in no case shall the volume of sand exceed three times the sum of the volume of cement and lime.
3. Cement: Type II Portland cement conforming to ASTM C 150.
4. Hydrated Lime: Type S conforming to ASTM C 207.
5. Sand: Inert natural sand conforming to the requirements of ASTM C 33 as follows:

<u>Sieve</u>	<u>Percent Passing</u>
#3/8	100
4	95-100
8	80-100
16	50-85
50	10-30
100	2-10
FINENESS MODULUS	2.3-3.1

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Precast Concrete Structures and Manholes:
 1. Place on a minimum 6-inch layer of crushed stone material after the impacted soil has been removed beneath the proposed manhole location.
 2. Dewater excavation while placing bedding material and setting the precast concrete base or pouring concrete. The base section shall be installed with the pipeline openings at the proper alignment and elevation and the base section must be true and level.
 3. Connect inlet and outlet stubs to the correct alignment and elevation and seal in accordance with the manufacturer's recommended procedure, and as indicated in the Construction Documents.
 4. Prior to placing manhole barrel and cone sections, wipe the joint and gasket clean. The gasket, gasket groove, and the entire concrete joint shall be liberally soaped in preparation for making the joints.
 5. Place barrel sections of the appropriate combination of heights using manufacturer's recommended procedure for sealing the horizontal joints, and as indicated in the Construction Documents. Use a screwdriver or hammer handle to run under the gasket to ensure proper seating prior to making the joint.
 6. Place the cone section containing the proper frame opening on the barrel section with the appropriate sealing of the concrete joint.
 7. After completion of the manhole, perform the leakage test as described herein.

- B. Floors and Inverts in Manholes:
1. Floors and inverts shall be constructed of vitrified sewer brick, concrete, or approved pre-cast concrete.
 2. Manhole inverts shall be constructed to match the exact shape of the mainline sewers connected to the structure.
 3. Changes in alignment or size shall be made evenly and gradually within the manhole, unless otherwise directed by the Engineer.
 4. Half pipe inverts may only be used in straight-through manholes.

3.02 TESTING

- A. Test concrete manhole and discharge structures in accordance with ASTM C 497
- B. Vacuum Leakage Tests (Manholes and Discharge Structures):
1. The leakage testing shall be observed by the OWNER on each Concrete structure.
 2. A vacuum test made as described below. Structure to pipe connection must be a flexible connector to perform this testing.
- C. Preparation for Test:
1. After the structure has been assembled in place, fill lifting holes and point with an approved non-shrinking mortar.
 2. Perform test prior to backfill. The exterior poly wrap for sealing the horizontal joints may be installed prior to testing.
 3. Plug pipes and other openings into the manhole and brace the plugs to prevent blow out.
- D. Test Procedure:
1. Test immediately after structure assembly.
 2. Use vacuum test equipment equal to NPC Systems, Inc., Milford, New Hampshire.
 3. Set tester in place.
 4. Inflate compression band to seal base to structure.
 5. Draw a vacuum of 10 inch Hg.
 6. Close the valve.
 7. Acceptable test:
 - a. Less than 1 inch Hg drop in 3 minutes for a manhole less than 10 feet in depth.
 - b. Less than 1 inch Hg drop in 2 minutes for a manhole 10 feet to 25 feet in depth.
 8. If leakage occurs fill those points with non-shrink grout, allow to set and retest.
 9. Rejected Structures: Disassemble, reconstruct or replace as directed by the OWNER.

--END OF SECTION--

SECTION 33 20 00

EARTHQUAKE DRAINS

PART 1 GENERAL

1.01 DESCRIPTION

- A. Furnish and install earthquake drains including all incidental work in strict accordance with the specifications, construction drawings and standard details.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 31 23 00 – Earthwork
- B. Section 31 23 19 - Dewatering

1.02 SUBMITTALS

- A. Product Data: Submit data on proposed earthquake drains and accessories.
- B. Installation Method: Provide details on proposed sequence and method of installation.

1.04 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. AASHTO M 252: Standard Specification for Corrugated Polyethylene Drainage Pipe
- B. American Society for Testing and Materials (ASTM)
 - 1. ASTM F 405: Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings
 - 2. ASTM D 3350 - Polyethylene Plastic Pipe and Fittings Materials

PART 2 PRODUCTS

2.01 PREFABRICATED VERTICAL LIQUEFACTION DRAINS

- A. Pipe shall be 3-inch with an annular-corrugated interior and exterior meeting the requirements of ASTM F-405 and SCS 806. Pipe material shall be slotted high-density polyethylene (HDPE) meeting the requirements of ASTM D 3350 Cell Classification 32440C or ASTM D 1248 Type III, Class C, Category 4, Grade P33. Pipe splices shall be made in a workmanlike manner to assure concentricity and continuity of the pipe conduit. In addition, the pipe shall have a minimum average wall thickness of 0.042 inches.
- B. The filter fabric sock shall be non-woven and made of thermally spunbonded polypropylene with a minimum weight of 3.9 oz/ft², maximum apparent opening size (AOS) of 0.21 mm,

minimum grab strength of 100 lbs, and shall be factory applied. The prefabricated vertical drain shall not be exposed to sunlight for more than 72 hours.

PART 3 EXECUTION

3.1 PREPARATION

- A. Verify working surface including stone drainage layer has been installed to the limits identified on the Drawings.
- B. Prior to installation of Earthquake Drains within the designated area the Contractor shall demonstrate that the proposed equipment, method, and materials produce a satisfactory installation.

3.2 INSTALLATION

- A. The prefabricated drains shall be installed using a mandrel that will be advanced through the soil to the required depth. The installation rig shall utilize a vibrator with an eccentric moment of at least 500 in-lbs to apply vertical vibration to the mandrel during installation.
- B. The mandrel shall be fitted with three symmetrically spaced fins for transmitting vibrations to the soil during installation.
- C. A suitable shoe or lost point shall be attached to the bottom of the drain to provide an anchor for the drain and to cover the lower open end of the mandrel during penetration.
- D. The mandrel shall protect the drains and filter sock from tears, cuts, and abrasions during installation and shall be retracted after each drain is installed.
- E. If obstructions are encountered which cannot be penetrated using normal and acceptable procedures, the Contractor shall complete the drain from the elevation of the obstruction to the working surface and notify the ENGINEER.
- F. Contractor shall provide a suitable means for the ENGINEER to determine the depth of the drain at any given time.
- G. Earthquake drains shall terminate within the crushed stone drainage layer as shown on the Drawings.

3.5 FIELD QUALITY CONTROL

- A. Equipment for installing vertical drains shall be plumbed prior to each drain and shall not deviate from vertical by more than 1 inch per foot during installation.
- B. Earthquake drains shall be numbered and staked out by the Contractor.

- C. The Contractor shall exercise necessary precautions to protect monitoring instrumentation from damage during installation of earthquake drains. Any damage to instrumentation will be repaired at the Contractor's expense.

END OF SECTION

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