ATTACHMENT J

Application Appendix D-7 – RMU-2 Landfill Technical Specifications

Imagine the result

CWM Chemical Services, LLC.

Technical Specifications

Residuals Management Unit 2

Model City Facility
1550 Balmer Road
Model City, Niagara County, New York

April 2003
Revised August 2009
Revised March 2011
Revised February 2013
Revised August 2013

TECHNICAL SPECIFICATIONS
FOR
MODEL CITY FACILITY
RESIDUALS MANAGEMENT UNIT 2
CWM CHEMICAL SERVICES, LLC
MODEL CITY, NEW YORK

GENERAL TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

SECTION 01000
GENERAL PROVISIONS

PART 1 GENERAL

1.01 PROJECT DESCRIPTION

A. Work included in construction of Residuals Management Unit 2 (RMU-2) entails construction of the baseliner system, installation of piping and electrical work for the landfill's leachate collection system, and the installation of the final cover system and stormwater management system. The Landfill is located in Model City, Niagara County, New York.

B. OWNER - CWM Chemical Services, LLC has overall authority of the facility and is responsible for selecting the CONTRACTOR, ENGINEER, and QUALITY ASSURANCE CONSULTANT. They are also responsible for the operation and maintenance of the facility, including areas directly and indirectly affected by the work.

C. ENGINEER - is responsible for technical review of the CONTRACTOR'S submittals for conformance with the project requirements, and is responsible for approving all design and specification changes and making design clarifications necessitated during construction. Alternative testing methods to those listed in the specifications may be substituted upon approval by the ENGINEER. The ENGINEER will approve design changes in writing.

D. QUALITY ASSURANCE CONSULTANT (QAC) – is under contract with the OWNER, and is responsible for ensuring the work is performed in accordance with the requirements of the RMU-2 Construction Quality Assurance Manual (CQAM). The QAC performs all conformance testing, survey documentation of work, and observes all major construction activities. The QAC duties may be spilt among more than one consultant.

E. CONTRACTOR – is responsible for completing all work in accordance with the contract, including the project specifications, project drawings, CQAM, and relevant RMU-2 permit conditions.

F. NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION – is the permitting agency for the construction and operation of the facility. As such, they must approve of various elements of the work during construction, as well as any changes or modifications to the permit (including the drawings and specifications).

1.02 IDENTIFICATION OF DRAWINGS

A. Work included in this Contract is presented on RMU-2 drawings; Nos. 1 through 39.

1.03 FORM OF SPECIFICATIONS

A. These Specifications are written in imperative and abbreviated form. This imperative language of technical sections is directed at the CONTRACTOR, unless specifically noted otherwise. Incomplete sentences in specifications shall be completed by inserting "shall", "CONTRACTOR shall", "shall be", and similar mandatory phrases by inference in the same manner as they are applied to notes on drawings. Words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to contrary, fulfill (perform) indicates requirements whether stated imperatively or otherwise.

B. Items of Work are specified by section. Specifications or requirements of one or more sections may apply or be referenced in other sections.

C. Provide Work stated and comply with requirements stated in each section unless specifically assigned to other Contractors or the OWNER.

D. Term “provide” or “provided” shall mean "furnished and installed by CONTRACTOR".

1.04 WORK BY OTHERS

A. Work at the site may be performed concurrently by other contractors, or the OWNER. Work by others will be identified during the pre-construction conference.

B. Coordinate Work to minimize interference with other work at the facility.

1.05 WORK SEQUENCE

A. Construct Work in stages to accommodate OWNER's use of premises during construction period; coordinate construction schedule and operations with OWNER's representative.

1.06 CONTRACTOR'S USE OF PREMISES

A. Limit use of premises for Work and storage to allow for:

1. Work by other Contractors.

2. OWNER occupancy.

B. Coordinate use of premises with OWNER.

C. Assume full responsibility for protection and safekeeping of products under this Contract.

D. Obtain and pay for use of additional storage or Work areas needed for operations at no additional cost to OWNER.

E. Conduct operations to ensure the least inconvenience to site operations and vehicle access.

1.07 OWNER OCCUPANCY

A. Schedule operations for completion of portions of Work, in accordance with construction schedule, for OWNER occupancy prior to substantial completion of entire Work.

1.08 OWNER-FURNISHED PRODUCTS

A. OWNER may obtain specific products, for the purpose of expediting delivery, and other purposes in OWNER's interest. These items, if any, will be discussed at pre-construction conference.

1.09 REFERENCE STANDARDS

A. Standards and standard specifications referenced in theses specifications shall be the latest published versions, unless otherwise noted.

B. Reference to NYSDOT, or DOT specifications shall mean the "Standard Specifications for Construction and Materials," published by State of New York Department of Transportation, latest edition.

C. Performance criteria for Work shall be in accordance with the RMU-2 Construction Quality Assurance Manual.

* * * END OF SECTION * * *

SECTION 01200
PROJECT MEETINGS

PART 1 GENERAL

1.01 GENERAL MEETING REQUIREMENTS

A. The OWNER or his/her representative shall schedule and administer the pre-construction conference, the pre-work conference, periodic progress meetings, and specially called meetings throughout progress of Work. This shall include at a minimum the following:

1. Prepare agenda for meetings.

2. Distribute written notice of each meeting 4 days in advance of meeting date.

3. Make physical arrangements for meetings.

4. Preside at meetings.

5. Assign individual to record minutes; include significant proceedings and decisions.

6. Reproduce and distribute copies of minutes within 3 days after each meeting to the following at a minimum.

   a. To attendees of the meeting.

   b. To parties affected by decisions made at meeting.

   c. Furnish 1 copy of minutes to OWNER, 2 copies to OWNER's site representative, and 2 copies to ENGINEER.

B. Representatives of Contractors, Subcontractors, and suppliers attending meetings shall be qualified and authorized to act on behalf of entity each represents.

1.02 PRECONSTRUCTION CONFERENCE

A. Before the OWNER issues the Notice to Proceed, CONTRACTOR shall meet with the OWNER for a pre-construction conference.

B. Purpose of Conference:

1. Status of Contract.

2. Review submittals.

3. Safety programs.

4. Environmental protection.

5. Progress schedules.

6. Requests for payment.

7. Retainage.

8. Staffing.

9. Payment and procurement of materials.

10. Review principal features of Work.

11. Address CONTRACTOR’s questions regarding Contract and Work site.

1.03 PRE-WORK CONFERENCE

A. As soon as possible after the Notice to Proceed is issued to the CONTRACTOR and prior to starting on-site Work, a pre-work conference will be held between CONTRACTOR, Quality Assurance Consultant(s) and OWNER or his representative.

B. Attendance:

1. CONTRACTOR's superintendent.

2. Quality control supervisor.

3. Safety personnel.

4. Major subcontractors' job superintendents.

5. Quality Assurance Consultant.

C. Purpose of Conference:

1. Further define quality control system.

2. Review RMU-2 Construction Quality Assurance Manual (CQAM).

3. Develop mutual understanding of specific requirements established by Contract.

D. Specifics of CONTRACTOR's health, safety, and emergency plan will be discussed so emergency procedures and safety requirements are understood by those directly related to site Work.

E. CONTRACTOR's schedule, particularly for initial startup period, will be discussed.

F. Questions concerning administrative requirements outlined during pre-construction conference or other aspects of the Project shall be addressed.

1.04 PROGRESS MEETINGS

A. Schedule and administer progress meetings at a minimum of once per week and such additional meetings as required, or as requested by OWNER.

B. Attendance:

1. OWNER or OWNER's representative.

2. CONTRACTOR's superintendent.

3. Subcontractors as appropriate to agenda.

4. Quality Assurance Consultant.

5. ENGINEER (as needed).

C. Suggested Agenda:

1. Review and approval of record of previous meeting.

2. Review work schedule.

3. Discuss progress of previous week.

4. Discuss work to be performed in upcoming week.

5. Review long term schedule.

6. Discuss applicable quality assurance test results.

7. Discuss technical issues associated with work and assign responsible parties.

8. Review need for specification and/or permit modification and/or clarification.

9. Review health and safety requirements and issues.

10. Miscellaneous issues.

* * * END OF SECTION * * *

SECTION 01340
SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

A. This section specifies procedural requirements for Work-related (non-administrative) submittals including Shop Drawings, proposed substitutions, product data, samples, and other miscellaneous Work-related submittals.

B. Administrative Submittals: Procedures concerning items such as listing of manufacturers, suppliers, Subcontractors, construction progress schedule, schedule of Shop Drawing submissions, bonds, payment applications, insurance certificates, and schedule of values are specified elsewhere.

C. Types of Work-Related Submittals:

1. Proposed Substitutes or "Or Equal" Items:

    a. Includes material or equipment that CONTRACTOR requests ENGINEER to accept, after Bids are received, as a substitute for items specified or described in the specifications or by the ENGINEER that are a name of a proprietary item or the name of a particular supplier.

2. Shop Drawings:

    a. Includes technical data and drawings specially prepared for the Project, including; fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports, instructions, design mix formulas, measurements, and similar information that is not in standard printed form.

3. Product Data:

    a. Includes standard printed information on manufactured products and systems not specially prepared for this Project, including manufacturer's product specifications and installation instructions, catalog cuts, standard wiring diagrams, printed performance curves, mill reports, and standard color charts.

4. Samples:

    a. Includes fabricated and manufactured physical examples of materials, products, and units of Work, includes complete units, partial cuts of manufactured or fabricated work, swatches showing color, texture, and pattern, and units of Work to be used for independent inspection and testing.

b. Mock-ups are special forms of samples too large or otherwise inconvenient for handling in a manner specified for transmittal of sample submittals.

5. Miscellaneous Submittals:

a. Work-related submittals that do not fit in one of the four previous categories: including guarantees, warranties, certifications, experience records, maintenance agreements, operating and maintenance data, workmanship bonds, survey data and reports, physical work records, quality testing and certifying reports, copies of industry standards, record drawings, field measurement data, overrun stock, keys, and similar information, devices, and materials applicable to Work.

1.02 SUBMITTAL PROCEDURES

A. Specific submittal requirements for individual units of Work are specified in applicable Specification sections. Except as otherwise indicated, comply with requirements specified herein for each indicated type of submittal.

B. Scheduling:

1. Provide a submittal schedule for submittals that are required by Specifications indicating principal Work-related submittals and time requirements for coordination of submittal activity with related Work.

2. Adjust submittal schedule to reflect revisions to construction progress schedule and submit to OWNER and/or OWNER's Representative.

3. Prepare and transmit each submittal sufficiently in advance of scheduled performance of related Work and other applicable activities.

C. Coordination:

1. Coordinate preparation and processing of submittals with performance of Work. Coordinate each submittal with other submittals and related activities such as substitution requests, testing, purchasing, fabrication, delivery, and similar activities that require sequential activity.

2. Coordinate submission of different units of interrelated Work so one submittal is not delayed by ENGINEER's need to review related submittal. ENGINEER may withhold action on any submittal requiring coordination with other submittals until related submittals are submitted.

D. Submittal Preparation:

1. Stamp and sign each submittal certifying to review of submittal, verification of products, field measurement, field construction criteria, and coordination of information within submittal with requirements of Work and Contract Documents.

2. Transmittal Form: Provide transmittal identifying:
   a. Date of submittal.
   b. Project title and number.
   c. Submittal and transmittal number.
   d. Contract identification.
   e. Names of:
      1) CONTRACTOR.
      2) Supplier.
      3) Manufacturer.
   f. If submittal is for substitute item of material or equipment identified as "substitute" on transmittal.
   g. Identification of equipment and material with equipment identification numbers, motor numbers, and Specification section number.
   h. Variations from Contract Documents.

E. Resubmittal Preparation:

1. Comply with requirements described in Submittal Preparation above, and in addition:
   a. Identify on transmittal form that submittal is resubmission and include dates of previous submittals.
   b. Make corrections or changes in submittals required by ENGINEER's notations on returned submittal.
   c. Respond to ENGINEER's notations.
      1) On transmittal or on separate page attached to CONTRACTOR's resubmission transmittal, answer or acknowledge in writing notations or questions indicated by ENGINEER on ENGINEER's transmittal form returning reviewed submission to CONTRACTOR.
      2) Identify each response by question or notation number established by ENGINEER.
      3) If CONTRACTOR does not respond to each notation or question, resubmission will be returned without action by ENGINEER until CONTRACTOR provides written response to ENGINEER's notations or questions.

d. CONTRACTOR-initiated revisions or variations.

1) On transmittal form, identify variations or revisions from previously reviewed submittal, other than those called for by ENGINEER.

1.03 SPECIFIC SUBMITTAL REQUIREMENTS

A. Requests for Substitutes or "Or Equal":

1. Collect data for items to be submitted for review as substitutes into one submittal for each item of material or equipment.

2. Submit with other scheduled submittals for material or equipment allowing time for OWNER to evaluate additional information required to be submitted.

3. If CONTRACTOR requests to substitute for material or equipment specified but not identified in Specifications as requiring submittals, CONTRACTOR shall schedule substitution submittal request in Submittal Schedule and submit as scheduled.

B. Shop Drawings:

1. Submit newly prepared 1nformation, with graphic information at accurate scale and name of preparer indicated (firm name). Show dimensions and clearly note which are based on field measurement, identify materials and products, which are included in Work, and revisions on resubmittals. Indicate compliance with standards and notation of coordination requirements with other Work. Highlight, encircle or otherwise indicate variations from Contract Documents or previous submittals.

2. Provide 8 in. by 3 in. blank space for CONTRACTOR and OWNER stamps.

3. Submittals:

a. Submit 7 blue line or black line prints, or; 1 reverse sepia reproducible and 1 blue line or black line print when required in Specification section; reproducible will be returned.

C. Product Data:

1. Preparation:

a. Collect required data into single submittal for each unit of Work or system. Where product data has been printed to include information on several similar products, some of which are not required for use on Project or not included in submittal, mark copies to clearly show such information is not applicable.

b. Where product data must be specially prepared for required products, materials or systems, because standard printed data is not suitable for use, submit data as Shop Drawing and not as product data.

2. Submittals:

   a. Submittal is for information and record, and to determine that products, materials, and systems comply with Contract Documents.

   b. Submit 7 copies.

3. Distribution:

   a. Do not proceed with installation of materials, products or systems until final copy of applicable product data is in possession of installer.

   b. Maintain one set of product data (for each submittal) at Project site, available for reference by OWNER and others.

D. Samples:

1. Preparation:

   a. Where possible, provide samples physically identical with proposed materials or products to be incorporated into Work. Where variations in color, pattern or texture are inherent in material or product represented by sample, submit multiple units (not less than 3 units) showing approximate limits of variations.

   b. Provide full set of optional samples where OWNER's selection is required. Prepare samples to match OWNER's sample where so indicated.

   c. Include information with each sample to show generic description, source or product name and manufacturer, limitations, and compliance with standards.

   d. Submit samples for OWNER's visual review of general generic kind, color, pattern, texture, and for final check of coordination of these characteristics with other related elements of Work.

2. Submittals:

   a. At CONTRACTOR's option, and depending upon nature of anticipated response from OWNER, initial submittal samples may be preliminary or final submittals.

   b. Preliminary submittal, of single set of samples, required where ENGINEER's selection of color, pattern, texture or similar characteristics from manufacturer's range of standard choices is necessary. Preliminary submittals will be reviewed and returned with ENGINEER's "Action" marking.

   c. Final Submittals: Submit 3 sets of samples in final submittal, 1 set will be returned.

3. Distribution:

   a. Maintain returned final set of samples at Project site, in suitable condition and available for quality control comparisons throughout course of performing Work.

   b. Returned samples intended or permitted to be incorporated in Work are indicated in Specification sections, and shall be in undamaged condition at time of use.

E. Mock-Ups:

1. Mock-ups and similar samples specified in Specification sections are recognized as special type of samples. Comply with samples submittal requirements to greatest extent possible. Process transmittal forms to provide record of activity.

F. Miscellaneous Submittals:

1. Inspection and Test Reports:

   a. Classify each inspection and test report as "Shop Drawings" or "product data," depending on whether report is specially prepared for Project or standard publication of workmanship control testing at point of production. Process inspection and test reports accordingly.

2. Guarantees, Warranties, Maintenance Bonds, Agreements, and Workmanship:

   a. Refer to Specification sections for specific requirements.

   b. In addition to copies desired for CONTRACTOR's use, furnish 2 executed copies. Provide 2 additional copies where required for maintenance data.

3. Survey Data:

   a. Refer to Specification sections for specific requirements on property surveys, building or structure condition surveys, field measurements, quantitative records of actual Work, damage surveys, photographs and similar data required by Specification sections. Copies will not be returned.

      1) Survey Copies: Furnish 2 copies of final property survey (if any).

      2) Condition Surveys: Furnish 2 copies.

4. Certifications:

   a. Refer to Specification sections for specific requirement on submittal of certifications. Submit 7 copies. Certifications are submitted for review of conformance with specified requirements and information. Submittal final when returned by OWNER marked "Approved".

5. Closeout Submittals:

    a. Refer to Specification sections for specific requirements on submittal of closeout information, materials, tools, and similar items.

        1) Material and Equipment: Section 01600.

        2) Operating and Maintenance (O&M) Data: Section 01730.

G. Operating and Maintenance (O&M) Data:

1. Organize O&M information into suitable sets of manageable size, and bind into individual binders properly identified and indexed (thumb-tabbed). Include emergency instructions, spare parts listing, copies of warranties, wiring diagrams, recommended "turn-around" cycles, inspection procedures, Shop Drawings, product data, and similar applicable information.

2. Bind each manual of each set in heavy duty 2-inch, 3-ring vinyl covered binder, and include pocket folders for folded sheet information. Mark identification on front and spine of each binder.

H. General Distribution:

1. Unless required elsewhere, provide distribution of submittals to Subcontractors, suppliers, governing authorities, and others as necessary for proper performance of the Work.

2. Provide copies of submittals bearing ENGINEER’s action stamp to:

    a. Job site file.

    b. Record documents file.

I. Electronic Submittals:

1. In general, submittals may be made electronically (PDF or similar format) in lieu of hard copy unless the ENGINEER indicates otherwise.

2. Survey-related electronic submittals shall be made in both PDF and AutoCAD (DWG) file formats.

1.04 ACTION ON SUBMITTALS

A. ENGINEER's Action:

1. General:

    a. Except for submittals for record and similar purposes, ENGINEER will review each submittal, mark with appropriate action, and return. Where submittal must be held for coordination, ENGINEER will so advise CONTRACTOR without delay.

b. ENGINEER will stamp each submittal with uniform, self-explanatory action stamp, appropriately marked with submittal action.

B. Action Stamp:

1. Marking: Approved.

a. Final Unrestricted Release: Where submittals are marked as "Approved", Work covered by submittal may proceed provided it complies with Contract Documents. Acceptance of Work depends on that compliance.

2. Marking: Approved With Noted Exceptions.

a. Final-But-Restricted Release: When submittals are marked as "Approved" With Noted Exceptions," Work covered by submittal may proceed provided it complies with ENGINEER's notations or corrections on submittal and Contract Documents. Acceptance of Work depends on that compliance. Resubmittal not required unless required by ENGINEER on returned submittal.

3. Marking: Not Approved.

a. Submittal Not Accepted: When submittals are marked "Not Approved", do not proceed with Work covered by submittal. Work covered by submittal does not comply with Contract Documents.

b. Prepare new submittal for either different material or equipment supplier or different product line or material of same supplier complying with Contract Documents.

4. Marking: Revise and Resubmit.

a. Returned for Re-submittal: When submittals are marked as "Revise and Resubmit", do not proceed with Work covered by submittal.

b. Revise submittal or prepare new submittal in accordance with ENGINEER's notations in accordance with Paragraph 1.02.D of this section. Resubmit submittal without delay. Repeat if required to obtain different action marking.

* * * END OF SECTION * * *

SECTION 01400
GENERAL PROVISIONS FOR GEOSYNTHETICS

PART 1 GENERAL

1.01 SUMMARY

A. Furnish and install geosynthetics including necessary labor, materials and equipment incorporated or to be incorporated into work.

1.02 RELATED SECTIONS

A. Section 02401 - Polyethylene Geomembranes.

B. Section 02410 - Geotexti1e.

C. Section 02430 - Geotextile/Geonet Composite.

D. Section 02413 - Geosynthetic Clay Liner.

1.03 DEFINITIONS

A. OWNER: Individual or firm owning or operating facility.

B. Geosynthetic Installer: Firm responsible for installation of geosynthetics. Firm may be affiliated with manufacturer.

C. Geosynthetic Quality Assurance Consultant (Geosynthetic QAC): Firm independent from OWNER, manufacturer(s) and Geosynthetic Contractor responsible for observing and documenting activities related to quality assurance of production and installation of geosynthetic systems on behalf of OWNER.

D. Lead Geosynthetic Quality Assurance Monitor (LGM): Lead Monitor representing the Geosynthetic QAC responsible for quality assurance work associated with geosynthetics.

E. Additional terms defined in RMU-2 Construction Quality Assurance Manual.

1.04 RESPONSIBILITIES

A. Procurement, transportation to site, and storage of geosynthetic materials if specified in Contract Documents.

B. Field handling, deploying, seaming, temporary restraining and all other aspects of geosynthetic installation.

1.05 QUALIFICATIONS

A. Manufacturer approved/qualified installer.

B. Provide sufficient qualified personnel to meet Project demands.

C. Provide materials from geosynthetic manufacturers having internal product quality control programs meeting OWNER’s requirements.

D. Provide Superintendent and Master Seamer.

1. Superintendent:

a. Previously demonstrated experience, management ability and authority.

b. Managed, at a minimum, 2 installation projects entailing installation of at least 1,000,000 square feet: (100,000 square meters) of polyethylene geomembrane unless otherwise approved in writing by OWNER.

2. Master Seamer:

a. Experience seaming minimum of 1,000,000 square feet (100,000 square meters) of polyethylene geomembrane using same type of seaming apparatus as type to be used during Project.

E. Provide personnel qualified to perform geomembrane seaming operations by experience or by successfully passing seaming tests (see Section 02401, Article 3.04.).

1.06 QUALITY ASSURANCE PROGRAM

A. Agree to participate in and conform to items and requirements of OWNER's quality assurance program as described in RMU-2 Construction Quality Assurance Manual.

B. Attend pre-construction meeting.

1.07 FIELD MEASUREMENTS

A. Units:

1. In Specifications, properties and dimensions shall be expressed in U.S. units, with approximate equivalent SI units in parentheses. Conversion is typically only accurate within 10%. In cases of conflict or clarification, U.S. units shall govern.

1.08 WARRANTY

A. Provide written warranty upon Project completion as required in Contract Documents. Warranty shall address quality of material and workmanship.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.01 LINING SYSTEM ACCEPTANCE

A. Geosynthetic Contractor shall retain ownership and responsibility for geosynthetic lining system until accepted by OWNER. At the OWNER's discretion, geosynthetic lining system may be accepted in sections or at points of substantial completion.

B. OWNER will accept geosynthetic lining system based on the following:

1. Installation of lining system, or section thereof.
2. Documentation of installation.
3. Verification of adequacy of field seams and repairs including associated testing.
4. Recommended acceptance by action of Geosynthetic QAC.

C. Progress payments made by OWNER to CONTRACTOR for installed and approved elements of the work do not constitute acceptance.

* * * END OF SECTION * * *

SECTION 01500
TEMPORARY CONSTRUCTION, FACILITIES AND UTILITIES

PART 1 GENERAL

1.01 SUMMARY

A. Provide and maintain temporary facilities and utilities required for construction; remove at completion of Work.

1.02 QUALITY ASSURANCE

A. Comply with federal, state, and local codes and regulations, and utility company requirements.

B. Coordinate all temporary utilities with the OWNER to minimize interruption of OWNER's operations.

PART 2 PRODUCTS

2.01 TEMPORARY ELECTRICITY AND LIGHTING

A. General:

1. Provide temporary electric service as specified herein.

2. Temporary lighting shall be sufficient to enable CONTRACTOR to complete Work and enable OWNER to check Work as it is being performed. Illumination shall meet or exceed OSHA requirements.

3. After Substantial Completion of permanent electrical system and building wiring, permanent receptacles may be used during finishing Work.

4. Use ground fault interrupters on all temporary circuits during construction.

B. Responsibilities:

1. Provide, maintain, and remove temporary electric service facilities.

2. Provide lamps, wiring, switches, sockets, and similar equipment required for temporary lighting and small power tools.

3. Facilities exposed to weather shall be weatherproof and electrical equipment enclosures locked to prevent access by unauthorized personnel.

4. Pay for installation of temporary services including poles, transformer charges, and metering.

5. Patch affected surfaces and structures after temporary services are removed.

6. Arrange with local electric utility for temporary electric service subject to their requirements and approval.

2.02 TEMPORARY HEAT

A. General:

1. Cold Weather Protection: Heating required before building is enclosed.

2. Temporary Heat: Heating required after enclosure of building. Building shall be considered as enclosed when it is roofed and has such protection at doorways, windows, and other openings as will provide reasonable heat retention.

3. See requirements of Specification for minimum temperature to be maintained for various trades and Work. Except as otherwise called for, temperature in all parts of building shall be kept above freezing.

4. Heat shall be warm air heat from oil- or gas-fired portable unit heaters suitably vented to outside as required for protection of health and property.

5. Open salamander type heaters are not permitted for interior use.

6. Site electricity shall not be used for construction-related heating.

B. Responsibilities:

1. Provide temporary heat. Make arrangements and pay fuel costs, supervise, and maintain heating units. Provide adequate heat to all parts of the work.

2. Pay for repairing or replacing any portion of the work that becomes damaged because of lack of heat.

3. Provide temporary throwaway filters if, at any time, permanent system is used for temporary ventilation. Upon acceptance or occupancy of building(s) by OWNER, CONTRACTOR's responsibility for temporary heating as specified shall be in accordance with OWNER'S USE Article, this section.

2.03 TEMPORARY TELEPHONE SERVICE

A. Provide temporary telephone service in job construction office. Locate for CONTRACTOR's use for local and long distance calls.

B. CONTRACTOR shall pay for telephone service directly or be billed by OWNER.

2.04 WATER FOR CONSTRUCTION

A. Water for construction may be available on-site. Provide water of quality and quantity suitable for construction if on-site source is not adequate.

2.05 WATER FOR TESTING

A. Water is available on-site.

2.06 SANITARY FACILITIES

A. Provide temporary sanitary toilet facilities conforming to state and local health and sanitation regulations, in sufficient number for use of CONTRACTOR's employees.

B. Maintain in sanitary condition and properly supply with toilet paper.

C. Remove from site before final acceptance of Work.

D. Do not use existing sanitary facilities.

2.07 TEMPORARY FIRE PROTECTION

A. Provide and maintain in working order a minimum of one fire extinguisher on each floor of each building, and such other fire protective equipment and devices as would be reasonably effective and approved by site Health and Safety Manager.

2.08 TEMPORARY ACCESS ROADS

A. Provide and maintain temporary roadways necessary to carry out construction operations in clean, dust free, snow free, ice free, driveable condition.

B. Provide a gravel surface for temporary access roads subject to vehicle traffic to minimize dust generation.

2.09 DAMAGE TO EXISTING PROPERTY

A. Repair or replace damage to existing facilities, including but not limited to buildings, sidewalks, roads, landscaping, parking lot surfacing, and other existing assets.

B. OWNER will have option of contracting for such Work and deducting cost from Contract amount.

2.10 SECURITY

A. Security not provided by OWNER.

B. CONTRACTOR is responsible for loss or injury to persons or property where his Work is involved, and shall provide such security and take such precautionary measures as deemed necessary to protect CONTRACTOR’s and OWNER’s interests.

2.11 TEMPORARY PARKING

A. Parking on construction site is not allowed, unless designated or approved by OWNER.

B. Make arrangements for parking area for employee's vehicles, in locale designated by OWNER.

C. Costs involved in obtaining parking area shall be borne by CONTRACTOR.

2.12 TEMPORARY FENCING

A. Provide temporary fencing sufficient to control traffic into construction site.

B. Materials shall be sufficiently durable to be effective for duration of construction period.

C. Temporary fencing shall be 4 ft. high, high visibility polyethylene fencing with steel stakes at 8 ft. centers.

2.13 FIELD OFFICES AND BUILDINGS

A. Provide where directed by OWNER, and maintain in good condition, temporary field office and tool storage building(s) for CONTRACTOR's use.

1. Tool storage building(s) shall be of ample size to provide space for tools and equipment. Building(s) shall be neat and well constructed, surfaced with plywood, drop siding, masonite or other similar material, well painted, and void of advertisements.

B. Provide lunch area acceptable to OWNER for CONTRACTOR's personnel and Subcontractors.

2.14 TEMPORARY CONTAINMENT STRUCTURES

A. Provide impervious, lined containment structures where CONTRACTOR handles volatile or hazardous chemicals and agents and where directed by OWNER.

1. Size to contain 110% of liquid volume being handled, plus 6 in. for rainfall.

2. Maintain 1 ft. freeboard at design conditions.

3. Remove upon completion of Work.

4. Clean up and dispose of spillage.

2.15 TEMPORARY EROSION AND SEDIMENT CONTROLS

A. Comply with the OWNER’s Storm Water Pollution Prevention Plan (SWPPP) for the site. Exercise caution to minimize increase in suspended solids and turbidity in surface waters within and adjacent to construction area. Do not deposit soils in surface waters. Control and minimize sediment runoff and excavation erosion to surface waters.

B. Provide temporary controls as necessary to minimize the potential migration of sediments from CONTRCTOR’s work areas. Maintain controls in proper working condition.

C. Temporary controls may include; grading, temporary vegetation, hay bales, silt fencing, or rock check dams. Hay bales shall not be used to control sediments in drainage channels or ditch lines.

D. Maintain temporary controls to limit erosion of completed work until permanent controls are installed, or vegetation is established.

PART 3 EXECUTION

3.01 GENERAL

A. Comply with applicable requirements specified in Divisions 15 and 16.

B. Maintain and operate systems to ensure continuous service.

C. Modify and extend systems, as Work progress requires.

3.02 REMOVAL

A. Completely remove temporary materials and equipment when no longer required.

B. In unfinished areas, clean and repair damage caused by temporary installations or use of temporary facilities, restore drainage, and evenly grade, seed or plant as necessary to provide appearance equal to or better than original.

C. In finished areas, restore existing or permanent facilities used for temporary services to specified or to original condition.

* * * END OF SECTION * **

SECTION 01600
MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Material and Equipment Incorporated into Work:

1. Conform to applicable specifications and standards. Comply with size, make, type, and quality specified or as specifically approved, in writing, by OWNER.

B. Manufactured and Fabricated Materials and Equipment:

1. Design, fabricate, and assemble in accordance with engineering and shop practices standard with industry.

2. Manufacture like parts of duplicate units to standard sizes and gauges, to be interchangeable.

3. Two or more items of same kind shall be identical by the same manufacturer.

4. Material and equipment shall be suitable for service conditions.

5. Equipment capabilities, sizes, arid dimensions shown or specified shall be adhered to, unless variations are specifically approved, in writing.

6. Equipment shall be adapted to best economy in power consumption and maintenance. Parts and components shall be proportioned for stresses occurring during continuous or intermittent operation, and for any additional stresses occurring during fabrication or installation.

7. Design, so working parts are readily accessible for inspection and repair, easily duplicated and replaced.

C. Do not use material or equipment for any purpose other than for which it is designed or specified.

1.02 SUBSTITUTIONS

A. Substitutions:

1. CONTRACTOR's requests for changes in equipment and materials from those required by Contract Documents are considered "requests for substitutions" and subject to CONTRACTOR's representations and review provisions of Contract Documents when one of the following conditions are satisfied.

   a. Where request directly related to "or equal" clause or other language of same effect in Specifications.

b. Where required equipment or material cannot be provided within Contract Time, but not as a result of CONTRACTOR's failure to pursue Work promptly or coordinate various activities properly.

c. Where required equipment or material cannot be provided in a manner compatible with other materials of Work, or cannot be properly coordinated therewith.

2. CONTRACTOR'S Options:

a. Compatibility of Options: Where more than one choice is available as options for CONTRACTOR's selection of equipment or material, select option compatible with other equipment and materials already selected.

b. Standards, Codes, and Regulations: Where compliance with imposed standard, code or regulation is required, select from among products which comply with requirements of those standards, codes, and regulations.

c. "Or Equal": For material or equipment specified by naming one or more equipment manufacturer and "or equal", CONTRACTOR shall submit request for substitution for equipment or manufacturer not specifically named. Submit in accordance with these general requirements.

d. Two or More Manufacturers: For equipment or material specified by naming several manufacturers, select one of the manufacturers named. Do not provide or offer to provide unnamed manufacturer or equipment.

e. Single Manufacturer or Material: For equipment or material specified by naming only one manufacturer or material and followed by words indicating no substitution, there is no option.

B. Conditions which are not substitutions:

1. Requirements for substitutions do not apply to CONTRACTOR options on materials and equipment provided for in Specifications.

2. Revisions to Contract Documents, where requested by OWNER or ENGINEER, are "changes" not "substitutions."

3. CONTRACTOR's determination of and compliance with governing regulations and orders issued by governing authorities do not constitute substitutions or basis for Change Orders, except as provided for in Contract Documents.

1.03 MANUFACTURER'S INSTRUCTIONS

A. Contract Documents require installation of equipment and materials to comply with manufacturer's instructions. Obtain and distribute printed copies of such instructions to parties involved in the installation, including 2 copies to OWNER.

1. Maintain one set of complete instructions at the job site during installation and until completion of Work.

B. Handle, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformity with Specifications.

1. Should job conditions or specified requirements conflict with manufacturer's instructions, consult OWNER for further instructions.

2. Do not proceed with Work without written instructions.

1.04 TRANSPORTATION AND HANDLING

A. Arrange deliveries of materials and equipment in accordance with Construction Progress Schedule; coordinate deliveries to avoid conflict with other Work and conditions at the site.

1. Deliver materials and equipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.

2. Protect machined surfaces, such as shafts and valve faces, with a heavy coat of grease prior to shipment.

3. Immediately upon delivery, inspect shipments to ensure compliance with Contract Documents and approved submittals and that products have been protected and are undamaged.

B. Provide equipment and personnel to handle materials and equipment by methods recommended by manufacturer to prevent soiling or damage to materials, equipment or packaging.

1.05 STORAGE, PROTECTION, AND MAINTENANCE

A. On-site storage areas and buildings shall conform to requirements of Section 01500.

B. OWNER assumes no responsibility for materials and equipment stored in buildings or on-site. CONTRACTOR assumes full responsibility for damage due to storage of materials and equipment.

C. Interior Storage:

1. Store materials and equipment in accordance with manufacturer's instructions, with seals and labels intact and legible.

2. Store materials and equipment subject to damage by elements in weather tight enclosures.

3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

D. Exterior Storage:

1. Exterior storage of all materials shall in be accordance with manufacturer's recommendations. Exterior storage shall not compromise any aspect of the manufacturer's or CONTRACTOR'S warranties.

2. Store fabricated materials and equipment above ground, on blocking or skids, to prevent soiling or staining. Cover materials and equipment subject to deterioration with impervious sheet coverings; provide adequate ventilation to avoid condensation.

3. Store loose granular materials in well-drained area on solid surfaces to prevent mixing with foreign matter. Materials such as pipe, reinforcing and structural steel, and equipment shall be stored on pallets or racks, off ground.

E. Inspection and Maintenance:

1. Arrange storage in manner providing easy access for inspection, maintenance, and inventory.

2. Make periodic inspections of stored materials and equipment to ensure materials and equipment are maintained under specified conditions and free from damage or deterioration, and coverings in-place and in condition to provide required protection.

3. Perform maintenance on stored material and equipment in accordance with manufacturer's written instructions and in presence of the OWNER.

   a. Notify OWNER 24 hours before performance of maintenance.

   b. Submit report of completed maintenance and condition of coverings to OWNER with each Application for Payment.

   c. Failure to perform maintenance, to notify ENGINEER of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.

F. Assume responsibilities for protection of completed construction and repair and restore damage to completed Work equal to original condition.

G. Wheeling of loads over finished floors, with or without plank protection is not permitted in anything except rubber-tired wheelbarrows, buggies, trucks or dollies. This applies to finished floors and exposed concrete floors, as well as those covered with composition tile or other applied surfacing.

H. Where structural concrete has a finished surface, avoid marking or damaging surface.

1.06 INSTALLATION, INSTRUCTIONAL, AND POST STARTUP SERVICES

A. General:

1. This article covers on-site services of supplier's or manufacturer's representatives provided by CONTRACTOR during construction, equipment startup, and training of OWNER's personnel for equipment or plant operation as specifically required in Specification section for equipment or system.

2. Include and pay costs for supplier's or manufacturer's services, including, but not limited to, those specified.

B. Installation Services:

1. Where installation services are called for in the Specifications, provide competent and experienced technical representatives of manufacturers of equipment and systems to resolve assembly or installation procedures attributable to, or associated with, equipment furnished.

2. After equipment is installed, representatives shall perform initial equipment and system adjustment and calibration to conform to Specifications and manufacturer's requirements and instructions.

3. Provide "Certificate of Installation Services" stating proper adjustments have been made to equipment or system and equipment or system is ready for startup and operation. Use form attached to this Section and furnish 2 copies to OWNER.

C. Instructional Services:

1. Where training is called for in the Specifications, provide competent and experienced technical representative of supplier to provide detailed instructions to OWNER's personnel for operation of equipment. Training services shall include pre-startup and equipment startup, classroom, and on-site equipment instruction, as stated in Specifications.

2. Coordinate pre-startup training periods with OWNER and supplier's representatives.

   a. Notify OWNER at least 2 weeks before training sessions are to begin so OWNER can make arrangements with operating personnel.

   b. Reschedule cancelled training sessions 48 hours in advance.

3. Similar types of equipment differing in model, size or manufacturer shall require equal service time as stated in "Supplier's or Manufacturer's Services" in Part One of specific Specification section.

4. Complete pre-startup training 14 days prior to actual system startup.

5. O&M data shall constitute basis of instruction.

   a. Review data contents with personnel in full detail to explain aspects of operations and maintenance.

6. Provide "Certificate of Instructional Services," co-signed by OWNER and supplier's representative, verifying training accomplished to satisfaction of all parties. Use form attached to this Section and furnish 2 copies to OWNER.

D. Post Startup Services:

1. After equipment/system has been in operation for at least 6 months, but no longer than 11 months, each equipment manufacturer or authorized equipment representative shall make final inspection where so required in Specifications. Final inspection will provide assistance to OWNER's operating personnel in making adjustments or calibrations required to ensure equipment or system is operating in conformance with design, manufacturer, and Specifications.

2. Provide "Certificate of Post Startup Services," co-signed by OWNER and equipment representative, verifying this service has been performed. Use form attached to this Section and furnish 2 copies to ENGINEER.

1.07 SPECIAL TOOLS AND LUBRICATING EQUIPMENT

A. Furnish, in accordance with manufacturer's recommendations, special tools required for checking, testing, parts replacement, and maintenance. Special tools are those specially designed or adapted for use on parts of equipment and are not customarily or routinely carried by maintenance mechanics.

B. Deliver to OWNER when unit is placed into operation and after operating personnel has been properly instructed in operation, repair, and maintenance of equipment.

C. Tools and lubricating equipment shall be of quality compatible to equipment that the manufacturer has furnished.

1.08 LUBRICATION

A. Where lubrication is required for proper operation of equipment, incorporate necessary and proper provisions in equipment in accordance with manufacturer's requirements. Where possible, lubrication shall be automated and positive.

B. Where oil is used, reservoir shall be of sufficient capacity to supply unit for a 24 hour period.

1.09 GUARDS

A. Provide necessary guards to meet federal, state, and local requirements. Construct guards of expanded metal where possible.

CERTIFICATE OF INSTALLATION SERVICES
(REFERENCE SECTION 01600)

Project ____

Equipment ____

Specification Section ____

Contract ____

I hereby certify the equipment supplier/manufacturer has inspected this equipment and that it has been properly installed, adjusted, and calibrated. I further certify this equipment may now be operated for test purposes and/or normal use.

MANUFACTURER'S REPRESENTATIVE

Signature ____ Date ________________________

Name (print) ____

Title ____

Representing ____

CONTRACTOR

Signature ____ Date ________________________

Name (print) ____

Title ____

This form shall be completed and submitted to ENGINEER prior to training of OWNER'S personnel.

CERTIFICATE OF INSTRUCTIONAL SERVICES
(REFERENCE SECTION 01600)

Project ____

Equipment ____

Specification Section ____

Contract ____

I hereby certify that the equipment supplier/manufacturer has instructed OWNER'S personnel in the startup operation and maintenance of this equipment as required in the specifications.

CONTRACTOR

Signature ______________________________________ Date ____________________

Name (print) ____

Title ____

OWNER

I hereby certify that my operating personnel received _____ days instruction from ___________________ for startup, operation, and maintenance of this equipment.

WARRANTY PERIOD COMMENCES ON ________________________________
(Date)

Signature ______________________________________ Date ____________________

Name (print) ____

Title ____

Representing ____

COMMENTS:

CERTIFICATE OF POST STARTUP SERVICES
(REFERENCE SECTION 01600)

Project ____

Equipment ____

Specification Section ____

Contract ____

I hereby certify that the equipment supplier/manufacturer has inspected this equipment, made adjustments and calibrations, and that it is operating in conformance with the design, specification, and manufacturer's requirements. Notation of improper operation shall be detailed and recommendations made and attached to this form.

MANUFACTURER'S REPRESENTATIVE

Signature ____ Date ___________________

Name (print) ____

Title ____

Representing ____

CONTRACTOR

Signature ____ Date ___________________

Name (print) ____

Title ____

OWNER

I hereby certify that the equipment supplier/manufacturer has inspected this equipment and made adjustments and calibrations.

Signature ____ Date ___________________

Name (print) ____

Title ____

COMMENTS

This form shall be submitted to as required by the specifications OWNER upon completion of l-year re-inspection.

* * * END OF SECTION * * *

SECTION 01669
TESTING HDPE PIPING SYSTEMS

PART 1 GENERAL

1.01 PROJECT/SITE CONDITIONS

A. Pipelines shall be pressure tested in the presence of the Quality Assurance Consultant (QAC).

B. Furnish water, air supply, or other OWNER approved test medium required for testing and provide necessary piping connections between section of line being tested and nearest available source of water or air supply, together with test pressure equipment, meters, pressure gauge, and other equipment, materials, and facilities necessary to make specified tests.

C. Provide bulkheads, flanges, valves, bracing, blocking or temporary sectionalizing devices that may be required.

D. Remove temporary sectionalizing device after tests are complete.

PART 2 PRODUCTS

(Not: Applicable)

PART 3 EXECTION

3.01 GENERAL

A. Testing:

1. Perform low air pressure testing on Secondary Containment piping prior to installation of welded HDPE pipe sections.

2. Perform hydraulic testing on all HDPE force main and Primary Carrier pipe sections after installation.

B. Commence test procedures when the following conditions are met.

1. Pipe section to be tested shall be clean and free of dirt, sand or other foreign material.

    a. CONTRACTOR is responsible for collection, containment, and disposal of flushing water and debris.

2. Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.

3. Add water or air slowly.

4. Pressurizing equipment shall include a regulator that is set to avoid over-pressurizing and damaging an otherwise acceptable line.

C. Pressure testing shall be in accordance with ASTM F2164 and/or manufacturer recommended procedures.

D. Cost of testing procedure including water, personnel, equipment, and materials shall be CONTRACTOR's responsibility.

E. Correct and re-test leaks or defects at no additional cost to the OWNER.

3.02 LOW PRESSURE AIR TESTING

A. General:

1. Perform air testing on all Secondary Containment piping after piping is butt fused together. Testing may be performed before placement in trench or after placement in trench, but before backfilling.

B. Preparation:

1. Isolate pipe section to be tested by plugging each end with airtight plugs. Plug ends of branches, laterals, and wyes, which are to be included in test section.

2. Brace plugs to prevent slippage and blowout due to internal pressure.

3. One plug shall have inlet tap or other provision for connecting supply air hose.

4. Connect one end of air hose to plug used for air inlet; other end to portable air control equipment.

5. Air control equipment shall consist of valves to control rate at which air flows into test section and gauges to monitor air pressure inside pipe. Air pressure gauges shall be capable of measuring air pressure to the nearest 1 psi or less.

6. Connect air hose between source of compressed air and control equipment.

C. Testing:

1. Pressurize test section to 10 psig.

2. Allow pressure to stabilize for 1 hour.

3. After 1 hour, re-pressurize test section to 10.

4. Record pressure at 15-minute intervals for 1 hour. Test section is acceptable for installation if less than 1 psig pressure drop is recorded over the entire hour, and there are no visible or audible signs of air leakage.

3.03 HYDROSTATIC PRESSURE TESTING

A. General:

1. Perform hydrostatic testing on all force main and primary carrier piping after piping is butt fused together and installed in place. Testing to be performed after placement in trench, but before backfilling.

B. Preparation:

1. Isolate pipe section to be tested by plugging each end with water tight plugs or blind flanges. Plug ends of branches, laterals, and wyes, which are to be included in test section.

2. Brace plugs to prevent slippage and blowout due to internal pressure.

3. One plug shall have inlet tap or other provision for connecting to water supply.

4. Connect one end of water supply pump to plug used for water inlet; other end to water supply.

5. Water supply pump shall consist of valves to control rate at which water flows into test section and gauges to monitor water pressure inside pipe. Water pressure gauges shall be capable of measuring pressure to the nearest 1 psi or less.

6. Connect water hose between source of clean water and water supply pump equipment.

C. Primary Testing Method (Pressure Drop Procedure):

1. Completely fill pipe line to be tested with fresh water or OWNER approved alternate, bleeding off all air from highest point.

2. Pressurize test section to 1.5 times the system operating pressure, or a minimum of 10-psi, and allow pressure to stabilize for 1 hour. During this stabilization period, sufficient liquid shall be added to maintain the test pressure.

3. Following stabilization period, monitor the test pressure for a minimum of 2 hours, checking and recording the pressure at each hourly interval. The test shall be considered complete after the second hourly interval. The test shall be considered successful if there is no visual evidence of leakage and there is no pressure loss during the second hourly interval.

4. At 1 hour intervals, the pressure will be checked and recorded by the Quality Assurance Consultant. If the pressure drops below the test pressure, the line shall be re-pressurized and the test re-started.

D. Alternate Testing Method (Volume Loss Procedure):

1. Completely fill pipe line to be tested with fresh water or OWNER approved alternate, bleeding off all air from highest point.

2. Pressurize test section to 1.5 times the system operating pressure, or a minimum of 10-psi, and allow pressure to stabilize for 1 hour. During this stabilization period, sufficient liquid shall be added to maintain the test pressure.

3. Following the stabilization period, maintain the test pressure by adding additional liquid at hourly intervals for 4 hours. The amount of liquid which is added, in any shall be measured and recorded each hour.

4. The amount of liquid added after the first hour of the test period, and if necessary, the cumulative amounts added after hours 2 and 3, shall be compared to the Expansion Allowance Criteria presented in Table 01669-1.

TABLE 01669-1
Allowances for Pipe Expansion Under Test Pressure
(Gallons per 100 feet of pipe)
Reference: Engineering & Technical Data S-26 – Recommended Testing Procedures for HDPE Pipe

Nominal Pipe Size (in.)	1-Hour Test Duration (gal/1 hour)	2-Hour Test Duration (gal/2 hour)	3-Hour Test Duration (gal/3 hour)
3	0.10	0.15	0.25
4	0.13	0.25	0.40
6	0.30	0.60	0.90
8	0.50	1.0	1.5
10	0.75	1.3	2.1
12	1.1	2.3	3.4

3.04 TEST REPORT

A. Prepare and submit a test report for each piping system tested. Include the following information in the test report.

1. Date of test.

2. Description and identification of piping system tested.

3. Type of test performed.

4. Test fluid.

5. Test pressure.

6. Type and location of leaks detected.

7. Corrective action taken to repair leaks.

8. Results of re-testing.

* * * END OF SECTION * * *

SECTION 01730
OPERATION AND MAINTENANCE (O&M) DATA

PART 1 GENERAL

1.01 DESCRIPTION

A. Compile equipment and product data and related information appropriate for OWNER's operation and maintenance for each item of equipment or product as specified in other sections of Specifications.

1.02 QUALITY ASSURANCE

A. Preparation of data shall be performed by personnel:

1. Trained and experienced in O&M of described products.

2. Familiar with requirements of this section.

3. Skilled as technical writer to extent required to communicate essential data.

4. Skilled as drafter competent to prepare required drawings.

1.03 FORM OF SUBMITTALS

A. Prepare data in a form for use by the OWNER's personnel.

B. Format:

1. Size: 8-1/2 in. by 11 in., or 11 in. by 17 in. folded, with standard 3-hole punching.

2. Paper: 20-lb minimum, white, for typed pages.

3. Text: Manufacturer's printed data, or neatly typewritten.

4. Drawings:

   a. Bind in with text.

   b. Fold larger drawings and place in text page size envelopes bound into binder. Place identification on outside of each envelope.

5. Provide tabbed section dividers between each major section.

   a. Provide title of section on each divider.

   b. Provide tab index in Table of Contents.

6. Cover Label: Label each submittal cover with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and the following:

a. Project title.

b. Name(s) of applicable building(s) or structure(s) as shown on Drawings in which equipment located.

c. Name of equipment as set forth in Contract Documents.

d. Specification section number for equipment as set forth in Contract Documents.

7. Binders:

a. Bind each submittal into commercial quality binder with durable and cleanable plastic covers. Paperboard, laminated paperboard, and canvas covers not acceptable.

b. When multiple binders are used, contents shall be organized into related groupings and each binder cover shall bear identification of specific content.

1.04 GENERAL CONTENTS OF DATA

A. Each submittal shall contain equipment data pertaining to not more than one Specification section number indicated in Contract Documents.

B. Title Sheet: First page in data listing the following:

1. Title: "OPERATION AND MAINTENANCE INSTRUCTIONS.”

2. Title of Project: "RESIDUALS MANAGEMENT UNIT 2".

3. Name(s) of applicable building(s) or structure(s) as shown on Drawings in which equipment located.

4. Name of equipment as set forth in Contract Documents.

5. Specification section number for equipment as indicated in Contract Documents.

6. CONTRACTOR's name, address, and telephone number. Subcontractor's name, address, and telephone number if the equipment is provided by Subcontractor.

7. CONTRACTOR's or Subcontractor's purchase order number, manufacturer's shop order number or any other such numbers required for parts and service ordering.

8. Manufacturer's name, address, and telephone number.

9. Name, address, and telephone number for local source of supply for parts and service.

C. Product List: Immediately after title-sheet containing:

1. List of each product and major components, indexed to content of submittal, and identified by product name and model number as set forth by manufacturer and specification section and article number.

D. Table of Contents: Immediately following product list. Arrange in logical, systematic order and shall be a tab index at minimum. Provide each tabbed section with table of contents for section, arranged in systematic order.

E. Text:

1. Include only those sheets pertinent to specific project.

2. Annotate each sheet to:

a. Clearly identify specific product or part installed.

b. Clearly identify text applicable to product or part installed.

c. Delete inapplicable information.

F. Drawings:

1. Supplement text with drawings to clearly illustrate:

a. Product and components.

b. Relations of component parts of equipment and systems.

c. Control and flow diagrams.

2. Drawings to be actual drawings of equipment from manufacturer. "Typical" drawings are not acceptable, unless they accurately illustrate actual installation.

G. Specially written information, as required to supplement text for a particular installation:

1. Provide explanation of interrelationships of equipment and components, and effects one component has on another and/or entire system.

2. Provide overall instructions and procedures for equipment tying in instructions and procedures for separate components into unified instructional package.

3. Provide glossary of special terms used by manufacturer.

4. Organize in consistent format under separate headings for different procedures.

5. Provide logical sequence of instructions for each procedure.

H. Copy of each warranty, bond, or service contract issued:

1. Provide information sheet for OWNER's personnel to explain:

   a. Proper procedures in event of failure or malfunction to prevent voiding warranty.

   b. Instances affecting validity of warranties or bonds.

1.05 SPECIFIC CONTENT OF DATA FOR EQUIPMENT AND SYSTEMS

A. Specific content, for each unit of equipment and system, shall include:

1. Description of Unit and Component Parts:

   a. Function, normal operating characteristics, and limiting conditions.

   b. Performance curves, engineering data, and tests as applicable. Complete nomenclature and commercial number of replaceable parts. Complete nameplate data. P&ID numbers for equipment as set forth in Drawings.

2. Operating Procedures:

   a. Startup, break-in, and normal operating instructions.

   b. Regulation, control, stopping, shutdown, and emergency instructions.

   c. Summer and winter operating instructions, as applicable.

   d. Special operating instructions.

3. Maintenance Procedures:

   a. Routine maintenance operations.

   b. Guide to troubleshooting.

   c. Disassembly, repair, and re-assembly instructions.

   d. Alignment, adjusting, and checking instructions.

4. Servicing and Lubrication Schedule:

   a. List of lubricants required and quantity to be applied.

   b. Schedule of lubrication.

   c. Schedule for other routine maintenance.

5. Manufacturer's printed instructions regarding safety precautions and features.

6. Description of sequence of operation of controls.

7. Original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

    a. Predicted life of parts subject to wear.

    b. Items recommended to be stocked as spare parts and quantities of same.

8. As-approved control diagrams. These shall be ladder diagrams, instrumentation loop diagrams and electrical schematics as, appropriate.

9. Bill of material.

10. Completed Equipment Data Form typewritten on copy of Form 1 of this section.

11. Other data as required under pertinent sections of Specifications.

B. Specific content for each electric and electronic system, as applicable to equipment such as switch gear, motor control centers, panelboards, switchboards, starters, breakers, relays, shall include:

1. Description of System and Component Parts:

    a. Function, normal operating characteristics, and limiting conditions.

    b. Performance curves, engineering data, rating tables, and tests as applicable.

    c. Complete nomenclature and commercial number of replaceable parts.

    d. Complete nameplate data.

    e. P&ID numbers for equipment as set forth in Drawings.

2. Circuit Directories of Panelboards:

    a. Electrical service.

    b. Controls.

    c. Communications.

3. Complete instrumentation loop diagrams with tabulated listing of components in each control circuit or loop.

4. Operating Procedures:

    a. Routine and normal operating instructions.

    b. Sequences required.

    c. Special operating instructions.

5. Maintenance Procedures:

   a. Routine maintenance operations.

   b. Guide to troubleshooting.

   c. Disassembly, repair, and re-assembly instructions.

   d. Adjustment and checking instructions.

6. Manufacturer's printed safety instructions.

7. List of original manufacturer's spare parts and recommended quantities maintained in storage.

8. Other data as required under pertinent sections of Specifications.

C. Prepare and include additional data when needed for such data that becomes apparent during instruction of OWNER's personnel as requested by OWNER.

1.06 SUBMITTAL SCHEDULE

A. Submit four copies of complete operation and maintenance data, bound in covers bearing suitable identification, for review within 90 days after time CONTRACTOR receives approved Shop Drawings for equipment.

B. ENGINEER's review and acceptance of O&M data will be only for conformance with requirements of this section, for form of submittal and organization of data and completeness of information provided, but not for technical content or coordination between individual suppliers of equipment or system(s).

C. Review O&M submittal and complete Form 2, Contractor Submittal Form, attached to this section in its entirety indicating requirements of this section have been met before submitting to OWNER. OWNER will reject submittals without completed Form 2. Pages for all submittals shall be numbered.

D. OWNER will be sole judge of completeness of data.

E. Payments:

1. An amount equal to 5% of value of equipment item as shown on Schedule of Values will be retained from Progress Payments until copies of O&M data meeting Contract Documents have been received by OWNER for each item of equipment with approved Shop Drawings.

1.07 INSTRUCTION OF OWNER’S PERSONNEL

A. Comply with requirements of Section 01600.

FORM 1 TO SECTION 01730

EQUIPMENT DATA FORM

PROJECT NAME ____________________
CONTRACT NO. ____________________
CONTRACTOR ____________________
EQUIPMENT NO. ____________________ASSET NO.*____________________
DESCRIPTION ____________________MAINT. NO.*____________________
LOCATION ____________________
MANUFACTURER ____________________
PURCHASED FROM ____________________
VENDOR ORDER NO. ____________________PURCHASE $ ____________________
DATE OF PURCHASE ____________________
LOCAL SUPPLIER____________________
ADDRESS ____________________
PHONE NO. ____________________
MODEL NO. ____________________
NO. OF UNITS ____________SERIAL NOS.____________________

NAMEPLATE DATA

ELECTRIC MOTOR

MANUFACTURER____________________
TYPE [ ] AC [ ] DC
HORSEPOWER____________________
RPM ____________________
VOLTAGE ____________________
AMPERAGE ____________________
PHASE ____________________
FRAME ____________________

PUMP /HVAC UNIT

MANUFACTURER____________________
TYPE ____________________
SIZE ____________________
CAPACITY ____________________
PRESSURE ____________________
ROTATION ____________________
IMPELLER
SIZE ____________________
MATERIAL ____________________

DRIVE/REDUCER

MANUFACTURER____________________
TYPE ____ GEAR ____ V-BELT ____ CHAIN
____ VARIDRIVE
SERVICE FACTOR ____________________
RATIO ____________________

OTHER (I & C)

MANUFACTURER ____________________
TYPE ____________________
SIZE ____________________
CAPACITY ____________________
RANGE ____________________

*By Owner

EQUIPMENT DATA FORM
Maintenance Summary

EQUIPMENT NO. ________________________

DESCRIPTION __________________________

ASSET NO.* ____________________________

MAINT NO.* ____________________________

MAINTENANCE OPERATION:

List briefly each maintenance operation required and refer to specific information in Manufacturer's Manual, if applicable. Refer by symbol to Lubricant List" for Lubrication Operation.

FREQUENCY:

List required frequency of each maintenance operation.

*By Owner

EQUIPMENT DATA FORM
Lubricant/Recommended Spare Parts List

EQUIPMENT NO. ______________________________________ ASSET NO.*___________________
DESCRIPTION ____ MAINT. NO.*___________________

LUBRICANT LIST

REFERENCE SYMBOL	LUBRICANT TYPE (MILITARY STANDARD)	RECOMMENDED LUB. AND MANUFACTURER
List symbols in "maintenance operation" (Page 2).	List general lubricant type.	List specific lubricant name, viscosity, and manufacturer.
___________________	___________________	___________________
___________________	___________________	___________________
___________________	___________________	___________________
___________________	___________________	___________________

RECOMMENDED SPARE PARTS LIST

PART NO.**	DESCRIPTION	UNIT	QUANTITY	UNIT COST

ADDITIONAL DATA AND REMARKS

____

____

*By Owner
**Identify parts provided by this contract with two asterisks.
Note:
Attach additional sheets, if necessary, identify each sheet at top with equipment number and description.

FORM 2 TO SECTION 01730

CONTRACTOR SUBMITTAL FORM

TO: ______________________________ DATE: ________________________________
(ENGINEER)

______________________________ SPECIFICATION SECTION TITLE:
(ADDRESS)

______________________________ SECTION NO. ___________________
(CITY, STATE, ZIP)

ATTN: _______________________ MANUFACTURER / VENDOR

FROM: ______________________________ ________________________________
(CONTRACTOR)

______________________________ NO. OF COPIES SUBMITTED: _____
(ADDRESS) (TO ENGINEER)

______________________________ ________________________________
(CITY, STATE, ZIP) (SIGNATURE OF CONTRACTOR)

GENTLEMEN:

We have checked the O&M manual submittal dated _____________________________, and have found it to be in accordance with the requirements of Specification Section 01730 as noted below.

FORMAT

Size: 8-1/2 x 11 or 11 x 17
Paper: 20-lb minimum
Text: Printed data/neatly typed
Drawings: Standard size bound in text; in text-size labeled envelopes
Tabbed Section Dividers
Cover Label:
- Title
- Project name
- Building/structure ID
- Equipment name
- Specification section

Binders: Plastic Cover

CONTRACTOR SUBMITTAL FORM

GENERAL CONTENTS

Provided	Not Applicable	Page No.	
_______	_______	_______	One specification only
_______	_______	_______	Title Page:
_______	_______	_______	Title
_______	_______	_______	Project title
_______	_______	_______	Building/structure ID
_______	_______	_______	Equipment name
_______	_______	_______	Specification section number
_______	_______	_______	Contract or ID
_______	_______	_______	Subcontractor ID
_______	_______	_______	Purchase order data
_______	_______	_______	Manufacturer ID
_______	_______	_______	Service/parts supplier ID
_______	_______	_______	Product List
_______	_______	_______	Table of Contents
_______	_______	_______	Tabbed Sections:
_______	_______	_______	Pertinent data sheets
_______	_______	_______	Annotated as needed
_______	_______	_______	Text
_______	_______	_______	Pertinent to project
_______	_______	_______	Annotated
_______	_______	_______	Drawings:
_______	_______	_______	Illustrate product and components
_______	_______	_______	Control and flow diagrams
_______	_______	_______	Special Information:
_______	_______	_______	Interrelationships of equipment and components
_______	_______	_______	Instructions and procedures provided
_______	_______	_______	Instructions organized in consistent format
_______	_______	_______	Instructions in logical sequence
_______	_______	_______	Glossary
_______	_______	_______	Warranty, Bond, Service Contract

SPECIFIC CONTENT (EQUIPMENT / SYSTEMS ONLY)

_______	_______	_______	Description of Unit and Components:
_______	_______	_______	Equipment functions
_______	_______	_______	Normal operating characteristics
_______	_______	_______	Limiting conditions

CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
_______	_______	_______	Performance curves
_______	_______	_______	Engineering data
_______	_______	_______	Test data
_______	_______	_______	Replaceable parts list (with numbers)
_______	_______	_______	Nameplate data
_______	_______	_______	P & ID numbers
_______	_______	_______	Operating Procedures:
_______	_______	_______	Startup
_______	_______	_______	Routine / normal operation
_______	_______	_______	Regulation and control
_______	_______	_______	Stopping and shutdown
_______	_______	_______	Emergency
_______	_______	_______	Seasonal operation
_______	_______	_______	Special instructions
_______	_______	_______	Maintenance Procedures:
_______	_______	_______	Routine/normal instructions
_______	_______	_______	Troubleshooting guide
_______	_______	_______	Disassembly / re-assembly / repair
_______	_______	_______	Servicing and Lubrication:
_______	_______	_______	List of lubricants
_______	_______	_______	Lubrication schedule
_______	_______	_______	Maintenance schedule
_______	_______	_______	Safety Precautions / Features
_______	_______	_______	Sequence of Operation of Controls
_______	_______	_______	Assembly Drawings
_______	_______	_______	Parts List and Illustrations:
_______	_______	_______	Predicted life
_______	_______	_______	Spare parts list
_______	_______	_______	Control Diagrams / Schematics
_______	_______	_______	Bill of Materials
_______	_______	_______	Completed Equipment Data form per Specification
_______	_______	_______	Other Data as Required

SPECIFIC CONTENT (ELECTRICAL AND ELECTRONIC EQUIPMENT ONLY)

_______	_______	_______	Description:
_______	_______	_______	Equipment functions
_______	_______	_______	Normal operating characteristics
_______	_______	_______	Performance curves
_______	_______	_______	Engineering data
_______	_______	_______	Test data

CONTRACTOR SUBMITTAL FORM

Provided	Not Applicable	Page No.	
_______	_______	_______	Replaceable parts list (with numbers)
_______	_______	_______	Nameplate data
_______	_______	_______	P & ID numbers
_______	_______	_______	Panelboard Directories:
_______	_______	_______	Electrical
_______	_______	_______	Controls
_______	_______	_______	Communications
_______	_______	_______	Instrumentation Loops:
_______	_______	_______	Diagrams
_______	_______	_______	Components list each circuit / loop
_______	_______	_______	Maintenance Procedures:
_______	_______	_______	Routine/normal instructions
_______	_______	_______	Troubleshooting guide
_______	_______	_______	Disassembly / re-assembly
_______	_______	_______	Adjusting and checking
_______	_______	_______	Safety Precautions / Features
_______	_______	_______	Spare Parts List
_______	_______	_______	Additional Data

* * * END OF SECTION * * *

SECTION 01737
ELECTRICAL SYSTEM DEMONSTRATIONS

PART 1 GENERAL

1.01 DESCRIPTION

A. Demonstrate proper operation of electrical systems and equipment in presence of OWNER.

1.02 SUBMITTALS

A. Demonstration log.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.01 PERFORMANCE

A. Demonstrations:

1. Each piece of equipment.

2. Each integrated system.

B. Demonstration Log:

1. Keep log of individual demonstrations.

2. Data:

a. Date and time of demonstration.

b. OWNER's representative.

c. Equipment or system demonstrated.

d. Result of demonstration.

1) Success or fail.

2) If failure, description of failure.

3) Corrective action taken.

4) Redemonstration result.

* * * END OF SECTION * * *

SECTION 02100
SITE PREPARATION AND MAINTENANCE

PART 1 GENERAL

1.01 PROJECT/SITE CONDITIONS

A. Protect and maintain on-site and off-site roads against damage from equipment and vehicular traffic. Repair damage at no added cost to OWNER.

B. CONTRACTOR shall be responsible for the location and protection of existing utilities. CONTRACTOR shall repair any damage to existing utilities at no added cost to OWNER.

C. Conduct operations and maintain Project site so as to minimize creation and dispersion of dust.

D. Restore existing utilities, surface features, and structures to condition equal to or exceeding condition which existed prior to construction.

E. Remove obstructions such as mounds of dirt, stone or debris located within working limits at no extra cost to OWNER.

F. OWNER will provide on-site stockpile area for excavated soil.

G. CONTRACTOR shall review, understand, and agree to adhere to all requirements of OWNER'S Stormwater Pollution Prevention Plan (SWPPP) prior to commencing any site work.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.01 SITE PREPARATION

A. Plan and construct erosion control measures as required for completion of work or as specified by OWNER.

B. Access and On-Site Roads:

1. Obtain necessary permission and prepare access and on-site roads as shown on Drawings and as follows.

   a. Grade, compact, prepare for specified working areas, and to accommodate equipment to be used on roads.

b. Gravel Surfacing: For access roads, crushed gravel or rock with adequate gradation and fines for compaction. Thickness shall be adequate for CONTRACTOR's operations.

c. Maintain access and on-site roads to provide positive drainage, dust control, mud control, and vehicle access. Repair damage such as washouts and excessive rutting promptly, at no additional cost to OWNER.

C. Material Staging Areas

1. Obtain permission and prepare material staging areas as follows.

a. Material staging areas shall be approved by OWNER prior to installation.

b. Material staging areas shall be built and operated in a manner that does not interfere with normal site operations , including maintenance of existing facilities

c. Upon completion of all activities that necessitated the material staging areas, all staging area materials shall be removed by CONTRACTOR for offsite disposal and the area shall be restored to its original condition or a condition deemed appropriate by OWNER.

3.02 SALVAGED TOPSOIL

A. Excavate and temporarily stockpile salvaged topsoil at on-site areas designated by OWNER.

B. Provide transportation of material and prepare site for stockpiles.

3.03 PROJECT CLOSEOUT

A. Repair access and on-site roads if damaged during work activities to condition equal to that at completion of site preparation. CONTRACTOR shall clean up debris and other site damage resulting from CONTRACTOR's activities.

B. Disconnect and remove temporary utilities and structures when no longer required.

C. Submit to OWNER, last utility meter readings or other information necessary relating to point where CONTRACTOR has been released of responsibility for payment of these services.

D. Complete recordkeeping and documentation and transmit to OWNER.

* * * END OF SECTION * * *

SECTION 02110
CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for clearing, grubbing, and disposal of trees, stumps, brush, and other vegetation.

1.02 DEFINITIONS

A. Standard Specifications: "Standard Specifications for Construction and Materials," State of New York Department of Transportation.

1.03 REGULATORY REQUIREMENTS

A. Conform to all applicable codes for disposal of debris. No burning debris on-site.

B. Coordinate clearing work with identification of utilities.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.01 PERFORMANCE

A. No clearing, grubbing or stripping of surficial soil shall commence until the CONTRACTOR has staked out the proposed work, except for the work that may be required to complete the stakeout survey.

B. Except as otherwise directed, the CONTRACTOR shall cut, grub, and remove all objectionable material such as trees, stumps, stones, brush, shrubs, roots, rubbish and debris within the limits of the clearing as defined in the Drawings and as directed by the OWNER. All such materials shall be removed from areas to be occupied by structures, roads and pipelines and from areas designated for stripping. No stumps, trees, limbs or brush shall be buried in any areas not designated to receive such material.

C. Following removal, trees shall be chipped as appropriate and managed as determined by the OWNER. Logs too thick to chip or grind will either be removed from site by the CONTRACTOR or managed on-site as directed by the OWNER.

D. When so designated by the OWNER, the CONTRACTOR shall protect trees or groups of trees, monitoring wells or other site features from damage by any construction operation by erecting suitable barriers, or by other approved means. The CONTRACTOR shall make every effort not to damage common native trees or shrubs, other than those he is permitted to cut, within or adjacent to the limits of work. Areas outside the limits of clearing shall be protected. No equipment or materials shall be stored in or allowed to damage these areas.

* * * END OF SECTION * * *

SECTION 02210
EARTHWORKS

PART 1 GENERAL

1.01 DEFINITIONS

A. Standard Specifications: "Standard Specifications for Construction and Materials," New York State Department of Transportation (NYSDOT).

B. Liner Material: Clay liner material shall be used to construct secondary clay liner. Lines and grades of liner material are designated on Drawings.

C. Unsuitable Material: Topsoil, peat, organic soils, organic debris or soil with less than required bearing capacity as determined by the ENGINEER and/or SOIL QUALITY ASSURANCE CONSULTANT (Soil QAC).

D. Topsoil: Refer to Section 02910 for topsoil definition.

E. Granular Material: Stone used to construct primary and secondary leachate collection systems.

F. Operations Layer: Select fill used to protect liner system during cell operations.

G. General Fill: Soil fill, other than clay liner material and topsoil, used for remainder of site earth work, including final cover, facultative pond berm construction, and replacement of unsuitable material in subgrade preparation.

H. Structural Fill: General Fill to be used in the construction of MSE wall.

I. Underdrain Filter Type Stone: Stone used to bed final cover drainage tile.

J. Influence Zone Around Leachate Force Main or Electrical Conduits: Area below limits bounded by line 12 inches above pipe or duct and by one horizontal to two vertical slope extending outward from that line one foot beyond outer edge of pipe or duct.

K. Influence Zone Under Foundations, Pavements or Sidewalks: Area below foundation, pavement or sidewalk base bounded by one horizontal to two vertical slope extending outward from one foot beyond outer edges of foundation, pavement or sidewalk.

1.02 REFERENCES

A. ASTM D422 - Standard Method for Particle-Size Analysis of Soils.

B. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.

C. ASTM D1140 – Standard Test Method for Amount of Material in Soils Finer Than No. 200 Sieve.

D. ASTM D1556 – Standard Test Method for Density of Soil In Place by the Sand Cone Method.

E. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).

F. ASTM D1587 - Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes.

G. ASTM D2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soils.

H. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

I. ASTM D2434 - Test Method for Permeability of Granular Soils (Constant Head).

J. ASTM D2435 - Test Method for One-Dimensional Consolidation Properties of Soils Using Incremental Loading.

K. ASTM D2487 - Standard Test Method for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

L. ASTM D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.

M. ASTM D2974 - Standard Test Method for Moisture, Ash, and Organic Matter of Peat and Other Organic Materials.

N. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil Soil-Aggregate by Nuclear Methods (Shallow Depth).

O. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

P. ASTM D4643 - Standard Test Method for Determination of Water (Moisture Content of Soil by Microwave Oven Heating.

Q. ASTM D5084 - Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.

R. ASTM D4767 - Standard Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils.

1.03 SUBMITTALS

A. Fill Materials: Name and location of source, stockpile number, and latest test results and DOT approval (if any). Analytical data shall also be submitted for non-aggregate materials (to demonstrate material does not contain chemical constituents exceeding concentrations established by the NYSDEC).

B. Samples: Assist the Soils QAC in taking samples of materials for conformance testing in accordance with the QAM. The OWNER will perform conformance testing.

1.04 QUALITY ASSURANCE

A. Soils QAC will perform quality assurance testing in accordance with the QAM.

B. Grading Tolerances

1. Topsoil:

a. Grade to 4 to 6 in. below finished grade in areas to receive topsoil and seed. Areas to receive topsoil and seed are the RMU-2 final cover and other previously vegetated areas requiring restoration following construction.

2. Access Road:

a. Grade to 12 in. below finished grade under crushed stone access road. Maximum allowable variation from correct elevation is 1 in. in 10 ft. After crushed stone is placed and compacted, maximum allowable variation in cross-slope shall be 0.005 ft/ft. Maximum allowable variation from correct elevation longitudinally along road is 1 in. in 20 ft.

3. Landfill Base:

a. Soil and aggregate components of landfill base, including intercell berms and MSE wall, shall be maintained at correct elevations to prevent ponding on liners. Refer to Drawings for elevations and construction grades. Secondary clay liner shall be a minimum of three feet thick at surveyed locations.

4. Primary Sumps:

a. Maximum allowable variation from correct sump elevation at any location shall be ½ in.

C. Trenching Tolerances

1. Excavate so pipes, ducts, and conduits can be laid straight at uniform grade without sags or humps, between elevations shown on drawings.

2. Maximum width of bottom of trench shall be outside diameter of pipe plus 24 inches. Minimum width shall be outside diameter of pipe plus 12 inches.

3. Where trench width for that portion of trench depth between trench bottom and outside top of pipe, for any reason within CONTRACTOR'S control, exceeds specified limits, CONTRACTOR shall, at his expense, furnish pipe with strength adequate for actual trench width.

4. Maximum width at surface of ground shall not exceed width at top of Leachate transfer pipe or electrical conduit by more than two feet, unless approved by ENGINEER.

5. Excavate electrical conduit trenches as required so center of conduit shall be minimum of 24 inches below final grade.

6. Excavate sidewall riser trenches to tolerances and dimensions shown on drawings.

1.05 PROJECT/SITE CONDITIONS

A. Schedule rough grading with work of other Contractors.

B. Notify corporations, companies, individuals or authorities owning above or below ground conduits, wires, pipes or other utilities running to property or encountered during grading operations. Cap or remove and relocate services in accordance with instructions by owners of said services. Protect, support, and maintain conduits, wires, pipes or other utilities that are to remain in accordance with requirements of owners of said services.

C. Do not block or obstruct roads, streets or pavements with excavation materials, except as authorized by OWNER.

D. Whenever necessary to prevent caving during excavation and to protect adjacent structures, property, workers, and public: excavations shall be adequately sheeted, braced, and shored. Sheeting, shoring, and bracing shall conform to safety requirements of federal, state or local public agency having jurisdiction over such matters. Type, design, detail, and installation of shoring, sheeting, and bracing shall be determined by and the sole responsibility of the CONTRACTOR.

E. Install and maintain erosion and sedimentation controls as prescribed in the RMU-2 Stormwater Pollution Prevention Plan (SWPPP; to be prepared by OWNER and provided to CONTRACTOR).

PART 2 PRODUCTS

2.01 CLAY LINER MATERIAL

A. OWNER may direct use of clay borrow from a designated off-site source or existing on-site borrow source(s). OWNER will make information available to CONTRACTOR for the indicated borrow sources.

B. For CONTRACTOR provided borrow sources, material must be pre-qualified by Quality Assurance Consultant and approved by the OWNER.

C. Clay liner material shall be free of roots, woody vegetation, other deleterious material, and rocks greater than 1-in. diameter at surface grade.

D. Material used for liner shall meet following requirements.

1. Classified as ML, MH, CL, or CH by ASTM D2487.

2. Minimum plasticity index of 10 or greater.

3. Re-compacted permeability less than 1 x 10^{-7} cm/sec.

4. Organic Content: less than 3%.

5. Maximum Particle Size: 1/3 the depth of a loose lift, except for final 4 in. adjacent to HDPE geomembrane. The final 4 in. of prepared clay liner (i.e., adjacent to HDPE membrane) shall have a maximum particle size no greater than 1 in.

6. Material shall have a minimum internal friction angle of 25º. The OWNER shall perform the direct shear test on proposed materials sources in accordance with ASTM D3080. The test specimen shall be molded at 90% of maximum density with normal stresses of 5, 10, and 15 psi.

E. Material testing will be performed continuously by the OWNER throughout Project and used to control placement.

2.02 GRANULAR LAYER MATERIAL

A. Granular layer material for leachate collection systems shall be Type 1A coarse aggregate in accordance with Section 703-02 of the NYSDOT "Standard Specifications", with the following modified gradation:

SCREEN SIZE	PERCENT PASSING (by weight)
0.5 in.	100
0.25 in.	90 - 100
0.125 in	0 - 15
No. 200	0 - 1

B. Permeability: 8.0 x 10^{-2} cm/sec or greater.

C. The OWNER will pre-qualify granular materials in accordance with QAM.

2.03 SELECT FILL (OPERATIONS LAYER)

A. Select fill for operations layer shall be Type 2 subbase material in accordance with Section 733-04 of the NYSDOT “Standard Specifications.”

B. Gradation for select fill for operations layer shall be as follows, unless otherwise approved by OWNER:

SIEVE SIZE	PERCENT PASSING (by weight)
2 in.	100
0.25 in.	25 - 60
No.40	5 - 40
No.200	0 - 10

C. Select fill shall be laboratory tested for shear strength to demonstrate equivalency to a minimum internal friction angle of 34 degrees. Acceptable material shall exhibit the following minimum shear strengths (inclusive of both cohesion and friction) at the indicated normal stresses:

NORMAL STRESS (psf)	MIN. REQ. SHEAR STRENGTH (psf)
100	67
250	169
500	337
1,000	675

2.04 GENERAL FILL

A. General fill shall consist of material taken from approved on-site or off-site excavations or stockpiles.

B. General fill material shall be well-graded granular or cohesive material and free of organics, topsoil, waste, frozen material or other deleterious matter. General fill to be used to replace unsuitable material in the subbase below clay liner shall not be granular.

C. General fill to be used in final cover construction (including above and below final cover geosynthetics) may be either granular or cohesive. If cohesive, general fill shall have a plastic limit of 5 or greater (ASTM D4318). One test shall be performed on each general fill source during each construction season. Material that does not meet these requirements shall be evaluated by the ENGINEER for other possible uses.

D. General fill material to be used for final cover construction (including above and below final cover geosynthetics) shall be laboratory tested for shear strength. Acceptable material shall exhibit the following minimum shear strengths (inclusive of both cohesion and friction) at the indicated normal stresses:

NORMAL STRESS (psf)	MIN. REQ. SHEAR STRENGTH (psf)
100	50
250	125
500	250
1,000	492

E. Acceptable permeability for general fill material to be used for final cover construction and placed above final cover geosynthetics is $1x10^{-5}$ cm/s or lower.

2.05 FILTER STONE

A. Filter Stone shall be granular material meeting the requirements of Section 733-20 of the NYSDOT “Standard Specifications” for Underdrain Filter Type I with the following gradation:

SIEVE SIZE	PERCENT PASSING (by weight)
1 in.	100
½ in.	30 - 100
¼ in.	0 - 30
No. 10	0 - 10
No. 20	0 - 5

2.06 SAND BEDDING MATERIAL

A. Sand bedding to be used under leachate forcemains and electrical conduits to be 6 in. minimum. Backfill with sand above forcemains and conduits to be 12 in. minimum.

B. Sand bedding material shall be Cushion Sand meeting requirements of Section 703-06 of the NYSDOT "Standard Specifications" with the follow graduation:

SIEVE SIZE	PERCENT PASSING (by weight)
1/4 in.	100
No. 50	0 - 35
No. 100	0 - 10

C. As directed by the ENGINEER, a minimum of 5% by weight sodium powdered bentonite, American Colloid or equal, may be added, with the following requirements:

1. Uniform gradation: 200-mesh diameter.

2. Pure bentonite with no additives: 90% sodium-montmorillonite.

3. Free Swell: High-swelling with minimum 16 cubic centimeters per 2 grams.

2.07 STRUCTURAL FILL (GENERAL FILL FOR MSE WALL CONSTRUCTION)

A. Structural fill shall consist of general fill material taken from approved on-site or off-site excavations or stockpiles and meeting the additional strength requirements presented below.

B. Structural fill material shall be well-graded granular or cohesive material and free of organics, topsoil, waste, frozen material, or other deleterious matter, and be free of particles greater in size and angularity that formed the basis of selecting the geogrid long-term design tensile strength.

C. Structural fill material shall be laboratory tested for shear strength (ASTM D4767) under both drained and undrained conditions. Acceptable material shall exhibit the minimum shear strengths (inclusive of both cohesion and friction) summarized below:

1. Consolidated-drained shear strength testing shall demonstrate the equivalent of a failure envelop defined by a cohesion of 195 psf and a friction angle of 28.7 degrees by achieving the following values:

NORMAL STRESS (psf)	MIN. REQ. SHEAR STRENGTH (psf)
500	469
1,000	742
2,000	1,290
4,000	2,385

2. Consolidated-undrained shear strength testing shall demonstrate the equivalent of a failure envelop defined by a cohesion of 2,000 psf and a friction angle of 0 degrees by achieving the following values:

NORMAL STRESS (psf)	MIN. REQ. SHEAR STRENGTH (psf)
500	2,000
1,000	2,000
2,000	2,000
4,000	2,000

3. In the event that non-cohesive soils are used for structural fill, the requirement for undrained shear strength testing is waived.

2.08 COMPACTED CLAY BACKFILL (FOR TRENCHES)

A. Soils classified as CL or CH in the Unified Soil Classification System.

2.09 SUMP BACKFILL MATERIAL

A. Sump Backfill Material shall be granular material meeting the requirements of Section 703-02 of the NYSDOT “Standard Specifications” for Type 3A Course Aggregate with the following gradation:

SIEVE SIZE	PERCENT PASSING (by weight)
2 in.	100
1.5 in.	90 - 100
1 in.	0 - 15

B. Permeability: 4.0×10^{-1} cm/sec or greater.

PART 3 EXECUTION

3.01 DEWATERING:

A. CONTRACTOR is responsible for choosing methods of groundwater and surface water control.

B. Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.

C. Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of foundation bottoms, undercutting footings, and soil changes detrimental to the stability of subgrades and foundations. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.

D. Remove soil disturbed by pressure or flow of groundwater and repair as approved by ENGINEER.

E. Protect adjacent utilities, structures, and properties from damage resulting from dewatering operations.

3.02 PREPARATION

A. CONTRACTOR shall notify corporations, companies, individuals or authorities owning above or below ground conduits, wires, pipes or other utilities running to property or encountered during excavation activities.

B. Cap or remove and relocate services in accordance with instructions by owners of all services.

C. Protect, support and maintain conduits, wires, pipes or other utilities that are to remain in accordance with requirements of owners of said services.

D. Prior to and during all excavation and soil disturbance activities, CONTRACTOR shall comply with all requirements of the Project Specific Site Soil Monitoring and Management Plan, as directed by OWNER.

3.03 EXCAVATION

A. The possibility exists during excavation to encounter localized sand lenses. Sand lenses may be under confined water pressure and cause localized heaving or water intrusion. CONTRACTOR shall be responsible for water intrusion control and excavation of water saturated sand lenses, or other unsuitable materials to provide a firm subgrade.

B. Excavate to lines and grades as shown on the drawings, and as necessary to complete the work. Do not excavate within influence zone of existing utilities, footings or foundations, without prior approval of OWNER.

C. Do not excavate for other structures until scheduled for construction.

D. Protect excavated areas from freezing and water damage.

E. Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).

   1. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.

F. Footings and Foundations: Trim bottoms to required lines and elevations. Excavate to final elevations by hand just prior to concrete placement when concrete is to bear on undisturbed soil.

   1. Stepping Footings: Cut sloping surfaces under footings, foundations, steps, and where required for other Work as indicated.

2. Pile Foundations: Stop excavations 6 to 12 in. above the bottom of pile cap elevation before the piles are placed. After pile installation, remove loose and displaced material and excavate to final grade, leaving a solid base to receive concrete pile caps.

3. Where footings and other Work requiring similar soil support will rest entirely on rock, remove loose soil and loose rock and place concrete to the required elevations. Where footings and other Work requiring similar soil support will rest partially on rock and partially on soil, immediately notify the ENGINEER before any backfilling or concrete placement occurs; the ENGINEER will determine the correct foundation treatment for the Work.

G. Pipe Trenches: Open only enough trench length to facilitate laying pipe sections. Unless otherwise indicated on the Drawings, excavate trenches approximately 24 in. wide plus the outside pipe diameter, equally divided on each side of pipe centerline. Cut trenches to cross section, elevation, profile, line, and grade indicated. Accurately grade and shape trench bottom for uniform bearing of pipe in undisturbed earth. Excavate at bell and coupling joints to allow ample room for proper pipe connections. Excavate so pipes and/or conduits can be laid straight at uniform grade without sags or humps.

H. Open Ditches: Cut ditches to cross sections and grades indicated.

I. Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the ENGINEER.

1. Unauthorized excavations under structural Work such as footings, foundation bases, and retaining walls shall be reported immediately to the ENGINEER before any concrete or backfilling Work commences.

J. Notify the ENGINEER upon completion of excavation operations. Do not proceed with the Work until the excavation is inspected and approved. Upon completion of excavation, the Soils QAC will document grades before CONTRACTOR proceeds with further work.

K. Removal of Unsuitable Material beneath Structures and Other Improvements: Excavate encountered unsuitable materials, which extend below required elevations, to additional depth as directed by the ENGINEER. The Soils QAC will survey cross sections to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement. Proof-rolling may be used to augment inspection/verification of suspect areas.

L. Excavate electrical conduit trenches as required so center of conduit shall be a minimum of 24 inches below final grade.

3.04 SUBGRADE PREPARATION

A. Fill settled areas where excavations or trenches were backfilled and holes made by demolition, tree removal, and site preparation work.

B. Natural soils or compacted fill softened by frost, flooding or weather shall be removed and replaced or compacted as required by the Soils QAC.

C. Subgrade preparation:

1. If CONTRACTOR and Soil QAC do not agree on qualitatively defined excessive pumping or displacement, scarify top 6 to 8 in. of natural subgrade and compact to 90% of Modified Proctor density.

2. Remove and replace soft or loose zones with sufficient thickness of compacted general fill. Thickness of replacement layer shall be as required to support heavy equipment and trucks without excessive pumping or displacement. If thickness of replacement layer is not sufficient to prevent pumping of base, material shall be removed and replaced with thicker layer at no additional cost to OWNER.

3. Replacement layer shall not be granular general fill.

4. Non-woven, heat-bonded geotextile or a geogrid may be used concurrent with removal and replacement efforts to stabilize soft or loose zones of the subgrade. ENGINEER will identify specific material and/or minimum performance criteria.

5. Provided the cutoff wall along the entire length of the cell boundary and the adjoining 25 feet of the adjacent cell(s), as measured from the centerline of the cell separation berm, is keyed into the Glaciolacustrine Clay layer (refer to Article 3.04.D of this section), only final proof rolling of the cell subgrade and approval from the NYSDEC and QAC are required to demonstrate that the cell subgrade has met the required 1×10^{-5} cm/sec permeability.

6. If the cutoff wall cannot be keyed into the Glaciolacustrine Clay (refer to Article 3.04.D of this section), areas of the cell subgrade suspected of having a permeability greater than $1\text{x}10^{-5}$ cm/sec shall be removed to a depth of 2 ft below original cell subgrade design elevation and replaced with general fill having a maximum permeability of $1\text{x}10^{-5}$ cm/sec.

7. The final cell subgrade shall be as described in Article 3.05.C of this section.

D. Cutoff Wall

1. The cutoff wall shall be keyed (vertical depth) into the Glaciolacustrine Clay a minimum of 1 ft. The minimum width of the cutoff wall key shall be 3 ft.

E. Sump Protection:

1. Prior to construction, safety factor against uplift failure (blowout) of sumps shall be verified in field.

2. Safety factor can be measured in one of the following ways.

   a. Excavate test pits outside landfill limits, but close to each proposed sump. Excavate to elevation below proposed sump elevation and inspect integrity of bottom of test pit. Submit results to ENGINEER for approval to proceed.

b. Utilize existing wells and piezometers, or install new piezometers to measure potentiometric surface of uppermost aquifer and calculate safety factor. Submit results to ENGINEER for approval to proceed.

c. Other methods may be submitted to ENGINEER for consideration and may be acceptable.

3. Sumps shall be backfilled with re-compacted clay as soon as sump excavation is complete and grades documented to prevent sump blowout due to changes in potentiometric surface. CONTRACTOR responsible for additional costs resulting from blowout of sump left open for more than 8 hrs.

3.05 PLACING FILL

A. Test plots will be performed for clay liner and final cover general fill materials to determine construction techniques and soil properties necessary to achieve the specified in-place performance requirements.

B. Place fill in accordance with conditions of QAM.

C. Subgrade Preparation for Clay Liner Placement

1. Initial lift of secondary clay liner shall be placed on subgrade that has been prepared to repair desiccation cracking and allow a 1 to 2 in. intermixing of the clay liner material with the subgrade soils.

2. The Soils QAC shall survey subgrade areas following excavation and prior to subgrade desiccation crack repairs.

3. When desiccation cracks are less than 2 in. deep, as measured by a blunt wood No. 2 pencil, the surface of the subgrade shall be wetted sufficiently to soften the subgrade soil for a depth of 1 in.; or, the surface shall be roughened by dozer tracking and blading to create a 1 to 2 in. loose soil layer. The clay liner will be placed on this softened or loosened layer.

4. When desiccation cracks are 2 to 6 in. deep, as measured by a blunt wood No. 2 pencil, the surface of the subgrade shall be wetted sufficiently to create a thin paste-like layer. This paste-like layer shall be back-bladed to smear the paste-like soil across the cracks to partially fill them. Where desiccation cracks measuring 2 to 6 in. deep exist in discrete areas, cracks may be filled in with granular bentonite to the discretion of the Soils QAC. Visual surface inspection after back-blading will approve the effort. The Soils QAC will document the activities, no measurements or tests are required.

5. When desiccation cracks exceed 6 in. deep, as measured by a blunt wood No. 2 pencil, the procedure described for cracks 2 to 6 in. deep may be attempted. The Soils QAC will investigate an area after back-blading by shallow hand excavation to

verify the cracks are substantially filled. Visual inspection with NYSDEC present is all that is needed for approval to place initial lift of secondary clay liner.

D. Clay Liner

1. Lift thickness shall not exceed 9 in. prior to compaction for all lifts, unless otherwise modified by the clay liner test plot results. The acceptability of greater pre-compaction lift thicknesses shall be determined by the ability of compaction equipment to achieve minimum 90% Modified Proctor density or greater throughout entire lift to meet permeability requirements with maximum of 20 passes. Compaction equipment shall be equivalent to equipment used for test pad construction.

2. Remove boulders, rocks, and cobbles exceeding maximum allowable size for respective lift. All removed material will be discarded away from working area.

3. Maintain clay liner surface in condition suitable for geomembrane installation until surface is covered. Clay liner surface shall be free of angular rocks.

4. CONTRACTOR to provide minimum of 3 ft. of secondary clay in all locations, however, maximum variation in remaining liner layer is 0.1 ft. per layer. CONTRACTOR responsible for meeting these requirements at his expense.

5. Scarify sealed lifts prior to next lift placement.

6. Placement of clay liner may occur below 32°F with the Soil QAC's approval, provided frozen soil is not placed. Frozen clay material shall be removed before additional clay lifts are placed. Additional requirements for desiccation due to warm weather construction are included in Quality Assurance Manual. Placement under these conditions does not relieve CONTRACTOR from achieving Specification requirements.

7. First lift testing of the secondary clay liner is modified as follows:

   a. Compaction testing shall be performed with a 4 in. probe depth to limit the influence of the subgrade soils.

   b. Undisturbed samples taken from the first lift shall be field marked by Soil QAC, based on recover length, to prevent permeability testing of clay liner material that has intermixed with subgrade material.

   c. If initial permeability test fails and subsequent re-testing fails, and it can be shown that the subgrade material is the cause of the failures; the NYSDEC will not require the lift to be removed.

E. Granular Layer Material

1. Place granular layer material in a manner that will not create folds in underlying geosynthetics. Walk out bumps and/or wrinkles in geosynthetics that could potentially fold over as granular material is placed.

2. Folds or creases in geosynthetics that cannot be walked out shall be cut out, patched, and tested in accordance with the appropriate specification.

3. A minimum of 36 in. of material shall be used to cover and protect underlying geosynthetics within the travel footprint of temporary haul routes for rubber-tire equipment (e.g., dump trucks, loader).

4. A minimum of 12 in. of material shall be used to cover and protect underlying geosynthetics where operation of low-ground pressure equipment will occur.

F. Select Fill

1. Operations Layer: Place material carefully to avoid damage to the primary leachate collection system and primary liner.

2. A minimum of 36 in. of material shall be used to cover and protect underlying geosynthetics within the travel footprint of temporary haul routes for rubber-tire equipment (e.g., dump trucks, loader). Where underlain by 12 in. of granular layer material, the minimum thickness of select fill shall be reduced to 24 in. to allow for similar equipment use.

3. Operations layer placement shall be performed under constant supervision of the Soil QAC.

G. General Fill

1. Shall not be placed above topsoil.

2. Lift thickness shall generally not exceed 12 in. prior to compaction. General fill compaction shall be specified by the ENGINEER on a case-by-case basis depending on application.

3. General fill material to be placed beneath final cover geosynthetics shall be placed in a 6-inch-thick lift (post compaction). Compaction assessment shall be performed via proof rolling.

4. General fill material to be placed above final cover geosynthetics shall be installed in a single 18-in.-thick minimum lift (post compaction) to protect the underlying geosynthetics.

5. Compaction requirement for the general fill layer above final cover geosynthetics shall be determined based on laboratory remolded permeability testing and test plot results. Required compaction is that which is determined necessary to achieve maximum allowable permeability. Compaction equipment shall be equivalent to equipment used for test plot construction.

6. Achievement of maximum allowable permeability for the general fill layer above final cover geoysnthetics shall be assessed as follows:

   a. In-place density measurements performed at a frequency of nine tests per acre. The measured dry density must equal or exceed the minimum required compaction determined from the test pad.

   b. Undisturbed samples collected from the constructed layer at a frequency of 4 tests per acre and submitted for laboratory permeability testing (ASTM D5084). The tests shall be performed with a confining pressure of 1 psi, which is approximately equal to the soil pressure experienced mid-depth in the general fill layer.

H. Structural Fill

1. Refer to Section 02450 – Mechanically Stabilized Earth (MSE) Wall of the Technical Specifications for placement, compaction, and testing requirements pertaining to structural fill.

I. Additional requirements for placing fill to support structures

1. Place fill within the entire area enclosed by a line 10 ft. outside the perimeter of the structure to be constructed as follows:

   a. Strip the area in accordance with the requirements for Surface Preparation of Fill Areas.

   b. Compact the stripped surface and verify subgrade compaction by proof-rolling.

   c. Place fill in horizontal layers not exceeding 8 in. prior to compaction and compact layers as specified.

2. Obtain written approval of fill area compaction before excavating for footing.

3. Excavate for footing width plus 1 ft. on each side.

4. Excavate 1 ft. below footing elevations where bottom of footings are 2 ft. or less above or 4 ft. or less below original ground surface.

   a. Compact footing bottom and place a 1 ft. bed of select fill. Compact in 6 in. layers to 95% Modified Proctor.

   b. Omit excavation and select fill below bottom of footings where footing elevations are more than 2 ft. above or more than 4 ft. below original ground surface.

J. BACKFILLING TRENCHES

1. Notify ENGINEER before placing backfill material.

2. Do not use frozen material or place fill on frozen subgrade. It is acceptable to place fill on frozen subgrade in the anchor trench where removal of frozen surface may damage the geomembrane liner system. For temporary stormwater diversion berms during construction, fill can be placed when temperatures are below 25 degrees Fahrenheit.

3. Compact each lift of sand bedding with hand held vibratory compactor in maximum lift thicknesses of 6 inches. If powdered bentonite is added to the sand, compact using hand tamping equipment instead of vibratory equipment.

4. Where pipes or electrical ducts must cross, ducts shall be a higher elevation and shall be separated from underlying pipes or ducts by a minimum of 6 inches.

5. Where pipes or electrical ducts leave structures, protect by backfilling pipe or duct influence zone down to undisturbed soil with compacted clay backfill.

6. Do not backfill until new concrete has properly cured.

7. Place warning tape, if required, in accordance with Section 15060.

K. BACKFILLING FOUNDATIONS

1. Do not use frozen material or place on frozen subgrade.

2. Fill excavations below foundations within influence zone with structural fill.

3. To minimize lateral forces against structures due to wedging action of soil, begin compaction of each lift at structure wall.

4. Thickness and Compaction: Place and compact fill materials in maximum lift thickness and to minimum densities as follows:

Location	Lift Thickness (inches)	Modified Proctor (%)
Footing, Foundation Slab or Floor Slab Influence Zone	8	95
Sidewalk, Paving, Piping or Electrical Ducts Influence Zones	12	90
Lawn and Landscape Areas	12	80

3.06 FIELD QUALITY CONTROL

A. The Soils QAC shall perform testing in accordance with QAM.

B. Moisture content of clay liner material and final cover general fill layer: Control the moisture of fill materials in order to achieve the desired compaction results. Moisture content is subject to modification by the ENGINEER after review of soils results.

C. Operations on earthwork shall be suspended at any time satisfactory results cannot be obtained due to field conditions.

D. Wetting or drying of clay liner and general fill material to meet compaction requirements shall be CONTRACTOR'S responsibility. Achieve acceptable moisture contents by blading, discing, harrowing, or other methods to dry material.

E. Assist OWNER in obtaining soil samples and soil testing. Fill placement shall be scheduled to facilitate testing. No additional fill material shall be placed until the Soils QAC approves in-place fill.

1. Maintain control of loose lift thickness with grade stakes or comparable method. When grade stakes are used, they shall be removed prior to subsequent lift placement, excluding the secondary clay layer. For the secondary clay layer, the Soils QAC will visually ensure that there will be no contamination of any secondary soil lift by the grade stakes. Grade stakes must be removed from loose soil lift prior to compaction.

3.07 ADJUSTMENT AND CLEANING

A. Place excavated material not suitable for backfilling or site grading and unsuitable materials in designated spoil areas and grade to drain.

B. Stockpile excavated material suitable for backfill in OWNER designated areas. CONTRACTOR shall not stockpile materials where trenches for sewers, water lines or other utilities will be located.

3.08 EROSION AND SEDIMENT CONTROLS

A. OWNER will prepare the RMU-2 SWPPP. The RMU-2 SWPPP will generally direct the location and type of various erosion and sediment controls necessary to minimize the potential for damage to constructed soil surfaces by water erosion and associated loss of soil. The RMU-2 SWPPP will identify controls to be used for both cell and final cover system construction.

B. CONTRACTOR shall review, understand, and agree to abide by all requirements contained in the RMU-2 SWPPP.

C. CONTRACTOR shall furnish, install, and maintain all erosion and sediment controls prescribed in the RMU-2 SWPPP, to be prepared by the OWNER and provided to the CONTRACTOR.

D. CONTRACTOR may be required to furnish, install, and maintain additional erosion and sediment controls in the event those specified in the RMU-2 SWPPP do not adequately achieve the erosion and sediment control objectives. This determination may be made by either OWNER, ENGINEER, or CONTRACTOR. Any changes to the controls specified in the RMU-2 SWPPP must be approved by OWNER and ENGINEER prior to implementation.

* * * END OF SECTION * * *

SECTION 02401
POLYETHYLENE GEOMEMBRANE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide 40 mil textured high-density polyethylene geomembrane for the landfill final cover system and 80 mil textured high-density polyethylene geomembrane for the base liner systems.

1.02 REFERENCES

A. ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

B. ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.

C. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastomer.

D. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

E. ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.

F. ASTM D3895 - Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.

G. ASTM D4437 - Standard Practice for Non-Destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

H. ASTM D4833 - Standard Test Method of Index Puncture Resistance of Geomembranes and Related Products.

I. ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

Modifications:

1. Perform interface shear testing of geomembrane with materials which will be installed above and below the geomembrane (i.e., geocomposite/80 mil textured geomembrane, 80-mil textured geomembrane/geosynthetic clay liner, 80-mil textured geomembrane/compacted clay liner, geocomposite/40-mil textured geomembrane, and 40-mil textured geomembrane/geosynthetic clay liner).

2. Normal loads: 100, 250, 500 and 1,000 psf for geomembrane in the cover system and 100, 250, 500, 1,000, 2,500, 5,000, 10,000 and 15,000 psf for geomembrane in the liner system.

J. ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

K. ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.

L. ASTM D5641 - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

M. ASTM D5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.

N. ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

O. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.

P. ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane.

Modifications:

1. Measure thickness at 1 ft. intervals across roll width.

2. Report individual measurements, average, and standard deviation.

Q. ASTM D6392 - Standard Test Method for Determining the Integrity of Non-reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.

Modifications:

1. For peel adhesion, seam separation shall not extend more than 25% of seam width into seam.

R. ASTM D6693 (Type IV) - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.

S. ASTM D7466 - Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.

T. GRI GM10 - Specification for the Stress Crack Resistance of Geomembrane Sheet.

U. GRI GM11 - Accelerated Weathering of Geomembranes Using a Fluorescent UVA-Condensation Exposure Device.

V. GRI GM13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.

W. GRI GM19 - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

Note: The most current version of the specified test methods indicated above should be followed by the GEOSYNTHETICS MANUFACTURER, GEOSYNTHETICS INSTALLER, or authorized testing laboratory. In the event that a new test method becomes available and is deemed by the ENGINEER to be appropriate for use, either in addition to those methods indicated above or as a replacement to one or more of the methods indicated above, the new method will be used.

1.03 QUALITY CONTROL SUBMITTALS

A. Pre-installation: The GEOSYNTHETICS MANUFACTURER shall submit the following to the OWNER for approval prior to geomembrane delivery.

1. Origin (supplier's name and production plant) and identification (brand name and number) of resin.

2. Copies of dated quality control certificates issued by resin supplier.

3. Results of tests conducted by the GEOSYNTHETICS MANUFACTURER to verify that resin used to manufacture geomembrane meets specifications listed in Article 2.01.

4. Statement that amount of reclaimed polymer added to resin during manufacturing was done with appropriate cleanliness and did not exceed 2% by weight.

5. List of materials, which comprise geomembrane, expressed in the following categories as percent by weight: polyethylene, carbon black, and other additives. Geomembrane shall not contain more than 1.0% by weight of other additives (fillers or extenders).

6. Manufacturer's specification, which includes properties, listed in Article 2.01 as measured using appropriate test methods.

7. Written certification that the minimum values given in GEOSYNTHETICS MANUFACTURER's specification are guaranteed by the GEOSYNTHETICS MANUFACTURER.

8. Quality control certificates, signed by responsible entity employed by geomembrane manufacturer. Each quality control certificate shall include applicable roll identification numbers, testing procedures, and results of quality control tests required by Article 2.03 A.

9. Submit a field panel layout diagram indicating the proposed layout of field seams and panel orientation. A field panel is defined as unit of geomembrane, which is to be seamed in field, (i.e., field panel roll or portion of roll cut in field).

B. Installation: The GEOSYNTHETICS INSTALLER shall submit the following to the OWNER and ENGINEER as installation proceeds:

1. Quality control documentation recorded during installation.

2. Submit prior to geomembrane deployment subgrade surface acceptance certificates signed by GEOSYNTHETICS INSTALLER for each area that will be covered directly by geomembrane.

C. Completion: The GEOSYNTHETICS INSTALLER shall submit the following to the OWNER and ENGINEER upon completion of the installation of the geomembrane:

1. The warranty obtained from the manufacturer of the flexible membrane liner (FML) to warranty material for a period no less than 10 years.

2. An installation warranty shall be submitted to cover the installation for a period of 1 year.

1.04 FIELD SAMPLES

A. Geomembrane sampling shall be conducted by the GEOSYNTHETICS QAC for the following, in accordance with Quality Assurance Manual (QAM).

1. Conformance Testing (Article 3.01 A of this section).

2. Destructive Seam Testing (Article 3.04 D of this section).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. The GEOSYNTHETICS MANUFACTURER shall provide the following information on labels attached to each roll of geomembrane delivered to the site:

a. Manufacturer's name.

b. Product identification.

c. Thickness.

d. Roll number.

e. Roll dimensions.

2. The GEOSYNTHETICS MANUFACTURER shall ensure that geomembrane rolls are properly loaded and secured to prevent damage during shipping.

3. The GEOSYNTHETICS INSTALLER shall protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions while stored on-site.

B. Acceptance at Site:

1. The GEOSYNTHETICS QAC and the GEOSYNTHETICS INSTALLER, together, shall perform inventory and outer surface inspection for defects and damage, of all geomembrane rolls upon delivery.

2. The GEOSYNTHETICS QAC may require the GEOSYNTHETICS INSTALLER to unroll and inspect any geomembrane roll that shows signs of damage.

3. Damage resulting from handling and transport of geomembranes shall be repaired at no cost to OWNER. If irreparable, in opinion of the ENGINEER, damaged materials shall be replaced at no cost of OWNER.

C. Storage and Protection:

1. The GEOSYNTHETICS INSTALLER and/or EARHWORK CONTRACTOR shall provide on-site storage in the area indicated by OWNER for geomembrane rolls from time of delivery until installed.

2. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall store and protect the geomembrane from dirt, water, and other sources of damage.

3. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall preserve integrity and readability of geomembrane roll labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. FINAL COVER GEOMEMBRANE MATERIAL - The GEOSYNTHETICS QAC shall obtain random samples of the proposed textured geomembrane to be used in the Final Cover System and materials that will be installed above and below the geomembrane. These samples will be tested for shear strength for each interface (i.e., geocomposite/40-mil textured geomembrane and 40-mil textured geomembrane/geosynthetic clay liner). A minimum of one round of interface shear strength testing (including testing at all indicated normal stresses, under all conditions, and for each interface) shall be completed prior to any construction season involving final cover construction. The interface shear strength testing shall be repeated if, in the opinion of the ENGINEER, the manufacturer, product, or material characteristics of the associated products (geomembrane, geocomposite, or GCL) change following acceptance of the initial testing. Testing must be conducted prior to the approval of the materials and performed with components that will be used in construction. Testing may be performed prior to or following delivery of the geomembrane material to the site. In either case, testing must be conducted on the actual material that will be used in construction of the final cover. Testing shall be conducted according to the most recent version of ASTM D5321, and the reported results shall meet the requirements of Paragraph A.1 of this Part.

1. Tests shall be performed at a normal load of 100, 250, 500 and 1,000 psf with a strain rate of 0.04 in./min. and a minimum displacement of 6 in. The minimum

required peak and residual interface shear strengths are provided in the following table.

GEOMEMBRANE INTERFACE SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.		
Normal Stresses (psf)	Required Peak Shear Strength (psf)*	Required Residual Shear Strength (psf)*
100	50	33
250	125	83
500	250	167
1,000	492	329

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

Additionally, testing for interface residual shear strength shall be performed at normal loads of 100, 250 and 500 psf at high strain rate (minimum of 0.5 in./min.) and large strains to simulate strength conditions during a seismic event. The required residual shear strengths are provided in the table below.

GEOMEMBRANE INTERFACE SHEAR STRENGTH DURING SEISMIC EVENT (ASTM D5321) Frequency of 1 test per product type.	
Normal Stresses (psf)	Required Residual Shear Strength (psf)*
100	38
250	95
500	191

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

B. BASELINER GEOMEMBRANE MATERIAL - The GEOSYNTHETICS QAC shall obtain random samples of the proposed textured geomembrane and materials that will be installed above and below the geomembrane for the Baseliner System. These samples will undergo interface shear strength testing for each interface (i.e., geocomposite/80 mil textured geomembrane, 80-mil textured geomembrane/geosynthetic clay liner, and 80-mil textured geomembrane/compacted clay liner). A minimum of one round of interface shear strength testing (including testing at all indicated normal stresses, under all conditions, and for each interface) shall be completed prior to any construction season involving Baseliner construction. The interface shear strength testing shall be repeated if, in the opinion of the ENGINEER, the manufacturer, product, or material characteristics of the associated products (geomembrane, geocomposite, GCL, or clay liner) change following acceptance of the initial testing. Testing must be conducted prior to the approval of the materials and performed with components that will be used in the construction. Testing may be performed prior to or following delivery of the geomembrane material to the site. In either case, testing must be conducted on the actual material that will be used in construction of the final cover. Testing shall be conducted according to the most recent version of ASTM D5321, and the reported results shall meet the requirements of Paragraph B.1 and B.2 of this Part.

1. Tests shall be performed at a normal load of 100, 250, 500, and 1,000 psf with a strain rate of 0.04 in./min. and a minimum displacement of 1 in. The minimum required peak interface shear strengths are provided in the following table.

GEOMEMBRANE INTERFACE SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.	
Normal Stresses (psf)	Required Peak Shear Strength (psf)*
100	41
250	103
500	206
1,000	412

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

2. Tests shall be performed at a normal load of 100, 250, 500, 1,000, 2,500, 5,000, 10,000 and 15,000 psf with a strain rate of 0.04 in./min. and a minimum displacement of 6 in. The minimum required residual interface shear strengths are provided in the following table.

GEOMEMBRANE INTERFACE SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.	
Normal Stresses (psf)	Required Residual Shear Strength (psf)*
100	31
250	78
500	156
1,000	311
2,500	1,200
5,000	2,100
10,000	3,500
15,000	4,400

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

C. Supply geomembranes and resins which meet the following specifications:

POLYETHYLENE GEOMEMBRANE PRODUCTS

PROPERTY	METHOD*	REQUIRED VALUE (min ave unless otherwise noted)	
		40 mil	**80 mil**
Thickness	ASTM D5994	38 mil (min ave) 36 mil (lowest individual for 8 of 10 values) 34 mil (lowest individual for any of 10 values)	76 mil (min ave) 72 mil (lowest individual for 8 of 10 values) 68 mil (lowest individual for any of 10 values)
Asperity Height	ASTM D7466	10 mil (min ave) 7 mil (min for 8 of 10 values) 5 mil (lowest individual)	
Density	ASTM D1505/D792	0.94 g/cm^3	
Tensile Properties (5 replicates each direction)	ASTM D6693 Type IV	84 lb/in (yield strength) 60 lb/in (break strength) 12% (yield elongation)	168 lb/in (yield strength) 120 lb/in (break strength) 12% (yield elongation)

PROPERTY	**METHOD***	**REQUIRED VALUE (min ave unless otherwise noted)**	
		40 mil	**80 mil**
		100% (break elongation)	100% (break elongation)
Tear Resistance	ASTM D1004	28 lb	56 lb
Puncture Resistance	ASTM D4883	60 lb	120 lb
Stress Crack Resistance	ASTM D5397	300 hr	
Carbon Black Content	ASTM D1603	2-3%	
Carbon Black Dispersion	ASTM D5596	9 in categories 1 or 2, 1 in category 3	
Oxidative Induction Time (OIT)	ASTM D3895 (Standard OIT) or ASTM D5885 (High Pressure OIT)	100 minutes or 400 minutes	
Oven Aging at 85° C	ASTM D5721 Standard OIT, % retained after 90 days (ASTM D3895) or High Pressure OIT, % retained after 90 days (ASTM D5885)	55% or 80%	
UV Resistance	High Pressure OIT, % retained after 1,600 hours (ASTM D5885)	50%	

* Test Methods as modified in Article 1.02

D. Geomembrane shall be manufactured from new polyethylene resin. A maximum of 2% by weight of factory regrind resin recycled during the manufacturing process may be used if the manufacturer provides resin documentation of reclaimed material.

E. Geomembrane manufactured from non-complying resin shall be rejected.

F. Resin shall be designed and manufactured specifically for use in geomembranes.

G. Geomembrane shall be free of pinholes and non-dispersed raw materials or other signs of contamination by foreign matter.

2.02 SEAMING AND TESTING EQUIPMENT

A. Welding:

1. Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus, or utilize hand-held gauges to measure extrudate temperatures.

2. Use fusion-welding apparatus that are self-propelled devices equipped with a gauge indicating temperature of heating element, and a method of monitoring relative pressure applied to geomembrane.

3. Maintain on-site a minimum of 2 spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.

4. Seaming equipment shall not damage geomembrane.

B. Vacuum Testing: Equipment shall consist of following:

1. Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing, porthole or valve assembly, and vacuum gauge.

2. Pump assembly equipped with pressure controller and pipe connections.

3. Pressure/vacuum rubber hose with fittings and connections.

4. Bucket of soapy solution and a wide paint brush or other means of applying the soapy solution.

C. Air Pressure Testing: Equipment shall consist of following:

1. Air pump equipped with a pressure gauge, capable of generating, sustaining, and measuring pressure between 24 and 35 psi (160 and 240 kPa), and mounted on cushion to protect geomembrane.

2. Rubber hose with fittings and connections.

3. Sharp hollow needle or other approved pressure feed device equipped with a pressure gauge.

2.03 MANUFACTURER QUALITY CONTROL

A. Tests, Inspections:

1. Geomembranes shall be tested by geomembrane manufacturer for quality control to demonstrate that resin meets these specifications. Testing frequency shall be in accordance with GRI GM13.

2. GEOSYNTHETICS MANUFACTURER shall continuously monitor during manufacturing process for inclusions, bubbles, or other defects. Geomembranes that exhibit defects shall not be acceptable for installation.

3. GEOSYNTHETICS MANUFACTURER shall monitor thickness continuously during manufacturing process.

4. No geomembrane shall be acceptable for installation, which fails to meet specified values. Samples not satisfying specifications shall result in rejection of rolls represented by tests. At GEOSYNTHETICS MANUFACTURER's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and to qualify individual rolls.

PART 3 EXECUTION

3.01 EXAMINATION

A. Conformance Testing:

1. Samples of the geomembrane shall be collected for conformance testing. As outlined in Section 10.4 of QAM, conformance samples shall be collected in one of the following manners:

a. The GEOSYNTHETICS QAC shall collect samples of geomembrane for conformance testing at the time of delivery to the site; or

b. The GEOSYNTHETICS QAC shall direct representatives of the GEOSYNTHETICS QAL to collect samples of the geomembrane for conformance testing from the material at the manufacturer's facility.

2. GEOSYNTHETICS MANUFACTURER may request retesting of failed conformance tests, as outlined in QAM. GEOSYNTHETICS MANUFACTURER shall bear cost of retesting if results lead to material rejection. GEOSYNTHETICS QAC shall bear cost of retesting if original conformance tests found to be in error. Material that does not meet the requirements specified in Article 2.01 C of this section shall be immediately removed from the site.

3.02 PREPARATION

A. Surface Preparation:

1. GEOSYNTHETICS INSTALLER shall verify that supporting soil or geosynthetic surface has been properly prepared for geomembrane deployment.

2. Geomembrane shall not be deployed until all necessary testing of underlying layer(s) has been completed and the associated results have been reviewed and approved by applicable parties.

3. After prepared surface has been accepted in accordance with QAM, report to OWNER any change in supporting soil condition that may require work. Take special care to maintain prepared soil surface.

4. Do not place geomembrane onto any area that has become softened by precipitation or cracked due to desiccation. Observe soil surface daily to evaluate softening and to check for desiccation cracking.

5. Repair, at GEOSYNTHETICS INSTALLER's expense, damage to subgrade caused by installation activities.

3.03 INSTALLATION

A. Panel Nomenclature:

1. The GEOSYNTHETICS INSTALLER shall mark each field panel with identification code (number or letter-number) consistent with approved layout plan. OWNER, GEOSYNTHETICS INSTALLER, and GEOSYNTHETICS QAC shall agree upon this identification code.

B. The following presents requirements to be followed by the GEOSYNTHETICS INSTALLER to protect geomembrane material during installation:

1. Do not use equipment, which damages geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means. Provide a protective layer under equipment (e.g., generators, welding apparatus) to prevent damage.

2. Ensure prepared surface underlying geomembrane has not deteriorated since previous acceptance and remains acceptable immediately prior to geomembrane deployment.

3. Keep geosynthetic elements immediately underlying geomembrane clean and free of debris.

4. Do not permit personnel to smoke or wear shoes that can damage geomembrane while working on geomembrane. Personnel shall not bring glass bottles onto the geomembrane.

5. Unroll panels in manner, which does not cause excessive scratches or crimps in geomembrane and does not damage supporting soil.

6. Place panels in manner, which minimizes wrinkles (especially differential wrinkles between adjacent panels).

7. Prevent wind uplift by providing adequate temporary loading and/or anchoring (e.g., sandbags, tires) that shall not damage geomembrane. In case of high winds, continuous loading is recommended along panel edges.

8. Protect geomembrane in areas where excessive traffic is expected with geotextiles, extra geomembrane, or other suitable materials.

C. The GEOSYNTHETICS INSTALLER shall adhere to the following requirements during geomembrane panel deployment:

1. Install field panels at locations indicated on the geomembrane approved layout plan, as approved by ENGINEER.

2. Replace seriously damaged (torn, twisted, or crimped) field panels or portions thereof, at no cost to OWNER. Repair less serious damage according to Article 3.03 H of this section. GEOSYNTHETICS QAC shall determine if material is to be repaired or replaced.

3. Remove from work area any damaged panels or portions of damaged panels that have been rejected.

4. Do not proceed with deployment at ambient temperature below 32°F (0°C) or above ambient temperature of 104°F (40°C) or above sheet temperature of 122°F (50°C) unless otherwise authorized, in writing, by OWNER AND ENGINEER.

5. Do not deploy during precipitation, in presence of excessive moisture (e.g., fog, dew), in area of ponded water or in presence of excessive winds.

6. Do not deploy more geomembrane field panels in l-day than can be seamed during that day.

D. The GEOSYNTHETICS INSTALLER shall adhere to the following requirements regarding seam location and layout:

1. When possible orient seams parallel to line of maximum slope, (i.e., oriented along, not across, slope).

2. No horizontal seam shall be less than 5 ft. (1.5 m) from toe of slope greater than 10H:1V or areas of potential stress concentration, unless otherwise authorized by OWNER AND ENGINEER and GEOSYNTHETICS QAC.

3. In general, maximize lengths of field panels and minimize number of field seams.

E. Temporary Bonding:

1. Hot air device (Liester) may be used to temporarily bond geomembrane panels that are to be extrusion welded. No other temporary bonding of geomembrane is allowed unless authorized by the ENGINEER.

2. Do not damage geomembrane when temporarily bonding adjacent panels. Apply minimal amount of heat to lightly tack geomembrane panels together. Control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to geomembrane.

3. Do not use solvent or adhesive.

F. Seaming Methods: Approved processes for field seaming are extrusion fillet welding and fusion welding. Proposed alternate processes shall be documented and submitted to OWNER and ENGINEER for approval. Alternate procedures shall be used only after being approved in writing by the OWNER and the ENGINEER.

1. Produce seams meeting following requirements in conformance with GRI GM19:

POLYETHYLENE SEAM PROPERTIES

PROPERTY	**METHOD**	**VALUE (minimum)**	
		40 MIL	**80 MIL**
Shear Strength	ASTM D4437*	80 lb/in	160 lb/in
Peel Strength			
Fusion	ASTM D4437*	60 lb/in	121 lb/in
Extrusion	ASTM D4437*	52 lb/in	104 lb/in

* Test methods as modified in Article 1.02.

2. Align geomembrane panels to have nominal overlap of 3 in. (75 mm) for extrusion welding and 5 in. (125 mm) for fusion welding. Provide sufficient overlap to allow peel tests to be performed on seam.

3. Use double-fusion welding as primary method of seaming adjacent field panels.

   a. For cross seam tees, associated with fusion welding, extrusion weld to minimum distance of 4 in. (100 mm) on each side of tee.

   b. When subgrade conditions dictate, use movable protective layer (e.g. extra piece of geomembrane) directly below each overlap of geomembrane that is to be seamed to prevent buildup of moisture between sheets and prevent debris from collecting around pressure rollers.

4. Use conventional fillet extrusion welding as secondary method for seaming between adjacent panels and as primary method of welding for detail and repair work. Fillet extrusion welding shall also be used as the primary method of welding in corners of the perimeter berm, and the perimeter/intercell berm.

   a. Purge heat-degraded extrudate from barrel of extruder prior to beginning seam and whenever extruder has been inactive.

   b. Use clean and dry welding rods or extrudate pellets.

   c. Complete grinding process without damaging geomembrane within l hr of seaming operation.

   d. Minimize exposed grinding marks adjacent to extrusion weld. Do not allow exposed grinding marks to extend more than ¼ in. outside finished seam area.

G. The GEOSYNTHETICS INSTALLER shall adhere to the following seaming procedures:

1. General Seaming Procedures

a. Perform seaming under dry conditions, i.e., no precipitation or other excessive moisture. Suspend seaming during periods of excessive winds. Portable shelters (tents) may be used to protect seam area, at no additional cost to the OWNER.

b. If required, provide firm substrate by using extra piece of geomembrane, or similar hard surface directly under seam overlap to achieve proper support for seaming apparatus.

c. Align seams with least possible number of wrinkles and fishmouths. Cut fishmouths or wrinkles along ridge of wrinkle in order to achieve flat overlap. Seam cut fishmouths or wrinkles and patch portions where overlap inadequate. Use oval or round patch of same geomembrane extending minimum of 6 in. (150 mm) beyond cut in all directions.

d. Provide adequate illumination if seaming operations carried out at night.

e. Extend seams to outside edge of panels placed in anchor trench.

f. Do not field seam without master seamer being present.

g. Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris, or foreign material of any kind.

2. Cold Weather Seaming Procedures: The GEOSYNTHETICS INSTALLER shall meet the following conditions, in addition to general seaming procedures, if seaming is conducted when the ambient temperature is below 32°F (0°C).

a. Preheating of seams is required if the geomembrane surface temperature is below 32°F (0°C). GEOSYNTHETICS QAC shall determine geomembrane surface temperatures at intervals of at least once per 100 ft. of seam length. Preheating devices used shall be pre-approved by OWNER prior to use.

b. Preheating may be waived by OWNER based on recommendation from GEOSYNTHETICS QAC, if demonstrated to GEOSYNTHETICS QAC's satisfaction that welds of equivalent quality may be obtained without preheating at expected temperature of installation.

c. GEOSYNTHETICS QAC shall observe all areas of geomembrane that have been preheated by hot air device prior to seaming, to ensure they have not been subjected to excessive melting.

d. GEOSYNTHETICS QAC shall confirm that surface temperatures not lowered below minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for seam area.

e. Additional destructive seam tests, as described in Article 3.04 D of this section, shall be taken at interval between 500 ft. and 250 ft. of seam length, at GEOSYNTHETICS QAC's discretion.

f. Sheet grinding may be performed before preheating, if applicable.

g. Trial seaming, as described in Article 3.04 B of this section, shall be conducted under same ambient temperature and preheating conditions as actual seams. New trial seams shall be conducted if ambient temperature drops by more than 10°F (3°C) from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature drop.

3. Warm Weather Procedures: The GEOSYNTHETIC INSTALLER shall meet following conditions, in addition to general seaming procedures, if seaming conducted when sheet temperature above 122°F (50°C) or ambient temperature above 104°F (40°C).

a. At sheet temperatures above 122°F (50°C) or ambient temperature above 104°F (40°C), no seaming of geomembrane shall be permitted unless demonstrated to OWNER's satisfaction that geomembrane seam quality will not be compromised.

b. Trial seaming, as described in Article 3.04 B, shall be conducted under same ambient temperature conditions as actual seams. New trial seams shall be conducted if ambient temperature rises by more than 5°F (3°C) from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature rise.

c. Additional destructive seam tests, as described in Article 3.04 D of this section, shall be taken, at the GEOSYNTHETICS QAC's discretion.

H. The following repair procedures shall be performed by the GEOSYNTHETICS INSTALLER:

1. Repair portions of geomembrane that are damaged, exhibit flaws, or fail destructive or non-destructive seam tests.

2. Final decision as to appropriate repair procedure shall be agreed upon between OWNER, ENGINEER, GEOSYNTHETICS INSTALLER, and GEOSYNTHETICS QAC.

3. Available repair procedures include following:

a. Patching: Piece of the same geomembrane extrusion welded into place. Use to repair large holes, tears, non-dispersed raw materials, and contamination by foreign matter.

b. Spot welding or seaming: Bead of molten extrudate placed on flaw. Use to repair small tears, pinholes ($\leq$ 1/16 of an in. in diameter), or other minor, localized flaws.

c. Capping: Strip of same geomembrane extrusion welded into place over inadequate seam. Use to repair large lengths of failed seams.

d. Extrusion welding flap shall not be allowed.

e. Removal and replacement: Remove bad area and replace with the same geomembrane welded into place. Use to repair large lengths of failed seams.

4. Repair seaming and welding shall comply with paragraphs F and G above.

5. For patches and cap strips extend repair a minimum of 6 in. beyond defect in all directions.

6. Do not place overlying layers over locations which have been repaired until appropriate passing nondestructive and destructive (laboratory) test results obtained.

I. Anchor Trench:

1. EARTHWORK CONTRACTOR shall excavate anchor trenches, unless otherwise specified, to lines and grades shown on design drawings, prior to geomembrane placement.

2. Slightly rounded corners shall be provided in anchor trench to avoid sharp bends in geomembrane.

3. If anchor trench excavated in clay material susceptible to desiccation, amount of trench open at any time should be minimized.

4. Remove all construction-related debris from anchor trench. Construction related debris shall be managed by EARTHWORK CONTRACTOR as directed by OWNER and ENGINEER.

5. EARTHWORK CONTRACTOR shall backfill and compact anchor trench as soon as practical after geomembrane installation completed. Care will be taken when backfilling trenches to prevent damage to geosynthetics.

6. GEOSYNTHETICS INSTALLER shall inspect the anchor trench subgrade prior to deploying geomembrane into the anchor trench. After GEOSYNTHETICS INSTALLER accepts subgrade, ensure excessive amounts of loose soil do not underlie geomembrane in anchor trench.

7. EARTHWORK CONTRACTOR shall ensure that anchor trench will be adequately dewatered to prevent ponding or softening of adjacent soils while trench open.

3.04 FIELD QUALITY CONTROL

A. Visual Inspection:

1. GEOSYNTHETICS QAC shall examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, non-dispersed raw materials, and any sign of contamination by foreign matter.

2. The GEOSYNTHETICS INSTALLER shall clean and wash the geomembrane surface if GEOSYNTHETICS QAC determines that the amount of dust or mud inhibits examination.

3. Do not seam any geomembrane panels that have not been examined for flaws by GEOSYNTHETICS QAC.

4. Non-destructively test each suspect location in seam and non-seam areas using methods described in Article 3.04 C of this section as appropriate.

B. The GEOSYNTHETICS INSTALLER shall adhere to the following Trial Seam requirements:

1. Prepare trial seams on fragment pieces of geomembrane under actual seaming conditions to verify those conditions are adequate for production seaming.

2. Make trial seams at the beginning of each seaming period, and at least once each 5 hrs, for each production welder/ seaming apparatus combination used that day.

3. Make trial seams only under observation of GEOSYNTHETICS QAC.

4. Make trial seam sample at least 5 ft. (1.5 m) long by l ft. (0.3 m) wide (after seaming) with seam centered lengthwise following procedures specified above.

5. Cut 2 specimens from sample with 1 in. (25 mm) wide die. GEOSYNTHETICS QAC shall select specimen locations randomly along trial seam sample. Test specimens in peel, as described in Article 3.04 D.5 of this section, and document the results.

6. If specimen fails, entire operation shall be repeated. If additional specimen fails, do not use the welder/seaming apparatus combination until deficiencies are corrected and 2 consecutive successful trial welds achieved.

7. Cut remainder of successful trial seam into 3 pieces; 1 to be retained in OWNER's archives, 1 to be retained by GEOSYNTHETICS INSTALLER, and 1 to be retained by GEOSYNTHETICS QAC for possible laboratory destructive seam testing. If required by OWNER, remaining portion of trial seam sample can be subjected to destructive testing as indicated in Article 3.04 D of this section.

C. The GEOSYNTHETICS INSTALLER shall adhere to the following non-destructive seam testing requirements:

1. General

a. Perform non-destructive tests is in the presence of QAC to verify continuity of seams. These tests do not provide quantitative information on seam strength.

b. Non-destructively test field seams over their full length using vacuum test (for extrusion seams), air pressure (for double-fusion seams) or other OWNER-approved method. Document the results.

c. Non-destructive testing of extrusion welds for pipe/manhole boots and flatstock bases of riser vaults may be performed using spark-testing technique.

d. Perform non-destructive testing as seaming work progresses, not at completion of all field seaming.

2. Vacuum Testing (for extrusion seam): Use following procedures.

a. Energize vacuum pump and reduce tank pressure to approximately 5 psi (10 in. of Hg) (35 kPa) gauge pressure.

b. Wet strip of geomembrane approximately 12 in. by 48 in. (0.3 m x 1.2 m) with soapy solution.

c. Place vacuum box over wetted area, apply vacuum for a period of not less than 10 seconds, and examine geomembrane through viewing window for presence of soap bubbles.

d. If no bubbles appear within 10 seconds, move box over to next adjoining area with minimum 3 in. (75 mm) overlap and repeat process.

e. Mark and repair areas where soap bubbles appear in accordance with Article 3.03 H of this section.

3. Air Pressure Testing (for double-fusion seam): Use following procedures.

a. Temporarily seal both ends of seam to be tested using locking pliers or other similar devices.

b. Insert needle or other approved pressure feed device into air channel created by fusion weld.

c. Pressurize air channel to pressure of approximately 30 psi (200 kPa). Close valve and allow pressure to stabilize for approximately 2 min. Ensure after 2 min. stabilization period pressure within range listed in Initial Pressure Schedule.

INITIAL PRESSURE SCHEDULE

MATERIAL (MIL)	MIN. PSI	MAX. PSI
40	24	30
80	30	35

d. Observe air pressure 5 min. after initial 2 min. stabilization period ends. If pressure loss exceeds Maximum Permissible Pressure Differential or pressure does not stabilize, locate faulty area and repair in accordance with Article 3.03 H.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL
AFTER 5 MINUTES

MATERIAL (MIL)	PRESSURE DIFF. (PSI)
40	4
80	2

e. Cut opposite end of tested seam area once testing completed to verify continuity of air channel. If air does not escape, locate blockage and retest unpressurized area. Repair cut end of air channel in accordance with Article 3.03 H of this section.

f. Remove needle or other approved pressure feed device and seal hole in geomembrane.

4. Inaccessible Seams:

a. Cap-strip seams that cannot be nondestructively tested in accordance with Article 3.03 H of this section.

b. Examine cap-stripping operations with GEOSYNTHETICS QAC for uniformity and completeness. Document observations.

D. The GEOSYNTHETICS INSTALLER shall adhere to the following destructive seam testing requirements:

1. General:

a. The purpose of destructive seam testing is to evaluate seam strength.

b. Perform destructive seam tests as seaming progresses, not at completion of all fieldwork.

c. Failed destructive seam sample shall result if grips of testing machine cannot be closed on sample test flap (available flap ½-in. long or less) due to excessive temporary welding.

2. Location and frequency:

   a. Test at a minimum frequency of 5 subsamples transverse to each seam. Provide a test frequency not less than 1 test location per 500 ft. (150 m) of seam length performed by each welder. This minimum frequency to be determined as average taken throughout entirety of work. In the event a specific welder is used on a given day for minimal seaming activities (minimal shall be defined as less than 100 feet of seaming), the Geosynthetics QAC may use the welders trial weld (as discussed in Part 3.04 B of this Section) as a representative destructive sample for that day.

   b. Test locations shall be determined during seaming, at GEOSYNTHETICS QAC's discretion.

   c. GEOSYNTHETICS INSTALLER will not be informed in advance of locations where seam samples will be taken.

   d. OWNER reserves right to increase frequency of testing in accordance with performance results of samples previously tested.

3. Sampling Procedures:

   a. Cut samples at locations chosen by GEOSYNTHETICS QAC.

   b. GEOSYNTHETICS QAC shall number each sample and record sample number and location in panel layout drawing.

   c. Repair holes in geomembrane resulting from destructive seam sampling immediately in accordance with repair procedures described in Article 3.03 H of this section.

   d. Non-destructively test continuity of new seams in repaired area according to Article 3.04 C of this section.

4. Sample Dimensions: Take following 2 types of samples at each sampling location.

   a. Take 2 samples for field-testing. Cut each of these samples with 1 in. (25 mm) wide die, with seam centered parallel to width. Distance between these 2 samples shall be 42 in. (1.1 m). If both samples pass field test described in Article 3.04 D.5 of this section, take sample for laboratory testing as described in paragraph b below.

   b. Sample for laboratory testing shall be located between samples cut for field-testing. Cut sample for laboratory testing 12 in. (0.3 m) wide by 42 in. (1.1 m) long with seam centered lengthwise. Cut this sample into three parts. GEOSYNTHETICS QAC shall distribute parts as follows:

      1) One portion to GEOSYNTHETICS CONTRACTOR for optional laboratory testing, 12 in. by 12 in. (0.3 m by 0.3 m).

2) One portion to GEOSYNTHETICS QAL for testing, 12 in. by 18 in. (0.3 m by 0.5 m).

3) One portion to OWNER for archive storage, 12 in by 12 in. (0.3 m by 0.3 m). Final determination of sample sizes shall be agreed upon at pre-construction meeting.

5. Field Testing:

a. Test two 1 in. (25 mm) wide strips described in Article 3.04 D.4 for peel strength. Use tensiometer as described in paragraph b below to conduct these tests. These tests shall not fail according to criteria in Article 3.03 F.l of this section. Document the results.

b. Use tensiometer capable of maintaining constant jaw separation rate of 2 in. per minute. Tensiometer shall be calibrated, and certificate of calibration less than 1 yr. old kept with tensiometer.

c. Test field samples only under GEOSYNTHETICS QAC's observation.

d. If test sample passes in accordance with this section, seam qualifies for laboratory testing.

e. If any field test sample fails to pass, then follow procedures outlined in Article 3.04 D.6 of this section.

f. Final judgment regarding seam acceptability, based on failure criteria in these specifications, rests with GEOSYNTHETICS QAC.

6. Destructive Test Failure Procedures: Apply following procedures when sample fails destructive testing, whether that test is conducted by laboratory, or by GEOSYNTHETICS INSTALLER using field tensiometer.

a. GEOSYNTHETICS INSTALLER has following options:

1) Repair seam between any 2 passing destructive test locations.

2) Trace welding path to intermediate point [10 ft. (3 m) minimum from point of failed test in each direction] and take small sample with 1 in. (25 mm) wide die for additional field test at each location. If these additional samples pass test, take full laboratory samples. If these laboratory samples pass tests, repair the seam between these locations. If either sample fails, repeat process to establish zone in which seam should be repaired.

b. Acceptable repaired seams shall be bound by 2 locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests, taken as indicated in Article 3.04 D, may be used as boundary for failing seam. In cases exceeding 150 ft. (50 m) of repaired seam, sample taken from zone in which seam has been repaired shall pass destructive testing. Make repairs in accordance with Article 3.03 H.

c. When sample fails, OWNER may require additional testing of seams that were welded by same welder and/or welding apparatus during same time shift.

E. Repair Verification:

1. GEOSYNTHETICS QAC shall number and log each repair.

2. Non-destructively test each repair using methods described in Article 3.04 C as appropriate. Document the results.

3. Passing non-destructive test results indicate adequate repair.

4. Repairs more than 150 ft. long require destructive test sampling, in accordance with Article 3.04 D of this section.

5. Failed destructive or non-destructive tests indicate that repair shall be redone and retested until passing test results.

F. Large Wrinkles: Wrinkle is considered to be large when geomembrane can be folded over onto itself.

1. When seaming of geomembrane liner is completed, and prior to placing overlying materials, GEOSYNTHETICS QAC shall identify all excessive geomembrane wrinkles.

2. Cut and reseam all wrinkles identified by GEOSYNTHETICS QAC. Test seam produced while repairing wrinkles in accordance with Article 3.03 H.

3. Repair wrinkles identified by GEOSYNTHETICS QAC. Repair during coldest part of installation period.

* * * END OF SECTION * * *

SECTION 02402
GEOELECTRIC LEAK LOCATION SURVEY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for performance of a geomembrane leak location survey using electrical methods for post-geomembrane installation performance for the secondary and primary geomembrane, baseliner components of the landfill cells and FAC Ponds.

B. Leak Location survey shall be conducted after water or earth materials are placed over the geomembrane liner to detect leaks resulting from installation defects and construction damage caused during placement of the overlying layers.

C. The optimum performance of a geomembrane leak location survey using electrical methods requires the conductive media above and below the geomembrane to be electrically isolated from each other except through the leaks being located in the geomembrane. It is also necessary to have a continuous electrically conducting pathway through an electrically conducting material above the geomembrane, through the leaks, and through an electrically conducting media under the geomembrane. Specifically, the conductive media must have some moisture.

D. GEOSYNTHETICS INSTALLER shall be aware of the leak detection activities outlined herein and shall account for these activities in the construction schedule.

1.02 REFERENCES

A. ASTM D7007 – Standard Practices for Locating Leaks in Geomembranes Covered with Water or Earth Materials.

1.03 SUBMITTALS

The LEAK LOCATION CONTRACTOR shall submit a Leak Location Survey Work Plan to the ENGINEER for approval prior to commencement of the leak location survey. The Leak Location Survey Work Plan shall include:

A. Qualifications of the proposed LEAK LOCATION CONTRACTOR including the number of years the LEAK LOCATION CONTRACTOR has performed the proposed survey method;

B. Resumes of proposed on-site supervisors;

C. Required site preparations;

D. Estimated duration of survey;

E. Quality control and field calibration procedures;

F. A list of projects demonstrating the qualifications and experience where the proposed Leak Location Contractor and leak location supervisor have met the requirements of paragraph 2.01 of this specification.

G. Sample of a final report (per ASTM D7007) provided by the Leak Location Contractor following the completion of the survey.

PART 2 PRODUCTS

2.01 LEAK LOCATION CONTRACTOR AND SUPERVISOR QUALIFICATIONS

The LEAK LOCATION CONTRACTOR shall have qualifications and experience in conducting the proposed survey method including having tested a minimum of 20,000,000 square feet of geomembrane liner within the previous three years. In addition, the leak location surveys must be supervised by a professional or technician with a minimum of three years and 6,500,000 square feet of liner testing experience using the proposed leak location survey method. The leak location supervisor must be on-site full-time during the performance of the leak location survey.

PART 3 EXECUTION

3.01 INFORMATION REQUIRED

The GEOSYNTHETICS QAC shall provide the LEAK LOCATION CONTRACTOR with drawings showing:

A. A Site Plan of the area to be leak location tested (including test limits).

B. Details of any liner penetrations.

C. Any structures and obstructions above the liner.

D. Any electrical equipment above the primary liner.

3.02 SITE PREPARATION

A. The GEOSYNTHETICS INSTALLER will identify actions required by the LEAK LOCATION CONTRACTOR to prepare the site for the leak location survey, including means to make electrical contact with the conductive material under the geomembrane. Specifically, bare copper wires shall be installed under the secondary geomembrane (ie. over the secondary soil layer) to test the secondary geomembrane layer of the baseliner system and under the GCL between the secondary and primary geomembranes to test the primary geomembrane layer of the baseliner system. To leak test the FAC ponds, bare copper wires shall be installed below the secondary geomembrane and the geocomposite between the secondary and primary geomembranes of the FAC Pond baseliner system. The bare copper wires shall be 10AWG or heavier. The bare copper wires shall be placed perpendicular to the machine direction of the overlying geosynthetic material. Four wires shall be spaced at 1/8, 3/8, 5/8, and 7/8 of the relevant dimension of the cell and/or FAC Pond (+/- 25 feet.) The wires shall exit from between the geomembranes at both edges of the cell and/or FAC Pond, remain exposed until after the leak location survey, not contact earth ground, and remain accessible to Leak Location Contractor. LEAK LOCATION CONTRACTOR shall be responsible for determining the placement of any electrodes needed for the leak location survey and the locations shall be depicted on the subgrade grading plan and submitted to the ENGINEER for review and record keeping purposes.

B. EARTHWORK CONTRACTOR shall ensure that the earth materials above and below the secondary and primary geomembranes contain sufficient moisture to conduct a leak location survey. For the landfill baseliner, the geocomposites placed on the geomembrane must be moist, either from a rainfall, from excess moisture in the granular material, or by wetting the area with the equivalent of 0.1 inch of water (2,700 gallons/acre) immediately prior to installing the earth materials on the geocomposites. Also, the granular layer must have some moisture. Adequate moisture is indicated when the material appears to be darker than the dry surface material. If the surface of the granular layer is dry, water must be sprayed on the granular layer immediately prior to the leak location survey, or the dry surface soil can be scraped from a narrow path along the survey lines. For the secondary geomembrane liner in the FAC Pond baseliner, the floor area of the pond must be filled with water to the toe of slope of the pond for the floor to be tested. The slope areas of the secondary geomembrane liner in the FAC Pond will be leak tested utilizing a water lance. For the FAC Pond primary geomembrane, the stone layer over the floor area of the pond must be saturated with water to the toe of slope of the pond for the floor area to be tested. The slope areas of the primary geomembrane liner in the FAC Pond will be leak tested utilizing a water lance.

C. GEOSYNTHETICS INSTALLER shall provide electrical isolation between the material above and below the geomembranes. This will be the case if the primary and secondary geomembrane are welded together. Any conducting penetrations through the geomembranes such as metal pipes or concrete structures should also be isolated using complete insulating coatings.

3.03 EXECUTION

A. LEAK LOCATION CONTRACTOR shall inspect the site prior to commencing the survey to ensure all site preparations are completed and the site conditions are appropriate for conducting the leak location survey.

B. Any discrepancy in the required site preparation described above or in the Leak Location Survey Work Plan shall be reported to the GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR for corrective or appropriate action.

C. After the geocomposite and granular layer is placed on the geomembrane, conduct a leak location survey on the earth materials using the procedures for surveys with earth materials covering the geomembrane described in the latest version of ASTM Standard D7007 except use a 12-mm-diameter actual or artificial leak. This larger size is because the earth materials on the geomembrane are thicker than usual.

D. After the geotextile and granular (Ballast) layer is placed on the FAC Pond primary geomembrane, conduct a leak location survey using the procedures for surveys with water covering the geomembrane (floor area of the secondary geomembrane liner) described in the latest version of ASTM Standard D7007.

E. LEAK LOCATION CONTRACTOR shall inform the Engineer and mark the locations of all identified or indicated leaks with flags, spray paint, or written coordinates.

F. In addition, any leaks that are found must be exposed by GEOSYNTHETICS INSTALLER and isolated from the materials covering the geomembrane. Then additional leak location measurements shall be made on the two closest leak location survey lines to determine if additional leaks are in the vicinity. If an additional leak is found, this process shall be repeated.

3.04 REPORTING

The Leak Location Contractor shall provide a written report within 14 calendar days of completion of the leak location survey field work as described in ASTM D7007. The written report shall be submitted to GEOSYNTHETICS QAC for review.

** END OF SECTION **

SECTION 02405
ETHYLENE INTERPOLYMER ALLOY LINER

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide 30 mil reinforced Ethylene Interpolymer Alloy (EIA) liner for Facultative (Fac) Pond liner system.

1.02 REFERENCES

A. ASTM D471-10 - Standard Test Method for Rubber Property - Effect of Liquids.

B. ASTM D751-06 - Standard Test Method for Coated Fabrics.

C. ASTM D413-98 - Standard Test Methods for Rubber Property- Adhesion to Flexible Substrate.

D. ASTM D3389-10 – Standard Test Method for Coated Fabrics Abrasion Resistance (Rotary Platform Abrader)

E. ASTM G153-04 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure to Nonmetallic Materials.

F. ASTM D1204-08 - Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at elevated Temperatures.

G. ASTM D2136-02 - Standard Test Method for Coated Fabrics-Low-Temperature Bend Test.

H. ASTM D4533-04 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

I. ASTM D4833-07 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.

J. ASTM D5641-94 - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.

K. ASTM D696-08 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer.

L. ASTM D814-95 - Standard Test Method for Rubber Property- Vapor Transmission of Volatile Liquids.

1.03 QUALITY CONTROL SUBMITTALS.

A. Pre-installation: The GEOSYNTHETICS MANUFACTURER shall submit the following to the OWNER for approval prior to EIA liner delivery.

1. Origin (supplier's name and production plant) and identification (brand name and number) of raw materials.

2. Copies of dated quality control certificates issued by raw material supplier.

3. Manufacturer's specification, which includes properties, listed in Article 2.01 as measured using appropriate test methods.

4. Written certification that the minimum values given in EIA liner manufacturer's specification are guaranteed by EIA liner manufacturer.

5. Quality control certificates, signed by responsible entity employed by EIA liner manufacturer. Each quality control certificate shall include applicable testing procedures and results of quality control tests required by Article 2.03.A.

6. Submit shop drawings with the proposed panel layout to cover the area to be lined with EIA liner. Shop drawings shall indicate the direction of factory welds and shall show panel sizes (following factory welding) consistent with the material quantity requirements.

B. Installation: The GEOSYNTHETICS INSTALLER shall submit the following to the OWNER as installation proceeds:

1. Quality control documentation recorded during installation.

2. Submit prior to EIA liner deployment subgrade surface acceptance certificates signed by GEOSYNTHETICS INSTALLER for each area that will be covered directly by the EIA liner.

C. Completion: The GEOSYNTHETICS INSTALLER shall submit the following to the OWNER upon completion of the installation of the EIA liner:

1. The warranty obtained from the manufacturer of the EIA liner to warranty material for a period no less than 10 years.

2. An installation warranty shall be submitted to cover the installation for a period of 1 year.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping

1. The GEOSYNTHETICS MANUFACTURER shall provide the following information on labels attached to each fabricated panel of EIA liner delivered to the site:

a. Manufacturer's name.

b. Product identification.

c. Panel number.

d. Panel dimensions.

2. The GEOSYNTHETICS MANUFACTURER shall ensure that EIA liner panels are properly loaded and secured to prevent damage during shipping.

3. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall protect the EIA liner from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions while stored on-site.

B. Acceptance at Site

1. The GEOSYNTHETICS QAC and the GEOSYNTHETICS INSTALLER, together, shall perform inventory and surface inspection for defects and damage, of all EIA liner panels upon delivery.

2. The GEOSYNTHETICS QAC may require the GEOSYNTHETICS INSTALLER to unroll or unfold and inspect any EIA liner panel that shows signs of internal damage.

3. Damage resulting from handling and transport of EIA liner shall be repaired at no cost to OWNER. If irreparable, in opinion of the ENGINEER, damaged materials shall be replaced at no cost of OWNER.

C. Storage and Protection

1. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall provide on-site storage in the area indicated by OWNER for the EIA liner from time of delivery until installed.

2. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall store and protect the EIA liner from dirt, water, and other sources of damage.

3. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall preserve integrity and readability of EIA liner panel labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. The GEOSYNTHETICS MANUFACTURER shall provide EIA liner materials in pre-fabricated panels that meet the following material specifications:

EIA LINER MATERIAL

PROPERTY	**METHOD**	**VALUE**
Base Material	NA	Polyester
Base Material Unit Weight	ASTM D751	6.5 oz per square yard

PROPERTY	METHOD	VALUE
Thickness	ASTM D751	30 mil nominal
Finished Coated Weight	ASTM D751	30 ± 2oz. per square yard
Trapezoidal Tear	ASTM D4533	40/55 pounds (minimum)
Grab Yield Strength	ASTM D751	550/550 pounds (minimum)
Elongation at Yield	ASTM D751	20% (minimum)
Adhesion – Heat Sealed Seam	ASTM D751 (Dielectric Weld)	40 pounds per 2-inch (minimum)
Adhesion – Ply	ASTM D413, Type A	15 pounds per inch (minimum) or Film Tearing Bond
Hydrostatic Resistance	ASTM D751 (Procedure A)	800 pounds per square inch (minimum)
Puncture Resistance	ASTM D4833	275 pounds (minimum)
Burst Strength	ASTM D751 (Ball Tip)	750 pounds (minimum)
Dead Load - Seam Strength, 4 Hour Test	ASTM D751 (2 in. Overlapped Seam)	240 pounds per inch of seam at 70 ^{o}F 120 pounds per inch of seam at 160 ^{o}F
Bonded Seam Strength	ASTM D751 (Grab Test Method, Procedure A)	550 pounds (minimum)
Low Temperature Resistance	ASTM D2136 (4 hours, 1/8-inch Mandrel)	Pass at -30 ^{o}F
Weathering Resistance	ASTM G153 (Carbon Arc)	8,000 hours (minimum) with no appreciable changes or stiffening or cracking of coating
Dimensional Stability	ASTM D1204 (212 ^{o}F for 1 hour)	0.5% (maximum each direction)
Water Absorption	ASTM D471 (Section 12, 7 days)	0.74 ounces per square yard (maximum) at 70 ^{o}F 4.13 ounces per square yard (maximum) at 212 ^{o}F
Abrasion Resistance	ASTM D3389 (H-18 Wheel, 1 kg load)	2,000 cycles (minimum) before fabric exposure 0.0018 ounce per 100 cycles maximum weight loss
Coefficient of Thermal Expansion/Contraction	ASTM D696	$8x10^{-6}$ inches/inch/ ^{o}F (maximum)
Vapor Transmission (Water)	ASTM D814	0.0032 ounces/square yard/hour (maximum)

B. EIA liner shall be manufactured from new raw materials.

C. EIA liner manufactured from non-complying raw materials shall be rejected.

D. Raw materials shall be designed and manufactured specifically for use in EIA liners.

E. EIA liner shall be free of pinholes and non-dispersed raw materials or other signs of contamination by foreign matter.

F. Acceptable materials include 8130 XR-5 as manufactured by Seaman Corporation or equivalent.

2.02 MANUFACTURER QUALITY CONTROL

A. Tests and Inspections

1. EIA liner shall be tested by the manufacturer for quality control to demonstrate that raw materials meet these specifications.

2. GEOSYNTHETICS MANUFACTURER shall continuously monitor during manufacturing process for inclusions, bubbles, or other defects. EIA liner, which exhibit defects, shall not be acceptable for installation.

3. GEOSYNTHETICS MANUFACTURER shall monitor material quality continuously during manufacturing process. No EIA liner shall be acceptable for installation, which fails to meet specified values.

4. At minimum, the GEOSYNTHETICS MANUFACTURER shall perform the tests specified in Article 2.01 A of this section on the EIA liner, at a minimum frequency of once for every lot of EIA liner produced.

5. Samples not satisfying specifications shall result in rejection of rolls represented by tests. At the GEOSYNTHETICS MANUFACTURER's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and to qualify individual rolls.

2.03 SEAMING AND TESTING EQUIPMENT

A. General

1. Use heat welding or RF welding apparatus with a minimum 2-inch overlap for all welds. Welding equipment shall include appropriate temperature monitoring devices during all welding activities.

2. Maintain on-site a minimum of 2 spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.

3. Seaming equipment shall not damage geomembrane.

B. Vacuum testing equipment shall consist of following:

1. Vacuum box assembly consisting of: rigid housing, transparent viewing window, soft neoprene gasket attached to bottom of housing, porthole or valve assembly, and vacuum gauge.

2. Pump assembly equipped with pressure controller and pipe connections.

3. Pressure/vacuum rubber hose with fittings and connections.

4. Bucket of soapy solution and a wide paint brush or other means of applying the soapy solution.

C. Air lance testing equipment shall consist of following:

1. Air compressor equipped with a pressure gauge, capable of generating, sustaining, and measuring air pressure of at least 55 psi , and mounted on cushion to protect the EIA liner.

2. Rubber hose with fittings and connections.

3. Air lance nozzle (3/16 of an inch diameter).

PART 3 EXECUTION

3.01 PREPARATION

A. Surface Preparation

1. GEOSYNTHETICS INSTALLER shall verify that supporting soil has been properly prepared for EIA liner deployment.

2. After prepared surface has been accepted in accordance with Quality Assurance Manual, report to OWNER any change in supporting soil condition that may require work. Take special care to maintain prepared soil surface.

3. Do not place EIA liner onto any area that has become softened by precipitation or cracked due to desiccation. Observe soil surface daily to evaluate softening and to check for desiccation cracking.

4. Repair, at GEOSYNTHETICS INSTALLER's expense, damage to subgrade caused by installation activities.

3.03 INSTALLATION

A. Panel Nomenclature

1. The GEOSYNTHETICS INSTALLER shall mark each field panel with identification code (number or letter-number) consistent with layout plan. OWNER, GEOSYNTHETICS INSTALLER, and GEOSYNTHETICS QAC shall agree upon this identification code.

B. The following presents requirements to be followed by the GEOSYNTHETICS INSTALLER to protect liner material during installation:

1. Do not use equipment, which damages the EIA liner by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means. Provide a protective layer under equipment (e.g., generators, welding apparatus) to prevent damage.

2. Ensure prepared surface underlying the EIA liner has not deteriorated since previous acceptance and remains acceptable immediately prior to EIA liner deployment.

3. Keep any geosynthetic elements immediately underlying the EIA liner clean and free of debris.

4. Do not permit personnel to smoke or wear shoes that can damage the EIA liner while working on EIA liner. Personnel shall not bring glass bottles onto the EIA liner.

5. Unroll or unfold panels in manner, which does not cause excessive scratches or crimps in the EIA liner and does not damage supporting soil.

6. Place panels in manner, which minimizes wrinkles (especially differential wrinkles between adjacent panels).

7. Prevent wind uplift by providing adequate temporary loading and/or anchoring (e.g., sandbags, tires) that shall not damage the EIA liner. In case of high winds, continuous loading is recommended along panel edges.

8. Protect the EIA liner in areas where excessive traffic is expected with geotextiles, extra EIA liner, or other suitable materials.

C. The GEOSYNTHETICS INSTALLER shall adhere to the following requirements during EIA liner panel deployment:

1. Install field panels at locations indicated on the liner layout plan, as approved by OWNER.

2. Replace seriously damaged (torn, twisted, or crimped) field panels or portions thereof, at no cost to OWNER. Repair less serious damage according to Article 3.03 H of this section. GEOSYNTHETICS QAC shall determine if material is to be repaired or replaced.

3. Remove from work area any damaged panels or portions of damaged panels that have been rejected.

4. Do not proceed with deployment at ambient temperature below 32°F (0°C) or above ambient temperature of 104°F (40°C) or above sheet temperature of 122°F (50°C) unless otherwise authorized, in writing, by OWNER.

5. Do not deploy during precipitation, in presence of excessive moisture (e.g., fog, dew), in area of ponded water or in presence of excessive winds.

6. Do not deploy more EIA liner panels in any one day than can be seamed during that same day.

D. The GEOSYNTHETICS INSTALLER shall adhere to the following requirements regarding seam location and layout:

1. When possible orient seams parallel to line of maximum slope, (i.e., oriented along, not across, slope).

2. No horizontal seam shall be less than 5 ft. (1.5 m) from toe of slope greater than 10H:1V or areas of potential stress concentration, unless otherwise authorized by OWNER.

3. In general, maximize lengths of field panels and minimize number of field seams.

E. Temporary Bonding

1. Hot air device (Liester) may be used to temporarily bond EIA liner panels that are to be welded. No other temporary bonding of liner is allowed unless authorized by the OWNER.

2. Do not damage EIA liner when temporarily bonding adjacent panels. Apply minimal amount of heat to lightly tack liner panels together. Control temperature of hot air at nozzle of any temporary welding apparatus to prevent damage to the EIA liner.

3. Do not use solvent or adhesive.

F. Seaming Methods: the approved process for field seaming is heat welding or RF welding. Proposed alternate processes shall be documented and submitted to OWNER for approval. Alternate procedures shall be used only after being approved in writing by OWNER.

1. Produce seams meeting following requirements:

EIA LINER SEAM PROPERTIES

Property	Method	Value (minimum)
Bonded Seam Strength	ASTM D751 (Grab Test Method, Procedure A)	550 pounds
Dead Load - Seam Strength, 4 Hour Test	ASTM D751 (2 in. Overlapped Seam)	240 pounds per inch of seam at 70 ^{o}F 120 pounds per inch of seam at 160 ^{o}F

2. Align EIA liner panels to have nominal overlap of 2 in. for seaming.

G. The GEOSYNTHETICS INSTALLER shall adhere to the following seaming procedures:

1. General Seaming Procedures

a. Perform seaming under dry conditions, i.e., no precipitation or other excessive moisture. Suspend seaming during periods of excessive winds. Portable shelters (tents) may be used during inclement weather to protect seam area at no additional cost to the OWNER.

b. If required, provide firm substrate by using extra piece of EIA liner, or similar hard surface directly under seam overlap to achieve proper support for seaming apparatus.

c. Align seams with least possible number of wrinkles and fishmouths. Cut fishmouths or wrinkles along ridge of wrinkle in order to achieve flat overlap. Seam cut fishmouths or wrinkles and patch portions where overlap is inadequate. Use oval or round patch of same EIA liner extending minimum of 6 in. (150 mm) beyond cut in all directions.

d. Provide adequate illumination if seaming operations carried out at night.

e. Extend seams to outside edge of panels placed in anchor trench.

f. Do not field seam without master seamer being present.

g. Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris, or foreign material of any kind.

2. Cold Weather Seaming Procedures: The GEOSYNTHETICS INSTALLER shall meet the following conditions, in addition to general seaming procedures, if seaming is conducted when the ambient temperature is below 32°F (0°C).

a. Preheating of seams is required if the EIA surface temperature is below 32°F (0°C). GEOSYNTHETICS QAC shall determine EIA liner surface temperatures at intervals of at least once per 100 ft. of seam length. Preheating devices used shall be pre-approved by OWNER prior to use.

b. Preheating may be waived by OWNER based on recommendation from GEOSYNTHETICS QAC, if demonstrated to GEOSYNTHETICS QAC's satisfaction that welds of equivalent quality may be obtained without preheating at expected temperature of installation.

c. GEOSYNTHETICS QAC shall observe all areas of EIA liner that have been preheated by hot air device prior to seaming, to ensure they have not been subjected to excessive melting.

d. GEOSYNTHETICS QAC shall confirm that surface temperatures not lowered below minimum surface temperatures specified for welding due to winds or other adverse conditions. It may be necessary to provide wind protection for seam area.

e. Trial seaming, as described in Article 3.04 B of this section, shall be conducted under same ambient temperature and preheating conditions as actual seams. New trial seams shall be conducted if ambient temperature drops by more than 10°F (3°C) from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature drop.

3. Warm Weather Procedures: The GEOSYNTHETIC INSTALLER shall meet following conditions, in addition to general seaming procedures, if seaming conducted when sheet temperature above 122°F (50°C) or ambient temperature above 104°F (40°C).

a. At sheet temperatures above 122°F (50°C) or ambient temperature above 104°F (40°C), no seaming of EIA liner shall be permitted unless demonstrated to OWNER's satisfaction that EIA liner seam quality will not be compromised.

b. Trial seaming, as described in Article 3.04 B, shall be conducted under same ambient temperature conditions as actual seams. New trial seams shall be conducted if ambient temperature rises by more than 5°F (3°C) from initial trial seam test conditions. Such new trial seams shall be conducted upon completion of seams in progress during temperature rise.

H. The following repair procedures shall be performed by the GEOSYNTHETICS INSTALLER:

1. Repair portions of the EIA liner that are damaged, exhibit flaws, or fail destructive or non-destructive seam tests.

2. Final decision as to appropriate repair procedure shall be agreed upon between OWNER, GEOSYNTHETICS INSTALLER, and GEOSYNTHETICS QAC.

a. Available repair procedures include patching a piece of the same EIA liner into place over the damaged area. Use to repair large holes, tears, non-dispersed raw materials, and contamination by foreign matter.

b. Capping: Strip of same EIA liner welded into place over inadequate seam. Use to repair large lengths of failed seams.

c. Welding flap shall not be allowed.

d. Removal and replacement: Remove bad area and replace with the same EIA liner welded into place. Use to repair large lengths of failed seams.

3. Repair seaming and welding shall comply with paragraphs F and G above.

4. For patches and cap strips extend repair a minimum of 6 in. beyond defect in all directions.

5. Do not place overlying layers over locations which have been repaired until appropriate test results have been obtained.

I. Anchor Trench

1. EARTHWORK CONTRACTOR shall excavate anchor trenches, unless otherwise specified, to lines and grades shown on design drawings, prior to EIA liner placement.

2. Slightly rounded corners shall be provided in anchor trench to avoid sharp bends in geomembrane.

3. If anchor trench excavated in clay material susceptible to desiccation, amount of trench open at any time should be minimized.

4. Remove all construction-related debris from anchor trench.

5. EARTHWORK CONTRACTOR shall backfill and compact anchor trench as soon as practical after EIA liner installation completed. Care will be taken when backfilling trenches to prevent damage to geosynthetics.

6. GEOSYNTHETICS INSTALLER shall inspect the anchor trench subgrade prior to deploying EIA liner into the anchor trench. After GEOSYNTHETICS INSTALLER accepts subgrade, ensure excessive amounts of loose soil do not underlie the EIA liner in anchor trench.

7. The EARTHWORK CONTRACTOR shall ensure that anchor trench will be adequately dewatered to prevent ponding or softening of adjacent soils while trench open.

3.04 FIELD QUALITY CONTROL

A. Visual Inspection

1. GEOSYNTHETICS QAC shall examine seam and non-seam areas of EIA liner for identification of defects, holes, blisters, non-dispersed raw materials, and any sign of contamination by foreign matter.

2. The GEOSYNTHETICS INSTALLER shall clean and wash the EIA liner surface if GEOSYNTHETICS QAC determines that the amount of dust or mud inhibits examination.

3. Do not seam any EIA liner panels that have not been examined for flaws by GEOSYNTHETICS QAC.

4. Non-destructively test each suspect location in seam and non-seam areas using methods described in Article 3.04 C of this section as appropriate.

B. The GEOSYNTHETICS INSTALLER shall adhere to the following Trial Seam requirements:

1. Prepare trial seams on fragment pieces of EIA liner under actual seaming conditions to verify those conditions are adequate for production seaming.

2. Make trial seams at the beginning of each seaming period, and at least once each 5 hrs, for each production welder/seaming apparatus combination used that day.

3. Make trial seams only under observation of GEOSYNTHETICS QAC.

4. Make trial seam sample at least 3 feet long by l ft. (0.3 m) wide (after seaming) with seam centered lengthwise following procedures specified above.

7. Test trial seam for bonded seam strength in accordance with paragraph F above.

C. The GEOSYNTHETICS INSTALLER shall adhere to the following non-destructive seam testing requirements:

1. General

a. Perform non-destructive tests in the presence of QAC to verify continuity of seams. These tests do not provide quantitative information on seam strength.

b. Non-destructively test field seams over their full length using vacuum test and/or air lance test methods. Document the results.

c. Perform non-destructive testing as seaming work progresses, not at completion of all field seaming.

2. Visual Inspection

a. EIA seaming require the application of pressure to the seam areas to force the two heated sheets together in their molten states. This applied pressure causes molten polymer to extrude from the edge of the seam.

b. A visual inspection of the full length of every seam shall be performed to verify that extruded polymer is visible continuously along the seam.

c. Observe, mark, and document all seam areas not having visible extruded polymer along the edge of the seam.

d. Repair noncompliant seams in accordance with Article 3.03. H of this section. Verify repairs in accordance with Article 3.04 E of this section.

3. Vacuum Testing Procedure

a. Energize vacuum pump and reduce tank pressure to approximately 5 psi (10 in. of Hg) (35 kPa) gauge pressure.

b. Wet strip of EIA liner approximately 12 in. by 48 in. (0.3 m x 1.2 m) with soapy solution.

c. Place vacuum box over wetted area, apply vacuum for a period of not less than 10 seconds, and examine the EIA liner through viewing window for presence of soap bubbles.

d. If no bubbles appear within 10 seconds, move box over to next adjoining area with minimum 3 in. (75 mm) overlap and repeat process.

e. Mark and repair areas where soap bubbles appear in accordance with Article 3.03 H of this section. Verify repairs in accordance with Article 3.04 E.

4. Air Lance Testing Procedure

   a. Provide source of compressed air capable of sustained discharge of air at a minimum pressure of 55 psi gauge pressure.

   b. Using a 3/16 inch diameter nozzle, direct jet of compressed air perpendicular to edge of seam and towards the overlying liner sheet.

   c. Maintain nozzle no greater than 4 inches away from seam edge and as close to in-plane with the liner as possible.

   d. Progress along the length of the seam to be tested at no greater than 40 feet per minute.

   e. Observe, mark, and document all seam areas having incomplete seaming (i.e., seam areas that allow compressed air to pass through the seam and underneath the overlying liner sheet) and all seam edges having unseamed areas 1/8 inch or greater inward from the seam edge.

   f. Repair noncompliant seams in accordance with Article 3.03. H of this section. Verify repairs in accordance with Article 3.04 E of this section.

D. The GEOSYNTHETICS INSTALLER shall adhere to the following destructive seam testing requirements:

1. A minimum frequency of one test location for each seam greater than 250 feet in length. For seams shorter than 250 feet in length, one test location shall be selected for every 500 linear feet of seaming collectively. Whenever possible, samples shall be collected near the anchor trenches to limit hydrostatic heads on seam repair areas and, depending on the amount of excess material at the anchor trench, to completely avoid the need to repair the sample area.

2. Samples shall be collected near the anchor trenches to limit hydrostatic heads on seam repair areas.

5. Results for destructive seam testing shall be in compliance with Article 3.03 F.

6. Repair sample areas and any seams failing destructive testing requirements in accordance with Article 3.03 H. Verify repairs in accordance with Article 3.04 E.

E. Repair Verification

1. GEOSYNTHETICS QAC shall number and log each repair.

2. Non-destructively test each repair using methods described in Article 3.04 C as appropriate. Document the results.

3. Passing non-destructive test results indicate adequate repair.

4. Failed non-destructive tests indicate that repair shall be redone and retested until passing test results.

F. Large Wrinkles: Wrinkle considered to be large when EIA liner can be folded over onto itself.

1. When seaming of EIA liner is completed, and prior to placing overlying materials, GEOSYNTHETICS QAC shall identify all excessive wrinkles.

2. Cut and reseam all wrinkles identified by GEOSYNTHETICS QAC. Test seam produced while repairing wrinkles in accordance with Article 3.03 H.

3. Repair wrinkles identified by GEOSYNTHETICS QAC. Repair during coldest part of installation period.

3.05 FACTORY PANEL FABRICATION QUALITY CONTROL

A. Factory-fabricated panels of EIA liner shall be subject to all seam testing requirements specified in this section or those recommended by the Manufacturer, whichever is more stringent.

B. Results of seam testing for factory-fabricated panels shall be provided to OWNER prior to delivery of subject panels.

* * * END OF SECTION * * *

SECTION 02410
GEOTEXTILE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Non-woven geotextiles for landfill lining and final cover systems and for erosion control and general use in ancillary construction outside of the landfill. Refer to Section 02430 - Geotextile/Geonet Composite for requirements of geotextile components of geocomposite drainage layers.

1.02 RELATED SECTIONS

A. Section 01400 - General Provisions for Geosynthetics

1.03 REFERENCES

A. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

B. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.

C. ASTM D4533 - Test Method for Trapezoid Tearing Strength of Geotextiles.

D. ASTM D4632 - Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

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

F. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

G. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

H. ASTM D5101 - Standard Test Method for Measuring the Soil-Geotextile System Clogging Potential by the Gradient Ratio.

I. ASTM D5567 - Standard Test Method for Hydraulic Conductivity Ratio (HCR) Testing of Soil/Geotextile Systems.

J. AASHTO M288-06 - Geotextile Specification for Highway Applications.

Note: The most current version of the specified test methods indicated above should be followed by the GEOSYNTHETICS MANUFACTURER, GEOSYNTHETICS INSTALLER, or authorized testing laboratory. In the event that a new test method becomes available and is deemed by the

ENGINEER to be appropriate for use, either in addition to those methods indicated above or as a replacement to one or more of the methods indicated above, the new method will be used.

1.04 QUALITY CONTROL SUBMITTALS

A. Pre-installation:

The GEOSYNTHETICS MANUFACTURER shall submit the following to OWNER for approval, prior to geotextile deployment:

1. Origin (supplier's name and production plant) and identification (brand name and number) of resin.

2. Copies of dated quality control certificates issued by resin supplier.

3. Results of test conducted by GEOSYNTHETICS MANUFACTURER to verify that quality of resin used to manufacture geotextile meets GEOSYNTHETICS MANUFACTURER’s resin specifications.

4. Statement indicating that reclaimed polymer added to resin during manufacturing was done with appropriate cleanliness.

5. List of materials that comprise geotextile, expressed in following categories as percent by weight: base polymer, carbon black, and other additives.

6. GEOSYNTHETICS MANUFACTURER specification for geotextile that includes properties contained in Article 2.01 of this section.

7. Written certification that minimum average roll values given in manufacturer's specification guaranteed by the GEOSYNTHETICS MANUFACTURER.

8. For needle-punched, non-woven geotextiles, written certification that the GEOSYNTHETICS MANUFACTURER has continuously inspected geotextile for presence of needles and found geotextile to be needle-free.

9. Quality control certificates, signed by responsible entity employed by GEOSYNTHETICS MANUFACTURER. Each quality control certificate shall include roll identification numbers, testing procedures and results of quality control test.

B. Installation:

The GEOSYNTHETICS INSTALLER shall submit the following as installation proceeds:

1. Subgrade surface acceptance certificates, signed by GEOSYNTHETICS INSTALLER, for each area that geotextile will be in direct contact with subgrade. Submit prior to geotextile deployment. Deployment of geotextile will be considered acceptance of subgrade if certificate not submitted.

C. Temporary/Sacrificial Applications:

1. For geotextiles to be used in applications designated on the Drawings as "temporary" or "sacrificial," the quality control submittals identified in Part 1.04 of this Section are not required.

1.05 DELIVERY, STORAGE AND HANDLING

A. The GEOSYNTHETICS MANUFACTURER shall adhere to the following packaging and shipping requirements:

1. Geotextiles shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

2. Geotextile rolls shall be marked or tagged with following information.

a. Manufacturer's name;

b. Product identification;

c. Roll number;

d. Roll dimensions; and

e. Special instruction as necessary.

B. The GEOSYNTHETICS INSTALLER and/or EARTHWORK CONTRACTOR shall adhere to the following storage and protection requirements:

1. Provide on-site storage in OWNER designated area for geotextile rolls from time of delivery until installed.

2. Store and protect geotextile from dirt, water, ultraviolet light exposure, and other potential sources of damage.

3. Preserve integrity and readability of geotextile roll labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. Baseliner System Cushion Geotextile: For baseliner geotextile serving as a cushion geotextile (i.e., the geotextile under the geosynthetic clay liner and the geotextile separating the liner system geomembranes from adjacent aggregate layers), the GEOSYNTHETICS MANUFACTURER shall provide material that meets or exceeds geotextile properties specified below. Certain values are based on survivability classification identified in the AASHTO M288-06 standard that was current as of the date of this specification. Should subsequent revisions to the AASHTO standard result in changes to these values, the values in the latest version of the AASHTO shall apply.

BASELINER SYSTEM CUSHION GEOTEXTILE PROPERTIES

Property	Method	Value (MARV)*
Mass per Unit Area	ASTM D5261	16 oz/sq yd min.
Grab Strength	ASTM D4632	157 lbs min. (AASHTO Class 2 Survivability)
Trapezoidal Tear Strength	ASTM D4533	56 lbs min. (AASHTO Class 2 Survivability)
Puncture Strength	ASTM D6241	309 lbs min. (AASHTO Class 2 Survivability)

* Minimum Average Roll Value

B. Baseliner System Separator Geotextile: For baseliner geotextile serving as a separator geotextile (i.e., the geotextile between the operations layer and the granular drainage layer and the geotextile used to wrap the leachate collection pipes and surrounding filter stone), the GEOSYNTHETICS CONTRACTOR shall provide material that meets or exceeds geotextile properties specified below. Certain values are based on survivability classification identified in the AASHTO M288-06 standard that was current as of the date of this specification. Should subsequent revisions to the AASHTO standard result in changes to these values, the values in the latest version of the AASHTO shall apply.

BASELINER SYSTEM SEPARATOR GEOTEXTILE PROPERTIES

Property	Method	Value (MARV, Except AOS)*
Grab Strength	ASTM D4632	157 lbs min. (AASHTO Class 2 Survivability)
Trapezoidal Tear Strength	ASTM D4533	56 lbs min. (AASHTO Class 2 Survivability)
Puncture Strength	ASTM D6241	309 lbs min. (AASHTO Class 2 Survivability)
Permittivity	ASTM D4491	9.6×10^{-2} s^{-1} min.
Apparent Opening Size	ASTM D4751	0.43 mm max.
Ultraviolet Stability	ASTM D4355	50% min. (after 500 hours of exposure)

* Minimum Average Roll Value

C. Final Cover Geotextile: For geotextile to wrap collection pipes in the final cover systems, the GEOSYNTHETICS CONTRACTOR shall provide material that meets or exceeds geotextile property values specified below. Certain values are based on survivability classification identified in the AASHTO M288-06 standard that was current as of the date of this specification. Should subsequent revisions to the AASHTO standard result in changes to these values, the values in the latest version of the AASHTO shall apply.

FINAL COVER GEOTEXTILE PROPERTIES

Property	Method	Value (MARV, Except AOS)*
Grab Strength	ASTM D4632	157 lbs min. (AASHTO Class 2 Survivability)
Trapezoidal Tear Strength	ASTM D4533	56 lbs min. (AASHTO Class 2 Survivability)
Puncture Strength	ASTM D6241	309 lbs min. (AASHTO Class 2 Survivability)
Apparent Opening Size	ASTM D4751	0.22 mm max.
Permittivity	ASTM D4491	0.1 s^{-1} min.
Clogging Potential	ASTM D5101	Constant Value ≤ 3
	or	
	ASTM D5567**	0.75 – 1.0
Ultraviolet Stability	ASTM D4355	50% min. (after 500 hours of exposure)

* Minimum Average Roll Value
** ASTM D5567 with modified sample and conditions as directed by the ENGINEER.

D. Erosion Control and General Use Geotextile: For geotextile to be placed beneath riprap for erosion control and for general use to separate dissimilar materials (e.g., underlayment beneath crushed stone material) in ancillary construction outside of RMU-2, the GEOSYNTHETICS CONTRACTOR shall provide material that meets or exceeds geotextile property values specified below. Certain values are based on survivability classification identified in the AASHTO M288-06 standard that was current as of the date of this specification. Should subsequent revisions to the AASHTO standard result in changes to these values, the values in the latest version of the AASHTO shall apply.

EROSION CONTROL AND GENERAL USE GEOTEXTILE PROPERTIES

Property	Method	Value (MARV, Except AOS)*
Mass per Unit Area	ASTM D5261	10 oz/sq yd min.
Grab Strength	ASTM D4632	202 lbs min. (AASHTO Class 1 Survivability)
Trapezoidal Tear Strength	ASTM D4533	79 lbs min. (AASHTO Class 1 Survivability)
Puncture Strength	ASTM D6241	433 lbs min. (AASHTO Class 1 Survivability)
Apparent Opening Size	ASTM D4751	0.22 mm max.
Permittivity	ASTM D4491	0.1 s^{-1} min.
Ultraviolet Stability	ASTM D4355	50% min. (after 500 hours of exposure)

* Minimum Average Roll Value

E. Temporary/Sacrificial Geotextile: For geotextiles indicated on the Drawings as “temporary” or “sacrificial,” the GEOSYNTHETICS CONTRACTOR shall provide material that has a minimum mass per unit area (ASTM D3776) of 6 oz/sq yd. No other minimum performance criteria apply to this material.

F. Geotextiles shall be a stock product, i.e., except when specifically authorized in writing by OWNER. Supplier shall not furnish products specifically manufactured to meet these specifications.

G. Geotextile shall be comprised of polymeric yarns, or fibers oriented into a stable network that retains its structure during handling and placement.

2.02 MANUFACTURER QUALITY CONTROL

Ensure that geotextile manufacturer meets conditions in this section for all geotextile materials identified in this Section, except Temporary/Sacrificial Geotextile.

A. Tests, Inspections:

1. GEOSYNTHETICS MANUFACTURER shall test geotextiles to evaluate characteristics for quality control. At minimum, the following tests shall be performed in accordance with test methods specified in Article 2.01 of this section. At a minimum, quality control tests shall be performed for at least one every lot or at minimum, every 100,000 ft^2 (10,000 m^2) of geotextile produced. Samples not satisfying these specifications and manufacturer's specifications shall result in rejection of applicable roll.

   a. Mass per unit area;

   b. Grab strength;

   c. Trapezoidal tear strength;

   d. Burst strength; and

   e. Puncture strength.

2. At OWNER'S discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and to qualify individual rolls.

3. GEOSYNTHETICS MANUFACTURER shall certify that UV resistance, filtration, and permeability testing has been performed for each product and resin type in accordance with test methods specified in Article 2.01 of this section. Frequency specified for other quality control tests does not apply to these three material properties.

PART 3 EXECUTION

3.01 EXAMINATION

A. Samples of the geotextile material(s) shall be collected for conformance testing. As outlined in Section 11.4 of the Construction Quality Assurance Manual (QAM), conformance samples shall be collected in one of the following manners:

1. The GEOSYNTHETICS QAC shall collect samples of geotextile for conformance testing at the time of delivery to the site; or

2. The GEOSYNTHETICS QAC shall direct representatives of the GEOSYNTHETICS QAL to collect samples of the geotextile for conformance testing from the material at the manufacturer's facility.

B. Conformance Testing: GEOSYNTHETICS QAC shall collect samples of all geotextile types delivered to the site for conformance testing, except Temporary/Sacrificial Geotextile. Sampling and testing shall be conducted as outlined in the QAM utilizing test methods provided in Part 1.03 of this Section.

3.02 INSTALLATION

A. Geotextile Deployment: The GEOSYNTHETICS INSTALLER shall handle geotextile in manner to ensure it is not damaged and complies with the following:

1. On slopes, anchor geotextile securely and deploy it down slope in a controlled manner to continually keep geotextile in tension.

2. Weight geotextile with sandbags or equivalent in presence of wind. Do not remove weights until replaced with cover material.

3. Cut geotextile with geotextile cutter (hook blade). Protect adjacent materials from potential damage due to cutting of geotextile.

4. Prevent damage to underlying layers during placement of geotextile.

5. During geotextile deployment, do not entrap in, or beneath geotextile, stones, excessive dust, or moisture that could damage underlying geomembrane, cause clogging, or impact subsequent seaming. Verify that materials such as stone, soil fill, etc. is not present beneath geotextile seams.

6. Visually examine entire geotextile surface before seaming. Ensure no potentially harmful or damaging foreign objects, such as needles, are present and remove any foreign objects encountered or replace geotextile.

7. Geotextile shall be protected during construction from damage by runoff and sedimentation. Damaged geotextile shall be removed and replaced.

8. If Geotextile is exposed to UV light for more than 4 months, 2 representative samples will be cut and submitted for wide width testing, at the GEOSYNTHETICS INSTALLER's expense, to determine if the Geotextile has sufficient tensile strength for use. The test results will be reviewed by the ENGINEER and accepted by the OWNER.

B. The GEOSYNTHETICS INSTALLER shall adhere to the following seaming procedures:

1. Horizontal seams or splices not allowed on slopes greater than 10H:1V, except as part of a patch. Seams shall be downslope, not across slope.

2. Overlap geotextile a minimum of 3 in. (75 mm) prior to seaming.

3. Seams shall be continuous using a locking stitch.

4. Thread shall be a polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of geotextile. Thread color shall contrast with geotextile to allow for visual inspection.

C. Defects and Repairs: The GEOSYNTHETICS INSTALLER shall repair holes or tears in geotextile as follows.

1. Sew into place, in accordance with Paragraph 3.02.B of this section, a patch made from same geotextile, with a minimum 12 in. (0.30 m) overlap in all directions.

2. Remove soil or other material that may have penetrated torn geotextile.

3.03 INTERFACE WITH OTHER PRODUCTS

A. When installing materials over geotextile, the EARTHWORKS CONTRACTOR shall ensure the following:

1. Geotextile and underlying lining materials not damaged.

2. Minimal slippage of geotextile on underlying layers occurs.

3. No excess tensile stresses occur in geotextile.

4. Minimum of 12 in. of fill is placed over geotextile maintained in traffic areas.

5. Other conditions as required in Section 02401.

* * * END OF SECT1ON * * *

SECTION 02413
GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provide all labor, materials, equipment, tools and appurtenances required to complete the installation of all GCL layers as shown on the Drawings.

B. GCL will be installed as part of the landfill baseliner system and final cover system construction. The following technical specifications present requirements for the manufacturing, testing, transport, storage and installation of the GCL.

1.02 REFERENCES

A. ASTM D4354 - Standard Practice for Sampling of Geosynthetics for Testing.

B. ASTM D4873 - Standard Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples.

C. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

D. ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.

E. ASTM D5887 - Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.

F. ASTM D5888 - Standard Guide for Storage and Handling of Geosynthetic Clay Liners.

G. ASTM D5889 - Standard Practice for Quality Control of Geosynthetic Clay Liners.

H. ASTM D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.

I. ASTM D5891 - Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.

J. ASTM D5993 - Standard Test Method for Measuring Mass per Unit Area of Geosynthetic Clay Liners.

K. ASTM D6102 - Standard Guide for Installation of Geosynthetic Clay Liners.

L. ASTM D6141 - Standard Guide for Screening Clay Portion of Geosynthetic Clay Liner (GCL) for Chemical Compatibility to Liquids.

M. ASTM D6243 - Standard Test Method for Determining the Internal and Interface Shear Resistance of Geosynthetic Clay Liner by the Direct Shear Method (with the following clarifications):

1. For interface shear test, test GCL with materials which will be installed above and below the GCL (i.e., 80-mil textured geomembrane/GCL, GCL/nonwoven geotextile, 40-mil textured membrane/GCL interface, and GCL/separation layer interfaces).

2. All specimens and interfaces shall be fully hydrated for at least 24 hours, under 200 psf normal stress.

3. For Final Cover GCL, tests shall be performed at normal loads of 100, 250, 500 and 1,000 psf.

4. For Baseliner GCL, tests shall be performed at normal loads of 260, 2,500, 5,000, 10,000 and 15,000 psf.

N. ASTM D6495 - Standard Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners.

O. ASTM D6496 - Standard Test Method for Determining Average Bonding Peel Strength Between the Top and Bottom Layers of Needle-Punched Geosynthetic Clay Liners.

P. ASTM D6766 - Standard Test Method for Evaluation of Hydraulic Properties of Geosynthetic Clay Liners Permeated with Potentially Incompatible Liquids.

Q. ASTM D6768 - Standard Test Method for Tensile Strength of Geosynthetic Clay Liners.

R. GRI GCL3 - Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners (GCLs).

Note: The most current version of the specified test methods indicated above should be followed by the GEOSYNTHETICS MANUFACTURER, GEOSYNTHETICS INSTALLER, or authorized testing laboratory. In the event that a new test method becomes available and is deemed by the ENGINEER to be appropriate for use, either in addition to those methods indicated above or as a replacement to one or more of the methods indicated above, the new method will be used.

1.03 DEFINITIONS

A. Minimum Value – Property value representing the lowest individual allowable result when tested according to the specified test method. This applies to individual readings such as thickness or for tests where only one specimen is tested for the specific parameter.

B. Minimum Average Value – Property value representing the lowest allowable value for the reported average of specimens tested for the specified parameter.

C. Minimum Average Roll Value (MARV) – Property value calculated as typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any sample taken during quality assurance will exceed the value reported.

D. Nominal Value – Property value that is representative of a measurable property, determined under a set of prescribed test conditions, by which a product may be described.

E. Typical Roll Value – Property value calculated from average or mean obtained from test data.

1.04 SUBMITTALS

A. The GEOSYNTHETICS MANUFACTURER and/or GEOSYNTHETICS INSTALLER shall submit to the OWNER, in accordance with Section 01340, all items described in subsequent sections, as outlined by the following schedule:

1. Prior to Delivery to the Site:

a. A project reference list demonstrating the GEOSYNTHETICS INSTALLER's experience on a minimum of 5 projects consisting of 10 million square feet of installed GCL, or as approved by the OWNER.

b. A list of all GCL installation crew personnel and resumes of the Supervisor and QC Manager including prior experience installing GCL. This information shall be submitted at least 60 days prior to the commencement of GCL installation. If the exact crew who will be performing the installation is not known 60 days in advance of the start date, the GEOSYNTHETICS INSTALLER shall submit a list of several potential crew members. This information shall be supplied in a timely manner for approval in order to avoid delay of any construction activities. GCL crew staff will be subject to approval by the OWNER.

c. A copy of the GEOSYNTHETICS MANUFACTURER's Manufacturing Quality Assurance/Manufacturing Quality Control (MQA/MQC) Plan for testing GCL.

d. A statement of the GEOSYNTHETICS MANUFACTURER's experience in manufacturing GCL, including the manufacturing and supplying company's name, address, and employee contact.

e. A certification from the GEOSYNTHETICS MANUFACTURER attesting that the proposed GCL meets the physical, mechanical and manufacturing requirements specified in Part 2 of this Section.

f. Copies of the Manufacturing Quality Control (MQC) certificates for the material to be delivered to the site. The reports shall include the quality control test results of samples obtained during the manufacturing of the material to be delivered to the site. The GCL will be rejected if it does not meet the specified requirements of Part 2 of this Section or if it is found to have defects, rips, holes, flaws, deterioration or other damage deemed unacceptable by the GEOSYNTHETICS QAC.

g. A certification from the manufacturer that the manufacturing process used to produce the GCL includes needle detection and a mechanism for removal of needles. The certification shall include a statement attesting that the needle detection and removal process will be applied to all GCL supplied to this project, and that all GCL rolls shall be needle free.

h. Summary report including results of MQC testing required by this Section for GCL material to be delivered to the site. The report must clearly demonstrate that the GCL material to be delivered to the site meets the requirements of Part 2 of this Section.

i. Proposed method of GCL panel seaming including overlap distance at sides and end of panels, and use of additional material to complete the seal (if any).

j. Proposed method of detection of needles in installed panels.

k. Internal and interface shear strength test results as required in Part 2, Article 2.01, Paragraph C and/or D of this Section.

2. Prior to Installation, the GEOSYNTHETICS INSTALLER shall provide:

a. A schedule of operations including means and methods of installation.

b. The proposed method of deploying material and placement of panels.

c. Proposed method or process by which adjacent panels will be joined to provide a continuous hydraulic barrier.

d. Shop drawings including details of all overlapping attachments and anchoring.

e. Proposed method of protecting installed GCL panels from rain, ponding water or other elements that could hydrate or damage the GCL.

3. During installation, the GEOSYNTHETICS INSTALLER shall submit weekly:

a. Weekly construction progress reports clearly showing GCL panels and GCL roll numbers placed by date.

4. Upon completion, the GEOSYNTHETICS INSTALLER shall provide:

a. Record Panel Layout Diagram.

b. Summary and log of all laboratory quality control and quality assurance completed by GEOSYNTHETIC INSTALLER.

c. Summary and log of all field quality control work completed by the GEOSYNTHETICS INSTALLER.

d. Certification that GCL installation is complete and in accordance with these specifications.

e. Statement of material and installation warranties.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. The GEOSYNTHETICS MANUFACTURER shall be responsible for the protection of the GCL against damage during transportation to the site. The GEOSYNTHETICS INSTALLER shall be responsible for the protection of the GCL against damage during storage and installation at the site and prior to placement of subsequent construction materials.

B. GCL labeling, shipment, and storage shall follow ASTM D4873 and D5888, as modified according to this Section.

C. Product labels shall clearly show the manufacturer or supplier name, style name, roll number and roll dimensions.

D. If any special handling is required, it shall be so marked on the outside surface of the wrapping, (e.g., do not stack more than three rolls high).

E. The GCL shall be supplied dry (i.e., unhydrated, less than 35% moisture content) and be delivered to the site undamaged.

F. Each GCL roll shall be wrapped with a material that will protect the bentonite from moisture and the GCL from damage due to shipment, water, sunlight and contaminants.

G. The protective wrapping shall be maintained during periods of shipment and storage. If the wrapping is damaged prior to installation, the packaging shall be immediately repaired and/or the roll covered with a tarp to prevent potential additional hydration. The roll shall be set aside and marked for closer inspection upon deployment. Sections of the roll may be rejected if the moisture content of the bentonite has become excessively high as determined by the GEOSYNTHETICS QAC.

H. Storage area should be relatively flat and well drained. During storage, the GCL rolls shall be elevated off the ground utilizing a method which will not damage the GCL. Material that is damaged as a result of the method of storage or handling shall be rejected and replaced at no additional cost to the OWNER. The GCL rolls shall be adequately covered to protect them from the following:

1. Site construction damage;

2. Precipitation and ponded water;

3. Chemicals that are strong acids or bases;

4. Flames or sparks, temperatures in excess of 49°C (120°F); and

5. Any environmental condition that might damage the GCL.

I. The GEOSYNTHETIC INSTALLER shall protect the work described in this Section before, during and after installation. Only non-damaged, sufficiently dry material (as determined by the GEOSYNTHETICS QAC) shall be included within the construction.

J. Roll numbers on partially used rolls shall be maintained such that each GCL roll number can be readily identified just prior to GCL deployment.

K. If the GEOSYNTHETICS QAC determines that GCL is damaged, the GEOSYNTHETICS INSTALLER shall make all repairs and replacements in a timely manner to prevent delays in the progress of work. Any material damaged by the GEOSYNTHETICS INSTALLER, or damaged by others due to improper delivery, installation and/or storage, as determined by the GEOSYNTHETICS QAC, shall be replaced by the GEOSYNTHETICS INSTALLER at no cost to the OWNER.

1.06 QUALITY ASSURANCE SAMPLING, TESTING AND ACCEPTANCE

A. FINAL COVER GEOSYNTHETIC CLAY LINER MATERIAL

1. The GCL shall be subject to sampling and testing to verify conformance with this specification. As outlined in Section 13.4 of Quality Assurance Manual (QAM), conformance samples of the GCL shall be collected in one of the following manners:

   a. The GEOSYNTHETICS QAC shall collect samples of GCL for conformance testing at the time of delivery to the site; or

   b. The GEOSYNTHETICS QAC shall direct representatives of the GEOSYNTHETICS QAL to collect samples of the GCL for conformance testing from the material at the manufacturer’s facility.

2. Samples shall be taken across the entire width of the GCL roll. Unless otherwise specified or permitted by the ENGINEER, samples shall be three feet long by the roll width. The GEOSYNTHETICS QAC or authorized representative shall mark the machine direction on the samples with an arrow. Unless otherwise specified, samples shall be taken at a frequency of one per 100,000 square feet (ft^2) of material delivered to the site. An appropriate number of samples as determined by the GEOSYNTHETICS QAC will be shipped directly to the GEOSYNTHETICS QAL. The GEOSYNTHETICS QAC shall examine the material properties required by this Section against all results from laboratory conformance testing. Non-conforming material will be rejected and bracketed from subsequent rolls from the same product lot.

3. Conformance testing shall be the responsibility of the OWNER and conducted by the GEOSYNTHETICS QAL. Conformance testing shall be conducted in accordance with ASTM D6495 but shall include the following parameters:

   a. Hydraulic Conductivity (ASTM D5887 – 1 test per 250,000 square feet).

   b. Mass per Unit Area of Bentonite (ASTM D5993).

c. Mass per Unit Area Upper and Lower Layer Geotextile (ASTM D5261).

d. Bentonite Moisture Content (ASTM D5993).

e. Index Flux of GCL (ASTM D5887).

f. Tensile Strength of GCL (ASTM D6768).

4. The GEOSYNTHETICS INSTALLER and/or MANUFACTURER shall, at no additional cost to the OWNER, provide whatever reasonable assistance the GEOSYNTHETICS QAC may require in obtaining the samples for conformance testing.

5. The GEOSYNTHETICS MANUFACTURER shall provide MQC data issued by the manufacturer prior to site delivery of the GCL. In the event the material is delivered prior to receipt of the manufacturer's quality control certificates, the GCL without quality control certificates will be stored separate from GCL with quality control certificates. GCL rolls with unacceptable quality control data shall be segregated from approved material and marked for rejection.

6. Internal and interface shear strength testing of the GCL is the responsibility of the OWNER. All testing must be conducted prior to approval and delivery of the GCL material and performed with components that will be used in construction. Final Cover GCL material must meet the requirements of Part 2, Article 2.01, Paragraph C of this Section.

B. BASELINER GEOSYNTHETIC CLAY LINER MATERIAL

1. The GCL shall be subject to sampling and testing to verify conformance with this specification. As outlined in Section 13.4 of QAM, conformance samples of the GCL shall be collected in one of the following manners:

   a. The GEOSYNTHETICS QAC shall collect samples of GCL for conformance testing at the time of delivery to the site; or

   b. The GEOSYNTHETICS QAC shall direct representatives of the GEOSYNTHETICS QAL to collect samples of the GCL for conformance testing from the material at the manufacturer's facility.

2. Samples shall be taken across the entire width of the GCL roll. Unless otherwise specified or permitted by the ENGINEER samples shall be three feet long by the roll width. The GEOSYNTHETICS QAC or authorized representative shall mark the machine direction on the samples with an arrow. Unless otherwise specified, samples shall be taken at a frequency of one per 100,000 ft^2 of material delivered to the site. An appropriate number of samples as determined by the GEOSYNTHETICS QAC will be shipped directly to the GEOSYNTHETICS QAL. The GEOSYNTHETICS QAC shall examine the material properties required by this Section against all results from laboratory conformance testing. Non-conforming material will be rejected and bracketed from subsequent rolls from the same product lot.

3. Conformance testing shall be the responsibility of the OWNER and conducted by the GEOSYNTHETICS QAL. Conformance testing shall be conducted in accordance with ASTM D6495 but shall include the following parameters:

    a. Hydraulic Conductivity (ASTM D5887 – 1 test per 250,000 square feet).

    b. Mass per Unit Area of Bentonite (ASTM D5993).

    c. Mass per Unit Area Upper and Lower Layer Geotextile (ASTM D5261).

    d. Bentonite Moisture Content (ASTM D5993).

    e. Index Flux of GCL (ASTM D5887).

    f. Tensile Strength of GCL (ASTM D6768).

4. The GEOSYNTHETICS INSTALLER and/or MANUFACTURER shall, at no additional cost to the OWNER, provide whatever reasonable assistance the GEOSYNTHETICS QAC may require in obtaining the samples for conformance testing.

5. The GEOSYNTHETICS MANUFACTURER shall provide MQC data issued by the manufacturer prior to site delivery of the GCL. In the event the material is delivered prior to receipt of the manufacturer's quality control certificates, the GCL without quality control certificates will be stored separate from GCL with quality control certificates. GCL rolls with unacceptable quality control data shall be segregated from approved material and marked for rejection.

6. Internal and interface shear strength testing of the GCL is the responsibility of the OWNER. All testing must be conducted prior to approval and delivery of the GCL material and performed with components that will be used in construction. Baseliner GCL material must meet the requirements of Part 2, Article 2.01, Paragraph D of this Section.

PART 2 MATERIALS

2.01 GENERAL

A. The GCL shall consist of a low permeability sodium bentonite encapsulated between two geotextiles. The bentonite and finished product requirements are described in the following Parts and include the minimum MQA and MQC testing.

B. The GEOSYNTHETICS INSTALLER shall obtain a certificate from the GCL MANUFACTURER for MQC testing described in this Part.

C. FINAL COVER GCL MATERIAL - The GEOSYNTHETICS QAC shall obtain random samples of the proposed GCL and materials that will be installed above and below the GCL for the Final Cover System. These samples will undergo interface shear strength testing for each interface (i.e., 40 mil textured membrane/GCL interface and GCL/separation layer interfaces). Additionally, random samples of the proposed GCL for the Final Cover System shall be submitted for testing of internal shear strength. A minimum of one round of interface/internal shear strength testing (including testing at all indicated normal stresses, under all conditions, and for each interface) shall be completed prior to any construction season involving final cover construction. The interface/internal shear strength testing shall be repeated if, in the opinion of the ENGINEER, the manufacturer, product, or material characteristics of the associated products (GCL, geomembrane, or separation layer general fill) change following acceptance of the initial testing. All testing must be conducted prior to the approval and delivery of the materials and performed with components that will be used in the construction. Testing shall be conducted according to the most recent version of ASTM D6243. Test preparations shall be in accordance with Paragraph C.1 of this Part and the reported results shall meet the requirements of Paragraph C.2 of this Part.

1. All specimens and interfaces shall be hydrated under a normal load of 200 pounds per square foot (psf) for a minimum period of 24 hours prior to shearing at a strain rate of 0.04 in./min.

2. Tests for both internal and interface peak and residual shear strength shall be performed at normal loads of 100, 250, 500 and 1,000 psf with a minimum displacement of 6 in. The required peak and residual shear strengths are provided in the table below.

GCL INTERFACE AND INTERNAL SHEAR STRENGTH (ASTM D6243) Frequency of 1 test per product type.		
Normal Stresses (psf)	Required Peak Shear Strength (psf)*	Required Residual Shear Strength (psf)*
100	50	33
250	125	83
500	250	167
1,000	492	329

* The required shear strengths above include both internal friction and cohesion (adhesion) components. GCL residual internal shear strength testing is only required if laboratory testing indicates that the peak internal shear strength of the GCL is the lowest of the various materials or interfaces in the final cover system.

Additionally, testing for both internal and interface residual shear strength shall be performed at normal loads of 100, 250 and 500 psf at high strain rate (minimum of 0.5 in./min.) and large strains to simulate strength conditions during a seismic event. The required residual shear strengths are provided in the table below.

GCL INTERFACE AND INTERNAL SHEAR STRENGTH DURING SEISMIC EVENT (ASTM D6243) Frequency of 1 test per product type.

Normal Stresses (psf)	Required Residual Shear Strength (psf)*
100	38
250	95
500	191

* The required shear strengths above include both internal friction and cohesion (adhesion) components. GCL residual internal shear strength testing is only required if laboratory testing indicates that the peak internal shear strength of the GCL is the lowest of the various materials or interfaces in the final cover system.

D. BASELINER GCL MATERIAL - The GESOYNTHETICS QAC shall obtain random samples of the proposed GCL and materials that will be installed above and below the GCL for the Baseliner System. These samples will undergo interface shear strength testing for each interface (i.e., 80 mil textured geomembrane/GCL, GCL/non-woven geotextile). Additionally, random samples of the proposed GCL for the Baseliner System shall be submitted for testing of internal shear strength. A minimum of one round of interface/internal shear strength testing (including testing at all indicated normal stresses, under all conditions, and for each interface) shall be completed prior to any construction season involving baseliner construction. The interface/internal shear strength testing shall be repeated if, in the opinion of the ENGINEER, the manufacturer, product, or material characteristics of the associated products (GCL, geomembrane, or non-woven geotextile) change following acceptance of the initial testing. All testing must be conducted prior to the approval and delivery of the materials and performed with components that will be used in the construction. Testing shall be conducted according to the most recent version of ASTM D6243, test preparations shall be in accordance with Paragraph D.1 of this Part and the reported results shall meet the requirements of Paragraph D.2 of this Part.

1. All specimens and interfaces shall be hydrated under a normal load of 200 psf for a minimum period of 24 hours prior to shearing at a strain rate of 0.04 in./min.

2. Tests for both internal and interface shear strength shall be performed at normal loads of 260, 2,500, 5,000, 10,000 and 15,000 psf with a minimum displacement of 6 in. The minimum required residual shear strength for each of the interfaces is provided in the table below.

GCL INTERFACE AND INTERNAL SHEAR STRENGTH (ASTM D6243)
Frequency of 1 test per product type.

Normal Stresses (psf)	Required Residual Shear Strength (psf)*
260	70
2,500	1,200
5,000	2,100
10,000	3,500
15,000	4,400

* The required shear strengths above include both internal friction and cohesion (adhesion) components. GCL residual internal shear strength testing is only required if laboratory testing indicates that the peak internal shear strength of the GCL is the lowest of the various materials or interfaces in the baseliner system.

2.02 BENTONITE

A. The bentonite used for the production of the GCL shall be low permeability sodium bentonite.

B. The bentonite portion of the GCL shall be granular bentonite.

C. The supplier and/or source of the bentonite shall be included on the MQA results for the bentonite.

2.03 GEOSYNTHETIC CLAY LINER

A. The GCL shall consist of a low permeability sodium bentonite encapsulated between two nonwoven geotextiles.

B. The following table represents the minimum required MQC testing that must be conducted by the GEOSYNTHTHICS MANUFACTURER on the GCL. The GCL shall be tested in accordance with ASTM D5889 as modified by the following table. Testing shall be conducted at the frequencies listed in the following table and must meet the required values provided:

GEOSYNTHETIC CLAY LINER

Property	Method	Value	Frequency
Bentonite Component Swell Index (As Received)	ASTM D5890	24 ml/2g min.	1 / 100,000 lb
Bentonite Component Fluid Loss (As Received)	ASTM D5891	18 ml max.	1 / 100,000 lb
Mass Per Unit Area			
1. Bentonite Content	ASTM D5993	0.75 lb/ft^2 dry weight MARV*	1 / 45,000 sf
2. Geotextile Upper Layer	ASTM D5261	5.8 oz/yd^2 MARV*	1 / 225,000 sf
3. Geotextile Lower Layer	ASTM D5261	5.9 oz/yd^2 MARV*	1 / 225,000 sf
Bentonite Moisture Content (As Manufactured)	ASTM D5993	35% max. ave. roll value	1 / 225,000 sf
Peel Strength	ASTM D6496	2.1 lb/in. MARV*	1 / 45,000 sf
Tensile Strength[2]	ASTM D6768	23 lbs/in MARV*	1 / 225,000 sf
Durability	GRI GCL3/ ASTM D5721/ ASTM D6768	65% of tensile strength (ASTM D6768) retained (min.) after 50 days incubation at 50^o C (ASTM D5721)	Yearly
Index Flux [1]	ASTM D5887	1 x 10^{-6} cm^3/cm^2/sec max.	1 / 270,000 sf
Permeability [1]	ASTM D5887	5 x 10^{-9} cm/sec max.	1 / 270,000 sf
Permeability with Potentially Incompatible Permeant[3]	ASTM D6766 (modified)	5x10^{-8} cm/s max. (10,000 psf Confining Pressure)	Yearly

* Minimum Average Roll Value.

1. Test according to manufacturer's recommendations, and in compliance with the specified ASTM standard as modified in this Section.

2. Tensile testing to be performed in the machine direction.

3. Permeability testing with potentially incompatible permeant to be performed using a calcium chloride solution as specified in GRI GCL3.

PART 3 EXECUTION

3.01 SITE PREPARATION

A. The surface to be covered by the GCL shall be cleared of sharp objects, boulders, sticks, or any materials that may puncture, shear, or tear the GCL. The GCL subgrade shall have a smooth, finished surface, free from pockets, holes, ruts and depressions that will cause bridging and overstress the material to the judgment of the GEOSYNTHETICS QAC.

B. The GEOSYNTHETIC INSTALLER and GEOSYNTHETICS QAC shall inspect the subgrade for unsuitable areas or soft spots before the GCL is placed. Additional surface preparation will be required to eliminate any unsuitable areas as determined by the GEOSYNTHETICS QAC.

C. The subgrade/geosynthetic surface below the GCL shall:

1. Be prepared in accordance with the Plans and Specifications.

2. For GCL deployment over soil surfaces, the prepared soil surface shall have no stones or other protrusions that may be damaging to the GCL as determined by the GEOSYNTHETICS QAC.

3. For GCL deployment over geotextile, the approved geotextile surface shall be smooth, free from pockets, indentations, ruts or depressions and be free from loose granular material.

4. Be approved, accepted and certified by the GEOSYNTHETICS QAC and GEOSYNTHETICS INSTALLER's quality assurance inspector.

3.02 INSTALLATION

A. GCL shall not be deployed during periods of excessive winds which could prevent an acceptable installation as determined by the GEOSYNTHETICS QAC.

B. All GCL materials shall be installed according to the grades and locations presented in the Construction Drawings and in accordance with manufacturer's recommendations.

C. The GEOSYNTHETICS INSTALLER shall furnish the roll number and panel number to the GEOSYNTHETICS QAC prior to the installation of each panel.

D. The GEOSYNTHETICS INSTALLER shall maintain the GCL in an "as received" condition up to and including the time that the overlying layer of the Final Cover and/or Baseliner System is accepted by the OWNER. While the GCL will begin to hydrate immediately upon deployment, it is essential that the GCL not become fully hydrated prior to loading, as placement of material over hydrated bentonite may destabilize a given area. For Final Cover areas, the GCL must have a minimum of 1 ft. of cover soils in place prior to full hydration. For Baseliner areas, the GCL must have a minimum of 1 foot of primary leachate collection material in place prior to full hydration. Additional restrictions and guidance with regard to hydrated or wet GCL are as follows:

1. GCL shall not be placed on wet subgrade, as determined by the GEOSYNTHETICS QAC.

2. GCL becoming partially hydrated prior to covering with geomembrane shall be evaluated by the GEOSYNTHETICS QAC to ascertain the condition of the material and to determine if removal and replacement is necessary.

3. In the event that full hydration occurs prior to placement of the overlying materials described above, the GCL material shall be evaluated by the GEOSYNTHETICS QAC to ascertain the condition of the material and to determine if removal is necessary. Full hydration in this case shall be defined as a bentonite moisture content of 80% or more.

E. The EARTHWORKS INSTALLER is required to place cover materials described in Part 3.02, Paragraph D as quickly as possible after deployment of GCL and overlying geosynthetics. The time period between deployment of GCL and cover materials shall not exceed 20 days. This period of time may be extended, at the discretion of the ENGINEER, in the event the GEOSYNTHETICS INSTALLER can adequately demonstrate that the GCL does not hydrate above 50% moisture prior to placement of the cover materials.

F. Each panel shall be checked for the presence of broken needles from the manufacturing process according to the approved method submitted by the GEOSYNTHETICS MANUFACTURER. All identified needles must be removed by the GEOSYNTHETICS INSTALLER at no cost to the OWNER. Any panel or roll exhibiting the presence of excessive amounts of broken needles shall be rejected and removed at no additional cost to the OWNER. Excessive amounts of broken needles will be determined by the GEOSYNTHETICS QAC.

G. GEOSYNTHETIC INSTALLER personnel shall not be allowed to wear shoes that can damage the GCL during deployment or placement of subsequent geosynthetic materials.

H. GCL Panels shall be deployed in a direction from the highest elevation to the lowest elevation within the area to be lined. Whenever possible, GCL panels shall be staggered such that end seams between any two panels are not aligned with adjacent end seams. GCL panels shall be installed free of tension.

I. GCL seams shall be overlapped a minimum of 6 in. on edge seams and minimum of 12 in. on end seams after shrinkage and before placing cover.

J. The GEOSYNTHETICS INSTALLER shall not deploy more GCL in one day than can be covered by end of that day with overlying geomembrane materials.

K. The GCL rolls shall be handled in a manner that minimizes loss of bentonite along edges during deployment.

L. The GEOSYNTHETICS INSTALLER shall be responsible for protection of the GCL during installation. Unless otherwise approved by the ENGINEER, no rubber tire ATV’s, tracked vehicles or any other equipment which may pose a risk of puncturing, tearing or otherwise damaging the GCL will be permitted for use directly over the GCL.

M. The GCL shall not be covered until inspected and approved by the GEOSYNTHETICS QAC. Field observations shall include a visual check of in-place GCL for the presence of needles.

3.03 REPAIRS

A. Repairs are to be made as soon as possible following deployment of GCL panels.

B. Damage to the GCL shall be repaired in the following manner, unless alternate procedures are proposed by the GEOSYNTHETICS INSTALLER and approved by the ENGINEER.

1. The damaged area shall be cleared of dirt and debris.

2. A patch of GCL shall be cut to extend a minimum of 12 in. beyond the damaged area in all directions.

3. Granular bentonite shall be placed around the perimeter of the damaged area at a rate of 0.25 pounds per linear foot.

4. The patch shall be placed over the damaged area and may be secured with an adhesive to keep the patch in position during backfilling or other activities over the GCL. The adhesive shall be approved by the GEOSYNTHETICS MANUFACTURER and the ENGINEER.

PART 4 QUALITY CONTROL

4.01 GENERAL

A. The GEOSYNTHETICS INSTALLER, before installation begins, shall appoint an experienced individual who will be on-site at all times during the installation, to represent the GEOSYNTHETICS INSTALLER in all matters pertaining to the work. This appointment shall be subject to approval by the OWNER.

B. All of the forms specified and required must be submitted in a timely fashion.

C. Any changes in the proposed method of work, subcontractors to be utilized, GCL or manufacturing, must be approved in advance by the OWNER. The GEOSYNTHETICS INSTALLER assumes all responsibility relevant to providing an acceptable product.

4.02 QUALITY CONTROL DURING MANUFACTURING

A. The GEOSYNTHETICS MANUFACTURER shall sample and test the GCL according to Part 2 of this Section to verify consistency of production and compliance with these specifications. Testing shall be in accordance with the test methods and at the frequencies specified in Part 2 of this Section.

B. The manufacturing process shall include a mechanism for needle detection and removal. This mechanism shall be in operation throughout the production of all GCL rolls to be delivered to the site. The GEOSYNTHETICS MANUFACTURER shall issue a certification listing all rolls with which the mechanism was utilized as well as a certification that all material supplied is needle-free.

C. The GEOSYNTHETICS MANUFACTURER shall provide the GEOSYNTHETICS QAC with certified copies of MQA/MQC test results. No material shall be installed prior to supply and approval of the required test results.

D. The GEOSYNTHETICS QAC may obtain additional random samples of the GCL for further confirmatory testing. This testing will be at the expense of the OWNER, unless the test reveals the GCL does not comply with the specifications, in which case the expense of the testing will be the responsibility of the GEOSYNTHETICS MANUFACTURER. This testing may include all properties specified in Part 2 of this Section or other tests deemed reasonable and necessary by the GEOSYNTHETICS QAC. The GEOSYNTHETICS INSTALLER shall, however, at no additional cost, provide whatever reasonable assistance the GEOSYNTHETICS QAC may require in obtaining the samples.

E. The GEOSYNTHETICS MANUFACTURER shall be solely responsible for the quality of the material provided. Should any tests performed on the material yield unsatisfactory results, the GEOSYNTHETICS MANUFACTURER will be responsible for replacing the material with materials that meet project specifications without delay to the project and at no additional cost to the OWNER.

4.03 QUALITY CONTROL DURING INSTALLATION

A. The GEOSYNTHETICS QAC and the GEOSYNTHETICS INSTALLER shall visually inspect all material for any damage incurred during transportation and for uniformity, and compare roll identification numbers with those on the certification provided by the manufacturer to assure delivery of the appropriate material.

B. The GEOSYNTHETICS QAC and GEOSYNTHETICS INSTALLER shall visually inspect all material for any damage incurred as a result of handling or on-site storage.

C. Damage to GCL during installation shall be repaired according to Part 3.03 of this Section. If the GEOSYNTHETICS QAC determines that the damage is considered un-repairable, the damaged material will be replaced at no additional cost to the OWNER.

D. Prior to installation, the GEOSYNTHETICS QAC will select random samples for internal shear strength and interface shear strength for each interface described in Part 2, Article 2.01, Paragraph C and/or D of this Section. Internal and interface shear strength testing will be at the expense of the OWNER, unless the tests reveal that the GCL does not comply with the specifications, in which case, the expense of the tests on failing material will be incurred by the GEOSYNTHETICS MANUFACTURER. No material will be installed before the internal and interface shear test results show that the GCL material meets the project specifications as determined and approved by the GEOSYNTHETICS QAC.

E. The GEOSYNTHETICS MANUFACTURER and GEOSYNTHETICS INSTALLER are responsible for verifying that the GCL is free of needles during both manufacturing and installation. If needles are detected or suspected by the GEOSYNTHETICS QAC, the OWNER may require the GEOSYNTHETICS INSTALLER to provide verification, at no additional cost to the OWNER, that installed GCL does not contain needles that could possibly damage the geomembrane.

* * * END OF SECTION * * *

SECTION 02430
GEOTEXTILE/GEONET COMPOSITE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Supply and install thermally bonded geotextile and geonet as a geocomposite drainage layer for landfill final cover system and landfill baseliner system.

1.02 RELATED SECTIONS

A. Section 01400 – General Provisions for Geosynthetics.

1.03 REFERENCES

A. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.

B. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

C. ASTM D1603 - Standard Test Method for Carbon Black in Olefin Plastics.

D. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.

E. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

F. ASTM D4533 - Test Method for Trapezoid Tearing Strength of Geotextiles.

G. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

H. ASTM D4716 - Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using Constant Head. Modifications:

Baseliner Test 1: Applied load = 14,500 psf with a hydraulic gradient of 0.1. Substrate to be (from bottom up) a steel plate followed by a sample of 80 mil textured HDPE geomembrane. Superstrate to be (from bottom up) a sample of granular drainage layer stone followed by a steel plate.

Baseliner Test 2: Applied load = 3,000 psf with a hydraulic gradient of 0.33. Substrate to be (from bottom up) a steel plate followed by a sample of 80 mil textured HDPE geomembrane. Superstrate to be (from bottom up) a sample of operations layer stone followed by a steel plate.

Final Cover Test 1: Applied load = 2,500 psf with a hydraulic gradient of 0.1. Substrate to be (from bottom up) a steel plate followed by a sample of 40 mil textured HDPE geomembrane. Superstrate to be (from bottom up) a sample of general fill soil followed by a steel plate.

Final Cover Test 2: Applied load = 2,500 psf with a hydraulic gradient of 0.33. Substrate to be (from bottom up) a steel plate followed by a sample of 40 mil textured HDPE geomembrane. Superstrate to be (from bottom up) a sample of general fill soil followed by a steel plate.

Confining pressure at least 100 hrs prior to test.

I. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

J. ASTM D5199 - Standard Test Method for Measuring Nominal Thickness of Geosynthetics.

K. ASTM D5261 - Standard Test Method for Measuring Mass per Unit Area of Geotextiles.

L. ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic, or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

Modifications:

1. Perform interface shear testing of geocomposite with materials which will be installed above and below the geocomposite (i.e., geocomposite/80 mil textured geomembrane, general fill/geocomposite, and geocomposite/40 mil textured geomembrane).

2. Normal loads: 100, 250, 500 and 1,000 psf for geocomposite in the cover system and 100, 250, 500, 1,000, 2,500, 5,000, 10,000 and 15,000 psf for geocomposite in the liner system.

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

N. ASTM D7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

O. AASHTO M288-06 - Geotextile Specification for Highway Applications.

Note: The most current version of the specified test methods indicated above should be followed by the GEOSYNTHETICS MANUFACTURER, GEOSYNTHETICS INSTALLER, or authorized testing laboratory. In the event that a new test method becomes available and is deemed by the ENGINEER to be appropriate for use, either in addition to those methods indicated above or as a replacement to one or more of the methods indicated above, the new method will be used.

1.04 QUALITY CONTROL SUBMITTALS

A. Pre-installation: The GEOSYNTHETICS MANUFACTURER shall submit the following to OWNER for approval, prior to geocomposite delivery.

1. Origins (supplier's name and production plant) and identifications (brand name and number) of geotextile and geonet used to manufacture geocomposite.

2. Copies of dated quality control certificates issued by geotextile and geonet manufacturer.

3. Specification for geocomposite that includes all properties published by manufacturer measured using appropriate test methods.

4. Written certification that minimum roll values given in manufacturer's specification guaranteed by geocomposite manufacturer.

5. Quality control certificates for geocomposite, signed by responsible party employed by geocomposite manufacturer. Quality control certificates shall include roll identification numbers, testing procedures, and results of quality control tests.

B. Installation: The GEOSYNTHETICS INSTALLER shall submit the following as installation proceeds.

1. Subgrade surface acceptance certificates if applicable, signed by GEOSYNTHETICS INSTALLER, for each area that will be covered directly by geocomposite. Submit prior to geocomposite deployment. Deployment of geocomposite will be considered acceptance of subgrade if certificate not submitted.

1.05 DELIVERY, STORAGE AND HANDLING

A. The GEOSYNTHETICS MANUFACTURER shall adhere to the following packing and shipping requirements:

1. Geocomposites shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.

2. Geocomposite rolls shall be marked or tagged with following information:

a. Manufacturer's name;

b. Product identification;

c. Roll number; and

d. Roll dimensions.

B. The CONTRACTOR shall adhere to the following storage and protection requirements:

1. Provide on-site storage in OWNER designated area for geocomposite rolls from time of delivery until installed.

2. Store and protect geocomposite from dirt, water, ultraviolet light exposure, and other sources of damage.
3. Preserve integrity and readability of geocomposite roll labels.

PART 2 PRODUCTS

2.01. MATERIALS

A. FINAL COVER GEOCOMPOSITE MATERIAL - The GEOSYNTHETICS QAC shall obtain random samples of the proposed geocomposite and materials that will be installed above and below the geocomposite for the final cover system. These samples will undergo interface shear strength testing for each interface (i.e., general fill/geocomposite and geocomposite/40 mil textured geomembrane). A minimum of one round of interface shear strength testing (including testing at all indicated normal stresses, under all conditions, and for each interface) shall be completed prior to any construction season involving final cover construction. The interface shear strength testing shall be repeated if, in the opinion of the ENGINEER, the manufacturer, product, or material characteristics of the associated products (geocomposite, geomembrane, or general fill) change following acceptance of the initial testing. Testing must be conducted prior to the approval of the materials and performed with components that will be used in the construction. Testing may be performed prior to or following delivery of the geocomposite material to the site. In either case, testing must be conducted on the actual material that will be used in construction of the final cover. Testing shall be conducted according to the most recent version of ASTM D5321, and the reported results shall meet the requirements of Paragraph A.1 of this Part.

1. Tests shall be performed at a normal load of 100, 250, 500 and 1,000 psf with a strain rate of 0.04 in./min. and a minimum displacement of 6 in. The minimum required peak and residual interface shear strengths are provided in the following table.

GEOCOMPOSITE INTERFACE SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.		
Normal Stresses (psf)	Required Peak Shear Strength (psf)*	Required Residual Shear Strength (psf)*
100	50	33
250	125	83
500	250	167
1,000	492	329

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

Additionally, testing for interface residual shear strength shall be performed at normal loads of 100, 250 and 500 psf at high strain rate (minimum of 0.5 in./min.) and large strains to simulate strength conditions during a seismic event. The required residual shear strengths are provided in the table below.

GEOCOMPOSITE INTERFACE SHEAR STRENGTH DURING SEISMIC EVENT (ASTM D5321) Frequency of 1 test per product type.	
Normal Stresses (psf)	Required Residual Shear Strength (psf)*
100	38
250	95
500	191

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

B. BASELINER GEOCOMPOSITE MATERIAL - The GEOSYNTHETICS QAC shall obtain random samples of the proposed geocomposite and materials that will be installed above and below the geocomposite for the baseliner system. These samples will undergo interface shear strength testing for each interface (i.e., geocomposite/80 mil textured geomembrane). A minimum of one round of interface shear strength testing (including testing at all indicated normal stresses, under all conditions, and for each interface) shall be completed prior to any construction season involving baseliner construction. The interface shear strength testing shall be repeated if, in the opinion of the ENGINEER, the manufacturer, product, or material characteristics of the associated products (geocomposite or geomembrane) change following acceptance of the initial testing. Testing must be conducted prior to the approval and delivery of the materials and performed with components that will be used in the construction. Testing shall be conducted according to the most recent version of ASTM D5321, and the reported results shall meet the requirements of Paragraph B.1 and B.2 of this Part.

1. Tests shall be performed at a normal load of 100, 250, 500, and 1,000 psf with a strain rate of 0.04 in./min. and a minimum displacement of 1 in. The minimum required peak interface shear strengths are provided in the following table.

GEOCOMPOSITE INTERFACE SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.	
Normal Stresses (psf)	Required Peak Shear Strength (psf)*
100	41
250	103
500	206
1,000	412

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

2. Tests shall be performed at a normal load of 100, 250, 500, 1,000, 2,500, 5,000, 10,000 and 15,000 psf with a strain rate of 0.04 in./min. and a minimum displacement of 6 in. The minimum required residual interface shear strengths are provided in the following table.

GEOCOMPOSITE INTERFACE SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.	
Normal Stresses (psf)	Required Residual Shear Strength (psf)*
100	31
250	78
500	156
1,000	311
2,500	1,200
5,000	2,100

10,000	3,500
15,000	4,400

* The required shear strengths above include both internal friction and cohesion (adhesion) components.

C. Geonet component shall meet the following specifications and be capable of retaining its structure during handling, placement, and long-term service. Geonet shall be a profiled mesh made from HDPE, and contain carbon black, anti-oxidants, and heat stabilizers. All geonet components shall be manufactured from resins provided by one supplier.

GEONET PROPERTIES

PROPERTY	METHOD	VALUE
Thickness	ASTM D5199	200 mils min.
Density (geonet)	ASTM D1505	0.936 g/cc min.
Melt Index (resin)	ASTM D1238	1.0 g/10 min.
Carbon Black Content	ASTM D1603	2.0 - 3.0%

D. Geotextile components shall meet the following specifications and be capable of withstanding stresses due to handling, installation, and long-term service. Certain values are based on survivability classification identified in the AASHTO M288-06 standard that was current as of the date of this specification. Should subsequent revisions to the AASHTO standard result in changes to these values, the values in the latest version of the AASHTO shall apply.

GEOTEXTILE PROPERTIES

Property	Method	Value (MARV, Except AOS)*
Mass per Unit Area	ASTM D5261	6 oz/sq yd min.
Grab Strength	ASTM D4632	157 lbs min. (AASHTO Class 2 Survivability)
Trapezoidal Tear Strength	ASTM D4533	56 lbs min. (AASHTO Class 2 Survivability)
Puncture Strength	ASTM D6241	309 lbs min. (AASHTO Class 2 Survivability)
Apparent Opening Size	ASTM D4751	0.43 mm max. (Baseliner Geocomposite) 0.25 mm max. (Final Cover Geocomposite)
Permittivity	ASTM D4491	0.5 s^{-1} min. (Baseliner Geocomposite) 0.2 s^{-1} min. (Final Cover Geocomposite)
Ultraviolet Stability	ASTM D4355	50% min. (after 500 hours of exposure)

* Minimum Average Roll Value

E. Provide geocomposite meeting following specifications and capable of retaining its structure during handling, placement and long-term service.

GEOCOMPOSITE PROPERTIES

PROPERTY	METHOD	VALUE
Ply Adhesion	ASTM D7005	0.5 lb/in min.
Transmissivity	ASTM D4716*	18.6 cm^2/s min. (Baseliner Test 1) 4.7 cm^2/s min. (Baseliner Test 2) 3.2 cm^2/s min (Final Cover Test 1) 1.1 cm^2/s min (Final Cover Test 2)

* Test methods as modified in Article 1.03.

F. Geotextiles and geonets used for manufacture of geocomposite shall be stock products, i.e., except when specifically authorized in writing by OWNER. Suppliers shall not furnish products specifically manufactured to meet specifications in Article 2.01 of this section.

2.02 MANUFACTURER QUALITY CONTROL

A. Tests, Inspection:

1. Geocomposites shall be tested by geocomposite manufacturer to evaluate characteristics for quality control. The manufacturer shall certify that these tests have been performed in accordance with test methods specified in Article 2.01 A of this section. At minimum, following tests shall be performed for quality control.

   a. Mass per unit area;

   b. Thickness;

   c. Geotextile-geonet adhesion (peel strength); and

   d. Transmissivity (one test per 100,000 ft^2).*

   * Transmissivity to be performed in accordance with ASTM D4716 and Article 1.03.

2. Geocomposite manufacturer shall perform quality control tests for at least every 40,000 ft^2 of geocomposite produced.

3. At geocomposite manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and to qualify individual rolls.

4. Geocomposite components shall be evaluated by the component manufacturers to determine characteristics for quality control. Each component shall be tested for the properties specified for that component, at a frequency of one per 40,000ft^2 of the component material produced.

PART 3 EXECUTION

3.01 EXAMINATION

A. Conformance Testing:

1. Samples of the geocomposite shall be collected for conformance testing. As outlined in Section 12.4 of the Quality Assurance Manual, conformance samples shall be collected in one of the following manners:

a. The GEOSYNTHETICS QAC shall collect samples of geocomposite for conformance testing at the time of delivery to the site; or

b. The GEOSYNTHETICS QAC shall direct representatives of the GEOSYNTHETICS QAL to collect samples of the geocomposite for conformance testing from the material at the manufacturer's facility.

2. GEOSYNTHETICS QAC (or GEOSYNTHETICS QAL representative) shall collect samples of the geocomposite for conformance testing. Sampling and testing shall be conducted as outlined in the QAM utilizing test methods provided in Part 1.03 of this specification.

3. GEOSYNTHETIC QAC shall collect archival samples of geocomposite to be installed.

3.02 INSTALLATION

A. Geocomposite Deployment: The GEOSYNTHETICS INSTALLER shall handle geocomposite material in a manner to ensure it is not damaged and complies with the following:

1. On slopes, anchor geocomposite securely and deploy it down slope in a controlled manner to continually keep geocomposite in tension.
2. Weight geocomposite with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material.

3. Prevent damage to underlying layers during placement of geocomposite.

4. During deployment, do not entrap in or beneath geocomposite, stones, excessive dust, or moisture that could damage the underlying geomembrane, cause clogging of geocomposite, or hamper subsequent seaming.

5. Visually examine entire geocomposite surface before seaming. Ensure no potentially harmful or damaging foreign objects such as needles are present and remove any foreign objects encountered or replace geocomposite.

B. Geonet Seams and Overlap: The GEOSYNTHETICS INSTALLER shall join geonet in adjacent geocomposite panels in accordance with Design Drawings and Specifications and at minimum, meet the following requirements:

1. Overlap adjacent geonet minimum of 4 in.

2. Tie geonet overlaps with plastic fasteners. Use white or yellow tying devices for easy inspection. Do not use metallic devices.

3. Tie every 5 ft. along slope, every 6 in. in anchor trench, and every 6 in. along butt seams.

4. In corners of side slopes of rectangular landfill configurations, where overlaps between perpendicular geonet strips are required, unroll extra layer of geocomposite along slope, on top of previously installed geocomposite, from top to bottom of slope.

5. Stagger joints when more than one layer of geocomposite is installed.

C. Geotextile Seaming Procedures: The GEOSYNTHETICS INSTALLER shall adhere to the following seaming procedures:

1. Overlap geotextile a minimum of 3 in. prior to sewing.

2. Continuously sew top geotextiles using a locking stitch. Spot sewing is not allowed.

3. Ensure that no soil cover material is present beneath geotextile at seams.

4. When sewing, use polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of geotextile.

D. Defects and Repairs: Repair small defects as judged by GEOSYNTHETICS QAC as follows, if geonet is undamaged but geotextile is damaged.

1. Remove damaged geotextile.

2. Cut patch of new geotextile to provide minimum 12 in. overlap in all directions.

3. Sew geotextile in-place.

E. If geonet is damaged:

1. Remove damaged geonet.

2. Cut patch of new material to replace geonet.

3. Secure patch to original geonet by tying every 6 in. Use tying device as indicated in Article 3.02 B of this section.

4. Place geotextile patch overlapping damaged area to provide minimum 12 in. overlap of geonet repair edge in all directions.

5. Sew geotextile in-place.

F. Replace geocomposite if judged by GEOSYNTHETICS QAC to be a large defect.

G. Geocomposite Installation Procedures:

The geocomposite will be installed in conformance with Article 3.02 B and 3.02 C of this section. At a minimum, meet the following requirements:

1. For baseliner applications, horizontal seams or field splices (butt seams) are not allowed on slopes greater than 10H:1V (i.e., seams shall be downslope, not across, slope) except as part of patch. Splices are defined as seams connecting the ends of 2 rolls.

2. Geocomposite butt seams are allowed on final cover slopes greater than 10H:1V.

3. Manufacturer's butt seams of the geotextile components of the geocomposite that exist on sideslopes shall be covered with a geotextile patch extending a minimum 6 in. in each direction. The geotextile patch shall be heat bonded to the geocomposite.

4. For butt seam locations where the geotextile cannot be pulled away from the geonet to the satisfaction of the GEOSYNTHETICS QAC, the seams are to be joined by overlapping sheets, utilizing plastic ties to fasten geonet with two rows of plastic ties spaced 6 in. apart. The butt seam is to then be capped by heat fusing a 2 ft. wide cap of geotextile over the full length of the seam. A minimum 6 in. of overlap of the geotextile to the seam is required.

5. Butt seams shall be staggered not less than 5 ft. unless otherwise authorized by the OWNER.

3.03 INTERFACE WITH OTHER PRODUCTS

A. The EARTHWORKS CONTRACTOR shall ensure the following when installing materials located on top of geocomposite.

1. Geocomposite and underlying lining materials are not damaged.

2. Minimize slippage of geocomposite on underlying layers.

3. Do not allow excess tensile stresses to occur in geocomposite.

4. Place a minimum initial lift thickness of 1 ft. post-compaction.

* * * END OF SECTION * * *

SECTION 02450
MECHANICALLY STABILIZED EARTH (MSE) WALL

PART 1 GENERAL

1.01 DEFINITIONS

A. ASTM: American Society for Testing and Materials.

B. GRI: Geosynthetics Research Institute.

1.02 REFERENCES

A. Reference standards for geosynthetic reinforcement and welded wire materials:

1. ASTM A123 - Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
2. ASTM A497 - Standard Specification for Steel Welded Wire Reinforcement, for Concrete.
3. ASTM D629 - Standard Test Method for Quantitative Analysis of Textiles.
4. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
5. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
6. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D1777 - Standard Test Method for Thickness of Textile Materials.
8. ASTM D4354 - Standard Practice for Sampling of Geosynthetics for Testing.
9. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
10. ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
11. ASTM D4603 - Standard Test Method for Determining Inherent Viscosity of Polyethylene Terephthalate (PET) by Glass Capillary Viscometer.
12. ASTM D5035 - Standard Test Method for Breaking Force and Elongation of Textile Fabrics (Strip Method).

13. ASTM D5199 - Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.

14. ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles

15. ASTM D5262 - Standard Test Method for Evaluating the Unconfined Tension Creep and Creep Rupture Behavior of Geosynthetics.

16. GRI GG-1 - Geogrid Rib Tensile Strength.

17. GRI GG-4(a) - Determination of the Long-Term Design Strength of Stiff Geogrids.

18. GRI GG-4(b) - Determination of the Long-Term Design Strength of Flexible Geogrids.

19. ASTM D6706 - Standard Test Method for Measuring Geosynthetic Pullout Resistance in Soil.

20. GRI GG-6 - Grip Types for Use in Wide Width Testing of Geotextiles and Geogrids.

21. GRI GG-7 - Determining Carboxyl End Groups in Polyethylene Terephthalate (PET) Geotextiles and Geogrids.

22. GRI GG-8 - Determination of the Number Average Molecular Weight of PET Yarns Based on a Relative Viscosity Value.

B. Reference standards for backfill materials (structural fill and aggregate):

1. ASTM G51 - Standard Test Method for Measuring pH of Soil for Use in Corrosion Testing.

2. ASTM D422 - Standard Test Method for Particle Size Analysis of Soils.

3. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction.

4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

5. ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

6. ASTM D2974 - Standard Test Method for Moisture, Ash and Organic Matter of Peat and Other Organic Soils.

7. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

8. ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

9. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

A. The EARTHWORK CONTRACTOR shall provide a list of at least three projects demonstrating the EARTHWORK CONTRACTOR's experience installing MSE Walls of similar wall height and face areas.

B. The EARTHWORK CONTRACTOR shall submit a detailed construction sequence plan for installing the MSE Wall indicating the limits of work, sequence of earthwork and geosynthetic installation operations and the procedures to be followed during construction.

C. The EARTHWORK CONTRACTOR shall submit Manufacturer's Quality Control Plans followed during the production of geosynthetic reinforcement material and the welded wire form facing material.

D. The EARTHWORK CONTRACTOR shall submit manufacturer's certifications that materials provided for geosynthetic reinforcement and welded wire form facing meet the acceptable criteria provided in Articles 2.01 and 2.02, respectively, of this Section. Manufacturer's certification shall include MQC test results in accordance with test methods and standards provided in this section and at the frequencies specified in the Manufacturer's Quality Control Plan.

E. For the geosynthetic reinforcement materials, the manufacturer's certificate shall state that the furnished geosynthetic materials meet the requirements of the specifications as evaluated by the manufacturer's quality control program. The certificates shall be attested to by a person having legal authority to bond the manufacturer. In case of dispute over validity of values, the ENGINEER can require the EARTHWORK CONTRACTOR to supply test data from a laboratory accredited by the Geosynthetic Accreditation Institute (GAI) to support the certified values submitted**.** The manufacturer's certifications shall include:

1. List of applicable roll numbers.

2. Sampling procedures followed.

3. Results of Quality Control testing performed on the materials utilizing specified test methods.

F. Submit in accordance with Section 01340.

1.04 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver welded wire form facing units, geosynthetic materials, and accessories necessary for construction of the MSE Wall to the project site in manufacturer's original packaging, with labels clearly identifying materials and name of manufacturer.

B. Storage: Store welded wire form facing units, geosynthetic materials, and accessories in a clean, dry area, off the ground, in accordance with manufacturer's instructions.

C. Handling: Protect welded wire form facing units, geosynthetic materials, and accessories during handling and installation from damage. Any damage to materials caused by EARTHWORK CONTRACTOR due to handling and/or installation will require the material to be replaced by the EARTHWORK CONTRACTOR at no additional cost to the OWNER.

PART 2 PRODUCTS

2.01 WELDED WIRE FORM FACING MATERIAL

A. Welded wire form facing units shall consist of prefabricated steel wire forms conforming to ASTM A497, and shall have the dimensions as shown on the Drawings.

B. All welded wire form facing units shall be hot-dipped galvanized per ASTM A123 after bending. All struts will be fabricated with hot-dipped galvanized wire. Strut length and cross-section dimensions of the forms shall be as noted on the Drawings.

2.02 GEOSYNTHETIC REINFORCEMENT MATERIAL

A. Geosynthetic reinforcement material shall consist of geogrids manufactured for primary and secondary soil reinforcement applications and shall be manufactured from high density polyethylene or high tenacity polyester yarn.

1. High density polyethylene materials shall conform to the requirements of ASTM D1248.

2. High tenacity polyester yarn shall conform to the requirements of ASTM D629 and shall be encapsulated in an acrylic latex or polyvinyl chloride material.

B. The geosynthetic reinforcement material shall meet the following requirements:

1. Open area: 60 percent minimum.

2. Long-term allowable design load (T_{AL}), as determined by GRI GG-4(a) and meeting the values shown on the Drawings for both primary and secondary reinforcement.

a. As described in GRI GG-4(a), T_{AL} is determined by considering reductions for creep, chemical and biodegradation, and installation damage and shall be based on MARV.

b. Service life to be 100 year minimum.

c. Backfill to be in accordance with Section 2.03 of this Specification.

3. Primary reinforcement shall consist of uniaxial geogrid. Secondary reinforcement shall consist of biaxial geogrid.

C. The base material from which the geosynthetic reinforcement is constructed shall meet the following, material-specific, minimum durability requirements:

Geosynthetic	Property	Test Method	Requirement
Polyethylene only	UV Oxidation Resistance	ASTM D 4355	Min. 70% strength retained after 500 hrs.
Polyester only	Hydrolysis Resistance	Intrinsic Viscosity Method (ASTM D 4603) with Correlation or Determined Directly Using Gel Permeation Chromatography	Min. Number (Mn) Molecular weight of 25,000
Polyester only	Hydrolysis Resistance	GRI GG-7	Max. Carboxyl End Group Number of 30
All materials	Survivability	Weight per Unit Area ASTM D 5261	Min. 270 g/m^2 (8 oz/sy)
All materials	% Post Consumer Recycled Material by Weight	Certification of material used	Maximum 0%

D. The geosynthetic reinforcement material shall be manufactured with a high degree of quality control. The Manufacturer is responsible for establishing and maintaining a quality control program to ensure compliance with the requirements of this section. Conformance testing shall be performed as part of the manufacturing process and varies for each type of product. At a minimum, the following index tests shall be considered as applicable for an acceptable quality assurance program:

Property	Test Method
Specific Gravity (HDPE only)	ASTM D1505
Wide Width Tensile Strength (All materials)	ASTM D4595 or GRI GG-1
Melt Flow (HDPE and PP only)	ASTM D1238
Intrinsic Viscosity (PET only)	GRI GG-8
Carboxyl End Group (PET only)	GRI GG-7

2.03 BACKFILL

A. Structural backfill shall comprise the majority of the MSE wall backfill and consists of material excavated from on-site or off-site sources and meeting the performance requirements of Section 02210 – Earthworks. Structural backfill shall provide a minimum shear strength described by a cohesion of 195 psf and a friction angle of 28.7 degrees.

B. NYSDOT #4 stone shall be used to backfill the welded wire form facing units. Material shall be crushed stone meeting the requirements of Section 703-02 of the NYSDOT "Standard Specifications," with the following gradation:

SCREEN SIZE	PERCENT PASSING (by weight)
4 in.	100
3 in.	90-100
2 in.	0 - 15
No. 200	0 - 0.7

C. NYSDOT #2 stone shall be used as the stone pad at the toe of the welded wire facing units. Material shall be crushed stone meeting the requirements of section 703-02 of the NYSDOT "Standard Specifications," with the following gradation:

SCREEN SIZE	PERCENT PASSING (by weight)
1.5 in.	100
1.0 in.	90-100
0.5 in.	0 - 15
No. 200	0 - 1.0

D. NYSDOT #1 stone shall be used as a filter between NYSDOT #4 stone and structural fill. Material shall be crushed stone meeting the requirements of Section 703-02 of the NYSDOT "Standard Specifications," with the following gradation:

SCREEN SIZE	PERCENT PASSING (by weight)
1 in.	100
0.5 in.	90-100
0.25 in.	0 - 15
No. 200	0 - 1.0

2.04 CQA CONFORMANCE TESTING

A. The GEOSYNTHETICS QAC shall perform sampling of geosynthetic reinforcement materials in accordance with ASTM D4354.

B. The GEOSYNTHETICS QAC shall obtain one random sample of the proposed geosynthetic reinforcement material and structural fill material, if not previously tested and accepted. These samples will be submitted to the QAL for interface friction/interaction testing. All testing must be conducted prior to the approval and delivery of the materials and performed with components that will be used in construction. Testing shall be conducted in accordance with, and results shall meet the following requirements:

Interaction Properties	**Test Method**	**Min. Required Value**
Coefficient of Interaction - C_I	ASTM D6706 (under normal loads of 500, 1,500, and 3,000 psf)	0.7

C. Conformance testing of structural fill material shall be in accordance with the test methods, frequencies and acceptable criteria required for structural fill in accordance with Technical Specification Section 02210 and the Quality Assurance Manual.

D. The GEOSYNTHETICS QAC shall verify that conformance testing performed on the geosynthetic reinforcement materials meet the minimum requirements specified above. The EARTHWORKS CONTRACTOR may request retesting of failed conformance tests, as outlined in the Quality Assurance Manual. EARTHWORKS CONTRACTOR shall bear the cost of retesting if results lead to material rejection. The GEOSYNTHETICS QAC shall bear the costs of retesting if the original conformance test results are found to be in error. Material that does not meet the requirements specified in this section shall be immediately removed from the site.

PART 3 EXECUTION

3.01 GENERAL

A. The EARTHWORKS CONTRACTOR shall coordinate the installation of required welded wire form facing units, geosynthetic materials, and backfill material such that the MSE Wall is constructed in accordance with this section, the Quality Assurance Manual and the Drawings.

B. The EARTHWORKS CONTRACTOR shall schedule a pre-construction meeting at least 30 days prior to the scheduled start of construction of the MSE Wall. The MSE Wall pre-construction meeting shall be attended by the EARTHWORK CONTRACTOR'S superintendent, necessary personnel from the QAC, the ENGINEER and the OWNER and/or OWNER'S Representative. At a minimum, the meeting shall include discussions on the required CQA procedures to be followed during construction of the MSE Wall and the EARTHWORKSCONTRACTOR'S construction sequence plan.

C. The EARTHWORKS CONTRACTOR shall determine exact configurations, lengths, sizes and quantities of welded wire form facing units, geosynthetic materials, backfill and associated ancillary items required by this section to construct the MSE Wall. The EARTHWORKS CONTRACTOR shall be responsible for the layout, elevation control, length, quantity, and quality of all items associated with construction of the MSE Wall.

D. The EARTHWORKS CONTRACTOR shall not prepare any subgrade, nor install any welded wire form facing units, geosynthetic materials, or backfill material unless the QAC is present. The EARTHWORKS CONTRACTOR shall keep the QAC informed of planned work activities to allow sufficient time to perform necessary CQA activities.

E. EARTHWORKS CONTRACTOR shall take appropriate actions to minimize erosion and fugitive dust during all phases of construction of the MSE Wall. EARTHWORKS CONTRACTOR shall modify construction procedures and equipment, as directed by the OWNER, to control dust during construction.

3.02 SUBGRADE PREPARATION

A. EARTHWORKS CONTRACTOR shall fill settled areas where excavations or trenches were backfilled and holes made by demolition, tree removal, and site preparation work in the areas immediately beneath the MSE Wall.

B. Natural soils or compacted fills softened by frost, flooding or weather shall be removed, replaced and compacted as required by the Soil QAC.

C. If EARTHWORKS CONTRACTOR and Soil QAC do not agree on the qualitatively defined excessive pumping or displacement, scarify top 6 to 8 inches of subgrade soils and compact to 90% of Modified Proctor density.

D. Remove and replace soft or loose zones with sufficient thickness of compacted general fill. Thickness of replacement layer shall be as required to support heavy equipment and trucks without excessive pumping or displacement. If thickness of replacement layer is not sufficient to prevent pumping of subgrade, material shall be removed, replaced and compacted with a thicker layer at no additional cost to OWNER.

E. Non-woven, heat-bonded geotextile or a geogrid may be used in conjunction with general fill to stabilize soft or loose zones of the subgrade.

F. Final subgrade conditions prior to the installation of MSE Wall materials shall be approved by the QAC.

3.03 MSE WALL CONSTRUCTION

A. The EARTHWORKS CONTRACTOR shall use welded wire form facing units to develop the specified wall face and batter. The welded wire form facing units, geosynthetic reinforcement, and backfill materials shall be placed in successive lifts in the sequence shown on the Drawings.

B. Wall Face Construction:

1. The MSE wall face shall be constructed by wrapping each layer of geosynthetic reinforcement around its overlying layer of backfill and then re-embedding the free end into the backfill, as indicated on the Drawings.

2. Welded wire form facing installation will be monitored by the Soils QAC during fill placement and compaction. The EARTHWORKS CONTRACTOR shall employ compaction equipment and procedures that will not result in excessive deformation of the welded wire form facing.

3. Adjacent welded wire form facing units shall be connected along vertical and horizontal seams with galvanized interlocking hog ring fasteners placed 4 in. on center.

C. Geosynthetic Reinforcement:

1. All materials shall be installed at the proper elevation and orientation as shown in the wall details on the Drawings. The geosynthetic reinforcement shall be installed in general accordance with the manufacturer's recommendations, unless otherwise modified by these specifications. The more stringent requirements shall govern in the event of any conflict between the references.

2. Overlap of the geosynthetic reinforcement in the design strength direction shall not be permitted, except where indicated on the Drawings. The design strength direction is that length of geosynthetic reinforcement perpendicular to the wall face and shall consist of one continuous piece of material. Adjacent sections of geosynthetic shall be placed in a manner to assure that the horizontal coverage shown on the Drawings is provided.

3. Place only that amount of geosynthetic reinforcement required for immediately pending work to prevent undue damage. After a layer of geosynthetic reinforcement has been placed and the next succeeding layer of backfill has been placed, the next geosynthetic reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geosynthetic reinforcement and backfill.

4. Geosynthetic reinforcement shall be placed to lay flat and be pulled tight prior to backfilling. After a layer of geosynthetic reinforcement has been placed, suitable means, such as pins or small stockpiles of reinforcement backfill shall be used to hold the geosynthetic reinforcement in position until the subsequent backfill layer can be placed.

5. During construction, the surface of the backfill should be kept approximately horizontal. Geosynthetic reinforcement shall be placed directly on the compacted horizontal fill surface. Geosynthetic reinforcements are to be placed within 3 in. of the design elevations and extend the length shown on the schedule unless otherwise directed by the ENGINEER. Correct orientation of the geosynthetic reinforcement shall be verified by the QAC.

C. Structural Fill Placement:

1. The structural fill shall be placed as shown on the Drawings in maximum compacted lift thicknesses of 9 inches. Each lift shall be compacted to 90% of the maximum dry density as determined by Modified Proctor Testing (ASTM D1557). Structural fill shall be placed, spread, and compacted in accordance with Section 02210 – Earthworks and the QAM and in such a manner that eliminates the development of wrinkles or movement of the geosynthetic reinforcement and the welded wire face. Any welded wire face forms or geosynthetic reinforcement that becomes damaged during reinforcement backfill placement shall be removed and replaced at the EARTHWORK CONTRACTOR'S expense. Any misalignment or distortion of the wall facing units outside the limits of these specifications shall be corrected at the EARTHWORK CONTRACTOR'S expense. Structural fill

placement methods near the facing shall assure that no voids exist directly beneath the reinforcing elements.

2. Tracked construction equipment shall not be operated directly on the geosynthetic reinforcement. A minimum thickness of 6 inches of structural fill is required, prior to operation of tracked vehicles over the geosynthetic reinforcement. Turning of tracked vehicles should be kept to a minimum to prevent displacing the fill and damaging or moving the geosynthetic reinforcement.

3. Rubber-tired equipment will not be allowed to pass over the geosynthetic reinforcement, unless it is performed in accordance with the manufacturer's recommendations and field tests are performed to demonstrate the geosynthetic reinforcement will not be damaged more than the geosynthetic manufacturer's installation damage reduction factor would indicate. If allowed, all equipment shall operate at speeds less than 10 mph. Sudden braking and sharp turning is prohibited.

4. At the end of each day's operation, the EARTHWORKS CONTRACTOR shall slope the last lift of structural fill away from the wall facing, to direct runoff of rainwater away from the wall face. In addition, the Contractor shall not allow surface runoff from adjacent areas to enter the wall construction site.

3.04 CONSTRUCTION QUALITY ASSURANCE

A. The QAC shall perform the following CQA activities during all phases of construction of the MSE Wall.

1. Observe the installation of all materials to verify the materials meet the requirements of this section, the Quality Assurance Manual or the Drawings. Any items of construction not meeting project requirements shall be immediately brought to the attention of the EARTHWORKS CONTRACTOR and the OWNER and/or OWNER's Representative.

2. Perform field moisture/density testing following compaction of structural fill material. Moisture/density testing shall be performed using a nuclear density gauge at a minimum frequency of one test for every 50 linear feet of each lift of structural fill material. Moisture/density tests shall be staggered across the surface of each lift of structural fill such that representative test results are obtained from the inside, center and outside areas of each lift. Structural fill compaction shall be considered acceptable if test results indicate compaction has achieved 90% of the maximum dry density identified by the Modified Proctor test results. Any areas identified by the QAC not meeting acceptable compaction criteria shall be immediately reported to the EARTHWORKS CONTRACTOR so the EARTHWORKS CONTRACTOR can take necessary action to correct unacceptable areas.

3. Verify that the welded wire form facing units, geosynthetic reinforcement material, and the backfill materials are obtained from approved stockpiles and/or staging areas.

** END OF SECTION **

SECTION 02910
TOPSOIL AND SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES

Requirements for site restoration by placement of topsoil, seeding, fertilizing, and mulching.

1.02 REFERENCES

A. American Society for Testing and Materials:

1. ASTM D422 - Standard Method for Particle-Size Analysis of Soils.

2. ASTM D2976 - Standard Test Method for pH of Peat Materials.

3. ASTM D2974 - Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.

1.03 SUBMITTALS

A. Analysis of proposed topsoil material (to demonstrate material does not contain chemical constituents exceeding concentrations established by NYSDEC).

B. Analysis of the seed (to demonstrate compliance with the seed mix identified in Section 2.01 of this specification), fertilizer (to identify chemical composition) and other amendments, and proposed application rates.

C. Should hydro-seeder be used, submit all data including material and application rates.

D. Location of source, and grain-size, pH, and organic content testing of stockpile.

PART 2 PRODUCTS

2.01 TOPSOIL

A. Topsoil shall be unfrozen, friable, natural loam and shall be free of clay lumps, brush, weeds, litter, stumps, stones, and other extraneous matter.

B. pH of material shall be between 5.5 and 7.6.

C. Organic content shall be not less than 2% or more than 20%.

D. Gradation:

Sieve Size	Percent Passing by Weight
2 in.	100
1 in.	85 - l00
1/4 in.	65 - 100
No. 200 mesh	20 - 80

E. Topsoil stripped and stockpiled on-site may be used, provided it meets above requirements.

2.02 SEED MIXTURE

A. Utilize one of the specified seed mixtures. OWNER to approve selection of seed mixture and seed source.

B. Fresh, clean, new-crop seed consisting of the following varieties, proportioned by weight.

1. Seed Mixture No. 1: Allow variance of 5% for each component except weed seed and inert maximums listed below at a rate of 160 lbs/acre.

Name	% by Weight of Pure Live Seed
Kentucky Bluegrass	29.71
Aquarious Perennial Ryegrass	19.51
Patriot II Perennial Ryegrass	19.50
Red Fescue, Creeping Origin: Canada	14.73
Chewing Fescue	14.63
Other Crop Seed	0.54
Weed Seed	0.02 max.
Inert Matter	1.36 max.

2. Seed Mixture No. 2: Allow variance of 5% for each component except weed seed and inert maximum listed below at a rate of 110 lbs/acre.

Name	% by Weight of Pure Live Seed
Aquarious Perennial Ryegrass	43.88
Kentucky Bluegrass	19.81
Annual Ryegrass	19.38
Red Fescue, Creeping Origin: Canada	14.73
Other Crop Seed	0.95
Weed Seed	0.02 max.
Inert Matter	1.23 max.

3. Seed Mixture No. 3: Allow variance of 5% for each component except weed seed and inert maximum listed below at a rate of 110 lbs/acre.

Name	% by Weight of Pure Live Seed
Red Fescue	45.45
Kentucky Bluegrass	9.09
Perennial Ryegrass	36.36
White Clover	9.09
Weed Seed	0.02 max.
Inert Matter	1.00 max.

2.03 FERTILIZER

A. Shall be a standard quality commercial carrier of available plant food elements. A complete prepared and packaged material containing a minimum of 5% nitrogen, 10% phosphoric acid, and 10% potash.

B. Each bag of fertilizer shall bear the manufacturer's guaranteed statement of analysis.

2.04 MULCH

A. Dry application mulch:

1. Mulch shall be stalks of oats, wheat, rye, or other approved crops 100% free from noxious weeds and coarse materials.

B. Hydro-seeding application:

1. Chopped wood cellulose fiber product with tackifier specifically designed for as a hydro-mechanical applied mulch.

2. Acceptable products are Hydro-Mulch® 2000 by Conwed Fibers, Inc. or equal.

2.05 LIMESTONE

A. Limestone shall be commercially available ground limestone designed for agricultural use.

B. Limestone shall have a minimum total neutralizing value of 88% calcium carbonate equivalence. Minimum of 90% shall pass 20-mesh sieve and minimum of 60% shall pass 100-mesh sieve.

C. Each bag of limestone shall bear the manufacturer's guaranteed statement of analysis.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Topsoil:

1. Surface of subgrade shall be true to grade, uniform, and free of loose stones. Do not place topsoil until subgrade is approved by the QAC.

2. Spread topsoil to a uniform, loosely compacted depth of 6 in. to finish grade.

3. Do not place or work topsoil in frozen or muddy condition.

4. Finish grade is established final grade as shown on the Drawings. Grades not otherwise indicated are uniform levels or slopes between points where elevations given.

B. Seeding:

1. Do not seed when wind velocity exceeds 10 mph.

2. Seed topsoiled areas only.

C. Fertilizer:

1. Minimum of 800 lbs/acre shall be applied unless soil test verifies lower rates required as approved by OWNER.

2. Fertilize topsoiled and seeded areas only. Do not apply fertilizer directly into surface waters.

D. Limestone:

1. Apply at rates to comply with pH soil requirements.

E. Watering and Maintenance:

1. Water and maintain seeded areas until 2 in. vertical growth of grass is achieved over 85% of the area.

2. If grass dies before 2 in. vertical growth obtained, areas shall be re-seeded at no additional cost to OWNER.

3. Protect slopes and embankments against erosion until Work is accepted. Repair eroded portions of seeded areas by re-filling, re-mulching, and re-seeding as required by condition.

* * * END OF SECTION * * *

SECTION 03300
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. American Concrete Institute (ACI):

1. ACI SP-66 - ACI Detailing Manual.
2. ACI 301 Specifications for Structural Concrete.
3. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
4. ACI 305R - Hot Weather Concreting.
5. ACI 306R - Cold Weather Concreting.
6. ACI 318 - Building Code Requirements for Structural Concrete.
7. ACI 347 - Guide to Formwork for Concrete.
8. ACI 350 – Concrete Structure for Containment of Hazardous Materials.
9. ACI 350R-01 – Code Requirements for Environmental Engineering Concrete Structures and Commentary.

B. American Society for Testing and Materials (ASTM):

1. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
2. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
3. ASTM C33 - Standard specification for Concrete Aggregates.
4. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
5. ASTM C94 - Specification for Ready-Mixed Concrete.
6. ASTM C143 - Standard Test Method for Slump of Hydraulic-Cement Concrete.
7. ASTM C150 - Standard Specification for Portland Cement.
8. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.

9. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

10. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

11. ASTM C494 - Specification for Chemical Admixtures for Concrete.

12. ASTM D471 - Test Method for Rubber Property- Effect of Liquids.

13. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

14. ASTM D746 – Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

D. Concrete Reinforcing Steel Institute (CRSI):

1. Placing Reinforcing Bars.

1.02 SUBMITALS

A. Statement by ready mix supplier giving source and material certificates, and proportions by weight of cement, fine and coarse aggregates, and admixtures. Provide test data for proposed mix design in accordance with ACI 301 4.2.

B. Provide with each load of concrete delivered, duplicate delivery tickets one for CONTRACTOR and one for ENGINEER with the following information.

1. Date and serial number of ticket.

2. Name of ready mixed concrete plant, operator, and job location.

3. Type of cement, admixtures, if any, and brand name.

4. Cement content in bags/cubic yards of concrete, and mix design.

5. Truck number, time loaded, and name of dispatcher.

6. Amount of concrete in load, in cubic yards, delivered.

7. Maximum size aggregate.

8. Gallons of water added at job, if any, and slump of concrete after water was added.

9. Temperature of concrete at delivery.

10. Number of revolutions of mixer.

C. Reinforcing steel Shop Drawings conforming to ACI SP-66 showing bending diagrams, assembly diagrams, location diagrams, splicing and laps of bars, shapes, dimensions, and details for bar reinforcing.

D. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Tolerances:

1. Maintaining formwork alignment during and after placing of concrete, in accordance with permissible tolerance limits set forth in ACI 347.

2. Concrete shall be within 1/4 in. of 10-ft. straightedge in all directions. Deviations from elevation indicated shall not exceed 1/4 in.

B. Concrete testing will be provided by QAC. Following tests will be performed.

1. Slump, ASTM C143; Air Entrainment, ASTM C231, and Temperature. If slump or air content fall outside of specified limit, a check test will be performed on another portion of same sample. If the second test fails, concrete load will be rejected. The frequency for testing will be one for each load of concrete delivered.

2. Compressive Strength, ASTM C31 and C39. Test cylinders will be tested for compressive strength at 7, 14, 21 and 28 days following concrete placement. In the event design compressive strength is achieved at 7, 14 or 21 days, the ENGINEER may waive subsequent compressive strength tests. If the design compressive strength is not achieved at 28 days, CONTRACTOR shall pay for testing, engineering analyses, and remedial work.

1.04 PROJECT/SITE CONDITIONS

A. Hot Weather:

1. Comply with ACI 305R.

2. Concrete temperature shall not exceed 85°F.

3. At air temperatures of 80°F or above, keep concrete as cool as possible during placement and curing. Cool forms by water wash.

B. Cold Weather:

1. Comply with ACI 306R.

2. Temperature of reinforcement, forms, fillers, and other materials in contact with concrete at time of placement shall not be less than 35°F. Preheat if temperature is below 35°F.

3. Maintain air and forms in contact with concrete at temperature above 50°F for at least first 3 days; and at temperature above 32°F for the remainder of the specified curing period.

PART 2 PRODUCT

2.01 MATERIALS

A. Portland Cement:

1. ASTM C150, Type I or II. Except tricalcium aluminae (C_3A) content of Type I shall not exceed 8%.

2. When aggregates are determined to be deleteriously reactive, as defined by Appendix XI of ASTM C33, alkali content of cement defined by Table 1A of ASTM C150 shall not exceed 0.60%.

B. Aggregates:

1. ASTM C33, free of foreign materials.

2. Fine Aggregate: Natural sand.

3. Coarse Aggregate: Crushed stone, crushed gravel or gravel. Size 467 (1 1/2 in. maximum).

4. Potential reactivity of aggregates shall be determined in accordance with Appendix XI of ASTM C33.

C. Admixtures for Concrete:

1. Air-Entraining: ASTM C260.

2. Chemical Admixtures: Optional, ASTM C494.

a. Water Reducing: Type A.

b. Retarding: Type B.

c. Water Reducing and Retarding: Type D.

D. Water: Potable.

E. Steel Reinforcing Bars:

1. Deformed bars conforming to ASTM A615, grade 60.

2. As noted on Drawings.

F. Waterstops:

1. Thermoplastic Elastrometric Rubber, Westec Envirostop TPE-R 600 series or equivalent.

2. Provide prefabricated tees, crosses, and other configurations as required. Splice in accordance with manufacturer's instructions.

3. Waterstops shall meet the following requirements:

Tensile Strength	ASTM D 638	2000psi
Elongation	ASTM D 638	450%
100% Modulus	ASTM D 638	1000psi
Brittle Temperature	ASTM D 746	-70F
Hardness	ASTM D 2240	85 Shore A

G. Membrane Forming Curing Compound:

1. Manufacturers:

a. Concrete Seal by Huntington Laboratories.

b. Toxkure by Tock Brothers, Inc.

c. Kur-N-Seal by Sonneborn Building Products, Inc.

d. Floor Treet by Forrer Chemical Company.

e. Or equal.

2. ASTM C309 and complete with coatings to be applied.

H. Epoxy Bonding Compound: Joining new to existing concrete.

1. Manufacturers:

a. Sikadur Hi-Mod by Sika Corporation.

b. Epoxtite 2362 by W.R. Grace and Company.

c. Euco Epoxy 452 mv or 620 by Euclid Chemical Company.

d. Or equal.

I. Non-epoxy Bonding Compound: Joining new to existing concrete where bonding compound cannot be placed immediately prior to pouring of new concrete.

1. Manufacturers:

a. Weld-Crete, by Larson Products Corporation.

b. Or equal.

J. Expansion Joints:

1. Premolded expansion joint material shall be sponge rubber conforming to ASTM D1752 Type 1. Expansion joint material shall be bonded to previously poured concrete edge with adhesive as recommended by the manufacturer.

2. Exposed edges of premolded expansion joint material shall be sealed with Sikaflex 2c NS elastomeric sealant.

2.02 CONCRETE MIX DESIGN

A. Concrete Mix: Measure and combine cement, aggregates, water and admixtures in accordance with ASTM C94.

1. Minimum Cement Content: 5-3/4-bags/cu yd.

2. Minimum Strength: 4,000 psi. @ 28 days.

3. Air Content: 6% $\pm$ 1%.

4. Maximum Slump: 4 in.

2.03 MIXING AND DELIVERY

A. Furnish and deliver concrete in conformance with ASTM C94.

B. Deliver and complete discharge within 1-1/2 hours of commencing mixing or before 300 revolutions of drum or blades, whichever comes first. This includes revolutions required by transit mix trucks. Limitations may be waived by ENGINEER if concrete is of such slump after 1-1/2 hours or 300-revolution limit; it can be placed without addition of water.

C. Do not add water on job unless authorized by OWNER. If water is added, additional mixing of 30 drum revolutions is required.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Subgrade and Bedding: Compacted and free of frost. If placement is allowed at temperatures below freezing, provide temporary heat and protection as required to remove frost.

B. At CONTRACTOR's option, provide vapor barrier or soak subgrade the evening before placement and sprinkle ahead of placement of concrete.

C. Remove standing water, ice, mud, and foreign matter before concrete is deposited.

3.02 FORMS

A. Formwork shall prevent leakage of concrete and be of sufficient strength to prevent deformation during placement and curing. Removal of wall ties shall leave holes clean cut and without appreciable spalling at face of concrete.

B. Materials:

1. Unless specified otherwise, type of forms used is CONTRACTOR's option. CONTRACTOR may use metal, plywood, presswood form liners or plastic surfaced plywood.

2. Use approved commercially manufactured devices for form ties. Arrange ties so when forms are removed, no metal will be within 1 in. of formed face of concrete. Ties for exterior walls shall have integral waterstop.

C. Do not disturb forms until concrete has adequately cured.

D. Form system design shall be CONTRACTOR's responsibility.

3.03 JOINTS

A. Joints not shown on Drawings shall be subject to ENGINEER's approval.

B. Provide waterstop in construction joints of all exterior walls and base slabs and at other joints as shown on drawings. Secure in-place. Place wire tie holes, if used, within 1 in. of edge. Vibrate concrete on both sides to ensure intimate contact between waterstop and concrete.

3.04 REINFORCEMENT PLACEMENT

A. Correct displacement of reinforcement prior to and during concrete pouring operations. Maintain clear cover as noted on the Drawings. Tolerances shall be in accordance with ACI 318, unless noted otherwise.

B. Locate reinforcing to avoid interference with items that will be drilled in later, such as concrete anchors and pipe penetrations.

C. Placement of reinforcing steel is to be approved by the ENGINEER before being covered with concrete.

D. Use concrete brick for supporting bottom mat reinforcing on grade. Use bolsters or chairs supported on concrete brick for supporting upper reinforcing mat.

E. Do not field bend bars including bars partially embedded in concrete.

F. Welding of reinforcing bars will not be permitted.

3.05 CONCRETE PLACEMENT

A. Except as modified herein, ACI 304 - Chapter IV, shall constitute requirements of this Specification.

B. Reinforcing steel shall be tied at intersections in accordance with CRSI "Placing Reinforcing Bars". Maximum spacing for footings and walls shall be every third intersection or 3 ft.-0 in. Maximum spacing for slabs and other work shall be every fourth intersection or 3 ft.-0 in. Dowels shall be tied in-place.

C. Care shall be taken to avoid damage to waterstop and reinforcing and ensure their accurate positioning after concrete is placed.

D. Provide construction joints as shown on Drawings and specified herein and when placing of concrete is temporarily halted or delayed.

E. Place concrete with aid of internal mechanical vibrator equipment capable of 7,000 impulses/min. Transmit vibration directly to concrete. Duration of vibration at any location shall be amount necessary to produce thorough consolidation and also to cause maximum amount of air bubbles to migrate to top of pour. Do not move or spread concrete with vibrators.

F. Set embedded items such as bolts, anchors, and piping, in concrete as required by manufacturer of equipment used. Verify location with equipment manufacturers.

G. Place items constructed of dissimilar metals to avoid physical contact with reinforcing. Secure item and reinforcing to ensure they will not shift and come into contact during pouring. Contact between reinforcing and any other metal, other than bare, coated or plated carbon steel will not be permitted.

3.06 SLAB FINISHES

A. Float and Broom Finish: Broom at right angles to direction of traffic to give nonskid finish. Use fine, soft bristled broom.

3.07 FINISHING FORMED CONCRETE

A. Finish surfaces resulting directly from formwork.

1. Patch honeycombing, stone pockets, form ties, spalls, and other irregularities.

2. Grind joint marks and fins smooth with adjacent wall surface. Remove oil stains and rinse surface.

3.08 PROTECTION AND CURING

A. Protect concrete from frost, rapid drying and keep moist for minimum curing period of 7 days after placing.

B. Wet cure; apply curing compound after receiving approval from OWNER. Do not use curing compound where other coating will be applied unless curing compound is compatible with coating to be applied.

C. Formed surfaces may be cured by leaving forms in-place. Spray surface of forms left in-place during curing period as frequently as drying conditions may required, keeping concrete surface moist. For vertical surfaces, apply water to run down on inside of forms, if necessary to keep concrete wet.

D. Protect finished concrete from damage caused by construction equipment vibration or loads, rain, or running water.

E. Do not load self-supporting structures in such way as to overstress concrete.

F. Prior to placing any loads on or against a newly cast-in-place concrete structure, test cylinders created from the pour shall be submitted for compressive strength. The ENGINEER shall review the test results to verify that the concrete has attained adequate compressive strength prior to loads being placed.

* * * END OF SECTION * * *

SECTION 03400
PRE-CAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 SUMMARY

A. Provide pre-cast concrete as shown on Drawings.

1.02 REFERENCES

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

1. ASTM A48 - Standard Specification for Gray Iron Castings.

2. ASTM A615 - Standard Specification for Deformed and Plain Carbon-Steel Bars.

3. ASTM C478 - Standard Specification for Precast Reinforced Concrete Manhole Sections.

4. ASTM C497 - Standard Test Methods for Concrete Pipe, Manhole Sections or Tile.

B. American Association of State Highway and Transportation Officials (AASHTO):

1. AASHTO M198 – Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.

1.03 SUBMITTALS

A. Include results of tests and certification reports with shipment of materials.

B. If manufacturer's test data is inadequate or unavailable, ENGINEER reserves right to require cores drilled for compressive strength tests.

C. Submit manufacturer’s data for flexible seals.

D. Submit in accordance with Section 01340.

1.04 QUALITY ASSURANCE

A. Source Quality Control:

1. Test pre-cast concrete structures in accordance with ASTM C497 for compressive strength compliance by compression tests on cores drilled from 5% of lot. Testing frequency may be reduced to 1% of lot, with minimum of 2 cores/lot, for manhole sections fabricated on sewer pipe machine.

2. Manufacturer's core drilling machine shall conform to ASTM C478. Operator shall take test cores as directed by testing laboratory.
3. Stamp risers and tops, meeting strength requirements, with appropriate monogram.

PART 2 MATERIALS

2.01 CAST-IN-PLACE STRUCTURES

A. Concrete: Comply with Section 03300.

2.02 PRE-CAST REINFORCED CONCRETE STRUCTURES

A. Provide flat pre-cast structures as shown on the Drawings with reinforced integral floors having a minimum thickness of 6 inches, or as shown on Drawings.

B. Elevations indicated on the Drawings designate pipe elevations at the center of the structures. Provide for pipe grade differential between center of structure and structure wall for each pipe penetration.

C. Minimum Wall Thickness:

Structure	Wall Thickness
Handhole	4 in.
Vault	6 in.

D. Seal pre-cast sections of structures with a 3/4-inch diameter, buytl rubber joint sealant, or as recommended by the manufacturer.

E. Mark each pre-cast section with the name or trademark of manufacturer and date of manufacture. Marking shall be indented into manhole section or painted on with waterproof paint.

2.03 CASTINGS

A. Conform to requirements of ASTM A48, Class 30-B, and dimensions shown on Drawings.

B. Castings shall be free from cracks, holes, swells, and cold shuts.

C. Casting types are shown on Drawings.

2.04 FLEXIBLE SEAL

A. Seals shall be Link-Seal (model S), as manufactured by Thunderline Corporation, or equal.

B. Size according to manufacturer's instructions for a watertight seal between pipe and core-drilled penetration or wall sleeve.

PART 3 EXECUTION

3.01 EXCAVATION AND PREPARATION OF SUBGRADE

A. Excavate and prepare subgrade in accordance with Section 02210, and as shown on the Drawings, to provide a minimum of 6 inches of select fill under base section.

3.02 BACKFILL

A. Backfill with required pipe bedding and cover material to spring line of incoming pipes as shown on the Drawings.

3.03 PIPE AND CONDUIT CONNECTIONS

A. Seal annular space between pipe and pre-cast wall with Link-Seal or approved equal.

B. Seal conduit openings with watertight caulking seal.

3.04 SETTING FRAMES AND CASTINGS

A. Set at elevation shown on the Drawings.

B. Provide a watertight seal between frame and structure using a buytl rubber sealing material or other material as approved by the OWNER.

C. Anchor frame to structure in accordance with manufacturer's instructions.

3.05 FIELD QUALITY CONTROL

A. Pre-cast reinforced concrete structures shall be subject to rejection on account of failure to conform to Specification requirements. In addition, individual sections may be rejected for any of following reasons.

1. Fractures or cracks passing through shell, except for single end crack not exceeding depth of joint.

2. Defects indicating imperfect proportioning, mixing, and molding.

3. The presence of surface defects indicating honeycombed or open texture.

4. Damaged ends where such damage prevents making satisfactory joint.

5. Internal diameter of section varies more than 1% from nominal diameter.

6. Continuous crack having surface width of 0.01 in. or more and extending for length of 12 in. or more, regard1ess of position.

* * * END OF SECTION * * *

SECTION 05500
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

A. American Institute of Steel Construction (AISC):

1. Specification for Design, Fabrication, and Erection of Structural Steel for Buildings.

2. Code of Standard Practice for Steel Buildings and Bridges.

3. Manual of Steel Construction (Allowable Stress Design), 9th Edition.

B. American Society for Testing and Materials (ASTM):

1. ASTM A36 - Standard Specification for Carbon Structural Steel.

2. ASTM A53 - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

3. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

4. ASTM A325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

5. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

6. ASTM A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

C. American Welding Society (AWS):

1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.

2. AWS A5.5 - Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.

3. AWS A5.17 - Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.

4. AWS D1.1 - Structural Welding Code-Steel.

D. Steel Structures Painting Council (SSPC):

1. SSPC SP6 - Commercial Blast Cleaning.

E. Aluminum Association (AA):

1. AA SAS30 - Specifications for Aluminum Structures Construction Manual Series Section 1.

F. American Iron and Steel Institute (AISI).

G. American Hot-Dip Galvanizers Association (AHDGA).

1.02 SUBMITTALS

A. Shop Drawings of items provided, detailing materials, sizes, connections, anchors, and painting.

1. One reproducible and one print of Shop Drawings.

B. Manufacturer's catalog sheets on manufactured items.

C. Provide International Conference of Building Officials (ICBO) or other similar building code organization recommendations regarding safe allowable design loads for concrete anchors.

D. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Welding:

1. Steel:

a. Conform to codes for arc and gas welding in building construction of AWS and to AISC Specifications. Surfaces to be welded shall be free from loose scale, rust, grease, paint, and other foreign material, except mill scale which will withstand vigorous wire brushing may remain. No welding shall be done when the base metal is lower than 0°F.

b. Qualify welding operators in accordance with AWS D1.1. Qualification tests shall be run by recognized testing laboratory approved by ENGINEER at the CONTRACTOR'S expense.

c. Welding operators shall be subject to examination for re-qualification using equipment, materials, and electrodes employed in execution of work. Such re-qualification, if ordered by the ENGINEER, shall be done at CONTRACTOR'S expense.

2. Aluminum: Weld with gas metal arc (GMA) or gas tungsten arc (GTA) processes in accordance with manufacturer's recommendations as approved and in accordance with recommendations of the AWS.

PART 2 PRODUCTS

2.01 MATERIALS

A. Conform to following specifications:

1. Steel Shapes and Plates: ASTM A36.

2. Square and Rectangular Structural Tubing: ASTM A500, Grade B.

3. Round Structural Tubing and Steel Pipe:

a. ASTM A53, Type E or S, Grade B.

4. Stainless Steel: Exterior and Submerged -AISI, Type 316; Interior and Architectural -AISI, Type 304; Bolts and Anchors -AISI, Type 303 or 304.

5. Aluminum Structural Shapes and Plates: Alloy 6061-T6 or 6063-T6; conform to referenced specifications and ASTM sections found in AA current construction manual series.

6. Connection Bolts for Steel Members: ASTM A325.

7. Anchor Bolts: ½ in. minimum diameter, non-submerged - ASTM A307 galvanized; submerged-stainless steel.

8. Connection Bolts for Wood Members: ASTM A307, galvanized.

9. Connection Bolts for Aluminum: Stainless steel.

2.02 FABRICATION

A. Connections and Workmanship:

1. Fabricate details and connection assemblies in accordance with drawings and with projecting corners clipped and filler pieces welded flush.

2. Weld shop connections, bolt or weld field connections, unless otherwise noted or specified.

3. Provide clips, lugs, brackets, straps, plates, bolts, nuts, washers, and similar items, as required for fabrication and erection.

4. Use connections of type and design required by forces to be resisted and to provide secure fastening.

a. AISC standard 2-angle web connections or single plate framing connections capable of supporting minimum of 50% total uniform load capacity of members joined as tabulated in uniform load constants of AISC "Manual of Steel Construction".

b. Connections shall consist of minimum of two ¾ in. diameter bolts or welds developing a minimum of 10,000 lbs.

c. Make bearing type bolted connections with minimum ¾ in. diameter bolts with threads included in shear plane, unless detailed otherwise.

5. Welding:

a. Grind exposed edges of welds to 1/8 in. minimum radius. Grind burrs, jagged edges, and surface defects smooth.

b. Prepare welds and adjacent areas so there is (1) no under-cutting or reverse ridges on weld bead, (2) no weld spatter on or adjacent to weld or any other area to be painted, and (3) no sharp peaks or ridges along weld bead. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

6. Bolting:

a. Draw up bolts or nuts tight. Use bolts of lengths required so bolts project at least 4 to 5 threads beyond face of nut. Use washers unless detrimental. Provide hexagonal head bolts with hexagonal nuts.

b. Provide holes required for connection of adjacent or adjoining work wherever noted on Drawings. Locate holes for bolting equipment to supports to tolerance of ± 1/16 in. of dimensions indicated.

B. Fit Work together in fabrication shop and deliver complete or in parts, ready to be set in place or assembled in field.

C. Galvanizing:

1. Galvanize after fabrication.

2. Galvanize by hot-dip process conforming to appropriate ASTM and AHDGA specifications.

3. Galvanize in plant having facilities to produce quality coatings and capacity for volume of work.

4. Ship and handle in manner avoiding damage to zinc coating.

D. Painting and Finishes:

1. Do not paint ferrous metal items to be encased in concrete.

2. Where other finish not specified, clean ferrous metal after fabrication to remove oil, mill scale, rust, and foreign matter in accordance with SSPC SP6. Apply one coat of shop primer yielding 1.5 mil dry thickness.

3. Give surfaces not accessible after assembly or erection 2 shop coats using different colors of paint, 3.0 mil total dry thickness.

4. Paint aluminum in contact with concrete in accordance with AA SAS30. Under no circumstances shall aluminum contact dissimilar metal.

2.03 CONCRETE ANCHORS

A. Wedge Anchors:

1. Manufacturers:

a. Rawl-Stud Anchor by Rawlplug Company, Inc.

b. Wedge Anchor by ITT Phillips Drill Division.

c. Kwik-Bolt II by Hilti Corporation.

d. Or equal.

2. Usage: In concrete.

a. Zinc or chromate plated carbon steel may be used where totally embedded, in interior locations with controlled humidity and other protected locations.

b. Stainless steel shall be used in other locations such as outside, in tanks or whenever attaching aluminum or galvanized steel.

B. Drop-In Anchors:

1. Manufacturers:

a. HDI Anchor by Hilti Corporation.

b. Multi-Set Anchor by ITT Phillips Drill Division.

c. H/S Drop-In by Rawlplug Company, Inc.

d. Or equal.

2. Zinc or chromate plated carbon steel.

3. Usage: In concrete.

a. Interior locations with controlled humidity and other protected locations.

b. Do not use drop-in anchors in corrosive or humid areas such as wet wells, liquid containing tanks, exterior applications.

C. Adhesive Anchors:

1. Manufacturers:

a. Anchor-It Fastening System by Adhesive Technology Corporation.

b. Foil-Fast Epoxy Injection Gel System by Rawl/Sika.

c. EPCON Injection System by ITW Ramset/Red Head.

d. Or equal.

2. Epoxy adhesive with Type 316 stainless steel stud or anchor rod assembly, nuts, and washers.

2.04 LADDERS

A. Fixed rail ladders shall be fiberglass unless approved by OWNER.

B. Punch rails and pass rungs through rails. Fabricate brackets for fastening ladder to wall and attach to ladder. Ladder shall conform to applicable federal, state, and local safety requirements.

2.05 FIBERGLASS GRATING

A. Fiberglass grating, Chemgrate or equal, maximum ¼ in. deflection under uniform load of 100 psf.

B. Band edges and cut outs.

PART 3 EXECUTION

3.01 INSTALLATION

A. Layout and install connectors such as concrete anchors and anchor bolts to secure metal fabrications to structure.

B. Concrete Anchors:

1. Drill holes in concrete and masonry work with rotary driven twist drills only. Fill voids in masonry with grout.

2. Do not install until concrete has reached specified minimum strength (fc).

3. Do not install closer than 6-bolt diameters to edge of concrete or masonry, or closer than 12-bolt diameters to another anchor unless detailed on Drawings.

4. Minimum embedment shall be 8 bolt diameters.

5. Install in accordance with manufacturer's recommendations.

C. Erect to lines and levels, plumb and true, and in correct relation to adjoining work. Secure parts using concealed connections whenever practicable.

D. Plumb and true vertical members to tolerance of ± 1/8 in. in 10 ft. Level horizontal members to tolerance of ± 1/8 in. in 10 ft.

E. Provide items such as bolts, shims, blocks, nuts, washers, and wedging pieces to complete installation.

F. Drill field holes for bolts. Do not burn holes.

G. New holes or enlargement of unfair holes by use of cutting torch is cause for rejection of entire member.

H. Perform cutting, drilling, and fitting required for installation of metal fabrications.

I. Field welds shall be approved by OWNER before prime painting. Clean slag from welds prior to inspection.

3.02 ADJUSTMENTS AND CLEANING

A. Field repair of damaged galvanized coatings.

1. Repair galvanized surfaces damaged during shipping or erection/construction operations.

2. Repair surfaces using zinc-rich paint.

3. Prepare surfaces and apply in accordance with ASTM A780, Annex A2.

* * * END OF SECTION * * *

SECTION 05520
ALUMINUM HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 REFERENCES

A. Aluminum Association:

1. AA SAS30 - Specifications for Aluminum Structures Construction Manual Series Section 1.

1.02 SUBMITTALS

A. Shop Drawings:

1. Shop drawings for railings including splices, attachments, and mounting.

2. Identify location and type indicated.

3. Indicate railings in related and dimensional position with scale elevations.

4. Indicate required field measurements.

5. One reproducible and one print of Shop Drawings.

B. Design and Test Data:

1. Catalog data or design information.

a. Submit test data showing load, and deflection due to load, in enough detail to prove handrail system and base connections satisfy OSHA requirements.

C. Samples:

1. Duplicate samples, 6 in. long, of typical pipe showing finish.

2. Sample of each fitting.

D. Manufacturer's literature and assembly and installation instructions.

E. Maintenance Instructions: Manufacturer's recommendations describing procedures for maintaining including cleaning materials, application methods, and precautions as to use of materials which may be detrimental to finish when improperly applied.

F. Submit above in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:

1. Handrails and railings shall meet requirements of OSHA and local building codes.

B. Handrails provided shall be end products of one manufacturer to achieve standardization for appearance, maintenance, and replacement.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle components in manner preventing damage to finished surfaces.

1. Pack pipe and elbows in individual plastic shrink film to protect finish. Do not remove until after installation.

B. Storage of Materials:

1. Store components in dry, clean location, away from uncured concrete and masonry.

2. Cover with waterproof paper, tarpaulin or polyethylene sheeting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Alumaguard.

B. Enerco Metal Products, Inc.

C. Or equal.

2.02 MATERIALS

A. Rails, Posts, and Formed Elbows: Aluminum, Alloy 6061-T6 or 6063-T6, Schedule 40, 1-1/2 in. IPS (1.90 in. OD, 0.145 in. wall thickness).

B. Fittings:

1. Fabricate from material similar to railings.

2. Elbows, flanges, sleeves, brackets, and similar items shall be set screw or bolted type.

3. Connections shall be continuous diameter type for smooth appearance and to permit continuous sliding of hands.

C. Safety Chains: ¼ in. stainless steel link chain with spring actuated stainless steel clasp.

2.03 FINISHES

A. Clear satin anodized finish on exposed surfaces.

1. Extruded Components: 0.7 mil anodized.

2. Cast Components: 0.4 mil anodized.

B. Light, circumferentially-brushed finish before anodizing on pipe shaped components.

2.04 FASTENINGS

A. Mechanical Fasteners: Stainless steel.

2.05 FABRICATION

A. Field verify dimensions before fabrication.

B. Fabricator to conform to details shown. Form connections and changes in rail direction by using prefabricated fittings or radius bends.

C. Remove burrs from exposed cut edges.

D. Form elbow bends and wall returns to uniform radius, free from buckles and twists, with smooth finished surfaces or use prefabricated bends.

E. Locate rails as shown on Drawings.

F. Close pipe ends using prefabricated fittings.

G. Space posts not more than 4 ft. on center. Erect posts plumb in each direction.

H. Provide minimum 1/4 in. thick toe plate. Extend not less than 4 in. above walking surface.

I. Blend in color discrepancies on anodized aluminum areas due to fabrication such as welding and exposed fasteners.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as shown on the Drawings and approved submittals.

B. Coat base flanges to be in contact with concrete with bituminous paint.

C. Set posts plumb and aligned to within 1/8 in. in 12 ft.

D. Set rails horizontal or parallel to rake of steps to within 1/8 in. in 12 ft.

E. Assemble and install in accordance with printed instructions of manufacturer.

F. Locate safety chains as shown on the Drawings. One chain shall be at top, other chain shall be centered between grating and to chain. Chain drape shall not exceed 3 in.

3.02 CLEANING

A. Wash thoroughly using clean water and soap, rinse with clean water.

B. Do not use acid solution, steel wool or other harsh abrasive.

C. If stain remains after washing, remove finish, and restore in accordance with manufacturer's recommendations.

3.03 REPAIR OF DEFECTIVE WORK

A. Remove stained or otherwise defective work and replace with material meeting Specification requirements.

* * * END OF SECTION * * *

SECTION 08018
FIBERGLASS REINFORCED PLASTIC DOORS AND FRAMES

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

2. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. Door and Hardware Institute (DHI):

1. Recommended locations for Builder's Hardware.

1.02 SUBMITTALS

A. Shop Drawings:

1. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items. Indicate coordination of glazing frames and stops with glass and glazing requirements.

B. Product Data:

1. Manufacturer's technical product data, substantiating product compliance with requirements.

C. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Provide fiberglass doors, frames and accessories as complete units produced by one manufacturer.

B. Fiberglass door manufacturer shall provide hardware.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to site in sealed, undamaged containers identified with manufacturer's name, brand, style, pattern, and color.

B. Store in original cartons, on end on such manner to prevent falling or damage to face, corners, and edges.

1.05 GUARANTEE

A. Manufacturer shall unconditionally guarantee fiberglass doors and frames for five years against failure due to corrosion.

B. Alterations to door by OWNER will void warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chem-Proof Door Company.

B. Or equal.

2.02 FABRICATION

A. Doors:

1. Construct of fiberglass reinforced plastic (FRP) using polymers tailored to specific corrosive environment with glass content of 35% by weight.

2. Flush construction having no seams or cracks and shall have mortises molded in by manufacturer.

3. 1-3/4-in. thick with 15 mil plus or minus 3 mil color gel coat and shall have a minimum R-factor of 9.

4. Sizes indicated on Drawings with clearances of 1/8 in. at jambs and head and 1/2 in. at bottom unless otherwise indicated or specified.

B. Styles and Rails:

1. Constructed of 2 layers of 1.5 oz/sq ft. fiberglass mat and one layer of 10 oz/sq yd fiberglass cloth.

2. Mold in one continuous piece to U-shaped configuration and to exact dimensions of door.

C. Door Plates:

1. Molded in one continuous piece with 2 layers of 1.5 oz/sq ft. of fiberglass mat and with 16 oz/sq yd uni-directional roving.

D. Frames:

1. Construct of same materials and method as doors.

2. Jamb shall be of uniform cross-sectional thickness so back of jamb shall preset uniform surface against wall opening.

3. Reinforcement for mounting hinges and other hardware shall be of mild steel plates strategically located, buried in matrix of polyester material so that they will not be exposed.

E. Reinforcing for Hardware:

1. Install reinforcing and compression members to accommodate half surface hinges and other hardware in voids between door plates.

2. Fill with equivalent of 4 to 6 lbs of expanded polyurethane foam having flame spread of 25 or less in accordance with ASTM E84.

F. Resins:

1. Fire retardant formulation plus antimony trioxide to achieve flame spread of 25 or less in accordance with ASTM E84.

2. Self-extinguishing in accordance with ASTM D635.

G. Ledge for Window Openings: One piece, molded integrally with both door plates so that no moisture may penetrate door cavity through window opening. Retain window glass by 4 fiberglass glazing pins and seal in such manner that integrity of seal remains intact.

H. Color: Grey.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install frames plumb, rigid and in true alignment. Brace securely during construction to retain their proper position and clearances.

B. Secure jambs with stainless steel concrete anchors.

C. Installation in accordance with manufacturer's written instructions using only non-corrosive materials and methods.

3.02 ADJUST AND CLEAN

A. Final Adjustment: Check and readjust operating finish hardware items, leaving frames undamaged and in complete and proper operating condition.

B. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from pre-finished doors.

* * * END OF SECTION * * *

SECTION 08110
STEEL DOORS AND FRAMES

PART 1 GENERAL

1.01 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI A115 - Door and Frame Preparation.

B. American Society for Testing and Materials (ASTM):

1. ASTM A153 - Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware.

2. ASTM A1008 - Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

3. ASTM A653 - Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

4. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

5. ASTM A568 - Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low Alloy, Hot-Rolled, and Cold-Rolled, General Requirements for.

6. ASTM C1363 - Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of Hot Box Apparatus.

7. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

8. ASTM E413 - Classification for Rating Sound Insulation.

C. Door and Hardware Institute (DHI):

1. Recommended Locations for Builder's Hardware.

D. National Fire Protection Association (NFPA):

1. NFPA 80 - Standard for Fire Doors and Other Opening Protectives.

2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

E. Steel Door Institute (SDI):

1. SDI 100 - Recommended Specifications for Standard Steel Doors and Frames.

2. SDI 105 - Recommended Erection Instructions for Steel Frames.

3. SDI 106 - Recommended Standard Door Type Nomenclature.

1.02 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data substantiating product compliance with requirements.

B. Shop Drawings: Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

1. Provide schedule of doors and frames using same reference numbers for details and openings as those on the Drawings.

2. Indicate coordination of glazing frames and stops with glass and glazing requirements.

C. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Provide doors and frames complying with SDI 100 and as specified.

B. Fire-Rated Door Assemblies: Where- indicated or required, provide fire-rated door and frame assemblies complying with NFPA 80 which have been tested, listed, and labeled in accordance with NFPA 252 by a nationally recognized independent testing and inspection agency acceptable to authorities having jurisdiction.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Identify Work not permanently factory assembled before shipment to ensure proper assembly at Project site.

B. Deliver hollow metal work cartoned or crated to provide protection during transit and job storage.

C. Inspect hollow metal work upon delivery for damage. Minor damages may be repaired provided refinished items equal new Work and are acceptable to OWNER, otherwise remove and replace damaged items.

D. Store doors and frames at Project site under cover. Place units on minimum 4 in. high wood blocking. Avoid use of non-vented plastic or canvas shelters which could create humidity chamber. If cardboard wrapper on door becomes wet, remove carton immediately. Provide minimum ¼ in. spaces between stacked doors to promote air circulation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermal Rated Steel Door and Frame Assemblies:

1. Ceco Corporation.

2. Curries Manufacturing, Inc.

3. Or equal.

2.02 MATERIALS

A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, ASTM A568.

B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, ASTM A1008 and A568.

C. Galvanized Steel Sheets: Zinc coated carbon steel sheets of commercial quality, ASTM A653 and A1101, G60 zinc coating, mill phosphatized.

D. Supports and Anchors: Fabricate of galvanized sheet steel, minimum 18 ga.

E. Inserts, Bolts, and Fasteners: Manufacturer's standard units, except hot-dip galvanize items built into exterior walls, ASTM A153, Class C or D as applicable.

F. Shop-Applied Paint:

1. Primer: Rust inhibitive enamel or paint, air-drying or baking, suitable as base for specified finish paints.

2.03 FABRICATION, GENERAL

A. Door and frame shall be rigid, neat in appearance, and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant.

B. Comply with SDI 100.

1. Exterior Doors: SDI 100, Grade III, extra heavy duty, Model 2, minimum 16 ga faces.

2. Interior Doors: SDI 100, Grade II, heavy duty, minimum 18 ga faces.

C. Materials:

1. Exposed faces of doors and panels, including stiles and rails of non-flush units shall be cold-rolled steel.

2. Frames, concealed stiffeners, reinforcement, edge channels, louvers, and moldings shall be cold- or hot-rolled steel, minimum 16 ga.

3. Exterior Doors: Close top and bottom edges as integral part of door construction or by addition of minimum 16 ga inverted steel channels.

D. Exposed Fasteners:

1. Countersunk flat Phillips heads for exposed screws and bolts.

E. Finish Hardware Preparation:

1. Comply with ANSI A115 for door and frame preparation.

2. Reinforce doors and frames to receive surface applied hardware. Drilling and tapping for surface applied finish hardware may be done at Project site.

3. Locate finish hardware as indicated on approved Shop Drawings or, if not indicated, in accordance with DHI.

F. Shop Painting:

1. Clean, treat, and paint exposed-surfaces of steel door and frame units, including galvanized surfaces.

2. Clean steel surfaces of mill scale, rust, oil, grease, dirt, and other foreign materials before application of paint.

3. Apply shop coat of prime paint of even consistency to provide uniformly finished surface ready to receive finish paint.

2.04 STANDARD STEEL DOORS

A. Provide metal doors of types and styles indicated on Drawings or schedules.

B. Door Louvers:

1. Sightproof stationary louvers for interior doors constructed of inverted V- or Y-shaped blades formed of 24 ga cold-rolled steel set into 20 ga steel frames.

2.05 STANDARD STEEL FRAMES

A. Provide metal frames for doors, transoms, side lights, borrowed lights, and other openings of types and styles shown on Drawings and schedules.

1. Fabricate of minimum 14 ga hot-dip galvanized steel.

2. Conceal fastenings unless otherwise indicated.

3. Miter and weld corners.

B. Door Silencers: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.

C. Plaster Guards: Provide 26 ga steel plaster guards or mortar boxes welded to frame at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation, and to close off interior of openings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install standard steel doors, frames, and accessories in accordance with Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames:

1. Comply with SDI 105 unless otherwise indicated.

2. Except for frames located at cast-in-place concrete or masonry and drywall installations, place frames prior to construction of enclosing walls and ceilings.

3. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors set.

4. After wall construction complete, remove temporary braces and spreaders leaving surfaces smooth and undamaged.

5. Masonry Construction: Locate 3 wall anchors per jamb at hinge and strike levels.

6. Metal Stud: Install minimum of 3 wall anchors per jamb at hinge and strike levels.

7. Fire-Rated Frames: In accordance with NFPA 80.

C. Door Installation:

1. Fit hollow metal doors accurately in frames within clearances specified in SDI 100.

2. Place fire-rated doors with clearances as specified in NFPA 80.

3.02 ADJUST AND CLEAN

A. Prime Touch-up: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touch-up of compatible air drying primer.

B. Final Adjustments: Check and re-adjust operating finish hardware items, leaving steel doors and frames undamaged and in complete and operating condition.

* * * END OF SECTION * * *

SECTION 10440
SPECIALTY SIGNS

PART 1 GENERAL

1.01 SUMMARY

A. Supply and install panel signs as indicated on the Drawings.

1.02 REFERENCES

A. Standard Specifications: "Standard Specifications for Construction and Materials," State of New York Department of Transportation (NYSDOT).

B. NYSDOT Standard Sheets.

C. New York State Manual for Uniform Traffic Control Devices (MUTCD).

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical data and installation instructions for each type of sign required.

B. Samples: Submit samples of each sign form and material showing finishes, colors, surface textures, and qualities of manufacture.

C. Shop Drawings: Submit layout and design of each sign panel including graphics.

PART 2 PRODUCTS

2.01 MATERIALS, GENERAL

A. Signs shall be aluminum sheet alloy in accordance with NYSDOT 645-2.01 B or ABS Plastic High impact thermoplastic composed of copolymers of acrylonitrile, butadiene, and stryene.

B. Fasteners: Use concealed fasteners, unless otherwise indicated, fabricated from metals, which are non-corrosive to either sign materials or mounting surface.

C. Anchors and Inserts: Use nonferrous metal or hot-dipped galvanized anchors and inserts. Use toothed steel or lead expansion bolt devices for drilled-in-place anchors. Furnish inserts, as required, to be set into concrete or masonry work.

D. Posts: Signposts shall be NYSDOT post size 2 (L 3 x 2.5 x 0.25) aluminum, or 4 x 4 pressure treated wood as approved by OWNER.

2.02 FABRICATION OF PANEL SIGNS

A. General:

1. Fabricate panel signs to comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.

2. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within tolerance of plus or minus 1/16 in. measured diagonally from corner to corner.

3. Unframed Panel Signs: Fabricate unframed panel signs with edges mechanically and smoothly finished to conform to the following requirements.

a. Edge Condition: Square cut.

b. Edge Color for Plastic Laminate: Same as copy.

c. Corner Condition: Rounded to radius indicated.

B. Graphic Image Process:

1. Graphic Content and Style: Provide sign copy to comply with requirements indicated for sizes, styles, spacings, content, positions, materials, finishes, and colors of letters, numbers, symbols, and other graphic devices as selected by OWNER.

2.02 FINISHES

A. General:

1. Colors and Surface Textures: For exposed sign materials which require selection of materials with integral or applied colors, surface textures, or other characteristics related to appearance, provide color matches indicated, or if not otherwise indicated, selected by OWNER from manufacturer's standards.

2. Metal Finishes: Comply with National Association of Architectural Metal Manufacturers (NAAMM) "Metal Finishes Manual" for finish designations and application recommendations.

B. Aluminum Finishes:

1. Baked Enamel Finish: AA-M4xC12C42R1x (manufacturer’s standard non-directional mechanical finish including sanding and filing; cleaning with inhibited chemicals’ conversion coated with an acid-chromate-fluoride-phosphate treatment; and painted with organic coating specified below).

a. Organic Coating: Manufacturer's standard thermosetting enamel system consisting of prime coat and finish coat.

PART 3 EXECUTION

3.01 INSTALLATION

A. Locate sign units and accessories where shown or scheduled, using mounting methods of type described and in compliance with manufacturer's instructions, unless otherwise indicated.

B. Install sign units level, plumb, and at height indicated, with sign surfaces free from distortion or other defects of appearance.

3.02 CLEANING AND PROTECTION

A. At completion of installation, clean soiled sign surfaces in accordance with manufacturer's instructions.

B. Protect units from damage until acceptance by OWNER.

* * * END OF SECTION * * *

SECTION 11309
PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Pumps to be used in primary and secondary leachate collection sumps and leachate vaults.

1.02 SUBMITTALS

A. Shop Drawings.

B. Manufacturer's written installation instructions.

C. Submit in accordance with Section 01340.

D. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 01730.

1.03 QUALITY ASSURANCE

A. Performance Criteria:

1. Provide pumps that meet the performance criteria in Table 11309-1 of this section.

2. Working parts shall be readily accessible for inspection and repairs, easily duplicated, and replaced.

3. Direct connect to vertical shaft motor.

4. Pumps shall be capable of safely rotating in reverse direction due to water returning through pump.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pumps:

1. Godwin Pumps of America, Inc.

2. Goulds, Inc.

3. Honda Power Equipment.

4. Or equal.

2.02 PUMPS

A. Provide pump and motor designed for continuous submerged operation.

B. Pumping down thrust absorbed by motor thrust bearing.

1. Adjustable Mitchell design (improved "Kingsbury" type).

2. Construct of ceramic running against self-aligning metal impregnated carbon pads.

C. Provide stainless steel priming inducer.

1. Design to ensure proper pump lubrication and prevent dry running if liquid level drops below pump intake.

D. Provide stainless steel filter screen.

1. Integral to suction inlet assembly.

E. Provide fabricated stainless steel diffuser guide vanes.

F. Provide fabricated stainless steel impellers.

1. Fit seal ring around each impeller eye or skirt.

a. Construct seal rings of stainless steel tetrafluoroethylene (TFE).

G. Provide centerless ground stainless steel pump shaft.

H. Provide TFE shaft bearings of hexed design.

I. Provide stainless steel split cones and split cone nuts.

J. Provide integral fabricated stainless steel diffuser chambers.

1. Design to eliminate up thrust.

2. Container diffuser guide vanes and intermediate shaft bearings.

K. Provide high tensile strength stainless steel straps.

L. Provide splined or keyed stainless steel pump shaft coupling.

M. Motor:

1. Canned rotor design.

2. Hermetically sealed epoxy encapsulated stator sealed in stainless steel enclosure.

3. Stainless steel clad rotor.

4. Construct parts in contact with pumped liquid of stainless steel.

5. Shaft and Seal:

   a. Tungsten carbide running on tungsten carbide.

   b. Upper seal ring molded into spring loaded rubber diaphragm.

6. Upper Radial Bearing:

   a. Diamond hard ceramic running against tungsten carbide shaft journal.

   b. Lubricated by pumped fluid.

7. Motor Circulation Pump:

   a. Stainless steel.

   b. Circulate pumped fluid in rotor.

   c. Design to ensure effective bearing lubrication and winding heat dissipation.

8. Lower Radial Bearing:

   a. Diamond hard ceramic running against tungsten carbide shaft journal.

   b. Lubricated with pumped fluid.

9. Rubber Diaphragm

   a. Design to automatically compensate for internal motor liquid expansion due to temperature or pressure changes.

10. Provide neoprene jacketed RHW insulated power cable.

2.03 SPECIAL REQUIREMENTS (Primary and Secondary Leachate collection sump pumps only)

A. Provide each pump with 100-ft, factory-installed, sealed, heavy duty, Teflon coated electric service cable.

2.04 ACCESSORIES (Primary and Secondary Leachate collection sump pumps only)

A. Hose and Quick Connect Couplings: Provide 100-ft. length of discharge hose with quick connect couplings, sized to match the discharge size of the Leachate pumps. For specifications of hose and quick connect couplings, refer to Section 15076.

B. Pullout Cable: Provide 100-ft of ¼ in. stainless steel, pullout cable.

C. Provide stainless steel fabricated wheeled carriage for conveyance of pump within the sump riser pipes.

PART 3 EXECUTION

3.01 INSTALATION

A. Install equipment according to manufacturer's written instructions and approved submittal.

B. Attach pump power cable to stainless steel pump pull-out cable at 5-ft intervals using nylon ties (Primary and Secondary Leachate collection sump pumps only).

C. Wiring shall conform to requirements of Division 16.

TABLE 11309-1
PUMP AND ELECTRICAL M0TOR CHARACTERISTICS

PUMP CHARACTERISTICS

Pump Designation (1)*	Medium Capacity Leachate Pump	Large Capacity Leachate Pump	Vault Pump
Number of Units	6 (includes 1 spare)	6 (includes 1 spare)	6 (includes 1 spare)
Materials Being Pumped	Leachate	Leachate	Vault Condensate
Minimum Solids Size (in.)	0.75	0.33	0.375
Constant or Variable Speed	Constant	Constant	Constant
Configuration (2)*	e	e	E
Minimum Suction Size (in.)(3)*	---	---	---
Minimum Discharge Size (in.)(3)*	2 NPT	3 NPT	1-1/4 NPT
Rated Capacity (gpm)	72	200	40
Total Dynamic Head at Rated Capacity (ft)(4)*	50	140	25
Minimum Capacity (gpm)	70	176	---
Total Dynamic Head at Minimum Capacity (ft)(4)*	34	57	---
Maximum Pump Speed (rpm)	3,500	3,400	---
Minimum Pump Speed (rpm)	---	---	---
Lubrication (5)*	Pumped Fluid	Pumped Fluid	Pumped Fluid
Rotation when Viewed from Driver	Clockwise	Clockwise	Clockwise
Type of Drive (6)*	---	---	---
Special Requirements	All Stainless Steel Construction	All Stainless Steel Construction	All Stainless Steel Construction
ELECTRIC MOTOR CHARACTERISTICS			
Horsepower- Min.	1-1/2	13	1/3
Rated Speed (rpm)	3,500	3,400	---
Service Factor	1.15	1.15	1.15
General Type (7)*	a	a	---

Housing Type (8)*	c, d	c, d	c, d
NEMADesign	B	B	B
Insulation Class	B	B	F
Voltage	460	460	115
Phase	3	3	---
Code Letter	G	G	G
Special Requirements	---	---	---

()* Indicates footnotes on following page
NA Indicates not applicable

TABLE 11309-1
PUMP AND ELECTRIC MOTOR CHARACTERISTICS
(Continued)

1. Pump Designations:

   a. Medium Capacity Leachate Pump: Goulds Pumps Model WE15HH, or approved equal.

   b. Large Capacity Leachate Pump: Godwin Pumps Model GSP130HH, or approved equal.

   c. Vault Pump: Honda Submersible Pump Model WSP33AM, or approved equal.

2. Configuration can be

   a. Propeller pump - axial flow.

   b. Propeller pump - mixed flow.

   c. Vertical turbine pump - enclosed impeller.

   d. Vertical turbine pump - semi-open impeller.

   e. Vertical submersible pump.

3. If larger pump size or different pump other than those shown are furnished by CONTRACTOR, he shall be responsible for added expense of piping and changes in Drawings.

4. Does not include elbow, column, strainer, and other internal losses in pump.

5. Product lubricated or oil lubricated.

6. Type of drive can be:

   a. Variable frequency.

   b. Magnetic coupling (eddy current coupling).

   c. Wound rotor.

   d. Fluid drive.

   e. Variable sheave (local or remote control).

7. General type can be:

   a. Squirrel cage.

   b. Wound rotor.

   c. Synchoronous.

8. Housing type can be:

   a. ODP (open dripproof).

   b. TEFC (totally enclosed fan cooled).

   c. Explosionproof.

   d. Submersible.

   e. Splashproof.

   f. Weather protected.

* * * END OF SECTION * * *

SECTION 13121
PRE-ENGINEERED METAL ROOF

PART 1 GENERAL

1.01 SUMMARY

A. Intent of these Specifications and Drawings is to establish quality and performance level for structural design, material, durability, and workmanship.

1.02 REFERENCES

A. Aluminum Association (AA):

1. Specification for Aluminum Structures.

B. American Institute of Steel Construction (AISC):

1. Manual of Steel Construction (Allowable Stress Design).

C. American Iron and Steel Institute (AISI):

1. Cold-Formed Steel Design Manual.

D. American Society for Metals (ASM):

1. Metals Handbook.

   a. Aluminum Alloy No.6063.

E. American Society for Testing and Materials (ASTM):

1. ASTM A6 - Standard Specification for General Requirements for Rolled Steel Bars, Plates, Shapes, and Sheet Piling, for Structural Use.

2. ASTM A36 - Standard Specification for Carbon Structural Steel.

3. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

4. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

5. ASTM D4214 - Standard Test Methods For Evaluating the Degree of Chalking of Exterior Paint Films.

6. ASTM D2244 - Standard Practice for Calculation of Color Differences and Color Differences from Instrumentally Measured Color Coordinates.

7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

F. American Welding Society (AWS):

1. AWS D1.1 - Structural Welding Code: Steel.

G. Federal Specifications (FS):

1. FS TT-P-664C(2) - Primer Coating, Synthetic, Rust-Inhibiting, Lacquer-Resisting.

H. International Conference Building Officials (ICBO):

1. Uniform Building Code and Supplements.

I. Metal Building Manufacturers Association (MBMA):

1. Metal Building Systems Manual.

1.03 SUBMITTALS

A. Shop Drawings:

1. Include structural framing details, connections, plans and sections for site specific roof stamped by Professional Engineer registered in State of New York.

2. Include anchor bolt setting plans.

3. Provide horizontal and vertical forces applied to structure wall.

4. State type of material, finishes, and painting for all locations.

B. Roof panel guarantees.

C. Color chips for roof panels and trim.

D. Submit in accordance with Section 01340.

1.04 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:

1. Roof shall be design of manufacturer regularly engaged in fabrication of pre-engineered structures.

2. Use new, unused materials, free from defect, and of American manufacture.

B. Regulatory Requirements:

1. Building code having jurisdiction over area in which site is located.

2. Underwriters' Laboratories, Inc. (UL).

1.05 DELIVERY, STORAGE, AND HANDLING

A. Protect stored materials from damage.

B. Replace damaged material if repair or corrections cannot be made in field.

1.06 GUARANTEE

A. Roof Panels:

1. Guarantee durability of roof panels due to rupture, structural failure, or perforation for 20 years.

PART 2 PRODUCTS

2.01 PERFORMANCE CRITERIA

A. Design Loads:

1. General:

a. Basic design loads: Dead, live, wind, and earthquake in addition to dead load.

b. Other design loads, whether static, dynamic, or kinetic nature, shall be considered as auxiliary loads.

2. Vertical Live Loads:

a. Design roof covering for 50 psf uniformly distributed or 200-lb concentrated (point) load (over 1ft. by 1ft. area) located at center of maximum roofing (panel) span. Most severe conditions govern.

b. Design purlins for 35 psf uniformly distributed over roof area they support.

c. Primary-framing (frames) shall be designed for 35 psf uniformly distributed over roof area it supports.

d. Above loads shall be in addition to applicable dead loads and applied to horizontal projection of roof.

3. Wind Loads:

a. Wind load: 15 psf pressure proportioned and applied as horizontal and uplift forces according to and as recommended by State of New York

Codes, Rules and Regulations Building Construction Subchapter B, and MBMA. Most severe condition governs.

4. Seismic (Earthquake) Loads:

a. Design roof for seismic forces.

b. Provisions for determining seismic forces shall be those as recommended by ICBO.

5. Auxiliary (Additional Collateral) Loads:

a. Consider other superimposed dynamic or static loads as part of design requirements and combined with normal design (live and wind) loads as prescribed hereafter.

1. Static loads such as piping and lighting systems.

B. Description:

1. Pre-engineered metal roof covered by this section shall be structure of steel (frames) rafter beams devoid of valleys.

2. Roof slope shall be not less than ½:12.

3. Interior column (supports) not allowed.

4. Horizontal plane bracing permitted if above building's required interior clear height.

5. Roof shall be designed for removal in one piece. Anchor bolts shall be readily accessible for roof removal. Provide lifting lugs at top of roof for removal.

2.02 COMPONENT CRITERIA

A. Structural Framing:

1. Shapes and Plates: ASTM A36 or manufacturer's standard.

2. Anchor Bolts: ASTM A307 minimum.

3. Connection Bolts: ASTM A325.

B. Roof Covering and Supports: Roof construction shall carry UL construction (uplift) classification of no less than Class 30.

1. Roof Panels:

a. Exposed metal roof covering: 24 ga (minimum) commercially pure aluminum-coated or zinc-aluminum-coated steel panels of configuration to provide specified load carrying capabilities and deflection requirements of this section.

b. Roof panels: “Standing-seam interlocking” design, secured to purlins with concealed structural fastening systems.

c. Concealed system: Shall provide minimal through penetration of exposed roofing surface and allow roof covering to move independently of any differential thermal movement by structural framing system.

d. Except at concealed fastener, there shall be no thermal contact of roof panels with supporting purlin.

e. Standing seams shall have factory-applied, non-hardening sealant, and be continuously locked or crimped together by mechanical means during erection.

f. Roof panels with lap-type side (longitudinal) joints and exposed structural fasteners not acceptable.

g. Fasten to purlins with concealed clip or backing device of steel having protective metallic coating. Through penetration of roofing surface by exposed fasteners shall occur only at terminal locations of roof panels. Such fasteners shall be stainless steel or aluminum screws, bolts or rivets with weather-seal washers. Carbon steel shank fasteners with vinyl heads are acceptable.

h. Deflection of roof panel shall not exceed L/180 of span when supporting applicable vertical live loads previously described.

2. Purlins:

a. Purlin configuration, thickness, and spacing shall be building manufacturer’s standard provided design criteria, including deflection, is met or exceeded.

b. Deflection of purlin shall not exceed L/180 of span when supporting applicable vertical live loads previously prescribed and any collateral loads required.

3. Roof Jacks and Curbs:

a. Openings, 8 in. or smaller:

1) May be flashed and sealed to roof panel by jacks, if complete structural support and weather-tightness maintained.

2) Material shall be metal with protective metallic coating or plastic alloy with acrylic film laminated to exterior surface.

2.03 FABRICATION

A. Fabricate as shown on approved Shop Drawing. Do not modify Shop Drawings or Specifications.

B. Welder shall be certified for type of welding required.

C. Fabrication and erection welding and welding equipment shall comply with requirements of AWS.

D. Electrodes for structural welds shall be E70 series.

E. Surface shall be free of scale, rust, grease, paint or other foreign matter prior to welding.

F. After welding, brush welds with wire brushes. Welds shall show uniform section, smoothness of weld metal, weather edges without overlaps, and freedom from porosity and clinkers. Where necessary to achieve smooth connections, joint shall be dressed smooth.

2.04 STRUCTURAL STEEL PRIMER

A. Provide uncoated structural steel surfaces one shop coat of rust inhibitive (primer) paint compatible with finish painting system.

B. Surfaces inaccessible after erection shall be covered with 2 coats before erection.

2.05 INSULATION

A. Providing overall heat transfer (U) value of not more than .09.

B. Apply insulation system under exposed metal roofing panels.

C. Place insulation of required thickness and density either over purlins or in roof cavity between purlins and support by sloped, unpierced, or pierced ceiling of noncombustible material.

D. Place vapor membrane nearest interior of building, whether it be exposed or non-exposed.

E. Lap or fold and staple joints in accordance with roof manufacturer's standard.

F. Except at each concealed structural fastener, thermal (break) spacer shall separate roof purlin from roof panel. Spacer shall be material having density of not less than 2 pcf and, if of combustible material, shall be classified (ASTM E84) as having flame spread rating no greater than 25.

G. Noncombustible roof insulation shall be flexible fiberglass blankets with vapor resistant membrane. Vapor resistant membrane may be laminated to insulation as composite unit or added as separate component of insulation system. Insulation and vapor membrane, if supplied as laminated composite unit, shall carry UL fire hazard classification indicating flame spread rating of 25 or less, as tested assembly. If supplied as separate components, each (tested separately) shall carry previously specified fire hazard classification.

PART 3 EXECUTION

3.01 GENERAL

A. Erection of metal roof, accessories, insulation, and interior finish, if applicable, shall be performed by one of the following:

1. Authorized dealers or builders of manufacturer.

2. Building manufacturer’s crews.

3. Other erectors authorized by manufacturer as trained and qualified to erect manufacturer’s product. In this case, manufacturer shall inspect Work and certify its correctness.

B. Assemble in accordance with approved erection or assembly drawings, details, and instructions. No modifications to assembly drawings, details, or instructions shall be made.

3.02 ADJUSTMENT AND CLEAING

A. Touch up defects such as mars and abrasions to panels and framing, weld burrs in field.

B. Adjust ridge ventilator to operate properly.

* * END OF SECTION * *

SECTION 13250
HIGH DENSITY POLYETHYLENE (HDPE) MANHOLES

PART 1 GENERAL

1.01 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM C1147 - Standard Practice for Determining the Short Term Tensile Weld Strength of Chemical Resistant Thermoplastics.

2. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

3. ASTM D790 - Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

4. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.

5. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

6. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort.

7. ASTM D2657 - Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.

8. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

9. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

10. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material.

11. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

12. ASTM F1473 - Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipe and Resin.

13. ASTM F1759 – Standard Practice for Design of High Density Polyethylene (HDPE) Manholes for Subsurface Applications.

1.02 SUBMITTALS

A. Submit results of manufacturer's tests with shipment of HDPE Manholes, with 2 additional copies of such test results furnished to OWNER. Cost for additional required testing not performed by the manufacturer shall be borne by the CONTRACTOR.

B. Submit shop drawings indicating the dimensions of HDPE Manhole(s), and location and dimensions of fittings (10-inch primary and secondary leachate containment pipe stub ends).

C. Submit manufacturer's certification that fittings for HDPE Manholes were constructed in accordance with ASTM D2657 (for butt fusion technique) or ASTM C1147 (for extrusion welding technique).

D. Submit certification from the manufacturer that each HDPE Manhole (with fittings) has passed a leak test (performed using air or water) prior to delivery of the HDPE Manhole to the project site. Manufacturer's certification for the leak test shall included appropriate data from the testing to verify results. The leak test shall be performed using the manufacturer's standard leak test procedures.

E. Submit in accordance with Section 01340.

1.03 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver HDPE Manholes to the project site in manufacturer's original packaging, with labels clearly identifying materials and name of manufacturer. Manufacturer shall provide clasps, hooks or other equipment necessary for unloading and installation upon delivery.

B. Storage: Store HDPE Manholes in a clean, dry area, off the ground, in accordance with manufacturer's instructions.

C. Handling: Protect HDPE Manholes during handling and installation from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. ISCO Industries.

B. Or equal.

2.02 FABRICATION

A. Construct HDPE Manholes (with appropriate fittings) in accordance with dimensions and locations provided in the Drawings.

B. Construct HDPE Manholes and fittings in accordance with the following physical properties of pipe compound:

1. Density: ASTM D1505, no less than 0.941 grams per cubic centimeter and no more than 0.955 grams per cubic centimeter.

2. Melt Flow: ASTM D1238 (Condition E), no greater than 0.4 grams per 10 minutes.

3. Flexural Modulus: ASTM D790, shall be no less than 110,000 psi and no greater than 160,000 psi.

4. Tensile Strength at Yield: ASTM D638, shall be no less than 3,000 psi and no greater than 3,500 psi.

5. Slow Crack Growth Resistance: ASTM F1473, shall be greater than 100 hours.

6. Hydrostatic Design Basis: ASTM D2837, shall be 1,600 psi at 23^{o}C.

7. HDPE Cell Classification: ASTM D3350, shall be a minimum cell classification value of PE 345464C.

C. HDPE Manholes shall be 60 inches or 72 inches in diameter (outside diameter) with a Standard Dimension Ratio (SDR) of 17 as indicated on the Drawings.

D. Pipe stub ends for leachate forcemain outer containment pipes shall match the sizes indicated on the Drawings and be SDR 11. Stub ends shall be extrusion welded to the inside and outside of the manhole.

E. HDPE Manhole base shall be fabricated from high performance, high molecular weight polyethylene with a resin conforming to the quality of the manhole and pipe (fittings).

F. HDPE Manholes shall include lifting rings and clasps, hooks or other equipment necessary for unloading and installation.

G. HDPE Manholes shall be equipped with a 30-inch-diameter slab opening with heavy duty manhole frame and “flow seal” cover or approved equal. Cover shall contain lettering “CHEM SEWER”.

2.03 CONSTRUCTION QUALITY ASSURANCE

A. The QAC shall confirm that submittals providing manufacturer’s test results and certifications meet the requirements of this section.

B. The QAC shall measure the manhole and fittings to verify that minimum wall thicknesses and dimension requirements have been met.

PART 3 EXECUTION

3.01 INSTALLATION

A. Subbase Preparation:

1. CONTRACTOR shall prepare subbase of HDPE Manholes utilizing select fill meeting the requirements of Section 02210, Part 2.03.

2. Select fill shall be placed to a minimum thickness of 12 inches, extending a minimum of 36 inches beyond the base of the manhole in all directions.

3. Select fill shall be compacted to a minimum 95% of the maximum dry density, as determined by modified proctor testing (ASTM D1557).

B. HDPE Manhole Installation:

1. CONTRACTOR shall install HDPE Manholes to the lines, grades and elevations depicted on the Drawings.

2. Contractor shall lift and place HDPE Manholes utilizing lifting rings and clasps, hooks or other equipment provided by the manufacturer.

3. HDPE Manhole top shall be extrusion welded to HDPE flatstock base of riser vaults.

C. Backfilling:

1. CONTRACTOR shall backfill soil around HDPE Manholes utilizing structural fill meeting the requirements of Section 02220, Part 2.07.

2. Structural fill shall be placed and compacted in 12 inch thick (maximum) lifts. Structural Fill shall be compacted to a minimum 90% of the maximum dry density, as determined by modified proctor testing (ASTM D1557).

3. CONTRACTOR shall utilize hand compaction equipment (i.e. vibratory plate tamper) to perform compaction of structural fill adjacent to the HDPE Manhole.

3.02 CONSTRUCTION QUALITY ASSURANCE

A. QAC shall perform nuclear density testing of subbase and backfill material in accordance with ASTM D6938 to verify the requirements specified above have been met.

B. QAC shall inspect the HDPE Manhole following installation to verify the manhole and fittings were not damaged during installation. Any damage identified to the manhole and/or fittings shall be repaired at no cost to the OWNER.

C. HDPE Manhole Testing:

1. Prior to testing HDPE manholes, the CONTRACTOR shall seal the opening of the annular space between the inner and outer HDPE pipes for both all leachate forcemain piping that passes through the manholes. The seal shall be performed by extrusion welding an HDPE “doughnut” to the inner and outer pipes, as shown on the Drawings.

2. CONTRACTOR shall fill manhole with water to a minimum depth of 12 inches below the top of the HDPE Manhole.

3. The QAC shall monitor the level of water for 4 hours. If the water level drops, the CONTRACTOR shall refill to the original level at start of test. If the water level does not drop, continue monitoring water level for 24 hours (Initial 4 hours may be included as part of the 24 hour monitoring period).

4. The QAC shall record the water level at the end of the 24 hour test period. If water level has not dropped more than 1 inch, the test shall be considered passed. If the water level drops more than 1 inch, the inlet and outlet pipe penetrations shall be inspected and repaired, if necessary, and the test shall be performed again.

D. Riser Vault Testing:

1. Welds for joints of HDPE flatstock riser vault base to the HDPE manhole top shall be spark tested in accordance with Section 02401, Part 3.04, Paragraph C.1.

* * END OF SECTION * *

SECTION 13330
MISCELLANEOUS FIBERGLASS STRUCTURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiberglass reinforced plastic (FRP) molded grating.

B. Fiberglass reinforced plastic (FRP) handrails

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

2. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.

3. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

4. ASTM D696 - Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30ºC and 30ºC With a Vitreous Silica Dilatometer.

5. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

6. ASTM D2344 - Standard Test Method for Short Beam Strength of Polymer Matrix Composite Materials and Their Laminates.

1.03 SUBMITTALS

A. FRP Molded Grating:

1. Product Data: Submit manufacturer’s product data, including resin description, structural properties, structural design tables and chemical resistance tables.

2. Shop Drawings: Submit manufacturer’s shop drawings, indicating grating size, bar size, top surface type, panel dimensions and installation details.

3. Samples: Submit the following manufacturer’s samples to the OWNER

   a. Grating: 6 inch by 6 inch sample of grating made from specified resin type with appropriate top surface type and color.

   b. Grating Clips: Two samples of each type and size of grating clip required for installation.

4. Manufacturer’s Quality Assurance:

a. Submit manufacturer's ASTM E84 test results for grating.

b. Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

B. FRP Handrails:

1. Product Data: Submit manufacturer's published literature including structural design data, corrosion resistance tables, and design calculations for systems not sized or specified in the Drawings.

2. Shop Drawings: Submit manufacturer's shop drawings, indicating material sizes, types, styles, part or catalog numbers, complete details for the fabrication of and erection of components, including location, lengths, type and sizes of fasteners, clip angles, member sizes and connection details.

3. Manufacturer's Quality Assurance:

a. Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.

C. Submit in accordance with Section 01340.

1.04 DELIVERY, STORAGE AND HANDLING

A. Delivery: Deliver materials to the project site in manufacturer's original packaging, with labels clearly identifying material name and manufacturer.

B. Storage: Store materials in a clean, dry area, off the ground, in accordance with manufacturer's instructions.

C. Handling: Protect materials during handling and installation from damage.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. International Grating and Flanges, Inc.

B. Or equal.

2.02 FABRICATION

A. FRP Grating:

1. Grating shall consist of a mixture of fiberglass reinforcement and polyester resin

2. Grating shall be fabricated using an open-mold woven cast process.

3. Fiberglass reinforcement shall utilize a continuous roving process

4. Tops of bearing bars and crossbars shall be in the same plane.

5. Finished surfaces shall be smooth, uniform, free from dry spots, cracks, crazes, unreinforced areas and visible glass fibers.

6. Resin shall be polyester with a flame spread rating (ASTM E84) of Class 1, 25 or less.

7. Gating shall be 1 inch thick square style with grid spacing of 1 1/2 inches by 1 1/2 inches, or as approved by ENGINEER.

8. Top surface of grating shall be a non-slip surface utilizing coarse clear grit by encapsulating grit with resin.

9. Grating clips shall be Type 316 Stainless Steel.

10. Color: Yellow.

B. FRP Handrails.

1. All posts and rails are to be FRP structural shapes manufactured by the pultrusion process. All structural shapes shall be composed of fiberglass reinforcement and resin in qualities, quantities, properties, arrangements and dimensions as necessary to meet this section.

2. Fiberglass reinforcement shall be a combination of continuous roving, continuous strand mat, bi-directional roving mat and surfacing veil in sufficient quantities as required by the application and/or physical properties required.

3. Resin shall be isophthalic polyester (ISOFR) with a chemical formulation necessary to provide the corrosion resistance, strength and physical properties required by this section.

4. All finished surfaces of handrails and support structures shall be smooth, resin-rich, free of voids and without dry spots, cracks, crazes or unreinforced areas. All glass fibers shall be well covered with resin to protect against their exposure from wear or weathering.

5. Top and bottom rails are to be 2-inch by 0.125-inch wall square tubing.

6. Posts are to be 1.75-inch by 0.25-inch wall square tubing.

7. Kick plates are to be 0.5-inch thick by 4-inch wide with two reinforcing ribs.

8. Handrail components shall exhibit the following minimum longitudinal mechanical properties:

Property	**ASTM Method**	**Value**	**Units**
Tensile Strength	D638	30,000 (206)	psi (Mpa)
Tensile Modulus	D638	2.5 X 10^6 (17.2)	psi (Gpa)
Flexural Strength	D790	30,000 (206)	psi (Mpa)
Flexural Modulus	D790	1.8 x 10^6 (12.4)	psi (Gpa)
Flexural Modulus (Full Section)	N/A	2.8 x 10^6 (19.3)	psi (Gpa)
Short Beam Shear (Transverse)	D2344	4,500 (31)	psi (Mpa)
Shear Modulus (Transverse)	N/A	4.5 x 10^5 (3.1)	psi (Gpa)
Coefficient of Thermal Expansion	D696	8.0 x 10^{-6} (1.4 x 10^{-6})	in/in/^{o}F (cm/cm/^{o}C)
Flame Spread	E84	25 or less	N/A

9. Color: Yellow

PART 3 EXECUTION

3.01 INSTALLATION

A. FRP Grating:

1. Install in accordance with manufacturer's written instructions and approved submittals at locations indicated on the Drawings.

2. Install grating level, square, accurately aligned with adjacent panels, rigid and without warp.

3. Trim grating panels, as necessary, with panel turned bottom side up, using cutting equipment in accordance with maufacturer's instructions. Apply catalyzed wax/resin solution equal to resin used in grating manufacturing to all cut surfaces.

4. Install a minimum of 4 clips to each full length panel side.

5. Grating panel to be installed over manhole shall extend a minimum of 12 inches beyond the opening of the manhole in any direction. Install a minimum of 4 clips, evenly spaced, on all sides of grating panel over manhole.

6. Use manufacturer provided grating clips.

7. CONTRACTOR shall replace damaged or defective grating at no cost to the OWNER.

B. FRP Handrails:

1. The handrail post/rail connection is to be installed such that the rails are continuous over the post without the use of packs or splices.

2. The bottom rails are to be installed over the posts at prepared holes made to fit the outside dimensions of the posts. The posts are to fit into machined pockets formed into the rails.

3. The rails are to be joined to the post by riveting. Spacing of the posts shall not exceed 6 feet.

4. All manufacturer and field cuts are to be coated with a vinyl ester resin to provide corrosion resistance.

* * END OF SECTION * *

SECTION 13624
FLOW METERS

PART 1 GENERAL

1.01 SUMMARY

A. Provide standard paddlewheel flow meters and converters as shown on the Drawings and Schedule 1 of this section.

B. Provide standard magnetic flow meter (as substitute for paddlewheel flow meter) at locations approved by the OWNER and ENGINEER as shown on Schedule 2 of this section.

1.02 SUBMITTALS

A. Submit maintenance-service contract.

B. Submit in accordance to Section 01340.

C. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 01730.

1.03 QUALITY ASSURANCE

A. Supplier’s or Manufacturer’s Services:

1. Supplier’s or manufacturer’s technician for equipment specified herein shall be present at job site or classroom designated by OWNER for minimum of 1 man-day, travel time excluded, for assistance during plant construction, plant startup, equipment calibration, and training of OWNER’s personnel for plant operation. Include minimum of:

   a. 1/2 man-day for Installation, Calibration, and Startup Services.

   b. 1/2 man-day for Instructional and Post Startup Services.

2. Supplier or manufacturer shall direct services to system and equipment operation, maintenance, and troubleshooting and system related areas other than process design and philosophy. See Section 01600.

B. Source Quality Control:

1. Flow meter shall be hydraulically calibrated at facility located in United States and calibration traceable to National Bureau of Standards.

2. Wire and test meter, suitable for operation. Conduit and signal wiring for meter installed between converter and terminals at designated panel.

1.04 GUARANTEE

A. Provide replacement parts during guarantee period for defective component at no additional cost.

PART 2 PRODUCTS

2.01 STANDARD PADDLEWHEEL FLOW METER

A. Manufacturers:

1. Digiflow from Chemline.

2. Omega.

3. Or equal.

B. A coil/Hall effect type sensor shall produce dc pulse signal directly proportional and linear to liquid flow rate.

C. Use single conduit run between sensor/transmitter/meter and control panel.

D. Splash-proof and weather-resistant housing. Watertight external and internal electrical conduit connections. Suitable for installation and operation in Class 1, Division 1 hazardous areas.

E. Operate on 5-24vdc supply power. Meter driven in current loop.

F. Flow meter paddle and body material shall be suitable for process but restricted to materials listed under Material of Construction in Schedule 1 of this section.

G. Output signal may be transmitted up to 1000 meters without the need for conditioning.

H. Electronics are entirely encapsulated with epoxy resin.

I. Flow meter to be mounted in pipe section where pipe is always full of liquid.

2.02 STANDARD MAGNETIC FLOW METER

A. Manufacturers:

1. Foxboro.

2. Rosemount.

3. Or equal.

B. Low frequency, electromagnetic induction type and shall produce dc pulse signal directly proportional and linear to liquid flow rate.

C. Use single conduit run between sensor/transmitter/meter and control panel.

D. Splash-proof and weather-resistant housing. Watertight external and internal electrical conduit connections. Suitable for installation and operation in Class 1, Division 1 hazardous areas.

E. Operate on 5-24vdc supply power. Meter driven in current loop.

F. Flow meter liner, electrode materials, and electrode type shall be suitable for process but restricted to materials listed under Material of Construction in Schedule 1 of this section.

G. Provide meter with capability for portable electrode cleaning. Portable cleaner to have easily accessible connections from liquid meter body.

H. Use grounding rings or gaskets on each end of magnetic flow meter to provide good ground path and prevent interference with flow signal. Probes not acceptable.

I. Sensing head interchangeable with meter body of same manufacturer without performing flow recalibration.

J. Ratio of flow velocity to reference voltage signals generated identical for all meter sized. Meter shall be compatible with secondary readout instrument without circuit modifications.

K. Changes in density, viscosity, temperature, pressure or conductivity within limits of flow meter shall not affect accuracy. Maintain accuracy for field repairs performed by supplier's service technician during warranty period.

L. Magnetic flow meter shall be high impedance device of not less than 10^{12} ohms to minimize span shift due to electrode coating.

M. Limit power consumption to 5 watts/in. of pipe diameter.

N. Where continuous submergence specified, remote mount driver near magnetic flow meter to have driven shielding on leads from electrode to converter.

O. Output signal may be transmitted up to 1,000 meters without need for conditioning.

P. Electronics are entirely encapsulated with epoxy resin.

Q. Flow meter to be mounted in pipe section where pipe is always full of liquid.

2.03 SIGNAL CONVERTER (Paddlewheel Flow Meter)

A. Local mounted, microprocessor controlled.

1. Operate on 5-24 vdc power.

2. Flow sensor signal is a square wave output frequency generated proportional to the rate of rotor rotation and flow velocity.

3. Convert flow signal from flow sensor to analog output 4-20 mAdc signal.

4. Convert flow signal from flow meter to analog output signals.

B. Span to be continuously adjustable between 0.5 and 33 ft./sec over 10:1 range. Adjustment shall be by keypad on local flow meter. Calibration is easily performed in the field. Accurate low flow measurement down to 0.5ft/sec.

C. Digital LCD 6 digit display can be set to read flow rate or total flow in any volumetric unit.

D. Power: 5-24 vdc.

E. System accuracy to be 1.0% of flow rate over calibrated range. Repeatability shall be 0.5% and linearity 1.0% over calibrated range.

F. 4-20 mAdc analog current output into 250 ohm load.

G. Housed in enclosure to meet NEMA 4X requirements.

2.04 SIGNAL CONVERTER (Magnetic Flow Meter)

A. Remote mounted, microprocessor controlled.

1. Operate on 120 vac, 60 Hz power.

2. Provide pulsed dc voltage to magnet coils of magnetic flow meter to establish magnetic field.

3. Voltage Frequency: 7.5 or 15 Hz field selectable.

4. Convert flow signal from magnetic flow meter to analog and digital output signals, for bi-directional flow.

B. Span to be continuously adjustable between 3 and 31 ft/sec over 10:1 range. Adjustment shall be by direct reading range switches. Zero adjustment not necessary; zero stability characteristic of meter system.

C. Standard back lighted display for easy reading of flow data. Display shall have 2 rows of 16 alpha numeric characters. Top row shall indicate instantaneous flow rate in direct engineering units, field selectable. Bottom row shall indicate totalizer count in direct engineering units, field selectable.

D. Converter interchangeable with magnetic flow meter of same manufacturer and requires no additional flow calibration adjustment.

E. Power: 120 vac, 60 Hz.

F. System accuracy, including magnetic flow meter, to be 0.25% of flow rate between 10% and 100% flow. Repeatability shall be 0.25% and linearity 0.2%.

G. 4-20 mAdc analog current output into 0 to 900 ohm load and 24 vdc scaled, pulse output that is software adjustable.

H. Locate flow rate indicator within each converter.

I. House in cast aluminum enclosure to meet NEMA 4 requirements.

J. Provide integral zero return which shall provide constant zero output when activated by external non-powered contact.

K. Noise reduction feature to minimize effects of noise generating processes.

2.05 TAGGING

A. Provide Type 316 stainless steel tag permanently affixed to unit.

B. Engrave with process application as listed in Specifications.

C. Include ENGINEER's tag number as listed in Specifications and on P&IDs.

2.06 SPECIAL TOOLS AND EQUIPMENT

A. Provide:

1. One spare converter for every 10 paddlewheel (or magnetic) flow meter converters.

2. One spare digital LCD meter for every 10 paddlewheel (or magnetic) flow meter units.

3. For magnetic flow meters: portable electrode cleaning generators with handle and 50 feet of cable with plug-in connectors. To a ratio of one ultrasonic generator for every five meters.

4. For magnetic flow meters: three sets of circuit boards for sensing head and signal converter.

5. For magnetic flow meters: Two sets of special tools and test equipment, including calibrator required for repair and re-calibration of equipment.

B. Provide flow sensor saddle and spool piece for paddle wheel flow meters, same size and diameter as pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s written instructions and approved submittals.

SCHEDULE 1 TO SECTION 13624
PADDLEWHEEL FLOW METER SCHEDULE

Tag No.	Location	Media	Flow Minimum (gpm)	Flow Maximum (gpm)	Design (gpm)	Size (in.)	Description
P-XXS	Cell XX Secondary Pump	Leachate	5	60	20	2”	2.5.8.10

XX = cell number

Type
1. standard
2. 2 wire sensor
3. 3 wire sensor

Body Material
4. PVC
5. 316 SS
6. PVDF
7. PP

Pipe Sizes
8. ½1/2”- 8” Standard Length Sensor
9. 10”- 40” Extended Length Sensor

Seal Material
10. Viton
11. EPDM

SCHEDULE 2 TO SECTION 13624
MAGNETIC FLOW METER SCHEDULE

Tag No.	Location	Media	Flow Minimum (gpm)	Flow Maximum (gpm)	Design (gpm)	Size (in.)	Description
P-XXS	Cell XX Secondary Pump	Leachate	5	60	20	2”	2.3.8.10.12

XX = cell number

Electrode Type
1. Plain (flush)
2. Bullet Nose

Liner Material
3. Teflon
4. Polyurethane
5. Neoprene

Electrode Material
6. Zirconium
7. Tantalum
8. Hastelloy “C”
9. 316 Stainless Steel

Flange Material
10. Carbon Steel
11. 304 Stainless Steel

Flange Rating
12. ANSI 150
13. ANSI 300

* * END OF SECTION * *

SECTION 15060
PIPE, TUBE, FITTINGS, AND MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping Materials:

a. Steel Pipe.

b. Plastic Pipe.

2. Pipe/Tube Fittings:

a. Fittings for steel pipe.

b. Fittings for plastic pipe

3. Miscellaneous piping materials/products.

4. Underground type plastic line markers.

B. Pipe, tube, fittings, and mechanical identification furnished as part of factory fabricated equipment, are specified as part of equipment assembly in other sections.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI/ASME A13.1 - Scheme for the Identification of Piping Systems.

2. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

3. ANSI/ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.

4. ANSI/ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.

5. ANSI/ASME B16.4 - Gray Iron Threaded Fittings Classes 125 and 250

6. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 25 - Metric/Inch Standard.

7. ANSI/ASME B16.9 - Factory-Made Wrought Steel Buttwelding Fittings.

8. ANSI/ASME B16.11 - Forged Fittings, Socket Welding and Threaded.

9. ANSI/ASME B16.12 - Cast Iron Threaded Drainage Fittings.

10. ANSI/ASME B16.14 - Ferrous Pipe Plugs, Bushings, and Lock Nuts with Pipe Threads.

11. ANSI/ASME B16.28 - Wrought Steel Buttwelding Short Radius Elbows and Returns.

12. ANSI/ASME B16.39 - Pipe Unions, Malleable Iron Threaded.

13. ANSI/ASME B31.1 - Power Piping.

B. American Society of Mechanical Engineers (ASME):

1. ASME Boiler and Pressure Vessel Code, Section II, Part C: Specifications for Welding Rods, Electrodes, and Filler Metals.

2. ASME Boiler and Pressure Vessel Code, Section IX. Welding and Brazing Qualifications.

C. American Society for Testing and Materials (ASTM):

1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.

2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless.

3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

4. ASTM A135/A135M - Standard Specification for Electric-Resistance-Welded Steel Pipe.

5. ASTM A183 - Standard Specification for Carbon Steel Track Bolts and Nuts.

6. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.

7. ASTM A312/A312M - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.

8. ASTM A333/A333M - Standard Specification for Seamless and Welded Steel Pipe

for Low-Temperature Service.

9. ASTM A518/A518M - Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.

10. ASTM A536 - Standard Specification for Ductile Iron Castings.

11. ASTM A671 - Standard Specification for Electric-Fusion-Welded Steel Pipe for Atmospheric and Lower Temperatures.

12. ASTM A672 - Standard Specification for Electric-Fusion-Welded Steel Pipe for High-Pressure Service at Moderate Temperatures.

13. ASTM A691 - Standard Specification for Carbon and Alloy Steel Pipe, Electric-Fusion-Welded for High-Pressure Service at High Temperatures.

14. ASTM D1785 - Standard Specifications for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.

15. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications.

16. ASTM D2104 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedule 40.

17. ASTM D2464 - Standard Specification for Threaded Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.

18. ASTM D2466 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.

19. ASTM D2467 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.

20. ASTM D2564 - Standard Specification for Solvent Cements for Polyvinyl Chloride (PVC) Plastic Piping Systems.

21. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe.

22. ASTM D2665 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe Fittings.

23. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Pipe and Tubing.

D. American Water Works Association (AWWA):

1. ANSI/AWWA C110 - Ductile-Iron and Gray-Iron Fittings, 3-in.Through 48-in., for Water and Other Liquids.

2. ANSI/AWWA C111/A21.11 – Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

3. ANSI/AWWA C200 - Steel Water Pipe 6 inch (150MM) and Larger.

4. ANSI/AWWA C203 – Standard for Coal-Tar Protective Coatings and Linings for Steel Water Pipe Lines -- Enamel and Tape -- Hot Applied.

5. ANSI/AWWA C206 - Standard for Field Welding of Steel Water Pipe.

6. AMSI/AWWA C207 - Standard for Steel Pipe Flanges for Water Works Services -- Sizes 4-in. Through 144-in.

7. ANSI/AWWA C606 – Standard for Grooved and Shouldered Joints.

E. Manufacturing Standardization Society of Valves and Fittings (MSS):

1. MSS SP-43 - Wrought Stainless Steel Buttwelding Fittings. Included Reference to Other Corrosion-Resistant Materials.

2. MSS SP-51 - Class 150LW Corrosion-Resistant Cast Flanges and Flanged Fittings.

3. MSS SP-79 - Socket Welding Reducer Inserts.

1.03 SUBMITTALS

A. Product Data: Submit catalog cuts, specifications, installation instructions, and dimensioned drawings for each type of pipe, tube, fitting, and mechanical identification. Submit piping schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

B. Welding Certifications: Submit reports as required for piping work.

C. Submit in accordance with Section 01340.

1.04 QUALITY ASSURANCE

A. Manufacturers: Firms regularly engaged in manufacture of pipe, tube, fittings, and mechanical identification of types and sized required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Welding: Quality welding procedures, welders, and operators in accordance with ANSI/ASME B31.1, Paragraph 127.5, for shop and Project site welding of piping work.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied basic end caps on each length of pipe. Maintain end caps through shipping, storage, and handling as required to prevent pipe end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

PART 2PRODUCTS

2.01 PIPING MATERIALS

A. General: Provide pipe of type, joint type, grade, size, and weight (wall thickness or class) indicated for each service.

B. Steel Pipe:

1. Black Steel Pipe: ASTM A53/A53M.

2. Seamless Steel Pipe: ASTM A53/A53M.

3. Electric Resistance-Welded Steel Pipe: ASTM A135/A135M.

4. Electric Fusion-Welded Steel Pipe: ASTM A671.

5. Alloy Steel Pipe: ASTM A333/A333M.

a. Grade: Provide Grade 9, except as otherwise noted.

6. Steel Water Pipe: ANSI/AWWA C200 for pipe 6 in. and larger.

7. Coal Tar Protective Coatings and Linings for Steel Water Pipe: ANSI/AWWA C203 for enamel and tape, hot applied.

8. Steel pipe shall be as follows.

a. 3-in. and smaller: Schedule 80.

b. 4-in. through 10-in.: Schedule 40.

c. 12-in. and greater: “Standard” class pipe.

C. Plastic Pipe:

1. Polyvinyl Chloride (PVC) Pipe: ASTM D1785.

2. Polyethylene (PE) Plastic Pipe: ASTM D2104.

3. Polyvinyl Chloride (PVC) Plastic Drain, Waste, and Vent Pipe: ASTM D2665.

4. PVC Pipe and Fittings: Schedule 80.

5. High Density Polyethylene (HDPE) Pipe; Section 15064.

2.02 PIPE FITTINGS

A. General: Provide factory-fabricated fittings of type, materials, grade, class, and pressure rating indicated for each service and pipe size. Provide sizes and types matching pipe, tube, and valve or equipment connection in each case. Where not otherwise indicated, comply with governing regulations and industry standards for selections and pipe manufacturer’s recommendations where applicable.

B. Fittings for Steel Pipe:

1. Cast Iron Flanged Fittings: ANSI/ASME B16.1, including bolting.

2. Cast Iron Threaded Fittings: ANSI/ASME B16.4.

3. Malleable Iron Threaded Fittings: ANSI/ASME B16.3, plain or galvanized as indicated.

4. Malleable Iron Threaded Unions: ANSI/ASME B16.39, selected by installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

5. Threaded Pipe Plugs: ANSI/ASME B16.14.

6. Steel Flanges/Fittings: ANSI/ASME B16.5, including bolting and gasketing of following material group, end connection, and facing except as otherwise

indicated.

a. Material group: Group 1.1

b. End connections: Buttwelding.

c. Facings: Raised face.

7. Corrosion-Resistant Cast Flanges/Fittings: MSS SP-51, including bolting and gasketing.

8. Forged Steel Socket Welding and Threaded Fittings: ANSI/ASME B16.11, except MSS SP-79 for threaded reducer inserts rated to match schedule of connected pipe.

9. Wrought Steel Buttwelding Fittings: ANSI/ASME B16.9, except ANSI/ASME B16.28 for short radius elbows and returns, rated to match connected pipe.

10. Stainless Steel Buttwelding Fittings: MSS SP-43 (R01).

11. Forged Branch Connection Fittings: Except as otherwise indicated, provide type as determined by installer to comply with installation requirements.

12. Pipe Nipples: Fabricated from same pipe as used for connected pipe, except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2 in., where pipe size is less than 1-1/2 in., and do not thread nipples full length (no close nipples).

13. Provide 1 uninstalled “Spectacle” flange for each size steel pipe.

14. Flanged connections are required at tanks, pumps, valves, and equipment, unless specifically noted otherwise.

C. Fittings for Plastic Pipe:

1. PVC Pipe Fittings: ASTM D2464for Schedule 80 threaded fittings; ASTM D2467for Schedule 80 socket type; ASTM D2564e1; and ASMT D2665for drain, waste, and vent.

2. PE Pipe Fittings: ASTM D2609for insert fittings, ASTM D3261for Schedules 40 and 80.

3. HDPE Pipe Fittings: Section 15064.

2.03 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welded Materials: Except as otherwise indicated, provide welding materials as determined by installer to comply with installation requirements.

1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Gaskets for Flanged Joints: Full faced for cast iron flanges, raised face for steel flanges unless otherwise indicated.

C. Piping Connectors for Dissimilar Non-pressure Pipe: Elastomeric annular ring insert or elastomeric flexible coupling secured at each end with stainless steel clamps, sized for exact fit to pipe ends, and subject to approval by plumbing code.

2.04 VIBRATION ISOLATION

A. Provide vibration isolation between tanks, pumps, and piping.

1. Type MFTFU or METNC with control cables, as manufactured by Mason Industries, Inc., or equal.

2. Size equal to pipe size.

2.05 UNDERGROUND TYPE PLASTIC LINE MARKERS

A. General: Manufacturer's standard permanent, bright colored, continuous printed plastic tape, intended for direct burial service; not less than 6 in. wide by 4 mils thick. Provide tape with printing most accurately indicating type of service of buried pipe.

B. Provide multi-ply tape consisting of solid aluminum foil core between 2 layers of plastic tape.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install pipe, tube, and fittings in accordance with recognized industry practices achieving permanently leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16 in. misalignment tolerance.

1. Comply with ANSI/ASME B31.1- Code for Pressure Piping.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details, and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and equipment. Hold piping close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building; limit clearance to ½ in. where furring is shown for enclosure to concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1.0 in. clearance outside insulation.

C. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.

D. Piping System Joints: Provide joints of type indicated in each piping system.

1. Thread pipe in accordance with ANSI/ASME B1.20.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint, and tighten joint to leave not more than 3 threads exposed.

2. Weld pipe joints in accordance with ANSI/ASME B31.1.

3. Weld pipe joints of steel water pipe in accordance with ANSI/AWWA C206.

4. Flanged Joints: Match flanges within piping system and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

E. Pipe greater than 3-in. diameter shall be connected by flange to pumps, tanks, meters, valves, cleanouts, air relief, and equipment.

1. At other locations, pipe greater than 3-in. diameter shall be welded.

2. Threaded connections may be used on pipe 3-in. diameter and smaller.

3.02 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superflous materials and prepare for application of specified coatings (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ANSI/ASME B31.1.

3.03 PIPE TESTS

A. Test pressure piping in accordance with ANSI/ASME B31.1.

B. Repair piping systems sections which fail required piping test, by disassembly and reinstallation, using new materials to extent required to overcome leakage. So not use chemicals, stop-leak compounds, mastics or other temporary repair methods.

C. Drain test water form piping systems after testing and repair work is complete.

3.04 IDENTIFICATION

A. Pipe shall be color coded and marked in accordance with ANSI/ASME A13.1"Scheme for Identification of Piping Systems", and as approved by OWNER.

1. For insulated and jacketed pipe, insulation or jacket shall be color coded and marked.

3.05 UNDERGROUND PIPING IDENTIFICATION

A. During backfilling/topsoiling of each exterior underground piping systems, install continuous underground type plastic line marker located directly over buried line at 6 to 8 inches below finished grade.

1. Plastic line marker tape as manufactured by Polycon or equal.

* * END OF SECTION * *

SECTION 15064
HIGH DENSITY POLYETHYLENE PIPE

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

2. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

3. ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.

4. ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wires and Cables.

5. ASTM D1505 or ASTM D792 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

6. ASTM D1693 - Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.

7. ASTM D2122 - Standard Method of Determining Dimensions of Thermoplastic Pipe and Fittings.

8. ASTM D2412 - Standard Test Method for Determining External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

9. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

10. ASTM D3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Materials.

11. ASTM D3261 - Standard Specification for Butt Heat Fusion of Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.

12. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

1.02 SUBMITTALS

A. Include results of Manufacturer's tests with shipment of materials, with 2 additional copies of such test results furnished to OWNER. Cost for additional required testing not performed by the Manufacturer shall be borne by CONTRACTOR.

B. If Manufacturer's test data inadequate or unavailable, OWNER reserves right to require cores drilled for compressive strength tests. Costs of these tests shall be borne by CONTRACTOR.

C. Submit manufacturing data listing stock density, melt flow, flextural modulus, tensile strength, and coloration.

D. Submit in accordance with Section 01340.

1.03. QUALITY ASSURANCE

A. Source Quality Control:

1. Conduct tests by OWNER approved testing agency to determine the following:

   a. Pipe dimensions:

      1) Average outside diameter.

      2) Average inside diameter.

      3) Minimum and average wall thickness.

   b. Pipe flattening:

      1) Deflect pipe to 40% deflection.

      2) Remove load and examine specimen for evaluation of splitting, cracking or breaking.

2. Test reports shall show results of tests and conformance to ASTM requirements.

3. CQA engineer must confirm that all manufacturer's piping certifications have provided testing to confirm that the required design parameters are met.

4. CQA engineer will randomly verify the pipe characteristics by measurement of the piping wall thickness and perforation hole diameter and spacing.

PART 2 PRODUCTS

2.01 PHYSICAL PROPERTIES OF PIPE COMPOUND

A. Density: ASTM D1505 or ASTM D792, not less than 0.941 to 0.955 gm/cu cm.

B. Melt Flow: ASTM D1238, Condition E, not greater than 0.4 gms/10 min.

C. Flexural Modules: ASTM D790, 110,000 to less than 160,000 psi.

D. Tensile Strength at Yield: ASTM D638, 3,000 to less than 3,500 psi.

E. Environmental Stress Crack Resistance (ESCR): ASTM D1693 - Condition C, shall be in excess of 1,000 hrs (5,000 hrs) with zero failures.

F. Hydrostatic Design Basis: ASTM D2837, 1,600 psi at 23^0C.

2.02 PIPE

A. Manufacturers:

1. Chevron Phillips Chemical Company, LP, Performance Pipe.

2. Or equal.

B. High performance, high molecular weight, high density polyethylene pipe.

C. ASTM D1248 (Type III, Class C, Category 5, P34).

D. ASTM D3350, minimum cell classification value PE 345464C.

E. Marking: Intervals of 5 ft. or less.

1. Manufacturer’s name or trademark.

2. Nominal pipe size.

3. HDPE cell classification, ASTM D3350.

4. Legend: 1000 Industrial pipe SDR 11.

5. ASTM D1248.

6. Extrusion date, period of manufacture or lot number.

F. Dimensions:

HDPE PIPE DIMENSIONS (inches)
SDR 7.3

Nominal Size	Nominal OD	Approx. ID	Minimum Wall	Nominal Weight lbs/ft
2-in.	2.375	1.686	0.325	0.92
3-in.	3.500	2.485	0.479	1.99
4-in.	4.500	3.194	0.616	3.29
6-in.	6.625	4.700	0.908	7.12
8-in.	8.625	6.119	1.182	12.07
10-in.	10.750	7.627	1.473	18.75
12-in.	12.750	9.046	1.747	26.38
24-in.	24.000	17.029	3.288	93.48

HDPE PIPE DIMENSIONS (inches)
SDR 11

Nominal Size	Nominal OD	Approx. ID	Minimum Wall	Nominal Weight lbs/ft
2-in.	2.375	1.943	0.216	0.64
3-in.	3.500	2.864	.318	1.39
4-in.	4.500	3.682	0.409	2.29
6-in.	6.625	5.421	0.602	4.97
8-in.	8.625	6.963	0.784	8.42
10-in.	10.750	8.796	0.977	13.09
12-in.	12.750	10.432	1.159	18.41
24-in.	24.000	19.636	2.182	65.24
26-in.	26.000	20.989	2.364	76.56
28-in.	28.000	22.604	2.545	88.80
30-in.	30.000	24.218	2.727	101.93
32-in.	32.000	25.833	2.909	116.67
34-in.	34.000	27.447	3.091	130.93

HDPE PIPE DIMENSIONS (inches)
SDR 26

Nominal Size	Nominal OD	Approx. ID	Minimum Wall	Nominal Weight lbs/ft
2-in.	2.375	---	---	---
3-in.	3.500	---	---	---
4-in.	4.500	4.133	0.173	1.03
6-in.	6.625	6.085	0.255	2.23
8-in.	8.625	7.921	0.332	3.80
10-in.	10.750	9.873	0.413	5.88
12-in.	12.750	11.710	0.490	8.27
24-in.	24.000	22.043	0.923	29.30
26-in.	26.000	23.880	1.000	34.39
28-in.	28.000	25.717	1.077	39.88
30-in.	30.000	27.554	1.154	45.78
32-in.	32.000	29.391	1.231	52.09
34-in.	34.000	31.228	1.308	58.81

2.03 FITTINGS

A. Molded from polyethylene compound having cell classification equal to or exceeding compound used in pipe to ensure compatibility of polyethylene resins.

B. Be or same manufacture as pipe being provided.

C. Flange Joints:

1. 150-lb stainless steel manufacturer-installed backup flanges as recommended by manufacturer.

2. Stainless steel bolts.

3. Flanges and bolt patterns as specified by manufacturer.

4. Surface weld joints to seal edges.

5. Seal riser joints within 80 mil HDPE boot welded and clamped to riser.

6. Stainless steel boot clamps.

D. Markings:

1. Manufacturer’s name of trademark.

2. Nominal size.

3. Material designation "HDPE".

4. ASTM D1248.

2.04 LINER PENETRATION BOOTS

A. Minimum in accordance with dimensions indicated on Drawings.

B. Construction from 80 mil HDPE flexible membrane, with manufacturer's recommendations. Clamp each boot to riser with stainless steel boot clamps, which will remain in-place after boot is welded to riser. Exposed edges of boot shall be filet welded to prevent moisture from penetrating between HDPE surfaces.

2.05 HIGH DENSITY POLYETHYLENE (HDPE) FLATSTOCK

A. Manufacturers:

1. Chevron Phillips Chemical Company, LP.

2. Or equal.

B. High performance, high molecular weight, sheet stock.

C. Provide to sizes and thickness indicated on the Drawings.

D. Conform to resin quality of pipe stock and liner stock.

E. Round cut edges to minimize potential for liner damage during installation.

2.06 DRAINAGE PIPE

A. Manufacturers

1. Advanced Drainage Systems, Inc.

2. Or equal.

B. Drainage pipe shall be corrugated smooth-bore HDPE, pipe compound and physical properties shall conform to Advanced Drainage Systems ADS N-12 Pipe, or equal.

C. Provide silt-tight pipe couplers.

D. Provide to sizes and type (solid wall or perforated wall) indicated on the Drawings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Trench, backfill, and compact in accordance with Section 02210.

B. Welded Joints:

1. Weld in accordance with manufacturer's recommendation for butt fusion methods.

2. Butt fusion equipment used in joining procedures shall be capable of meeting conditions recommended by pipe manufacturer, including, but not limited to, temperature requirements, alignment, and fusion pressures.

3. Extrusion welding may be allowed as a secondary method for joining containment piping where butt fusion welding is not practical, but only where approved by ENGINEER and OWNER in writing.

C. Mechanical Jointing:

1. Use on riser pipe sections.

2. Butt fuse fabricated flange adapters to pipe.

3. Connect slip-on stainless steel backup flanges with stainless steel bolts.

4. Weld HDPE adapters to provide watertight fit. Fit mechanical jointing on risers with protective HDPE boots clamped and bolted to riser.

5. Clamp boot to riser with boot clamps to remain in-place after boot is welded to riser.

6. Filet weld exposed edges of boot to prevent moisture from penetrating between HDPE surfaces.

3.02 FIELD QUALITY CONTROL

A. Pipe may be rejected for failure to conform to Specifications, or following.

1. Fractures or cracks passing through pipe wall, except single crack not exceeding 2 in. in length at either end of pipe which could be cut off and discarded. Pipes within one shipment will be rejected if defects exist in more than 5% of shipment of delivery.

2. Cracks sufficient to impair strength, durability or service-ability of pipe.

3. Defects indicating improper proportioning, mixing, and molding.

4. Damaged ends, where such damage prevents making satisfactory joint.

B. Acceptance of fittings, stubs or other specially fabricated pipe sections shall be based on visual inspection at job site and documentation they conform to these Specifications.

C. The leachate collection pipes along the centerline of the primary and secondary leachate collection systems shall be placed directly on the geocomposite drainage layer. There shall be no requirement for tolerance regarding achievement of design grade and shimming is not required.

3.03 PRESSURE TESTING

A. Test in accordance with ASTM F2164.

B. Pressure testing is not required for the perforated leachate collection pipe and solid pipe extending from the perforated pipe as a riser pipe.

3.04 VERTICAL LEACHATE RISERS

A. Install first section of vertical HDPE risers. Concrete riser section length shall extend vertically no more than 2 ft below HDPE section. HDPE riser section shall be flanged to allow later extension during normal operations.

* * * END OF SECTION * * *

SECTION 15076
HOSE AND QUICK-CONNECT COUPLING

PART 1 GENERAL

1.01 REFERENCES

A. United States Department of Defense (DoD):

1. A-A-59326B - Coupling Halves, Quick-Disconnect, Cam-Locking Type.

1.02 SUBMITTALS

A. Submit manufacturer’s literature and shop drawings in accordance with Section 01340.

PART 2 PRODUCTS

2.01 QUICK-CONNECT COUPLINGS

A. Manufacturers:

1. “Kamlok” quick couplings by OPW, Division of Dover Corporation.

2. Or equal.

B. Description:

1. Each coupling shall consist of 2 pieces; male part (adaptor), and female part (coupler). Connection of 2 parts shall be made by inserting male into female and then moving 2 cam arms into locked position.

C. Couplings shall conform to A-A-59326B.

D. Pressure Rating: 150 psig (hydrostatic).

E. Materials:

1. Body: Stainless steel.

2. Cam Arms: Stainless steel.

3. Gaskets: Teflon.

F. Couplers and adapters shall be mounted on hoses using hose shank or pipe nipple, and stainless steel, spiral, double bolt clamps.

G. Adaptors shall be mounted on fixed pipes using female NPT fitting.

2.02 HOSE

A. Manufacturers:

1. Green XLPE Chemical Transfer Hose, by Goodyear Tire and Rubber Company, Industrial Products Division.

2. Or equal.

B. Description:

1. Nominal Size: 2 in. through 6 in.

2. Smooth inner bore.

3. Flexible to min. 15^{o}F.

4. Abrasion resistant.

5. Crush resistant.

6. Pressure Rating: 150 psi.

7. Provide continuous, uncut lengths.

a. Couple only where shown on Drawings, or as specified by ENGINEER.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer’s written instructions and approved submittals.

* * * END OF SECTION * * *

SECTION 15078
POLYVINYL CHOLORIDE (PVC) PIPE

PART 1 GENERAL

1.01 REFERENCES

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

1. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

2. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

3. ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.

4. ASTM D1785 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe, Schedules 40, 80, and 120.

5. ASTM D2122 - Standard Test Method for Determining Dimensions of Thermoplastic Pipe and Fittings.

6. ASTM D2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel Plate Loading.

7. ASTM D2467 - Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.

8. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

1.02 SUBMITTALS

A. Include results of Manufacturer’s tests with shipment of materials, with 2 additional copies of such test results furnished of OWNER. Cost for additional required testing not performed by the Manufacturer shall be borne by CONTRACTOR.

B. If manufacturer’s test data inadequate or unavailable, OWNER reserves right to require cores drilled for compressive strength tests. Costs of these tests shall be borne by CONTRACTOR.

C. Submit manufacturing data listing stock density, flexural modules, and tensile strength.

D. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Source Quality Control:

1. Conduct tests by OWNER approved testing agency to determine by following.

a. Pipe dimensions:

1) Average outside diameter.

2) Average inside diameter.

3) Minimum and average wall thickness.

2. Test reports shall show results of the tests and conformance to ASTM requirements.

3. CQA engineer must confirm that all manufacturer's piping certifications have provided testing to confirm that the required design parameters are met.

4. CQA engineer will randomly verify the pipe characteristics by measurement of the piping wall thickness and perforation hole diameter and spacing.

PART 2 PRODUCTS

2.01 PHYSICAL PROPERTIES OF PIPE COMPOUND

A. The PVC pipe and fittings shall be manufactured from Type 1, Grade 1, PVC conforming to ASTM D1785.

B. All PVC pipe to be Schedule 80.

2.02 PVC PIPES AND FITTINGS

A. PVC pipe shall be supplied in standard laying lengths not exceeding 40 feet.

B. PVC pipe shall be furnished perforated as specified on the Drawings. If pipes are manufactured unperforated and are to be installed perforated, then perforations shall be drilled into the pipe prior to delivery to the site.

C. PVC pipes and fittings shall be homogeneous throughout, free of visible cracks, holes (other than international manufactured perforation), foreign inclusions, or other deleterious effects, and shall be uniform in color, density, melt index and other physical properties.

D. Fittings at the end of pipes shall consist of PVC end caps unless indicated otherwise on the Drawings.

E. The following shall be continuously indent printed on the pipe, or spaced at intervals not exceeding 5 feet:

1. Name and/or trademark of the pipe manufacturer.

2. Nominal pipe size.

3. Schedule.

4. Manufacturing Standard Reference (e.g. ASTM D1785).

5. A production code from which the date and place of manufacture can be determined.

F. Fittings.

1. Schedule 80 PVC.

2. Provide socket type joints at all locations.

G. Joints.

1. Provide socket type at all locations.

H. Solvent Cement.

1. No joint solvent shall be used for joint socket connections.

PART 3 EXECUTION

3.01 HANDLING AND PLACEMENT

A. Care shall be exercised when transporting, handling and placing PVC pipe and fittings, such that they will not be cut, kinked, twisted, or otherwise damaged.

B. Ropes, fabric or rubber-protected slings and straps shall be used as necessary when handling PVC pipe. Slings, straps, etc. shall not be positioned at joints. Chains, cables or hooks shall not be inserted in the pipe ends as a means of handling pipe.

C. Pipe or fittings shall not be dropped onto rocky or unprepared ground. Under no circumstances shall pipe or fittings be dropped into trenches.

D. PVC pipe shall be stored on clean level ground, free of sharp objects which could damage the pipe. Stacking shall be limited to a height that will not cause excessive deformation of the bottom layers of pipes under anticipated temperature conditions. The pipes should be stored out of direct sunlight.

E. The maximum allowable depth of cuts, gouges or scratches on the exterior surface of PVC pipe or fittings is 10 percent of the wall thickness. The interior of the pipe and fittings shall be free of cuts, gouges and scratches. Sections of pipe with excessive cuts, gouges or scratches shall be removed and the ends of the pipe joined at no cost to the OWNER.

F. Whenever pipe laying is not actively in progress, the open end of pipe that has been placed shall be closed using a watertight plug.

3.02 INSTALLATION

A. All PVC pipe and fittings shall be installed in accordance with the manufacturer's instructions.

B. The Contractor shall carefully examine all pipe and fittings for cracks, damage or defects before installation. Defective materials shall be immediately removed from the site and replaced at no cost to the OWNER.

C. The interior of all pipe and fittings shall be inspected, and any foreign materials shall be completely removed from the pipe interior before it is moved into final position.

D. Field-cutting of pipes, where required, shall be made with machine specifically designed for cutting pipe. Cuts shall be carefully made, without damage to pipe or lining, so as to leave a smooth end at right angles to the axis of pipe. Cut ends shall be tapered and sharp edges filed off smooth. Flame cutting will not be allowed.

E. The leachate collection pipes along the centerline of the primary and secondary leachate collection systems shall be placed directly on the geocomposite drainage layer. There shall be no requirement for tolerance regarding achievement of design grade and shimming is not required.

3.03 PRESSURE TESTING

A. Pressure testing is not required for the perforated leachate collection pipe and solid pipe extending from the perforated pipe as a riser pipe.

* * * * END OF SECTION * * * *

SECTION 15090
PIPE HANGERS, SUPPORTS, AND ANCHORS

PART 1 GENERAL

1.01 SUMMARY

A. Description of Work:

1. Furnish complete system of pipe supports and anchors with necessary inserts, bolts, nuts, restraining and hanger rods, washers, miscellaneous steel, and other accessories.

2. Absence of pipe supports and details on the Drawings shall not relieve CONTRACTOR of responsibility for providing them.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI/ASME B31.1 - Power Piping.

B. American Society for Testing and Materials (ASTM):

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

2. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

C. Manufacturer's Standardization Society (MSS):

1. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, and Manufacture.

2. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

D. National Fire Protection Agency (NFPA):

1. NFPA No. 13 - Installation of Sprinkler Systems.

1.03 SUBMITTALS

A. Shop Drawings:

1. Pipe supporting system, including manufacturer's product data, dimensions, sizes, types, location, maximum loadings, thrust anchorage, and installation instructions.

B. Submit in accordance with Section 01340.

1.04 QUALITY ASSURANCE

A. Source Quality Control:

1. Firms regularly engaged in manufacture of pipe supports, hangers, anchors, and related products.

2. Provide factory fabricated piping hangers and supports, clamps, hanger rod attachments, building attachments, saddles, shields, thrust anchorage, and other miscellaneous products of MSS SP-69 type indicated or shop-fabricated supports; comply with MSS SP-58 and manufacturer's published product information.

B. Design Criteria:

1. Pipe support system components shall withstand dead loads imposed by weight of pipes filled with water plus insulation, internal test pressures, and have minimum safety factor of 5.

1.05 PROJECT/SITE CONDITIONS

A. Support piping, in general, as described hereinafter. MSS types indicated are typical of types and quality of standard pipe supports and hangers to be employed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fee and Mason.

B. Grinnell.

C. Carpenter-Patterson.

D. Unistrut.

E. Superstrut.

F. Or equal.

2.02 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. Hangers:

1. Unless otherwise shown or specified, hangers for 3-in. and smaller pipe shall be stainless steel U-bolts. Hangers for 3-in. pipe or greater shall be clevis or roller type.

2. Each hanger shall be designed to permit minimum 1-1 ½ in. adjustment after installation.

B. Single Roll Support:

1. MSS Type 41, including axle roller and threaded sockets.

C. Miscellaneous Materials:

1. Steel Plates, Shapes and Bars: ASTM A36/A36Msteel.

PART 3 EXECUTION

3.01 GENERAL

A. Proceed with installation of hangers, supports, and anchors after required manholes complete.

B. Install hangers, supports, clamps, and attachments from manhold structure; comply with MSS SP-69. Group parallel runs of horizontal piping to be supported together on trapeze type hangers where possible.

C. Install supports to provide indicated pipe slopes and maximum pipe deflections allowed by ANSI/ASME B31.1 are not exceeded.

D. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

E. Install supports to allow controlled movement of piping systems, permit freedom of movement between pipe anchors, and facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

F. Piping shall be free to move when pipe expands or contracts, except where fixed anchors are indicated. Where adequate hanger rod swing length cannot be provided or where pipe movement based on expansion of 1 in./100 ft. for each 100ºF change in temperature exceed ½ in., provide approved roller supports.

G. Prevent contact between dissimilar metals. Where concrete or metal pipe support used, place 1/8 in. thick teflon, asbestos, neoprene rubber or plastic strip under piping at point of bearing. Cut to fit entire area of contact between pipe and support.

H. Apply anti-seize compound to nuts and bolts.

I. Do not use pipe supports inside steel tank in leachate pump station. This is to preserve integrity of epoxy coating.

J. Support piping in junction manholes and leachate transfer manholes.

3.02 THRUST ANCHORS AND GUIDES

A. Thrust Anchors:

1. For suspended piping, center thrust anchors as closely as possible between expansion joints and between elbows and expansion joints. Anchors shall hold pipe securely and be sufficiently rigid to force expansion and contraction movement to take place at expansion joints or elbows and preclude separation of joints.

2. Provide thrust anchors as required to resist thrust due to changes in diameter or direction of dead ending of pipe lines. Anchorage shall be required wherever bending stresses exceed allowable for pipe.

B. Pipe guides shall be provided adjacent to sliding expansion joints in accordance with recommendations of National Association of Expansion Joint Manufacturers.

3.03 PIPE SUPPORT

A. Spacing:

Type of Pipe	Range of Diameters (in)	Maximum Pipe Support Spacing (ft)
HDPE	1 to < 4 4 to 8	2.5 5, and as noted below
Steel	1 to < 2 2 to < 4 4 to < 6 6 to 12	5 10 15 20

1. Support HDPE pipe on both sides of reducing tee in leachate transfer vaults.

2. In junction manholes, provide 3 pipe supports.

B. Where piping of various sizes is to be supported together, space supports for smallest pipe size or install intermediate supports for smaller diameter pipe.

C. Provide minimum of 2 pipe supports for each pipe run.

D. Where piping connects to equipment, support by pipe support and not equipment, unless otherwise approved by manufacturer.

E. Unless otherwise shown or authorized by ENGINEER, place piping running parallel to walls approximately 1 – 1½ inches out from face of wall and at least 3 inches below ceiling.

F. Pedestal pipe supports shall be adjustable with stanchion, saddle, and anchoring flange.

G. Piping supports for vertical piping passing through floor sleeves shall be galvanized steel riser clamps.

H. Support piping in a manner preventing undue strain on valve, fitting or equipment.

3.04 BURIED PIPING

A. Provide reaction blocking, anchorages or other fittings installed in fills or other unstable ground or above grade as shown on the Drawings.

* * * END OF SECTION * * *

SECTION 15092
MODULAR MECHANICAL SEAL SYSTEMS

PART 1 GENERAL

1.01 SUBMITTALS

A. Manufacturer’s literature and fabrication drawings.

B. Submit in accordance with Section 01340.

PART 2 PRODUCTS

2.01 MODULAR MECHANICAL JOINT SEAL

A. Manufacturers:

1. "Link Seal" as manufactured by Thunderline Corporation, Wayne, Michigan.

2. Or equal.

B. Form continuous interlocking synthetic rubber links shaped to continuously fill annular space between pipe and wall opening or wall sleeve. Provide pressure plate under each bolt head and nut.

C. Compression of unit shall cause rubber sealing elements to expand and provide watertight seal.

D. Size according to manufacturer’s instructions.

E. Withstand hydrostatic head of 40 ft of water.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide for penetration of vaults, manhole walls, bases, covers, and carrier pipes as shown on Drawings.

B. Verify size, location, and type of penetrations prior to pouring concrete.

C. Install in accordance with manufacturer’s written instructions and approved submittals.

* * * END OF SECTION * * *

SECTION 15100
VALVES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Ball valves.

2. Check valves.

   a. Split disc check valves.

   b. Ball check.

1.02 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI/ASME B1.20.1 - Pipe Threads, General Purpose (Inch).

2. ANSI/ASME B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings.

3. ANSI/ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through 25 - Metric/Inch Standard.

4. ANSI/ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.

5. ANSI/ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.

6. ANSI/ASME B16.34 - Valves Flanged, Threaded, and Welding End.

B. American Society of Mechanical Engineers (ASME):

1. ANSI/ASME B31.1 - Power Piping.

C. Manufacturing Standardization Society of the Valves and Fittings Industry, Inc. (MSS):

1. MSS SP-25– - Standard Marking System for Valves, Fittings, Flanges and Unions.

2. MSS SP-45 - Bypass and Drain Connections Standard.

3. MSS SP-71 - Grey Iron Swing Check Valves, Flanged and Threaded Ends.

4. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including installation instructions for each type of valve. Include pressure drop curve or chart for each type and size of valve. Submit valve schedule showing manufacturer's figure number, size, service rating, and valve features for each required valve.

B. Shop Drawings: Submit manufacturer's assembly type (exploded view) Shop Drawings for each type of valve indicating dimensions, weights, materials, and methods of assembly of components.

C. Submit in accordance with Section 01340.

D. Operation and Maintenance (O&M) Data:

1. Submit maintenance data and spare parts lists for each type of valve, include product data and Shop Drawings.

2. Submit in accordance with Section 01730.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of valves of types and sizes required, whose products have been in satisfactory service(s) for not less than 5 years.

B. Valve Types: Provide valves of same type by same manufacturer to greatest extent possible.

C. Valve and Rating Identification: Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

D. Codes and Standards:

1. MSS Compliance: Mark valves in accordance with MSS SP-25.

2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged or welded end valve bodies, comply with ANSI B16.10.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Ball Valves:

1. Conbraco Apollo.

2. Or equal.

B. Check Valves:

1. Techno Check.

2. APCO.

3. Or equal.

2.02 VALVES

A. General:

1. Factory fabricated valves recommended by manufacturer for use in service indicated.

2. Types and pressure ratings indicated.

3. End connections which properly mate with pipe, stub, and equipment connections.

4. Where more than one type indicated, selection is CONTRACTOR's option.

5. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

B. Operators:

1. Lever handle for ¼ turn valves smaller than 6 in.

2. Mechanical gear operator for valves 6 in and larger.

C. Valve Features: Provide valves with features indicated and, where not otherwise indicated, provide proper valve features as determined by CONTRACTOR for installation requirements.

1. ASME B31.1 for power piping.

2. Flanged: Valve flanges comply with ANSI B16.1 (cast iron), ANSI B16.5 (steel) or ANSI B16.34 (bronze).

2.03 BALL VALVES

A. Stainless Steel Construction: 1,500 psi WOG, 150 psi steam, reinforced TFE packing and trim, stainless steel lever and nut, stainless steel port ball.

B. MSS Compliance: MSS SP-72

2.04 SPLIT DISC CHECK VALVES

A. Incorporate true butterfly design.

B. Seatless construction.

C. Valve disc shall seal against body at angle of 30 to 45 degrees.

D. Nonslam operation.

E. Withstand temperature of -20ºF to 450ºF.

F. Type 316 stainless steel body and internals.

G. Teflon seal.

H. Capable of installation in any position.

I. Maximum pressure drop of 0.5 psi at 100 gpm flow rate.

J. 150-lb class.

K. Threaded or flanged body.

2.05 BALL CHECK VALVES

A. Cast iron body, cover, and baffle.

B. Stainless steel float, center guided for positive sealing.

C. Inlet and Outlet: 2-in. NPT.

D. Maximum diameter: 10 inches.

E. APCO Model 144 or equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Except as otherwise indicated, comply with following requirements.

1. Install valves where required for proper operation of piping and equipment, include valves in branch lines where necessary to isolate sections of piping. Locate valves so accessible and separate support can be provided when necessary.

2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable.

B. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

C. Fluid Control: Except as otherwise indicated, install ball valves to comply with ANSI/ASME B31.1.

3.02 ADJUSTING AND CLEANING

A. Valve Adjustment: After piping systems tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks. Replace valve if leak persists.

B. Valve Identification: Tag valves to include manufacturer’s and supplier’s name and phone number, and operating and basic maintenance instructions. Enclose in plastic sleeve fastened to valve.

C. Cleaning: Clean factory finished surfaces. Repair marred or scratched surface with manufacturer’s touch up paint.

* * * END OF SECTION * * *

SECTION 16100
BASIC MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. National Electrical Manufacturer’s Association (NEMA).

B. Underwriters Laboratories, Inc. (UL):

1. UL 943 - Standard for Safety for Ground-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Shop Drawings:

1. Required for all disconnects, motor starters and overcurrent protective devices. Include the following information:

a. Enclosure dimensions, nameplate nomenclature, electrical ratings, and thermal unit schedule.

b. Product data sheets with printed installation instructions.

c. Wiring diagrams and schematics.

B. Submit in accordance with Section 01340.

C. Operating and Maintenance (O&M) Data: Submit O&M data as specified for disconnects, motor starters and overcurrent protective devices.

1. Manufacturer’s printed instructions for replacing parts, performing cleaning, and operating and maintaining equipment.

2. Repair parts list.

3. Submit in accordance with Section 01730.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Fire Protection Association (NFPA):

a. NFPA No. 70 - National Electric Code (NEC) and New York amendments thereto.

2. Underwriters Laboratories, Inc. (UL).

3. Local codes and ordinances.

PART 2 PRODUCTS

2.01 GENERAL

A. Use of manufacturer’s name and model or catalog number is for the purpose of establishing standard of quality and configuration desired.

2.02 GALVANIZED OR COATED RIGID STEEL CONDUITS

A. Manufacturers:

1. Allied Steel.

2. Republic Steel.

3. Plasti-Bond.

4. Or equal.

B. Manufacturer’s standard lengths.

C. Protected inside and outside by hot-dipped galvanized or electro-galvanized coating or inside by hot-dipped galvanized or electro-galvanized coating and outside by Plasti-Bond coating.

2.03 FLEXIBLE CONDUIT

A. Manufacturers:

1. Triangle PWC, Inc.

2. Flexsteel.

3. Or equal.

B. Galvanized flexible steel.

C. Standard conduit sizes.

D. Minimum Size: ½ in.

2.04 LIQUIDTIGHT FLEXIBLE CONDUIT

A. Manufacturers:

1. O-Z/Gedney Company.

2. Flex-Guard, Inc.

3. Carol Cable Company.

4. Or equal.

B. Galvanized flexible steel.

C. Standard conduit sizes.

D. Minimum Size: ½ in.

E. Heavy wall PVC jacket.

2.05 FITTINGS

A. Manufacturers:

1. Appleton Electric Company.

2. Steel City, Midland-Ross Corporation.

3. Or equal.

B. Steel or malleable iron, PVC coated steel (Plasti-Bond), zinc galvanized or cadmium plated.

C. Do not use set screw or indentor type fittings.

D. Galvanized Steel Connectors and Couplings:

1. Threaded.

2. Insulated throat.

3. Gland compression type.

E. Flexible Conduit Connectors and Couplings:

1. Threaded.

2. Grounding type.

3. Insulated throat.

4. Gland compression type.

F. Liquidtight Flexible Conduit Fittings:

1. Liquidtight.

2. As specified in Paragraph 2.05.E.

G. Expansion Joints:

1. Conduit expansion fittings complete with copper bonding jumper, Crouse-Hinds Type XJ.

2. Conduit expansion/deflection fittings with copper bonding jumper, Crouse-Hinds Type XD.

H. Seals:

1. Wall entrance, Appleton Type FSK or FSC.

I. Drain Fittings:

1. Automatic Drain Breather:

a. Explosion-proof.

1) Safe for Class I, Groups C and D.

b. Capable of passing minimum 25 cc water/min and minimum 0.05 cu ft air/min at atmospheric pressure.

J. Hazardous Areas:

1. Explosion-proof.

2. Horizontal seal fittings, Crouse-Hinds Type EYS.

3. Vertical Seal fittings, Crouse-Hinds Type EYD.

4. Vertical seal fittings shall have drain plug.

2.06 WIRES, CABLES AND CONNECTORS

A. Manufacturers:

1. Wire and Cable:

a. Rome.

b. ITT.

c. Beldon.

d. Dekoron.

e. Or equal.

2. Connectors:

a. Burndy.

b. Thomas and Betts.

c. Or equal.

B. Copper wire only.

C. 600 v insulation (ASTM standard compounds) color code conductors for low voltage (secondary feeders and branch circuits) as required by NEC.

1. Type THWN Stranded: Single conductor No. 10 American Wire Gauge (AWG) and smaller, No. 12 AWG minimum for 120 v, and 240 v general use wiring.

2. Type XHHW Stranded : Single conductor No 8. AWG and larger for 120 v, 240 v, and 480 v general use wiring.

3. Type TW Stranded: Single conductor green equipment ground.

4. Type USE Stranded: Single conductor for under-ground direct burial.

5. Type THWN Stranded: Single conductor No. 12 AWG minimum for 120 v control wiring and No. 14 AWG minimum for graphic indication, nonshielded instrumentation and other control wiring operating at less than 120 v unless otherwise noted on the Drawings.

   a. Provide high density polyethylene jacketed multi-wire cable assemblies in underground conduit or duct.

6. Polyethylene insulated, tinned copper (19 by 27) stranding, No. 16 AWG, two conductors cabled with aluminum polyester electrostatic shielding, stranded tinned copper drain wire, and chrome vinyl outer jacket for interference sensitive instrumentation wiring.

   a. Additional high density neoprene jacket on cables installed below ground and in duct encasements.

D. Joints, Taps, and Splices:

1. Joints, Taps, and Splices in Conductors No. 10 AWG and Smaller: Compression type solderless connectors with plastic cover.

2. Joints, Taps, and Splices in Conductors No. 8 AWG and Larger: Solderless compression type connectors of type that will not loosen under vibration or normal strains.

2.07 BOXES

A. Manufacturers:

1. Interior Outlet Boxes:

   a. Appleton Electric Company.

b. Raco.

c. Steel City, Midland-Ross Corporation.

d. Or equal.

2. Weatherproof Outlet Boxes:

a. Appleton Electric Company.

b. Crouse-Hinds Company.

c. O-Z/Gedney Company.

d. Or equal.

3. Junction and Pull Boxes:

a. Hoffman Engineering Company.

b. Keystone Columbia, Inc.

c. Or equal.

B. Outlet Boxes - Surface Mounted:

1. General Use: 4-in. sq with raised device cover.

2. Weatherproof: Cast galvanized box with threaded hub.

C. Junction and Pull Boxes:

1. Fabricate from code gauge galvanized steel, with covers held in-place by corrosion resistant machine screws.

2. Size as required by code for number of conduits and conductors entering and leaving box.

3. Provide with welded seams where applicable, and equip with corrosion resistant nuts, bolts, screws, and washers.

4. Finish with rust inhibiting primer.

2.08 WIRING DEVICES

A. Manufacturers:

1. Arrow-Hart, Inc.

2. Hubbel Wiring Device Division.

3. Pass and Seymour, Inc.

4. Appleton Electric Company.

5. Sierra Electric.

6. Crouse-Hinds Company.

7. Or equal.

B. Fabricated Devices:

1. Factory fabricated, specification grade wiring devices in type and electrical rating for service indicated.

2. Wiring devices of one manufacturer.

3. See Drawing symbol schedule for identification of device type.

C. Switches:

1. General Use Lighting Switches: 20 amp toggle, equal to Hubbell No. 1221-I series.

2. Switches controlling equipment, operation of which is not evident from switch position, shall include flush neon pilot light in conjunction with proper switch. Each switch shall be complete with engraved plate to identify equipment being controlled (white letters on black, 1/8 in. high minimum).

D. Receptacles:

1. General use duplex receptacles: NEMA No. 5-20R, grounding type, 20-amp Hubbell No. 5362.

2. Special purpose receptacles as shown on Drawings and schedules.

E. Wiring Device Plates and Covers:

1. Wall plates for wiring devices with ganging and cut-outs as indicated, provided with metal screws for securing plates to devices, screw heads colored to match finish of plate.

2. Device plates for surface mounted Type FS or FD boxes to be Type FSK galvanized steel.

3. Device plates for surface mounted, 4-in. square boxes to be ½-in. raised galvanized steel covers.

4. Weatherproof plates and covers for exterior devices or devices in damp locations to be galvanized gray cast malleable with gasketed, lift cover plate as shown on Drawings.

2.09 MOTOR STARTERS

A. Manufacturers:

1. Allen Bradley.

2. Cutler-Hammer.

3. Square D.

4. Or equal.

B. Magnetic Starters:

1. Minimum short circuit withstand rating in combination with motor circuit protective device shall be 22,000 symmetrical amps or as indicated on Drawings.

C. Magnetic Motor Starter Construction:

1. Mounted in vertical position, gravity dropout.

2. Double break silver alloy contacts.

3. Molded coil.

4. Contacts and/or coil replacement without removing starter from enclosure or power wiring from starter.

5. Straight-through wiring.

6. Overload Relay:

a. 1-piece thermal unit construction.

b. One melting alloy type overload relay per phase, manually reset.

c. Interchangeable thermal units.

d. Thermal units must be in-place to operate starter.

e. Replaceable overload relay circuit contacts.

f. Trip at 6 times LRC in 20 sec.

7. Overload relay submersible pumps and hermetically sealed motors.

a. Same as above except trip at 6 times LRC in 3 to 5 sec.

8. NEMA standards for size and hp rating.

9. NEMA 1 minimum.

D. Control Circuits:

1. Voltage not to exceed 120 v.
2. Control transformer mounted in starter enclosure.
3. Fuses on all ungrounded conductors.
4. One secondary line grounded.
5. Transformer sized for device, accessories connected thereto, and 25% extra capacity minimum.

E. Controls:

1. Reset button mounted in enclosure cover.
2. Heavy duty, oiltight green push to test pilot lights mounted in enclosure cover when indicated.
3. Heavy duty, oiltight pushbuttons and selector switches mounted in enclosure when indicated.
4. 6-digit type elapsed time meters in tenths of hr. mounted in enclosure cover when indicated.

F. Enclosures:

1. Magnetic Starters:
   a. NEMA 4X stainless steel outdoors and wet locations.

2.10 MOTOR AND CIRCUIT DISCONNECTS

A. Manufacturers:

1. Cutler-Hammer.
2. Square D.
3. Or equal.

B. Enclosed Circuit Breaker Construction:

1. Dual cover interlock.
2. External trip indication.
3. Provisions for control circuit interlock.

4. Padlock provisions for padlock if Off position.

5. Handle attached to box, not cover.

6. Handle position indicates On, Off or Tripped.

7. Provisions for insulated or groundable neutral.

C. Safety Switches

1. NEMA heavy duty Type HD.

2. Dual cover interlock.

3. Visible blades.

4. Provisions for control circuit interlock.

5. Pin type hinges.

6. Tin plated current carrying parts.

7. Quick make and break operator mechanism.

8. Handle attached to box, not cover.

9. Handle position indication, On in up position, and Off in down position.

10. Padlock provisions for up to 3 padlocks in Off position.

11. UL listed lugs for type and size of wire specified.

12. Spring reinforced fuse clips for Type R fuses.

13. Provisions for insulated or groundable neutral.

D. Enclosures

1. Indoor: NEMA 1 or 12 code gauge steel with rust inhibiting primer and baked enamel finish, or as noted.

2. Outdoor: NEMA 3R code gauge zinc coated steel with baked enamel finish or NEMA 4X stainless steel, unpainted with metal finish determined by OWNER.

2.11 FUSES

A. Manufacturers:

1. Bussmann.

2. Chase Shawmut.

3. Or equal.

B. 250 v Fuses:

1. Class RK-1, 1-end rejection or to fit mountings specified, 0 to 600 amps, 200,000-amp interrupting rating.

   a. Bussmann Low-Peak. LPN-R, dual element, time delay with short circuit protection for motor, transformer, welder, feeder, and main service protection.

C. 600 v Fuses:

1. Class RK-1, 1-end rejection or to fit mountings specified, 0 to 600 amps, 200,000-amp interrupting rating.

   a. Bussmann Low-Peak. LPS-R, dual element, time delay with short circuit protection for motor, transformer, welder, feeder, and main service protection.

2. Class CC, fast acting, single element, 0 to 30 amps, 200,00-amp interrupting rating.

   a. Bussmann Limitron. KTK-R, UL listed for motor control circuits, lighting ballasts, control transformers, and street lighting fixtures.

D. Spare Fuses:

1. 10%, minimum of 3, of each type and rating of installed fuses.

2.12 PANELBOARDS

A. Manufacturers:

1. Cutler-Hammer.
2. Square D.
3. Or equal.

B. Panelboard Ratings:

1. UL listed short circuit rating (integral equipment rating):

   a. Up to 240v: 10,000 RMS symmetrical amp minimum.

   b. Up to 480v: 14,000 RMS symmetrical amp minimum.

   c. As shown on Drawings.

C. Panelboard Construction:

1. Main breaker or main lugs only, in accordance with panelboard schedule.

2. Branch Breaker Details: As specified in Article 2.13.

3. Terminals:

    a. UL listed for type of wire specified.

    b. Anti-turn solderless type.

4. Bussing:

    a. Distributed phase sequence type.

    b. 225 amps or as shown on panelboard schedule or Drawings.

    c. Plated copper.

    d. Behind usable space, with mounting hardware.

5. Gutters adequate for wire size used, 4-in. minimum.

6. Boxes:

    a. Code gauge galvanized steel.

    b. Without knockouts.

7. Fronts:

    a. Rust inhibiting primer, baked enamel finish.

    b. Dead front safety type.

    c. Concealed hinges.

    d. Flush stainless steel cylinder tumbler type locks with spring loaded door pulls.

    e. Circuit Directory:

        1) Suitable for complete descriptions.

        2) Clear plastic cover.

        3) Typewritten card.

2.13 MOLDED CASE CIRCUIT BREAKERS

A. Manufacturers:

1. Cutler-Hammer.
2. Square D.

3. Or equal.

B. Permanent Trip Circuit Breakers.

1. Lighting Panel Circuit Breakers:

   a. Thermal and magnetic protection.

   b. Single-handle common trip, 2 and 3 poles (handle ties not acceptable).

   c. Bolt-on type unless otherwise noted on DRAWINGS.

   d. Quick make and break toggle action.

   e. Handle trip indication.

   f. Handle position indication, On, Off and Tripped centered.

   g. UL listed for type of wire specified.

   h. UL listed short circuit rating (integrated equipment rating).

      1.) Up to 240v: 25,000 RMS symmetrical amp minimum.

      2.) Up to 480v: 18,000 RMS symmetrical amp minimum.

2. Power Panel Circuit Breakers

   a. Thermal and magnetic protection.

   b. Magnetic protection only in combination with motor starters and motor circuit protectors (MCP).

   c. Single magnetic trip adjustment.

   d. Single-handle common trip, 2 or 3 poles, (handle ties not acceptable).

   e. Push-to-trip test button.

   f. Bolt-on type.

   g. Quick make and break toggle action.

   h. Handle trip indication.

i. Handle position indication, On, Off, and Tripped centered.

j. UL listed for type of wire specified.

k. UL listed short circuit rating (integrated equipment rating).

1.) Up to 240v: 25,000 RMS symmetrical amp minimum.

2.) Up to 480v: 18,000 RMS symmetrical amp minimum.

2.14 GROUND-FAULT CIRCUIT INTERRUPTER RECEPTACLES

A. Ratings:

1. 120 vac.

2. 20 amp.

B. Tripping Requirement:

1. UL Class A.

C. Construction:

1. Shallow depth.

2. Line and load terminal screws.

3. Noise suppression.

4. Feed through.

5. Standard duplex wall plates shall fit.

6. NEMA 5-20R configuration.

D. UL Listed:

1. Meet requirements of UL 943 Standard for Safety for Ground-Fault Circuit-Interrupters.

PART 3 EXECUTION

3.01 GENERAL

A. Install products in accordance with NEC, manufacturer's instructions, applicable standards, and recognized industry practices to ensure products serve intended function.

3.02 CONDUITS AND CONDUIT FITTINGS

A. Install conduit and tubing products in accordance with NEC, manufacturer's written instructions, applicable standards, and recognized industry practices to ensure products serve intended function.

B. Complete conduit installation prior to installing cables.

C. Unless specifically indicated otherwise on the Drawings, use rigid galvanized steel conduit for general wiring.

D. Use Schedule 40 PVC in concrete.

E. Provide watertight conduit system.

F. Use PVC coated rigid steel conduit when conduit is run below slabs on grade or in earth, unless otherwise noted on the Drawings.

   1. Exterior underground conduit shall be a minimum of 1 inch in diameter, buried at a depth of not less than 24 inches below grade.

   2. Provide conduits or ducts terminating below grade with means to prevent entry of dirt or moisture.

G. Conduit shall be run concealed except exposed surface conduit may be installed where noted on the Drawings or where concealment found to be impractical or impossible, and only with approval of DESIGNER.

H. Continuous from outlet to outlet and from outlets to cabinets, junction or pull boxes.

I. Enter and secure to boxes ensuring electrical continuity from point of service to outlets.

J. Conduit runs extending through areas of different temperature or atmospheric conditions or partly indoors and partly outdoors shall be sealed, drained, and installed in manner preventing drainage of condensed or entrapped moisture into cabinets, motors or equipment enclosures.

K. Secure conduit in-place with not less that 1 malleable corrosion-proof alloy strap or hanger/8 ft of conduit.

   1. Do not use perforated strapping.

L. Connections to Motors and Equipment Subject to Vibration:

   1. Flexible steel conduit not over 3 ft long or where exposed in mechanical and utility areas and not subjected to moisture, dirt, and fumes.

   2. Liquidtight flexible conduit not over 3 ft long where exposed in finished areas or where subject to moisture, dirt, fumes, oil, corrosive atmosphere, exposed or concealed, with connectors to ensure liquidtight, permanently grounded connection. Locate where least subject to physical abuse.

M. Use double lock nuts and insulated bushings with threads fully engaged.

N. Connectors at fixture bodies and boxes shall be rigidly secured with galvanized lock nut and bushing.

O. Cap conduits after installation to prevent entry of debris.

P. Use explosion-proof fittings and seals in hazardous areas in accordance with NEC.

Q. Install conduit expansion fittings complete with bonding jumper in following locations.

1. Conduit runs crossing structural expansion joint.

2. Conduit runs attached to two separate structures.

3. Conduit runs where movement perpendicular to axis of conduit may be encountered.

3.03 WIRE AND CABLE

A. Run wire and cable in conduit unless otherwise indicated on Drawings.

B. On branch circuits, use standard colors.

C. Each tap, joint or splice in conductors No. 8 AWG and larger shall be taped with two half-lap layers of vinyl plastic electrical tape and finish wrap of color coding tape, where required by code.

3.04 BOXES

A. Install knockout closures to cap unused knockout holes where blanks have been removed.

B. Locate boxes to ensure accessibility of electrical wiring.

C. Secure boxes rigidly to subsurface upon which being mounted or solidly embed boxes in concrete of masonry. Do not support from conduit.

D. Do not burn holes, use knockout punches or saw.

E. Provide outlet box accessories as required for each installation such as mounting brackets, fixture studs, cable clamps, and metal straps for supporting outlet boxes compatible with outlet boxes being used and meeting requirements of individual wiring situations.

F. Location of outlets and equipment as shown on the Drawings is approximate, and exact location to be verified.

G. Minor modification in location of outlets and equipment considered incidental up to distance of 10 ft with no additional compensation, provided necessary instruction given prior to roughing in of outlet.

H. Mounting Height:

1. Switches: 48 in. above floor.

2. AC Receptacles: 48 in. above floor in unfinished areas.

3. Wall Bracket Lighting Fixtures: 6 ft-6 in. above floor.

4. Pushbuttons: 48 in. above floor.

5. Motor Starters and Disconnect Switches: 60 in. above floor.

6. Thermostats: 60 in. above floor.

7. Bells and Horns: 8 ft-0 in. above floor.

3.05 WIRING DEVICES

A. Do not install devices until wiring complete.

B. Do not use terminals on wiring devices (hot or neutral) for feed-through connections, looped or otherwise. Make circuit connections via connectors and pigtails.

C. Install gasket plates for devices or system components having light emitting features such as switch with pilot light and dome lights. Where installed on rough textured surfaces, seal with black self-adhesive polyfoam.

D. Ground receptacles with insulated green ground wire from device ground screw to bolted outlet box connection.

3.06 MOTOR STARTERS

A. Examine area to receive motor starters to ensure adequate clearance for starter installation.

B. Install on equipment rack in MCC or anchor firmly to wall or structural surface.

3.07 MOTOR AND CIRCUIT DISCONNECTS

A. Locate disconnect switches as shown on Drawings and required by NEC.

B. Provide control circuit interlock as required by NEC.

3.08 OVERCURRENT PROTECTIVE DEVICES

A. Install fuses just prior to energizing equipment.

B. Locate circuit breakers as shown on Drawings.

C. Install GFCI receptacles as required by NEC.

3.09 PANELBOARDS

A. Surface mount as specified on Drawings and schedules.

B. Support panel cabinets independently to structure with no weight bearing on conduits.

C. Install panelboards so top breaker not higher than 6 ft-0 in. above floor.

D. Adjacent panel cabinets shall be same size and mounted in horizontal alignment.

E. Install typewritten directory in each panelboard, accurately indicating rooms or equipment being served.

3.10 FIELD QUALITY CONTROL

A. Control Circuits, Branch Circuits, Feeders, Motor Circuits, and Transformers;

1. Megger check of phase-to-phase and phase-to-ground insulation levels.

    a. Do not megger check solid state equipment.

2. Continuity.

3. Short circuit.

4. Operational check.

B. Wiring Devices:

1. Test receptacles with Hubbell 5200, Woodhead 1750 or equal tester for correct polarity, proper ground connection, and wiring faults.

3.11 ADJUSTMENT AND CLEANING

A. Motor Starters and Disconnects:

1. Adjust covers and operating mechanisms for free mechanical movement.

2. Tighten wire and cable connections.

3. Verify overcurrent protection thermal unit size with motor nameplate to provide proper operation and compliance with NEC.

4. Clean interior of enclosures.

5. Touch up scratched or marred surfaces to match original finish.

B. Circuit Breakers:

1. Adjustable settings shall be set to provide selective coordination, proper operation, and in compliance with NEC.

* * * END OF SECTION * * *

SECTION 16150
ELECTRIC MOTORS

PART 1 GENERAL

1.01 SUMMARY

A. Motors furnished under other sections of these Specifications as part of equipment items shall conform to requirements of this section except as noted otherwise in that section or indicated otherwise on Drawings or schedules.

1.02 REFERENCES

A. Anti-Friction Bearing Manufacturers Association (AFBMA):

1. AFBMA Standards for Ball and Roller Bearings and Balls.

B. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE 112 - Standard Test Procedure for Polyphase Induction Motors and Generators.

C. National Electrical Contractors Association (NECA):

1. Standard of Installation.

D. National Electrical Manufacturers Association (NEMA):

1. NEMA MG 1 - Motors and Generators.

1.03 SUBMITTALS

A. Include motor submittal as part of equipment submittal for equipment specified in other sections.

B. Include identification of equipment by name and tag number as indicated in Specifications or on Drawings.

1. Complete nameplate data in accordance with NEMA standards.

2. Full load power factor and maximum correction capacitor kVa for motors 5 hp and larger.

3. Nominal efficiency in accordance with Standard IEEE 112 for motors 5 hp and larger.

4. Motor dimensions and frame size.

5. Manufacturer’s printed data on each motor type being provided to indicate compliance with specified performance and construction.

6. Service manual to include storage and alignment instructions.

C. Submit in accordance with Section 01340.

D. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 01730.

1.04 QUALITY ASSURANCE

A. Source Quality Control:

1. Perform individual motor test on motors over 1 hp.

2. Test shall be standard NEMA routine production test in accordance with MG 1-12.51 consisting of following:

a. No load running current.

b. Locked rotor current.

c. High potential test.

d. Bearing inspection.

B. Regulatory Requirements:

1. National Fire Protection Association (NFPA):

a. NFPA No. 70 - National Electrical Code (NEC) and New York amendments thereto.

2. Underwriters Laboratories, Inc. (UL).

3. Local codes and ordinances.

PART 2 PRODUCTS

2.01 GENERAL

A. Use of manufacturer's name and model or catalog number is for purpose of establishing standard of quality and general configuration desired.

2.02 MANUFACTURERS

A. Louis Allis.

B. General Electric.

C. Or equal.

2.03 GENERAL

A. Unless otherwise specified, meet or exceed following.

1. High efficiency, equivalent to Louis Allis Spartan for motors 3 hp and above.

2. Motors ½ hp and Larger: 3-ph, 60 Hz, 230/460 v.

a. Squirrel cage type, NEMA B.

b. Motor Housing and Bearing Brackets: Cast grey iron with tensile strength of 30,000 psi. Do not provide rolled steel and aluminum.

c. Secure bearing brackets to motor cast iron housing. Do not use bolt clamping methods.

3. Motors Less than ½ hp: 1-ph, 60 Hz, 115/230 v.

4. Suitable for continuous operation with line voltage variation within " 10% of rated voltage.

5. Suitable for continuous operation in 40^{o}C ambient.

6. Copper motor windings.

B. Design for frequent starting when specified in other sections.

2.04 ENCLOSURES

A. Totally Enclosed Fan Cooled (TEFC): Indoor or outdoor areas where exposed to moisture or dirt.

1. Waterproof conduit box.

2. Cast brass or polypropylene external ventilation fan.

3. Automatic breather/drain.

4. Ground wire.

5. External water slinger on shaft extension.

6. Lip seals on both ends of motor.

B. Explosionproof (EP): Indoor or outdoor areas exposed to flammable volatile liquids, flammable gases or mixtures or combustible flyings are handled, manufactured, stored or used.

1. Waterproof conduit box.

2. Cast brass or polypropylene external ventilation fan.

3. Automatic breather/drain.

4. Ground wire.

5. External water slinger on shaft extension.

6. Lip seals on both ends of motor.

C. Submersible (SUB): Underwater conditions.

1. As specified under equipment section.

2.05 INSULATION

A. TEFC: Class F, 1.15 service factor.

1. Two extra dips and bakes of epoxy varnish.

B. EP: Class F, 1.15 service factor.

1. Two extra dips and bakes of epoxy varnish.

C. SUB: Class F, 1.10 service factor.

2.06 BEARINGS

A. Ball or roller bearing type at manufacturer's option, unless specified in equipment sections of Specifications.

B. Support side thrust loadings.

C. Regreasable with alamite fittings extended to accessible location for Frame 250 and larger.

D. AFBMA B10 bearing life rated (flexible coupled) at 50,000 hrs.

2.07 SPEED

A. As specified under equipment section.

2.08 TORQUE

A. Breakdown torque shall be 200% or more of maximum torque load placed on motor shaft.

B. Provide necessary WK_2 curves for special loads to coordinate with motors.

C. Supply special motors where load requirements exceed standard design.

2.09 SLIDE RAILS AND SOLE PLATE

A. As required for application.

2.10 SINGLE PHASE FRACTIONAL HP MOTORS

A. Capacitor or open split phase start, unless otherwise specified.

2.11 3-PH MOTORS

A. Provide horizontal or vertical squirrel cage induction motors for standard duty.

B. Full voltage starting or as specified in equipment sections of Specifications or on Drawings.

C. Design in conformance with Article 2.08.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation," and recognized industry practices.

3.02 ALIGNMENT

A. Contractor furnishing motor shall be responsible for alignment.

B. Check alignment of motors prior to startup.

* * * END OF SECTION * * *

SECTION 16450
GROUNDING

PART 1 GENERAL

1.01 REFERENCES

A. National Electrical Contractors Association (NECA):

1. Standard of Installation.

1.02 SUBMITTALS

A. Test Data:

1. Ground resistance at each ground rod.

a. Rod location.

b. Resistance.

c. Soil conditions.

2. Building water service resistance.

B. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Fire Protection Association (NFPA):

a. NFPA No. 70 - National Electrical Code (NEC) and New York amendments thereto.

2. Niagara Mohawk Power Company standards.

3. Local codes and ordinances.

PART 2 PRODUCTS

2.01 MATERIALS

A. Ground Clamp Fittings:

1. Interlocking clamp type fabricated from high strength corrosion-resistant metal with high strength silicon bronze U-bolt, nuts, and lock washers.

B. Cable Connections and Joints:

1. Thermoweld.

C. Ground Rods:

1. Thick copper covering inseparably welded to strong steel core.

2. ¾ in. diameter minimum and 10 ft long unless otherwise shown on Drawings.

D. Ground Wires:

1. Copper.

2. Do not use aluminum.

3. Size as shown on Drawings or required by NEC.

4. No. 6 AWG minimum.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Ground electrical systems and equipment as required by code, utility, local ordinances, and requirements herein.

2. Install separate code-related grounding conductors to special equipment and activity areas as required by code.

3. Bond metallic piping systems and service equipment as required by NEC.

B. System Ground:

1. Attach ground wire to building steel and ground rods.

2. Augment piping systems ground with two supplemental NEC approved electrodes to achieve effective ground resistance as required by NEC.

C. Main Grounding Conductor:

1. Continuous without splice.

2. Install in rigid metal conduit.

3. Attach nonferrous metal tag to warn against removal.

D. Bond metallic conduits, supports, cabinets, and other equipment so ground will be electrically continuous from service to outlet boxes.

E. Locate grounding conductor in nonmetallic or flexible conduit to complete equipment ground continuity.

F. Where ground conductor runs through metallic conduit, bond to conduit at entrance and exit with bolted clamp.

G. Install separate equipment grounding conductor in each conduit containing branch circuit or feeder without neutral conductor and to special equipment as shown on Drawings.

H. Green ground bar in panels to be similar to neutral bar, except tinted green and bonded to panel tub.

I. Connections shall be accessible for inspection and checking. No insulation shall be installed over ground connections.

J. Clean ground connection surfaces.

K. Drive ground rod as shown on Drawings.

1. Drive top of ground rod to depth 4 in. below finished grade.

L. Make connections to ground electrodes with bolted clamp or approved molded exothermic weld process.

M. Attach rounds permanently before permanent building service energized.

N. Install green ground conductor from 1-ph motors or equipment frames to first junction box beyond flexible conduit.

3.02 MANHOLES AND HANDHOLES

A. Drive ground rod at convenient point close to wall.

B. Connect ground rod to metal cable supports, groundable end bushings on ducts and conduits, and metallic cable sheaths and armor with No. 4 AWG, tinned, stranded or equivalent braided copper cable.

C. Attach ground wire neatly and firmly to walls.

3.03 FIELD QUALITY CONTROL

A. Resistance Measurements:

1. Measure at each ground rod.

2. Measure at each connection to building water service.

3. Measure in normally dry conditions.

   a. Not less than 48

4. Isolate ground under test from other grounds.

* * * END OF SECTION * * *

SECTION 16471
FEEDER CIRCUITS

PART 1 GENERAL

1.01 REFERENCES

A. National Electrical Contractors Association (NECA):

1. Standard of Installation

1.02 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Fire Protection Association (NFPA):

a. NFPA No. 70 - National Electrical Code (NEC) and New York amendments thereto.

2. Local codes and ordinances.

PART 2 PRODUCTS

2.01 FEEDERS

A. Materials shall comply with other sections of Specifications.

B. Size and protect in accordance with NEC 215.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's written instructions, applicable requirements of NEC, NECA "Standard of Installation," and recognized industry practices.

B. Extend feeders at full capacity from origin to termination.

C. Each conduit raceway shall contain only those conductors constituting single feeder circuit.

D. Where multiple raceways are used for single feeder, each raceway shall contain conductor of each phase and neutral if used.

E. Where feeder conductors run in parallel, conductors shall be of same length, material, circular-mil area, insulation type, and terminated in same manner.

F. Where parallel feeder conductors run in separate raceways, raceways shall have same physical characteristics.

G. Feeder shall follow most accessible routes exposed to minimum temperature gradient and fluctuation.

H. Trapped runs without facilities for continuous drainage not acceptable.

I. Where impractical to do otherwise and with approval of ENGINEER, feeder conduits may installed in ground floor slabs subject to requirements they be totally encased in concrete or through use of PVC jacketed rigid conduit if in direct contact with earth.

J. Do not draw conductors into conduits until building enclosed, watertight, and Work causing cable damage complete.

K. Identify main feeders with heavy tags.

L. On network systems, neutral shall be run with phase wires. Unbalanced neutral current shall not exceed normal or derated conductor capacity.

* * * END OF SECTION * * *

SECTION 16857
ELECTRIC HEAT TAPE

PART 1 GENERAL

1.01 SUMMARY

A. System consists of self-regulating heat tapes and control equipment to provide complete UL listed system to prevent pipelines from freezing, installed and tested in-place.

1.02 SUBMITTALS

A. Shop Drawings:

1. Submitted by supplier of electrical pipe tracing systems as specified in other sections.

2. Submit manufacturer's product data sheets.

3. Submit Shop Drawings showing isometric layout of pipe tracing cables over customer's piping layout. Drawings shall also include installation details and connection diagrams sufficient to install pipe tracing cable system.

B. Submit in accordance with Section 01340.

1.03 QUALITY ASSURANCE

A. Design Criteria:

1. Provide pipe tracing cable system capable of maintaining pipe contents at temperature of 40^{o}F when outside ambient temperature is -20^{o}F with 20 mph wind.

B. Regulatory Requirements:

1. National Fire Protection Association (NFPA):

a. NFPA No. 70 - National Electrical Code (NEC) current edition, and New York amendments thereto.

2. Underwriters Laboratories, Inc. (UL).

3. Local codes and ordinances.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chemelex, Division of Raychem Corporation.

B. Nelson Electric, Division of General Signal.

C. Or equal.

2.02 CABLE DESIGN

A. Voltage: 120 v, 60 Hz, 1-ph as shown on Drawings for electrical connection.

B. Parallel design, current flow across cable.

C. Heat output/ft constant, independent of length.

1. 5 watts/foot.

D. Capable of overlapping without creation of hot spots.

E. Cut to any length in field.

F. Self-regulating heat output.

G. Braided metallic shield.

H. Outer Flouropolymer jacket.

2.03 MATERIAL AND EQUIPMENT

A. Furnish electrical pipe tracing system as shown on Drawings.

B. Thermostatic ambient sensing control on each type set at 40^{o}F.

1. Provide non-adjustable thermostats, calibrated and tested at factory to operate pipe heating system when temperature of pipe drops to 40^{o}F.

2. Provide adjustable thermostats, calibrated and tested at factory to close alarm contracts when temperature of pipe drops to 35^{o}F at its coldest location.

3. Thermostats to have repeatability and maximum temperature differential of $\pm 2^{o}$F.

4. Provide thermostats with NEMA 4X die cast aluminum housing outdoor enclosures.

C. Provide each cable with proper fittings and appurtenances for field connection of system to conduit and wiring without need for procurement of special fittings or wiring devices.

D. Install heat tape with 2-1/2 inch aluminum tape.

E. Provide connection kit.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pipe tracing cables where specified or indicated on Drawings in accordance with manufacturer's written instructions.

B. Coordinate circuit connection points and voltages with Drawings.

C. Apply "electrical traced" signs to outside of thermal insulation.

3.02 FIELD QUALITY CONTROL

A. Examine material for defects prior to installation.

B. Examine final installation for damage and defects in workmanship prior to startup and installation of insulation.

C. Prior to installation, start pipe tracing system and check for temperature increase over full length of each tracing cable.

D. Prior to and after installation of insulation, heat trace circuits shall be tested with minimum 1,000 vac megger and readings recorded. Readings shall be minimum of 20 mega-ohms regardless of circuit length. Take megger test between outer braid and 2 bus wires.

* * *END OF SECTION * * *

SECTION 16915
MISCELLANEOUS INSTRUMENT PANELS

PART 1 GENERAL

1.01 SUMMARY

A. Provide instrumentation and control (I&C) panels as shown on Drawings.

1.02 DEFINITIONS

A. Systems House: Organization whose principal function is design, manufacture, and servicing of I&C systems.

1.03 SUBMITTALS

A. Submit following information for each panel in accordance with Section 01340, tabulate in booklet form, and provide in one submittal.

1. Panel fabrication and dimension drawings, nameplate legends, and wiring and piping schematic diagrams.

2. Equipment dimension drawings.

3. Component specification sheets.

4. Equipment terminal and piping connections.

5. Loop-by-loop system electrical schematic including terminal-to-terminal interconnections between panel and field equipment.

6. Instruction manuals including detailed operating sequence descriptions and controller I/O charts.

7. Parts list.

B. Operation and Maintenance (O&M) Data:

1. Submit in accordance with Section 01730.

1.04 QUALITY ASSURANCE

A. Standardization:

1. Equipment shall be latest and most modern design at time of bidding.

2. I&C equipment components shall be end product of one manufacturer to achieve standardization for maintenance, spare parts, operation, and service.

B. Systems House's Services:

1. Systems House shall provide services of qualified service engineer to supervise and inspect equipment installation to ensure it is installed in accordance with System House's recommendations.

2. Systems House's engineer for equipment specified herein shall be present at job site or classroom designated by OWNER for minimum of 7 man days, travel time excluded, for assistance during construction startup, equipment adjustment, and training of OWNER'S personnel.

3. Systems House shall provide, during first year after substantial completion of system, one 8-hr service call for preventative maintenance and to make necessary adjustments on no-charge basis.

1.05 RESPONSIBILITY AND COORDINATION

A. Install, adjust, and place into satisfactory operation.

B. Drawings and Specifications intended to identify overall system functions. Provide equipment necessary to provide complete and operable system whether specifically identified or not.

C. Inspect and test at factory prior to shipment.

D. Assume responsibility for additional costs resulting from deviations from Specifications.

E. Coordinate startup with startup services for equipment furnished under other sections.

1.06 GUARANTEE

A. During guarantee period, furnish and install replacement parts for defective component at no additional cost, except for those items normally consumed in service.

PART 2 PRODUCTS

2.01 I & C EQUIPEMNT

A. Provide I & C system as shown on Drawings and specified herein.

B. Equipment provided in this section shall conform to the following.

1. Instrument and Control Panel Construction: Section 16930.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panels in locations indicated on Drawings and in accordance with manufacturer's written instructions and approve submittals.

B. Touch up paint on panels after installation.

* * * END OF SECTION * * *

SECTION 16930
INSTRUMENT AND CONTROL PANEL CONSTRUCTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

1. Panel and enclosure requirements for entire instrumentation and control (I&C) system.

1.02 REFERENCES

A. Instrument Society of America (ISA).

B. National Electrical Manufacturer’s Association (NEMA).

1.03 QUALITY ASSURANCE

A. Test wiring and plumbing prior to shipment.

PART 2 PRODUCTS

2.01 CONTROL PANELS

A. Factory fabricate, install instruments, plumb and wire in factory.

B. Make external connections except for data highway cables by way of numbered terminal blocks.

C. Conform to ISA standards.

D. Refer to DRAWINGS for internal and external layout details.

2.02 PANEL CONSTRUCTION FOR OTHER THAN FREE-STANDING

A. Enclosures shall conform to NEMA requirements as follows.

1. Inside Buildings: NEMA 12 (except as noted).

2. Outside Buildings: NEMA 4X stainless steel.

3. Class I, Division 1 or 2 Areas: NEMA 7.

B. In addition to NEMA standards, conform to following requirements.

1. Minimum Metal Thickness: 14 ga.

2. Doors: rubber-gasketed with continuous hinge.

3. Wherever practical, enclosures shall be manufacturer's standard product.

4. Size to adequately dissipate heat generated by equipment mounted in or on panel.

5. Equip panels mounted outside buildings with thermostatically controlled space heaters capable of maintaining internal temperature of 10°C, ∀2°C, with 20 mph wind at ambient temperature of -30°C. Heaters shall operate on 110 vac, 60 Hz power.

6. Use manufacturers and model numbers as listed unless otherwise approved by OWNER.

7. Wireway, mounting hardware, wire and wire markers shall be used as required.

8. Provide isolation barriers around intrinsic safety barriers. Mount isolation barriers to panel enclosure and extend to the bottom of the enclosure. Provide access cover.

9. Control panel builder shall check all component mounting locations and dimension for proper clearance before mounting components or cutting holes in enclosure.

2.03 STANDARD SIGNAL INTERFACES

A. Unless otherwise specified, discrete input and output signals shall conform to following.

1. Isolated unpowered (dry) contact closures.

2. Power contact from panel receiving signal or device receiving signal.

2.04 PANEL FINISH (Applies to carbon steel panels only)

A. Sand panel and remove mill scale, rust, grease, and oil. Fill imperfections and sand smooth.

B. Paint interior and exterior with one coat of epoxy coating metal primer, 2 finish coats of 2-component type epoxy enamel.

C. Sand surfaces lightly between coats.

D. Dry film thickness shall not be less than 3.0 mils.

E. Color: Selected by OWNER.

F. Stainless steel panels shall be unpainted with the type of finish selected by OWNER.

2.05 NAMEPLATES

A. Provide nameplates for I&C panels and each front-of-panel instrument and device with designations as shown on Drawings and as listed in Specifications.

B. Panel Designation: Engraved with ENGINEER'S panel tag number and description with 1/2 in. high characters.

C. Application/Function Nameplate: Locate 3/16 in. characters above or near panel mounted instrument or device consisting of descriptive phrase using nomenclature as 1isted in Specifications (when available).

D. Tag Number: Include ENGINEER'S tag number as shown on P&ID and in Specifications on each nameplate.

E. Laminated white plastic inscribed with black characters.

F. Provide aluminum decal with black 3/16 in. characters on top side at rear of instrument on or near each device on rear side of panel using tag number or device designation.

G. Secure front-of-panel and front-of-instrument nameplate with drive screws or self-tapping fasteners.

2.06 SPARE PARTS

A. Provide 10% of each type fuse, light bulb, surge protector, intrinsic barrier, and I/O module used on project for use as spare components.

B. Provide minimum of 30% spare terminals; to be shown as such on panel drawings.

2.07 MATERIAL SPECIFICATIONS

LIST OF MATERIALS

(This list is typical for each remote primary & secondary pump control panel)

ITEM	DESCRIPTION	MANUFACTURER	PART NUMBER	QUANTITY
1	SINGLE DOOR NEMA 4X STAINLESS STEEL ENCLOSURE	HOFFMAN ENG. CO.	A-36H2410SSLP	1
2				
3	ENCLOSURE SUB-PANEL	HOFFMAN ENG. CO.	A-36P24	1
4				
5	FAST OPERATING ENCLOSURE CLAMP ASSEMBLY	HOFFMAN ENG. CO.	A-FC412SS	7
6	120VAC SURGE PROTECTOR BASE	PHOENIX CONTACT	UAK 2/2-110 AC-BE	1
7	120VAC SURGE PROTECTOR PLUG	PHOENIX CONTACT	UAK 2/2-110 AC-ST	1
8	TERMNAL BLOCK	ALLEN-BRADLEY	1492-F1	21
9	FUSIBLE SWITCH	ALLEN-BRADLEY	1492-H6	7
10	FUSE – 2 AMP	LITTELFUSE	313002	4
11	FUSE – 5 AMP	LITTELFUSE	313005	3
12	POWER SUPPLY 24VDC, 1.2 AMP	SOLA	SLS-24-012	1
13				
14				
15	ANALOG/DIGITAL I/O RACK	DUTEC	I/O PLEXER IOP-AD	2
16	SINGLE CHANNEL AC OUTPUT MODULE	DUTEC	OAC5	3
17	SINGLE CHANNEL AC INPUT MODULE	DUTEC	IAC5	9
18	4 TO 20 MA CURRENT INPUT MODULE	DUTEC	II420	1
19				
20				
21	RS-422/485 SURGE PROTECTOR BASE	PHOENIX CONTACT	UFBK 2-PE-24 DC-HF-	2
22	RS-422/485 SURGE PROTECTOR PLUG	PHOENIX CONTACT	UFBK 2-PE-24 DC-HF-ST	2
23	INTRINSIC SAFETY BARRIER	MTL INCORPORATED	MTL 702+	2
24	INTRINSIC SAFETY BARRIER	WARRICK	SERIES 17A1CO	4

25	PUSH TO TEST TRANSFORMER PILOT LIGHT W/RED LENS	ALLEN-BRADLEY	800H-PRT16R	1
26	PUSH TO TEST TRANSFORMER PILOT LIGHT W/GREEN LENS	ALLEN-BRADLEY	800H-PRT16G	1
27	PUSH TO TEST TRANSFORMER PILOT LIGHT W/AMBER LENS	ALLEN-BRADLEY	800H-PRT16A	2
28	MOMENTARY PUSHBUTTON SWITCH	ALLEN-BRADLEY	800H-AR2D1	1
29	HAND-OFF-AUTO 3 POSITION MAINTAINED SELECTOR	ALLEN-BRADLEY	800H-JR2B	2
30	9 PIN FEMALE D SHELL CONNECTOR W/HOOD	CINCH	DE-9S / SDH-9GL	1
31				
32	LEACHATE LEVEL TRANSMITTER	DELTA	591-GX-PVC-XX	1
33	LEAK DETECTOR ELECTRODE FITTING	WARRICK	SERIES 3E2C	2
34	LEAK DETECTOR ELECTRODE	WARRICK	SERIES 3R5C5	1
35				
36				
37				

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panel in locations indicated on DRAWINGS and in accordance with manufacturer’s written instructions and approved submittals.

B. Touch up panel after installation.

* * * END OF SECTION * * *

SECTION 16931
VAULT ELECTRICAL COMPONENTS

PART 1 GENERAL

1.01 REFERENCES

A. National Electrical Manufacturer's Association (NEMA).

B. Underwriters Laboratories, Inc. (UL):

1. UL 943 - Standard for Safety for Ground-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Shop Drawings:

1. Required for all disconnects, motor starters, and overcurrent protective devices. Include the following information:

a. Enclosure dimensions, nameplate nomenclature, electrical ratings, and thermal unit schedule.

b. Product data sheets with printed installation instructions.

c. Wiring diagrams and schematics.

B. Submit in accordance with Section 01340.

C. Operating and Maintenance (O&M) Data: Submit O&M data as specified for disconnects, motor starters, and overcurrent protective devices.

1. Manufacturer's printed instructions for replacing parts, performing cleaning, and operating and maintaining equipment.

2. Repair parts list.

3. Submit in accordance with Section 01730.

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:

1. National Fire Protection Association (NFPA):

a. NFPA No. 70 - National Electric Code (NEC) and New York amendments thereto.

2. Underwriters Laboratories, Inc. (UL).

3. Local codes and ordinances.

1.04 PRODUCTS AND ELECTRICAL

A. Refer to Section 16100, Basic Materials And Methods, for general construction and materials.

1.05 MATERIAL SPECIFICATIONS

RMU-2 RISER VAULT ELECTRICAL SPECIFICATIONS TABLE

ITEM	QTY.	DESCRIPTION	MANUFACTURER	PART NUMBER(S)
1	1	INCOMING POWER PULL BOX, NEMA 4X STAINLESS STEEL, 316SS, WALL MOUNTED (ON OUTSIDE OF BUILDING).	HOFFMAN ENG. CO.	A-1412CHNFSS
2	1	MINI POWER ZONE TRANSFORMER, 3-PHASE 480VAC DELTA PRIMARY – 120/240VAC SINGLE PHASE SECONDARY, 60HZ, 7.5 KVA RATED, 2-5% FCBN, UL LISTED, WALL MOUNTED NEMA TYPE 3R RATED ENCLOSURE, WITH 30 AMP MAIN BREAKER AND (8) 20 AMP 1-POLE FEEDER BREAKERS.	SQUARE D	MPZB7S40F FAL24030 (FOR MAIN BREAKER)
3	1	CIRCUIT BREAKER PANEL DP-1, 100 AMP 480V RATED 3-POLE MAIN LUGS, 6 BRANCH CIRCUITS (2) 20/3, (3) 15/3 AND (1) 30/3 BREAKERS TO BE BOLT-ON, SURFACE MOUNTED PANEL, NEMA 12, 3-SINGLE COPPER BUSES, NEUTRAL/GROUND BAR AND LUG.	SQUARE D	NF SERIES PANELBOARD
4	1	CLASS 8538 COMBINATION STARTER AND ENCLOSURE NEMA 4X STAINLESS STEEL RATED, WITH NEMA SIZE 2 480V MAGNETIC STARTER, 120VAC STARTER COIL, AND RESETABLE THERMAL BI-METAL OVERLOADS.	SQUARE D	SDW16
5	1	CLASS 8538 COMBINATION STARTER AND ENCLOSURE NEMA 4X STAINLESS STEEL RATED, WITH NEMA SIZE 00 480V MAGNETIC STARTER, 120VAC STARTER COIL, AND RESETABLE THERMAL BI-METAL OVERLOADS.	SQUARE D	SBW13
6	1	INDUSTRIAL BASEBOARD ELECTRIC CONVECTION HEATER, WITH BUILT-IN THERMOSTAT, 120VAC 1 PHASE POWER, 1.0 KW.	INDEECO	905U01000B
7	1	WALL MOUNTED ELECTRIC CONVECTION (EXPLOSION PROOF) HEATER, WITH BUILT-IN THERMOSTAT, SIZE 2 MAGNETIC STARTER, 120VAC CONTROL TRANSFORMER, 2.5 KW, 480 VAC, 3-PHASE, RATED FOR CL 1, DIV 2, GP D AREA.	INDEECO	254-F0320252U
8	1	PRIMARY/SECONDARY PUMP CONTROL PANEL SEE SPECIFICATION SECTION 16930.		
9	1	SECONDARY PUMP PADDLEWHEEL FLOWMETER, 2-WIRE TRANSMITTER, 4-20 MADC OUTPUT, BODY MATERIAL PVC VITON SEALS, LCD DIGITAL DISPLAY, 24VDC SUPPLY. SUPPLY EEx ia IIC T6 INTRINSICALLY SAFE VERSION. (BY C.W.M.)	CHEMLINE DIGIFLOW	FLS TYPE 2110H
10	2	PRIMARY AND SECONDARY PUMP POWER RECEPTACLES, 480VAC, CLASS 1 DIV 1 GPS D, CPS 3-WIRE, 4-POLE ANGULAR HOUSING WITH CPP MATCHING PLUG.	CROUSE HINDS	
11	1	LEAK DETECTION PROBE, NEMA 4X STAINLESS STEEL HOUSING, 1”NPT MOUNTING CONN., 24VDC.	WARRICK	SERIES 3E2C
12	2	SWITCH, ON-OFF POSITIONS FOR INTERIOR LIGHT, 120VAC, 20 AMP, NEMA 4X STAINLESS STEEL HOUSING.	CROUSE HINDS	

13	1	OUTDOOR WEATHERPROOF DUPLEX GFCI RECEPTACLE, 120VAC, 20 AMP.	CROUSE HINDS	
14	1	DUPLEX WEATHERPROOF RECEPTACLE, 120VAC, 20AMP, NEMA 4X STAINLESS STEEL HOUSING.	CROUSE HINDS	
15	1	FLUORESCENT LIGHTING FIXTURE, 2-48” TUBES, 120VAC, 60HZ, LOW TEMPERATURE RAPID START BALLAST, WRAP-AROUND ACRYLIC DIFFUSER, NEMA 3R ENCLOSURE.		
16	4	FUSED SAFETY DISCONNECT SWITCH, NEMA 4X STAINLESS STEEL ENCLOSURE, RATED 60 AMP 480VAC 3-PHASE, SUPPLY WITH CLASS R 40 AMP FUSES.	SQUARE D	H362DS
17	2	INTERIOR LIGHTING FIXTURE, INCANDESCENT 100W, 120VAC, 60HZ, LIGHT BULB, EXPLOSION PROOF HOUSING, WRAP-AROUND ACRYLIC OR GLASS GLOBE.	CROUSE HINDS	

1.06 CONDUIT AND CABLE SCHEDULE

CABLE & CONDUIT SCHEDULE – RISER VAULT

CONDUIT NO.	CONDUIT SIZE	CABLE TYPE	CABLE SIZE	NO. OF WIRES
C-101	1”	XHHW	#8	4
C-102	1”	XHHW	#8	4
C-103	3/4”	ANALOG	2C#16 STP	1 Cable
C-104	3/4”	XHHW	#8	4
C-105	1”	THWN	#12	15
C-106	3/4”	THWN	#12	3
C-107	1-1/4”	XHHW,THWN	#8, #10, #14	4(8), 3(10), 6(14)
C-108	1”	THWN	#12, #14	3(12), 16(14)
C-109	3/4”	THWN	#12	3
C-110	3/4”	THWN	#12	2
C-111	3/4”	THWN	#12	3
C-112	3/4”	THWN	#12	3
C-113	3/4”	THWN	#14	4
C-114	3/4”	THWN	#10	6
C-115	3/4”	THWN	#14	4
C-116	3/4”	THWN	#14	6
C-117	3/4”	THWN	#10	3

C-118	3/4”	THWN	#14	6
C-119	3/4”	THWN	#14	3
C-120	3/4”	THWN	#14	3
C-121	3/4”	THWN	#12	6
C-122	3/4”	THWN	#12	3
C-123	3/4”	THWN	#12	3
C-124	3/4”	THWN	#12	2
C-125	3/4”	THWN	2C#18 STP, #14	1 Cable; 6(14)
C-126	3/4”	THWN	#14	2
C-127	3/4”	THWN	2C#18 STP, #14	1 Cable; 4(14)
C-128	3/4”	THWN	#14	2
C-129	3/4”	THWN	2C#18 STP	1 Cable
C-130	3/4”	THWN	#14	2

* * * END OF SECTION * * *

ATTACHMENT J

Application Appendix D-8 – RMU-2 Landfill Quality Assurance Manual

WASTE MANAGEMENT, INC.

CWM Chemical Services, LLC

Construction Quality Assurance Manual

Residuals Management Unit 2

Model City Facility
1550 Balmer Road
Model City, Niagara County, New York

April 2003
Revised August 2009
Revised March 2011

Appendices

1. General

1.1 Scope

This Construction Quality Assurance Manual (CQAM) addresses quality assurance (QA) for the installation of soil and geosynthetic materials used by the Model City Facility, owned by CWM Chemical Services, LLC (Owner) in the construction of Residuals Management Unit 2 (RMU-2). Extreme care and detailed documentation are required in the selection and installation of all soil materials and the production and installation of the geosynthetic materials used in waste containment applications.

This manual addresses QA testing, observations and documentation. In the context of this CQAM, QA refers to the means and actions employed to ascertain that the lining system production and installation conform with the project-specific Quality Assurance Plan (QAP) and contractual and regulatory requirements. QA is provided by a party independent from production and installation. Quality control (QC) refers only to those actions taken to determine that materials and workmanship meet the requirements of the plans and specifications. QC is provided by the manufacturers, suppliers, contractor and installers of the various components of the lining system.

A project-specific QAP is required for each project in accordance with 40 Code of Federal Regulations (CFR) Part 264. This project-specific plan consists of the following:

1. This CQAM.

2. Project-Specific Addenda to this CQAM. (Project-specific addenda shall be used to provide for additions, deletions and changes necessary to this CQAM)

3. Project-Specific Plans, Specifications and other specified documents.

4. Permits for RMU-2.

The scope of this CQAM applies to selecting, testing, handing and installing soil components, and to manufacturing, shipping, handling and installing geosynthetics that are components of the containment lining system. This CQAM contains the elements necessary to make certain that the project is constructed in accordance with design plans and specifications.

This CQAM was developed consistent with United States Environmental Protection Agency (USEPA) guidance, including "Construction Quality Assurance for Hazardous Waste Landfill Disposal Facilities," USEPA/530-SW-86-031, and regulations governing construction quality assurance (CQA) requirements listed in 40 CFR Part 264 at the date of this CQAM.

1.2 Parties

The parties discussed in this section are associated with the ownership, design, supply, manufacture, transportation, installation and QA of the lining system. The definitions, qualifications and responsibilities of these parties are outlined in the following subsections. A list (Appendix D) of parties' names and addresses will be prepared during the pre-construction meeting.

1.2.1 Project Manager

1.2.1.1 Definitions

The Project Manager is the official project representative of the Owner; in this CQAM, the term *Project Manager* shall apply equally to *Construction Coordinator* (i.e., the individual[s] responsible for coordinating construction and QA activities for the project). The Project Manager and/or Construction Coordinator may be one or more individuals designated by the Owner.

1.2.1.2 Responsibilities

The Project Manager is responsible for the organization and implementation of the CQAM for the project as outlined in Section 1.1 of this CQAM. Other responsibilities include approval of the Earthwork Contractor, Geosynthetics Installer, QAC and the QAL.

The Project Manager shall serve as communications coordinator for the project and shall initiate the resolution, pre-construction and construction meetings outlined in Section 1.3. As communications coordinator, the Project Manager shall serve as a liaison between all parties involved in the project to facilitate and maintain communications.

1.2.1.3 Qualifications

The selection of the Project Manager is the direct responsibility of the Owner. Qualifications for this position include familiarity with the following:

1. Sections of this CQAM or other applicable CQAMs.
2. General earthwork construction techniques.
3. General geosynthetic installation techniques.
4. All applicable permit and regulatory requirements.
5. Company policies and procedures for project management.

1.2.2 Engineer

1.2.2.1 Definitions

The Engineer is the individual and/or firm responsible for the preparation of the design, including plans and project-specific specifications for the lining system.

1.2.2.2 Responsibilities

The Engineer is responsible for performing the engineering design and preparing the associated drawings and specifications for the lining system. The Engineer is responsible for approving all design and specification modifications and making design clarifications necessitated during construction of the lining system. Design changes will be approved in writing by the Engineer. Design-related issues will be resolved through discussion directed by the Project Manager, with the Engineer responsible for the respective feature. Upon the request of the Project Manager, the Engineer may attend the resolution and pre-construction meetings outlined in Section 1.3 of this CQAM.

1.2.2.3 Qualifications

The Engineer shall be a qualified engineer, certified or licensed as required by regulation. The Engineer shall be familiar with the use of soils and/or geosynthetics, including detailed design methods and procedures. In addition, the Engineer should be familiar with applicable regulatory requirements.

1.2.2.4 Submittals

The Engineer shall submit the project design drawings, specifications and associated engineering calculation reports to the Project Manager. The Engineer shall also submit completed design or specification modification or clarification forms to the Project Manager in a timely manner upon request. Other information may also be required by the Owner.

1.2.3 Geosynthetics Manufacturer

1.2.3.1 Definitions

The Geosynthetics Manufacturer (Manufacturer) is the firm responsible for production of any of the various geosynthetic liner system components outlined in this CQAM. In the case of a geocomposite, the Manufacturer is the firm responsible for combining the components into the final product.

1.2.3.2 Responsibilities

Each Manufacturer is responsible for the production of its geosynthetic product. In addition, each Manufacturer is responsible for the condition of the geosynthetic until the material is accepted by the Project Manager upon delivery. Each Manufacturer shall produce a consistent product meeting the requirements set forth by this CQAM and the Project Specifications. Each Manufacturer shall provide QC documentation for its product as specified in this CQAM.

1.2.3.3 Qualifications

Each Manufacturer shall:

1. Be pre-qualified and approved by the Owner.

2. Provide sufficient production capacity and qualified personnel to meet the demands of the project.

3. Have an internal QC program for its product that meets the requirements presented in this CQAM.

1.2.3.4 Submittals

1.2.3.4.1 Pre-Qualification

A Manufacturer shall meet the following requirements and submit the following information to be considered for pre-qualification:

1. Corporate background and information.

2. Manufacturing capabilities:

   a. Information on plant size, equipment, personnel, number of shifts per day and capacity per shift;

   b. Daily production quantity available for the Owner's facilities;

   c. A list of material properties, including certified test results to that are attached geosynthetic samples; and

   d. A list of at least 15 completed landfill or surface impoundment facilities totaling a minimum of 15,000,000 square feet (ft^2) (1,500,000 square meters [m^2]), for which the Manufacturer has manufactured a geosynthetic. For each facility, the following information shall be provided:

      (1) Name and purpose of facility, its location and date of installation.

      (2) Name of owner, project manager, designer, fabricator (if any) and installer.

      (3) Type of geosynthetic and surface area of geosynthetic manufactured.

      (4) Available information on the performance of the lining system.

3. The Manufacturer's QC manual, including a description of the QC laboratory facilities.

4. The origin (i.e., supplier's name and production plant) and identification (i.e., brand name and number) of resin used to manufacture the product.

1.2.3.4.2 Pre-Installation

Prior to the installation of any geosynthetic material, the Manufacturer shall submit to the Project Manager all QC documentation required by the appropriate section of this CQAM and the Technical Specifications. This documentation shall be reviewed and approved in writing by the Geosynthetics QAC as outlined in Section 1.2.7 of this CQAM before installation can begin.

1.2.4 Earthwork Contractor

1.2.4.1 Definitions

The Earthwork Contractor is the firm responsible for the earthwork associated with site preparation, excavation and subgrade preparation and construction of the soil components of the lining system.

The Earthwork Superintendent is responsible for the Earthwork Contractor's field crew. The Superintendent shall represent the Contractor at all site meetings and shall be responsible for acting as the Earthwork Contractor's spokesman on the project. The Earthwork Superintendent shall be present (onsite) at all times during earthwork activities. In the event that the Earthwork Superintendent cannot be present, the Earthwork Superintendent shall inform the Project Manager, in advance of his/her absence, and designate an alternate on-site individual as the Superintendent capable of acting in the role outlined in this CQAM.

1.2.4.2 Responsibilities

The Earthwork Contractor is responsible for constructing soil components of the lining systems in conformance with the project design and specifications to a condition suitable for geomembrane placement. The Earthwork Contractor may also be responsible for locating and transporting the required earth and granular materials, concrete and piping and for other work, as outlined in the Project Specifications and/or contract documents.

1.2.4.3 Qualifications

The Earthwork Contractor shall be:

1. Pre-qualified and approved by the Owner.

2. Able to provide qualified personnel to meet the demands of the project.

At a minimum, the Earthwork Contractor shall provide an Earthwork Superintendent as described below.

The Earthwork Superintendent must be qualified based on previously demonstrated experience, management ability and authority. The Earthwork Superintendent, unless otherwise approved by the Project Manager, shall have previously managed, at a minimum, two projects that entailed the installation of at least 1,000,000 ft^2 (100,000 m^2) of soil liner or final cover components.

1.2.4.4 Submittals

1.2.4.4.1 Pre-Qualification

To be considered for pre-qualification, the Earthwork Contractor shall provide the following information to the Project Manager:

1. Company background and information.

2. Demonstration of bonding capability.

3. List of outstanding contracts.

4. List of readily available equipment required to perform the work (i.e., scrapers, graders, scarifiers, compactors, discing equipment, water trucks and admixing equipment, if required).

5. List of at least five comparable projects, with the following information for each project:

    a. Name of the facility, its location and date of installation;

    b. Name of project manager or contact person for the installation; and

    c. Description and purpose of installation and definition of contractor's scope of work.

6. Other information required by the Owner's Project Manager.

1.2.4.4.2 Pre-installation

Prior to commencement of the earthwork activities, the Earthwork Contractor shall submit to the Project Manager:

1. Resume of the Earthwork Superintendent to be assigned to this project, including the dates and duration of employment.

2. Schedule of construction activities; the schedule shall be submitted to the Owner at least 30 days prior to construction and shall be revised, as necessary, to reflect new tasks, new initiation dates or new completion dates and re-submitted within 1 week of any such changes.

3. List of specific equipment and personnel to be used on the project.

1.2.4.4.3 Installation

During the installation, the Earthwork Contractor shall be responsible for the submission of the QC documentation recorded during installation.

1.2.4.4.4 Completion

Upon completion of the installation, the Earthwork Contractor shall submit a letter certifying completion of the work in accordance with the project-specific requirements, unless otherwise approved by Owner.

1.2.5 Geosynthetics Installer

1.2.5.1 Definitions

The Geosynthetics Installer is the firm responsible for installation of the geosynthetic components of the lining system. The Geosynthetics Installer may be affiliated with the Manufacturer.

The Geosynthetics Superintendent is responsible for the Geosynthetics Installer's field crew. The Geosynthetics Superintendent shall represent the Geosynthetics Installer at all site meetings and shall act as the Geosynthetics Installer's spokesman on the project.

The Master Seamer shall be the most experienced seamer of the Geosynthetics Installer's field crew. The Master Seamer shall provide direct supervision over less-experienced seamers.

1.2.5.2 Responsibilities

The Geosynthetics Installer shall be responsible for field handling, storing, deploying, seaming, temporary restraining and all other aspects of the geosynthetics installation. The Geosynthetics Installer shall also be responsible for the protection and maintenance of exposed portions of installed geosynthetics until completion of the project(s). The Geosynthetics Installer may also be responsible for transportation of these materials to the site and for anchor systems, if required by the Project Specifications. The Geosynthetics Installer shall be responsible for submittal of the documentation listed in Section 1.2.5.4.

1.2.5.3 Qualifications

The Geosynthetics Installer shall be pre-qualified and approved by the Owner. The Geosynthetics Installer shall be able to provide qualified personnel to meet the demands of the project. At a minimum, the Geosynthetics Installer shall provide a Geosynthetics Superintendent and a Master Seamer as described below.

The Geosynthetics Superintendent must be qualified based on previously demonstrated experience, management ability and authority. The Geosynthetics Superintendent, unless otherwise approved by the Project Manager, shall have previously managed, at a minimum, two installation projects that entailed the installation of at least a total of 1,000,000 ft^2 (100,000 m^2) of polyethylene geomembrane.

For geomembrane installation, all personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests. These seaming tests shall be performed under similar site weather conditions and using seaming methods approved for this project. The Master Seamer shall have experience seaming a minimum of 1,000,000 ft^2 (100,000 m^2) of polyethylene geomembrane using the same type of seaming apparatus to be used at the site.

1.2.5.4 Submittals

1.2.5.4.1 Pre-Qualification

To be considered for pre-qualification, the Geosynthetics Installer shall submit the following information:

1. Corporate background and information.

2. Description of installation capabilities.

    a. Information on equipment (e.g., numbers and types) and personnel (e.g., number of Geosynthetics Superintendents, number of crews);

    b. Average daily production anticipated; and

    c. Samples of field geomembrane seams and a list of minimum values for geomembrane seam properties.

3. List of at least 10 completed facilities, totaling a minimum of 10,000,000 ft^2 (1,000,000 m^2) for which the Geosynthetics Installer has installed geosynthetics. For each installation, the following information shall be provided:

    a. Name and purpose of facility, its location and date of installation;

    b. Name of owner, project manager, designer, manufacturer, fabricator (if any) and name of contact at the facility who can discuss the project;

    c. Name and qualifications of the Geosynthetics Superintendent(s) and Master Seamer of the Geosynthetics Installer's crew(s);

    d. Type of geosynthetic and surface area installed;

    e. Type of seaming and type of seaming apparatus used;

    f. Duration of installation; and

    g. Available information on the performance of the lining system.

4. The Geosynthetics Installer's QC manual.

5. A copy of a letter of recommendation supplied by the geomembrane manufacturer.

1.2.5.4.2 Pre-Installation

Prior to commencement of the installation, the Geosynthetics Installer must submit to the Project Manager:

1. Resume of the Geosynthetics Superintendent to be assigned to the project, including dates, duration of employment and managerial experience as specified in Section 1.2.5.3.

2. Resume of the Master Seamer to be assigned to the project, including dates, duration of employment and square footage of lines seamed as specified in Section 1.2.5.3.

3. A panel layout drawing showing the installation layout, identifying field seams, as well as any variance or additional details that deviate from the engineering drawings. The layout shall be adequate for use as a construction plan and shall include, but not be limited to, dimensions and details.

4. Installation schedule to be submitted to the Owner at least 30 days prior to installation and revised, as necessary, to reflect new tasks, new initiation dates or new completion dates and re-submitted within 1 week of any such changes.

5. A list of personnel performing field seaming operations, including pertinent experience information.

6. All geosynthetic QC certificates as required by this CQAM (unless submitted directly to the Project Manager by the Manufacturer).

7. Certification that extrudate to be used is composed of the same resin type as the geomembrane to be used.

This documentation shall be reviewed and approved in writing by the Geosynthetics QAC, as outlined in Section 1.2.5 of this CQAM, before installation of the geosynthetic can begin.

1.2.5.4.3 Installation

During the installation, the Geosynthetics Installer shall be responsible for the submission of:

1. QC documentation recorded during installation.

2. Subgrade surface acceptance certificates, signed by the Geosynthetics Installer, for each area to be covered by the lining system.

1.2.5.4.4 Completion

Upon completion of the installation, the Geosynthetics Installer shall submit, unless otherwise approved by the Owner:

1. The warranty obtained from the manufacturer of the flexible membrane liner (FML). This warranty shall be submitted to the Project Manager and warranty the material for a period no less than 10 years.

2. An installation warranty to be submitted to the Project Manager. The warranty shall cover the installation for a period of 1 year.

1.2.6 Soil Quality Assurance Consultant

1.2.6.1 Definitions

The Soil QAC is the firm responsible for observing and documenting activities related to the QA of the installation of the soil components of the lining system. The Soil QAC is independent from the Owner. The Soil QAC and Geosynthetics QAC may be the same party.

In this CQAM, the term *Lead Soil Quality Assurance Monitor* (LSM) refers to the engineer who is personally in charge of the soil QA work. In some cases, the duties of the LSM described below may be shared by two individuals: a Soil Quality Assurance Managing Engineer (Soil QAME), located at the headquarters of the Soil QAC, and a Soil Quality Assurance Resident Engineer (Soil QARE), located at the site. The personnel of the Soil QAC also include Soil Quality Assurance Inspectors (Soil QAIs) who are located at the site for construction observation and documentation. Although not located at the site, the Soil QAME shall visit the site often enough to be familiar with the project specifics.

1.2.6.2 Responsibilities

The Soil QAC is responsible for observing and documenting activities related to the QA of the construction of the soil components of the lining systems. The Soil QAC is responsible for the implementation of the Project Quality Assurance Manual (QAM) prepared by the Project Manager. The Soil QAC is also responsible for issuing a certification report, signed by a registered Professional Engineer, as outlined in Section 2.7 of this CQAM. Other duties of the Soil QAC shall include overseeing the soil laboratory testing.

The specific duties of the Soil QAC personnel are as follows:

1. The LSM:

    a. Reviews all design drawings and specifications.

    b. Develops, if necessary, a site-specific addendum for QA of soil components with the assistance of the Project Manager.

    c. Administers the soil portions of the CQAM, including assigning and managing all soil QA personnel, reviews all field reports and provides engineering review of all QA-related issues.

    d. Reviews all changes to design drawings and specifications as issued by the Engineer.

    e. Acts as on-site (resident) representative of the Soil QAC.

    f. Familiarizes all Soil QAIs with the site and the Project QAM, as well as all requirements detailed in the Technical Specifications.

    g. Attends all QA-related meetings, including pre-construction, resolution, daily and weekly meetings.

    h. Reviews the Earthwork Contractor's personnel qualifications for conformance with those qualifications pre-approved for work on site.

i. Manages the preparation of the soil documentation drawings.

j. Reviews the Soil QAIs, daily reports, logs and photographs.

k. Notes any on-site activities that could result in damage to the installed soil components.

l. Reports to the Project Manager and logs, in the daily report, any relevant observations reported by the Soil QAIs.

m. Prepares a daily report.

n. Prepares a daily summary of the soil component quantities installed each day of construction activity.

o. Prepares a summary of soil QA activities at the end of each week of the construction activity.

p. Oversees marking, packaging and shipping of all laboratory test samples.

q. Reviews the results of laboratory testing and makes appropriate recommendations.

r. Designates a Soil QAI to represent the LSM whenever the LSM is absent from the site while operations are ongoing.

s. Reports any unapproved deviations from this CQAM to the Project Manager.

t. Prepares the final certification report.

2. The Soil QAIs:

a. Monitor, log, photograph and/or document all soil component installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the LSM.

b. Monitor the following operations for all soil components:

(1) Material delivery.

(2) Unloading and on-site transport and storage.

(3) Sampling and conformance testing.

(4) Deployment operations.

(5) Condition of the soil components as placed.

(6) Visual observation by walkover of the finished soil components.

(7) Sampling and field-testing of the soil components.

(8) Repair operations, if and when necessary.

c. Document any on-site activities that could result in damage to the constructed soil components. Any problems noted shall be reported as soon as possible to the LSM.

Any differences between the Soil QACs interpretation of the plans and specifications and the Earthwork Contractor's interpretation shall be properly and adequately assessed by the Soil QAC. If such assessment indicates any actual or suspected work deficiencies, the Soil QAC shall inform the Project Manager and the Earthwork Contractor, or the Earthwork Contractor's representative of these deficiencies.

1.2.6.3 Qualifications

The Soil QAC shall be pre-qualified and approved by the Owner. The Soil QAC shall be experienced in the preparation of QA documentation, including QA forms, reports, certifications and manuals.

The Soil QAC's on-site representative (the LSM or Soil QARE) shall have a B.S., M.S. or Ph.D. degree in civil engineering or a related field. The LSM shall also comply with the experience requirements listed in the previous paragraph. The LSM shall be specifically experienced in the installation of soil liners and shall have the necessary training and certification by the Soil QAC in the duties of an LSM. The LSM or one of the LSM's subordinate engineers shall be continually available during construction of the soil lining system, and shall inspect any suspected substandard work promptly when identified by the Soil QAIs. The LSM or LSM's subordinate engineer shall be present and witness initial installation of any significant components, critical aspects of work and all completed components prior to their being buried, covered or otherwise obscured. The LSM shall provide to the Project Manager a list of items that will require inspection in the field.

Soil QAIs shall have specific training in the CQA of engineered soil structures. At a minimum, one of every four monitors shall have a minimum of 1,000,000 ft^2 (100,000 m^2) of field experience in soil liner construction.

1.2.6.4 Submittals

1.2.6.4.1 Pre-Qualification

To be considered for pre-qualification, the Soil QAC shall provide the following information in writing to the Project Manager:

1. Corporate background and information:

    a. General company information.

    b. Proof of insurance:

        (1) Professional liability;

        (2) "Umbrella" coverage; and/or

        (3) Other coverages, as required by statute and/or proposed contractual agreement.

2. QA capabilities:

    a. A summary of the firm's experience in QA, specifically QA of soil components of the liner system.

    b. A summary of QA documentation and methods used by the firm, including sample QA forms, reports, certifications and manuals prepared by the firm.

    c. Resumes of key personnel.

1.2.6.4.2 Pre-Construction

Prior to beginning work on the project, the Soil QAC shall provide in writing to the Project Manager the following:

1. Resumes of personnel to be involved in the project, including LSM and Soil QAIs.

2. Qualifications of the personnel to be designated as the CQA Officer, LSM, QAME, and/or QARE..

3. Proof of the required soil component QA experience of all of the QA personnel.

4. For each Professional Engineer involved in the certification of the construction in any capacity:

    a. Name and work address;

    b. Professional Engineer license number assigned by the State of New York;

    c. Date registration period ends;

    d. Date of first issuance of license; and

    e. Resume of experience related to the types of construction involved in this facility.

5. Components or steps of construction that will be inspected or observed by each of the following:

    a. The LSM;

    b. Subordinate professional engineers; and

    c. Others without professional engineering licenses.

6. Training and instructions that will be given to any QAIs, including instructions to contact the LSM when requirements of the Permit are not being met.

1.2.7 Geosynthetics Quality Assurance Consultant

1.2.7.1 Definitions

The Geosynthetics QAC is a firm independent from the Owner that is responsible for observing and documenting activities related to the QA of the production and installation of the geosynthetic system on behalf of the Owner. The Geosynthetics QAC and Soil QAC may be the same party.

In this CQAM, the term *Lead Geosynthetics Quality Assurance Monitor* (LGM) shall be used to designate the engineer (working for the Geosynthetics QAC) in charge of the geosynthetic QA work. In some cases, the duties of the LGM described below may be shared by two individuals: a Geosynthetics QAME, located at an office of the Geosynthetics QAC, and a Geosynthetics QARE, located at the site. The personnel of the Geosynthetics QAC also include the Geosynthetics QAIs who are located at the site for construction observation and documentation. Although not located at the site, the Geosynthetics QAME shall visit the site often enough to be familiar with the project specifics.

1.2.7.2 Responsibilities

The Geosynthetics QAC is responsible for observing and documenting activities related to the QA of the production and installation of the geosynthetic system. The Geosynthetics QAC is responsible for implementation of the project QAP prepared by the Project Manager. The Geosynthetics QAC is also responsible for issuing a final geosynthetic certification report, signed by a registered Professional Engineer, as outlined in Section 2.7 of this CQAM.

The specific duties of the Geosynthetics QAC personnel are as follows:

1. The LGM:

    a. Reviews all design drawings and specifications.

    b. Reviews other site-specific documentation, including proposed layouts and Manufacturer's and Geosynthetics Installer's literature.

    c. Develops a site-specific addendum for QA of geosynthetics (if necessary) with the assistance of the Project Manager.

d. Administers the geosynthetic portions of the CQAM (e.g., assigns and manages all geosynthetic QA personnel, reviews all field reports and provides engineering review of all QA-related issues).

e. Reviews all changes to design drawings and specifications as issued by the Engineer.

f. Acts as the on-site (resident) representative of the Geosynthetics QAC.

g. Familiarizes all Geosynthetics QAIs with the site and the project QAP, as well as with all requirements detailed in the Technical Specifications.

h. Attends all QA-related meetings (e.g., resolution, pre-construction, daily and weekly).

i. Reviews all Manufacturer and Geosynthetics Installer certifications and documentation and makes appropriate recommendations.

j. Reviews the Geosynthetics Installer's personnel qualifications for conformance with those qualifications pre-approved for work on site.

k. Manages the preparation of the geosynthetic documentation drawing(s).

l. Reviews the calibration certification of the on-site geosynthetic testing equipment, if applicable.

m. Reviews all Geosynthetics QAI daily reports, logs and photographs.

n. Notes any on-site activities that could result in damage to the geosynthetics.

o. Reports to the Project Manager and logs in the daily report any relevant observations reported by the Geosynthetics QAIs.

p. Prepares daily reports.

q. Prepares daily summary of the quantities of geosynthetics installed that day.

r. Prepares weekly summary of geosynthetic QA activities.

s. Oversees the marking, packaging and shipping of all laboratory test samples.

t. Reviews the results of laboratory testing and makes appropriate recommendations.

u. Designates a Geosynthetics QAI to represent the LGM whenever the LGM is absent from the site while operations are ongoing.

v. Reports any unapproved deviations from the CQAM to the Project Manager.

w. Prepares the final certification report.

2. The Geosynthetics QAI:

   a. Monitors, logs, photographs and/or documents all geosynthetic installation operations. Photographs shall be taken routinely and in critical areas of the installation sequence. These duties shall be assigned by the LGM.

   b. Monitors the following operations for all geosynthetics:

      (1) Material delivery.

      (2) Unloading and on-site transport and storage.

      (3) Sampling for conformance testing.

      (4) Deployment operations.

      (5) Joining and/or seaming operations.

      (6) Condition of panels as placed.

      (7) Visual inspection by walkover.

      (8) Repair operations.

c. Monitors and documents the geomembrane seaming operations, including:

    (1) Trial seam.

    (2) Seam preparation.

    (3) Seaming.

    (4) Non-destructive seam testing.

    (5) Sampling for destructive seam testing.

    (6) Field tensiometer testing.

    (7) Laboratory sample marking.

    (8) Repair operations.

d. Documents any on-site activities that could result in damage to the geosynthetics. Any problems noted shall be reported as soon as possible to the LGM.

Any differences between the Geosynthetics QAC's interpretation of the plans and specifications and the Geosynthetics Installer's interpretation shall be properly and adequately assessed by the LGM and shall be reported to the Project Manager. If such assessment indicates any actual or suspected work deficiencies, the LGM shall inform the Project Manager, the Geosynthetics Installer or the Geosynthetics Installer's representative of these deficiencies.

1.2.7.3 Qualifications

The Geosynthetics QAC shall be pre-qualified by the Owner. The Geosynthetics QAC shall be experienced in QA of geosynthetics, with emphasis on polyethylene geomembranes. The Geosynthetics QAC shall be experienced in the preparation of QA documentation, including QA forms, reports, certifications and manuals.

The Geosynthetics QAC's on-site representative (the LGM or Geosynthetics QARE) shall have a B.S., M.S. or Ph.D. degree in civil engineering or a related field. The LGM shall comply with the experience requirements listed in the previous paragraph. The LGM shall be specifically experienced in the installation of geosynthetics and shall be trained and certified by the Geosynthetics QAC in the duties of an LGM. The LGM or the LGM's subordinate engineers shall be continually available during construction activities and shall inspect any suspected substandard work promptly when identified by the Geosynthetics QAIs. The LGM or the LGM's subordinate engineer shall be present and witness initial installation of any significant components, critical aspects of work and all completed components prior to their being buried, covered or otherwise obscured. The LGM shall provide to the Project Manager a list of items that will require inspection in the field.

Geosynthetics QAIs shall be QA personnel who have been specifically trained in the QA of geosynthetics. At a minimum, one of every four monitors (or at least one monitor per project) shall have a minimum of 1,000,000 ft^2 (100,000 m^2) of field experience in polyethylene geomembrane QA.

1.2.7.4 Submittals

1.2.7.4.1 Pre-Qualification

To be considered for pre-qualification, the Geosynthetics QAC shall provide, in writing, the following information:

1. Corporate background and information.

    a. General company information.

2. QA capabilities:

    a. A summary of the firm's experience with geosynthetics.

    b. A summary of the firm's experience in QA, including installation QA of geosynthetics.

    c. A summary of QA documentation and methods used by the firm, including sample QA forms, reports, certifications and manuals prepared by the firm.

    d. Resumes of key personnel.

1.2.7.4.2 Pre-installation

Prior to beginning work on a project, the Geosynthetics QAC must provide the Project Manager with the following information:

1. Resumes of personnel to be involved in the project, including LGM and Geosynthetics QAIs.

2. Proof of professional engineering registration for the engineer to be designated as the CQA Officer, LGM, or QAME.

3. Proof of the required QA experience of all of the QA personnel, with emphasis on polyethylene geomembranes.

4. For each professional engineer involved in the certification of the construction in any capacity:

    a. Name and work address.

    b. Professional Engineer license number assigned by the State of New York.

    c. Date registration period ends.

    d. Date of first issuance of license.

    e. Resume of experience related to the types of construction involved in this facility.

5. Components or steps of construction that will be inspected or observed by each of the following:

    a. The LGM.

    b. Subordinate Professional Engineers and intern engineers.

    c. Others without professional engineering licenses.

6. Training and instructions that will be given to any field observers who are not registered Professional Engineers, including instructions to contact the LGM when requirements of the Permit are not being met.

1.2.8 Construction Quality Assurance Officer

1.2.8.1 Definitions

The CQA Officer will be selected by the Project Manager from the Soil or Geosynthetics QACs, based on the personnel resumes.

1.2.8.2 Responsibilities

The CQA Officer is the individual assigned and has the responsibility for all aspects of CQA Plan implementation. The CQA Officer will report directly to the Project Manager.

1.2.8.3 Qualifications

The CQA Officer should possess a B.S., M.S. or Ph.D. degree in civil engineering or a related field and be registered as a Professional Engineer in the State of New York. The CQA Officer shall have sufficient practical, technical and managerial experience to successfully oversee and implement CQA activities for hazardous waste land disposal facilities. The CQA Officer is expected to make sure that communication of all CQA-related matters is conveyed to and acted upon by the affected organizations.

1.2.9 Soil Quality Assurance Laboratory

1.2.9.1 Definitions

The Soil Quality Assurance Laboratory (Soil QAL) is a firm independent from the Earthwork Contractor or the Owner. The Soil QAL and Geosynthetics QAL may be the same party.

1.2.9.2 Responsibilities

The Soil QAL is responsible for conducting the appropriate laboratory tests, as directed by the LSM. The test procedures shall be done in accordance with the test methods outlined in this CQAM and/or the project QAP. The Soil QAL shall be responsible for providing test results as outlined in this CQAM and the Technical Specifications.

1.2.9.3 Qualifications

The Soil QAL shall be approved by Owner. The Soil QAL shall have properly maintained and regularly calibrated appropriate testing equipment. The Soil QAL shall utilize personnel who are trained and experienced in soil testing fundamentals and are familiar with American Society for Testing and Materials (ASTM) and other applicable test standards. The Soil QAL shall be capable of providing test results within project deadlines throughout the installation phase of the soil components.

The Soil QAL shall submit to the Project Manager sample data and analysis to be used during the laboratory tests.

1.2.9.4 Submittals

The Soil QAL shall submit all test results within project deadlines to the LSM. Soil test results shall be provided verbally to the LSM as soon as possible after test completion. Written test results shall be in an easily readable format and include references to the standard test methods used.

1.2.10 Geosynthetics Quality Assurance Laboratory

1.2.10.1 Definitions

The Geosynthetics QAL is a firm independent from the Project Manager, Manufacturer(s) and Geosynthetics Installer and is responsible for conducting tests on samples of geosynthetics taken from the site. The Geosynthetics QAL and the Soil QAL may be the same party.

1.2.10.2 Responsibilities

The Geosynthetics QAL shall be responsible for conducting the appropriate laboratory tests as directed by the LGM. The test procedures shall be done in accordance with the test methods outlined in this CQAM and/or the project QAP. The Geosynthetics QAL shall be responsible for providing test results as outlined in this CQAM and the Technical Specifications.

1.2.10.3 Qualifications

The Geosynthetics QAL personnel shall have training and experience in testing geosynthetics and be familiar with ASTM, Geosynthetic Research Institute (GRI) and other applicable test standards. The Geosynthetics QAL shall be capable of providing verbal results of destructive seam tests within 24 hours of receipt of test samples and other test results within project deadlines throughout the installation. Destructive seam tests may be performed by the Geosynthetics QAC onsite, providing that the appropriately calibrated equipment and experienced personnel are present, as approved by the Owner. The Geosynthetics QAL shall be approved by the Owner.

1.2.10.4 Submittals

The Geosynthetics QAL shall submit all test results within project deadlines to the LGM. All destructive seam test results shall be submitted to the LGM in written form within 48 hours of receipt of test samples, unless otherwise specified by the Project Manager. Geomembrane destructive test results shall typically be provided verbally to the LGM within 24 hours of receipt of test samples. Written test results shall be in an easily readable format and include references to the standard test methods used.

1.3 Communication

To provide a high degree of quality during installation and to determine that the final product meets all Project Specifications, open channels of communication are essential. This section discusses appropriate lines of communication and describes all necessary meetings.

1.3.1 Lines of Communication

The typical lines of communication necessary during a project are illustrated in Exhibit 1-1 (shown below). The CQA Officer, QAME, QARE LSM and LGM, shall be capable of direct communication with the Project Manager at all times. Access to the Owner shall also be available for issue resolution, if necessary.

1.3.2 Resolution Meeting

Following permit approval and the completion of the construction drawings and specifications for the project, a resolution meeting may be held as determined by the Owner. The resolution meeting is recommended to be held prior to bidding the construction work and should include all parties involved; typically includes the Project Manager, Engineer, LSM/LGM, CQA Officer, QAME(s), QARE(s) and an Owner representative.

The purpose of this meeting is to establish lines of communication, review construction drawings and specifications for completeness and clarity, begin planning for coordination of tasks, anticipate any problems that might cause difficulties and delays in construction and complete the CQAM. All aspects of the design shall be reviewed during this meeting so that clarification and/or design changes may be made before the construction work is bid. In addition, the guidelines regarding QA testing and problem resolution must be known and accepted by all. In addition, design-related issues will be resolved through discussions directed by the Project Manager with the Engineer(s) responsible for the respective feature.

A recommended agenda for the resolution meeting is presented in Exhibit 1-2 (as listed below). The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties. At the discretion of the Owner, the resolution meeting may be waived and the recommended agenda items discussed during the pre-construction meeting.

1.3.3 Pre-Construction Meeting

A pre-construction meeting shall be held at the site prior to baseliner/final cover system installation. Typically, the meeting shall be attended by the Project Manager, Engineer, Earthwork Contractor, Geosynthetics Installer, LSM/LGM and an Owner representative.

The agenda for this meeting should include a review of the Project QAM for any problems or additions. In addition, the responsibilities of each party should be reviewed and clearly understood. A recommended agenda with specific topics for the pre-construction meeting is presented in Exhibit 1-3 (as listed below). The meeting shall be documented by a person designated at the beginning of the meeting, and minutes shall be transmitted to all parties.

An additional meeting, a pre-work conference, may be held at the request of the Project Manager to further define project CQA requirements identified at the pre-construction meeting.

EXHIBIT 1-1
LINES OF COMMUNICATION

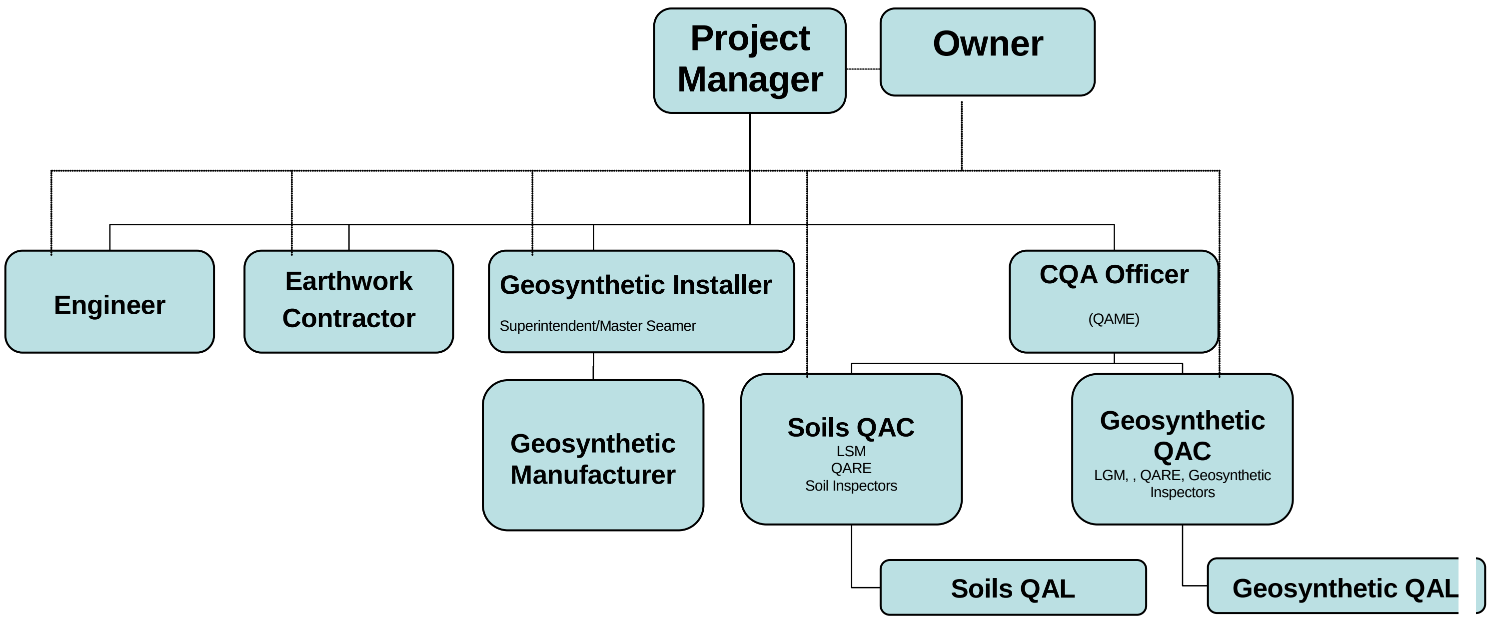

EXHIBIT 1-2
RESOLUTION MEETING AGENDA

1. Introduction

    A. Assign Minute Taker
    B. Identify Parties
        (1.) Project Manager
        (2.) Engineer
        (3.) Soil/Geosynthetics Quality Assurance Consultant
        (4.) Owner Representative
        (5.) Others

2. Tour Project Site

3. Distribute and Review Documents
    A. Design and Construction Drawings
    B. Specifications
    C. Construction Quality Assurance Manuals
    D. Permit Documents

4. Complete Quality Assurance Plan
    A. Project-specific Addendum to Quality Assurance Manual(s)
    B. Project-specific Addendum to Specifications

5. Discuss Contract Administration and Construction Issues

6. Define Lines of Communication

7. Define Project Deliverables

8. Determine Time Schedule

EXHIBIT 1-3
PRE-CONSTRUCTION MEETING AGENDA

1. Introduction

   A. Assign Minute Taker
   B. Identify Parties
      (1.) Project Manager
      (2.) Engineer
      (3.) Surveyor
      (4.) Earthwork Contractor
      (5.) Geosynthetics Installer
      (6.) Soil/Geosynthetics Quality Assurance Consultant
      (7.) Soil/Geosynthetics Quality Assurance Laboratory
      (8.) Owner Representative
      (9.) Others

2. Tour Project Site

3. Distribute and Review Documents
   A. Design and Construction Drawings
   B. Specifications
   C. Geosynthetic Panel Layout
   D. Project Quality Assurance Plan

4. Define Lines of Communication
   A. Lines of Communication
   B. Reporting Methods
   C. Distribution Methods
   D. Progress Meetings
   E. Procedures for Approving Design or Specifications Clarifications and Modifications during Construction

5. Review of Site Requirements
   A. Safety Rules
   B. Site Rules
   C. Work Schedule
   D. Storage of Materials
   E. Available Facilities

Exhibit 1-3 (Continued)
PRE-CONSTRUCTION MEETING AGENDA

6. Discuss Construction Issues
   A. Scope of Work
   B. Review Design
      (1.) Construction Drawings
      (2.) Specifications
      (3.) Geosynthetic Panel Layout
   C. Construction Procedures
      (1.) Proposed Construction Sequencing
      (2.) Development of Soil Test Fill
      (3.) Location of Soil Stockpile Areas
      (4.) Location of Geosynthetic Storage Area
      (5.) Equipment
   D. Construction Schedule
   E. Procedures for Preparing and Approving Change Orders

7. Construction Quality Assurance Plan Specifics
   A. Soils
   B. Geosynthetics
   C. Structural Systems (e.g., risers, piping)

8. Establish Project Deliverables

   A. Responsibilities
      (1.) Engineer
      (2.) Geosynthetics Installer
      (3.) Earthwork Contractor
      (4.) Soil/Geosynthetics Quality Assurance Consultant
      (5.) Soil/Geosynthetics Quality Assurance Laboratory
      (6.) Project Manager

   B. Distribution of Deliverables
   C. Approval Procedures

1.3.4 Progress Meetings

A weekly progress meeting shall be held between the LSM/LGM, Earthwork Contractor's Superintendent, Geosynthetics Installer's Superintendent, Project Manager and any other concerned parties. This meeting shall discuss current progress, planned activities for the next week, issues requiring resolution and any new business or revisions to the work. The first progress meeting shall be held within 1 week of the start of work. The LSM/LGM shall log any problems, decisions or questions arising at this meeting in the meeting minutes. If any matter remains unresolved at the end of this meeting, the Project Manager shall be responsible for the resolution of the matter and the communication of the decision to the appropriate parties. Additional meetings can be called by any of the parties at any time. It is the responsibility of the LSM/LGM to request a meeting if problems arise without resolution.

On-site New York State Department of Environmental Conservation (NYSDEC) personnel will be invited to weekly meetings for the purpose of staying informed on current construction details. Schedules for such meetings will be distributed to the appropriate NYSDEC personnel prior to construction.

1.3.5 Training Program

The Soil and Geosynthetics QACs will provide an on-site training program to CQA personnel and may be observed by on-site NYSDEC monitors. This training program will consist of brief weekly meetings to highlight permit requirements and implementation of QA/QC activities, including construction observations, documentation procedures and data management. An outline of the training program will primarily be based on the preparation of progress reports, as discussed in Section 2.4, which includes those items found in reporting requirements and changes or additions to details. Also, the Soil and Geosynthetics QAC will provide checklists that will serve as guidelines for the CQA inspectors to successfully complete inspection.

2. Documentation

2.1 General

An effective CQAM depends largely on the identification of all construction activities that shall be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of QA activities. The Soil/Geosynthetics QAC shall document that all requirements of the project QAP have been addressed and satisfied.

The Soil/Geosynthetics QAC shall provide the Project Manager with signed descriptive remarks, data sheets and checklists to verify that all monitoring activities have been carried out. The Soil/Geosynthetics QAC shall also maintain at the job site a complete file of all documents that comprise the CQAM, including plans and specifications, checklists, test procedures, daily logs and other pertinent documents.

All testing of soils and geosynthetics shall be performed in accordance with the current version of the test method stated in the Project Specifications or this CQAM.

2.2 Daily Reports

2.2.1 Soils Reports

Each Soil QAI shall complete a daily report and/or logs on prescribed forms that outline(s) the monitoring activities for that day. The report, at a minimum, shall consist of field notes, observations, test data sheets, construction problems and solution data sheets. A summary of all supporting data sheets, as well as with final testing results and the LSM’s approval of the work shall be required upon completion of construction.

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

2.2.2 Geosynthetics Reports

Each Geosynthetics QAI shall complete a daily report and/or logs on prescribed forms that outline(s) the monitoring activities for that day. The precise areas, panel numbers, seam completed and approved and measures taken to protect unfinished areas overnight shall be identified. The location of failed seams or other panel areas requiring remedial action shall be identified with regard to nature of action, required repair and precise location. Repairs completed must also be identified. Any problems or concerns with regard to on-site operations should also be noted. This report must be completed at the end of each inspector's shift prior to his/her leaving the site and be submitted to the LGM.

The Geosynthetics Installer will provide the LGM with daily reports outlining:

1. Total amount of geomembrane deployed and location according to the panel layout drawing.

2. Total amount and location of seam completed, seamer and units used.

3. Changes to the panel layout drawing.

The LGM will provide to the QARE and CQA Officer daily reports outlining, at a minimum, the following:

1. Results of test seam completed.

2. Location (indicated on panel layout drawings) and results of non-destructive/destructive testing.

3. Location and results of repairs.

2.2.3 Daily CQA Summary Report

The QARE shall review the daily reports submitted by the QAIs and incorporate a summary of the reports into the QARE's daily report. Any matters requiring action by the Project Manager shall be identified. The report shall include a summary of the quantities of all material installed that day. This report must be completed daily and summarize the previous day's activities, and a copy must be submitted to the Project Manager at the beginning of the next workday following the report date.

2.3 Test Reports

2.3.1 Soils Field Testing Reports

Records of field and laboratory testing performed on the soil components of the landfill shall be collated by the Soil QAC. A summary list of test results shall be prepared by the Soil QAC on an ongoing basis and submitted with the weekly progress reports.

2.3.2 Geosynthetics Destructive Testing Reports

The destructive test reports from all sources shall be collated by the Geosynthetics QAC. This includes field tests, Geosynthetics Installer's laboratory tests (if performed) and Geosynthetics QAL tests. A summary list of test samples' pass/fail results shall be prepared by the Geosynthetics QAC on an ongoing basis and submitted with the weekly progress reports.

2.4 Progress Reports

Progress reports shall be prepared by the CQA Officer or QARE and submitted to the Project Manager. These reports shall be submitted every week, beginning on the first Friday of soil placement or geosynthetics deployment on site. This report shall include an overview of the progress to date and an outline of any changes made to the plans, drawings or specifications. The report shall also include any problems or deficiencies in installation at the site, an outline of any action taken to remedy the situation, a summary of weather conditions and a brief description of activities anticipated for the next reporting period. All applicable daily reports for the period should be appended to each progress report.

2.4.1 Reporting Requirements

The CQA Officer shall provide the Project Manager the following for submittal to the NYSDEC:

1. Borrow Area(s) Report(s);

2. Geosynthetic clay liner (GCL) Material Properties Report and QC Certifications;

3. GCL Conformance Testing Results Report;

4. Geomembrane Material Properties Report and QC Certificates;
5. Geotextile Conformance Testing Results Report;
6. Geocomposite Properties Report;
7. Geocomposite Conformance Testing Results Report;
8. Geomembrane Installer Qualifications;
9. Certifying Engineers Personnel Information;
10. Inspection of Exposed Surface Following Excavation Report; and
11. Weekly Reports on Construction, including the inspection of all installation practices and QA and QC monitoring:
    a. Clay placement and compaction.
    b. Prepared surface inspection and acceptance.
    c. GCL installation.
    d. Flexible membrane liner.
    e. Geomembrane liner installation and seam testing.
    f. Geotextile installation.
    g. Geocomposite installation.
    h. Placement of granular drainage layers.
    i. Leachate collection pipe installation.
    j. Leachate transfer system installation.
    k. Double containment leachate transmission pipe installation.

l. Miscellaneous installation.

m. Documentation drawings and summary report.

Note: The Project Manager will submit the weekly construction reports to the NYSDEC's Central and Region 9 offices.

2.4.2 Changes or Additions to Details

For all changes and/or additions to details, the Project Manager shall:

1. Obtain verbal approval from NYSDEC representatives;

2. Report changes or additions in weekly progress reports;

3. Obtain written agreement from the Engineer; and

4. Detail changes or additions in record drawings.

Failure to perform any of the above tasks may be basis for qualification of approval by the Commissioner of the NYSDEC.

2.4.3 Punchlist Completion

A punchlist for soils and geosynthetics CQA items shall be prepared by the CQA Officer and submitted to the Project Manager for items to be completed prior to liner placement. The CQA Officer is responsible for punchlist distribution to the QAIs and for the completion of punchlists.

2.5 Documentation Drawings

2.5.1 Soils Drawings

Documentation drawings shall be prepared by the Soil QAC. The documentation drawings shall include, at a minimum, the following information for soils:

1. Measured grade of the prepared subgrade.

2. Measured grade of the clay liner and other soil components.

3. Measured dimensions of any excavation within the subgrade and also within the soil liner.

4. Locations of all field tests and samples obtained for laboratory testing.

5. Locations of all repairs performed on soil components.

6. Location of grade changes relative to site survey grid.

If necessary and for the purpose of clarity in the drawings, separate sheets shall be used to illustrate the locations of test sampling points. The applicable drawings shall be shown in both plan and in cross-section views. A qualified land surveyor shall perform the surveying for all documentation information.

2.5.2 Geosynthetics Drawings

Documentation drawings shall be prepared by the Geosynthetics QAC. The documentation drawings shall include, at a minimum, the following geomembrane information:

1. Dimensions of all geomembrane field panels.

2. The location, as accurate as possible, of each panel relative to the site survey grid (furnished by the Project Manager).

3. Identification of all seams and panels with appropriate numbers or identification codes.

4. Location of all patches and repairs.

5. Location of all destructive testing samples.

The documentation drawings shall illustrate each layer of geomembrane and, if necessary, another drawing shall identify problems or unusual conditions of the GCL, geotextile or geocomposite layers. In addition, applicable cross-sections shall show the layouts of GCL and geocomposites in sump areas or any other areas that are unusual or differ from the design drawings. A qualified land surveyor shall perform the surveying for all documentation information.

2.6 Certification

The Geosynthetics QAC shall provide the following certification items:

1. Geomembrane Acceptance:

   a.) The Geomembrane shall be accepted by the Owner when:

      (1.) The installation is finished;

      (2.) All documentation of installation is completed; and

      (3.) Verification of the adequacy of all field seams and repairs, and associated testing are complete.

   A passing test seam shall be an indicator of the adequacy of the seaming unit and seamer working under prevailing site conditions, but not necessarily an indicator of seam adequacy. A passing non-destructive test of seams and repairs shall be taken to indicate the adequacy of field seams and repairs. If the field tests seams fail the laboratory tests, this failure shall be taken as an indicator of the possible inadequacy of the entire seamed length corresponding to the test seam. Destructive test portions shall then be taken by the Geosynthetics Installer at locations suggested by the LGM, and the same laboratory tests required of test seams shall be performed. Passing tests shall be taken as an indicator of adequate seams. Failing tests shall be an indicator of non-adequate seams, and the seams represented by the destructive test location shall be repaired. The repair shall be non-destructively tested and repaired, as required, until adequacy of the seams is achieved.

   b.) The geomembrane shall be accepted by the NYSDEC when:

      (1.) The installation is finished; and

      (2.) The Engineer's acceptance and supporting documentation are submitted to the NYSDEC by the Owner and the NYSDEC notifies the Owner in writing of its acceptance.

2. Certification of Construction.

The CQA Officer and the Owner will submit to the NYSDEC certification that the unit has been constructed in accordance with the specifications and requirements of the issued permit and the unit is fully capable of operation in accordance with the specifications and requirements of the permit.

2.7 Final Certification Report

Upon completion of the work, the QAC shall submit a final certification report to the Owner. The report shall summarize the duties of the project and document all aspects of the QA program performed.

The final certification report shall include, at a minimum, the following information:

1. Parties and personnel involved with the project.

2. Scope of work.

3. Outline of project.

4. QA methods.

5. Test results (e.g., conformance, destructive and non-destructive, including laboratory tests).

6. NYSDEC/Owner correspondence.

7. Design changes differing from original approved plans and specifications.

8. Certification: stamped and signed by a Professional Engineer registered in New York State.

9. Documentation drawings: stamped and signed by a Professional Engineer registered in New York State.

A recommended outline for the final certification report is given in Exhibit 2-1, below.

Exhibit 2-1
FINAL CONSTRUCTION QUALITY ASSURANCE CERTIFICATION REPORT
GENERAL OUTLINE

1. Introduction
   A. Facility/Unit Description
   B. Scope
   C. Organization of Document

2. Project Design
   A. General Description of Landfill
   B. Liner and Leachate Collection Systems
   C. Leachate Removal and Transfer System

3. Preconstruction Testing and Submittal Review
   A. Scope
   B. Soil Liner Material
   C. Geomembrane
   D. GCL
   E. Geotextiles
   F. Geocomposite
   G. Granular Materials
   H. Leachate Collection and Transfer Pipes
   I. Qualifications of Parties

4. Modifications and Clarifications to the Design and Specifications

5. Record Survey Tolerances

6. Quality Assurance of Work Performed
   (Specific Items for each Cell Construction and Final Cover Construction Component)
   A. Project Specifications
   B. Acceptance of Material
   C. Construction Procedures
   D. Quality Assurance Monitoring
   E. Quality Assurance Testing
   F. Survey

7. Summary and Conclusions

8. Project Certification

9. Figures

10. Appendices
    A. Project Correspondence
    B. Specification/Design Clarification and Modification Forms

Exhibit 2-1 Continued
FINAL CONSTRUCTION QUALITY ASSURANCE CERTIFICATION REPORT
GENERAL OUTLINE

C. Record Drawings
D. Preconstruction Test Results (all applicable materials)
E. Manufacturer Quality Control/Assurance Documentation (all applicable materials)
F. Conformance Test Results (all applicable materials)
G. Subgrade Acceptance Certificates
H. Geosynthetics and/or Soils QAC Personnel
I. Earthwork Contractor Personnel
J. Geosynthetic Contractor Personnel
K. Destructive/Non-Destructive Test Results
L. Geosynthetics Warranty
M. Daily Construction Reports

3. Lining System Acceptance

3.1 Soil Components Acceptance

Upon written recommendation by the Soil QAC, the Project Manager shall consider accepting the soil components of the lining system. The Earthwork Contractor will retain all responsibility for the soil lining components until acceptance by the Owner.

The soil components of the lining system will be accepted by the Owner when:

1. The installation of the soil components is finished.

2. Verification of the adequacy of the constructed components, including repairs, if any, is completed in accordance with the project-specific QAP.

3. All documentation of installation is completed.

4. The Soil QAC is able to recommend acceptance.

The Soil QAC shall certify that installation of the soil components has proceeded in accordance with the project-specific QAP, except as noted by the Project Manager. This certification shall be provided in the final certification report, as outlined in Section 2.7.

3.2 Geosynthetic Components Acceptance

Upon written recommendation by the Geosynthetics QAC, the Project Manager shall consider accepting the geosynthetic components of the lining system, based on the conditions of acceptance described below. At the Owner's discretion, the geosynthetic lining system may be accepted in sections or at points of substantial completion. The conditions of acceptance are described below.

The Geosynthetics Installer and Manufacturer(s) will retain all ownership and responsibility for the geosynthetics in the lining system until acceptance by the Owner.

The geosynthetic lining system will be accepted by the Owner when:

1. The installation of the geosynthetic component of the lining system or section is finished.

2. Verification of the adequacy of all seam and repairs, including the associated testing, is completed.

3. Geosynthetics Installer provides a warranty in accordance with Section 1.2.5.4.4.

4. All documentation of installation is completed.

5. The Geosynthetics QAC recommends acceptance.

The Geosynthetics QAC shall certify that installation has proceeded in accordance with the geosynthetic portions of the project QAP, except as noted to the Project Manager. This certification shall be provided in the final certification report, as outlined in Section 2.7.

4. Soil Liner Material

4.1 Description and Applicability

Soil liner material generally consists of cohesive soils with low hydraulic conductivity and is used as barriers in lining systems. Soils used in soil liners shall consist of clean, select material that is free of trash, excessive coarse particles or other deleterious matter. Soils proposed for liner construction shall be classified as CL or CH in accordance with the Unified Soil Classification System. Soils with an organic content in excess of specifications or soils classified as organic slit or clay (OL, OH) shall not be used as soil liner materials.

4.2 Pre-Qualification Source Testing

Prior to construction of a soil liner, tests to confirm the adequacy of soil liner materials shall be performed on specimens procured from each source area. All material evaluation tests are to be performed in a geotechnical laboratory that may be the Soil QAL or another laboratory approved by the Project Manager. The Project Manager will forward the test results to the NYSDEC for review and approval prior to the installation of the soil liner.

Conformance testing will be performed as specified in Section 4.3 and the Project Specifications. Materials that do not meet minimum required properties shall be rejected. If additional soil liner sources become necessary during the construction, the same material qualification and testing procedures shall be applied to each new source.

The compaction method necessary to achieve the required hydraulic conductivity can be established by defining an acceptable moisture-density range and/or zone. The acceptable moisture-density range is the range of compaction that achieves the specified hydraulic conductivity. Definition of the acceptable range(s) can simplify the field QA work and increase the confidence level in the quality of the field compaction work.

A test fill will be constructed for each new borrow source to establish the placement and compaction procedure to be used during construction in order to achieve the required performance standard. Samples of compacted liner soil obtained from the test fill can be tested for hydraulic conductivity. The testing will establish the acceptability of the liner soil and the construction techniques. The detailed test fill procedure is presented in Appendix A. Alternate placement and compaction methods (i.e., thinner lifts and smaller compaction equipment) may be used for small areas of limited access provided that the specified compaction and hydraulic conductivity can be achieved as demonstrated by in-place density testing and laboratory testing respectively, as appropriate.

4.2.1 Borrow Source Evaluation

Potential borrow sources intended for use in this project shall be excavated to the full extent of the clay deposits in the borrow source and in a manner that will not exceed the limits of these deposits as identified through testing and field observations of the Soil QAC (i.e., test pits and/or soil borings). Test pits and/or soil borings shall be conducted in advance of the excavation to the full depth of the borrow source layer to be excavated. Additional test pits and/or soil borings shall be performed at any location in the borrow source to further define the extent of any unacceptable material, upon the request of the Soil QAC.

The Soil QAC shall record observations made at each test pit and/or soil boring and specifically note the type and thickness of any unsuitable material for segregation during excavation. The Soil QAC shall evaluate the suitability of the material in the area represented by each test pit or soil boring by visual observation and conformance testing results. The Soil QAC shall grant acceptance or qualified acceptance of the represented area of the borrow source prior to excavation of that area.

The Project Manager shall present the recorded field observations, as well as with the conformance testing results of each borrow source to the NYSDEC for review prior to use. Materials identified from test pit and soil boring observations or from observations of the actual borrow source excavation that do not meet the requirements of the Technical Specifications shall be put aside in a separate spoil pile(s) or will be avoided during the borrow source excavation.

4.2.2 Clay Stockpiles

If stockpiles are constructed, suitable clay soil material shall be placed in the designated stockpile areas in a manner that allows control of the material and its moisture content. Materials from different borrow sources or from markedly different sub-areas within one source shall be placed in separate stockpiles. Laboratory compaction tests (i.e., moisture-density relationship) shall be performed on stockpiled clay material prior to placement to establish the acceptable moisture/density zone, as specified in Appendix B.

4.2.3 Compatibility Demonstration

Representative samples of clay soil from each borrow source that were sampled and approved for use for this project by the Soil QAC shall be exposed to leachate samples from Residuals Management Unit 1 (RMU-1) and tested in accordance with the following procedures.

Atterberg limit testing (ASTM D4318) will be performed on two samples of clay soil obtained from each borrow source. On the first sample, Atterberg limit testing will be performed utilizing water, while on the second sample, Atterberg limit testing will be performed utilizing leachate obtained from RMU-1. The results of the two samples will then be reviewed by the LSM. The soil will be determined compatible with the leachate if the Atterberg limit test results for the two samples are within 10% of each other. It is recognized that if the leachate does not significantly alter the soils Atterberg limit properties, then it will have no effect on the permeability of the soil. In the event the Atterberg limit test results for the two samples are not within 10% of each other, the clay soil shall be tested in accordance with USEPA Method 9100 from the latest edition of the USEPA SW-846 using laboratory method ASTM D5084.

Borrow sources previously approved based on Method 9100 testing using secure landfill-12 or RMU-1 leachates are exempt from this requirement.

4.3 Conformance Testing

Conformance testing of the soil liner materials shall be performed to verify the consistency of the properties of the soil received from the borrow source. Conformance testing shall be performed prior to construction and after the completion of any necessary conditioning of the liner soil. Conditioning may include gradation adjustments, addition of admix materials or adjustments in the compaction moisture content.

The following tests should be performed in accordance with the Project Specifications on representative samples from each borrow source.

1. Organic content.

2. Particle size analysis.

3. Moisture content.

4. Atterberg limits.

5. Laboratory compaction.

6. Laboratory (remolded) hydraulic conductivity.

7. Direct shear (Internal Friction Angle).

Samples shall be obtained at least 1,000 cubic yards in advance of the borrow source excavation at the frequencies specified in Section 4.3.1 for each test. The Soil QAC must review the test results for each area of the borrow source and grant acceptance or qualified acceptance for each area based upon test results and field observations prior to commencing excavation of that area. The Soil QAC's acceptance, which includes test results and documented field observations, shall be made available to the NYSDEC for review, upon request.

In the event the soil QAC determines the test results are not in conformance with the project requirements, the soil QAC shall inform the Project Manager. The Project Manager shall accept or reject the soil based on this review and the requirements of the project specifications.

If the proposed soils fail to meet the specified requirements, then, at a minimum, special QC measures may be imposed, such as more frequent or additional tests. Soil amendments or alternative materials may be proposed to the NYSDEC.

4.3.1 Conformance Testing Frequency, Method and Criteria

4.3.1.1 Organic Content

- *Frequency During Construction*: Whenever organic materials are suspected, based on visual observation and cannot be removed (i.e., roots can be removed, peat cannot).

- *Method*: ASTM D2974.

- *Pass Criteria*: Less than 3.0%.

4.3.1.2 Particle Size Analysis (Except Hydrometer)

- *Frequency During Construction*: Every 1,000 cubic yards.
- *Method*: ASTM D422.
- *Pass Criteria*: Similar to material for which the most recent moisture-density curve has been developed.

4.3.1.3 Particle Size Analysis of Fines by Hydrometer

- *Frequency During Construction*: Every 5,000 cubic yards.
- *Method*: ASTM D422.
- *Pass Criteria*: Similar to material for which the most recent moisture-density curve has been developed. *Minimum*: 50% by weight passing No. 200 sieve.

4.3.1.4 Moisture Content (Drying in Oven and Microwave)

- *Frequency During Construction*: Every 1,000 cubic yards.
- *Method*: ASTM D4643 – Microwave; ASTM D2216 – Drying Oven.
- *Pass Criteria*: The results of each test should be compared to the acceptable compaction window to determine that the proper percent compaction and moisture content are being attained.

4.3.1.5 Atterberg Limits (Liquid Limit, Plastic Limit and Plasticity Index of Soils)

- *Frequency During Construction*: Every 1,000 cubic yards.
- *Method*: ASTM D4318.
- *Pass Criteria*: Similar to material for which the most recent moisture-density curve has been developed. Minimum plasticity index of 10 or greater.

4.3.1.6 Laboratory Compaction

- *Frequency During Construction*: Every 5,000 cubic yards, or changes in materials. This frequency may be extended to once every 10,000 cubic yards, if a 1-point Proctor test is determined after 5,000 cubic yards on a sample that is dried to moisture content below the optimum moisture content, upon approval of the Engineer.
- *Method*: ASTM D1557.
- *Pass Criteria*: Results shall be used for in-place density testing.

4.3.1.7 Laboratory Hydraulic Conductivity (Remolded Sample)

Note: The test sample shall be compacted to at least 90% Modified Proctor from 0 to 3% wet of optimum moisture content.

- *Frequency During Construction*: One prior to test fill construction and one at each change in soil characteristics, as documented by ± 5-pound change in the maximum dry density of a laboratory compaction test; based on comparison with a running average of maximum dry densities of previous tests of the same material.
- *Method*: ASTM D5084.
- *Pass Criteria*: Equal to or less than 1×10^{-7} centimeter per second (cm/sec).

4.3.1.8 Direct Shear Tests (Remolded Samples)

Note: The Engineer may delete this test if the soil is being used where strength parameters are not a concern.

- *Frequency During Construction*: Every 5,000 cubic yards and whenever the plasticity index changes. The frequency of every 5,000 cubic yards may be extended by the LSM if the borrow source has been determined to be consistent during the initial construction of this unit.
- *Method*: ASTM D3080.

- *Pass Criteria*: Acceptable material shall have an internal friction angle of at least 25 degrees.

4.4 Subbase Preparation

The Earthwork Contractor shall be responsible for preparing the subbase soil for liner placement in accordance with the requirements of the Project Specifications. Upon completion of the subgrade preparation work, the LSM shall inspect the subbase and prepare a notice of acceptance to be submitted to the Project Manager. In this notice of acceptance, the LSM shall, at a minimum:

1. Verify that a qualified land surveyor has verified all lines and grades.

2. Verify that a qualified engineer has verified that the subbase soil meets the criteria in the Project Specifications.

3. Determine the suitability of the subbase for fill placement by:

    a. Continuous visual inspection during proof rolling.

    b. Pocket penetrometer test in suspected soil areas.

At any time during construction of the liner, the LSM shall indicate to the Project Manager any locations that are not adequate for the placement of the soil liner. Such defects in the subbase soil shall be repaired by the Earthwork Contractor, at the direction of the Project Manager, in accordance with the Project Specifications.

4.5 Construction Observation and Inspection

Observation and inspection of the soil liner construction shall be coordinated with the construction testing described in Section 4.6. Acceptance criteria for construction work shall be as identified in the Project Specifications.

The LSM shall observe, inspect and record the following during the construction of soil liners:

1. Moisture content and consistency of the soil during processing, placement and compaction.

2. Type and level of compactive effort:

   a. Roller type.

   b. Rated Dynamic Force.

   c. Number of passes.

3. Action of compaction equipment on the soil surface (e.g., sheepsfoot penetration, pumping, cracking).

4. Maximum clod size.

5. Condition of any soil stockpile.

6. Loose and compacted lift thickness.

7. Method of tying together the lifts.

8. Dimensions of the compacted embankment.

9. Areas where damage due to excess moisture, insufficient moisture or freezing may have occurred.

10. Additional clay barrier placement requirements to be monitored are provided in Appendix C.

Upon completion of subbase and the soil liner construction, the LSM shall inspect the liner and prepare a certificate of acceptance to be submitted to the Project Manager. The LSM shall verify, at a minimum, the following:

1. A qualified land surveyor has verified all lines and grades on a 50-foot grid pattern. Also, document additional features, such as undercuts and sumps.

2. A qualified engineer has verified that the liner soil meets the criteria in the Project Specifications.

4.6 Construction Testing

All CQA testing shall be conducted in accordance with the Project Specifications or as directed by the Project Manager and as documented in the site-specific addenda to this CQAM. All field and laboratory tests shall be conducted on samples taken from the soil liner materials during the course of the construction work. CQA testing shall consist of field and laboratory testing as described in Sections 4.6.1 and 4.6.2, respectively. Testing and sampling procedures shall be observed and documented by the Soil QAC. Documentation and reporting of test results shall be in accordance with the requirements identified in Section 2.

4.6.1 Field Testing for Soil Compaction and Moisture Content

The Soil QAC shall perform the following field tests on each lift of the compacted soil liner:

Note: The calibration of each nuclear densitometer shall be checked when standard counts on the instrument indicate and as recommended by the equipment manufacturer. The zone of moisture content and density of each instrument shall be checked daily by ASTM D6398. Actual moistures and densities shall be within an acceptable range when compared to the values measured using the nuclear densitometer, as determined by the QAC. Gauge corrections will be made as necessary.

- *Frequency During Construction*: A minimum of 9 per acre per lift, but not less than 1 per 300 cubic yards in long thin areas and one per lift in small fill areas.

- *Method*: ASTM D6398 (nuclear methods), with the probe located at or slightly below the bottom of the upper lift.

- *Pass Criteria*: A minimum of 90% maximum dry density, and as required by the moisture-density range (i.e., zone) determined to meet Project Specifications for hydraulic conductivity (refer to Appendix B).

4.6.2 Laboratory Hydraulic Conductivity

Undisturbed samples (i.e., Shelby tube) shall be obtained from the compacted fill in a manner to avoid over consolidation of samples. Damaged Shelby tubes shall not qualify as laboratory samples. Each sample shall be recovered from a density test location between the probe and source. In addition to hydraulic conductivity, each tube shall be tested for moisture content, dry density, wet density, particle size and Atterberg limits. The laboratory shall report the condition of tube and extruded soil prior to testing. Dry lenses and rocks shall be documented and reported to the LSM.

- *Frequency During Construction*: One per acre per lift, but no less than one per 800 cubic yards in long thin areas.
- *Method*: ASTM D5084.
- *Pass Criteria*: 1 x 10^{-7} cm/sec or less.

4.6.3 Soil Repair and Additional Testing

Unless otherwise noted in the Project Specifications or as directed by the Project Manager, all perforations of the clay liner shall be backfilled with a soil bentonite mixture and be compacted in place with a tamping rod, Modified Proctor hammer or a hand tamper, as specified in the Project Specifications, depending upon the size of the perforation. At a minimum, the Soil QAC shall observe the backfilled areas. Perforations that must be backfilled shall include, but not be limited to, the following:

- Nuclear density test probe locations;
- Drive-cylinder test locations;
- Hydraulic conductivity sampling locations; and
- Survey grade stakes.

At the discretion of the Project Manager, if one or more of the following conditions develop during construction, the frequency of testing shall be increased based on the recommendations from the Soil QAC:

1. Rollers slip during operation.
2. Clay liner material is at improper and/or variable moisture content.
3. Dirt-clogged rollers are used to compact the material.

4. The uniformity of compaction of the material is suspect.

Additional testing may also be considered if the following conditions exist:

1. Weather conditions are adverse.

2. Rollers have not used optimum ballast.

3. Equipment breaks down frequently.

4. Grading is being started or finished.

4.7 Defects and Repairs

At locations where the field density and moisture content testing indicates that compaction is below the requirements of the specifications, the LSM shall determine the extent and the nature of the defect.

If the compacted soil liner has been subject to adverse weather conditions, the LSM shall re-inspect the liner for possible damage, including additional testing, if necessary.

Evaluation of layer bonding may be determined by using test pits to make visual observations. All test pits shall be excavated at least 1 foot in depth and in a manner acceptable to the LSM. All test pits shall be backfilled and compacted in accordance with the Project Specifications. The backfill shall be compacted using hand compaction equipment or other methods approved by the LSM.

4.7.1 Notification

After determining the extent and nature of the defect, the LSM shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held, as needed, between the Earthwork Contractor, the LSM and the Project Manager to assess the problem, review alternative solutions and implement an action plan.

4.7.2 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to the satisfaction of the LSM. If Project Specification criteria cannot be met or unusual weather conditions hinder work, the LSM shall develop and present to the Project Manager suggested solutions for the Project Manager’s approval.

The LSM shall schedule appropriate retests when the work defect has been corrected. All retests shall verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

5. Granular Drainage Media

5.1 Description and Applicability

Granular drainage media consist of high permeable materials as specified in the Project Specifications and are used in leachate collection layers and sumps.

5.2 Quality Control Documentation

Prior to the construction of a granular drainage layer, tests to confirm the adequacy of the granular drainage materials shall be performed on specimens procured from each source area. All material evaluation tests shall be performed in a geotechnical laboratory that may be the Soil QAL or another laboratory approved by the Project Manager. The Earthwork Contractor shall submit the source evaluation test results to the Project Manager for approval.

The following tests shall be conducted in accordance with the methods indicated in the Project Specifications:

1. Particle size (ASTM D1140 and ASTM D422).

2. Laboratory hydraulic conductivity (ASTM D2434).

Unless otherwise indicated in the Project Specifications, one series of these tests shall be performed per source or upon visually observable changes in the material type. If identification of additional drainage material sources becomes necessary during construction, the same material qualification and consistency checking procedures shall be applied to each such source.

5.3 Conformance Testing

Conformance testing of the granular drainage materials shall be performed to establish the consistency of the drainage layer material properties received from the borrow source.

The following tests shall be conducted in accordance with the methods indicated in the Project Specifications:

1. Particle size (ASTM D1140 and ASTM D422).

2. Laboratory hydraulic conductivity (ASTM D2434).

Unless otherwise indicated in the Project Specifications, particle size tests shall be performed on samples collected from in-place materials at a frequency of one per 1,000 cubic yards of drainage layer material placed or upon visually observable changes in the material type. The laboratory hydraulic conductivity tests shall be performed upon visually observable changes in the material type or as required in the Project Specifications.

The LSM shall examine all test results and report any non-conformance to the Project Manager. The Project Manager shall accept or reject the material based on a review and the requirements of the Project Specifications.

5.4 Construction Observation, Testing and Inspection

The Soil QAC shall observe the procedures used by the Earthwork Contractor during placement of the drainage material to determine that the materials are placed at the specified thickness. The thickness of the drainage layer shall be verified by a survey on a 50-foot grid pattern across cell base area by the Soil QAC following completion of the drainage layer placement.

In-place conformance samples will be taken for hydraulic conductivity at a frequency of one sample per 1,000 cubic yards. These samples may be the same samples collected for particle size testing required under Section 5.3. The frequency of in-place samples to be tested for hydraulic conductivity may be increased to one per 5,000 cubic yards by the CQA Officer and the Project Manager based on the results of the QC source evaluation, conformance and in-place testing for each source.

The Soil QAC shall prepare a certificate of acceptance for the drainage layer to be submitted to the Project Manager.

5.5 Defects and Repairs

If a defect is discovered in the final drainage layer product, the LSM shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the LSM shall determine the extent of the deficient area by additional tests, observations, a review of records or other means that the LSM deems appropriate.

5.5.1 Notification

After determining the extent and nature of the defect, the LSM shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held, as needed, between the Earthwork Contractor, the LSM and the Project Manager to assess the problem, review alternative solutions and implement an action plan.

5.5.2 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to the satisfaction of the LSM. If Project Specification criteria cannot be met or unusual weather conditions hinder work, the LSM shall develop and suggest solutions to the Project Manager for his approval.

The LSM shall schedule appropriate retests when the work defect has been corrected. A retest shall verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

6. Operations Layer

6.1 Description and Applicability

The Operations Layer generally consists of non-cohesive soils used to protect the geosynthetic components of the lining systems during waste placement. This cover prevents direct contact between the liner system and the waste materials, as well as between the leachate collection system and the waste materials. The Operations Layer shall consist of select fill material that meets the requirements of the Project Specifications. The Operations Layer material shall not have a particle size or sharp edges that may damage the geosynthetic component. If necessary, processing may be required to remove oversized particles.

6.2 Quality Control Documentation

Prior to construction of the Operations Layer, tests to confirm the adequacy of the proposed materials shall be performed on samples collected from each source area. The LSM shall verify that the grain-size distribution of the Operations Layer material is as specified in the Project Specifications. All required testing shall be performed by the Soil QAL or another laboratory approved by the Project Manager. The Earthwork Contractor shall submit to the Project Manager the results of the source evaluation tests. The material shall be accepted or rejected by the Project Manager based on the results.

The following tests shall be conducted in accordance with the methods indicated in the Project Specifications:

1. Particle size (ASTM D422).

The particle size distribution tests shall be performed at a frequency of one per 20,000 cubic yards of Operations Layer material. If identification of additional sources becomes necessary during construction, the same material qualification and testing procedures shall be applied to each new source.

6.3 Conformance Testing

The Soil QAC shall conduct particle size tests (i.e., ASTM D422) from material at the frequency of one per 5,000 cubic yards of Operations Layer material prior to, or during, placement. The Soil QAC shall report any non-conformance to the Project Manager.

The Project Manager shall accept or reject the material based on a review and the requirements of the Project Specifications.

6.4 Construction Observation and Inspection

The Soil QAC shall verify the Operations Layer thickness by spot-checks and direct measurements after placement. The Soil QAC shall also observe the placement of any geosynthetic that may come in contact with the Operations Layer. The Soil QAC shall prepare a certificate of acceptance for the Operations Layer to be submitted to the Project Manager.

6.5 Defects and Repairs

If a construction defect is discovered in the Operations Layer, the LSM shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the LSM shall determine the extent of the deficient area by additional tests, observations, a review of records or other means that the LSM deems appropriate.

6.5.1 Notification

After determining the extent and nature of the defect, the LSM shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held, as needed, between the Earthwork Contractor, the LSM and the Project Manager to assess the problem, review alternative solutions and implement an action plan.

6.5.2 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to the satisfaction of the LSM. If Project Specification criteria cannot be met or unusual weather conditions hinder work, the LSM shall develop and present to the Project Manager suggested solutions for approval.

The LSM shall schedule appropriate retests when the work defect has been corrected. A retest by the Soil QAC shall verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

7. Vegetative Cover

7.1 Description and Applicability

Vegetative cover material consists of medium-textured soils capable of supporting vegetative growth. The establishment of vegetation will provide the following items:

1. Protection of the soil and/or geosynthetic covers against damage due to frost and excessive temperatures;

2. Reduction in cover erosion due to water and wind; and

3. An aesthetically pleasing appearance to the landfill.

7.2 Quality Control Documentation

Prior to the construction of a vegetative cover layer, the particle size distribution, pH and organic content of soil from each source (one test per source) shall be determined by the Soil QAC and the results shall be submitted to the Project Manager. All testing shall be performed by the Soil QAL.

The Earthworks Contractor shall submit the source data for the proposed seed mix and soil amendments, as identified in the Project Specifications, to the Project Manager for approval. Specific requirements for topsoil, seed mixture, fertilizer and mulch materials, including placement procedures and testing requirements, are included in the Project Specifications.

7.3 Construction Observation and Inspection

The vegetative cover layer shall be placed uniformly to the specified thickness. The firmness of the compacted vegetative cover varies with the type of vegetation specified for the cover, and is indicated in the Project Specifications.

The Soil QAC shall:

1. Verify the thickness of the vegetative cover after placement by direct measurements. The vegetative layer final grades will be verified by surveying.

2. Make certain that care is taken in the vicinity of protrusions to prevent physical damage by the construction equipment.

3. Observe the quantity and the uniformity of any soil amendment incorporated within the tilled depth before seeding.

4. Determine that the seeding application equipment is appropriate for the job. The rate of seed and mulch application, amount and uniformity of coverage and watering instructions shall be observed, as provided in the construction specifications.

5. Examine the perimeter areas to make certain that no bare spots are left.

6. Periodically inspect the cover until the vegetative cover has been established.

If erosion protection is provided through the use of coarse materials (e.g., cobbles, riprap) instead of a vegetative cover, the LSM shall verify that the particle-size distribution is as specified in the Project Specifications.

The LSM shall report any non-conformance to the Project Manager. Upon completion of the vegetative cover layer placement, the Soil QAC shall prepare a certificate of acceptance for the vegetative layer to be submitted to the Project Manager.

7.4 Defect and Repairs

If a defect is discovered in the vegetative cover, the LSM shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the LSM shall determine the extent of the deficient area by additional tests, observations, a review of records or other means that the LSM deems appropriate. If the vegetative cover has been subject to adverse weather conditions during construction, the Soil QAC shall inspect the vegetative cover for possible damage in overly wet or desiccated areas.

7.4.1 Notification

After determining the extent and nature of the defect, the LSM shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held, as needed, between the Earthwork Contractor, the LSM and the Project Manager to assess the problem, review alternative solutions and implement an action plan.

7.4.2 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to the satisfaction of the LSM. If Project Specification criteria cannot be met or unusual weather conditions hinder work, the LSM shall develop and present to the Project Manager suggested solutions for approval.

The LSM shall schedule appropriate retests when the work defect has been corrected. A retest by the Soil QAC must verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

8. General Fill

8.1 Description and Applicability

General fill consists of random granular or cohesive material from on-site excavations, approved off-site excavations or stockpiles that may be used for non-critical applications. General fill consists of a broad range of soils that are relatively free of organics, trash or other deleterious matter. Uses of general fill include facultative pond berm construction, replacement of unsuitable material in subgrade construction beneath soil liners, final cover construction, and other miscellaneous applications as identified on the Drawings. A subset of general fill, referred to as structural fill, will be used to construct the MSE wall and is discussed separately in Section 9.

This section does not identify specific tests to determine the suitability of earth materials for use in general fill. Testing and/or material qualification requirements specified for the general fill material in site-specific Project Specifications shall override the minimum qualifications given in this section.

8.2 Quality Control Documentation

The general fill sources shall be evaluated to determine acceptance with the Project Specifications, as appropriate, for the particular use. Testing may include the compaction characteristics, Direct Shear, remolded permeability, undisturbed sample permeability, and Atterberg limits. The visual inspection and laboratory testing of general fill soil shall be performed and documented by the Soil QAC. If required, the general fill shall be processed to remove particles exceeding the maximum size established in the Project Specifications. The Project Manager shall accept or reject the general fill.

8.3 Construction Observation and Inspection

The Soil QAC shall verify that the requirements of the Project Specifications are met. For unreinforced soil berms (such as around Fac Ponds), this includes minimum field density testing of one test per lift per 600 cubic yards of berm construction. For applications involving thinner placement over large areas, such as final cover construction, a minimum field density testing of nine tests per lift per acre shall be performed. The CQA Officer may request more frequent testing, if necessary. The LSM shall report all non-conformances to the Project Manager.

8.4 Defects and Repairs

If a defect is discovered in the finished general earthwork, the LSM shall determine the extent and the nature of the defect. If the defect is indicated by an unsatisfactory test result, the LSM shall determine the extent of the deficient area by additional tests, observations, a review of records or other means deems appropriate by the LSM. Defective soil is identified as damage to any compacted lift at any time during the construction, such as from weather or rutting under the loads imposed by earth moving equipment.

8.4.1 Notification

After determining the extent and nature of the defect, the LSM shall promptly notify the Project Manager and the Earthwork Contractor. A work deficiency meeting shall be held, as needed, between the Earthwork Contractor, the LSM and the Project Manager to assess the problem, review alternative solutions and implement an action plan.

8.4.2 Repairs and Retesting

The Earthwork Contractor shall correct all deficiencies to the satisfaction of the LSM. If Project Specification criteria cannot be met or unusual weather conditions hinder work, the LSM shall develop and present to the Project Manager suggested solutions for approval.

The LSM shall schedule appropriate retests, if any required, when the work defect has been corrected. A retest by the Soil QAC must verify that the defect has been corrected before any additional work is performed by the Earthwork Contractor in the area of the deficiency.

8.5 Additional Requirements for General Fill to be Used in Final Cover System

General fill is used to construct a separation layer between the final waste surface and the bottom of the final cover system, as well as the majority of the soil thickness above the final cover geosynthetics. General fill to be used in the construction of the final cover system requires additional pre-qualification actions, testing during production, and conformance with additional performance standards. These additional requirements are discussed below. Unless otherwise noted, general fill to be used in the final cover system must comply with the additional requirements discussed below, as well as the general requirements presented above.

8.5.1 General Prequalification Testing

Prior to accepting the proposed general fill material for construction of the final cover system, tests to confirm adequacy of the material shall be performed on samples procured from each borrow area. The Soil QAC shall verify that the grain-size distribution of the material meets the requirements of the project specifications. Additionally, for the general fill to be placed above the final cover geosynthetics, compatibility of the general fill with the underlying geotextile component of the geocomposite drainage layer must be assessed to verify that fines from the general fill will not clog the geotextile.

For cohesive general fill materials, the Soil QAC shall obtain the moisture content of the material at the source, as specified in the project specifications, to evaluate its workability. The Atterberg Limits tests shall be performed on these materials at the frequency specified in the project specifications.

The proposed general fill material shall also be tested to verify that the material meets the minimum required shear strength values contained in the project specifications.

8.5.2 Compaction and Permeability Prequalification Testing for General Fill to be Placed Above Final Cover Geosynthetics

The proposed general fill material shall be tested for compaction characteristics (using standard Proctor, modified Proctor, and reduced Proctor efforts) to understand the range of in-place soil density and optimum moisture contents. Remolded permeability testing shall also be performed with the sample compacted to varying levels of compaction relative to modified Proctor. The range of compaction shall extend from 75 to 95% relative density, at approximately 5% increments (i.e., a total of five permeability tests). This will allow an assessment of the material to be compacted to meet the permeability requirement contained in the project specifications. Remolded samples shall be subject to a confining pressure of 1 psi to simulate anticipated field normal pressures experienced at mid-depth in the general fill layer. These test results shall be used to establish the line of optimums and develop an acceptable zone for compaction as described in Appendix B. The acceptable zone of compaction specifies the range of moisture content and dry unit weight that will allow the soil to achieve an in-place permeability that is less than or equal to the maximum allowable value contained in the project specifications. The lower bound of the acceptable zone of compaction is equal to the required density corresponding to the maximum allowable permeability and will be initially estimated from the remolded permeability test results.

The lower bound will then be refined, if necessary, based on the results of the test fill (discussed below).

Once the acceptable zone of compaction is determined from laboratory test results, a test pad shall be constructed to verify that the actual equipment and compaction methods to be used by the Earthwork Contractor to construct the general fill layer above the final cover geosynthetics can attain field soil densities that are within the acceptable zone of compaction. The test fill shall be constructed and tested as described in Appendix A.

8.5.3 Prequalification Test Results and Reporting

All required testing shall be performed by the Soil QAL or another laboratory approved by the Project Manager. The Earthwork Contractor shall submit to the Project Manager the results of source evaluation tests. The material shall be accepted or rejected by the Project Manager based on the laboratory testing results. If identification of additional soil sources becomes necessary during construction, the same material qualification and testing procedures shall apply for each new source.

8.5.4 Conformance Testing

Conformance testing of the general fill shall be performed to confirm the consistency of the material's physical properties and to verify that the material continues to comply with the specified requirements. The Soil QAC shall conduct particle size tests at the frequency of one per 5,000 yd^3 of material before placement.

The Soil QAC shall report any non-conformance to the Project Manager. The Project Manager shall accept or reject the material based on this review and the requirements of the project specifications prior to construction.

8.5.5 Construction Observation and Inspection for General Fill to be Placed Above Final Cover Geosynthetics

During construction of the general fill layer above the final cover geosynthetics, the Soil QAC shall perform in-situ moisture/density testing of the compacted material at a frequency of nine tests per acre. The Soil QAC shall verify that all moisture/density test results are within the acceptable zone for compaction established by pre-qualification testing. Additionally, the Soil QAC shall collect undisturbed samples from the constructed general fill layer at a frequency of four tests per acre for laboratory permeability testing. The Soil QAC shall notify the Project Manager of any unacceptable moisture/density test results, and the area shall be recompacted and retested until acceptable moisture/density test results are obtained.

The Soil QAC shall verify the general fill thickness by spot checks and direct measurements after placement. The Soil QAC shall also observe the placement of any geosynthetic the general fill may come in contact with. The Soil QAC shall prepare a certificate of acceptance for the protective layer to be submitted to the Project Manager.

9. Mechanically Stabilized Earth Wall

9.1 Description and Applicability

A mechanically stabilized earth (MSE) wall will be constructed as the perimeter berm for RMU-2. Because of the reinforcing properties of the Geosynthetics used in the MSE wall, the outboard sideslope of the MSE wall can be significantly steeper than the outboard sideslope of a general soil fill perimeter berm. For RMU-2, the outboard sideslope of the MSE wall will be 1:4 (approximately 76 degrees). The interior sideslope of the MSE wall will be 3:1 to provide required liner system stability. Components of the MSE wall include welded wire form facing units, geosynthetic reinforcement (i.e., geogrid), aggregate, and structural fill.

This section does not identify specific tests to determine the suitability of MSE wall construction components nor the minimum performance standards. Testing and/or material qualification requirements specified for the MSE wall components are contained in Section 02450 – Mechanically Stabilized Earth (MSE) Wall of the Project Specifications.

9.2 Structural Fill Pre-Qualification Source Testing

The majority of the MSE wall shall be constructed of structural fill, which is a subset of general fill with additional shear strength requirements. Structural fill may consist of either on-site or imported material meeting the minimum project requirements. Prior to construction of the MSE wall, tests to confirm the adequacy of structural fill materials shall be performed on specimens procured from each source area. Pre-qualification testing shall include one sample each for soil classification, Atterberg limits (if cohesive), particle size distribution, internal shear strength (consolidated drained and consolidated undrained), and compaction characteristics. All material evaluation tests are to be performed in a geotechnical laboratory that may be the Soil QAL or another laboratory approved by the Project Manager. The Project Manager will forward the test results to the NYSDEC for review and approval prior to the construction of the MSE wall.

9.3 Construction Material Conformance Testing

Conformance testing of the various materials associated with the MSE wall construction shall be performed to verify the consistency of the properties of the materials. Conformance testing shall be performed prior to and throughout construction at the indicated frequencies to verify that materials continue to meet the minimum requirements. Materials that do not meet minimum required properties shall be rejected. If other sources or products become necessary during the construction, the same material qualification and testing procedures shall be applied to each new source or product. Conformance testing for the various construction materials are discussed separately below.

9.3.1 Structural Fill Material

The structural fill material shall meet the requirements of Technical Specification 02210, Article 2.07 and Technical Specification 02450, Article 2.03.A. Conformance testing shall be performed in accordance with the Project Specifications on representative samples of soil from each borrow source as summarized in the following table.

Conformance Test	Frequency
Particle Size Analysis	1 test per 5,000 cubic yards
Atterberg Limits	1 test per 5,000 cubic yards
Laboratory Compaction (Modified Proctor)	1 test per 5,000 cubic yards

The Soil QAC must review the test results for each area of the borrow source and grant acceptance or qualified acceptance for each area based upon test results and field observations prior to commencing excavation of that area. The Soil QAC's acceptance, which includes test results and documented field observations, shall be made available to the NYSDEC for review, upon request.

In the event the soil QAC determines that the test results are not in conformance with the project requirements, the soil QAC shall inform the Project Manager. The Project Manager shall accept or reject the soil based on this review and the requirements of the project specifications.

If the proposed soils fail to meet the specified requirements, then, at a minimum, special QC measures may be imposed, such as more frequent or additional tests. Soil amendments or alternative materials may be proposed to the NYSDEC.

9.3.2 NYSDOT #4 Stone

NYSDOT #4 stone shall be used to backfill the welded wire form facing units. The stone shall meet the requirements of Technical Specification 02450, Article 2.03.B. Conformance testing shall be performed in accordance with the Project Specifications on representative samples of stone from each borrow source as summarized in the following table.

Conformance Test	Frequency
Particle Size Analysis	1 test per 5,000 cubic yards

If the proposed material fails to meet the specified requirements, then, at a minimum, special QC measures may be imposed, such as more rejecting the portion of the material stockpile represented by the failing sample, frequent or additional tests, or identification of an alternate source. Such measures shall be proposed to the NYSDEC for approval.

9.3.3 NYSDOT #2 Stone

NYSDOT #2 stone shall be used to construct a pad at the toe of the MSE wall. The stone shall meet the requirements of Technical Specification 02450, Article 2.03.C. Conformance testing shall be performed in accordance with the Project Specifications on representative samples of stone from each borrow source as summarized in the following table.

Conformance Test	Frequency
Particle Size Analysis	1 test per 5,000 cubic yards

If the proposed material fails to meet the specified requirements, then, at a minimum, special QC measures may be imposed, such as rejecting the portion of the material stockpile represented by the failing sample, more frequent or additional tests, or identification of an alternate source. Such measures shall be proposed to the NYSDEC for approval.

9.3.4 NYSDOT #1 Stone

NYSDOT #1 stone shall be used as a filter between NYSDOT #4 stone and the structural fill. The stone shall meet the requirements of Technical Specification 02450, Article 2.03.D. Conformance testing shall be performed in accordance with the Project Specifications on representative samples of stone from each borrow source as summarized in the following table.

Conformance Test	Frequency
Particle Size Analysis	1 test per 5,000 cubic yards

If the proposed material fails to meet the specified requirements, then, at a minimum, special QC measures may be imposed, such as rejecting the portion of the material stockpile represented by the failing sample, more frequent or additional tests, or identification of an alternate source. Such measures shall be proposed to the NYSDEC for approval.

9.3.5 Geosynthetic Reinforcement Material

The geosynthetic reinforcement material consists of geogrids manufactured for soil reinforcement applications meeting the requirements of Technical Specification Section 02450, Article 2.02. The geogrid may be manufactured from high-density polyethylene (HDPE) or high-tenacity polyester yarn. Prior to delivery of the rolls of geogrid, the LGM shall obtain one random conformance test sample from each geogrid material type to evaluate the coefficient of interaction with the proposed structural fill and verify that the proposed geogrid achieves the minimum value contained in the Project Specifications. The sample(s) shall be forwarded to the Geosynthetics QAL for testing to verify conformance with the Project Specifications.

The Geosynthetics QAC may perform the conformance test sampling at the manufacturing plant, if approval is granted by the Project Manager. This can be advantageous in expediting the installation process for large projects.

9.4 Subbase Preparation

The Earthwork Contractor shall be responsible for preparing the subbase soil for MSE wall construction in accordance with the requirements of the Technical Specifications. Upon completion of the subbase preparation work, the LSM shall inspect the subbase and prepare a notice of acceptance to be submitted to the Project Manager. In this notice of acceptance, the LSM shall, at a minimum:

1. Verify that a qualified land surveyor has verified all lines and grades.

2. Verify that a qualified engineer has verified that the subbase soil meets the criteria in the Project Specifications.

3. Determine the suitability of the subbase for fill placement by:

    a. Continuous visual inspection during proof rolling.

b. Pocket penetrometer test in suspected soil areas.

At any time during construction of the liner, the LSM shall indicate to the Project Manager any locations that are not adequate for subsequent construction of the MSE wall. Such defects in the subbase soil shall be repaired by the Earthwork Contractor, at the direction of the Project Manager, in accordance with the Technical Specifications.

9.5 Construction Observation and Inspection

Observation and inspection of the MSE wall construction shall be coordinated with the construction testing described in Section 9.6. Acceptance criteria for construction work shall be as identified in the Technical Specifications.

The LSM shall observe, inspect and record the following during the construction of the MSE wall:

1. Moisture content and consistency of the structural fill material during placement and compaction.

2. Source, material type, identification markings and condition of geosynthetic reinforcement material.

3. Type and level of compactive effort for structural fill material:

    a. Roller type.

    b. Rated dynamic force.

    c. Number of passes.

4. Action of compaction equipment on the soil surface (e.g., sheepsfoot penetration, pumping, cracking).

5. Condition of soil/aggregate stockpiles.

6. Loose and compacted lift thicknesses of structural fill.

7. Dimensions of the compacted embankment.

8. Areas where damage due to excess moisture, insufficient moisture or freezing may have occurred.

Upon completion of subbase and the MSE wall construction, the LSM shall inspect the MSE wall and prepare a certificate of acceptance to be submitted to the Project Manager. The LSM shall verify, at a minimum, the following:

1. A qualified land surveyor has verified all lines and grades as presented on the Drawings.

2. A qualified engineer has verified that the MSE wall meets the criteria in the Project Specifications.

9.6 Construction Testing

All CQA testing shall be conducted in accordance with the Project Specifications or as directed by the Project Manager. All field and laboratory tests shall be conducted on samples taken from materials during the course of the construction work. CQA testing shall consist of field testing as described in Section 9.6.1. Testing procedures shall be observed and documented by the Soil QAC. Documentation and reporting of test results shall be in accordance with the requirements identified in Section 9.6.2.

9.6.1 Field Testing for Soil Compaction and Moisture Control

The Soil QAC shall perform field density tests on each lift of the compacted structural fill material as indicated in the table below. Moisture/density tests shall be staggered across the surface of each lift such that representative test results are obtained from the inside, center and outside areas of each lift.

Test	Frequency
In-Place Field Density (Modified Proctor)	1 test per lift per 50 linear feet of wall

Notes:

1. The calibration of each nuclear density gauge shall be checked when standard counts on the instrument indicate that calibration is required and as recommended by the equipment manufacturer. The zone of moisture content and density of each instrument shall be checked daily by ASTM D2216 and ASTM D2937, respectively. Actual moistures and densities shall be within an acceptable range when compared to the values measured using the nuclear density gauge, as determined by the Soils QAC. Gauge corrections will be made as necessary.
2. Moisture/density probe shall be located at or slightly below the bottom of the upper lift.

9.6.2 Additional Testing

At the discretion of the Project Manager, if one or more of the following conditions develop during construction, the frequency of testing shall be increased based on the recommendations from the Soil QAC:

1. Rollers slip during operation.
2. Structural fill is at improper and/or variable moisture content.
3. Dirt-clogged rollers are used to compact the material.
4. The uniformity of compaction of the material is suspect.

Additional testing may also be considered if the following conditions exist:

1. Weather conditions are adverse.
2. Rollers have not used optimum ballast.
3. Equipment breaks down frequently.
4. Grading is being started or finished.

9.7 Defects and Repairs

At locations where the field density and moisture content testing indicates that compaction is below the requirements of the specifications, the LSM shall determine the extent and the nature of the defect. If the compacted structural fill material has been subject to adverse weather conditions, the LSM shall re-inspect the surface of the exposed layer for possible damage and perform additional testing, if necessary.

The Soils QAC shall immediately report any damaged or defective portions of in-place welded wire form facing material and/or geosynthetic reinforcement material to the Project Manager and the Earthwork Contractor. Any identified damaged or defective areas shall be repaired and/or replaced by the Earthwork Contractor in accordance with the Technical Specifications.

10. Geomembranes

10.1 Description and Applicability

Geomembranes are low hydraulic conductivity barriers used in lining systems. This section is applicable to smooth HDPE, roughened HDPE and co-extruded HDPE geomembranes. This section is not applicable to other geomembrane materials, including Hypalon, polyvinyl chloride and very low-density polyethylene.

10.2 Manufacturer's Plant Inspection

The purpose of the plant inspection is to review the manufacturing process and QC procedures implemented during the manufacturing of the geomembrane. The Owner may conduct an inspection of the Manufacturer's plant. In addition, the Project Manager or the Project Manager's designated representative may visit the manufacturing plant for a project-specific inspection, if deemed necessary. If possible, the project-specific inspection shall be conducted prior to or during the manufacturing of the geomembrane rolls for the project.

The manufacturing plant inspection shall include:

1. Verification that properties guaranteed by the Manufacturer meet all Project Specifications.

2. Verification that the measurement of properties by the Manufacturer is properly documented and the test method used is acceptable.

3. Spot inspection of the rolls and verification that they are free of imperfections or any sign of contamination by foreign matter.

4. Review of the handling, storage and transportation procedures and verification that the procedures will not damage the geomembrane.

5. Verification that roll packages have a label indicating the name of the manufacturer, type of geomembrane, thickness, roll number and roll dimensions.

6. Verification that extrusion rods and/or beads are produced from the same base resin type as the geomembrane.

A report describing the inspection shall be retained by the Owner for annual inspections and by the Project Manager for project-specific inspections.

10.3 Quality Control Documentation

Prior to the installation of any geomembrane material, the Geosynthetics Manufacturer or Geosynthetics Installer shall provide the Project Manager with the following information:

1. The origin (i.e., supplier's name and production plant) and identification (i.e., brand name and number) of the resin.

2. Copies of dated QC certificates issued by the resin supplier.

3. Results of tests conducted by the Manufacturer to verify that the resin used in the manufacture of the geomembrane meets the Project Specifications for melt flow index and density.

4. A statement indicating that the amount of reclaimed polymer added to the resin during manufacturing was done with appropriate cleanliness and did not exceed 2% by weight.

5. A list of the materials that comprise the geomembrane expressed as percent by weight of polyethylene, carbon black and other additives.

6. A specification for the geomembrane that includes all properties contained in the Project Specifications, measured using the appropriate test methods.

7. A written certification that states that the minimum values given in the specification are guaranteed by the Manufacturer.

8. QC certificates signed by a responsible party employed by the Manufacturer. Each QC certificate shall include roll identification numbers, testing procedures and results of QC tests. At a minimum, results shall be given for:

    a. Density.

    b. Carbon black content.

c. Carbon black dispersion.

d. Thickness.

e. Tensile properties.

f. Tear strength.

g. Puncture strength.

These QC tests shall be performed in accordance with the test methods as specified in the Project Specifications for every 40,000 ft^2 (4,000 m^2) of geomembrane produced.

Additional QC tests consisting of Dimensional Stability, Low Temperature Brittleness and Multi-Axial Elongation shall be performed in accordance with the Project Specifications at a frequency of 1 test per resin blend.

The Manufacturer shall identify the rolls of geomembrane with the following:

1. Manufacturer's name.
2. Product identification.
3. Thickness.
4. Roll number.
5. Roll dimensions.

The LGM shall review and approve in writing these documents and shall report any discrepancies with the above requirements to the Project Manager. The LGM shall verify the following:

1. Property values certified by the Manufacturer meet Project Specifications.
2. Measurements of properties by the Manufacturer are documented, and the test methods used are acceptable.

3. QC certificates have been provided at the specified frequency for the rolls and each certificate identifies the rolls related to it.

4. Rolls are appropriately labeled.

10.4 Conformance Testing

Upon delivery of the rolls of geomembrane, the LGM shall obtain conformance test samples from the geomembrane. The samples shall be forwarded to the Geosynthetics QAL for testing to verify conformance with the Project Specifications.

The Geosynthetics QAC may perform the conformance test sampling at the manufacturing plant, if approval is granted by the Project Manager. This can be advantageous in expediting the installation process for large projects.

The following conformance tests shall be performed in accordance with the test methods, as specified in the Project Specifications:

1. Density.

2. Carbon black content.

3. Carbon black dispersion.

4. Thickness.

5. Tensile characteristics.

Interface shear strength testing shall be performed in accordance with Project Specifications, at a frequency of 1 test per material type.

10.4.1 Sampling Procedures

The LGM shall select the rolls to be sampled. Samples shall be taken across the entire width of the roll and shall not include the first 3 feet of the roll. Unless otherwise specified, samples shall be 3 feet long by the roll width. The LGM shall mark the machine direction on the samples with an arrow.

Except for interface shear strength testing, samples shall be taken at a minimum rate of one per lot or one test per 100,000 ft^2 of geomembrane. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. A lot may be designated by the LGM based on a review of the roll information, including QC documentation and manufacturing records.

10.4.2 Test Results

All conformance test results shall be reviewed and approved in writing, and the material accepted or rejected by the LGM prior to the deployment of the geomembrane. The LGM shall report any non-conformance to the Project Manager.

If a test result is in non-conformance, the material from that lot represented by the failing test should be considered out of specification and rejected. At the option of the Project Manager and at the Geosynthetics Manufacturer’s expense, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when the rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If the additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If the additional tests fail, the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetics QAL conducting the tests, the Geosynthetics Manufacturer may request that the sample be re-tested by the Geosynthetics QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. This re-testing shall be done at the expense of the Geosynthetics Manufacturer. The Geosynthetics Manufacturer may have the same sample re-tested at two different Owner-approved Geosynthetics QALs. If both laboratories produce passing results, the material shall be accepted; otherwise, the original Geosynthetics QAL’s test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval by Project Manager.

10.5 Subgrade Preparation

10.5.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the supporting soil for geomembrane placement. The Project Manager shall coordinate the work of the Earthwork Contractor and the Geosynthetics Installer so that the requirements of the Project Specifications and the project QAP are met.

Prior to the installation of the geomembrane, the LGM shall verify the following:

1. A qualified land surveyor has verified all lines and grades.

2. The LSM has verified that the supporting soil meets the criteria in the Project Specifications.

3. The surface to be lined has been rolled, compacted or hand-worked and is free of irregularities, protrusions, loose soil and abrupt changes in grade.

4. Sufficient leak locator probes have been installed on the surface to be lined. The leak locator probes shall be provided by the Leak Location Contractor and installed by the LGM in the locations determined by the Leak Location Contractor.

The Geosynthetics Installer shall certify, in writing, that the surface on which the geomembrane will be installed is acceptable. A certificate of acceptance shall be provided by the Geosynthetics Installer to the LGM prior to the deployment of the geomembrane in the area under construction. The LGM shall provide the Project Manager with a copy of this certificate.

After the supporting soil has been accepted by the Geosynthetics Installer, it is the Geosynthetics Installer’s responsibility to indicate to the Project Manager any change in the supporting soil condition that may require repair work. The Project Manager may consult with the LGM regarding the need for repairs. If the LGM concurs with Geosynthetics Installer, the Project Manager shall verify that the supporting soil is repaired. At any time prior to or during the geomembrane installation, the LGM shall indicate to the Project Manager any locations that may not be adequately prepared for the geomembrane.

Prior to the installation of geomembranes over GCL, the LGM shall verify the following:

1. The surface of the GCL is free of debris that may potentially damage the geomembrane.

2. The GCL has not become hydrated beyond the limits specified in the Technical Specifications.

3. Seaming and overlapping requirements of installed GCL are maintained.

10.5.2 Anchor Trench

The LGM shall verify that the anchor trench has been constructed according to the Design Drawings and Project Specifications. If the anchor trench is excavated in a clay material that is susceptible to desiccation, the amount of anchor trench open at any time shall be minimized. The LGM shall inform the Project Manager of any signs of significant desiccation associated with the anchor trench construction. The anchor trench shall be adequately drained to prevent ponding or softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted as specified in the Project Specifications.

When backfilling the anchor trenches, care shall be taken to prevent any damage to the geosynthetics. A Geosynthetics QAI shall observe the backfilling operation and advise the Project Manager of any problems. Problems shall be documented by the Geosynthetics QAI in a daily report.

10.6 Geomembrane Deployment

10.6.1 Panel Nomenclature

A field panel is defined as a unit of geomembrane that is to be seamed in the field (i.e., a field panel is a roll or a portion of a roll cut in the field).

The LGM shall make certain that each field panel is given an identification code (i.e., number or letter-number) consistent with the layout plan. The identification code shall be agreed upon by the Project Manager, Geosynthetics Installer and LGM. The LGM shall establish a table or chart showing the relationship between roll numbers and field panel identification codes. The field panel identification code shall be referenced on all QA records.

The LGM shall verify that field panels are installed at the locations indicated on the Geosynthetics Installer's layout plan as approved by the Project Manager. The LGM shall record the identification code, location and date of installation of each field panel.

10.6.2 Panel Deployment Procedure

The LGM shall review the panel deployment progress of the Geosynthetics Installer (keeping in mind issues relating to wind, rain, clay liner desiccation and other site-specific conditions). The LGM shall advise the Project Manager on the compliance with the approved panel layout drawing and the suitability to the actual field conditions. Once approved, the Project Manager can authorize changes to the panel deployment procedure. The Geosynthetics QAI shall verify that the condition of the supporting soil does not change detrimentally during installation.

To protect against wind damage, a temporary hold-down (i.e., sandbagging, tires or other means as approved by the Project Manager) will be used during geomembrane installation. The selected temporary hold-down method will not damage or cause leakage on liner surfaces or other materials (i.e., clay liner). Sand used in sandbags shall be well graded and clean sand with a maximum particle size of 0.25 inches by visual inspection. The source of the sand will be approved by the Project Manager.

10.6.3 Deployment Weather Conditions

Geomembrane deployment shall not be undertaken if weather conditions will preclude material seaming following deployment (see Section 10.7.5). Ambient temperature shall be measured by the Geosynthetics QAI in the area where the panels are to be deployed. The LGM shall inform the Project Manager of any weather-related problems that may not allow geomembrane placement to proceed.

10.6.4 Method of Deployment

Before the geomembrane is handled on site, the Geosynthetics QAC shall verify that the handling equipment to be used on the site is adequate and does not pose a risk of damage to the geomembrane. During the handling, the Geosynthetics QAC shall observe and verify that the Geosynthetics Installer's personnel handle the geomembrane with care.

The Geosynthetics QAC shall verify the following:

1. Any equipment used on the liner does not damage the geomembrane by handling, excessive heat, leakage of hydrocarbons or other means.

2. The prepared surface underlying the geomembrane has not deteriorated since previous acceptance and is still acceptable immediately prior to geomembrane placement.

3. Any geosynthetic element immediately underlying the geomembrane is clean and free of debris.

4. No personnel shall smoke or wear damaging shoes while working on the geomembrane or engage in other activities that could damage the geomembrane.

5. The method used to unroll or adjust the panels does not cause excessive scratches or crimps in the geomembrane and does not damage the supporting soil.

6. The method used to deploy geomembrane panels does not adversely impact the leak locator probes installed on the approved surface to be lined.

7. The method used to place the panels minimizes wrinkles, especially differential wrinkles between adjacent panels.

8. Adequate temporary loading and/or anchoring (e.g., sand bags, tires) have been placed to prevent uplift by wind.

9. Direct contact with the geomembrane is minimized, and the geomembrane is protected by geotextiles, extra geomembrane or other suitable materials in areas where excessive traffic may be expected.

The LGM shall inform the Project Manager if the above conditions are not fulfilled.

10.6.5 Damage and Defects

Upon delivery to the site, the Geosynthetics QAC shall conduct a surface inspection of the rolls for defects and for damage. The inspection shall be conducted without unrolling the rolls unless defects or damages are found or suspected. The LGM shall advise the Project Manager, in writing, of any rolls or portions of rolls that should be rejected and removed from the site due to severe flaws and/or minor repairable flaws.

The Geosynthetics QAC shall inspect each panel after placement and prior to seaming for damage and/or defects. The LGM shall advise the Project Manager on which panels or portions of panels should be rejected, repaired or accepted. Damaged panels or portions of damaged panels that have been rejected shall be marked and removed from the work area and recorded by the Geosynthetics QAC. Repairs shall be made using procedures described in Section 10.10.

10.6.6 Writing on the Liner

The Geosynthetics Installer and the Geosynthetics QAC shall use different colored markers that are readily visible for writing on the geomembrane. The Geosynthetics Installer shall use a white marker and the Geosynthetics QAC shall use a yellow marker to write on the geomembrane. The markers used must be semipermanent and compatible with the geomembrane.

10.7 Field Seaming

10.7.1 Seam Layout

Before installation begins, the Geosynthetics Installer shall provide the Project Manager and the Geosynthetic QAC with a panel layout diagram. This diagram shall consist of a to-scale plan view of the area to be lined, the direction of slopes, the orientation of geomembrane panels, and the planned location of seams. The LGM shall review the panel layout diagram for acceptance with the project requirements and accepted state-of-practice. No panels shall be deployed or seamed until the Project Manager has reviewed and approved the Geosynthetics Installer’s panel layout diagram. In addition, panels not specifically shown on the panel layout drawing may not be used without the Project Manager’s prior approval. The Geosynthetics QAC shall use a seam numbering system compatible with the panel numbering system.

In general, seams should be oriented parallel to the line of maximum slope (i.e., oriented along, not across, the slope). In corners and odd-shaped geometric locations, the number of seams should be minimized. No horizontal seam should be less than 5 feet from the toe of the slope or from areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

10.7.2 Accepted Seaming Methods

Approved processes for field seaming are extrusion welding and fusion welding. Proposed alternate processes shall be documented and submitted by the Geosynthetics Installer to the Project Manager for approval. Apparatus that have been specifically approved by make and model shall be used. The Project Manager shall submit documentation regarding the seaming methods to be used to the LGM for review.

Temporary bonding by leistering shall be performed in accordance with Appendix E, Leister Bond Procedures.

10.7.2.1 Extrusion Process

The Geosynthetics QAC shall log ambient temperature, seaming apparatus temperature and geomembrane surface temperature at appropriate intervals and report any non-compliance to the Project Manager.

The Geosynthetics QAC shall verify the following items:

1. Equipment used for seaming is not likely to damage the geomembrane.

2. Prior to beginning a seam, the extruder is purged until all heat-degraded extrudate has been removed from the barrel.

3. Clean and dry welding rods or extrudate pellets are used.

4. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

5. Grinding shall be completed no more than 1 hour prior to seaming.

6. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the geomembrane.

7. The geomembrane is protected from damage in heavy traffic areas.

8. Exposed grinding marks adjacent to an extrusion weld shall be minimized. In no instance shall exposed grinding marks extend more than ¼ inch from the finished seamed area.

9. In general, the geomembrane panels are aligned to have a nominal overlap of 3 inches (715 millimeters) for extrusion welding. The final overlap shall be sufficient to allow peel tests to be performed on the seam.

10. No solvent or adhesive is used.

The procedure used to temporarily bond adjacent panels together does not damage the geomembrane. The temperature of hot air at the nozzle or any temporary welding apparatus is controlled such that the geomembrane is not damaged.

10.7.2.2 Fusion Process

The Geosynthetics QAC shall log ambient temperature, seaming apparatus temperature and geomembrane surface temperature at appropriate intervals and report any non-compliance to the Project Manager.

The Geosynthetics QAC shall also verify the following:

1. Equipment used for seaming is not likely to damage the geomembrane.

2. For cross-seams, the edge of the cross-seam is ground to an incline prior to welding.

3. The electric generator is placed on a smooth base such that no damage occurs to the geomembrane.

4. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs.

5. The geomembrane is protected from damage in heavy traffic areas.

6. In general, the geomembrane panels are aligned to have a nominal overlap of 5 inches for fusion welding. The final overlap shall be sufficient to allow peel tests to be performed on the seam.

7. No solvent or adhesive is used.

10.7.3 Seam Preparation

The Geosynthetics QAC shall verify that, prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind. If seam overlap grinding is required, the Geosynthetics QAC must make certain that the process is completed according to the Manufacturer's instructions within 1 hour of the seaming operation and in a manner that does not damage the geomembrane. The Geosynthetics QAC shall also verify that seams are aligned with the fewest possible number of wrinkles and "fishmouths."

10.7.4 Trial Seams

Trial seams shall be made on scraps of the geomembrane liner to be seamed to verify that conditions are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once every 5 hours for each production seaming apparatus/seamer combination to be used that day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 5 feet long by 1 foot wide (after seaming), with the seam centered lengthwise. Seam overlap shall be as required for production seams.

Two specimens shall be cut from the trial seam with a 1-inch-wide die by the Geosynthetics Installer at locations selected randomly by the Geosynthetics QAC. The specimens shall be tested in peel using a field tensiometer as described in Section 10.9.5. If a specimen fails, the entire operation shall be repeated. If the additional specimen fails, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The Geosynthetics QAC shall observe all trial seam procedures.

The remainder of the successful trial seam sample shall be cut into three pieces and distributed as follows:

- One to the Project Manager;
- One to the Geosynthetics Installer; and

- One to the Geosynthetics QAC for possible laboratory testing.

Each portion of the sample shall be assigned a number and marked accordingly by the Geosynthetics QAC. The Geosynthetics QAC shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer and pass or fail description.

If agreed upon between the Project Manager and the LGM and documented by the LGM in a daily report, the remaining portion of the trial seam sample can be subjected to destructive testing as indicated in Section 10.9.6. If a trial seam fails a test conducted by the Geosynthetics QAL, then a destructive seam test sample shall be taken from each seam completed by a combination of the production seaming apparatus and seamer related to the subject trial seam. These samples shall be forwarded to the Geosynthetics QAL for testing in accordance with Section 10.9.6 and, if they fail the tests, the procedures indicated in Section 10.9.7 shall apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

10.7.5 Seaming Procedures

The Geosynthetics QAC shall verify that the seaming conditions, including weather conditions and seam preparation, meet the Project Specifications. The LGM shall notify the Project Manager, in writing, if the Project Specifications are not met. Ambient temperature shall be measured by the Geosynthetics QAC in the area where the panels are to be placed. The Project Manager will decide if the installation is to be stopped or if special procedures will be used.

Trial seaming, as described in Section 10.7.4, shall be conducted under the same ambient temperature conditions as the actual production seams. The LGM may recommend more frequent destructive tests to the Project Manager, as described in Section 10.9, for any suspect areas.

10.8 Non-Destructive Seam Testing

10.8.1 Concept

The purpose of non-destructive tests is to check the continuity of the seams. It does not provide quantitative information on the seam strength. The Geosynthetics Installer shall non-destructively test all field seams over the full length using a vacuum test unit, air pressure test for double-fusion seams only, or another method approved by the

Project Manager. Non-destructive testing shall be conducted in accordance with the Project Specifications as the seaming work progresses – not at the completion of all field seaming.

For all seams, the Geosynthetics QAC shall perform the following:

1. Observe non-destructive testing procedures.

2. Record location, data, test unit number, name of tester and outcome of all testing.

3. Visually inspect all tests.

4. Inform the Installer and Project Manager of any required repairs.

Any seams that cannot be non-destructively tested shall be cap-stripped with the same geomembrane material. The Geosynthetics QAC and Geosynthetics Installer shall inspect the completed cap-stripping operation for uniformity and completeness.

The spark test method may be used for non-destructive testing of extrusion welds associated with penetrations (e.g., HDPE pipe boots) or other areas where access is limited, as approved by the Project Manager.

10.8.2 Test Failure Procedures

The Geosynthetics Installer shall complete any required repairs in accordance with Section 10.10. For repairs, the Geosynthetics QAC shall perform the following:

1. Observe the repair and testing of the repair.

2. Mark on the geomembrane that the repair has been approved.

3. Document the repair procedures and test results.

10.9 Destructive Seam Testing

10.9.1 Concept

The purpose of destructive seam testing is to evaluate seam strength. Destructive seam tests shall be performed at locations selected by the Geosynthetics QAC, in accordance with the Project Specifications. Seam strength testing shall be done as the seaming work progresses – not at the completion of all field seaming.

10.9.2 Location and Frequency

The Geosynthetics QAC shall select locations where seam samples will be cut out for laboratory testing. The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples will be taken. The seam sample locations shall be established as follows:

1. A minimum frequency of one test location per 500 feet of seam length performed by each welder. This minimum frequency is to be determined as an average taken throughout the entire facility. In the event a specific welder is used on a given day for minimal seaming activities (minimal shall be defined as less than 100 feet of seaming), the Geosynthetics QAC may use the welders trial weld (discussed in Section 10.7.4 above) as a representative destructive sample for that day.

2. Test locations shall be determined during seaming at the Geosynthetics QAC's discretion and may be influenced by suspicion of overheating, contamination, off-set welds or any other potential cause of unacceptable welding.

10.9.3 Sampling Procedures

Samples shall be cut by the Geosynthetics Installer at locations chosen by the Geosynthetics QAC as the seaming progresses, following the completion of non-destructive testing. This will allow the laboratory test results to be available prior to covering the geomembrane with another material. The Geosynthetics QAC shall perform the following:

1. Observe sample cutting.

2. Assign a number to each sample and mark it accordingly.

3. Record the sample location on layout drawing.

4. Record the reason for taking the sample at this location (e.g., statistical routine, suspicious weld).

5. Examine samples for holes, grooves, melt-through, wavering welds, unusual weld width and any other unusual characteristics.

All holes in the geomembrane resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 10.10.3. The continuity of the new seams in the repaired area shall be tested according to Section 10.8.

10.9.4 Sample Dimensions

At each sampling location, two types of samples shall be taken by the Geosynthetics Installer. First, two samples will be collected for field testing by the Geosynthetics Installer. Each of the samples shall be cut with a 1-inch-wide die, with the seam centered parallel to the width. The distance between the two samples shall be 42 inches. If both samples pass the field test described in Section 10.9.5, a sample for laboratory testing shall be collected.

The sample for laboratory testing shall be located between the samples for field testing. The sample for laboratory testing shall be 12 inches wide by 42 inches long, with the seam centered lengthwise. The sample shall be cut into three parts and distributed as follows:

1. One portion to the Geosynthetics Installer for optional laboratory testing (12 inches by 12 inches);

2. One portion for Geosynthetics QAL testing (12 inches by 18 inches); and

3. One portion to the Project Manager (12 inches by 12 inches).

Final determination of the samples sizes shall be made at the pre-construction meeting.

10.9.5 Field Testing

As mentioned in Section 10.9.4 and 10.7.4, the two 1-inch-wide strips shall be tested in the field using a tensiometer for peel adhesion and shall not fail according to the criteria in the Project Specifications. The tensiometer shall be capable of maintaining a constant jaw separation rate of 2 inches per minute. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If it fails, the seam should be repaired in accordance with Section 10.10. Alternately, the Geosynthetics Installer may elect to collect additional destructive seam samples on both sides of the original sample and test them in an effort to bound the area. The alternate procedure shall be as per Section 10.9.7. Final judgment regarding seam acceptability, based on the failure criteria, is the responsibility of the LGM.

The Geosynthetics QAC shall observe all field tests and mark all samples and portions with their number. The Geosynthetics QAC shall also log the date, time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures and pressures and pass or fail description. A copy of this information shall be attached to each sample portion.

10.9.6 Laboratory Testing

Destructive test samples provided by the Geosynthetics Installer to the Geosynthetics QAC shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetics QAC in a manner that will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing by the Geosynthetics QAL. The Project Manager shall be responsible for storing archive samples.

Testing shall include “Seam Shear Strength and Peel Adhesion.” These terms, as well as with minimum acceptable values, shall be defined in the Project Specifications. At least five specimens shall be tested in both shear and peel. Specimens shall be selected alternately by test from the samples (e.g., peel, shear, peel and shear). A passing test shall meet the minimum acceptable values in at least four of the five specimens tested for each method.

The Geosynthetics QAL shall provide verbal test results within 24 hours of receipt of the sample. The LGM shall review laboratory test results as soon as the results become available and make appropriate recommendations to the Project Manager.

10.9.7 Destructive Test Failure Procedures

The following procedures shall apply when a sample fails a destructive test, whether that test is conducted by the Geosynthetics QAL or by field tensiometer. The Geosynthetics Installer has two options:

1. The Geosynthetics Installer can repair the seam between any two passing destructive test locations; or

2. The Geosynthetics Installer can trace the welding path to an intermediate location, a minimum of 10 feet from the point of the failed test in each direction, and take a sample with a 1-inch-wide die for an additional field test at each location. If these additional samples pass the test, full laboratory samples are taken. If the laboratory samples pass the tests, the seam is repaired between these locations. If either sample fails, the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. Passing laboratory destructive tests, taken as indicated in Section 10.9, may be used as a boundary for the failing seam. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 10.10.3.

The Geosynthetics QAC shall document all actions taken in conjunction with destructive test failures. No installation of material above the HDPE geomembrane shall be done until destructive testing for that section is completed and accepted by the Geosynthetics QAC and test results are delivered to the NYSDEC monitor.

10.10 Defects and Repairs

10.10.1 Identification

All seams and non-seam areas of the geomembrane shall be examined by the Geosynthetics QAC for identification of defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Light reflection by the geomembrane helps to detect defects. The surface of the geomembrane shall be clean at the time of examination. The geomembrane surface shall be cleaned by the

Geosynthetics Installer if the Geosynthetics QAC determines that the amount of dust or mud inhibits examination.

10.10.2 Evaluation

Each suspect location (seam and non-seam areas) shall be non-destructively tested using the methods described in Section 10.8. Each location that fails the non-destructive testing shall be marked by the Geosynthetics QAC and repaired by the Geosynthetics Installer. All defects found during testing shall be numbered and marked immediately after detection. Work shall not proceed with any materials that will cover locations that have been repaired until appropriate non-destructive and laboratory test results with passing values are available.

10.10.3 Repair Procedures

Any portion of the geomembrane exhibiting a major flaw or failing a destructive or non-destructive test shall be repaired in accordance with the Project Specifications. The Project Manager, Geosynthetics Installer and LGM shall be in agreement on the final decision as to the appropriate repair method.

1. The repair procedures available include the following:

    a. *Patching*: used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

    b. *Patching*: used to repair small tears, pinholes or other minor, localized flaws.

    c. *Capping*: used to repair large lengths of failed seams.

    d. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

    a. Surfaces of the geomembrane that are to be repaired using extrusion methods shall be ground no more than 1 hour prior to the repair.

    b. All surfaces shall be clean and dry at the time of the repair.

c. All seaming equipment used in repairing procedures shall meet the requirements of the project QAP.

d. Extrusion welding the flap of a failed fusion weld shall not be accepted.

e. Patches or caps shall be of the same geomembrane thickness and extend at least 6 inches beyond the edge of the defect. All corners of patches shall be rounded, with a radius of approximately 3 inches.

f. Extrusion welding (i.e., “beads”) shall be used to repair very small tears, pin holes, punctures or other minor, localized flaws (less than or equal to 1/16 of 1 inch in greatest dimension).

10.10.4 Repair Verification

Each repair shall be non-destructively tested using the methods described in Section 10.8, as appropriate. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. The Geosynthetics QAC shall observe all non-destructive testing of repairs and shall record the number of each repair, date and test outcome. Repairs more than 150 feet long require destructive test sampling at the discretion of the LGM. Failed tests indicate that the repair shall be redone and retested until a passing test results.

10.10.5 Large Wrinkles

When seaming of the geomembrane is completed, but prior to placing overlying materials, the LGM shall indicate to the Project Manager which wrinkles should be cut and re-seamed by the Geosynthetics Installer. The LGM shall also indicate to the Project Manager which areas are in tension (bridging or trampoline effect) and should be cut and repaired by the Geosynthetics Installer. The number of wrinkles and trampolines to be repaired should be kept to an absolute minimum. Therefore, wrinkles and trampolines should be located during the coldest part of the installation period while keeping in mind the forecasted weather to which the uncovered geomembrane may be exposed. Wrinkles are considered to be large when the geomembrane can be folded over onto itself. This is generally the case for a wrinkle that extends 12 inches from the subgrade. Trampolines are considered for repair when the geomembrane is 9 inches above the subgrade. Seams produced while repairing wrinkles or trampolines shall be tested as outlined in Section 10.10.4.

When placing overlying material on the geomembrane, every effort must be made to minimize wrinkle development. If possible, cover should be placed during the coolest periods of weather. In addition, small wrinkles should be isolated and covered as quickly as possible to prevent growth of that wrinkle. The placement of cover materials shall be observed by the Geosynthetics QAC to determine that wrinkle formation is minimized.

10.11 Electrical Resistivity Leak Testing

A geomembrane leak location survey shall be conducted on the secondary and primary geomembrane layers of the landfill cell baseliner system. For the landfill cell baseliner system, testing shall be conducted after the secondary granular drainage layer is placed for the secondary liner system and after the soil operations layer is completely placed over the primary geomembrane liner in the floor area of the landfill cells. If the sideslope area is only partially covered with the soil operations layer, then the leak location survey shall extend to the edge of the soil operations layer for the primary liner leak location survey. The Earthwork Contractor shall leave a small strip (3 to 5 feet wide) of soil operations layer uncompleted at the top of the sideslopes and tie-in areas to provide electrical isolation of the liner system. Completion of the soil operations layer placement will follow successful completion of the leak location survey.

The Geosynthetic Installer shall install, if applicable and at the direction of the Leak Location Contractor, at least two permanent electrodes in the soil liner or GCL located directly beneath the secondary and primary geomembrane liner layers during construction of the landfill baseliner system. The Earthwork Contractor shall prepare the liner for the leak location survey by ensuring that a minimum of 1 foot and maximum of 3 feet of the secondary and primary geomembrane layers are continuously exposed around the edge of the landfill cell for each test, including removal of a portion of the access ramp(s) to the operations layer.

The Geosynthetic Installer shall supply an AC power source for the leak location survey (110 volts, 5A).

For the landfill baseliner system, the Earthwork Contractor shall supply two supervised laborers with equipment to help lay out the survey string lines and apply water to the survey area if the operations layer is dry. Approximately 1 to 2% by weight of water is required in the earth materials located above the geomembrane liner. The Leak Location Contractor shall survey the established grid on the floor of the cell and mark any potential leaks identified by the survey with paint and/or flagging. The Geosynthetics Installer shall expose all potential leaks identified by the Leak Location Contractor and repair all identified leaks in accordance with repair requirements included in Section 10.10 above and the Technical Specifications. Following repair activities of identified leaks, the repaired areas shall be re-surveyed by the Leak Location Contractor.

10.12 Geomembrane Protection

The QA procedures indicated in this section are intended only to prevent damage to the geomembrane during the installation of adjacent materials. No installation of materials above the geomembrane shall proceed until all geomembrane testing has been completed for that segment. The QA of the adjacent materials is covered in other sections of this manual.

10.12.1 Soils

A copy of the specifications prepared by the Engineer for placement of soils shall be given to the LGM by the Project Manager. The LGM shall verify that these specifications are consistent with the current state-of-practice and are as follows:

1. Placement of soils on the geomembrane shall not proceed at an ambient temperature less than 32 degrees Fahrenheit (°F) or greater than 104°F, unless written approval is obtained from Project Manager.

2. Placement of soil on the geomembrane should be done during the coolest part of the day to minimize the development of wrinkles in the geomembrane.

3. A geotextile or other cushion approved by the Engineer is generally required between aggregate and the geomembrane.

4. Equipment used for placing soil shall not be driven directly on the geomembrane.

5. A minimum thickness of 1 foot of soil is required between light equipment, with ground pressures of 5 pounds per square inch (psi) or lighter, and the geomembrane.

6. In any areas traversed by vehicles other than low-ground-pressure vehicles approved by the Project Manager, the soil layer shall have a minimum thickness of 3 feet. This requirement may be waived if provisions are made to protect the geomembrane through an engineered design. Drivers shall proceed with caution when on the overlying soil and prevent spinning of tires or sharp turns. In the event that the QAC believes that underlying geosynthetics may have incurred damage due to “rutting” or excessive traffic on overlying soils, the Earthwork Installer shall expose the geosynthetic materials in the area in question for inspection by the QAC.

The Soil QAC shall measure soil thickness and verify that the required thicknesses are present. The Geosynthetics QAC must also verify that placement of the soil is done in such a manner that geomembrane is not damaged. The LGM shall inform the Project Manager if the above conditions are not fulfilled.

10.12.2 Concrete

A copy of the specifications prepared by the Engineer for placement of concrete shall be given by the Project Manager to the Geosynthetics QAC. The Geosynthetics QAC shall verify that the specifications are consistent with the state-of-practice, including the use of geosynthetic layers between concrete and geomembrane. The Geosynthetics QAC shall verify that geosynthetic layers are placed between the concrete and the geomembrane according to design specifications. The Geosynthetics QAC will also verify that construction methods used did not damage the geomembrane.

10.12.3 Sumps and Appurtenances

A copy of the plans and specifications prepared by the Engineer for sumps and appurtenances shall be given by the Project Manager to the Geosynthetics QAC. The Geosynthetics QAC shall review these plans and verify the following:

1. Installation of the geomembrane in sump and appurtenant areas and connection of geomembrane to sumps and appurtenances are made according to specifications.

2. Extreme care is taken while welding around appurtenances since neither non-destructive nor destructive testing may be feasible in these areas.

3. The geomembrane is been visibly damaged while making connections to sumps and appurtenances.

4. A representative of the Geosynthetics QAC is present at all times when the installer is welding geomembrane to appurtenant structures.

The Geosynthetics QAC shall inform the Project Manager, in writing, if the above conditions are not fulfilled.

11. Geotextiles

11.1 Definitions and Applicability

Geotextiles are used in the cushioning and filtering applications of lining systems. This section does not describe procedures for other applications (i.e., erosion control or reinforcement). This section is applicable to non-woven geotextiles made of polyester or polypropylene and is not applicable to non-woven geotextiles made of other materials or woven geotextiles.

11.2 Manufacturing and Plant Inspection

The purpose of the plant inspection is to review the manufacturing process and QC procedures. The Owner may conduct a periodic inspection of the Manufacturer's plant. In addition, the Project Manager or the designated representative may visit the manufacturing plant for a project-specific inspection, if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the geotextile rolls for the project.

The manufacturing plant inspection shall include the following:

1. Verification that those properties guaranteed by the Manufacturer meet all Project Specifications.

2. Verification that the measurement of properties by the Manufacturer is properly documented and that test methods used are acceptable.

3. Spot inspection of the rolls and verification that the rolls are free of imperfections or any sign of contamination by foreign matter.

4. Review of packaging, handling, storage and transportation procedures and verification that these procedures will not damage the geotextile.

5. Verification that roll packages have a label indicating the name of the manufacturer, type of geotextile, thickness, roll number and roll dimensions.

6. Verification that the geotextiles are inspected continuously for the presence of needles, using a metal detector.

A report describing the inspection will be retained by the Owner for periodic inspections and by the Project Manager for project-specific inspections.

11.3 Quality Control Documentation

Prior to the installation of any geotextile, the Geosynthetics Manufacturer or Geosynthetics Installer shall provide the Project Manager with the following information:

1. The origin (i.e., resin supplier's name and resin production plant) and identification (i.e., brand name and number) of the resin used to manufacture the geotextile.

2. Copies of dated QC certificates issued by the resin supplier.

3. The Manufacturer's test reports that verify that the resin used to manufacture the geotextile meets the Manufacturer's resin specifications.

4. The Manufacturer QC test reports that verify that the geotextile manufactured for the project meets the Project Specifications.

5. Documentation that less than or equal to 2% of the resin was from reclaimed polymer during manufacturing and was done with the appropriate cleanliness.

6. A list of the materials that comprise the geotextile expressed in the following categories as percent by weight: base polymer, carbon black and other additives.

7. A geotextile specification that includes all properties published by the Manufacturer and measured using the appropriate test methods.

8. Written certification that the minimum roll values given in the specification are guaranteed by the Manufacturer.

9. Written certification that the Manufacturer has continuously inspected the geotextile for the presence of needles and has found the geotextile to be needle-free.

10. QC certificates signed by a responsible party employed by the Manufacturer. The QC certificates shall include roll identification numbers, testing procedures and results of QC tests. At a minimum, results shall be given in accordance with the methods indicated in the Project Specifications for the following:

    a. Mass per unit area;

    b. Grab strength;

    c. Trapezoidal tear strength;

    d. Puncture strength;

    e. Ultraviolet stability;

    f. Apparent opening size; and

    g. Permitivity.

QC tests shall be performed once for every 100,000 ft^2 of geotextile produced (minimum). Manufacturer QC certificates that include roll testing procedures and results of QC tests are required for all QC tests.

The Manufacturer shall identify all rolls of geotextiles with the following:

1. Manufacturer's name.

2. Product identification.

3. Roll number.

4. Roll dimensions.

5. Special instructions, when required (e.g., "this side up").

The LGM shall review these documents and approve them in writing and shall report any discrepancies with the above requirements to the Project Manager. The LGM shall verify that:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented and that the test methods used are acceptable.

3. QC certificates have been provided at the specified frequency for all rolls and that each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum roll properties meet the Project Specifications.

6. Project Specifications were submitted by the Project Manager to the Geosynthetics Installer.

7. Certification has been provided that less than 2% reclaimed polymer has been added.

11.4 Conformance Testing

The Geosynthetics QAC shall make sure that conformance test samples are obtained from the geotextile materials manufactured for RMU-2. Conformance test samples may be either collected by the Geosynthetics QAC from material delivered to the site or collected by representatives of the Geosynthetics QAL, under the direction of the Geosynthetics QAC, from material at the manufacturer's facility. The samples shall be forwarded to the Geosynthetics QAL for testing to determine conformance with the Project Specifications.

Depending on the particular geotextile being tested and its intended application for the project, the following conformance tests shall be performed in accordance with the test methods specified in the Project Specifications on geotextiles:

1. Mass per unit area.

2. Grab strength.

3. Trapezoidal tear strength.

4. Puncture strength.

5. Apparent opening size.

6. Permitivity.

Refer to Project Specifications for required conformance testing for a given geotextile application.

11.4.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetics QAC. Samples shall be taken across the entire width of the roll and shall not include the first complete revolution of fabric on the roll. Samples shall not be taken from any portion of a roll that has been subjected to excess pressure or stretching. Unless otherwise specified, samples shall be 3 feet long by the roll width. The Geosynthetics QAC shall mark the machine direction on the samples with an arrow.

Geotextile shall be sampled at a rate of one per lot, or at a minimum of one conformance test per 100,000 ft^2. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Alternatively, a lot may be designated by the Geosynthetics QAC based on a review of all roll information, including QC documentation and manufacturing records. All lots of material and the particular test sample that represent each lot should be defined before the samples are taken.

11.4.2 Test Results

All conformance test results shall be reviewed, and the material shall be accepted or rejected by the LGM prior to the deployment of the geotextile. The LGM shall examine the results from laboratory conformance testing and shall report any non-conformance to the Project Manager. The LGM shall be responsible for checking that all test results meet or exceed the property values listed in the Project Specifications. Materials that are in non-compliance shall be rejected.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetics QAL incorrectly conducting the tests, the Geosynthetics Manufacturer may request that the sample in question be re-tested by the Geosynthetics QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. The re-testing shall be done at the expense of the Geosynthetics Manufacturer. Alternatively, the Geosynthetics Manufacturer may have the same sample re-tested at two different Owner-approved Geosynthetics QALs at the expense of the Geosynthetics Manufacturer. If both laboratories produce a passing result, the material shall be accepted. If both laboratories do not produce a passing result, the original Geosynthetics QAL's test results shall be accepted. The use of these procedures is subject to the approval of the Project Manager.

If a test result is in non-conformance, all material from the lot represented by the failing test should be considered out of specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification. (Note that this procedure is valid only when rolls in the lot are consecutively produced and numbered from one manufacturing line.) To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If additional test results are passing, the roll represented by the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If one or both of the additional test results are failing, the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the specified lot.

11.5 Geotextile Deployment

During geotextile shipment and storage, the geotextile shall be protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting or any other damaging conditions. Geotextile rolls shall be shipped and stored in opaque and watertight wrappings. Wrappings shall be removed shortly before deployment.

The Geosynthetics QAC shall observe rolls upon delivery to the site, and any deviation from the above requirements shall be reported to the Project Manager.

The Geosynthetics Installer shall handle all geotextiles in a manner as to make certain the geotextile is not damaged in any way, and the following items shall be complied with:

1. On slopes, the geotextiles shall be securely anchored and rolled down the slope in a manner as to continually keep tension on the geotextile sheet.

2. All geotextiles shall be temporarily weighted with sandbags or the equivalent to prevent wind damage. Temporary weights shall be installed during deployment and shall remain until replaced with cover material.

3. Geotextiles shall be cut using a geotextile cutter (i.e., hook blade) only. Care shall be taken to protect other materials from damage that could be caused by the cutting of the geotextiles.

4. The Geosynthetics Installer shall take any necessary precautions to prevent damage to underlying layers during placement of the geotextile.

5. During placement of geotextiles, care shall be taken not to entrap in or beneath the geotextile the following that could damage the geotextile or hamper subsequent seaming:

   a. Stones;

   b. Excessive dust;

   c. Surface runoff; or

   d. Moisture.

6. After installation, a visual inspection of the geotextile shall be performed over the entire surface to determine that no potentially harmful foreign objects (e.g., needles) are present.

7. Geotextile shall be placed and anchored in the manner and locations shown on the drawings. The Project Manager shall approve any modifications to geotextile placement requirements.

8. The geotextile shall be protected at all times during construction from contamination by surface runoff (silt and sediment control) and any geotextile so contaminated shall be removed and replaced with uncontaminated geotextile.

The Geosynthetics QAC shall record any non-compliance and report it to the Project Manager.

11.6 Seaming Procedures

The Geosynthetics QAC shall make certain that geotextile seaming is performed in accordance with the Project Specifications. Securing pins will not be used in geotextile installation. Sewing shall be done using polymeric thread with chemical and ultraviolet light-resistance properties that equal or exceed those of the geotextile. Sewing shall be done using the machinery and stitch types specified in the Project Specifications or as approved, in writing, by the Project Manager and the LGM.

As an option, the geotextile may be overlapped and heat-leistered in limited areas that are approved by the LGM, the Project Manager and the NYSDEC. When the Geosynthetics Installer has demonstrated that sewing is not feasible based on the field conditions, an alternate method will be used to overlap the existing geotextile onto the new geotextile a minimum of 12 inches and continuously heat-leister the two pieces together. If any burn holes are detected, the burn hole will be patched with a minimum 12 inches of overlap and continuously heat-leistered.

11.7 Defects and Repairs

Any holes or tears in the geotextile shall be repaired as follows:

1. On slopes greater than 10 horizontal (H):1 vertical (V), a patch made from the same geotextile shall be sewn into place in accordance with the Project Specifications. If any tear exceeds 10% of the width of the roll, the roll shall be removed from the slope and replaced.

2. On slopes equal to or less than 10H:1V, a patch made from the same geotextile shall be continuously heat-leistered or sewn into place with a minimum overlap of 12 inches in all directions.

The Geosynthetics QAC shall observe all repairs and report any non-compliance with the above requirements in writing to the Project Manager.

11.8 Geotextile Protection

All materials located on top of a geotextile shall be deployed in a manner as to make certain the following:

1. The geotextile and underlying lining materials are not damaged.

2. Minimal slippage of the geotextile on underlying layer occurs.

3. No excess tensile stresses occur in the geotextile.

Granular materials shall be placed on geotextiles in the prepared area. During placement, a minimum depth of 1 foot of granular material shall be maintained at all times between the fabric and placement equipment. All equipment used in spreading or traveling on the 1 foot granular material layer shall exert a pressure of less than 63 psi to the underlying geotextile using a 2H:1V stress distribution. Dozer blades and other equipment shall not make direct contact with the fabric. However, if a tear occurs in the fabric during spreading operations, the granular material shall be cleared from the fabric and the damage area repaired as described in Section 11.7.

Large fabric wrinkles that may develop during the spreading operations shall be folded and flattened in the direction of the spreading.

Any non-compliance shall be recorded by the Geosynthetics QAC and reported to the Project Manager.

12. Geocomposites

12.1 Definition and Applicability

Geocomposites are materials used as drainage and filter media in lining systems. This section is applicable to drainage geocomposites made of non-woven geotextiles (i.e., polyester or polypropylene) heat-bonded to a HDPE geonet (single or double-sided). This section is not applicable to composites made with other components.

12.2 Manufacturing Plant Inspection

The purpose of the geocomposite manufacturing plant inspection is to review the manufacturing process and QC procedures. The Owner may conduct a periodic inspection of the geocomposite Manufacturer's plant. In addition, the Project Manager or the designated representative may visit the manufacturing plant for a project-specific inspection, if deemed necessary. If possible, the project-specific inspection shall be prior to or during the manufacturing of the geocomposite rolls for the project.

The manufacturing plant inspection shall include the following:

1. Verification that the proper QC documentation has been received by the Geocomposite Manufacturer from the individual component manufacturers (geonet and geotextile).

2. Verification that those properties guaranteed by the Manufacturer meet all Project Specifications.

3. Verification that the measurement of properties by the Manufacturer is properly documented and test methods used are acceptable.

4. Spot inspection of rolls and verification that the rolls are free of imperfections or contamination by foreign matter.

5. Review of packaging, handling, storage and transportation procedures and verification that the procedures will not damage the geocomposite.

6. Verification that roll packages have a label indicating the name of the manufacturer, type of geocomposite, roll number and roll dimensions.

A report describing the inspection will be retained by the Owner for periodic inspections and by the Project Manager for project-specific inspections.

12.3 Quality Control Documentation

Prior to the installation of any geocomposite, the Geosynthetics Manufacturer or Geosynthetics Installer shall provide the Project Manager with the following information:

1. The origin (i.e., supplier's name and production plant) and identification (i.e., brand name and number) of the geotextile and geonet used to fabricate the geocomposite.

2. Copies of dated QC certificates issued by the geotextile and geonet supplier.

3. Certificates that contain the results of QC tests performed on the geocomposite components as outlined in the Project Specifications.

4. A geocomposite specification that includes all properties published by the Manufacturer, measured using the appropriate test methods.

5. Written certification that the minimum roll values given in the specification are guaranteed by the Manufacturer.

6. QC certificates for the geocomposite signed by a responsible party employed by the Manufacturer. The QC certificates shall include roll identification numbers, testing procedures and results of QC tests. At a minimum, results shall be given for the following:

   a. Mass per unit area;

   b. Thickness;

   c. Geotextile-geonet adhesion; and

   d. Transmissivity testing.

QC tests shall be performed in accordance with the Project Specifications for every 40,000 ft^2 (at a minimum), except that transmissivity testing shall be performed for every 100,000 ft^2 (at a minimum) of geocomposite produced.

The Geosynthetics Manufacturer shall identify all rolls of geocomposite with the following:

1. Manufacturer's name.

2. Product identification.

3. Roll number.

4. Roll dimensions.

The LGM shall review the documents and approve all documentation in writing. The LGM shall report any discrepancies with the above requirements to the Project Manager. The LGM shall verify the following:

1. Property values certified by the Manufacturer meet all of its guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented, and the test methods used are acceptable.

3. QC certificates have been provided at the specified frequency for the rolls, and each certificate identifies the rolls related to it.

4. Roll packages are appropriately labeled.

5. Certified minimum roll properties meet the Project Specifications.

6. The Project Manager has submitted the Project Specifications to the Geosynthetics Installer.

12.4 Conformance Testing

The Geosynthetics QAC shall verify that conformance test samples are obtained for the geocomposite materials manufactured for RMU-2. Conformance test samples may be either collected by the Geosynthetics QAC from material delivered to the site or collected by representatives of the Geosynthetics QAL, under the direction of the Geosynthetics QAC, from material at the manufacturer's facility. The samples shall be forwarded to the Geosynthetics QAL for testing to verify conformance with the Project Specifications.

At a minimum, the following conformance tests shall be performed on geocomposites in accordance with the methods identified in the Project Specifications:

1. Density (geonet component only).
2. Thickness (geonet component only).
3. Melt Index (geonet component only).
4. Carbon Black Content (geonet component only).
5. Geotextile-geonet adhesion (geocomposite).
6. Tensile Strength (geocomposite).
7. Transmissivity (geocomposite).

Additional conformance tests may be required by the Project Specifications.

12.4.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetics QAC. Samples shall not be taken from any portion of a roll that has been damaged. Unless otherwise specified, samples shall be 3 feet long by the roll width. The machine direction shall be marked on the conformance samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

Samples for conformance testing shall be taken at a rate of one per lot, or at a minimum of one per 100,000 ft^2 of geocomposite. A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. Also, a lot may be designated by the Geosynthetics QAC based on a review of the roll information, including QC documentation and manufacturing records.

12.4.2 Test Results

All conformance test results shall be reviewed, and the material shall be accepted or rejected by the LGM prior to the deployment of the geocomposite. The LGM shall be responsible for verifying that all test results meet or exceed the property values listed in the Project Specifications.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetics QAL incorrectly conducting the tests, the Geosynthetics Manufacturer may request that the sample in question be re-tested by the Geosynthetics QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. This re-testing shall be done at the expense of the Geosynthetics Manufacturer. Alternatively, the Geosynthetics Manufacturer may have the same sample re-tested at two different Owner-approved Geosynthetics QALs at the expense of the Geosynthetics Manufacturer. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, the original Geosynthetics QAL's test results shall be accepted. The use of the procedures for dealing with failed test results is subject to the approval of the Project Manager.

If a test result is in non-conformance, all material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification. (Note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line.) To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If the additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (i.e., next larger roll number) shall be rejected. If one or both of the additional tests fail, the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

12.5 Geocomposite Deployment

During shipment and storage, the geocomposite shall be protected from ultraviolet light exposure, moisture, mud, dirt, dust, puncture, cutting or any other damaging conditions. Geocomposite rolls shall be shipped and stored in opaque and watertight wrappings. The roll wrappings shall be removed shortly before deployment. The

Geosynthetics QAC shall inspect the rolls upon delivery to the site, and any deviation from the above requirements shall be reported to the Project Manager.

The Geosynthetics Installer shall handle the geocomposite in a manner as to make certain the geocomposite is not damaged in any way, and the following requirements shall be complied with. The Geosynthetics QAC shall note any non-compliance and report it to the Project Manager.

1. On slopes, the geocomposite shall be securely anchored and rolled down the slope in a manner as to continually keep tension on the geocomposite sheet. If necessary, the geocomposite shall be positioned by hand after being unrolled to minimize wrinkles.

2. In the presence of wind, all geocomposites shall be weighted with sandbags or the equivalent. Sandbags shall be installed during deployment and shall remain until replaced with cover material.

3. Geocomposites shall be cut using a hook blade or other tool approved by the Project Manager. If in place, special care shall be taken to protect underlying geosynthetics from damage that could be caused by the cutting of the geocomposite. Care shall be taken to remove all tools from the geocomposite.

4. The Geosynthetics Installer shall take necessary precautions to prevent damage to underlying layers during placement of the geocomposite.

5. During placement of geocomposite, care shall be taken not to entrap in or beneath the geocomposite stones or dirt that could damage the geocomposite and cause clogging of drains or filters, hampering subsequent seaming.

6. A visual examination of the geotextile of the geocomposite shall be performed over the entire surface after installation to determine that no potentially harmful foreign objects (e.g., needles, razor blades) are present.

12.6 Seaming Procedures

In general, no horizontal seams shall be allowed on sideslopes greater than 10H:1V (i.e., seams shall be along and not across the slope), except as part of a patch. Adjacent geocomposites (geotextile and geonet components) shall be joined according to the Engineering Drawings and Project Specifications. The Geosynthetics QAC shall note any non-compliance and report it to the Project Manager.

12.7 Defects and Repairs

Any portion of the geocomposite exhibiting a flaw shall be repaired. Prior to acceptance of the geocomposite, the Geosynthetics Installer shall locate and repair all damaged areas as directed by the Geosynthetics QAC. The Geosynthetics QAC shall observe any repair and report any non-compliance with the requirements in writing to the Project Manager.

12.7.1 Small Defects

If the Geosynthetics QAC determines a defect to be small (i.e., typically smaller than 3 feet by 3 feet), the geocomposite shall be repaired as follows:

1. If the geonet is determined to be undamaged but the geotextile is damaged, a patch of geotextile shall be placed. The geotextile patch shall be sewn in place with a minimum of 12-inch overlap in all directions.

2. Damaged geonet shall be removed and replaced with a section of geonet, equivalent to the damaged geonet, cut to fit. The geonet shall be tied to the existing geonet using white or yellow plastic fasteners that are placed every 6 inches (at a minimum). A geotextile patch shall be placed over the repaired geonet section. The geotextile patch shall be sewn in place or continuously heat-leistered (for slopes less than or equal to 10H:1V only) with a minimum of 12-inch overlap in all directions.

3. Care shall be taken to remove any soil or other material that may have penetrated the torn geotextile.

12.7.2 Large Defects

If the Geosynthetics QAC determines the defect to be large (i.e., typically larger than 3 feet by 3 feet), the geocomposite shall be replaced.

12.8 Protection

All materials located on top of the geocomposite shall be placed in a manner to provide the following:

1. The geocomposite and underlying lining materials are not damaged.

2. Minimal slippage of the geocomposite on underlying layers occurs.

3. No excess tensile stresses occur in the geocomposite.

Any non-compliance shall be recorded by the Geosynthetics QAC and reported to the Project Manager.

13. Geosynthetic Clay Liners

13.1 Definition and Applicability

GCLs are materials that consist of a low hydraulic conductivity montmorillonite-rich expansive clay (bentonite) core that is bonded to a geotextile backing. GCLs are used as barriers in lining systems.

13.2 Manufacturing Plant Inspection

The purpose of the plant inspection is to review the manufacturing process and QC procedures. The Owner or appropriate representative may conduct a periodic inspection of the Manufacturer's plant. In addition, the Project Manager or the designated representative may visit the manufacturing plant for a project-specific inspection, if deemed necessary. The project-specific inspection shall be prior to, or during, the manufacturing of the GCL rolls for the project.

The manufacturing plant inspection shall include the following:

1. Verification that properties guaranteed by the Manufacturer and all Project Specifications are met.

2. Verification that the measurement of properties by the Manufacturer is properly documented and that the test methods used are acceptable.

3. Spot inspection of the rolls and verification that the rolls are free of imperfections or contamination by foreign matter.

4. Review of handling, storage and transportation procedures, and verification that the procedures will not damage the GCL.

5. Verification that roll packages have a label indicating the name of the manufacturer, roll number and roll dimensions.

6. Verification that overlap lines are printed on the rolls.

A report describing the inspection shall be retained by the Owner for periodic inspections and by the Project Manager for project-specific inspections.

13.3 Quality Control Documentation

Prior to installation of any GCL, the Geosynthetics Manufacturer or Geosynthetics Installer shall provide the Project Manager with the following information:

1. QC certificates signed by a responsible party employed by the Manufacturer.

2. The origin (i.e., supplier's name and location of material source) and identification of the bentonite used for production of the GCL.

3. Copies of dated QC information issued by the bentonite supplier.

4. Results of QC tests conducted by the GCL Manufacturer to verify that the bentonite supplied meets the GCL Manufacturer's specifications.

5. Copies of dated QC information provided by the geotextile Manufacturer.

6. The Manufacturer's specification for the GCL that includes all properties contained in the Project Specifications for GCLs.

7. Written certification that the minimum values given in the Project Specifications are guaranteed by the Manufacturer. QC certificates shall include roll identification numbers, testing procedures and results of QC tests. At a minimum, results shall be given for the following:

    a. Bentonite swell index (as received).

    b. Bentonite fluid loss (as received).

    c. Bentonite mass per unit area in GCL.

    d. Geotextile mass per unit area (upper and lower layers).

    e. Bentonite moisture content (following manufacture into GCL).

    f. Peel strength.

    g. Tensile strength of GCL

h. Durability (based on percent of tensile strength retained).

i. Index flux.

j. Permeability.

k. Permeability with potentially incompatible permeant.

The QC tests shall be performed using methods and at frequencies as required by the Project Specifications.

The Geosynthetics Manufacturer shall identify the rolls of GCL with the following:

1. Manufacturer's name.

2. Product identification.

3. Roll number.

4. Roll dimensions.

The LGM shall review the documents and shall report any discrepancies with the above requirements to the Project Manager. The LGM shall verify the following:

1. Property values certified by the Manufacturer meet all of the guaranteed specifications.

2. Measurements of properties by the Manufacturer are properly documented, and the test methods used are acceptable.

3. QC certificates have been provided at the specified frequency for the rolls, and each certificate identifies the rolls related to it. Rolls are appropriately labeled.

4. Certified minimum properties meet the Project Specifications.

5. The Project Manager has provided the Project Specifications and this CQAM to the GCL Installer.

6. The Manufacturer confirms a field drying shrinkage potential to allow proper seam overlap in the field.

13.4 Conformance Testing

The Geosynthetics QAC shall verify that conformance test samples are obtained from the GCL materials manufactured for RMU-2. Conformance test samples may be either collected by the Geosynthetics QAC from material delivered to the site or collected by representatives of the Geosynthetics QAL, under the direction of the Geosynthetics QAC, from material at the manufacturer’s facility. The samples shall be forwarded to the Geosynthetics QAL for testing to verify conformance with the project specifications.

At a minimum, the following conformance tests shall be performed on the GCL in accordance with the methods identified in the project specifications:

1. Hydraulic Conductivity.

2. Mass per Unit Area of Bentonite.

3. Mass per Unit Area Upper and Lower Layer Geotextile (geotextile component only).

4. Bentonite Moisture Content.

5. Index Flux.

6. Tensile Strength of GCL.

7. Internal and Interface Shear Strength.

Additional conformance tests may be required by the project specifications.

13.4.1 Sampling Procedures

The rolls to be sampled shall be selected by the Geosynthetic QAC. Samples shall not be taken from any portion of a roll that has been damaged. Unless otherwise specified, samples shall be 1 foot long by the roll width. The machine direction shall marked on the conformance samples with an arrow. All lots of material and the particular test sample that represents each lot should be defined before the samples are taken.

Unless otherwise specified in the Project Specifications, samples shall be taken at a rate of one per lot, or at a minimum of one per 100,000 ft^2 of GCL, except for hydraulic conductivity and internal/interface shear strength testing. Samples for hydraulic conductivity conformance tests shall be taken at a rate of one per lot, or at a minimum of one per 250,000 ft^2 of GCL. One sample per material type, per application, is required for internal/interface shear strength testing (i.e., separate samples for baseliner and final cover are required). A lot shall be defined as a group of consecutively numbered rolls from the same manufacturing line. A lot may also be designated by the Geosynthetics QAC based on a review of the roll information, including QC documentation and manufacturing records. If approval is obtained from the Project Manager, the Geosynthetics QAC can perform the conformance test sampling at the manufacturing plant. This testing may expedite the installation process for certain projects.

13.4.2 Test Results

All conformance test results shall be reviewed and be accepted or rejected by the LGM prior to the deployment of the GCL. The LGM shall be responsible for verifying that all test results meet or exceed the property values listed in the Project Specifications and shall report any non-conformance to the Project Manager.

If a test result is in non-conformance, all material from the lot represented by the failing test should be considered out-of-specification and rejected. Alternatively, at the option of the Project Manager, additional conformance test samples may be taken to “bracket” the portion of the lot not meeting specification. (Note that this procedure is valid only when all rolls in the lot are consecutively produced and numbered from one manufacturing line.) To isolate the out-of-specification material, additional samples must be taken from the rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If additional tests pass, the roll that represents the initially failed test and the roll manufactured immediately after that roll (i.e., next larger roll number) shall be rejected. If one or both of the additional tests fail, then the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

If the Geosynthetics Manufacturer has reason to believe the failing tests may be the result of the Geosynthetics QAL incorrectly conducting the tests, the Geosynthetics

Manufacturer may request that the sample in question be re-tested by the Geosynthetics QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. The Geosynthetics Manufacturer may have the same sample re-tested at two different Owner-approved Geosynthetics QALs. If both laboratories produce passing results, the material shall be accepted. If both laboratories do not produce passing results, the original Geosynthetics QAL's test results shall be accepted. The use of these procedures with respect to a failed test result is subject to the approval of the Project Manager, and the cost of the additional testing will be responsibility of the Geosynthetics Manufacturer.

13.5 Geosynthetic Clay Liner Deployment

During shipment and storage, the GCL shall be protected from ultraviolet light exposure, moisture, excessive humidity, puncture, cutting or any other damaging conditions. GCL rolls shall be shipped and stored in opaque and watertight wrappings. The GCL rolls shall be stored away from wet ground and be covered with a watertight tarp or under a roof to protect from exposure to hydration or precipitation. The roll wrappings shall be removed shortly prior to deployment. The Geosynthetics QAC shall inspect GCL rolls upon delivery and prior to deployment at the site and report any deviations from the above requirements to the Project Manager.

The Geosynthetics QAC shall review the GCL panel deployment progress and advise the Project Manager on the conformance of the GCL with the Project Specifications. The Geosynthetics QAC shall verify that the Geosynthetics Installer handles the GCL material in a manner as to make certain the GCL is not damaged and to determine that the following requirements are satisfied:

1. Final cover subgrade areas prepared for GCL deployment have been proof rolled and visually observed by the Geosynthetics QAC in accordance with the Technical Specifications.

2. The supporting soil surface for the GCL is smooth, firm, unyielding and free of debris, vegetation, sticks, sharp rocks, void spaces, ice, abrupt elevation changes, standing water or other materials that could damage the GCL. As determined by the Geosynthetics QAC, all protrusions having the potential to damage the GCL must be removed, crushed or pushed into the surface with a smooth-drum compactor.

3. On slopes, the GCL rolls shall be securely anchored, and the GCL material shall be deployed down the slope in a manner as to keep tension on the GCL panel.

4. The GCL should be installed with the proper side of the material facing upward. The orientation of the GCL should be as specified by the Project Specifications.

5. The Geosynthetics Installer shall take necessary precautions to prevent damage to underlying layers during placement of the GCL. If the GCL is cut in place, special care shall be taken to protect underlying geosynthetic materials from damage that could be caused by cutting of the GCL.

6. During placement of the GCL, care shall be taken not to entrap beneath the GCL any stones, excessive dust or moisture that could damage the GCL or any underlying geosynthetics.

7. After installation, a visual examination of the GCL shall be performed over the entire surface to verify that no potentially harmful foreign objects, contaminated soil or damaged areas are present.

8. Excess loss of bentonite on edges during deployment should be minimized.

The Geosynthetics QAC shall verify that the final cover subgrade surface for which the GCL will be installed is not wet and meets the requirements of applicable sections of the Technical Specifications.

The Geosynthetics QAC shall verify that the quantity of GCL material deployed during 1 working day can be covered by the end of that day. The Project Manager may give exceptions to this requirement if dry weather is forecast for several consecutive days. GCL deployment shall not be undertaken during precipitation or when there is an immediate threat of precipitation. The Geosynthetics QAC shall record any non-compliance and report it to the Project Manager. It is the responsibility of the Geosynthetics Installer to protect the GCL from premature hydration during and after installation.

13.6 Seaming Procedures

Adjacent GCL panels shall be joined according to Project Plans and Specifications. At a minimum, the Geosynthetics QAC shall verify that the Geosynthetics Installer complies with the following requirements:

1. Edge seam overlap shall be a minimum of 6 inches.

2. Roll-end seam overlap shall be a minimum of 12 inches.

3. The addition of powdered bentonite to seam locations shall be in accordance with the Project Specifications.

4. End-to-end seams on slopes shall be minimized.

Prior to approval of the GCL, the Geosynthetics QAC shall visually verify the following requirements:

1. The required overlaps are provided. The overlap shall be continuously monitored since the panels may be subject to shrinkage.

2. The amount of the powdered bentonite is placed on the seam as required by the Project Specifications.

13.7 Defects and Repairs

Any portion of the GCL exhibiting flaws shall be repaired, as required by the Project Specifications. Prior to acceptance of the installed GCL, the Geosynthetics Installer shall locate and repair all damaged areas as directed by the Geosynthetics QAC. Defects or damage can be identified by rips, tears, premature hydration of the GCL or delamination of the geotextiles.

Rips or tears in the GCL shall be covered by a piece of geotextile equivalent to the damaged geotextile. The material shall extend a minimum of 6 inches in all directions and heat bonded (leistered) in place. If the bentonite layer has been damaged, additional bentonite of comparable quality shall be added.

Where the GCL has been exposed to moisture and has prematurely hydrated prior to placement of overlying material, the material shall be removed and replaced. The term “prematurely hydrated” shall not include minor partial hydration of the GCL material that may have been exposed to moisture within limited areas during construction. All defects and repairs shall be reported to the Project Manager.

13.8 Geosynthetic Clay Liner Protection

All materials located on top of the GCL shall be placed in a manner as to provide the following:

1. The GCL and underlying liner materials are not damaged.

2. Minimal slippage of the GCL on underlying layers occurs.

3. No excess tensile stresses occur in the GCL.

Any non-compliance with these guidelines or the Project Specifications shall be noted by the Geosynthetics QAC and reported to the Project Manager.

14. Facultative Pond Liner Geomembranes

14.1 Description and Applicability

Geomembranes are low hydraulic conductivity barriers used in lining systems. This section is applicable to ethylene interpolymer alloy (EIA) geomembranes, also referred to as EIA liners, to be used in the liner systems of facultative ponds. This section is not applicable to other geomembrane materials, including HDPE, Hypalon, polyvinyl chloride, and very low-density polyethylene.

14.2 Manufacturer's Plant Inspection

The purpose of the plant inspection is to review the manufacturing process and QC procedures implemented during the manufacturing of the EIA liner. The Owner may conduct an inspection of the Manufacturer's plant. In addition, the Project Manager or the Project Manager's designated representative may visit the manufacturing plant for a project-specific inspection, if deemed necessary. If possible, the project-specific inspection shall be conducted prior to or during the manufacturing of the EIA liner panels for the project.

The manufacturing plant inspection shall include:

1. Verification that properties guaranteed by the Manufacturer meet all project specifications.

2. Verification that the measurement of properties by the Manufacturer is properly documented and the test method used is acceptable.

3. Spot inspection of the panels and verification that they are free of imperfections or any sign of contamination by foreign matter.

4. Review of the handling, storage, and transportation procedures, and verification that the procedures will not damage the EIA liner.

5. Verification that panel packages have a label indicating the name of the manufacturer, type of EIA liner, thickness, panel number, and panel dimensions.

A report describing the inspection shall be retained by the Owner for annual inspections and by the Project Manager for project-specific inspections.

14.3 Quality Control Documentation

Prior to the installation of any EIA liner material, the Geosynthetics Manufacturer or Geosynthetics Installer shall provide the Project Manager with the following information:

1. A list of the materials that comprise the EIA liner expressed as percent by weight of polyester, finished coatings, and other additives.

2. A product information sheet for the EIA liner that includes all properties contained in the project specifications, measured using the appropriate test methods.

3. A written certification that states that the minimum values given in the product information sheet are guaranteed by the Manufacturer.

4. QC certificates signed by a responsible party employed by the Manufacturer. Each QC certificate shall include panel identification numbers, testing procedures, and results of QC tests. At a minimum, results shall be given for:

    a. Fabric weight

    b. Finished coated weight

    c. Tensile properties.

    d. Tear strength.

    e. Puncture strength.

These QC tests shall be performed in accordance with the test methods and at the frequency specified in the project specifications, or as indicated in the Manufacturer's quality control program documentation, whichever is more stringent.

The Geosynthetics Manufacturer shall identify the panels of EIA liner with the following:

1. Manufacturer's name.

2. Product identification.

3. Panel number, for which the installed location is to be indicated on the panel layout diagram.

4. Panel dimensions.

The EIA liner will be prefabricated in large panels at the Manufacturer's plant. Factory seams are subject to the same quality control/quality assurance standards and testing as field seams. Prior to the installation of any EIA liner material, the Manufacturer or Geosynthetics Installer shall provide the Project Manager with the results of all destructive and non-destructive seam testing for all factory seams, as well as the location and identification of any necessary repairs.

The LGM shall review and approve in writing these documents and shall report any discrepancies with the above requirements to the Project Manager. The LGM shall verify the following:

1. Property values certified by the Manufacturer meet project specifications.

2. Measurements of properties by the Manufacturer are documented, and the test methods used are acceptable.

3. QC certificates have been provided at the specified frequency for the material produced for the project and each certificate identifies the panels related to it.

4. Testing and repair of all factory seams has been performed in accordance with the project specifications, the Manufacturer's quality control program, and applicable testing standards.

5. Panels are appropriately labeled.

14.4 Conformance Testing

Prior to delivery of the panels of EIA liner to the site, the LGM shall obtain conformance test samples from the prefabricated EIA liner panels. The samples shall be forwarded to the Geosynthetics QAL for testing to verify conformance with the project specifications.

The following conformance tests shall be performed in accordance with the test methods, as specified in the project specifications:

1. Finished coated weight.

2. Thickness.

3. Tensile characteristics.

4. Destructive seam testing.

14.4.1 Sampling Procedures

The LGM shall collect samples from the manufactured material prior to the material being delivered to the site. The LGM shall collect destructive seam test samples from the prefabricated panels prior to the panels being packaged for shipping. Samples shall be taken from the edges that will be placed in the anchor trenches so that the panels can be folded in preparation for shipping as soon as the samples are collected. (Because the samples will be collected from the edges, repairs of sampled areas will not be necessary.) For this reason, the prefabricated panels should be sized slightly larger than the final installed dimensions would require to allow for the conformance samples to be collected from the edges and avoid the need to repair the sampled areas. Destructive seam test samples shall be collected at a frequency of one sample per prefabricated panel, unless the seaming for a given panel spans more than 1 working day, in which case, the sample frequency shall be one sample per day of seaming for that panel.

14.4.2 Test Results

All conformance test results shall be reviewed and approved in writing, and the material accepted or rejected by the LGM prior to the deployment of the EIA liner. The LGM shall report any non-conformance to the Project Manager.

If a material test result is in non-conformance, the material from the lot represented by the failing test will be considered out-of-specification and rejected. At the option of the Project Manager and at the Manufacturer’s expense, additional conformance test samples may be taken to "bracket" the portion of the lot not meeting specification (note that this procedure is valid only when the rolls in the lot are consecutively produced and numbered from one manufacturing line). To isolate the out-of-specification material, additional samples must be taken from rolls that have roll numbers immediately adjacent to the roll that was sampled and failed. If the additional tests pass, the roll that represents the initial failed test and the roll manufactured immediately after that roll (next larger roll number) shall be rejected. If the additional tests fail, the entire lot shall be rejected or the procedure repeated with two additional tests that bracket a greater number of rolls within the lot.

If a destructive seam test result is in non-conformance, all seams in the panel represented by the failing test will be considered out-of-specification and rejected. At the option of the Project Manager and at the Manufacturer’s expense, additional destructive seam test samples may be taken to bracket the non-conforming seam. To isolate the non-conforming seam, the seam to either side of the non-conforming seam shall be sampled and destructively tested. If both adjacent seams pass, only the seam that resulted in the non-conforming result will be considered out-of-specification and either cut out and replaced with a new seam. If either or both of the adjacent seams fail, all seams in the panel will be considered out-of-specification and shall be cut out and replaced with new seams or the panel may be replaced in its entirety.

If the Geosynthetics Manufacturer has reason to believe that failing tests may be the result of the Geosynthetics QAL conducting the tests, the Geosynthetics Manufacturer may request that the sample be re-tested by the Geosynthetics QAL with a technical representative of the Geosynthetics Manufacturer present during the testing. This re-testing shall be done at the expense of the Geosynthetics Manufacturer. The Geosynthetics Manufacturer may have the same sample re-tested at two different Owner-approved Geosynthetics QALs. If both laboratories produce passing results, the material shall be accepted; otherwise, the original Geosynthetics QAL’s test results shall be accepted. The use of these procedures for dealing with failed test results is subject to the approval by Project Manager.

14.5 Subgrade Preparation

14.5.1 Surface Preparation

The Earthwork Contractor shall be responsible for preparing the supporting soil for EIA liner placement. The Project Manager shall coordinate the work of the Earthwork

Contractor and the Geosynthetics Installer so that the requirements of the project specifications and this QAM are met.

Prior to the installation of the EIA liner, the LGM shall verify the following:

1. A qualified land surveyor has verified all lines and grades.

2. The LSM has verified that the supporting soil meets the criteria in the project specifications.

3. The surface to be lined has been rolled, compacted, or hand-worked and is free of irregularities, protrusions, loose soil, angular rocks, roots, grass, vegetation, and abrupt changes in grade.

4. All necessary testing of underlying layer(s) has been completed, and the associated results have been reviewed and approved by applicable parties.

5. Sufficient leak locator probes have been installed on the surface to be lined. The leak locator probes shall be provided by the Leak Location Contractor and installed by the LGM in the locations determined by the Leak Location Contractor.

The Geosynthetics Installer shall certify, in writing, that the surface on which the EIA liner will be installed is acceptable. A certificate of acceptance shall be provided by the Geosynthetics Installer to the LGM prior to the deployment of the EIA liner in the area under construction. The LGM shall provide the Project Manager with a copy of this certificate.

After the supporting soil has been accepted by the Geosynthetics Installer, it is the Geosynthetics Installer’s responsibility to indicate to the Project Manager any change in the supporting soil condition that may require repair work. The Project Manager may consult with the LGM regarding the need for repairs. If the LGM concurs with the Geosynthetics Installer, the Project Manager shall verify that the supporting soil is repaired. At any time prior to or during the EIA liner installation, the LGM shall indicate to the Project Manager any locations that may not be adequately prepared for the EIA liner.

14.5.2 Anchor Trench

The LGM shall verify that the anchor trench has been constructed according to the Drawings and project specifications. If the anchor trench is excavated in a clay material that is susceptible to desiccation, the amount of anchor trench open at any time shall be minimized. The LGM shall inform the Project Manager of any signs of significant desiccation associated with the anchor trench construction. The anchor trench shall be adequately drained to prevent ponding or softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled and compacted as specified in the project specifications.

When backfilling the anchor trenches, care shall be taken to prevent any damage to the geosynthetics. A Geosynthetics QAI shall observe the backfilling operation and advise the Project Manager of any problems. Problems shall be documented by the Geosynthetics QAI in a daily report.

14.6 EIA liner Deployment

14.6.1 Panel Nomenclature

The individual EIA liner roll sheets shall be prefabricated at the Manufacturer's plant into large sheets custom designed to this project so as to minimize field seaming. If additional panels are deemed necessary by the LGM or to line odd-shaped areas (such as corners), a field panel may be used. A field panel is defined as a unit of EIA liner that is to be seamed in the field. Each prefabricated panel shall be shipped with a label identifying it with a unique designation that is also indicated on a panel layout diagram. The LGM shall verify that prefabricated panels are installed at the locations indicated on the Geosynthetics Installer's panel layout diagram as approved by the Project Manager. The LGM shall record the identification code, location, and date of installation of each prefabricated panel.

14.6.2 Panel Deployment Procedure

The LGM shall review the panel deployment progress of the Geosynthetics Installer (keeping in mind issues relating to wind, rain, clay liner desiccation, and other site-specific conditions). The LGM shall advise the Project Manager on the compliance with the approved panel layout drawing and the suitability to the actual field conditions. Once approved, only the Project Manager can authorize changes to the panel deployment procedure. The Geosynthetics QAI shall verify that the condition of the supporting soil does not change detrimentally during installation.

To protect against wind damage, a temporary hold-down (i.e., sandbagging, tires, or other means as approved by the Project Manager) will be used during EIA liner installation. The selected temporary hold-down method will not damage or cause leakage on liner surfaces or other materials (i.e., clay layer). Alternatively, the EIA liner may be held down by the permanent weight tubes as indicated on the Drawings. Sand used in sandbags or permanent weight tubes shall be well graded and clean sand, with a maximum particle size of 0.25 inches by visual inspection. The source of the sand shall be approved by the Project Manager.

14.6.3 Deployment Weather Conditions

EIA liner deployment shall not be undertaken if weather conditions will preclude material seaming following deployment (see Section 14.7.5). Ambient temperature shall be measured by the Geosynthetics QAI in the area where the panels are to be deployed. The LGM shall inform the Project Manager of any weather-related problems that may not allow EIA liner placement to proceed.

14.6.4 Method of Deployment

Before the EIA liner is handled on site, the Geosynthetics QAC shall verify that the handling equipment to be used on the site is adequate and does not pose a risk of damage to the EIA liner or underlying surfaces. During the handling, the Geosynthetics QAC shall observe and verify that the Geosynthetics Installer's personnel handle the EIA liner with care.

The Geosynthetics QAC shall verify the following:

1. Any equipment used on the liner does not damage the EIA liner by handling, excessive heat, leakage of hydrocarbons, or other means. Additionally, the equipment and techniques used will not damage the underlying surfaces.

2. The prepared surface underlying the EIA liner has not deteriorated since previous acceptance and is still acceptable immediately prior to EIA liner placement.

3. Any geosynthetic element immediately underlying the EIA liner is clean and free of debris.

4. No personnel shall smoke or wear damaging shoes while working on the EIA liner or engage in other activities that could damage the EIA liner.

5. The method used to unroll or adjust the panels does not cause excessive scratches or crimps in the EIA liner and does not damage the supporting soil or underlying geosynthetics.

6. The method used to deploy EIA liner panels does not adversely impact the leak locator probes installed on the approved surface to be lined.

7. The method used to place the panels minimizes wrinkles, especially differential wrinkles between adjacent panels.

8. Adequate temporary loading and/or anchoring (e.g., sand bags, tires) have been placed to prevent uplift by wind.

9. Direct contact with the EIA liner is minimized, and the EIA liner is protected by geotextiles, extra geomembrane, or other suitable materials in areas where excessive traffic may be expected.

The LGM shall inform the Project Manager if the above conditions are not fulfilled.

14.6.5 Damage and Defects

Upon delivery to the site, the Geosynthetics QAC shall conduct an initial inspection of the panels for signs of shipping-related damage to the outer surfaces. The LGM shall advise the Project Manager, in writing, of any panels that appear to have been damaged in transit and that should be either rejected and removed from the site or noted so that a more complete inspection can be made following deployment.

The Geosynthetics QAC shall inspect each panel after placement for damage and/or defects. The LGM shall advise the Project Manager of panels or portions of panels that should be rejected, repaired, or accepted. Damaged panels or portions of damaged panels that have been rejected shall be marked and removed from the work area and recorded by the Geosynthetics QAC. Repairs shall be made using procedures described in Section 14.10.

14.6.6 Writing on the Liner

The Geosynthetics Installer and the Geosynthetics QAC shall use different colored markers that are readily visible for writing on the EIA liner. The Geosynthetics Installer shall use a white marker, and the Geosynthetics QAC shall use a yellow marker to write on the EIA liner. The markers used must be semipermanent and compatible with the EIA liner.

14.7 Seaming

The majority of EIA liner seaming shall be performed by the Manufacturer when prefabricating large panels for the project. Limited field seaming will be necessary to join prefabricated panels, to line odd-shaped areas, such as corners, and to make repairs. However, field seaming should be minimized to the extent possible. All seaming, whether performed at the Manufacturer's plant or in the field, shall adhere to the same requirements as outlined below and in the project specifications. The format of the following sections is based on the seaming being performed in the field and responsible parties are identified as such. During the process of factory seaming, the Manufacturer will perform the role of the Geosynthetics Installer and the Geosynthetics QAC.

14.7.1 Seam Layout

Before installation begins, the Geosynthetics Installer shall provide the Project Manager and the Geosynthetic QAC with a panel layout diagram. This diagram shall consist of a to-scale plan view of the area to be lined, the direction of slopes, the orientation of geomembrane panels, and the planned location of seams. The LGM shall review the panel layout diagram for acceptance with the project requirements and accepted state-of-practice. No panels shall be deployed or seamed until the Project Manager has reviewed and approved the Geosynthetics Installer's panel layout diagram. In addition, panels not specifically shown on the panel layout drawing may not be used without the Project Manager's prior approval. The Geosynthetics QAC shall use a seam numbering system compatible with the panel numbering system.

In general, seams shall be oriented parallel to the line of maximum slope (i.e., oriented along, not across, the slope). In corners and odd-shaped geometric locations, the number of seams should be minimized. No end seam should be less than 5 feet from the toe of the slope or from areas of potential stress concentrations, unless otherwise authorized by the Project Manager.

14.7.2 Accepted Seaming Methods and General Process

Approved processes for EIA liner seaming are heat (hot air) welding or radio frequency (RF) welding. Proposed alternate processes may be proposed and submitted to the Project Manager for review and approval. Seaming shall only be performed using equipment that has been specifically designed and manufactured for this purpose. Regardless of seaming method, the proposed process and listing of equipment shall be submitted to the Project Manager and Geosynthetics QAC for review and approval.

During the seaming process, the Geosynthetics QAC (or the Manufacturer in the case of factory seaming) shall log ambient temperature, seaming apparatus temperature, and EIA liner surface temperature at appropriate intervals and report any non-compliance to the Project Manager. The Geosynthetics QAC (or the Manufacturer in the case of factory seaming) shall verify the following items:

1. Equipment used for seaming is not likely to damage the EIA liner.

2. The electric generator is placed on a smooth base such that no damage occurs to the EIA liner.

3. A smooth insulating plate or fabric is placed beneath the hot welding apparatus after usage such that no damage occurs to the EIA liner.

4. The EIA liner is protected from damage in heavy traffic areas.

5. In general, the EIA liner panels are aligned to have a nominal overlap of 2 inches (50 millimeters) for seaming.

6. The liner has been cleaned using a cloth soaked in water or solvent to remove any foreign materials. In some instances, where excessive deposition of foreign material exists, abrasion of the membrane surface with a wire brush or mesh is suggested to loosen or remove pollutants.

14.7.3 Seam Preparation

The Geosynthetics QAC (or the Manufacturer in the case of factory seaming) shall verify that, prior to seaming, the seam area is clean and free of moisture, dust, dirt, debris, or foreign material of any kind. The Geosynthetics QAC shall also verify that seams are aligned with the fewest possible number of wrinkles and “fishmouths.”

14.7.4 Trial Seams

Trial seams shall be made on scraps of the EIA liner to be seamed to verify that conditions, equipment, and personnel are adequate for production seaming. Such trial seams shall be made at the beginning of each seaming period, and at least once every 5 hours for each production seaming apparatus/seamer combination to be used that day. Trial seams shall be made under the same conditions as actual seams.

The trial seam sample shall be at least 3 feet long by 12 inches wide (after seaming), with the seam centered lengthwise. Seam overlap shall be as required for production seams.

The entire trial weld will first be non-destructively tested as described in Section 14.8. Following successful completion of non-destructive testing, the trial weld will be subject to destructive testing. Three specimens shall be cut from the trial seam with a 2-inch-wide die by the Geosynthetics Installer at locations selected randomly by the Geosynthetics QAC. The specimens shall be tested for bonded seam strength as described in Section 14.9.5. If the destructive testing results in non-conformance, the seaming apparatus and seamer shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful trial seams are achieved. The Geosynthetics QAC shall observe all trial seam procedures.

The remainder of the successful trial seam sample shall be cut into three 6-inch-long (measured along the seam length) pieces and distributed as follows:

- One to the Project Manager;
- One to the Geosynthetics Installer; and
- One to the Geosynthetics QAC for possible laboratory testing.

Each portion of the sample shall be assigned a number and marked accordingly by the Geosynthetics QAC. The Geosynthetics QAC shall also log the date, hour, ambient temperature, number of seaming unit, name of seamer, and pass or fail description.

If agreed upon between the Project Manager and the LGM and documented by the LGM in a daily report, the remaining portion of the trial seam sample can be subjected to laboratory destructive testing as indicated in Section 14.9.6. If a trial seam fails a laboratory test conducted by the Geosynthetics QAL, then a destructive seam test sample shall be taken from each seam completed by a combination of the production seaming apparatus and seamer related to the subject trial seam. These samples shall be forwarded to the Geosynthetics QAL for testing in accordance with Section 14.9.6 and, if they fail the destructive tests, the procedures indicated in Section 14.9.7 shall apply. The conditions of this paragraph shall be considered satisfied for a given seam if a destructive seam test sample has already been taken.

14.7.5 Seaming Procedures

The Geosynthetics QAC shall verify that the seaming conditions, including weather conditions and seam preparation, meet the project specifications. The LGM shall notify the Project Manager, in writing, if the Project Specifications are not met. Ambient temperature shall be measured by the Geosynthetics QAC in the area where the panels are to be placed. The Project Manager will decide if the installation is to be stopped or if special procedures will be used.

Trial seaming, as described in Section 14.7.4, shall be conducted under the same ambient temperature conditions as the actual production seams. The LGM may recommend more frequent destructive tests to the Project Manager, as described in Section 14.9, for any suspect areas.

14.8 Non-Destructive Seam Testing

14.8.1 Concept

The purpose of non-destructive tests is to check the continuity of the seams. It does not provide quantitative information on the seam strength. The Geosynthetics Installer shall visually inspect and then non-destructively test all field seams over the full length using a vacuum test unit and/or air lance method testing, or another method approved by the Project Manager. Non-destructive testing shall be conducted in accordance with the project specifications as the seaming work progresses – not at the completion of all field seaming.

For all seams, the Geosynthetics QAC shall perform the following:

1. Visually inspect the full length of all seams to insure that molten polymer has extruded from the seam edge.

2. Observe non-destructive testing procedures.

3. Record location, data, test unit number, name of tester, and outcome of all testing.

4. Visually inspect all tests.

5. Inform the Installer and Project Manager of any required repairs.

Any seams that cannot be non-destructively tested shall be cap-stripped with the same EIA liner material. The Geosynthetics QAC and Geosynthetics Installer shall inspect the completed cap-stripping operation for uniformity and completeness.

14.8.2 Test Failure Procedures

The Geosynthetics Installer shall complete any required repairs in accordance with Section 14.10. For repairs, the Geosynthetics QAC shall perform the following:

1. Observe the repair and testing of the repair.

2. Mark on the EIA liner that the repair has been approved.

3. Document the repair procedures and test results.

14.9 Destructive Seam Testing

14.9.1 Concept

The purpose of destructive seam testing is to evaluate seam strength. Bonded seam strength destructive tests shall be performed at locations selected by the Geosynthetics QAC, in accordance with the QAM and the project specifications. The minimum acceptance criteria for destructive testing are defined in the project specifications. Seam strength testing shall be done as the seaming work progresses – not at the completion of all field seaming.

14.9.2 Location and Frequency

The Geosynthetics QAC shall select locations where seam samples will be cut out for laboratory testing. The Geosynthetics Installer shall not be informed in advance of the locations where the seam samples will be taken. The seam sample locations shall be established as follows:

1. A minimum frequency of one test location for each seam greater than 250 feet in length. For seams shorter than 250 feet in length, one test location shall be selected for every 500 linear feet of seaming collectively. Whenever possible, samples shall be collected near the anchor trenches to limit hydrostatic heads on seam repair areas and, depending on the amount of excess material at the anchor trench, to completely avoid the need to repair the sample area.

2. Test locations shall be determined during seaming at the Geosynthetics QAC's discretion and may be influenced by suspicions of unacceptable welding or substandard quality.

14.9.3 Sampling Procedures

Samples shall be cut by the Geosynthetics Installer at locations chosen by the Geosynthetics QAC as the seaming progresses and following the successful completion of non-destructive testing. The Geosynthetics QAC shall perform the following:

1. Observe sample cutting.

2. Assign a number to each sample and mark it accordingly.

3. Record the sample location on layout drawing.

4. Record the reason for taking the sample at this location (e.g., statistical routine, suspicious weld).

5. Examine samples for holes, grooves, melt-through, wavering welds, unusual weld width, and any other unusual characteristics.

If samples are collected along the edge of the lined area and the sample is collected from what otherwise would be trimmed off as waste during anchor trench backfilling, the sample area does not require repair (i.e., patching). Otherwise, holes in the EIA liner resulting from destructive seam sampling shall be immediately repaired in accordance with repair procedures described in Section 14.10.3. The continuity of the new seams in the repaired area shall be tested according to Section 14.8.

14.9.4 Sample Dimensions

At each sampling location, a sample measuring at least 3 feet long by 8 inches wide, (after seaming) with the seam centered lengthwise, shall be cut from the production seam by the Geosynthetics Installer. Bonded seam strength testing requires that the test specimens be cut into 2-inch-wide strips (measured along the seam). The 3-foot-long sample shall be subdivided into two 6-inch-long pieces (measured along the seam), and one piece will be tested in the field by the Geosynthetics Installer and the other will be tested in a laboratory by the Geosynthetics QAL. The remainder of the sample shall be cut into three parts and distributed as follows:

1. One portion to the Geosynthetics Installer.

2. One portion for Geosynthetics QAL testing.

3. One portion to the Project Manager.

14.9.5 Field Testing

As mentioned in Sections 14.9.4 and 14.7.4, three 2-inch-wide strips shall be tested in the field using the modified grab test for bonded seam strength and shall not fail according to the criteria in the project specifications. If the test passes in accordance with this section, the sample qualifies for testing in the laboratory. If the field destructive testing fails, the seam should be repaired in accordance with Section 14.10. Alternately, the Geosynthetics Installer may elect to collect additional destructive seam samples on both sides of the original sample and test them in the field in an effort to bound the affected area. The alternate procedure shall be as per Section 14.9.7. Final judgment regarding seam acceptability, based on the failure criteria, is the responsibility of the LGM.

The Geosynthetics QAC shall observe all field tests and mark all samples and portions with their number. The Geosynthetics QAC shall also log the date, time, ambient temperature, number of seaming unit, name of seamer, welding apparatus temperatures, and pass or fail description. A copy of this information shall be attached to each sample portion.

14.9.6 Laboratory Testing

Destructive test samples provided by the Geosynthetics Installer to the Geosynthetics QAC shall be packaged and shipped, if necessary, under the responsibility of the Geosynthetics QAC in a manner that will not damage the test sample. The sample shall be shipped as soon as possible to expedite laboratory testing by the Geosynthetics QAL. The Project Manager shall be responsible for storing archive samples.

Laboratory destructive testing shall consist of the same test method as the field destructive testing and using the same number and individual size of test strips. The Geosynthetics QAL shall provide verbal test results within 24 hours of receipt of the sample. The LGM shall review laboratory test results as soon as the results become available and make appropriate recommendations to the Project Manager.

14.9.7 Destructive Test Failure Procedures

The following procedures shall apply when a sample fails a destructive test, whether that test is conducted by the Geosynthetics QAL or by field tensiometer. The Geosynthetics Installer has two options:

1. The Geosynthetics Installer can repair the seam between any two passing destructive test locations; or

2. The Geosynthetics Installer can trace the welding path to an intermediate location, a minimum of 10 feet from the point of the failed test in each direction, and take a sample as described in Section 14.9.4 at each location. If field destructive testing of these additional samples is successful, a portion of each sample shall be sent to the Geosynthetics QAL for laboratory destructive testing. If the laboratory testing is successful, the seam is repaired between these locations. If either sample fails, the process is repeated to establish the zone in which the seam should be repaired.

All acceptable repaired seams shall be bound by two locations from which samples passing laboratory destructive tests have been taken. In cases exceeding 150 feet of repaired seam, a sample taken from the zone in which the seam has been repaired must pass destructive testing. Repairs shall be made in accordance with Section 14.10.3.

The Geosynthetics QAC shall document all actions taken in conjunction with destructive test failures. No installation of material above the EIA liner shall be done until destructive testing for that section is completed and accepted by the Geosynthetics QAC and test results are delivered to the NYSDEC monitor.

14.10 Defects and Repairs

14.10.1 Identification

All seams and non-seam areas of the EIA liner shall be examined by the Geosynthetics QAC for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Light reflection by the EIA liner helps to detect defects. The surface of the EIA liner shall be clean at the time of examination. The EIA liner surface shall be cleaned by the Geosynthetics Installer, if the Geosynthetics QAC determines that the amount of dust or mud inhibits examination.

14.10.2 Evaluation

Each suspect location (seam and non-seam areas) shall be non-destructively tested using the methods described in Section 14.8. Each location that fails the non-destructive testing shall be marked by the Geosynthetics QAC and repaired by the Geosynthetics Installer. All defects found during testing shall be numbered and marked immediately after detection. Work shall not proceed with any materials that will cover locations that have been repaired until appropriate non-destructive and laboratory test results with passing values are available.

14.10.3 Repair Procedures

Any portion of the EIA liner exhibiting a major flaw or failing a destructive or non-destructive test shall be repaired in accordance with the project specifications. The Project Manager, Geosynthetics Installer, and LGM shall be in agreement on the final decision as to the appropriate repair method.

1. The repair procedures available include the following:

    a. *Patching*: used to repair large holes, tears, undispersed raw materials and contamination by foreign matter.

   b. *Patching*: used to repair small tears, pinholes or other minor, localized flaws.

   c. *Capping*: used to repair large lengths of failed seams.

   d. Removing bad seam and replacing with a strip of new material welded into place.

2. For any repair method, the following provisions shall be satisfied:

   a. All surfaces shall be clean and dry at the time of the repair.

   b. All seaming equipment used in repairing procedures shall meet the requirements of the QAM and the project specifications.

   c. Patches or caps shall be of the same liner material and extend at least 4 inches beyond the edge of the defect. All corners of patches shall be rounded, with a radius of approximately 3 inches.

   d. Patch shall be seamed to the original material using heat or RF welding. EIA liner shall be overlapped a minimum of 4 inches. Pressure shall be applied to the top and bottom surfaces for the full seam width while the welded area is in the melt condition. Heat and pressure shall be applied so as to cause a bead of material to extrude from the welded edges.

14.10.4 Repair Verification

Each repair shall be non-destructively tested using the methods described in Section 14.8, as appropriate. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. The Geosynthetics QAC shall observe all non-destructive testing of repairs and shall record the number of each repair, date, and test outcome. Repairs more than 150 feet long require destructive test sampling at the discretion of the LGM. Failed tests indicate that the repair shall be redone and retested until a passing test results.

14.11 Electrical Resistivity Leak Testing

Leak location surveys shall be conducted on both the primary and secondary EIA liners on the floor and sideslopes of the Fac ponds. The surveys shall be performed as each layer is constructed to allow for the repair of identified defects.

The Geosynthetics Installer shall install at least two permanent electrodes in the soil liner located below the secondary EIA liner and above the geocomposite layer between the secondary and primary EIA liners. The permanent electrodes will be provided by the Leak Location Contractor and their locations established as directed by the Leak Location Contractor. The Contractor shall supply an AC power source for the leak location survey (110 volts, 5A).

For leak testing of the secondary EIA liner of the Fac pond in the floor areas, the Earthwork Contractor shall fill the base of Fac pond with water, such that the water extends to the toe of the sideslope of the Fac pond over the entire base of the Fac pond. For safety reasons, this may be done in stages to minimize the depths of water needed to perform the leak test. The sideslopes of the secondary EIA liner shall be leak tested utilizing a water lance. To test the primary EIA liner layer of the Fac Pond in the floor areas, the Earthwork Contractor shall wet the stone layer above the primary EIA liner over the entire base of the Fac Pond to the toe of the sideslopes. The sideslopes of the primary EIA liner shall be leak tested utilizing a water lance. The Leak Location Contractor shall establish a grid over the surface of the areas to be leak tested prior to conducting the leak testing. Areas where potential leaks are identified by the Leak Location Contractor shall be recorded and transferred to the surface of the EIA liner after the leak testing is completed. The Geosynthetics Installer shall expose all potential leaks identified by the Leak Location Contractor and repair all identified leaks in accordance with repair requirements included in the Technical Specifications.

Appendix A

Test Fill Program for New Clay and CGL Final Cover Protective Soil Sources

TEST FILL PROGRAM FOR NEW CLAY AND GCL FINAL COVER PROTECTIVE SOIL SOURCES

1.0 PURPOSE AND SCOPE

The purpose of the test fill is to establish a sequential and logical approach for the development of the placement and compaction procedures to be used during construction of compacted clay liners and geosynthetic clay liner (GCL) final cover protective soil layers that meets the required performance standard. The test fill program will allow the Earthwork Contractor, the Engineer or Project Manager and the Soil Quality Assurance Consultant (QAC) to identify appropriate placement and compaction procedures. Once the construction procedures have been established by the test fill program, the Earthwork Contractor and the Soil QAC will monitor the compacted clay liner and GCL final cover protective soil layer construction procedures as an indicator that the performance standards are being achieved.

This test fill program documents the requirements for construction of the test fill. The test fill program will include:

- Subgrade preparation.
- Construction of the test fill.
- Inspection and testing of the test fill.
- Sampling of portions of the test fill.

This test fill program may be modified with approval from the New York State Department of Environmental Conservation (NYSDEC).

2.0 TEST FILL MATERIAL

Feasibility testing of new clay and GCL final cover protective soil sources (not previously qualified) shall be performed prior to construction of the test fill. The material shall be evaluated in accordance with Sections 4.2 and 8.2 of the Quality Assurance Manual (QAM), as well as requirements in the Project Specifications. These tests shall provide the basic relationship of permeability with varying density and moisture content. A typical representation of compaction and laboratory permeability test results for one clay source is shown on Figure 2.

3.0 CONSTRUCTION EQUIPMENT

The equipment to be used for the test fill shall be proposed by the Earthwork Contractor and approved by the QAC and Project Manager. The equipment to be used for the test fill shall be consistent with the equipment that will be used during actual layer construction. Variations may be approved by the Engineer provided that the equipment exhibits similar physical characteristics (e.g., weight, width, foot height, speed). For GCL final cover protective soil test fills, only tracked low ground pressure equipment may be used for compaction unless otherwise approved by the Engineer.

4.0 TEST FILL CONSTRUCTION

4.1 SUBGRADE PREPARATION

The area within the limits of the test fill shall be cleaned and grubbed of all trees, debris, brushes, stumps, roots, trash and any other vegetation or objectionable material. Following clearing and grubbing, the area shall be stripped of topsoil. Topsoil shall be stockpiled in an area designated by the Project Manager.

The surface of the subgrade shall be proof-rolled so as to be firm and free of irregularities, loose earth and abrupt changes in grade. A drainage layer shall be installed on the subgrade. The drainage layer shall be firm, smooth and flat, shall have a hydraulic conductivity of a least two orders of magnitude higher than the expected hydraulic conductivity of the constructed test fill and shall prevent fine particles of the test fill material from piping into the voids of the drainage layer. A layer of geotextile filter fabric may be placed between the drainage layer and test fill material, with the approval of the Engineer, to help prevent mixing of the materials. Upon the approval of the Engineer, the Earthwork Contractor may place a compacted sacrificial soil layer 2 to 5 inches thick over the drainage layer prior to construction of the first test fill lift. This is to provide a layer of separation between the drainage layer and the first lift compaction and testing equipment. The subgrade, drainage layer, and test fill surfaces shall be sloped at a 2% grade. Line and grades shall be controlled by survey. No standing water or excessive moisture shall be allowed on the surface of the subgrade. The surface shall be inspected by the Soil QAC prior to beginning construction of the test fill.

4.2 TEST FILL REQUIREMENTS

The test fill shall be constructed and evaluated with the minimum criteria below. The requirements of Section 5 and general guidance from the NYSDEC presented in Appendix B will form additional requirements. In general, clay test fills will include multiple lifts, whereas GCL final cover protective soil test fills will include a single lift. In both cases, lift thicknesses will be comparable to those used in actual layer construction.

4.2.1 Lift Thickness for Clay Test Fills

In general, loose lift thickness shall not exceed length of the feet or pads as measured from the drum of the compactor prior to compaction or 9 inches, whichever is less. Refer to test fill construction procedure for thicknesses of the various test fill lifts.

4.2.2 Lift Thickness for GCL Final Cover Protective Soil Test Fills

Post-compaction lift thickness shall be approximately 18 inches to simulate the minimum allowable lift thickness used in actual construction.

4.2.3 Density for Clay Test Fills

Dry density at or greater than 90% maximum modified proctor dry density.

4.2.4 Density for GCL Final Cover Protective Soil Test Fills

Required dry density will not be definitively known during the construction of the test fills. Approximate dry density will be known from laboratory remolded permeability testing. Exact value will be determined by the results of the test fill permeability testing. Required compaction is that which is determined necessary to achieve the maximum allowable permeability.

4.2.5 Moisture Content

1. At or greater than Optimum Moisture Content.
2. In-place moisture within acceptable compaction window.

4.2.6 Permeability Testing

1. For clay test fills, conduct field hydraulic permeability testing by using the Sealed Double Ring Infiltrometer (SDRI) Test, Single Ring Infiltrometer (SRI) or Boutwell Two Stage Borehole Test as specified in Appendix B.

2. For clay and GCL final cover protective soil test fills, obtain undisturbed samples by thin-walled Shelby tube or block as indicated on the example test fill configuration plan (Figure 1). Conduct constant head permeability testing on samples.

4.3 FILL PLACEMENT

The test fill shall be a rectangle approximately 60 feet long and at least 4 times wider than the widest piece of compaction equipment to be used in construction of a full-scale facility (Figure 1). In no case shall the width be less than 20 feet.

The test fill shall be constructed in uniform horizontal lifts to a total thickness of at least 24 inches for compacted clay and approximately 18 inches for GCL final cover protective soil after compaction in accordance with the procedures specified below. The procedures, which vary with the lift considered, are intended to allow determination of a relationship between soil compaction criteria, which include density and moisture content, permeability and compaction method parameters. Compaction method parameters include:

- Compactor characteristics.
- Thickness of compacted/uncompacted layers.
- Number of compactor passes and moisture content.

4.3.1 First Lift (Clay and GCL Final Cover Protective Soil Test Fills)

1. For both clay and GCL final cover protective soil test fills, the first lift shall be placed according to the thicknesses presented in Section 4.2.

2. Soil moisture content shall be maintained at or above optimum water content determined by the Soil QAC. The Earthwork Contractor shall adjust the moisture content as necessary to obtain the specified density criteria.

3. The test fill material shall be compacted with passes using the previously agreed compaction equipment.

4. The Earthwork Contractor shall permit the Soil QAC to performed in-place density tests and collect soil samples as specified in Section 5.3.1.

5. Holes left in the lift shall be repaired in accordance with methods outlined in the QAM. The repairs shall be made using procedures that have been shown to meet the required moisture and density criteria.

6. The test fill material shall be compacted a second time by applying two more one-way passes with the selected compactor.

7. Steps 4 and 5 shall be repeated. Second series of tests shall be taken near the original tests.

8. The test fill material shall be compacted a third time by applying two more one-way passes with the selected compactor.

9. Steps 4 and 5 shall be repeated. Third series of tests shall be taken near the first and second tests.

10. Steps 8 and 9, respectively, shall be repeated and continued until specified compaction criteria are obtained as identified by the Soil QAC.

4.3.2 Second Lift (Clay Test Fills Only)

1. The loose thickness of the second lift shall be such that the thickness of the lift will be 6 inches after compaction.

2. A competent bond with the first lift shall be achieved by the Earthwork Contractor and approved by the Soil QAC.

3. Steps 2 through 10 of Section 4.3.1 shall be repeated.

4.3.3 Remaining Lifts (Clay Test Fills Only)

1. The loose thickness of the remaining lifts shall be such that the thickness of the lifts will be 6 inches after compaction.

2. The procedures for compacting and testing the remaining lifts shall be those that have been tested and proven effective during the compaction of the second lift.

4.3.4 Final Surface Preparation (Clay Test Fills Only)

The surface of the test fill shall be rolled with a smooth steel drum or pneumatic roller so as to be free of irregularities, loose earth and abrupt changes in grade. Stones larger than 1 inch shall be removed. Stones which are smaller than 1 inch and are judged to be detrimental to a geomembrane liner will be removed. One-half of the prepared soil surface shall be protected against damage with temporary plastic sheets. The sheets shall be placed immediately after the completion of surface preparation. Observations and documentation of desiccation cracking versus time shall be made on the uncovered section of the test fill.

5.0 INSPECTION AND TESTING

5.1 TEST FILL MATERIAL

The Soil QAC shall perform testing on the soil material prior to its use in the test fill. Testing will be performed in accordance with the test methods provided in the technical specifications and include at least the following:

- Soil density/moisture content relationship using the Standard Proctor Method and Modified Proctor Method.
- Moisture content.
- Particle size distribution.
- Atterberg limits.
- Soil classification.
- Organic content.
- Hydraulic conductivity testing.
- Direct shear test (general fill source for GCL final cover protective soil only).
- Unconsolidated undrained triaxial shear test (clay source material only).

5.2 SUBGRADE PREPARATION

The Soil QAC shall observe the prepared subgrade for firmness, smoothness and absence of abrupt changes in grade. The subgrade shall be surveyed to serve as the origin when determining thicknesses.

5.3 TEST FILL CONSTRUCTION

Test fill shall be constructed as described previously under Section 4.

5.3.1 Lift Compaction

For the first and second lifts, the Soil QAC shall perform the following activities:

- Estimate the thickness of the loose lifts.
- Count the number of compactor passes and observe compactor coverage of the test fill.
- Perform a minimum of eight nuclear gauge in-place density and moisture readings at every two passes, and a minimum of two in-place density tests using the sand-come method, the rubber balloon method or the drive cylinder method to verify the nuclear gauge readings; compute degree of compaction (i.e., in-place dry density divided by the

Modified Proctor maximum dry density); collect four additional soil samples for moisture content determination and organic content.

- Observe the repair of holes left in the lift as a result of density testing and soil sample collection.

- Continue in-place density testing and moisture content determination to enable development of a curve giving in-place dry density versus number of compactor passes for each lift thickness (Figure 3).

For each of the remaining lifts on clay test fills, the Soil QAC shall perform the following activities:

- Verify that the thickness of the loose lift does not exceed the loose thickness determined from testing of the second lift.

- Count the number of compactor passes, determined from testing of the second lift, which are necessary to achieve the specified density and observe compactor coverage of the test till.

- Perform a minimum of eight nuclear density tests and two sand-cone density tests per lift to verify the adequacy of the construction procedures previously established.

The Soil QAC shall collect a minimum of six undisturbed Shelby tube samples or eight samples measuring 8-inch by 8-inch by 6-inch undisturbed block soil samples from varying depths of the completed test fill. The samples shall be waxed or otherwise protected to retain natural moisture and tested in the laboratory for the following:

- Hydraulic conductivity (permeability) using water as the permeant.
- Soil density/moisture with Modified Proctor.
- Particle size distribution.
- Atterberg limits.
- Soil classification.
- Soil moisture content.
- Organic content.

For clay test fills, the Soil QAC shall observe the test fill to verify the adequacy of the bonding between adjacent lifts. Such observation shall be exercised on the portion of the test fill that has been excavated to permit removal of undisturbed soil block samples and/or the sand-cone density testing.

5.3.2 Final Surface Preparation

The Soil QAC shall observe the prepared surface for firmness, smoothness and absence of abrupt changes in grade. The final surface will be surveyed to verify the test fill thickness.

5.4 BULK FIELD HYDRAULIC CONDUCTIVITY FOR CLAY TEST FILLS

One or more field bulk hydraulic conductivity test device(s) must be installed and performed in the area of the clay test fill that is prepared by the methods and controls that will be used in the actual construction. Acceptable field bulk hydraulic conductivity test devices include (but are not limited to) the following:

- SDRI.
- SRI.
- Boutwell two stage borehole.

Information from the field bulk hydraulic conductivity test must be used to confirm or deny that the soil, the methods of compaction and the controls on compaction have produced a uniformly compacted soil with a bulk hydraulic conductivity of $1x10^{-7}$ centimeters per second (cm/s) or less. The results of the bulk field hydraulic conductivity test(s) should be submitted to the NYSDEC for review and approval at least 30 days prior to actual construction involving the soil material for which the test fill was performed.

6.0 DOCUMENTATION

The Soil QAC shall document activities associated with the construction, monitoring and testing of the test fill and provide recommendations on placement and compaction procedures. Such documentation shall include daily reports of construction activities and oral communications with the Contractor. The following shall be documented for the specific sections listed below.

6.1 TEST FILL MATERIAL

The Soil QAC shall provide a moisture-density relationship for the test fill material and other test results as specified in Section 5.1

6.2 TEST FILL CONSTRUCTION

6.2.1 Subgrade Preparation

The Soil QAC shall document observations on a subgrade preparation, as specified in Section 5.2.

6.2.2 Test Fill Construction

The Soil QAC shall document activities of the test fill construction, monitoring and testing in a test fill summary report, which shall include, but not be limited to:

- Record the compactor type, configuration and weight for sheepsfoot compactors, record the drum diameter and length, empty and ballasted weight, length and face area of feet, yoking arrangement, if any.

- Record thicknesses of lifts prior to and after compaction.

- Observe that construction equipment reaches normal operating speed before entering the area to be used for testing.

- Record density versus number of compactor passes for each lift thickness, as specified in Section 5.3.1.

- Record the number of compactor passes, which will provide the specified degree of compaction and permeability.

- Record the procedure to bond lifts.

- Record results of moisture, in-place density and degree of compaction, as specified in Section 5.3.1.

- Document repair of holes left in the lift as a result of density testing and soil sample collection, as specified in Section 5.3.1.

- Record results of laboratory permeability testing and other soil properties tests performed on undisturbed soil samples.

- Include as-built drawing of the test fill and locations of all test samples for each lift.

- Include cross-section of the test fill showing number of lifts and lift thickness.

- Describe actual construction procedures.

- Observe test fill excavation for removal of undisturbed soil samples and observations of layer bonding, as specified in Section 5.3.1.

Appendix B

Requirements for Designing Acceptable Zone of Compaction Control

Imagine the result

CWM Chemical Services, LLC

Requirements for Designing Acceptable Zone of Compaction Control

Residuals Management Unit 2

Model City Facility
1550 Balmer Road
Model City, Niagara County, New York

April 2003
Revised August 2009

ARCADIS

Residuals Management Unit 2 Requirements for Designing Acceptable Zone of Compaction Control

April 2003
Revised August 2009

Figures

ARCADIS

Residuals Management Unit 2 Requirements for Designing Acceptable Zone of Compaction Control

April 2003
Revised August 2009

1. Introduction

One of the most significant factors affecting the performance of compacted soil liners is the control of water content and dry unit weight during construction. A carefully written compaction specification can improve the likelihood of achieving low hydraulic conductivity while also satisfying other factors affecting performance, such as strength, compressibility and desiccation resistance. Because a soil liner is meant to be a hydraulic barrier, low hydraulic conductivity (or hydraulic conductivity lower than the regulatory standard) should be the primary factor affecting the design of a compaction specification. The specification should then be tightened to meet other performance standards.

2. Concept of Acceptable Zone

Figures 1 through 3 show three compaction curves that correspond to high compactive effort (Modified Proctor), moderate compactible effort (Standard Proctor) and low compactive effort (Reduced Proctor). It is believed that these compactive efforts simulate the range of compactive efforts that can be achieved in the field (Benson and Daniel, 1990). A description of the procedure to achieve Reduced Proctor compactive effort is included in Section 3.

For each compaction curve shown on these figures, the lowest hydraulic conductivity is achieved for water contents in excess of optimum water content. Furthermore, similar water contents can yield radically different hydraulic conductivities if the compactive effort is changed. For example, at a water content of 11%, the hydraulic conductivity of this soil can be as low as 2×10^{-9} centimeters per second (cm/sec) and as high as 1×10^{-6} cm/sec. Therefore, to achieve the required hydraulic conductivities, a compaction specification should be designed that delineates a zone in the compaction plane that yields the desired hydraulic conductivity for the rate of compactive efforts that may be realized in the field. This zone of water contents and dry unit weights is called an "Acceptable Zone." For most cases, where the low hydraulic conductivity is desired, the acceptable zone will have a shape similar to the shaded region shown on Figures 1 through 3.

3. Developing an Acceptable Zone

The procedure to develop an Acceptable Zone involves: 1) establishing a zone of water content and dry unit weight that yields the required hydraulic conductivity and 2) modifying the zone to account for other factors beside hydraulic conductivity. A moisture and density control evaluation, as outlined in Section 3.1, will be conducted as required by the New York State Department of Environmental Conservation (NYSDEC) and submitted to the NYSDEC for approval of an acceptable zone.

3.1 Moisture and Density Control

Moisture and density control can be accomplished by meeting any of the three sets of requirements that are described as Case I, II or III. The overall basis for these approaches can be found in a paper entitled “Water Content-Density Criteria for Compacted Soil Liners,” by D. E. Daniel and C. H. Benson in the *Journal of Geotechnical Engineering*, Vol. 116, No.12, pages 1811-1830, December 1990.

3.1.1 Case I

For this case, the following compaction control conditions have been proven to be necessary via the laboratory testing and the test fill.

1. The measured in-place moisture content immediately after soil compaction always shall be at, or greater than, the optimum moisture content from the most recent representative Modified Proctor curve developed on soil from the same borrow source.

2. The measured in-place dry density immediately after soil compaction shall be at, or greater than, 90% of the maximum Modified Proctor dry density from the most recent representative Modified Proctor curve developed on soil from the same borrow source.

3. The measured in-place moisture content and the measured in-place dry density immediately after soil compaction shall plot above the line of optimums on a plot of the most recent representative Modified and Standard Proctor curves. The line of optimums shall be a curve that passes through the maximums of both the Standard Proctor curve and the Modified Proctor curve and is parallel to the curve of zero air voids.

4. Compaction to the density required in Requirement 2 and 3 is waived at locations where any effort made to achieve this density would damage underlying geosynthetics, or otherwise prevent the material from achieving its intended function.

Requirements 1 through 3 of this case determine a bounded area on a plot of moisture and density that may be termed the "acceptable range." Figure 1, "Acceptable Moisture-Density Plot for Soil for Case I," illustrates this acceptable range for moisture and density.

A Standard Proctor curve and a Modified Proctor curve are determined and plotted on the same figure. The line of optimums is a line that passes through the maximum point on both the Modified and Standard Proctor curves and is generally parallel to the curve of zero air voids. This line of optimums is one of the bounds of the acceptable range. The other is the horizontal line determined by 90% of the maximum value on the Modified Proctor curve.

3.1.2 Case II

For this case, compaction control to a density below 90% of the maximum Modified Proctor density has been proven in the laboratory and the test fill to be acceptable.

1. The measured in-place moisture content immediately after soil compaction shall always be at, or greater than, the optimum moisture content from the most recent representative Modified Proctor curve developed on soil from the same borrow source.

2. The measured in-place dry density immediately after soil compaction shall be at, or greater than, a density that corresponds to an alternate percent of the maximum Modified or Standard Proctor dry density from the most recent representative Modified Proctor curve developed on soil from the same borrow source. The density limit should be greater than 90% of the Standard Proctor density to prevent incomplete compaction of a very moist soil and the consequent creation of a structurally weak soil mass. The density limit shall be shown to meet the hydraulic conductivity limit of 1×10^{-7} cm/sec maximum or less as demonstrated by remolded laboratory tested samples and by the field bulk hydraulic conductivity test on the test fill and shall be shown to have sufficient structural strength for the intended use.

3. The measured in-place moisture content and the measured in-place dry density immediately after soil compaction shall plot above the line of optimums on a plot of the most recent representative Modified and Standard Proctor curves. The line of optimums shall be a curve that passes through the maximums of both the Standard Proctor curve and the Modified Proctor curve and is parallel to the curve of zero air voids.

4. Compaction to the density required in Requirements 2 and 3 is waived at locations where any effort made to achieve this density would damage underlying geosynthetics, or otherwise prevent the material from achieving its intended function.

Requirements 1 through 3 of this case determine a bounded area on a plot of moisture and density that may be termed the "acceptable range." Figure 2, "Example Acceptable Moisture-Density Plot for Soil for Case II," illustrates one example of this acceptable range for moisture density.

A Standard Proctor curve and a Modified Proctor curve are determined and plotted on the same figure. Again, the line of optimums is one of the bounds of the acceptable range. In this second case, the other bound is the horizontal line determined by 90% of the maximum value on the Standard Proctor curve.

3.1.3 Case III

For this case, special compaction control below the line of optimums have been proven in the laboratory and the test fill to be acceptable.

1. The measured in-place moisture content immediately after soil compaction shall always be at, or greater than, the optimum moisture content from the most recent representative Modified Proctor curve developed on soil from the same borrow source.

2. The measured in-place dry density immediately after soil compaction shall be at, or greater than, 90% of the maximum Modified Proctor dry density from the most recent representative Modified Proctor curve developed on soil from the same borrow source.

3. The measured in-place moisture content and the measured in-place dry density immediately after soil compaction shall plot above an alternate line that

is parallel to the line of optimums on a plot of the most recent representative Modified and Standard Proctor curves. The line of optimums is described in Case II above. The alternate line shall be offset by a certain percent moisture from the line of optimums. The offset is arrived at by demonstrating that the soil compacted to a moisture and density, which plots above the alternate line, has a hydraulic conductivity less than or equal to 1×10^{-7} cm/sec as demonstrated by remolded laboratory tested samples and by the field bulk hydraulic conductivity test on the test fill. The compacted soil shall have sufficient structural strength for the intended use as demonstrated by laboratory triaxial strength tests.

4. Compaction to the density required in Requirements 2 and 3 is waived at locations where any effort made to achieve this density would damage underlying geosynthetics, or otherwise prevent the material from achieving its intended function.

Requirements 1 through 3 of this case determine a bounded area on a plot of moisture and density that may be termed the “acceptable range.”

Figure 3, “Example Acceptable Moisture-Density Plot for Soil for Case III,” illustrates one example of this acceptable range for moisture and density.

A Standard Proctor curve and a Modified Proctor curve are determined and plotted on the same figure. Similar to Case I, the horizontal line determined by 90% of the maximum value on the Modified Proctor curve is one of the bounds. The other bound is now an alternate line that is parallel to the line of optimums but is offset by a certain percent moisture.

3.2 Additional Moisture Control Details

The moisture content shall be maintained uniform throughout the lift. Whenever the moisture content of the soil at the borrow source is lower than the Modified Proctor optimum moisture content, water shall be added and distributed within the soil sufficiently soon to achieve complete dispersion within the soil mass. Usually this means that water must be added before shipment of the soil to the site. If examination of the most recent representative Modified and Standard Proctor curves indicates that the proper density cannot be reached at its present moisture content, then the material will be dried before compaction. Drying will be accomplished by blading, disking, harrowing or other aeration methods to hasten the drying process. The affected soil will be mixed thoroughly within the loose lift or stockpile to achieve an even distribution of moisture within every loose lift prior to compaction.

If additional moisture must be added at the compaction site, then disking, watering and disking again shall be conducted prior to compaction to achieve an even distribution of moisture within every lift.

4. Variable Soil Properties

In some cases, the borrow source may be so variable that different acceptable zones are needed to describe soils that have significantly different properties. If the soils can be easily distinguished in the borrow pit and/or the construction area, separate acceptable zones can be developed and supplied to field inspectors. If the soils are not easily distinguished, a composite acceptable zone can be developed by overlaying the acceptable zones, as shown on Figure 3. The intersection of the acceptable zones is then the composite Acceptable Zone.

5. Use of Acceptable Zone

The Acceptable Zone can be used directly in the field. Inspectors measuring water content and dry unit weight can plot the field data on the compaction curve. If the data fall in the Acceptable Zone and no visible defects are present, the compaction is deemed acceptable. Otherwise, the soil needs additional processing and compaction.

6. References

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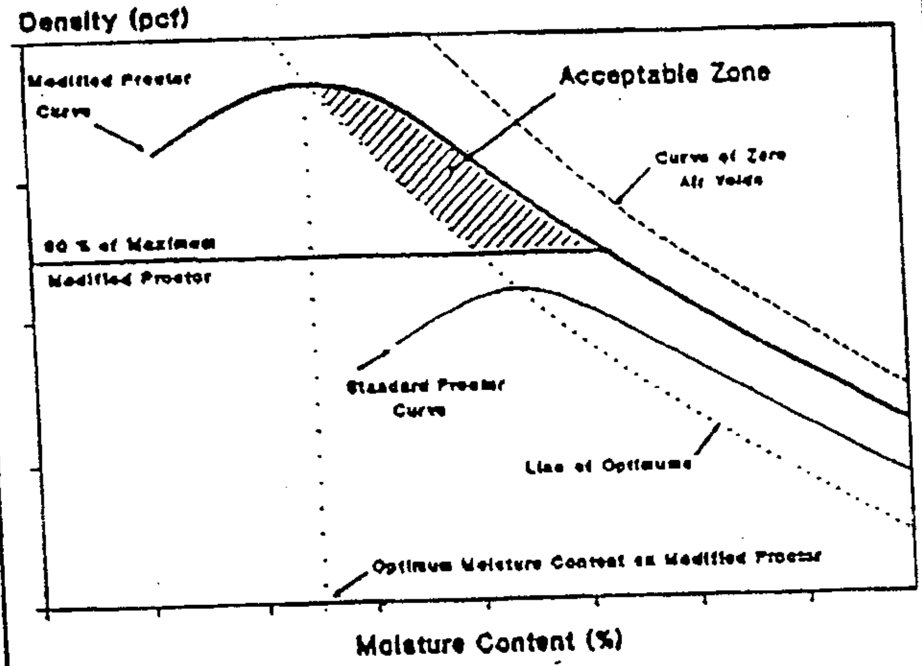
Figures

Figure 1. Acceptable Moisture-Density Plot for Case I



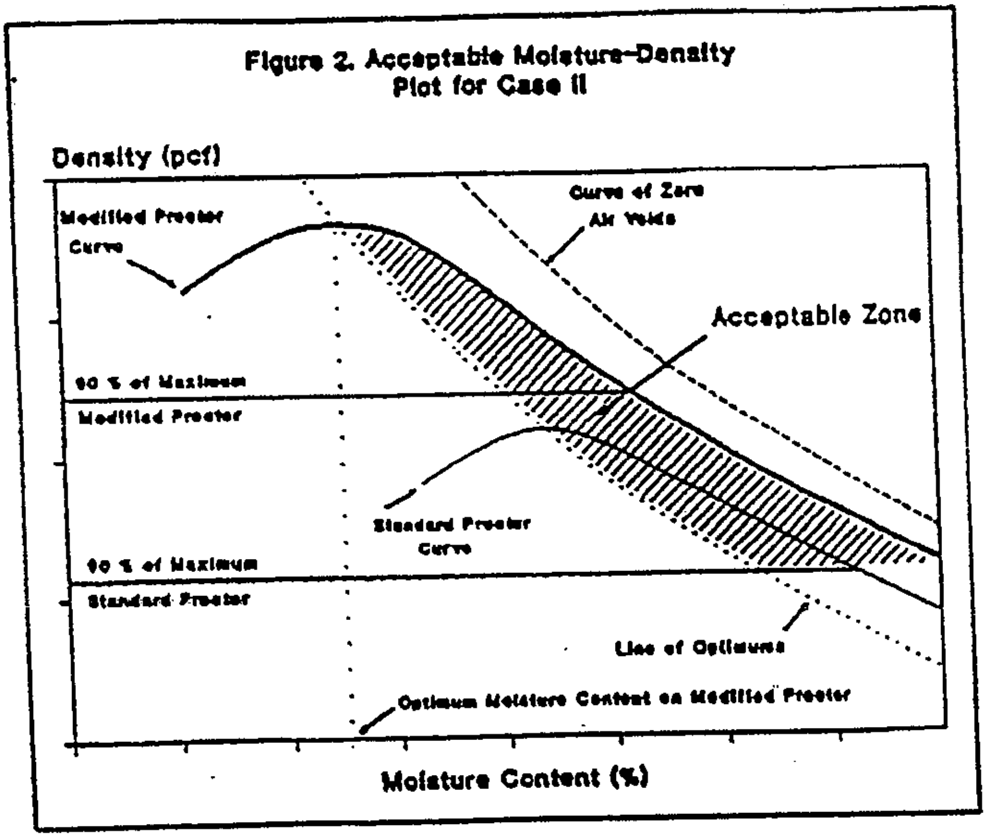
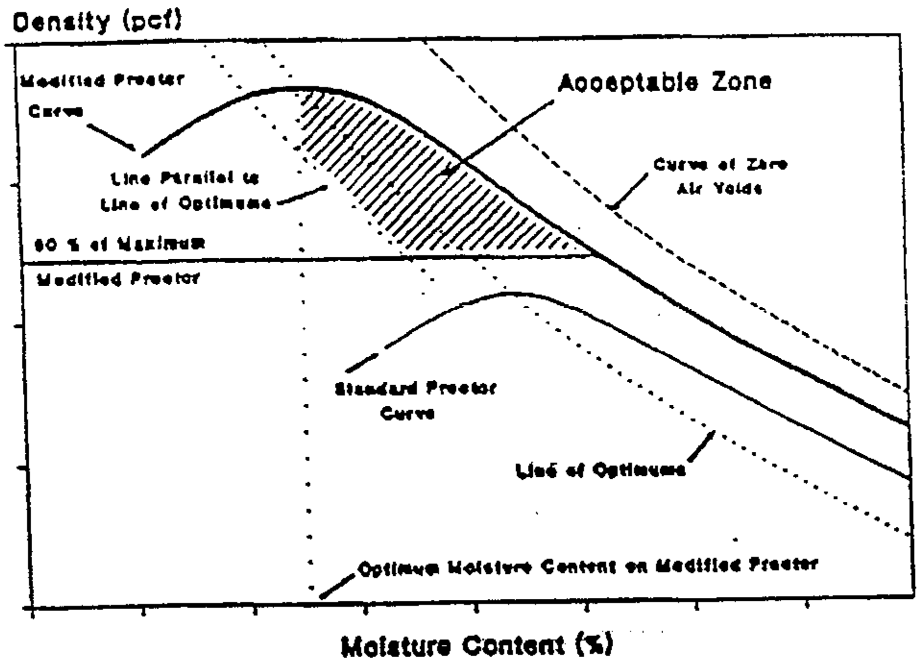


Figure 2. Acceptable Moisture-Density
Plot for Case II
Density (pcf)
Modified Proctor
Curve
Curve of Zero
Air Voids
Acceptable Zone
90 % of Maximum
Modified Proctor
Standard Proctor
Curve
90 % of Maximum
Standard Proctor
Line of Optimums
Optimum Moisture Content on Modified Proctor
Moisture Content (%)

Figure 3. Acceptable Moisture-Density Plot for Case III



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Appendix C

Additional Clay Barrier Placements Required to be Monitored

NYSDEC OHMS Document No. 201469232-00003

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Infrastructure, environment, buildings

Imagine the result

WASTE MANAGEMENT, INC.

CWM Chemical Services, LLC

Additional Clay Barrier Placements Requirements to be Monitored

Residuals Management Unit 2

Model City Facility
1550 Balmer Road
Model City, Niagara County, New York

April 2003
Revised August 2009

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Residuals Management Unit 2
Additional Clay Barrier Placements
Requirements to be Monitored

April 2003
Revised August 2009

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Residuals Management Unit 2
Additional Clay Barrier Placements
Requirements to be Monitored

April 2003
Revised August 2009

1. Additional Clay Barrier Placement Requirements to be Monitored

The Earthwork Contractor will conform with the additional clay barrier construction requirements listed below. The Soil Quality Assurance Consultant (QAC) will verify through observation and documentation that the requirements are implemented.

1. Soil

   Only natural soil material shall be utilized in the compacted soil barrier. This soil material must be free from roots, organic matter, frost, ice, frozen soil, trash, debris, rocks or slag larger than 1 inch at the finish surface, and other deleterious materials.

   If additional moisture must be added at the compaction site, then disking, watering and disking again shall be conducted prior to compaction to achieve an even distribution of moisture within every lift.

2. Seal Rolling

   Intermediate lifts shall be rolled to seal for protection from infiltration of precipitation. To prepare for subsequent lifts, the sealed surface of intermediate lifts shall be scarified, as necessary, and shall be adjusted to a proper moisture content adequately in advance of subsequent soil placement to achieve a uniform moisture content in the intermediate lift and complete bonding of the lifts to one another.

3. Overworking

   The soil shall not be overworked such that compaction and permeability requirements cannot be achieved, as indicated by test fill or recent actual construction standards. In no case shall an excessively compacted crust be formed on the top of a lift that is too smooth to bond to the next lift or is so brittle that it cracks.

4. Facility Sidewalls

   Soil lifts used to build the facility sidewall liners shall be inclined at approximately the same angle sideslope. Lift interfaces must not traverse the barrier layer, unless special actions are taken to prevent these interfaces from becoming more permeable than the core of lifts.

5. Contact Surfaces

   A. Complete bonding of one placed volume of soil to another shall take place along any and all soil-to-soil contact surfaces. Contact surfaces include but are not limited to:

      1. Berm soil placed over the floor soil that was placed at a previous time;

      2. Newly placed soil subject to desiccation, including hot or freezing conditions; and

      3. Soil from one borrow source that contacts soil from a different borrow source.

   B. At a minimum, the previously placed soil shall be scarified and, if needed, adjusted to a proper moisture content. Frozen soil shall be removed from the liner area. If differences in the soil types are encountered or if incomplete bonding occurs, then the contact surface shall be stepped and/or keyed.

   C. Other contact surfaces as determined by the Soil QAC.

6. Final Surface

   Final lift shall be seal rolled as soon as practical after final compaction to prevent moisture loss.

   Within areas lined with flexible membrane liner (FML), the top surface of each completed soil barrier layer shall be smooth, and the final surface shall be free of stones larger than 1 inch in diameter.

   Surface to be lined with an FML shall be rolled with a smooth drum steel or pneumatic roller free of irregularities, loose earth and abrupt changes in grade. The surface shall be maintained after certification of acceptance of that surface by the Geosynthetic Installer and Soil QAC.

To achieve a seal, the FML shall be installed as soon as practicable after the soil barrier layer is judged acceptable by the Soil QAC. The soil surface shall be observed daily by the Soil QAC and FML Installer to check for soft areas or desiccation cracking.

No FML shall be placed in an area that has become softened by precipitation resulting in substandard strength requirements of 0.5 tons per square feet.

The FML Installer shall provide written acceptance of surface preparation to the Soil QAC prior to any FML installation. Thereafter, the FML Installer shall provide the Soil QAC with daily written acceptance of the surface to be covered by the FML in that day's operations.

7. Desiccation Crack Control and Repair

Daily or hourly observations shall determine the effects of surface desiccation cracking upon the integrity of soil barrier layer. The FML Installer shall take precautions for reducing the desiccation potential of the final soil surface prior to installation of any FML or succeeding layer (i.e., installation of a temporary FML cover, application of water or prompt placement of succeeding layers).

A temporary FML cover, such as a 10-mil polyethylene or other available FML, may be used as temporary protection for soil. A temporary FML should be overlapped 1 foot and does not need to be seamed. Temporary FML must be removed prior to placement of the design FML or succeeding layer.

Minor soil barrier layer cracks from desiccation that are visible but too narrow to measure depth may be repaired by re-wetting and allowing for sufficient time for crack healing.

The method for measuring any crack depth shall be the insertion of a 20-gauge wire. This method will remain consistent throughout soil barrier layer construction. If cracks exhibit bends that interfere with or prohibit crack measurement, then hand shovels will be used to excavate soil to assist in depth measurement. Any holes excavated with a hand shovel will be repaired by complete filling with dry powdered bentonite/clay mixture hand tamped in place.

In the event that measurable desiccation cracks develop on the soil surface, the following corrective procedures will be followed:

A. For cracks measuring 2 inches in depth or less, a dry powdered bentonite may be used for repairing, provided that the cracks do not have sharp bends that would interfere with complete filling of the crack with bentonite. If dry powdered bentonite is used, the cracks should be completely filled with bentonite. If this procedure is not used, then the following procedure must be used. Alternatively, a water truck may apply water over the surface, followed by smooth drum rolling.

B. If cracks deeper than 2 inches but less than the depth of penetration of the disking blade (depth of penetration is defined as 75% of the distance measured from the axle to the edge of blade) are present, addition of bentonite will not be acceptable, and the surface shall be rewetted, disked, re-compacted and retested, or the lift will be removed and the exposed soil will be scarified with a disk to the full depth of the cracks, if any remain. The soil barrier layer will be re-compacted in conformance with applicable requirements. If this procedure is not used, then the following procedure (below) must be used.

C. If cracks deeper than the depth of penetration of the disking blade are observed, the lift shall be removed; exposed soil scarified with a disk to full depth of the cracks, and re-compacted in conformance with the applicable requirements.

D. For cracks deeper than 2 inches in areas with limited access, an acceptable method for repairing cracks is as follows:

    1. Open the crack with a hand shovel or pick to the depth of the crack;

    2. Fill void with clay fines or a bentonite powder/clay mixture; and

    3. Compact clay/bentonite mixture with hand tools.

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Appendix D

Parties Involved

APPENDIX D
PARTIES INVOLVED

PROJECT MANAGER

Name: ______________________________
Title: ______________________________
Company Name: ______________________________
Address: ______________________________
City: ______________________________
State: ______________________________
Zip Code: ______________________________
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ENGINEER

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GEOSYNTHETIC MANUFACTURER

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EARTHWORK CONTRACTOR

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EARTHWORK CONTRACTOR SUPERINTENDENT

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GEOSYNTHETIC INSTALLER

Contract Representative: ______________________
Title: ______________________
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GEOSYNTHETIC INSTALLER SUPERINTENDENT

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GEOSYNTHETIC INSTALLER MASTER SEAMER

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Address: ____________________
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State: ____________________
Zip Code: ____________________
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E-mail Address: ____________________

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Representative: ____________________
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GEOSYNTHETIC QUALITY ASSURANCE CONSULTANT MANAGING ENGINEER

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SOIL QUALITY ASSURANCE LABORATORY

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GEOSYNTHETIC QUALITY ASSURANCE LABORATORY

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LAND SURVEYOR

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Zip Code: ______________________
Telephone: ______________________
Fax: ______________________
E-mail Address: ______________________

Appendix E

Leister Bond Procedures

NYSDEC OHMS Document No. 201469232-00003

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Infrastructure, environment, buildings

Imagine the result

WASTE MANAGEMENT, INC.

CWM Chemical Services, LLC

Leister Bond Procedures

Residuals Management Unit 2

Model City Facility
1550 Balmer Road
Model City, Niagara County, New York

April 2003
Revised August 2009

ARCADIS

Residuals Management Unit 2
Liester Bond Procedures
April 2003
Revised August 2009

1. Quality Assurance Monitoring Plan for Leister Bond Procedure

1.1 Purpose

The purpose of this plan is to establish a quality assurance (QA) plan for monitoring the leister bond method on high-density polyethylene (HDPE) geomembrane seams and repairs and geotextiles (including the geotextile component of geocomposites). Leister welds will be used to tack HDPE geomembrane sheets prior to extrusion welding and in limited use of performing geotextile repairs. Observance, by all parties, of a specific quality control protocol for the leister bond method, and assurance that no damage to the HDPE geomembrane and geotextile occurs as a result of this process is required.

1.2 Restricted Use

Use of the leister bond method for geomembranes shall be restricted to seam lengths where the extrusion seaming method is used. Extrusion seams may occur at the following locations:

1. Patches and cap strips;

2. Areas where the use of a fusion welder is physically impossible or is cumbersome and impractical. Such areas might include sump areas, short seam lengths or corner areas; and

3. Penetration points, such as boots around pipes.

The use of the leister bond method should be employed only in cases where the use of the extrusion seaming method is preferred over the fusion seaming method.

The use of the leister bond method for geotextiles (and geotextile components of the geocomposite) shall only be employed in cases where sewing geotextiles is not practical.

1.3 Leister Bonding Procedures for Geomembranes

1. Direction of seaming on slopes shall be the most expedient direction for the type of seaming used. Seaming shall extend to the outside edge of panels to be placed or as otherwise approved in writing by the manufacturer and

deemed acceptable by the New York State Department of Environmental Conservation (NYSDEC).

2. Lap joints shall be used to seam factory-fabricated HDPE geomembrane sheets together in the field. All field joints shall be made on a supporting smooth surface.

3. Set air discharge temperature typically at 250 degrees Celsius (^{o}C) to 270°C. This temperature may vary based on field conditions and on the adequacy of the temporary leister bond. The hot air discharge must always be below the true welding temperatures of 295°C for 80-mil HDPE geomembrane. Other temperatures for differing HDPE sheet thickness will be as per the manufacturer's specifications.

4. Align HDPE geomembrane with a minimum 3-inch overlap for seams and 6-inch overlap for patches and cap strips.

5. Insert air discharge nozzle between the overlap of the two HDPE geomembrane sheets and manually progress the nozzle along the overlap while, at the same time, compressing the heated overlap surface. At no time should the leister contact with a specific point on the FML exceed 10 to 15 seconds. (Estimated time for total burn-through on 80-mil HDPE at 250°C is 60 seconds.)

6. The following criteria for leister or "tack" bonds shall be observed:

   A. Ordinary Circumstances

      Under "ordinary" circumstances for patches or cap strips that are more than 2 feet in length on any one side, the leister bond spacing shall be a minimum of 2 feet in length, and a maximum of four leister bonds shall be allowed on each patch. Leister bonds that are used on a patch or cap strip shall at no time exceed 5 inches in length.

   B. Extraordinary Circumstances

      Leister bonding of patches or cap strips in a continuous fashion is proposed for "extraordinary" circumstances, such as imminent bad weather or difficult HDPE geomembrane configurations or conditions.

This procedure shall provide a surface-type "tack" bond to secure HDPE geomembrane overlaps prior to extrusion seaming.

1.4 Leister Bonding Procedures for Geotextiles

1. Set air discharge temperature to the manufactures' recommended temperature for specific geotextile unit weights and material type.

2. Align geotextile with a minimum 12-inch overlap in all directions.

3. Insert air discharge nozzle between the overlap of the two geotextile sheets and manually progress the nozzle along the overlap while, at the same time, compressing the heated overlap surface. At no time should the leister contact with a specific point on the geotextile cause excessive damage to either layers of the geotextile (excessive damage shall be determined by the LGM).

4. Leister bonding to be performed in a continuous fashion.

1.5 Quality Control Procedures

1. As part of the extrusion welding trial seam, the leister bond method is typically used to secure the two remnant pieces of HDPE geomembrane. An approximately 6-inch portion of the trial seam will be left unwelded so as to allow direct observation of the leister bond. On all trial seams, both the extrusion gun operator and the leister operator will be recorded. Trial seams will not be required for geotextiles.

2. Shear specimens for the extrusion method trial seam can be biased so as to include a section of the trial seam that has been "leistered" together. The field tensiometer is capable of reading load values. The load value for each shear test specimen shall be recorded, with a minimum passing value of 160 pounds per square inch; in peel, Film Tear Bond must be achieved.

3. The surface of the lapped edges of any embossed and/or textured sheets shall be prepared, as recommended by the manufacturer, to provide a seam to equal or exceed the bonded seam strength requirement specified. The fusion weld shall have a 2-inch minimum width. The extrusion welding process shall bond the exposed edge of the panel to the underlying HDPE geomembrane.

4. All leister bonds for geomembranes and geotextiles in the field will be 100% visually observed for overheating by the Master Seamer and/or field superintendent. In addition, technicians will maximize, as is practical, the spacing between individual leister "tacks."

5. When the leister tool is not in use, the switch shall in the "off" position, and care will be taken to avoid contact with geomembrane or geotextile by the nozzle until it has cooled.

6. It is not intended that the motor-propelled leister be used on this project.

The Geosynthetic Quality Assurance Consultant (QAC) shall verify the following:

1. The seaming personnel have the appropriate qualifications;

2. The overlaps meet the requirements;

3. The seaming area is clean;

4. Subgrade is hard, and no soft spots are present;

5. Seaming equipment is available on site and meets the requirements;

6. Weather conditions for seaming are acceptable;

7. Seaming procedures are followed;

8. All cap-snips required in an earlier section are placed;

9. Equipment for testing seams is available on site; and

10. Panels are properly positioned to minimize wrinkling, and the wrinkled areas are seamed according to the procedures presented in the Construction Quality Assurance Manual (CQAM) and Project Specifications.

1.5.1 Testing Requirements

1. For each extrusion weld trial seam, the leister bond will be employed to secure the overlap prior to welding. Approximately 6 inches of the trial seam will be

left unwelded to as to allow easy observation at the leister bond. The Geosynthetic QAC representative shall observe and document the condition of the leister bond on the unwelded portion of the seam and record the name of the leister operator.

Extrusion weld trial seam coupons will be cut using a 1-inch-wide die and removed from "leistered" portions of the trial seam. The peel adhesion and shear strength criteria shall, at a minimum, equal or exceed Project Specifications and criteria recommended in Table 4 of the National Sanitation Foundation (NSF) Standard No. 54-1991. Any trial seam test coupon that does not meet any of these test criteria will be considered a failure. Follow-up procedures for failed trial seams are stated in Section 9.10 of the CQAM.

Additionally, the Geosynthetic QAC monitor shall determine whether any failure in a test seam coupon was a result of the use of the leister. If it is determined that the cause of failure was from the use of the leister, then that leister operator will be disqualified for the day.

2. Destructive testing of extrusion weld field seams that contain leistered tack welds will be subjected to NSF Standard No. 54 test criteria. Any test coupons that fail to meet these criteria will be considered a failure. If any more than one test coupon in the shear or peel strength test fails to meet the NSF Standard No. 54 test criteria, the test will be considered a failure and will be repaired as stated in Section 9.10.3 of the CQAM. In addition, the laboratory technician performing the test will observe the yield areas of all extrusion weld destructive test coupons and record whether the yield originated in the leistered area.

3. For leister bonded geotextiles, the LGM shall observe the placement of cover materials over the geotextile to ensure the leister bonded area does not become detached during placement of overlying materials.

1.5.2 Field Applications

1. The operating temperature of each leister tool in use will be recorded at least daily by the Geosynthetic QAC and compared against the typical operating temperature.

2. The Geosynthetic QAC Inspector shall periodically observe the field use of the leister procedure and report cases of abuse.

3. If a particular leister operator is abusive in the field or does not appear to be knowledgeable about leistering procedures, the operator may be disqualified from leistering on the recommendation of the Geosynthetic QAC to the Owner or Project Manager.

4. In extraordinary cases, such as anticipated events of rain or high winds or in areas, such as the crest and toes of slopes, continuous leister of geomembrane patches may be allowed but only with supplemental approval from the QA Officer. The QA Officer shall document the circumstances of approval and consult the NYSDEC construction observer immediately if available or, if not available, at the next earliest time.

5. The Project Manager shall be notified if installer does not follow the procedures outlined in the approved Quality Control Protocol for the use of the leister.

ATTACHMENT K

Application Appendix D-9 - RMU-2 Landfill Response Action Plan

CWM Chemical Services, LLC

Response Action Plan

Residuals Management Unit 2

Model City Facility
1550 Balmer Road
Model City, Niagara County, New York

April 2003
Revised August 2009
Revised August 2013

Appendices

1. Introduction

1.1 General

CWM Chemical Services, LLC (CWM) owns and operates the Model City Treatment Storage, Disposal, and Recovery (TSDR) Facility (Model City Facility), in Niagara County, New York. The Model City Facility is regulated at the federal level under the Resource Conservation and Recovery Act (RCRA) and the Toxic Substances Control Act. Since the United States Environmental Protection Agency (USEPA) has delegated the implementation of the RCRA regulations to the New York State Department of Environmental Conservation (NYSDEC), the Model City Facility operates under an NYSDEC-issued Permit pursuant to Title 6 of the New York Codes, Rules, and Regulations (6 NYCRR) Part 373. The general site layout, shown on Permit Drawing No. 2 of the permit drawing set, comprises waste receiving areas, storage and mixing tanks, chemical treatment facilities, biological treatment impoundments, and secure landfills. Current operations include treatment, recovery, stabilization, disposal, and transfer of hazardous and industrial non-hazardous waste.

As part of the permit application for Residuals Management Unit 2 (RMU-2) and as required by 6 NYCRR Part 373-2.14(o), a Response Action Plan (RAP) must be approved prior to receipt of any waste. The RAP is a site-specific plan that the owner develops to address leakage through the primary liner and into the secondary leachate collection systems (SLCSs) to minimize the potential migration of liquids out of the unit. This RAP, which is part of CWM's overall leachate management program, describes the criteria used to establish key inflow rates to the SLCSs that require the implementation of certain response actions as described herein. RMU-2 consists of six cells, each divided by a cell separation berm. This RAP pertains to all six cells. The layout of RMU-2, including the cell orientation and designations, is shown on Permit Drawing No. 5.

This RAP addresses the potential sources of inflows to the SLCSs in RMU-2 and discusses the development of site-specific performance characteristics for the individual cells comprising RMU-2. It should be noted that liquids encountered in the SLCSs of RMU-2 are not necessarily derived from contact with waste materials. Depending on the rate, responses to inflows of liquids into the SLCSs of RMU-2 include no action, modifying operating procedures, and, where appropriate, notifying the USEPA and the NYSDEC. The various response actions are described in Section 4.

1.2 Action Leakage Rate and Response Rate

In accordance with 6 NYCRR Parts 373-2.14(n) and (o), this RAP presents the Action Leakage Rate (ALR) for the cells within RMU-2, which is the primary trigger to implement a response action. The ALR is based on the maximum flow rate that the SLCS can collect and remove from the cell without the fluid head on the secondary liner exceeding 1 foot. Consistent with the Residuals Management Unit 1 (RMU-1) RAP, this RAP also presents a secondary trigger level known as the Response Rate (RR). The RR is based on the anticipated maximum inflow to the SLCS that could be expected under normal operating conditions. The RR could be used in identifying potential problems with the primary liner by alerting CWM personnel to unanticipated inflows to the SLCS. The trigger levels are presented both as “unit-specific” and “cell-specific.” The term “unit-specific” relates to a unit area (e.g., 1 acre), whereas “cell-specific” is a function of each cell area. (Unit-specific rates are presented in terms of gallons per acre per day [gpad]; cell-specific rates are presented in terms of gallons per day [gpd]). The development of the ALR and RR values is discussed in greater detail in Sections 2 and 3, respectively.

1.3 RMU-2 Overview

The facility has been a waste TSDR facility since 1972. The portion of the Model City Facility accommodating RMU-2 encompasses approximately 43.5 acres (as measured to the outside toe of the perimeter mechanically stabilized earth wall). RMU-2 is divided into six cells that are separated hydraulically from each other by intercell berms. The size of the six cells varies from approximately 5.77 acres to 6.32 acres (as measured planimetrically to the centerlines of the intercell berms and the top of slope for the sideslope liner system).

1.3.1 RMU-2 Liner System Description

RMU-2 has been designed to meet or exceed the requirements for hazardous waste landfills as specified in 6 NYCRR Part 373-2.14. As shown on Permit Drawing No. 15, the RMU-2 liner system consists of the following components (in descending order):

- *Primary Leachate Collection System*
  - 1 foot of operations layer stone on the cell floors and 2 feet of operations layer stone on the cell sideslopes;

- A layer of non-woven geotextile on the cell floors;
- 1 foot of granular drainage material on the cell floors with an 8-inch-diameter perforated leachate collection pipe along the cell centerline; and
- A layer of geocomposite on the cell floors and sideslopes.

· *Primary Liner System*

- An 80-mil textured high-density polyethylene (HDPE) geomembrane on the cell floors and sideslopes; and
- A geosynthetic clay liner (GCL) layer on the cell floors (which extends a minimum of 15 feet up the cell sideslopes) that provides a maximum equivalent hydraulic conductivity equal to or less than 1.5 feet of compacted clay with a hydraulic conductivity of 1 x 10^{-7} centimeters per second (cm/s).

· *Secondary Leachate Collection System*

- A layer of non-woven geotextile on the cell floors;
- 1 foot of granular drainage material on the cell floors with an 8-inch-diameter perforated collection pipe along the cell floor centerline; and
- A layer of geocomposite on the cell floors and sideslopes.

· *Secondary Liner System*

- An 80-mil textured HDPE geomembrane on the cell floor and sideslopes; and
- 3 feet of compacted glacial till or other suitable clay having a maximum hydraulic conductivity of 1 x 10^{-7} cm/s on the cell floor and sideslopes.

On the RMU-2 perimeter sideslopes, the granular drainage layer of the primary leachate collection system (PLCS) has been omitted (consistent with RMU-1). However, both the primary and secondary HDPE geomembranes extend up the perimeter sideslopes. A 2-foot-thick operations layer will be maintained over the PLCS on the sideslopes during waste placement to protect the underlying geocomposite and geomembrane from damage by operating equipment. The operations layer on the cell floors and sideslopes will be run-of-crush stone or equal.

A low-permeability cut-off wall will be keyed at least 1 foot into the Glaciolacustrine Clay layer (discussed in Section 1.3.3 below), as shown on Permit Drawing No. 15. The cut-off wall will significantly restrict lateral groundwater flow beneath RMU-2 after it is constructed.

1.3.2 Liquid Collection and Removal from the Leachate Collection Systems

Each cell within RMU-2 is separated hydraulically from adjacent cells by cell separation berms. Each cell is equipped with both a PLCS and an SLCS and separate riser pipes for each system. The PLCSs and SLCSs are designed and managed to control and remove liquids in a manner consistent with the requirements of 6 NYCRR Part 373-2.14(c)(3)(ii) and (iii). Sumps located at the low point of individual cells collect liquids that enter the leachate collection systems. Liquids that collect in the PLCSs and SLCSs will be removed by pumping through the HDPE sideslope riser pipes. Liquids will be removed from each PLCS at regular intervals with dedicated automatic pumps to provide effective leachate management and to minimize the hydrostatic head on the primary liner. The performance of the PLCSs of RMU-2 will be monitored based on regular documentation of the liquid volume encountered in and removed from the SLCSs of the six cells.

1.3.3 Geologic and Hydrogeologic Setting

Numerous past investigations have been conducted throughout the Model City Facility. Geologic and hydrogeologic investigations for the entire Model City Facility have been performed and were submitted to the NYSDEC and the USEPA in March 1985 (*Hydrogeologic Characterization*, Golder Associates, Inc. [Golder], March 1985). Two updates to the 1985 hydrogeologic report were prepared and submitted in 1988 (*Hydrogeologic Characterization Update*, Golder, February 1988) and in 1993 (*Hydrogeologic Characterization Update*, Golder, June 1993). These studies detail the physiography, drainage, regional geology, site stratigraphy, hydrogeology and site hydrologic parameters. In terms of hydrogeology, these studies focused on defining the uppermost aquifer underlying the Model City Facility, groundwater flow direction and rates. A supplemental geologic investigation within the footprint of RMU-2 was also performed and presented in a letter report entitled *Geotechnical Investigation for Proposed Residuals Management Unit Number 2 Western Expansion Area* (Golder, December 2002). In general, the 2002 geotechnical investigation confirmed the geologic findings presented in the 1985, 1988 and 1993 site-wide investigations. Additional hydrogeologic investigations were performed by Golder in 2004 and again in 2009 to obtain geological and subsurface site stratigraphy data specific to the proposed RMU-2 location. The 2009 investigation was summarized in a report entitled *Landfill Footprint Analytical Data Study and Western Boundary Relocation Investigation, Residuals Management Unit Number 2* (Golder, August 2009). Additionally, groundwater elevation was collected in 2008 in the area of the proposed RMU-2. Copies of the 2002 and 2009 Golder reports are presented in Appendices A-2 and A-4, respectively, of the *RMU-2 Engineering Report* (ARCADIS, April 2003, revised June 2013).

The facility is situated on the Ontario Plain that is an area of low topographic relief between the Niagara Escarpment and Lake Ontario. The upper portion of the stratigraphy at the Model City Facility generally includes low-permeability silt and clay tills over Glaciolacustrine Clay, underlain by a Glaciolacustrine Silt/Sand unit. Beneath these units is a lodgment of till (Basal Red Till) above shale bedrock. Over the northwestern portion of the Model City Facility, the Glaciolacustrine Clay is separated into an upper and lower member by a silt till (Middle Silt Till). Because of variations in topography, the thickness of the prevailing materials and the subbase depth of the cells, RMU-2 penetrates either one or both of the Upper Tills and the Glaciolacustrine Clay units.

In general, a varying thickness of in-situ glacial till will be left in place above the in-situ Glaciolacustrine Clay formation to withstand hydrostatic pressures and provide a suitable surface for construction equipment. The thickness of glacial till varies because of the irregularity of the surface of the Glaciolacustrine Clay. However, in particular areas, the entire in-situ glacial till may be removed in order to accommodate excavation grades in certain sump elevations. Natural surface elevations in the vicinity of RMU-2 are approximately 320 feet above mean sea level.

The typical hydraulic conductivity values of the geologic formations indicate that the Glaciolacustrine Silt/Sand stratum is the most permeable geologic unit and forms the uppermost aquifer underlying the Model City Facility. The Silt Till, Clay Till and Glaciolacustrine Clay above this aquifer are very low-permeability materials and restrict aquifer recharge from infiltration. The Basal Red Till and bedrock beneath the aquifer are also low-permeability units, although the shallow, weathered bedrock is more permeable than the deep bedrock.

Water level data collected on May 15, 2001 and in October 2004 from wells screened in the Glaciolacustrine Silt/Sand unit appear to represent the period of greatest piezometric heads for the confined aquifer since regular recording of site-wide groundwater elevation data began in the early 1980s. Of these two monitoring events, the May 2001 levels were found to be more critical (i.e., higher) and, thus, governed the establishment of design elevations for the RMU-2 cells. The May 2001 levels were also used to estimate the inflow rate of groundwater through the secondary liner (see Section 3).

2. Action Leakage Rate

2.1 General

The purpose of this section is to quantify the ALR for each cell within RMU-2. The NYSDEC defines the ALR as the maximum design leakage rate that the SLCS can remove without the fluid head on the secondary liner exceeding 1 foot. As such, the ALR is dependent on the hydraulic capacities of the various components of the SLCS. The ALR for RMU-2 is established by evaluating each component of the SLCS to determine the limiting component (i.e., the component having the least hydraulic capacity that would cause the fluid head on the secondary liner to exceed 1 foot). A factor of safety is typically applied to the hydraulic capacity of the limiting component to arrive at the actual ALR. The individual flow rate components that are used to determine the ALR are discussed in the following section. The ALR calculation is presented in Appendix A and summarized in Section 2.3.

2.2 ALR Flow Rate Components

The following hydraulic capacities for the various SLCS components are calculated to determine the ALR for each cell:

- Flow rate through the 8-inch-diameter perforated leachate collection pipe along the cell centerline;
- Flow rate through the geocomposite that drains directly to the SLCS sump;
- Flow rate through the drainage stone surrounding the perforated section of the 24-inch-diameter sideslope riser pipe within the SLCS sump; and
- Flow rate through the perforations in the horizontal portion of the sideslope riser pipe.

The analysis of each of these components is discussed in greater detail below.

2.2.1 Flow Rate through the Leachate Collection Pipe

Each cell within RMU-2 contains a perforated leachate collection pipe along the cell centerline that discharges into the sump. The leachate collection pipe collects liquids from the majority of the geocomposite in each cell (a portion of the geocomposite in each cell drains directly into the sump and bypasses the leachate collection pipe). The capacity of the leachate collection pipe is designed to exceed the contributing maximum flow rate from the geocomposite. Consequently, the maximum flow rate conveyed through the leachate collection pipe is assumed to equal the maximum possible flow rate from the contributing geocomposite. This flow rate is estimated by multiplying the flow per unit width through the geocomposite by two times the length of the leachate collection pipe length. The factor of two accounts for the entry of liquids from both sides of the leachate collection pipe.

2.2.2 Flow Rate through the Geocomposite Draining Directly into the SLCS Sump

As described above, a portion of the geocomposite in each cell bypasses the leachate collection pipe and drains directly into the sump. The maximum flow rate conveyed into the sump via this mechanism is estimated by multiplying the flow per unit width through the geocomposite by the perimeter of the SLCS sump.

2.2.3 Flow Rate through the Drainage Stone Surrounding the Perforated Section of the Sideslope Riser Pipe within the SLCS Sump

Liquids that drain into the SLCS sump from the surrounding geocomposite and the leachate collection pipe must permeate through the stone surrounding the perforated section of the sideslope riser pipe and pass through the perforations. The maximum flow rate through the drainage stone is computed using Darcy’s law and a flow net for the drainage stone surrounding the perforated portion of the sideslope riser pipe.

2.2.4 Flow Rate through the Perforations in the Horizontal Portion of the Sideslope Riser Pipe

Liquids that flow through the drainage stone surrounding the perforated portion of the sideslope riser pipe must ultimately pass through the perforations themselves. The flow rate through the perforations is determined from calculations presented in Appendix E-3 of the RMU-2 Engineering Report, which are based on the orifice equation and the effective head on each perforation in the sideslope riser pipe.

2.3 ALR Values

For all cells within RMU-2, the limiting flow rate is determined to be the flow rate through the geocomposite that drains directly into the sump (discussed in Section 2.2.2). Because this flow rate is dependent on the post-settlement slope of the cell floor, the ALRs are cell-specific (i.e., the ALR per unit area differs from one cell to the next). The calculated ALRs are summarized in the following table. As discussed above, these ALRs are calculated by multiplying the limiting flow rate by a factor of safety. To maintain consistency with the RMU-1 RAP, a factor of safety of two is applied to the calculated ALRs, as recommended by the USEPA.

Table 1: Calculated ALR Values

Cell	Cell-Specific ALR [gpd]	Cell Area[1] [acres]	Unit-Specific ALR [gpad]
15	31,458	6.07	5,183
16	30,700	6.12	5,016
17	31,670	5.81	5,451
18	34,901	5.77	6,049
19	30,054	5.77	5,209
20	30,700	6.32	4,858

Notes:

1. Cell area is the planimetric area as measured to the centerlines of intercell berms and the top of slope for the sideslope liner system.

Based on the lowest unit-specific ALR shown above, a unit-specific ALR of 4,858 gpad is selected for every cell in RMU-2. This unit-specific ALR value is multiplied by each cell area to calculate a cell-specific ALR, as summarized in the following table.

Table 2: Final ALR Values

Cell	Unit-Specific ALR[1] [gpad]	Cell Area[2] [acres]	Cell-Specific ALR [gpd]
15	4,858	6.07	29,488
16	4,858	6.12	29,731
17	4,858	5.81	28,225
18	4,858	5.77	28,031
19	4,858	5.77	28,031
20	4,858	6.32	30,703

Notes:

1. Unit-specific ALR is based on the minimum calculated value (Cell 20) from Table 1.
2. Cell area is the planimetric area as measured to the centerlines of intercell berms and the top of slope for the sideslope liner system.

3. Response Rate

3.1 General

The purpose of this section is to quantify the RR for each cell within RMU-2. As described earlier in this RAP, the RR is the anticipated maximum inflow to the SLCS that could be expected under normal operating conditions. The individual flow rate components that are used to determine the RR are discussed in the following section. The RR calculation is presented in Appendix B and summarized in Section 3.3.

3.2 RR Flow Rate Components

In order to estimate the RR, it is necessary to identify potential inflow sources to the SLCS and estimate the peak anticipated inflow to the SLCS from each source. The following potential inflow sources to the SLCS are considered in the estimation of the RR:

- Leakage and permeation of liquids through the primary liner due to 1 foot of hydrostatic head on the primary liner;
- Leakage and permeation of groundwater through the secondary liner; and
- Leakage and permeation of consolidation water from the compacted clay layer in the secondary liner.

Construction liquids (i.e., liquids that have entered the cell during the SLCS construction period) are not considered in the RR because these liquids will have been collected by the SLCS during the earlier stages of cell operation. Furthermore, because the liner system of RMU-2 utilizes a GCL in the primary liner in lieu of the 1.5-foot-thick compacted clay layer used in RMU-1, the RMU-2 RR calculation does not consider the generation of liquids from the consolidation of a primary clay layer. The potential inflow sources to the SLCS are discussed in greater detail below and in Appendix B.

3.2.1 Leachate Inflow through the Primary Liner

Leakage and permeation through the primary liner is considered one of the three main long-term sources for liquids entering the SLCSs. Higher heads on the primary liner will cause a corresponding increase in flow to the SLCS due to permeation and leakage through the primary geomembrane. In addition, increased flows above the PLCS increase the probability of liquids coming in contact with a defect in the primary HDPE geomembrane, particularly on landfill perimeter sideslopes. The computation of leakage and permeation rates through the primary liner is discussed separately in the following sections.

3.2.1.1 Leakage of Leachate through the Primary Liner

Past studies have shown that, even when good construction practices are followed and thorough construction quality control/quality assurance procedures are used, several defects in the geomembrane may typically occur per acre during the course of installation. Defects in the form of pinholes are also known to occur during the manufacturing process. The frequency and size of these installation and manufacturing defects are estimated from the *Hydrologic Evaluation of Landfill Performance (HELP) Model User's Guide for Version 3* (USEPA, September 1994).

Leakage through defects in the primary liner geomembrane will occur whenever a hydrostatic head exists on the primary liner geomembrane and is a function of the frequency of defects, their size, head on the geomembrane and the hydraulic conductivity of the material beneath the geomembrane (i.e., the GCL). For the purposes of determining the RR, the leakage rate is estimated assuming 1 foot of head on the primary liner geomembrane. Using equations from the *HELP Model Engineering Documentation for Version 3* (USEPA, September 1994), leakage though the assumed geomembrane defects is estimated to be approximately 0.064 gpad and is the same for all cells within RMU-2.

3.2.1.2 Permeation of Leachate through the Primary Liner

Permeation of liquids through the primary liner will occur whenever a hydrostatic head exists on the primary liner. As with the leakage rate calculation in the preceding section, the permeation rate estimate assumes 1 foot of head on the primary liner geomembrane. In order for liquids to permeate completely through the primary liner and into the SLCS, they must pass through a geomembrane layer and a GCL. The presence of both of these low-permeability layers is accounted for in the permeation rate estimate by combining their individual thicknesses and using an average effective hydraulic conductivity, as recommended in the *HELP Model Engineering Documentation for Version 3* (USEPA, September 1994). The resulting permeation rate through the primary liner is 0.028 gpad and is the same for all cells within RMU-2.

3.2.2 Groundwater Inflow through Secondary Liner

In general, the elevations of the components in the secondary liner on the cell floors are below the historical high piezometric head in the confined aquifer (i.e., those recorded in May 2001). The resulting hydrostatic head exerted on the compacted clay layer and geomembrane in the secondary liner will cause groundwater to enter the SLCS by permeation and leakage through the geomembrane, similar to the mechanisms discussed in Section 3.2.1. Although the rate of groundwater inflow to the SLCS is expected to fluctuate due to seasonal variations in groundwater elevations, the presence of this external hydrostatic head is expected continuously throughout the life of the landfill. The computation of leakage and permeation rates of groundwater through the secondary liner is discussed separately in the following sections.

3.2.2.1 Leakage of Groundwater through the Secondary Liner

Leakage of groundwater into the SLCS through assumed defects in the secondary liner geomembrane (refer to Section 3.2.1.1) will occur whenever the confined aquifer piezometric head beneath a given cell exceeds the lowest SLCS elevation for that cell. For the purposes of determining the RR, the leakage rate of groundwater through the secondary liner is estimated using the bottom of the liner system design grades (i.e., subgrades) depicted on Permit Drawing No. 4 and the Glaciolacustrine Silt/Sand unit piezometric heads as measured in May 2001. Using equations from the *HELP Model Engineering Documentation for Version 3* (USEPA, September 1994), leakage of groundwater though the assumed defects in the secondary liner geomembrane is estimated to range from 2.25 to 6.06 gpad and is cell-specific.

3.2.2.2 Permeation of Groundwater through the Secondary Liner

Permeation of groundwater into the SLCS through the secondary liner will occur whenever the confined aquifer piezometric head beneath a given cell exceeds the lowest SLCS elevation for that cell. As with the leakage rate calculation in the preceding section, the permeation rate estimate is based on the design grades for the bottom of the compacted clay layer in the secondary liner and the average piezometric heads from the May 2001 monitoring event. In order for groundwater to permeate completely through the secondary liner and into the SLCS, it must pass through the compacted clay layer and the geomembrane. As discussed in Section 3.2.1.2, the presence of both of these low-permeability layers is accounted for in the permeation rate estimate by combining their individual thicknesses and using an average effective hydraulic conductivity. The flow rate of groundwater through the cell floors due to permeation is estimated to range from 0.09 to 0.24 gpad and is cell-specific.

3.2.3 Consolidation Water Inflow from the Secondary Liner Compacted Clay Layer

Construction of the cell liner system and subsequent waste filling activities result in increasing applied stresses to the compacted clay layer in the secondary liner. The applied stress will continue to increase until final waste grades are achieved and the final cover is installed, and is expected to slowly dissipate over time. The resulting consolidation of the compacted clay layer produces excess pore pressures within the clay, which drive water from the clay layer. The resulting flow rate depends on, and is expected to temporarily lag slightly behind, the filling rate. The inflow of consolidation water to the SLCS is expected to continue well after the closure of the cell and gradually diminish over time. As with the other potential inflow sources discussed thus far, this consolidation water will enter the SLCSs via leakage and permeation through the secondary liner. The computation of leakage and permeation rates of consolidation water through the secondary liner is based on modeling of the fill progression design prepared for Cell 20 (depicted on Permit Drawing No. 8 and discussed separately in the following sections.

3.2.3.1 Leakage of Consolidation Water through the Secondary Liner

The leakage rate of consolidation water through assumed defects in the secondary liner geomembrane is calculated using equations from the *HELP Model Engineering Documentation for Version 3* (USEPA, September 1994), as discussed in previous sections. The hydrostatic head used to calculate leakage is equal to the excess pore pressure produced within the compacted clay layer during consolidation divided by the unit weight of water. The resulting leakage rate through geomembrane defects is estimated to be approximately 35.46 gpad and is the same for all cells within RMU-2.

3.2.3.2 Permeation of Consolidation Water through the Secondary Liner

The permeation rate of consolidation water through the secondary liner geomembrane is estimated using Darcy's law. The flow rate of consolidation water through the cell floors is estimated to be approximately 1.08 gpad and is the same for all cells within RMU-2.

3.3 RR Values

The individual flow rates into the SLCS from the sources described in Section 3.2 are combined to generate a single unit-specific RR for each cell within RMU-2. The following table summarizes the estimated flow rates into the SLCS from each potential inflow source for each cell within RMU-2.

Table 3: Calculated Unit-Specific RR Inflow Components (from Calculations in Appendix B)

Cell	Leachate Inflow through Primary Liner		Groundwater Inflow through Secondary Liner		Consolidation Water Inflow through Secondary Liner		Combined [gpad]
	Leakage Rate [gpad]	Permeation Rate [gpad]	Leakage Rate [gpad]	Permeation Rate [gpad]	Leakage Rate [gpad]	Permeation Rate [gpad]	
15	0.064	0.028	5.17	0.21	35.46	1.08	42.01
16			6.06	0.24			42.93
17			3.09	0.13			39.85
18			3.77	0.15			40.55
19			4.51	0.18			41.32
20			2.25	0.09			38.97

Although the calculated RR values presented in Table 3 are deemed reasonable, a unit-specific value of 20 gpad has been requested by the NYSDEC based on a recommendation by USEPA for an allowable flow rate in SLCSs of double-lined landfill cells. Consequently, the USEPA recommended value of 20 gpad has been adopted for all RMU-2 cells. The following table presents the final RR value for each cell based on the USEPA recommended unit-specific value of 20 gpad.

Table 4: Final RR Values

Cell	Unit-Specific RR[1] [gpad]	Cell Area[2] [acres]	Cell-Specific RR [gpd]
15	20	6.07	121
16		6.12	122
17		5.81	116
18		5.77	115
19		5.77	115
20		6.32	126

Notes:
1. Unit-specific RR is based on USEPA recommended value.
2. Cell area is the planimetric area as measured to the centerlines of intercell berms and the top of slope for the sideslope liner system.

4. Response Actions

4.1 General

The purpose of this section is to outline the required response actions corresponding to various flow rates in the SLCS sumps of each cell within RMU-2, including the ALRs and RRs calculated in Sections 2 and 3, respectively. For all flow rates, the following procedure is required for monitoring of the SLCS:

- Each SLCS sump will be monitored at least once every 7 days for the presence of liquids. Pumpable amounts of liquids contained in the sump will be removed, and the liquid quantity will be measured and recorded. The inflow value will be determined by adding the liquid volumes removed each week divided by 7 days to establish a daily average inflow for the week. If liquids are removed more frequently than once every 7 days, the inflow will be determined for each pumping event.

4.2 Flow Rates at or Below the RR

Routine monitoring should continue. No action is required.

4.3 Flow Rates Between the RR and the ALR

1. Verbally notify the NYSDEC within 3 working days of an apparent exceedance of the RR. Complete one or more of the following activities to determine whether the apparent exceedance is actually due to an electronic or mechanical equipment malfunction:

    a. Evaluate the SLCS volume data transferred from RMU-2 to the aqueous wastewater treatment system computer terminal by checking recent level trends and alarm summary logs.

    b. Verify proper operation of the SLCS pump via computer control and by manually switching it on and off.

    c. Inspect the SLCS flow meter and verify its proper operation using timed pumping and comparing the estimated volume with the meter flow readings.

d. Remove the SLCS pump and level probe and inspect for any obvious defects. Verify proper operation of level probe by either electrical simulation or by manually placing the probe in water.

2. If the average daily flow to an SLCS sump for a weekly pumping event exceeds the RR and if not conclusively determined within 2 weeks of an apparent RR exceedance to be clearly attributable to an operational failure (e.g., equipment or power failures based on the investigation specified in Item 1 above), the following will be performed:

a. Conduct a review of the most recent SLCS and PLCS analytical data available from the sampling programs required by the site permit.

b. Immediately perform the following tests and observations on samples of the SLCS and PLCS liquids:

– color;

– turbidity;

– specific-conductance; and

– pH.

Make a preliminary comparison of these values with the previous results and record the information.

c. Perform, within 1 week after the RR exceedance, the sampling and analysis of the SLCS liquid that would normally occur on a quarterly basis. Test results are to be available within 45 days of the exceedance. Results will be reviewed with the NYSDEC to determine what, if any, additional response actions are necessary based on the results. This sampling will satisfy the next quarterly sampling requirements for that sump and cell.

d. Increase monitoring and pumping frequency of the SLCS sump of the cell involved, if pumpable quantities are present, to every day until flow decreases below the RR. Also, verify that the automatic removal of liquid from the PLCS sumps is occurring as designed. If the automatic pumping of the PLCS is unable to maintain a level of 12 inches or less in the PLCS, evaluate whether it is necessary to increase the pumping rate and prioritization of that cell.

e. Review all analytical data and investigate alternative sources of liquid.

3. If the flow is between the RR and the ALR for 7 consecutive additional daily pumping events, provide written notification to the NYSDEC within 14 days from the date of determination and implement the following steps:

    a. Remove all standing water, if any, from within the landfill.

    b. Assess the potential cause or causes of the RR exceedance. In the affected cell, examine any exposed portions of the cell liner.

    c. Repair any observed damage.

    d. If no obvious defects are detected, propose mitigative actions to return the leakage rate to below the RR. Upon approval, sequentially inspect sideslope liner and likely locations of base liner, if necessary, removing waste as needed. Repair any observed damage.

    e. Document location, type and extent of liner damage, if any.

4. If the leakage rate cannot be returned and maintained below the RR after all feasible mitigative measures have been taken, automatic pumping and volume measurement of the secondary collection system must be instituted.

4.4 Flow Rates Greater than the ALR

1. Notify, in writing, the USEPA and NYSDEC within 7 working days from the date of determination if the average flow to an SLCS sump for one pumping event exceeds the ALR, if this is not clearly attributable to an operational disturbance. Determine the need to temporarily stop placing waste into the affected cell during the cell's normal operation, unless the ALR value is exceeded within the first 30 days of operation of the cell when flows are not truly representative and unless this occurs during post-closure operations. If the ALR value is exceeded after the first 30 days of cell operation, determine whether waste placement in the cell should cease until repairs to the lining system or other appropriate actions are completed and flows to the SLCS

sump have decreased to below the ALR. Prepare a written preliminary assessment report describing the amount of liquids; likely source of liquids; possible location, size and cause of any leaks and short-term actions taken and planned. Submit this report to the USEPA and NYSDEC within 14 days from the date of determination of exceedance. Waste placement may not resume in the cell until written notification is given by the NYSDEC.

2. Increase monitoring and pumping frequency from the SLCS sump of the cell involved, if pumpable quantities are present, to every day until flow decreases below the ALR. Also, verify that the automatic removal of liquid from the PLCS sumps is occurring as designed.

3. Perform the following tests and observations on samples of the SLCS and PLCS liquids:

   - color;
   - turbidity;
   - specific-conductance; and
   - pH.

   Make a preliminary comparison of these values with the previous results and record the information.

4. Determine, to the extent practicable, the location, size and cause of any leak.

5. Determine other short-term and longer-term actions necessary to mitigate or stop any leaks.

6. Within 30 days after the notification that the ALR has been exceeded, submit to the USEPA and the NYSDEC the results of the analyses of Responses 1 through 5 above, as well as the results of actions taken and actions planned.

7. If the average flow exceeds the ALR for two consecutive pumping events, implement the following steps:

a. Test a sample of the liquid obtained from the SLCS for constituents listed in the table in Appendix C;

b. Remove all standing water inside RMU-2;

c. Examine any exposed portion of the cell liner; and

d. Repair any observed damage.

8. If flow continues to exceed the ALR for an additional two pumping events, provide third-party inspection by a registered professional engineer who will investigate alternative sources of liquid, review available analytical and pumping event data for the cell to identify any trends and prepare a written report to the USEPA and the NYSDEC on the findings and recommended actions to protect human health and the environment. The Groundwater Monitoring Plan will also be evaluated to determine whether supplemental response actions are necessary.

9. As long as the flow rate in the SLCS exceeds the ALR, submit monthly reports to the USEPA and the NYSDEC summarizing actions taken and planned.

10. If the ALR value continues to be exceeded after taking all reasonable corrective measures, closure of the affected cell shall be considered.

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Appendix A

Action Leakage Rate Calculation

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Calculation Sheet

Client: **CWM Chemical Services, LLC**

Project Location: **Model City, New York**

Project: **RMU-2 Response Action Plan** **Project No.:** **B0023725.2011**

Subject: **Appendix A: Action Leakage Rate Calculation**

Prepared By: **PTO** **Date:** **August 2013**

Reviewed By: **BMS** **Date:** **August 2013**

Checked By: **PHB** **Date:** **August 2013**

OBJECTIVE:

Determine the action leakage rate (ALR) for the RMU-2 secondary leachate collection system (SLCS).

REFERENCES:

1. Appendix E-1 to the RMU-2 Engineering Report entitled "Liner System Geocomposite Design," ARCADIS, February 2013.
2. Appendix E-2 to the RMU-2 Engineering Report entitled "Leachate Collection Pipe Design," ARCADIS, May 2013.
3. Appendix E-3 to the RMU-2 Engineering Report entitled "Sideslope Riser Pipe Design," ARCADIS, February 2013.
4. RMU-2 Permit Drawing No. 5 entitled "Top of Operations Layer Grades," ARCADIS, February 2013.
5. Appendix C-1 to the RMU-2 Engineering Report entitled "Consolidation Settlement of Glaciolacustrine Clay," P.J. Carey & Associates, PC, August 2009.
6. RMU-2 Permit Drawing No. 12 entitled "Typical Sump Plans," ARCADIS, February 2013.
7. RMU-2 Technical Specification Section 02210 – Earthworks, ARCADIS, February 2013.

ASSUMPTIONS:

1. The pipe-full capacity of the 8-inch-diameter perforated leachate collection pipe along the centerline of the cell floor exceeds the maximum flowrate through the contributing geocomposite layer per Reference 2.
2. The flow capacity through the orifices in the 8-inch diameter perforated leachate collection pipe exceeds the maximum flowrate through the contributing geocomposite layer per Reference 2.

METHODOLOGY:

The ALR is equal to the steady-state flowrate through the SLCS which corresponds to 1 foot of head in the SLCS. In order for leachate to flow through the SLCS, it must be collected and conveyed to the sump (by one of several mechanisms) and then flow into the perforated section of the sideslope riser pipe and

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be pumped out. As such, several potentially limiting flowrates are evaluated to determine the ALR. They are:

- Flowrate from the 8-inch-diameter perforated leachate collection pipe along the cell centerline
- Flowrate from the geocomposite that drains directly into the sump
- Flowrate through the drainage stone in the vicinity of the perforated section of the sideslope riser pipe
- Flowrate through the perforations in the horizontal portion of the sideslope riser pipe

CALCULATIONS:

1. Flowrate from the 8-inch Diameter Perforated Leachate Collection Pipe

Based on Assumptions 1 and 2, the flowrate from the 8-inch-diameter pipe is not limited by the pipe-full flowrate or the flow through the orifices. Instead, the limiting flowrate is that of the contributing geocomposite layer. The daily flowrate from the geocomposite into the leachate collection pipe can be calculated as:

$$Q_{Pipe} = \Phi i(2L)$$

where,

Φ = geocomposite transmissivity = 18.6 cm^2/s = 0.020 ft^2/s (per Reference 1)

i = hydraulic gradient = average post-settlement slope of cell floor perpendicular to the leachate collection pipe (per Reference 5)
= 2.45% (Cell 15)
= 2.56% (Cell 16)
= 2.61% (Cell 17)
= 3.18% (Cell 18)
= 2.11% (Cell 19)
= 2.27% (Cell 20)

L = length of leachate collection pipe (later multiplied by 2 to account for flow from both sides of pipe)
= 267 ft (Cell 15)
= 452 ft (Cell 16)
= 644 ft (Cell 17)
= 623 ft (Cell 18)
= 305 ft (Cell 19)
= 408 ft (Cell 20)

$\therefore$ Q_{Pipe} = 0.262 cfs = 169,116 gpd (Cell 15)
= 0.462 cfs = 299,148 gpd (Cell 16)
= 0.672 cfs = 434,544 gpd (Cell 17)
= 0.792 cfs = 512,180 gpd (Cell 18)
= 0.257 cfs = 166,376 gpd (Cell 19)
= 0.370 cfs = 239,438 gpd (Cell 20)

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2. Flowrate from the Geocomposite that Drains Directly into the Sump

Because of the cell floor grading, some of the geocomposite does not drain into the 8-inch-diameter leachate collection pipe. Instead, it drains directly into the sump. The daily flowrate from this component can be calculated as:

$$Q_{Geo} = L\Phi i$$

where,

Φ = geocomposite transmissivity (per Reference 1)
= 18.6 cm^2/s = 0.020 ft^2/s for hydraulic gradients of 0.10 or smaller
= 4.7 cm^2/s = 0.0051 ft^2/s for a hydraulic gradient of 0.33
i = hydraulic gradient perpendicular to the rim of the sump (varies depending on which of the four sump edges is analyzed)
L = length of geocomposite draining directly into the sump at the sump rim (varies depending on which of the four sump edges is analyzed)
= 33.1 ft along the sump edges that are parallel with the cell centerline
= 34.9 ft or 31.1 ft along the sump edges that are perpendicular to the cell centerline

The slope of the geocomposite along the two sump edges parallel to the cell centerline is assumed to be equal to the post-consolidation slope perpendicular to the cell centerline (per Reference 5), which were presented above for each cell. The slope of the geocomposite along the sump edge at the toe of the perimeter berm sideslope is assumed to be 33 percent. The slope of the geocomposite along the fourth sump edge (across the sump from the 33 percent perimeter berm sideslope) is assumed to be equal to the post-consolidation slope parallel to the cell centerline (per Reference 5), which are presented below for each cell:

i = hydraulic gradient = post-settlement slope of cell floor parallel to the leachate collection pipe (per Reference 5)
= 1.80% (Cell 15)
= 1.24% (Cell 16)
= 1.59% (Cell 17)
= 1.90% (Cell 18)
= 1.77% (Cell 19)
= 1.78% (Cell 20)

Thus for Cell 15, for example, the daily flowrate from the geocomposite at the sump fringe is:

Q = 0.020 ft^2/s[(2)(33.1 ft)(0.0245) + (34.9 ft)(0.0180)] + (0.0051 ft^2/s)(31.1 ft)(0.33) = 0.097 cfs = 62,915 gpd

Similarly, for Cells 16 through 20, the daily flowrate from the geocomposite at the sump fringe, Q_{Geo}, is:

$\therefore Q_{Geo}$ = 0.095 cfs = 61,400 gpd (Cell 16)
= 0.098 cfs = 63,339 gpd (Cell 17)
= 0.108 cfs = 69,802 gpd (Cell 18)
= 0.093 cfs = 60,107 gpd (Cell 19)

Calculation Sheet

= 0.095 cfs = 61,400 gpd (Cell 20)

3. Flowrate Through the Drainage Stone Surrounding the Perforated Section of the Sideslope Riser Pipe

Because leachate enters the perforated section of the sideslope riser pipe through several sets of perforations, each with different heads, the daily flowrate through the drainage stone to the perforations is estimated using a flow net that assumes the circumference of the pipe is porous. The flow net is included in Attachment 1. The daily flowrate for the flow net is calculated as:

$$Q_{\text{Flow net}} = kH\frac{N_f}{N_d}L$$

where,

k = hydraulic conductivity of drainage stone = 0.4 cm/s = 1,134 ft/day (per Reference 7)
H = head difference between free surface at top of drainage stone (equal to 1 foot above the top of the secondary liner at the sump fringe) and average centroid of perforations (i.e., center of pipe)
= 2.7 ft
N_f = number of flow paths from flow net = 11
N_d = number of potential drops from flow net = 4
L = length of perforated section = 10 ft (Reference 6)

$\therefore$ $Q_{\text{Flow net}}$ = 84,200 ft^3/day = 629,860 gpd (Each cell – 15 through 20)

Because each cell in RMU-2 employs the same sump design, the above-calculated flowrate is constant for all cells in RMU-2.

4. Flowrate Through the Perforations of the Horizontal Portion of the Sideslope Riser Pipe

Based on Reference 3, the perforation pattern in the horizontal portion of the sideslope riser pipe provides a hydraulic capacity of 0.137 cfs per linear foot of perforated sideslope riser pipe. Reference 6 indicates that each sump contains 10 linear feet of perforated pipe. Therefore, the daily flowrate through the perforations in the horizontal portion of the sideslope riser pipe is:

Q_{perf} = (10 ft)(0.137 cfs/ft) = 1.37 cfs = 885,458 gpd (Each cell – 15 through 20)

Because each sump contains the same amount of perforated pipe, the above calculated flowrate is constant for all cells in RMU-2.

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SUMMARY:

The daily flowrate from the drainage composite at the edge of the sump is the limiting factor for flow to the pump in the SLCS sump. Because this flowrate is cell-dependent, the ALR is cell-specific within RMU-2. To be conservative and maintain consistency with the RMU-1 ALR calculations, a factor of safety of 2 is applied to determine the cell-specific ALRs:

ALR = ½*62,915 gpd = 31,458 gpd (Cell 15)
= ½*61,400 gpd = 30,700 gpd (Cell 16)
= ½*63,339 gpd = 31,670 gpd (Cell 17)
= ½*69,802 gpd = 34,901 gpd (Cell 18)
= ½*60,107 gpd = 30,054 gpd (Cell 19)
= ½*61,400 gpd = 30,700 gpd (Cell 20)

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Appendix B

Response Rate Calculation

Imagine the result

Calculation Sheet

Client: CWM Chemical Services, LLC

Project Location: Model City, New York

Project: Response Action Plan Calculations **Project No.: B0023725.2011**

Subject: Appendix B: Response Rate Calculation

Prepared By: BMS **Date: August 2013**

Reviewed By: BMS **Date: August 2013**

Checked By: PHB **Date: August 2013**

OBJECTIVE:

Determine the response rate (RR) for the secondary leachate collection system (SLCS) in the RMU-2 cells.

REFERENCES:

1. RMU-2 Permit Drawing No. 4 entitled "Subgrade Grades," ARCADIS, February 2013.
2. RMU-2 Permit Drawing No. 15 entitled "Liner System Sections and Details," ARCADIS, February 2013.
3. "Report on Shear Strength Evaluation for Slope Stability Analyses RMU-1 Model City Treatment, Storage, and Disposal Facility Model City, New York," Koerner, K.R., Gilbert, R.B., Stark, T.D., and Adams, F.T., March 2001.
4. "Hydrologic Evaluation of Landfill Performance (HELP) Model Engineering Documentation for Version 3," U.S. Environmental Protection Agency, August 1994.
5. Appendix E-1 to the RMU-2 Engineering Report entitled "Liner System Geocomposite Design," ARCADIS, February 2013.
6. RMU-2 Technical Specifications, Section 02210 entitled "Earthworks", ARCADIS, February 2013.
7. Excess pore pressure data for secondary compacted clay layer during simulated construction of initial fill progression waste grades in Cell 20, PJ Carey & Associates, PC, provided to ARCADIS via e-mail August 6, 2013.
8. "Hydrologic Evaluation of Landfill Performance (HELP) Model User's Guide for Version 3," U.S. Environmental Protection Agency, September 1994.

ASSUMPTIONS:

1. Manufacturing defects within the geomembrane occur at the rate of 1 per acre and are approximately 1 mm in diameter (from page 81 of Reference 4). Therefore, each manufacturing defect is equivalent to a hole having an area of 0.0079 cm^2.
2. Installation defects within the geomembrane occur at the rate of 5 per acre and each is assumed to

Calculation Sheet

be 1 cm^2 in area (from page 82 of Reference 4).

3. The hydraulic conductivities of the various liner system components are:

   - Geomembrane: $2x10^{-13}$ cm/s = $5.7x10^{-10}$ ft/day (page 81 of Reference 4)
   - GCL: $5x10^{-9}$ cm/s = $1.4x10^{-5}$ ft/day (manufacturer literature)
   - Compacted clay: $1x10^{-7}$ cm/s = $2.8x10^{-4}$ ft/day (Reference 6)

4. The combined effective hydraulic conductivity through two or more liner components is calculated using the procedure described on page 29 of Reference 8.

<u>METHODOLOGY:</u>

The RR is equal to the maximum anticipated inflow to the SLCS from all likely sources.
Consistent with the RR calculation for RMU-1, the following inflow mechanisms are evaluated to determine the RR for RMU-2:

- Leakage and permeation through the primary liner due to 1 ft of head on primary liner
- Leakage and permeation through the secondary liner from groundwater
- Leakage and permeation through the secondary liner due to excess pore pressure from secondary clay layer consolidation

Since RMU-2 employs a GCL instead of a compacted clay layer in the primary liner, the RR calculation for RMU-2 does not include an analysis of consolidation water from a primary clay layer, as the RMU-1 RR did.

<u>CALCULATIONS:</u>

1. Leakage and Permeation Through Primary Liner Due to 1 ft of Head on Primary Liner

Leakage through the primary liner is attributable to the potential for a small number of manufacturer and installation defects in the primary liner geomembrane. The resulting flowrate through these imperfections is governed by the frequency of defects, their size, and the hydraulic conductivity of the material beneath the geomembrane (i.e., the GCL). Leakage through geomembrane imperfections is estimated using equation 149 from Reference 4:

$$q_h = k_s i_{ave} n \pi R^2 (0.87719)$$

where,

q_h = flow per unit area of geomembrane
k_s = hydraulic conductivity of controlling soil layer or GCL = $1x10^{-7}$ cm/s (clay) or $5x10^{-9}$ cm/s (GCL)
i_{ave} = average hydraulic gradient from HELP eqn. 150 (see below)
n = number of defects per unit area (Assumptions 1 and 2)
R = radius of wetted area around flaw from HELP eqns. 162 or 159 (see below)

The average hydraulic gradient is calculated using equation 150 from Reference 4:

Calculation Sheet

$$i_{ave} = 1 + \left[\frac{h_g}{2T_s \ln\left(\frac{R}{r_o}\right)}\right]$$

where,

h_g = head on geomembrane = 1 ft
T_s = thickness of controlling soil layer or GCL = 3 ft (clay) or 200 mil (GCL)
r_o = radius of flaw (calculated from Assumptions 1 and 2)

The radius of the wetted area around each flaw is dependent on the degree of contact between the geomembrane and the controlling soil layer adjacent to the flaw (i.e., whether the controlling layer is compacted clay or GCL). Based on Reference 4, the radius of the wetted area is calculated using equation 162 for situations where flawed geomembrane is in contact with compacted clay (based on “good” liner contact) or equation 159 for situations where flawed geomembrane is in contact with GCL (based on “excellent” liner contact). Equation 159 is as follows:

$$R = 0.5 a_o^{0.05} h_g^{0.5} k_s^{-0.06}$$

where,

a_o = area of flaw

Assuming the size and frequency of defects in Assumptions 1 and 2, a head of 1 foot on the primary liner results in the following leakage rates using the above equations:

q_h = 0.005 gal/acre/day (gpad) due to manufacturing defects (i.e., pinholes)
q_h = 0.059 gpad due to installation defects

Calculations for these leakage estimates are provided in Attachment 1.

Permeation through the primary liner occurs regardless of the presence of material or installation defects. The flowrate through the primary liner (both the geomembrane and the GCL) is estimated using Darcy’s Law:

Q=kiA

where,

k = effective hydraulic conductivity of geomembrane and GCL = 7.0×10^{-13} cm/s = 2.0×10^{-9} ft/day
i = hydraulic gradient across geomembrane and GCL = H/t
H = head on primary liner = 1 ft
t = combined thickness of geomembrane and GCL = 80 mil + 200 mil = 0.0233 ft
A = area = 1 acre = 43,560 ft^2

Q = 0.0037 ft^3/day/acre = 0.028 gpad

Summing these individual components, a total of 0.092 gpad (0.005 + 0.059 + 0.028 = 0.092) is calculated to enter the SLCS from leachate flow in the PLCS.

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2. Leakage and Permeation Through Secondary Liner from Groundwater

Leakage through the secondary liner from groundwater is evaluated using similar analyses outlined above except that the hydraulic heads, gradients, and hydraulic conductivities are different. To be conservative, the May 2001 piezometric heads from the confined aquifer in the Glaciolacustrine Silt/Sand unit are used. Groundwater levels measured during this time are generally accepted as representing the historical high since regular recording of site-wide groundwater levels began in the early 1980s. Using the piezometric head contours from this monitoring event, the following average piezometric heads are considered representative for the cells within RMU-2:

- Cell 15: 315.7 ft
- Cell 16: 315.9 ft
- Cells 17 and 18: 316.3 ft
- Cell 19: 316.4 ft
- Cell 20: 316.6 ft

Because the floor of each cell is sloped, the hydrostatic head acting on the bottom of the liner system varies across the cell floor. Therefore, an average hydrostatic head from the confined aquifer acting on the bottom of the compacted clay layer in the secondary liner of each cell is determined from an isopach surface created using Reference 1 and the average piezometric heads discussed above. Areas of the cell floor that lie above the average piezometric head elevation are not included in the computation of the average hydrostatic head because these areas would experience zero head. The resulting average hydrostatic head acting on the bottom of the compacted clay layer in the secondary liner of each cell is:

- Cell 15: 7.44 ft
- Cell 16: 8.66 ft
- Cell 17: 4.50 ft
- Cell 18: 5.49 ft
- Cell 19: 6.54 ft
- Cell 20: 3.26 ft

Supporting output for the determination of these average heads is included in Attachment 2 to this calculation sheet.

Groundwater inflow to the SLCS through defects in the secondary liner geomembrane is inhibited by the presence of the 3-foot thick compacted clay layer and is calculated using the equations from Reference 4 presented earlier. The radius of the wetted area is calculated using Equation 162 based on "good" contact between the geomembrane and the compacted clay layer as follows:

$$R = 0.26a_o^{0.05}h_g^{0.45}k_s^{-0.13}$$

Table 1 below summarizes the calculated groundwater leakage rates for each cell due to manufacturing and installation defects.

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Table 1 – Groundwater Leakage Through Secondary Geomembrane Flaws

Cell	Due to Manufacturing Defects [gpad]	Due to Installation Defects [gpad]	Total [gpad]
15	0.55	4.62	5.17
16	0.64	5.42	6.06
17	0.33	2.76	3.09
18	0.40	3.37	3.77
19	0.48	4.03	4.51
20	0.24	2.01	2.25

Calculations for the leakage estimates summarized in Table 1 are provided in Attachment 1.

Permeation through the secondary liner occurs regardless of the presence of material or installation defects. The flowrate through the secondary liner (both the compacted clay and the geomembrane) is estimated using Darcy's Law:

$Q=kiA$

where,

k = effective hydraulic conductivity of compacted clay and geomembrane = $9.0\text{x}10^{-11}$ cm/s = $2.6\text{x}10^{-7}$ ft/day
i = hydraulic gradient across compacted clay and geomembrane = H/t
H = cell-averaged head acting on the bottom of the compacted clay layer in the secondary liner (see values above)
t = combined thickness of compacted clay and geomembrane = 3 ft + 80 mil = 3.0067 ft
A = area = 1 acre = 43,560 ft^2

Q = 0.028 ft^3/day/acre = 0.21 gpad (Cell 15)
= 0.033 ft^3/day/acre = 0.24 gpad (Cell 16)
= 0.017 ft^3/day/acre = 0.13 gpad (Cell 17)
= 0.021 ft^3/day/acre = 0.15 gpad (Cell 18)
= 0.025 ft^3/day/acre = 0.18 gpad (Cell 19)
= 0.012 ft^3/day/acre = 0.09 gpad (Cell 20)

Table 2 summarizes the individual components representing groundwater leakage and permeation into the SLCS.

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Calculation Sheet

Table 2 – Groundwater Leakage and Permeation Totals

Cell	Leakage [gpad]	Permeation [gpad]	Total [gpad]
15	5.17	0.21	5.38
16	6.06	0.24	6.30
17	3.09	0.13	3.22
18	3.77	0.15	3.92
19	4.51	0.18	4.69
20	2.25	0.09	2.34

3. Leakage and Permeation Through Secondary Liner Due to Excess Pore Pressure from Secondary Clay Layer Consolidation

Landfill construction and waste placement will result in consolidation of the compacted clay layer in the secondary liner. Reference 7 includes excess pore pressures in the secondary compacted clay layer of Cell 20 at different times during simulated waste placement associated with the initial fill progression design depicted on RMU-2 Permit Drawing No. 8. Specifically, the waste is assumed to advance instantaneously by one lift thickness (6 feet) at a time, at which point, the load is held constant for a time period approximately equal to the elapsed time associated with the waste filling in that lift. At each lift, the pressures are calculated for various locations along a typical cross section passing through the cell at specific time steps. Reference 7 indicates that the peak excess pore pressure occurs when the waste mass is at elevation 383 ft. For the worst-case time step at that lift, an average excess pore pressure of 2,389 psf along the cell floor is calculated. This is equivalent to a head of approximately 38.3 feet. The leakage from this excess pressure through defects in the secondary liner is calculated using the equations from Reference 4 presented earlier. The leakage rates are as follows:

q_h = 3.50 gpad due to manufacturing defects
q_h = 31.96 gpad due to installation defects

Calculations for these leakage estimates are provided in Attachment 1.

The permeation through the geomembrane in the secondary liner from the excess pore pressure in the compacted clay layer is estimated using Darcy's Law:

$Q=kiA$

where,
k = effective hydraulic conductivity of compacted clay and geomembrane = 9.0×10^{-11} cm/s = 2.6×10^{-7} ft/day
i = hydraulic gradient across compacted clay and geomembrane = H/t
H = head on geomembrane = excess pore pressure/unit weight of water = 38.3 ft
t = combined thickness of compacted clay and geomembrane = 3 ft + 80 mil = 3.0067 ft
A = area = 1 acre = 43,560 ft^2

Q = 0.14 ft^3/day/acre = 1.08 gpad

Summing these individual components, a total of 36.54 gpad (3.50 + 31.96 + 1.08 = 36.54) is calculated to enter the SLCS from consolidation water from the secondary compacted clay layer.

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The individual components quantified above are combined to yield a single RR value for each cell in RMU-2 as shown in Table 3.

Table 3 – Summary of Calculated RR Values

Cell	Leakage and Permeation Estimates from Various Sources [gpad]			
	From Leachate Flow in PLCS	From Groundwater Below Liner System	From Secondary Clay Consolidation	Total
15	0.092	5.38	36.54	42.01
16		6.30		42.93
17		3.22		39.85
18		3.92		40.55
19		4.69		41.32
20		2.34		38.97

Although the values summarized in Table 3 are deemed reasonable, a unit-specific value of 20 gpad has been requested by the NYSDEC, as recommended by USEPA (Federal Register No. 19, January 29, 1992) for leakage and permeation through primary liners.

<u>SUMMARY:</u>

The calculated RRs for the cells in RMU-2 range from 38.97 to 42.93 gpad. However, an RR of 20 gpad will be used for all cells based on a USEPA-recommended unit-specific value.

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Attachment 1

Calculated Leakages Through Geomembrane Flaws

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Leakage Through Primary Liner Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 159:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	1.00	0.3048
K_s = Permeability of Controlling Soil Layer [cm/s]	5.00E-09	5.00E-11
T_s = Thickness of Controlling Soil Layer [ft]	0.0167	0.00509016
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 159) [cm^2/s]		0.57
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 5.26

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 5.76E-14

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.005**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Leakage Through Primary Liner Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 159:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	1.00	0.3048
K_s = Permeability of Controlling Soil Layer [cm/s]	5.00E-09	5.00E-11
T_s = Thickness of Controlling Soil Layer [ft]	0.0167	0.00509016
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 159) [cm^2/s]		0.72
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 7.17

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 6.38E-13

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.059**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Secondary Clay Layer Consolidation Water Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	38.30	11.67384
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		5.75
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.68

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 3.79E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**3.503**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Secondary Clay Layer Consolidation Water Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	38.30	11.67384
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		7.33
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.89

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 3.46E-10

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**31.963**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 15 Groundwater Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	7.44	2.267712
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		2.75
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.14

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 5.90E-12

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.545**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 15 Groundwater Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	7.44	2.267712
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		3.51
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.19

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 5.00E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**4.615**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 16 Groundwater Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	8.66	2.639568
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		2.95
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.17

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 6.90E-12

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.637**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 16 Groundwater Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	8.66	2.639568
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		3.76
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.22

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 5.87E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**5.421**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 17 Groundwater Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	4.50	1.3716
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		2.20
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.09

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 3.57E-12

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.330**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 17 Groundwater Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	4.50	1.3716
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		2.80
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.12

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 2.99E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**2.758**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 18 Groundwater Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	5.49	1.673352
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		2.40
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.11

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 4.35E-12

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.402**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 18 Groundwater Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	5.49	1.673352
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		3.06
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.15

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 3.65E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**3.371**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 19 Groundwater Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	6.54	1.993392
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		2.60
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.13

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 5.18E-12

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.478**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 19 Groundwater Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	6.54	1.993392
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		3.31
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.17

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 4.37E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**4.034**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 20 Groundwater Leakage Due to Pinholes

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	3.26	0.993648
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	0.5	0.0005
a_0 = Flaw Area [m^2]		7.85398E-07
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Equn 162) [cm^2/s]		1.90
n = Density of Flaws [number per acre]	1	0.000247105

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.07

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 2.62E-12

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**0.242**

Note: Shaded cells are calculated. All others are user-input.

Leakage Through Geomembrane Flaws Using HELP Model Methods

Scenario: Cell 20 Groundwater Leakage Due to Installation Defects

Step 1 - User Input and Calculation of Wetted Radius, R, Using HELP Model Eqn. 162:

	User-Input Value	Value in SI Units (m, s)
h_g = Hydraulic Head on Liner [ft]	3.26	0.993648
K_s = Permeability of Controlling Soil Layer [cm/s]	1.00E-07	1.00E-09
T_s = Thickness of Controlling Soil Layer [ft]	3	0.9144
r_0 = Radius of Flaw [mm]	5.65	0.0057
a_0 = Flaw Area [m^2]		0.000100287
R = Radius of Wetted Area Around Flaw (from HELP Model Engineering Documentation Eqn. 162) [cm^2/s]		2.42
n = Density of Flaws [number per acre]	5	0.001235527

Step 2 - Calculation of Average Hydraulic Gradient, i_{avg}, Using HELP Model Eqn. 150:

i_{avg} = 1.09

Step 3 -Calculation of Leakage Rate Through Flawed Geomembrane, q_h, Using HELP Model Eqn. 149:

q_h [m/s] = 2.17E-11

Step 4 - Determine Daily Leakage Volume Based on Acreage:

	Acres	Daily Leakage [gal]
Daily Leakage Volume:	**1**	**2.006**

Note: Shaded cells are calculated. All others are user-input.

ARCADIS

Attachment 2

Average Hydrostatic Head on Bottom of Secondary Clay Liner Compacted Clay Layer Due to Confined Aquifer

CELL 15 SURFACE TO DATUM VOLUME REPORT

ARCADIS
6723 Towpath Road PO Box 66
Syracuse, NY 13214
315.446.9120

Project: C:\Documents and Settings\BStone\Desktop\RMU-2 2009 Redesign.pro
Report Generated: Monday, July 27, 2009 11:08:07 AM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

DTM Surface Layer Name	Number of Points	Datum Elevation
P-SUBGRADE REV	4,374	315.70

Volume limited to that within the constraining boundary - Object 432790
Area within boundary: 265,607.44 Sq. Ft. (6.0975 Acres)
Total triangulated area: 265,608.57 Sq. Ft. (6.0975 Acres)

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
44,105.0	57,987.7

Net Difference: 13,882.7 Cu. Yd. excess volume above datum

Subgrade Area Below El. 315.7 = 160,002 sq.ft.

Ave Depth Below El. 315.7 = 44,105 x 27 / 160,002 = 7.44 ft

CELL 16 SURFACE TO DATUM VOLUME REPORT

ARCADIS
6723 Towpath Road PO Box 66
Syracuse, NY 13214
315.446.9120

Project: C:\Documents and Settings\BStone\Desktop\RMU-2 2009 Redesign.pro
Report Generated: Monday, July 27, 2009 11:14:25 AM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

DTM Surface Layer Name	Number of Points	Datum Elevation
P-SUBGRADE REV	4,374	315.90

Volume limited to that within the constraining boundary - Object 432754
Area within boundary: 257,254.75 Sq. Ft. (5.9058 Acres)
Total triangulated area: 257,251.35 Sq. Ft. (5.9057 Acres)

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
58,921.5	36,170.3

Net Difference: 22,751.2 Cu. Yd. excess volume beneath datum

Subgrade Area Below El. 315.9 = 183,665 sq.ft.

Ave Depth Below El. 315.9 = 58,922 x 27 / 183,665 = 8.66 ft

CELL 17 SURFACE TO DATUM VOLUME REPORT

ARCADIS
6723 Towpath Road PO Box 66
Syracuse, NY 13214
315.446.9120

Project: C:\Documents and Settings\BStone\Desktop\RMU-2 2009 Redesign.pro
Report Generated: Monday, July 27, 2009 11:26:29 AM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

DTM Surface Layer Name	Number of Points	Datum Elevation
P-SUBGRADE	3,917	316.30

Volume limited to that within the constraining boundary - Object 328341
Area within boundary: 251,917.38 Sq. Ft. (5.7832 Acres)
Total triangulated area: 251,917.39 Sq. Ft. (5.7832 Acres)

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
28,473.1	20,931.8

Net Difference: 7,541.2 Cu. Yd. excess volume beneath datum

Subgrade Area Below El. 316.3 = 170,955 sq.ft.

Ave Depth Below El. 316.3 = 28,473 x 27 / 170,955 = 4.50 ft

CELL 18 SURFACE TO DATUM VOLUME REPORT

ARCADIS
6723 Towpath Road PO Box 66
Syracuse, NY 13214
315.446.9120

Project: C:\Documents and Settings\BStone\Desktop\RMU-2 2009 Redesign.pro
Report Generated: Monday, July 27, 2009 11:31:31 AM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

DTM Surface Layer Name	Number of Points	Datum Elevation
P-SUBGRADE REV	4,374	316.30

Volume limited to that within the constraining boundary - Object 317013
Area within boundary: 250,692.04 Sq. Ft. (5.7551 Acres)
Total triangulated area: 250,705.47 Sq. Ft. (5.7554 Acres)

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
36,252.9	27,810.3

Net Difference: 8,442.6 Cu. Yd. excess volume beneath datum

Subgrade Area Below El. 316.3 = 178,273 sq.ft.

Ave Depth Below El. 316.3 = 36,253 x 27 / 178,273 = 5.49 ft

CELL 19 SURFACE TO DATUM VOLUME REPORT

ARCADIS
6723 Towpath Road PO Box 66
Syracuse, NY 13214
315.446.9120

Project: C:\Documents and Settings\BStone\Desktop\RMU-2 2009 Redesign.pro
Report Generated: Monday, July 27, 2009 11:36:11 AM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

DTM Surface Layer Name	Number of Points	Datum Elevation
P-SUBGRADE REV	4,374	316.40

Volume limited to that within the constraining boundary - Object 317013
Area within boundary: 252,340.43 Sq. Ft. (5.7929 Acres)
Total triangulated area: 252,335.73 Sq. Ft. (5.7928 Acres)

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
34,173.3	60,479.6

Net Difference: 26,306.3 Cu. Yd. excess volume above datum

Subgrade Area Below El. 316.4 = 141,057 sq.ft.

Ave Depth Below El. 316.4 = 34,173 x 27 / 141,057 = 6.54 ft

CELL 20 SURFACE TO DATUM VOLUME REPORT

ARCADIS
6723 Towpath Road PO Box 66
Syracuse, NY 13214
315.446.9120

Project: C:\Documents and Settings\BStone\Desktop\RMU-2 2009 Redesign.pro
Report Generated: Monday, July 27, 2009 12:10:04 PM

Where the DTM surface is above the datum the volume is reported as fill.
Where the DTM surface is below the datum the volume is reported as excavation.

Shrinkage/swell factors: Excavation 1.0000 Fill 1.0000

DTM Surface Layer Name	Number of Points	Datum Elevation
P-SUBGRADE REV	4,374	316.60

Volume limited to that within the constraining boundary - Object 317012
Area within boundary: 267,523.01 Sq. Ft. (6.1415 Acres)
Total triangulated area: 267,517.34 Sq. Ft. (6.1414 Acres)

Excavation Volume Beneath Datum (Cu. Yd.)	Fill Volume Above Datum(Cu. Yd.)
16,313.6	53,381.4

Net Difference: 37,067.8 Cu. Yd. excess volume above datum

Subgrade Area Below El. 316.6 = 135,222 sq.ft.

Ave Depth Below El. 316.6 = 16,314 x 27 / 135,222 = 3.26 ft

ARCADIS

Appendix C

Table of Priority Pollutants

TABLE OF

PRIORITY POLLUTANTS

NDPES NO.	COMPOUND
ACIDS	
1A	2-Chlorophenol
2A	2,4-Dichlorophenol
3A	2,4-Dimethylphenol
4A	4,6-Dinitro-o-cresol
5A	2,4-Dinitrophenol
6A	2-Nitrophenol
7A	4-Nitrophenol
8A	p-Chloro-m-cresol
9A	Pentachlorophenol
10A	Phenol
11A	2,4,6-Trichlorophenol
BASE/NEUTRALS	
1B	Acenaphthene
2B	Acenaphtylene
3B	Anthracene
4B	Benzidine
5B	Benzo(a)anthracene
6B	Benzo(a)pyrene
7B	Benzo(b)fluoranthene
8B	Benzo(ghi)perylene
9B	Benzo(k)fluoranthene
10B	bis(2-Chloroethoxy)methane
11B	bis(2-Chloroethyl)ether
12B	bis(2-Chloroisopropyl)ether
13B	bis(2-Ethylhexyl)phthalate
14B	4-Bromophenyl phenyl ether
15B	Butyl benzyl phthalate
16B	2-Chlornaphthalene
17B	4-Chlorophenyl phenyl ether
18B	Chrysene
19B	Dibenzo(a,h) anthracene
20B	1,2-Dichlorobenzene
21B	1,3-Dichlorobenzene
22B	1,4-Dichlorobenzene
23B	3,3-Dichlorobenzidine
24B	Diethyl phthalate
25B	Dimethyl phthalate
26B	Di-n-butyl phthalate
27B	2,4-Dinitrotoluene

NDPES NO.	COMPOUND
BASE/NEUTRALS (CONTINUED)	
28B	2,6-Dinitrotoluene
29B	Di-n-octyl phthalate
30B	1,2-Diphenylhydrazine
31B	Fluoranthene
32B	Fluorene
33B	Hexachlorobenzene
34B	Hexachlorobutadiene
35B	Hexachlorocyclopentadiene
36B	Hexachloroethane
37B	Indeno (1,2,3-c,d)pyrene
38B	Isophorone
39B	Naphthalene
40B	Nitrobenzene
41B	N-Nitrosodimethylamine
42B	N-Nitrosodi-n-propylamine
43B	N-Nitrosodiphenylamine
44B	Phenanthrene
45B	Pyrene
46B	1,2,4-Trichlorobenzene

METALS (TOTAL)

Antimony
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc

TABLE OF

PRIORITY POLLUTANTS

(Continued)

NDPES NO.	COMPOUND
PESTICIDES/PCB	
1P	Aldrin
2P	Alpha-BHC
3P	Beta-BHC
4P	Gamma-BHC
5P	Delta-BHC
6P	Chlordane
7P	4,4'-DDT
8P	4,4'-DDE
9P	4,4'-DDD
10P	Dieldrin
11P	Endosulfan I
12P	Endosulfan II
13P	Ensosulfan sulfate
14P	Endrin
15P	Endrin aldehyde
16P	Heptachlor
17P	Heptachlor epoxide
18P	PCB-1242
19P	PCB-1254
20P	PCB-1221
21P	PCB-1232
22P	PCB-1248
23P	PCB-1260
24P	PCB-1016
VOLATILES	
3V	Benzene
5V	Bromoform
6V	Carbon tetrachloride
7V	Chlorobenzene
8V	Chlorodibromethane
9V	Chloroethane

NDPES NO.	COMPOUND
VOLATILES (CONTINUED)	
10V	2-Chloroethylvinyl ether
11V	Chloroform
12V	Dichlorobromomethane
14V	1,1-Dichloroethane
15V	1,2-Dichloroethane
16V	1,1-Dichloroethylene
17V	1,2-Dichloropropane
18V	cis-1,3-Dichloropropylene
19V	Ethylbenzene
20V	Methyl bromide
21V	Methyl chloride
22V	Methylene chloride
23V	1,1,2,2-Tetrachloroethane
24V	Tetrachloroethylene
25V	Toluene
26V	1,2-Trans-dichloroethylene
27V	1,1,1-Trichloroethane
28V	1,1,2-Trichloroethane
29V	Trichloroethylene
31V	Vinyl chloride
18V	trans-1,3-Dichloropropylene

ATTACHMENT L

No Modifications Proposed

ATTACHMENT L

Sections D-10
Fugitive Dust Control Plan

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FUGITIVE DUST CONTROL PLAN

FUGITIVE DUST CONTROL PLAN

As a hazardous waste management facility, the possibility exists that potentially contaminated dust could be released to the atmosphere. 6 NYCRR 373-2.14(c)(9) specifies that if a landfill contains any particulate matter which may be subject to wind dispersal, the owner or operator must cover or otherwise manage the landfill to control wind dispersal. Controls, such as wetting, must be applied to dusty waste streams when they are disposed of in the landfill to prevent particulate emissions. Vehicles exiting the landfill are cleaned of any gross contamination at the exit of the landfill. In order to control any potentially contaminated dust that may accumulate on the roads outside the landfill which are used by waste hauling vehicles, road maintenance is performed.

In addition to the control of potentially contaminated dust from waste management activities, CWM employs best management practices to reduce the amount of soil-type particulate dust. The practices are employed during construction, site and stockpile maintenance and the maintenance of roadways which are used by non-waste hauling vehicles.

I. Control of Potentially Contaminated Dust

A. Landfill Operations

1. Waste stream evaluation.

   a) Waste streams are evaluated for dusting potential during the approval process. Recommendations for dust control, including wetting, containerization, stabilization treatment, etc. will be included on the disposal decision for any wastes identified with dusting potential.

   b) Recommendations for dust control will be considered by the On-Site DEC Monitors during their review and approval of the landfill waste stream. DEC comments will be incorporated into the management approach as appropriate.

   c) Upon receipt of the first shipment of any new waste, the sampler will inspect the load and consider its potential for dusting. The disposal decision may be updated if necessary.

   d) A dusty load for direct landfill disposal will be flagged for special handling by the landfill personnel and the control method prescribed on the Waste Tracking Form.

2. Waste Disposal

   a) If the prescribed method for dust control is wetting, an operator with a water canon may wet the load in the container in the landfill. If required, an operator may use a backhoe to mix the water and the material in the container prior to dumping to ensure proper wetting of the waste. Additional water may be sprayed during the unloading or after waste placement.

b) Any excess or free liquid resulting from the operations contemplated by the activity above shall be treated as liquid from a precipitation event and shall not be deemed to constitute the disposal of free liquids or bulk waste containing free liquids. This interpretation is in keeping with USEPA policy contained in a statutory interpretative guidance document issued in April, 1986.

c) If a dusty waste load not previous identified as having a dusting potential is noted by the landfill personnel, the lab will be notified and the disposal decision amended as needed to specify controls.

d) If the specified dust controls are unsuccessful during a trial load, CWM shall cease disposal of additional loads and revise the dust control procedure.

e) In addition, a trash fence is employed to prevent wind blown debris from escaping the landfill. On a routine basis, all plastic and paper debris escaping the boundaries of the waste management area will be collected.

f) Additional water may be applied to the landfill operating area to control dust. DEC approved cover material such as ConCover may be used to provide dust control of the waste placed in the landfill.

g) All exposed waste is covered at the end of each day of operation using a DEC approved cover material.

NOTE: The procedures specified above in sections 1. a)-c) and 2. c)-d) must be included in this and any future versions of CWM's Fugitive Dust Control Plan according to a Memorandum of Understanding (89-151) between CWM and NYSDEC.

B. Roadways Used By Waste Hauling Vehicles

1. Potential Contamination Control

a) Vehicles or any other equipment which have entered the landfill facility where it has come into direct contact with waste, shall be inspected for gross contamination prior to leaving the landfill area.

b) Any gross contamination identified on the wheels or equipment will be physically removed before leaving the area to prevent contamination of on-site roads.

c) Despite the efforts described above, the potential exists that contaminated dust may be present on the roadways outside the landfill. These roadways will be cleaned and maintained. A sweeper or other road cleaning equipment may be employed to minimize dust accumulation on these roads. Water trucks may also be employed to wet the road surfaces and to minimize air borne dust. Note: If truck washing is performed at the landfill exit, the potential for contaminated dust on the roadway will be eliminated.

d) In addition, the site traffic control plan has generally limited these roadways to waste hauling vehicles. A low speed limit has been posted and speed bumps are employed to minimize dust generation.

II. Control of General Particulate Dust

A. Construction Projects

Dust management procedures for new site and landfill construction projects are addressed in the related permit applications where appropriate. A Stormwater Pollution Prevention Plan has been developed for construction projects affecting areas of at least 5 acres to control soil erosion and contain sediments.

B. Erosion

Vegetative cover is maintained using on-site and contracted services. This includes the application of clay, top soil, fertilizer, hydroseeding and hand seeding. Some berm areas may also be covered with stone or gravel. The use of gabion mats and especially Miramet geotextile fabric has reduced erosion and enhanced vegetative growth.

C. Other Site Roads

Roadways other than those used by waste hauling vehicles will be cleaned and maintained as good housekeeping dictates. In general, the paved roads will be swept as needed, weather permitting. These roads may be wetted down as needed to provide general dust management, adequate visibility and nuisance control.

III. Air Monitoring - Fugitive Dust Emissions

CWM has an Ambient Air Monitoring Program. This program determines the impact, if any, of the hazardous waste activities and other site activities on the surrounding air quality at the Model City facility. This Ambient Air Monitoring Program has been approved by NYSDEC.

A. PM-10 Monitoring

A detailed discussion of the PM-10 monitoring network relative to dust emissions is presented in the PM-10 monitoring system QA/QC manual previously approved by NYSDEC (H. Sandonato to J. Pizzuto, 9/26/90). This monitoring program demonstrates CWM's compliance with the national primary and secondary 24 hour ambient air quality standard for particulate matter of 150 micrograms/cubic meter, 24 hour average concentration. The level of the national primary and secondary annual standards for particulate matter is 50 micrograms/cubic meter, annual arithmetic mean.

The fugitive dust control measures discussed in this plan have consistently resulted in particulate matter levels below the ambient air quality standards. If this monitoring network begins to show levels above the standards, CWM will investigate the cause and revise the Fugitive Dust Control Plan, if necessary.

ATTACHMENT M

Surface Water Sampling and Analysis Plan

(proposed modified pages are designated with a revision date at the bottom of the respective page)

SURFACE WATER

SAMPLING AND ANALYSIS PLAN

Revised August 2013

DISCLAIMER

It should be noted that the State Pollutant Discharge Elimination System (SPDES) monitoring and compliance requirements which are applicable to this Facility, are not part of this Surface Water Sampling & Analysis Plan (SWSAP), but are referenced in this SWSAP for informational purposes only. Adherence to this SWSAP in no way obviates CWM from fulfilling its SPDES monitoring and compliance obligations.

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LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

CWM Chemical Services, L.L.C. (CWM) owns and operates a Treatment, Storage, Disposal and Recovery (TSDR) Facility at Model City, New York. As a condition of the Part 373-2 Operating Permit, the New York State Department of Environmental Conservation (NYSDEC) has required the preparation of a Surface Water Sampling and Analysis Plan (SWSAP).

The overall purpose of the SWSAP is to demonstrate that there is no migration of hazardous constituents from the Model City Facility into surface water run-off, (i.e. stormwater). This sampling and analysis program in which long term trends of surface water quality are monitored meets the objective.

The SWSAP provides procedures for collecting surface water samples that are:

1) fully comprehensive to cover any sampling circumstance that might occur during the routine monitoring program;

2) technically sound so that the surface water samples collected are subject to minimal sampling and analytical bias; and

3) uniform so that all the surface water samples are collected and analyzed in a consistent manner for comparison purposes.

The SWSAP has been prepared to satisfy the *routine surface and storm water monitoring requirements of the above-mentioned Operating Permit and CWM's current State Pollutant Discharge Elimination System (SPDES) Discharge Permit.*

This document only addresses the current monitoring requirements of the site's routine surface water monitoring programs. These programs are very specific as to sample collection, location, parameters, and frequencies. Other monitoring programs (Groundwater Monitoring, Air Monitoring, etc.) have sampling and analysis plans developed specifically for them.

The SWSAP is kept at the facility and is updated as needed and all site personnel involved in collecting surface water samples are appropriately trained in its application.

2.0 SITE BACKGROUND

The Model City TSDR Facility is located in Niagara County, New York, near the Niagara River and Lake Ontario (see Figure 1). The facility was used for a variety of industrial purposes by the U.S. Government between 1942 and 1959.

The site was sold to a real estate company in 1966. In 1972, Chem-Trol Pollution Services purchased the site and began to use it as a private industrial waste operations facility. Chem-Trol was purchased by SCA Services, Inc. in 1973, then in 1984, SCA Services, Inc. was acquired by a WMI affiliate, Waste Management Acquiring Corporation, making SCA Chemical Services, Inc. a wholly-owned subsidiary of WMI.

In 1987, SCA Chemical Services, Inc. became a wholly owned subsidiary of Chemical Waste Management, Inc. and in July 1988, the facility name was changed to CWM Chemical Services, Inc. In 1998, CWM became a Limited Liability Company (L.L.C.) while its parent company, Waste Management, Inc. merged with USA Waste.

2.1 SITE DESCRIPTION

Current operations at the facility include treatment, recovery, disposal, and transfer of hazardous and industrial waste. The operations are comprised of waste receiving areas, storage and mixing tanks, chemical treatment facilities, biological treatment impoundments, and secure landfills.

The general site layout is shown on Figure 2.

2.2 SITE STRATIGRAPHY

The Model City Facility is situated on the Ontario Plain, an area of low topographic relief located between the Niagara Escarpment and Lake Ontario. The ground surface slopes northward at less than one percent with elevations ranging between approximately 310 and 320 feet above mean sea level.

Basically, the unconsolidated geology at the site consists of about 30 feet to 60 feet of glacial and glaciolacustrine deposits of Late Wisconsin Age. The glacial deposits overlie an estimated 1,000-foot thick sequence of red shale, siltstone, and sandstone of the Queenston Formation of Upper Ordovician Age.

2.3 SOIL CLASSIFICATION AND USE

The surface of the site is composed of low permeability soils. The U.S. Soil Conservation Service classifies many of the surface soil types present as Group C and Group D. These soil groups are characterized as having moderately high to high run-off potential, respectively, due to very slow infiltration rates.

Group C soil groups include the Appleton Silt Loam and the Ovid Silt Loam. Group D soil groups include the Canandaigua Silt Loam, Cheektowaga Fine Sandy Loam, Rhinebeck Silt Loam, Sun Silt Loam, and Madalin Silt Loam. Each group comprises approximately 50% of the soils on site .

The various land uses at the Model City Facility also influence site drainage characteristics. These uses are described in terms of the three general areas identified below:

1. Non-containment operational areas,

2. Active containment and disposal areas, and

3. Natural buffer area.

Each of these areas has different run-off and storage characteristics.

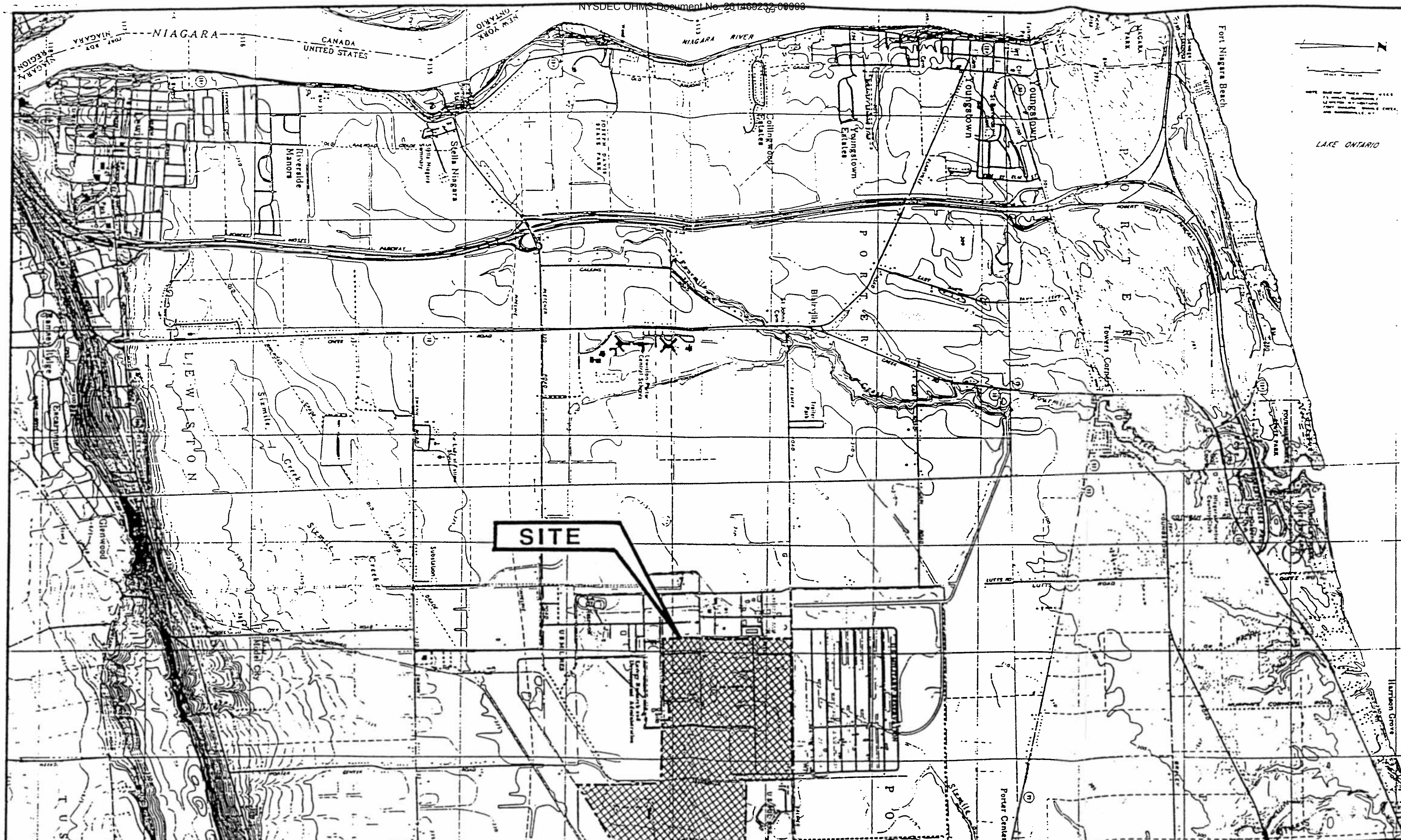
The non-containment operational areas include closed landfills, buildings, roads, parking lots, and open areas being prepared for future operations. These areas are not classified with a particular soil type as discussed above; rather they are referred to as "made land." The blacktop, roofing, and grading characteristics of these operational areas typically make them areas of rapid run-off.

The active containment and disposal areas include Stabilization, RMU-1, which is bermed, active tank farms, which have secondary containment, and the full trailer park, which has secondary containment. These areas act to contain surface water and prevent run-off and would not normally contribute to general site run-off. . Development of proposed RMU-2 will add additional active disposal capacity as well as replacements for the Stabilization and Full Trailer Parking areas. RMU-1 will be closed in accordance with the RMU-1 Closure Plan upon reaching capacity.

The natural buffer areas consist of wooded areas, wetlands, ponds, and topographically low areas that generally act as water storage areas. These buffer areas are mostly located in the central and northern portions of the site.

FIGURE 1

SITE LOCATION MAP



JOB NO. 853-3055	SCALE AS SHOWN	SITE LOCATION MAP
DRAWN SKB	DATE 3/19/87	
CHECKED DJM	DWG. NO 176	
Golder Associates		CHEMICAL WASTE MANAGEMENT, INC. FIGURE 1

FILE NUMBER 853-3047

FIGURE 2

FIGURE 2 - MODEL CITY SURFACE WATER MONITORING POINT LOCATIONS

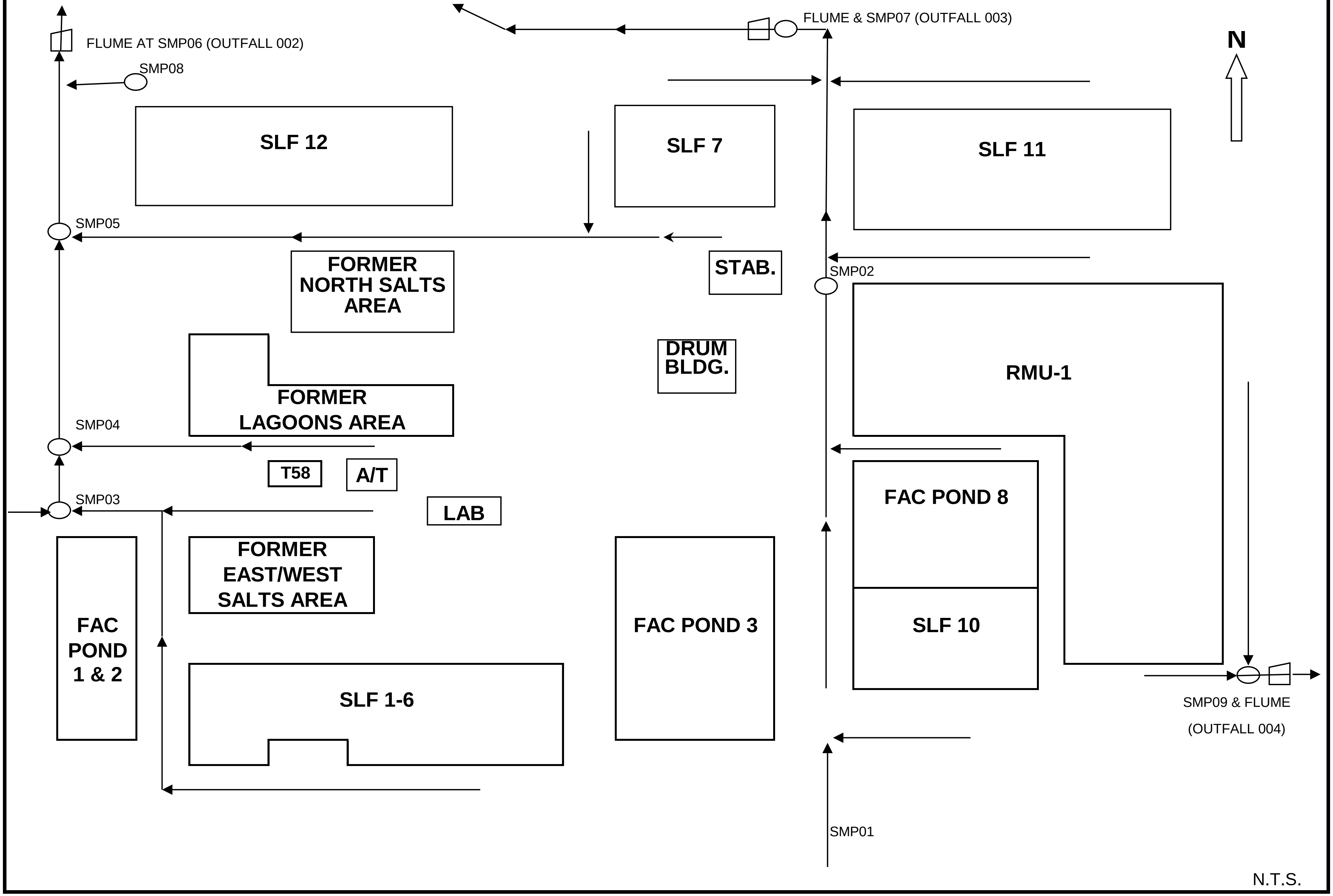
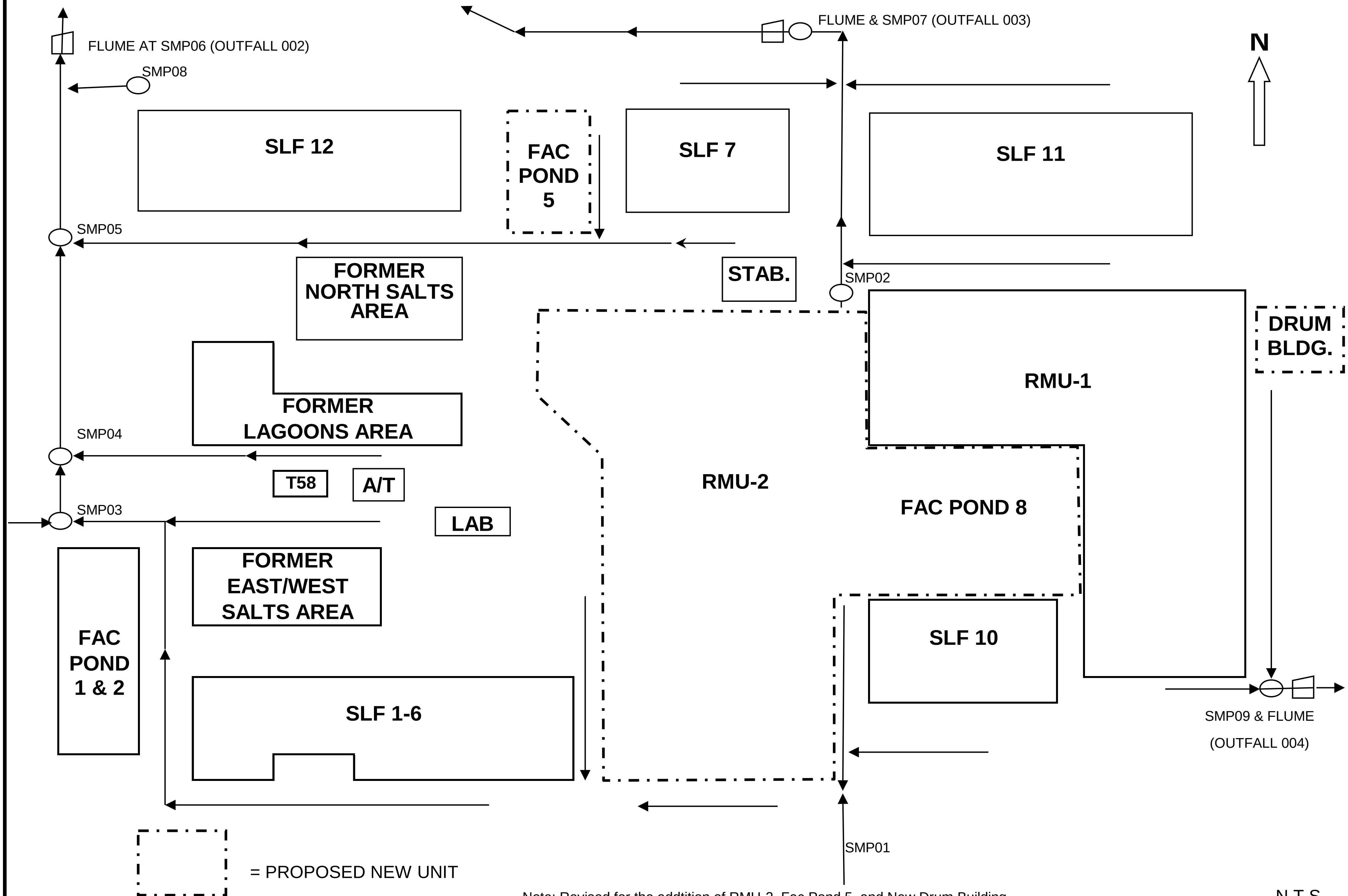


FIGURE 2a

FIGURE 2a - MODEL CITY SURFACE WATER MONITORING POINT LOCATIONS



Note: Revised for the addtition of RMU-2, Fac Pond 5, and New Drum Building

N.T.S.

3.0 SURFACE WATER CONDITIONS

The Model City Facility receives 2.40 inches of precipitation (as rainfall) per month and 29.3 inches per year on average. (Based on data collected at the Model City Facility from June 1976 through December 2012). Surface water run-off from the Model City Facility ultimately flows to either Four Mile Creek (Surface Water Index No. H-156-1C, C) or Twelve Mile Creek (Surface Water Index No. H-156-1C-3, C). Most of the Facility drains north and west until it finally reaches Four Mile Creek approximately one-quarter mile north of the Facility's northwestern boundary. Four Mile Creek then flows north to Lake Ontario. According to 6 NYCRR Part 701.8, Four Mile Creek and its tributaries contain Class C fresh surface waters, which are suitable for fish propagation and survival.

Twelve Mile Creek receives some surface water discharge from a small part of the Facility's southeastern property. On January 6 2004, approval was received from NYSDEC to allow additional run-off from the eastern and southern portions of RMU-1. This run-off is discharged to a Storm Water Retention Basin and then through Outfall 004 (SMP09) to Twelve Mile Creek, which flows northward to Lake Ontario. According to 6 NYCRR Part 701.8, Twelve Mile Creek also contains Class C fresh surface waters in the area of the Model City Facility. (See W. Mirabile to J. Knickerbocker, 01/06/04).

Figure 2 relates the locations of the various waterways at the Facility.

3.1 SURFACE WATER DRAINAGE SYSTEM

Surface water run-off at the Facility is managed in a complex series of man-made and natural ditches, swales, basins, and control gates. Retention capacity for a 25-year, 24-hour storm is required under the Facility's Operating Permit. The construction of retention basins and the placement of six control gates {SMP03, SMP04, SMP05, SMP07, SMP08, and SMP09} that are normally closed have achieved this. A seventh internal control gate {SMP02} is located upstream of SMP07. It is routinely left open, but may be closed if control or isolation of this area is desired.

Three main drainage channels receive all of the surface water run-off from the Facility. One channel receives run-off from the western and central portion of the Facility and is managed by 4 control gates. The second channel receives run-off from the eastern portion of the Facility and is managed by a control gate located at a retention basin north of the Facility. The third drainage channel flows to the southeast and receives controlled run-off from a portion of RMU-1.

Site surface water collects behind each of the six control gates in dedicated surface water holding areas; release occurs only after sampling and analytical qualification has occurred. Control gates are opened regularly and may be left open for several days to ensure that storage capacity is available for a large storm. The flow in all channels is intermittent; only occurring when there is sufficient precipitation to promote surface run-off.

3.2 CONTROL GATE OPERATION AND INSPECTION

As previously mentioned, storm water control gates are used to retain surface water until analytical qualification has occurred. These gates are equipped with manually-operated valves, which are used to release run-off.

Prior to release, water on the upstream side of each gate is visually inspected for an oil sheen or other visible evidence of potential contamination. Then it is sampled and analyzed for specific conductance. The results are compared with a “Site-Wide Alarm Value" of 2500 µmhos. (This value has been selected to prevent the unnecessary shutdown of operations due to groundwater infiltration, road salting, or other site wide construction activities; yet this value is still adequate for the determination of potential contamination based on the historic specific conductivity readings of landfill leachate and other on-site wastewaters.)

If the conductivity of the sample exceeds the alarm level, another sample is collected from the same location. If the conductivity of the resample exceeds the alarm level, then either the Technical Manager or Environmental Monitoring Manager is immediately notified. These individuals then determine whether to sample and analyze the surface water for VOCs, PCBs, or any other suspected contaminants.

Regardless of the conductivity level, CWM will sample and analyze the surface water at the control gates for VOCs, PCBs, or other suspected contaminants, if requested to do so by the On-Sire NYSDEC Monitors or other NYSDEC staff, unless it is demonstrated to the staff's satisfaction that such sampling is unnecessary. Also, CWM will, upon notification, allow the On-Site NYSDEC Monitors or other NYSDEC staff to collect surface water samples for NYSDEC analysis prior to, or during any release of surface water from a control gate.

Based on the results of any additional analyses and the manager's knowledge of activities (past or present) in the area, a decision will be made regarding the disposition of the stormwater. The manager will notify On-Site NYSDEC Monitors if elevated VOCs, PCBs, or other contamination is found. The presence of significant contamination may require the water to be processed to remove the constituent(s).

No storm water is released from the Facility at SMP06, SMP07, or SMP09 without prior testing if the manager has found or suspects contamination. All surface water released from control gates must meet the contamination concentration limits in the Facility's SPDES Permit at the respective Outfalls.

Continuous flow meters are installed at SMP06, SMP07, and SMP09 for measuring totalized flow exiting the Facility. Monthly, each flow meter is inspected to ensure that the equipment is in proper operating condition, (see Figure 3). The flow meters are routinely calibrated and maintained as necessary.

3.3 SURFACE WATER MONITORING LOCATIONS

The surface water monitoring point (SMP) sampling locations coincide with control gate locations unless noted and are as follows:

SMP01 - southwest of SLF 10, upgradient of all process areas. SMP01 is not equipped with a Control Gate. SMP01 is no longer routinely sampled. SMP01 was designated as an upgradient surface water reference point, which may be sampled in an investigation of a surface water contamination event.

SMP02 - northwest corner of RMU-1, receives surface water from the south of SLF 10 and from the west of SLF 10, Fac Pond 8, and RMU-1. SMP02 will also receive surface water from north and east portions of closed RMU-2 upon development and closure. SMP02 is an internal control gate, which is routinely maintained in an open position. It is no longer routinely sampled. It may be sampled in an investigation of a surface water contamination event.

SMP03 - northwest corner of FAC Ponds 1 & 2, receives surface water from a retention basin to the west and several smaller channels to the south and east. SMP03 will also receive surface water from western portions of closed RMU-2 upon development and closure. The water in SMP03 is routinely inspected and sampled for conductivity prior to opening the control gate. Additional sampling and analysis may be performed in the investigation of a surface water contamination event.

SMP04 - northwest corner of former West Drum Area, receives surface water from low lying areas in the vicinity of Tank 58 and the Aqueous Wastewater Treatment Facility. The water in SMP04 is routinely inspected and sampled for conductivity prior to opening the control gate. Additional sampling and analysis may be performed in the investigation of a surface water contamination event.

SMP05 - southwest corner of SLF 12, receives surface water from south of SLF 12 and north and west of the inactive Lagoons/Salts Areas. SMP05 will also receive surface water from western portions of closed RMU-2 upon development and closure. The water in

SMP05 is routinely inspected and sampled for conductivity prior to opening the control gate. Additional sampling and analysis may be performed in the investigation of a surface water contamination event.

SMP06 - SPDES Outfall 002, northwest of SLF 12, not equipped with a Control Gate, receives all water from SMP03, SMP04, SMP05, and SMP08. This location has a flow meter for measuring totalized flow and an ISCO Refrigerated Auto-Sampler or similar equipment.

SMP07 - SPDES Outfall 003, north of SLF 7 and SLF 11, this man-made Retention Basin receives all water from the northeast half of SLF 7, SLF 11, north of RMU-1, and SMP02. SMP07 will also receive surface water routed through SMP02 from north and east portions of closed RMU-2 upon development and closure. This location has a flow meter for measuring totalized flow and an ISCO Refrigerated Auto-Sampler or similar equipment.

SMP08 - a man-made Retention Basin north of SLF 12 and east of Castle Garden Road. The water in SMP08 is routinely inspected and sampled for conductivity prior to opening the control gate. Additional sampling and analysis may be performed in the investigation of a surface water contamination event

SMP09 - SPDES Outfall 004 is located southeast of RMU-1. This location has a flow meter for measuring totalized flow and an ISCO refrigerated Auto-Sampler or similar equipment.

3.4 OTHER SURFACE WATER RUN-OFF LOCATIONS

On occasion, precipitation from major rainfall events (or spring meltwater) may collect at locations other than those indicated above. For such occurrences, this water may be sampled and analyzed for Specific Conductance and/or PCBs and/or Volatile Organic Constituents and qualified for release at the nearest SMP location, if appropriate.

Water is released only after reviewing the analytical results. Careful consideration is given to the operating area from which the water may have come. Presence of significant contamination may require the water to be processed to remove the constituent(s). The manager will notify On-Site NYSDEC Monitors if elevated VOCs, PCBs, or other contamination is found.

3.5 MONITORING PARAMETERS, FREQUENCIES, AND METHODOLOGIES

Table A outlines the outfalls, parameters, analytical methodologies, and frequencies required by the current SPDES Permit . The SPDES requirements presented in this SWSAP can only be altered by obtaining a modification of both the Facility’s SPDES and Operating Permits, as appropriate.

USEPA/TSCA requirements for surface water monitoring were eliminated effective July 1996.

FIGURE 3

CWM CHEMICAL SERVICES, L.L.C.

MODEL CITY, NEW YORK

GENERAL FACILITY SITE INSPECTION REPORT

FREQUENCY: Monthly

DATE AND TIME OF INSPECTION: ___/___/___/___:___.
MM DD YY TIME

EQUIPMENT/PROCESS UNIT NAME: Storm Water Flow Monitoring Flumes and ISCO Auto Samplers

INSPECTION CHECKLIST

INSPECTION ITEM	Y/N	COMMENTS
Are the Flow Level Indicators and ISCO Auto Samplers receiving power?		
Are the Flow Level Indicators and ISCO Auto Samplers in good operating condition and functioning properly?		
Is the water level indicated appropriate?		
Is the recorder marking and printing properly?		
Is there sufficient chart paper?		
Is each flume free of cracks, debris, and blockage?		
Acceptable ISCO calibration check performed? (I.e. Actual calibration volume between 100% and 110% of expected?)		SMP06: Expected Vol. = 200 mL. Actual Vol. = SMP07: Expected Vol. = 200 mL. Actual Vol. = SMP09: Expected Vol. = 200 mL. Actual Vol. =

NAME/TITLE:________________________________

SIGNATURE:________________________________

TABLE A

NYSDEC SURFACE WATER MONITORING REQUIREMENTS

OUTFALL	FREQUENCY	PARAMETER	ANALYTICAL METHOD
002, 003, 004	CONTINUOUS	FLOW	IN FIELD
	EACH DAY OF RELEASE	SETTLEABLE SOLIDS	2540F
	WEEKLY	SPECIFIC CONDUCTANCE	2510B
		pH	SM 4500 H* B
		TOTAL SUSPENDED SOLIDS	SM 2540D
		TOTAL DISSOLVED SOLIDS	SM 2540C
		PCB	608
	EVERY 2 WEEKS	OIL & GREASE (HEXANE EXTRACTABLES)	1664
		DICHLORODIFLUOROMETHANE	624 or 601
		2-CHLOROETHYL VINYL ETHER	624
		METHYLENE CHLORIDE	
		VOC	
	MONTHLY	BOD-5	SM 5210B
		DISSOLVED OXYGEN	IN FIELD
		AMMONIA (as N)	350.1
		TOTAL COPPER	200.7/220.2
		TOTAL ZINC	200.7/289.1
		TOTAL PHENOLS	420.1
	As required by Radiation Environmental Monitoring Plan	ISOTOPIC URANIUM	USDOE A-01-R MOD
		ISOTOPIC THORIUM	USDOE A-01-R MOD
		RADIUM-226	USEPA 903.0 MOD
		RADIUM-228	USEPA 904.MOD
		GAMMA Cs-137 & HITS	USEPA 901.1

NOTES: The Frequencies, Parameters, and Analytical Methods are prescribed by CWM's SPDES Permit and Radiation Environmental Monitoring Plan (REMP), as applicable. Adjustments to the above requirements may be made if the SPDES Permit or REMP changes.

4.0 GENERAL RESPONSIBILITIES

4.1 PERSONNEL RESPONSIBILITIES

Surface water monitoring at the Model City Facility is performed under the direction of the Environmental Monitoring Manager.

The Environmental Monitoring Manager is responsible for:

- communication between the laboratory and regulatory personnel,
- (re)-training sample personnel,
- scheduling, supervision, and proper execution of the sampling event, including field equipment procurement, calibration, maintenance, field parameter measurements, sample event documentation , prompt sample shipment, and inspections, and
- accurate data evaluation and timely reporting.

4.2 ANALYTICAL LABORATORIES AND RESPONSIBILITIES

Adirondack Environmental Services, Inc. (AES) (Lab Code No. NY00063) in Albany, New York provides primary analytical services. Additionally, primary radiological services are provided by Test America in St. Louis, Missouri.

Each laboratory provides the Facility with all sampling containers and associated paperwork in a sealable container (cooler). The Laboratory Contact shall notify the Environmental Monitoring Manager if sample containers do not arrive on schedule or intact after a sampling event. The Laboratory Contact is also responsible for overseeing the laboratory analysis and notifying the Environmental Monitoring Manager if problems arise.

5.0 PRE-SAMPLING PROCEDURES

All procedures for sampling, sample preservation, sample storage, chain-of-custody and sample transfer, and equipment calibration and field measurements will follow all applicable requirements specified in the contract laboratory's quality assurance management plan, CWM Chemical Services LLC Quality Manual and equipment manufacturer's manuals.

Pre-sampling procedures include the procurement and calibration of equipment and procurement and preparation of sample containers. Each of these procedures is addressed in the following sections. Preparation for a sampling event begins at least two weeks before the event is to take place to allow adequate time to accomplish all of the procedures and to correct any problems that may surface.

5.1 LABORATORY NOTIFICATION/VERIFICATION

The Environmental Monitoring Manager works closely with the laboratory to schedule sampling events for each month. Two weeks prior to each sampling event, the Environmental Monitoring Manager notifies the laboratory of tentative sampling dates, number and types of samples, and numbers and types of blanks. The laboratory prepares the necessary sample containers and sends them to the site in coolers. The Environmental Monitoring Manager checks in the coolers and notifies the lab of any discrepancies.

5.2 PROCUREMENT, INSPECTION, AND CALIBRATION OF EQUIPMENT

The procurement of equipment is the responsibility of the Environmental Monitoring Manager.

Field measurements along with proper documentation are integral parts of the monitoring program. Before the actual trip to the field, all equipment necessary for a sampling event is cleaned, checked, and calibrated, as necessary. Prior to use in the field, all meters are calibrated to ensure proper working order and to render integrity to the measured values. Calibration procedures provided by the manufacturer are followed.

When Dissolved Oxygen (D O_2) Measurements are required, calibration of the D O_2 field meter is made using the Air Saturated with Water Method. Calibration is performed each day that D O_2 readings are taken and whenever D O_2 readings appear to be erratic.

NOTE: Instrument-specific calibration procedures are subject to change as newer field equipment is put into use. CWM will continue to follow the Manufacturer's recommendations and standard QA/QC procedures.

A Log Book is maintained for all field meters. The log book contains information including field meter serial number, name and model of meter, year purchased, QA results, calibration notes for each day the equipment is used, etc.

5.3 PROCUREMENT AND PREPARATION OF SAMPLE BOTTLES

The procurement and preparation of sample bottles is the responsibility of the laboratory. For routine VOC monitoring, only pre-cleaned, pre-preserved, 40-mL, glass vials with Teflon-lined septa are used.

If parameters other than VOCs are required, the laboratory also supplies these additional bottles. As necessary, pre-measured amounts of preserving reagents are supplied by the laboratory along with the sample bottles. The appropriate preservative is attached to each bottle in a small vial or has been added to each container as required by the analytical method.

The lab sends sample bottles, trip blanks, and field blank water to the site in sealed coolers. Upon arrival, the cooler seal is checked for intactness. The cooler is then "checked in" which involves removing the Chain-of-Custody (COC) and Field Information Form (FIF), visually examining, inventorying, and labeling the sample bottles, and ensuring the appropriate number and types of preservatives are present. Also, Trip Blank samples are examined for air bubbles.

(NOTE: Not all laboratories utilize an FIF. When an FIF is not used, a bound Field Notebook is kept to record pertinent information and observations surrounding the sampling event. Although "FIF" is used throughout this document, FIF should be considered interchangeable with "Field Notes".)

5.4 STORAGE AND HANDLING OF SAMPLING EQUIPMENT

The sample bottles are stored inside coolers. When unattended, the coolers (and bottles) are stored in a designated "clean area" with limited access during the day. This building is kept locked overnight.

All equipment is handled in a responsible manner to prevent breakage or contamination. New clean, powderless PVC or Latex gloves may be worn when handling any equipment that will come in contact with the sample water.

6.0 SAMPLING PROCEDURES

Sampling is performed during run-off events caused by either precipitation or snow/ice melt. When rain falls (or a thaw occurs) at a greater rate than water can be absorbed by the soil, the excess water flows over the ground surface and into the drainage courses. The rate at which this process occurs is dependent upon storm intensity, soil type, cover, grading, etc.

If there is no flow through a given outfall during a given week, then the sampling event is canceled and a record is made of the cancellation.

6.1 FIELD OBSERVATIONS

Upon arrival at the sample point, various field observations regarding conditions at the sample point and its surrounding area are made and recorded on the FIF. These observations may include:

- The presence and condition of the sample point identification marker;
- Physical surroundings that may bias the sample (i.e. high weeds, stagnant water - no flow, nearby activities, etc.);
- Weather conditions;
- Any upwind or upstream site activity; and
- Evidence of contamination such as a visual sheen.

6.2 FIELD MEASUREMENTS

Field measurements are taken immediately for D O_2 and temperature, if required, and recorded on the FIF. Any additional parameter measurements would also be recorded on the FIF, as required.

The duplicate field measurements, if any, are also recorded on the FIF.

6.3 GRAB SAMPLE COLLECTION

(**NOTE:** Sampling for pH, Specific Conductance, and Settleable Solids is performed by trained Site personnel. All of these samples are analyzed "in-house." As such, collection, receiving, documentation, and laboratory procedures and methods may vary from those procedures that follow. However, the sampling and analysis for these parameters will be conducted in accordance with the latest edition of "Standard Methods for the Examination of Water and Wastewater.")

Immediately prior to sampling, the sample point identity is recorded on the COC and FIF. The sample bottles, COC, and FIF forms are re-checked to ensure that all match with respect to sample point, parameter, and preservative.

Samples, which are to be split with regulatory agencies, are also checked for consistent sample point ID numbers and for other methods of identification if used by the agency.

Grab surface water samples are collected under flow conditions. Grab samples are collected for VOC, Oil & Grease, Phenols, Ammonia, BOD-5, Copper, and Zinc (and other additional parameters as may be required.) Grab samples may be taken using a dedicated, long-handled, polyethylene dipper. If used, the dipper is thoroughly rinsed at the outfall before each use. New, disposable, powderless PVC or latex gloves may be worn at each sample point during sampling and are changed when dirty, torn, etc. Flow-proportioned composite samples are collected over approximately 24 hours for PCB, Total Suspended Solids (TSS), and Total Dissolved Solids (TDS) (and other additional parameters as may be required.) (See Section 6.4 below.)

When filling sample bottles, the following procedures and precautions are followed:

1. Bottle caps are removed carefully so that the inside of the cap is not touched. Bottle caps are not interchanged between sample bottles. Caps for VOC vials contain a Teflon-lined septum. The Teflon side of the septum must face the sample to prevent contamination of the sample through the septum.

2. The sample bottles are filled with a minimal amount of air contact and without contacting the inside of the bottles.

3. Sample bottles containing preservatives are filled with as little overflow as possible and are inverted to mix the preservative with the sample. If the required preservative(s) are not in the bottles, the bottles should be filled, leaving adequate space to add the preservative(s) later.

No substitutes for the chemical preservatives supplied are used as the reagents are special high grade and are metal free. Arrangements may be made with the laboratory if the storage of additional preservatives at the site is necessary. If substitutions are made from on-site storage, it is noted on the COC form.

4. VOC vials are filled so that they contain no headspace. These sample vials, therefore, need to be over-filled (water tension will maintain a convex water surface in the bottle). The caps for these vials are replaced gently, so as to prevent introducing air bubbles in the sample. Check each vial by inverting and snapping it sharply with a finger. If any air bubbles appear, the vial is opened, more water is added, and the process is repeated until no air bubbles are present. The vial is not emptied and refilled as this would result in the loss of the preservative.

5. All sample bottles, once filled and preserved as necessary, are shipped on ice or refrigerated until they are ready to be shipped. The VOC vials are not placed in direct contact with ice as the samples may freeze and break.

6. Sample bottles, caps, or septa, which fall on the ground before filling, are thoroughly rinsed with sample water before being used or are discarded. All circumstances regarding dropped caps or bottles, and their subsequent rinsing and use, are noted on the FIF.

6.4 COMPOSITE SAMPLE COLLECTION

A flow-proportioned composite sample is collected for approximately 24 hours under normal flow conditions for PCB, TSS, and TDS. This sample is collected using a dedicated ISCO Model 6712FR Refrigerated Auto-Sampler or similar equipment.

The Auto-Sampler is programmed to collect a grab sample aliquot per a specified volume of stormwater run-off leaving the Facility in a 24-hour period as determined by the dedicated ISCO Model 4210 Flow Meter (or similar equipment.) If a heavier-than-normal (or lighter-than-normal) discharge volume is anticipated, the grab sampling frequency may be increased or decreased by adjusting the “Sample Pace” function on the Flow Meter. This function signals the Auto-Sampler to grab a sample each time a specified volume of liquid passes by the Flow Meter.

Proper Sample Pacing is essential to ensure that:

1. An adequate sample volume is collected,
2. the composite sample consists of at least 8 discreet grab samples, and
3. sampling continues for approximately 24 hours.

Improper Sample Pacing could result in:

1. Insufficient sample volume collected,
2. the termination of grab sampling well short of the required 24 hours, or
3. grab sampling to continue well beyond the required 24 hours.

However, as long as the sample volume collected is sufficient to perform analysis for the specified parameters (PCB, TSS, and TDS), the composite sample will be sent for analysis as usual.

Basic procedures for the collection of the composite sample are as follows:

1. Immediately prior to sampling, the sample point identity is recorded on the COC and FIF. The sample bottles, COC, and FIF forms are re-checked to ensure that all match with respect to sample point, parameter, and preservative.

2. Activate Auto-Sampler to immediately collect a sample thus demonstrating proper operability.

   If the Auto-Sampler has already been calibrated this collection month, skip this step. Otherwise, calibrate the Auto-Sampler. Catch the volume collected in a graduated cylinder and compare with the desired volume. If the volume collected is between 100% and 110% of the desired volume, the calibration is acceptable. Re-calibrate as necessary to ensure an adequate sample volume is collected.

3. Remove the dedicated 5 gallon glass collection bottle from the refrigerator and rinse it thoroughly with fresh surface water run-off. Return bottle to refrigerator.

   Set the Sampler Pacing to the appropriate anticipated discharge volume.

4. Begin composite sampling. View initial sample collection to ensure proper operations.

5. Record date, start time, start volume, location, and other appropriate field information at this time.

As soon as possible after the completion of the 24-hour sample period, the following steps are taken.

1. Check the main menu screen to ensure that there were no interruptions in the sampling program. (Note any error messages that may impact sample integrity.)

2. Remove the sample collection bottle and, if used, the dedicated glass funnel.. Agitate the sample collection bottle to ensure sample homogeneity. If needed, rinse the dedicated, glass, sample funnel thoroughly.

3. Fill all sample bottles completely, leaving room for any necessary preservatives. Cap bottles, complete field information forms, and package samples for shipment to the lab.

4. Record the end time, end volume, and number of grab samples taken to make the composite.

{NOTE: During freezing weather conditions, the ISCO sample line may freeze before 24 hours have elapsed. In such instances, the “partial” composite sample is used providing sufficient volume is available to fill the necessary bottles. Circumstances surrounding these “partial” composite samples are noted.}

6.5 ORDER OF SAMPLE COLLECTION

In the event that parameters other than VOCs are required, the priority sequence of parameter collection during sampling is as follows:

Priority	Parameter
1	pH, Specific Conductance, Temperature, Dissolved Oxygen, Settleable Solids
2	Volatile Organics
3	PCB, Total Suspended Solids, Total Dissolved Solids
4	Total Metals {Copper and Zinc only}
5	Total Phenols
6	Ammonia
7	Oil & Grease
8	BOD-5
9	Radiologicals

This priority list is only followed if there was insufficient sample volume available to completely fill all sample bottles.

6.6 DUPLICATE SAMPLES

For every tenth sample collected, the sampling team must submit a duplicate sample to the lab. A different sample point is selected for the duplicate sample each time. Eventually, all sample points will be utilized as duplicates.

The duplicate sample, identified as "DUP," receives the same analyses as the other routine samples. The actual identity of the duplicate sample is noted in the Comments section of the FIF.

6.7 TRIP BLANKS AND FIELD BLANKS

Trip blanks and field blanks are used as controls and/or external QA/QC samples. They indicate contamination that may have been introduced in the field, in transit to or from the sampling site, during bottle preparation, sample log-in, or sample storage at the laboratory. The blanks may also reflect contamination that may have occurred during the analytical process.

Trip blanks are samples of GC/MS Reagent Grade water that are prepared at the same location and time as the bottles that are to be used for sampling. They remain with the sample bottles while in transit to the site, during sampling, and during the return trip to the laboratory. Upon returning to the laboratory, they are analyzed for VOCs using the same QA/QC procedures as a sample. Trip blanks are not to be opened until they are returned to the lab. If they are opened by accident, it must be noted on the COC form.

Each daily shipment of coolers to the laboratory will contain a trip blank if any cooler contains samples for VOA analysis. Trip blanks are reported in the Technical Report as separate samples using "TB" as the sample point designation.

Field blanks are similar to trip blanks, however, the field blank is prepared at the sampling location using empty bottles and GC/MS reagent grade water supplied by the laboratory. The location where the field blank is prepared is noted in the Comments section of the FIF and on the COC.

The number of field blanks is dependent on the number of samples included in the sampling event. For every 10 VOC samples collected, one field blank is analyzed for VOCs. Field blank results are reported in the laboratory's Technical Report as separate samples using "FB" as the sample point designation.

6.8 SAMPLE PACKAGING AND SHIPMENT PROCEDURES

After sampling, samples are placed in coolers containing loose ice or are otherwise refrigerated in a clean, secure area until shipping arrangements can be made.

There are three important reminders for repacking the coolers:

1. Glass should not be packed in contact with glass. Ice or packing sleeves are placed around and between bottles.

2. Completed COC and FIF forms must be returned to the cooler <u>before</u> the cooler is sealed.

3. Sample coolers are sealed with a Custody Seal provided by the lab.

Once the samples have been placed on ice, the COC and FIF are completed. All paper work is then put into a plastic bag and placed inside the cooler. A member of the sampling team arranges for sample pickup and transportation to the laboratory. Coolers are transported via overnight courier for receipt at the laboratory within 72 hours of sample collection; often samples are received within 24 hours. (NOTE: Although samples are chilled after sampling, it is a priority to ship the samples to the lab as soon as possible. As a result, some of the samples may arrive at the lab with a temperature of greater than 4°C. The Lab notes this on the COC and these "warm" samples are typically analyzed as usual.)

6.9 SAMPLE RECEIPT

Upon arrival at the laboratory, the samples are logged-in and COC procedures are maintained until the analyses are completed and reported.

Once a cooler is received at the laboratory, the Environmental Monitoring Manager is notified if the Sample Control Group encounters any discrepancies. Prompt notification is essential since analyses could be delayed beyond the allowable holding times.

7.0 FIELD RECORDS AND DOCUMENTATION

Standard COC and FIFs are filled out during a sampling event and are used to establish and document COC, sampling conditions, field measurements, and sampler's names . The original forms are sent with the samples to the laboratory and copies are included in the Technical Report when the analysis is complete. All forms are completed using permanent ink only.

The Technical Report, including copies of the COC and FIF are maintained by the Environmental Monitoring Manager for easy reference. Analytical data is also permanently maintained in the site files.

7.1 CHAIN-OF-CUSTODY FORM

In order to maintain and document sample integrity, strict COC procedures are necessary.

From the time the empty sample bottles leave the laboratory until the analytical results are issued, the sample and/or sample containers are in the custody of trained CWM or laboratory personnel. In order to maintain COC, the samples must be either:

- in sight of the assigned custodian;
- locked in a tamper-proof location; or
- sealed with a tamper-proof seal.

A written record of sample bottle possession and transfer is maintained and documented on the COC form.

The COC form is signed with the date and time for the following activities:

- Initially, when the cooler is opened for inspection, the COC is signed and the condition is noted.
- Whenever the cooler is transferred to a new sample custodian if the tamper-proof seal has been compromised.
- When the cooler is finally sealed for transport to the laboratory. If samples collected from one sample point are placed in more than one cooler, a COC is placed in each cooler.

Additional information on the COC includes the sample point ID, sample date, and sample start time. Any problems with cooler or its contents are also noted on the form. Upon receipt of the cooler at the laboratory, the date and time the seal is broken, the condition of the samples, and the temperature, are recorded on the COC form.

7.2 FIELD INFORMATION FORM

The FIF contains information regarding site conditions, sampling procedures used, and field measurements. The FIF is filled out for each sample point and is enclosed along with the COC in the cooler. FIFs are filled out for each sample point, unless no sample is collected. Information to be documented is as follows:

Sample Point - which is contained on the COC is also recorded on the FIF.

Sampling Information - Includes the types of equipment used for sample collection.

Field Measurements - For surface water sampling events, temperature, and dissolved oxygen are determined, as required. Additional parameters, (e.g. color, odor, turbidity, etc.) may also be required.

Field Comments - The section on field comments may include the following field observations:

- Condition of the sample point and dedicated equipment;
- Weather conditions (e.g. wind speed and direction, precipitation, temperature, upwind activities, etc.);
- Sample appearance - odor, color, etc.;
- Location where field blank or duplicate is prepared;
- Duplicate field measurement results;
- Any other uncommon sampling conditions, such as sample splits with regulatory agencies, potential safety or health hazards (i.e. presence of flying, stinging insects, etc.).

Sampling Certification - On the bottom of the FIF, the sampler must certify that the sampling procedures used were in accordance with applicable USEPA, State, and Corporate Protocols.

NOTE: AES does not provide an FIF with their sample bottles. For samples sent to AES, pertinent information regarding the sampling event is documented in a field notebook.

8.0 LABORATORY HANDLING AND ANALYTICAL PROTOCOLS

The following information provides a brief description of how samples are analyzed.

8.1 LABORATORY PROCESSING PROCEDURES

The laboratory receives, logs-in samples, and maintains the COC procedures until the analyses are completed and reported, as described in Section 6.9.

8.2 LABORATORY METHODOLOGIES

For the routine surface water monitoring at the site, samples are analyzed according to Table A for NYSDEC SPDES requirements. The SPDES requirements presented in this SWSAP can only be altered by obtaining a modification of both the Facility's SPDES and Operating Permits, as appropriate.

For the analysis of samples outside the routine monitoring program, the methodology will be specified by the Environmental Monitoring Manager and will depend on the Data Quality Objectives.

8.3 QUALITY ASSURANCE

The analytical laboratory used for the analysis of surface water samples has NYSDOH ELAP certification and CWM approval. In addition, QA is provided by following the standard analytical methods referenced in

Table A. Technical Reports contain analytical results and methodologies, dates sampled and received, sample identification, COC, and FIFs.

8.4 QUALITY CONTROL

Quality control is provided in the field through the collection of duplicate samples, field blanks, trip blanks, and duplicate field measurements.

Duplicate - collected from any sample location (SMP) and analyzed for a complete set of parameters once every 10 samples, (see Section 6.6).

Field Blank - one collected and analyzed for every ten samples taken for VOC analysis only. (See Section 6.7).

Trip Blank - one analyzed for every "batch" of samples sent to the analytical laboratory for VOC analysis only. (See Section 6.7).

Numerous laboratory and field quality control checks are performed. The following list includes the various checks used and the frequency at which the checks are performed.

BLANKS

- Method Blank or Laboratory Blank - Daily
- Reagent Blank - Daily
- Trip Blank - Determined by field staff (daily with VOC analysis)
- Field Blank - Determined by field staff, once every 10 samples.

DUPLICATES

- Field Duplicate - Determined by field staff, once every 10 samples.
- Laboratory Duplicate - once every 20 samples or daily, whichever is more frequent
- Matrix Spike Duplicate - once every 20 samples or daily, whichever is more frequent

SPIKES

- Spiked Blank - once every 20 samples or daily, whichever is more frequent
- Surrogate Spike - every sample and QC sample, (organic analyses only)
- Matrix Spike - once every 20 samples or daily, whichever is more frequent

INDEPENDENT QC CHECKS

- Laboratory Control Standards - daily
- Blind QC - each analyte at least quarterly
- Check Sample - as requested by Quality Programs Coordinator
- Internal Standard - as method requires

- Standards - daily
- Control Standards - as method requires
- Method of Standard Additions - every sample that demonstrates matrix interference

9.0 DATA EVALUATION

Typically, all analytical results are reviewed within five days of receipt from the analytical laboratory.

Data from SMP06, SMP07, and SMP09 are compared with the discharge limitations established in the Facility's SPDES Permit. Any exceedences are noted in the monthly Discharge Monitoring Report (DMR) including an explanation of the potential cause(s).

Since the control gates are routinely closed and visually inspected and tested prior to release, it is unlikely that any potentially contaminated surface water would be released from the Facility. If such an unlikely situation were to occur, then a follow-up investigation would be performed to determine the source and extent of contamination. This investigation would be based upon current SPDES Permit requirements and guidance received from NYSDEC.

10.0 REPORTING

SPDES Discharge Monitoring Reports (DMRs) are due to NYSDEC by the 28th of each month. DMR submittal requirements are specified in the Facility's SPDES Permit. If additional monitoring (i.e., an additional constituent or sampling event beyond that required under the Facility's SPDES Permit) is conducted, the results will be submitted as an appendix to the required DMR.

10.1 RECORDS

Records of all surface water monitoring activities, including Technical Reports, QA/QC Reports, COCs, and FIFs are maintained at the Model City Facility. The analytical labs also maintain a computer data base system which is backed-up daily for permanent storage.

ATTACHMENT N

No Modifications Proposed

ATTACHMENT O

Major/Minor Modifications

ATTACHMENT O - MAJOR/MINOR MODIFICATIONS

All Permit modifications shall be listed in the following Permit Modification Log.

The name of the specific document being modified (sections, and/or attachments)	**Modified page numbers**		**Date of Revised pages**	**The effective date of permit modification**	**The nature of the modifications**
	Old	**New**			
Schedule I of Module I,	S-1 to S-16	S-1 to S-16	12/18/13		**MAJOR PERMIT MODIFICATION:** Development of Residuals Management Unit No. 2, including construction of Fac Pond 5, new Tank T-9001, new Full Trailer Parking Area, New Stab Trailer Parking Area, new Drum Management Building, new Loading/Unloading ramps at T-109 and T-158
Schedule I of Module I, Exhibit A (General Provisions)	A-5, A-7, A-9	A-5, A-7, A-9	12/18/13		
Schedule I of Module I, Exhibit C (Containers)	C-1 to C-10	C-1 to C-13	12/18/13		
Schedule I of Module I, Exhibit D (tanks)	D-4, D-6 to D-15	D-4, D-6 to D-15	12/18/13		
Schedule I of Module I, Exhibit E (surface impoundments)	E-1 to E-3	E-1 to E-6	12/18/13		
Schedule I of Module I, Exhibit F (landfills)	F-56 to F-71	F-56 to F-72	12/18/13		
Attachment A	Page 4 of 4 Page 1 of 6 Page 3 of 6 Page 5H of 6 Fig A-2 Photo 1	Page 4 of 4 Page 1 of 6 Page 3 of 6 Page 5H of 6 Fig A-2 Photo 1 Photos 16 to 25	11/08/13		
Attachment D, Appendix D-1 (text)	TOC Page iv	TOC iv, v,	12/18/13		

The name of the specific document being modified (sections, and/or attachments)	Modified page numbers		Date of Revised pages	The effective date of permit modification	The nature of the modifications
	Old	New			
		Pages 36-47			
Attachment D, Appendix D-1 (permit drawings)		Dwg C-2, Dwg C-5, Dwg E-8, Dwg FP-1, Dwg FP-2, Dwg S-0, Dwg S-1, Dwg S-2, Dwg S-3, Dwg S-4, Dwg S-5	10/22/13 6/11/13 1/19/12 6/20/12 6/20/12 6/20/12 6/20/12 6/2012 6/20/12 8/13/13 8/13/13		
Attachment D, Appendix D-1, Figures & Calcs.		Figs-D1B	1/22/13 & 6/22/12		
		D3A D4A, D12A,D14A & Calc pages	7/2013 & 8/2013		
Attachment D, Appendix D-2	Toc Page i, Pages 1-4	Toc Page i, Pages 1-7,	11/08/13		
Attachment D, Appendix D-2 (permit drawings)	N/A	Dwgs 1-14	11/05/13		
	N/A	Fac Pond RAP	11/08/13		

The name of the specific document being modified (sections, and/or attachments)	Modified page numbers		Date of Revised pages	The effective date of permit modification	The nature of the modifications
	Old	New			
Attachment D, Appendix D-3 (text)	Toc Page i, Pages 11,12, 19-22	Toc Page i, Pages 11,12, 19-23	11/08/13		
Attachment D, Appendix D-3, Section VIII	Sec VIII	Sec VIII	11/08/13		
Attachment D, Appendix D-3, Figures & Calcs.	N/A	Fig D-36 & Calc pages	10/28/13		
Attachment F (Inspection Forms)	7, 18, 20	7, 12a, 14a, 14b, 14c, 14d 18, 20	12/18/13		
Attachment G (Contingency Plan)	Entire Text	Entire Text	12/18/13		
	Org Chart	Org Chart	12/18/13		
Attachment I, Section I.1 (Site-Wide Closure Plan)	Cover Toc ii,iii 4-8,11, 17-36	Cover Toc ii,iii 4-8,11, 17-38	11/08/13		Revise Sitewide Closure Plan
Attachment I, Section I-1	N/A	Add New	02/2013		Add RMU-2 Closure Plan for proposed RMU-

The name of the specific document being modified (sections, and/or attachments)	Modified page numbers		Date of Revised pages	The effective date of permit modification	The nature of the modifications
	Old	New			
(RMU-2 Closure Plan)					2 to Section I-1 and revise Sitewide Closure Plan for proposed development associate with RMU-2.
Attachment I, Section I-2 (RMU-2 Post Closure Plan)	N/A	Add New	2/2013		Add RMU-2 Post-Closure Plan for proposed RMU-2 to Section I-2.
Attachment J, Appendix D-6 (RMU-2 Permit Drawings)	N/A	Add New Dwg Nos. 1 2 3 to 7 8 9 to 25 26, 27 28 to 36	 2/27/13 11/5/13 2/27/13 6/3/13 2/27/13 8/15/13 2/27/13		New RMU-2 Permit Drawings, Technical Specifications, and Construction Quality Assurance Manual for proposed RMU-2 added to Appendix D-6, D-7, and D-8, respectively, of Attachment J
Attachment J, Appendix D-7 (RMU-2 Technical Specifications)	N/A	Add New	03/2011		
Attachment J, Appendix D-8 (RMU-2 Quality Assurance Manual)	N/A	Add New	03/2011		
Attachment K, Appendix D-9 (RMU-2 Response Action Plan)	N/A	Add New	8/28/13		New RMU-2 Response Action Plan for proposed RMU-2 added to Appendix D-9 of Attachment K

The name of the specific document being modified (sections, and/or attachments)	**Modified page numbers**		**Date of Revised pages**	**The effective date of permit modification**	**The nature of the modifications**
	Old	**New**			
Attachment M (Surface Water SAP)	Cover, TofC Pages i-iii Pares, 2,4 – 19	Cover, TofC Pages i-iii Pares, 2,4 – 20	8/28/13		

The name of the specific document being modified (sections, and/or attachments)	Modified page numbers		Date of Revised pages	The effective date of permit modification	The nature of the modifications
	Old	New			
Incorporated Documents:					**MAJOR PERMIT MODIFICATION: (continued)**
Department-Approved "Site-Wide and RMU-1 Closure Cost Estimates"	N/A	Add New			Development of Residuals Management Unit No. 2
2.01 New Drum Management Building			8/28/13		
4.01 Stabilization Area (Revised)			8/28/13		
5.32 AWTS (Fac Pond 5 w/1 tk)			8/28/13		
6.01 Fac Ponds (3&1-2			11/08/13		
6.02 Fac Ponds (3&1-2 & New Fac 5)			11/08/13		
6.03 Fac Ponds (1-2 & New Fac 5)			11/08/13		
8.01 CSA New Full Trail Parking (5 tankers)			8/28/13		
P&IDs	Sht 3,9a	Sht 3,9a	5/23/13		
AWTS O&M Manual	Fig 1.1	Fig 1.1a, 1.1b	11/08/13		

The name of the specific document being modified (sections, and/or attachments)	Modified page numbers		Date of Revised pages	The effective date of permit modification	The nature of the modifications
	Old	New			
GWSAP	Entire Doc	Entire Doc	8/28/13		
New Reference Documents					
RMU-2 Closure Cost Estimate	N/A	Add New	8/28/13		
15.01 RMU - 2 (1 cell)					
15.02 RMU - 2 (2 cells)					
15.03 RMU - 2 (3 cells)					
15.04 RMU - 2 (4 cells)					
15.05 RMU - 2 (5 cells)					
15.06 RMU - 2 (6 cells)					
RMU-2 Post-Closure Cost Estimate	N/A	Add New	8/28/13		
PCC-9.01 RMU - 2 (1 cell)					
PCC-9.02 RMU - 2 (2 cells)					
PCC-9.03 RMU - 2 (3 cells)					
PCC-9.04 RMU - 2 (4 cells)					
PCC-9.05 RMU - 2 (5 cells)					
PCC-9.06 RMU - 2 (6 cells)					
RMU-2 Engineering Report	N/A	Add New	11/08/13		
RMU-2 SEMP including CA Plan	N/A	Add New	11/08/13		
RMU-1 to RMU-2 Transition Plan	N/A	Add New	4/29/13		