APPENDIX D-7 RMU-1 TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS
FOR
MODEL CITY FACILITY
RESIDUALS MANAGEMENT UNIT 1
MODEL CITY, NEW YORK

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Modified: 07/09

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

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DIVISION 1

GENERAL REQUIREMENTS

SECTION 01000 GENERAL PROVISIONS

PART 1

GENERAL

1.01 PROJECT DESCRIPTION

A. Work included in construction of Residual Management Unit 1 for CWM Chemical Services, Inc. (hereinafter referred to as OWNER), entails construction of liner, lift station, and installation of piping and electrical work for leachate collection system and appurtenances. Landfill is located in Model City, Niagara County, New York.

1.02 IDENTIFICATION OF DRAWINGS

A. Work included in this Contract is shown on Residual Management Unit 1 drawings; Nos. 1 through 34.

1.03 FORM OF SPECIFICATIONS

- A. These Specifications are written in imperative and abbreviated form. This imperative language of technical sections is directed at 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 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) indicated 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 OWNER.
- D. Term "provide" or "provided" shall mean "furnished and installed by CONTRACTOR".
- E. Alternate testing methods to those listed in the specifications may be substituted upon approval of the ENGINEER.

1.04 CONTRACTS

A. Perform Work of Contract under a single lump sum Contract with OWNER.

1.05 WORK BY OTHERS

- A. Work at site which will be executed and may be concurrent to this Contract as follows.
 - 1. Construction of leachate transfer system.
 - 2. Paving of entrance and scale areas.

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- 3. Construction and installation of clay liners, geosynthetics, and leachate collection layers.
- 4. Installation of monitoring wells and removal of old wells.
- 5. Construction of a water main.
- B. Work stated above limits site access and storage areas available to CONTRACTOR and will be discussed at preconstruction meeting.

1.06 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. Stage Work to accommodate monitoring well removal.

1.07 CONTRACTOR'S USE OF PREMISES

- A. Limit use of premises for Work and storage to allow for:
 - 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 least inconvenience to site operations and vehicle access.

1.08 OWNER OCCUPANCY

- A. Schedule operations for completion of portions of Work, in accordance with construction schedule, for OWNER'S occupancy prior to substantial completion of entire Work.
- B. OWNER will occupy premises for purpose of:
 - 1. Disposal operations.

1.09 OWNER-FURNISHED PRODUCTS

A. OWNER may or will obtain specific products, for purpose of expediting delivery, and other purposes in OWNER'S interest. These items, if any, will be discussed at preconstruction meeting.

- 1.10 FUTURE WORK
 - A. Landfill will be filled with waste and daily cover as designated by OWNER.
 - B. Final cover will be placed over waste when filling is complete.
- 1.11 STANDARD SPECIFICATIONS
 - A. References are made herein to "Standard Specifications for Construction and Materials," published by State of New York Department of Transportation, latest edition.
 - B. Performance criteria for Work shall be in accordance with the site specific RMU-1 Quality Assurance Manual.

* * * END OF SECTION * * *

SECTION 01200 PROJECT MEETINGS

PART 1 GENERAL

1.01 REQUIREMENTS INCLUDED

- A. CONTRACTOR shall schedule and administer preconstruction meeting, prework meeting, periodic progress meetings, and specially called meetings throughout progress of Work.
 - 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. Record minutes; include significant proceedings and decisions.
 - 6. Reproduce and distribute copies of minutes within 3 days after each meeting.
 - a. To participants in 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 DESIGNER.
- 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 OWNER issues Notice to Proceed, CONTRACTOR shall meet with OWNER for preconstruction conference.
- B. Purpose of Conference:
 - 1. Status of Contract.
 - 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 questions regarding Contract and Work site.

1.03 PREWORK CONFERENCE

A. As soon after Notice to Proceed as practicable, and prior to starting on-site Work, prework conference will be held between CONTRACTOR, Quality Assurance Consultant(s) and OWNER or his representative.

B. Attendance:

- CONTRACTOR'S superintendent.
- Quality control supervisor.
- 3. Safety personnel.
- Major subcontractors' job superintendents.
- 5. Quality Assurance Consultant.

C. Purpose of Conference:

- Further define quality control system.
- Review QC plan.
- 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 preconstruction conference or other aspect of Project shall be addressed.

1.04 PROGRESS MEETINGS

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

B. Attendance:

- OWNER or OWNER'S representative.
- CONTRACTOR'S superintendent.
- Subcontractors as appropriate to agenda.
- Quality Assurance Consultant.
- DESIGNER (as needed).

C. General Meeting Requirements:

- Administer following general requirements for progress meetings.
 - a. Prepare agenda for meetings.
 - Make physical arrangements for meetings.

- Preside at meetings.
- d. Record significant proceedings and decisions of meeting.
- e. Reproduce and distribute copies of meeting record within 3 days after each meeting to participants in meeting and to parties affected by decisions made at meeting. Furnish 1 copy to OWNER, 2 copies to OWNER'S site representative, and 2 copies to Quality Assurance Consultant.

D. Suggested Agenda:

- 1. Review and approval of record of previous meeting.
- 2. Review of Work progress since previous meeting.
- 3. Field observations, problems, and conflicts.
- 4. Problems which impede Work schedule.
- 5. Review of off-site delivery schedules.
- 6. Corrective measures and procedures to regain projected schedule.
- 7. Revisions to Project schedule.
- 8. Planned progress during Work period.
- 9. Coordination of schedules.
- 10. Review submittal schedules; expedite as required.
- ll. Maintenance of quality and safety standards.
- 12. Pending changes and substitutions.
- 13. Review proposed changes for effect on construction schedule and completion date, and on other contracts of projects.
- 14. Other business.

* * * END OF SECTION * * *

SECTION 01340 SUBMITTALS

PART 1 GENERAL

1.01 DESCRIPTION OF REQUIREMENTS

- A. This section specifies procedural requirements for Work-related (nonadministrative) submittals including Shop Drawings, 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. Substitutes or "Or Equal" Items:
 - a. Includes material or equipment CONTRACTOR requests DESIGNER to accept, after Bids are received, as substitute for items specified or described in Specifications by using name of proprietary item or name of particular supplier.

2. Shop Drawings:

- a. Includes technical data and drawings specially prepared for Project, including fabrication and installation drawings, diagrams, actual performance curves, data sheets, schedules, templates, patterns, reports, instructions, design mix formulas, measurements, and similar information not in standard printed form.
- b. Standard information prepared without specific reference to Project is not considered Shop Drawing.

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 manner specified for transmittal of sample submittals.

5. Miscellaneous Submittals:

a. Work-related submittals that do not fit in 4 previous categories includes 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. Scheduling:

- 1. Provide submittal schedule for items of material and equipment for which submittals 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.
- 3. Prepare and transmit each submittal sufficiently in advance of scheduled performance of related Work and other applicable activities.

B. Coordination:

- 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.
- Coordinate submission of different units of interrelated Work so one submittal not delayed by DESIGNER'S need to review related submittal. DESIGNER may withhold action on any submittal requiring coordination with other submittals until related submittals are forthcoming.

C. 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 and dates of previous submittals.
 - 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 identify 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.

D. Resubmittal Preparation:

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

- d. CONTRACTOR-initiated revisions or variations.
 - On transmittal form, identify variations or revisions from previously reviewed submittal, other than those called for by DESIGNER.

1.03 SPECIFIC SUBMITTAL REQUIREMENTS

A. General:

- 1. Specific submittal requirements for individual units of Work are specified in applicable Specification section. Except as otherwise indicated in Specification sections, comply with requirements specified herein for each indicated type of submittal.
- B. Requests for Substitutes or "Or Equal":
 - Collect data for items to be submitted for review as substitutes into one submittal for each item of material or equipment.
 - 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.

C. Shop Drawings:

- Submit newly prepared information, 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; I reverse sepia reproducible and I blue line or black line print when required in Specification section; reproducible will be returned.

D. 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. Submittal final when DESIGNER returns submittal marked "Approved."
- 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.

E. 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 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 of samples may be preliminary or final submittal.

- b. Preliminary submittal, of single set of samples, required where requirements indicate DESIGNER'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 DESIGNER'S "Action" marking.
- c. Final Submittals: Submit 3 sets of samples in final submittal, 1 set will be returned.

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.

F. 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.

G. 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 Agreements, and Workmanship Bonds:
 - a. Refer to Specification sections for specific requirements. Submittal final only when submittal returned by OWNER, marked "Approved" or "Approved as Noted."
 - 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

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Work, damage surveys, photographs, and similar data required by Specification sections. Copies will not be returned.

- Survey Copies: Furnish 2 copies. Provide 10 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 and Section 01730 for specific requirements on submittal of closeout information, materials, tools, and similar items.
 - 1) Materials and Tools: Spare parts, extra and overrun stock, maintenance tools and devices, keys, and similar physical units to be submitted.
 - 2) Operating and maintenance data.

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

- 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-in., 3-ring vinyl covered binder, and include pocket folders for folded sheet information. Mark identification on front and spine of each binder.

I. General Distribution:

- 1. Unless required elsewhere, provide distribution of submittals to Subcontractors, suppliers, governing authorities, and others as necessary for proper performance of Work.
- 2. Provide copies of submittals bearing OWNER'S action stamp to:
 - a. Job site file.
 - b. Record documents file.

1.04 ACTION ON SUBMITTALS

A. DESIGNER'S Action:

1. General:

- a. Except for submittals for record and similar purposes, where action and return on submittals is required or requested, DESIGNER will review each submittal, mark with appropriate action, and return. Where submittal must be held for coordination, DESIGNER will so advise CONTRACTOR without delay.
- b. DESIGNER will stamp each submittal with uniform, selfexplanatory 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 OWNER'S notations or corrections on submittal and Contract Documents. Acceptance of Work depends on that compliance. Resubmittal not required unless required by OWNER on returned submittal.
- 3. Marking: Not Approved.
 - 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 Resubmittal: When submittals are marked as "Revise and Resubmit," do not proceed with Work covered by submittal. Do not permit Work covered by submittals to be used at Project site or elsewhere where Work is in progress.

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b. Revise submittal or prepare new submittal in accordance with DESIGNER'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 02400 - Smooth Geomembranes.
B.	Section 02401 - Textured Geomembranes.
C.	Section 02410 - Geotextiles.
D.	Section 02413 - Geosynthetic Clay Liner (GCL).
E.	Section 02413-FC - Final Cover Geosynthetic Clay Liner (GCL).
F.	Section 02420 - Geonets.
G.	Section 02430 - Geotextile/Geonet Composite.
1.03	DEFINITIONS
A .	OWNER: Individual or firm owning or operating CWM Chemical Services, LLC (CWM) Model City 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): DESIGNER (working for Geosynthetic QAC) in charge of quality assurance work.
E.	Additional terms defined in Quality Assurance Manual.
1.04	FORM OF SPECIFICATIONS
A.	Specifications written in Construction Specifications Institute (CSI) 3-part format (General, Products, and Execution).
В.	Specifications written in imperative and abbreviated form. Imperative language of technical sections directed at Geosynthetic Installer, unless specifically noted otherwise. Incomplete sentences

Revised: September 2007 Modified: 07/09 in Specifications shall be completed by inserting "shall", "Geosynthetic Installer shall", "shall be", and similar mandatory phrases by inference in same manner as applied to notes on Drawings. Except as worded to contrary, Geosynthetic Installer shall fulfill (perform) indicated requirements whether stated imperatively or otherwise.

1.05 RESPONSIBILITIES

- A. Procurement of geosynthetic products.
- B. Transportation of geosynthetic materials to site, if specified in Contract Documents.
- C. Field handling, deploying, seaming, temporary restraining and all other aspects of geosynthetic installation.

1.06 QUALIFICATIONS

- A. Pre-qualified by OWNER.
- 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 minimum, 2 installation projects entailing installation of at least total of 1,000,000 sq ft (100,000 sq m) of polyethylene geomembrane unless otherwise approved in writing by OWNER.

2. Master Seamer:

- a. Experience seaming minimum of 1,000,000 sq ft (100,000 sq m) 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 02400, Article 3.04.).

1.07 QUALITY ASSURANCE PROGRAM

A. Agree to participate in and conform with items and requirements of OWNER'S quality assurance program as described in site specific Quality Assurance Manual.

B. Attend pre-construction meeting.

1.08 FIELD MEASUREMENTS

A. Units:

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

1.09 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 retains ownership and responsibility for geosynthetic lining system until accepted by OWNER. At OWNER'S discretion, geosynthetic lining system may be accepted in sections or at points of substantial completion.
- B. OWNER will accept geosynthetic lining system when following complete:
 - 1. Installation of lining system, or section thereof.
 - Documentation of installation.
 - Verification of adequacy of field seams and repairs including associated testing.
 - 4. Recommended acceptance by action of Geosynthetic QAC.

* * * 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 on completion of Work.

1.02 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. National Fire Protection Association (NFPA):
 - National Electric Code (NEC), (NFPA No. 70), and New York amendments.
 - Comply with federal, state, and local codes and regulations, and utility company requirements.

PART 2 PRODUCTS

2.01 TEMPORARY ELECTRICITY AND LIGHTING

A. General:

- 1. Provide temporary electric service as specified herein.
- 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 state code requirements.
- 3. After Substantial Completion of permanent electrical system and building wiring, permanent receptacles may be used during finishing Work.
- 4. Use ground fault interrupt breaking during construction.

B. Responsibilities:

- 1. Provide, maintain, and remove temporary electric service facilities.
- Facilities exposed to weather shall be weatherproof and electrical equipment enclosure locked to prevent access by unauthorized personnel.
- Pay for installation of temporary services including poles, transformer charges, and metering.
- 4. Patch affected surfaces and structures after temporary services removed.

- 5. Arrange with local electric utility for temporary electric service subject to their requirements and approval.
- 6. Register meter in CONTRACTOR'S name, if required.
- 7. Provide lamps, wiring, switches, sockets, and similar equipment required for temporary lighting and small power tools.
- 8. Pay for electrical energy consumed for construction purposes including operation of ventilating equipment, for heating of buildings, and also for testing and operating of equipment after permanent wiring has been installed, until final acceptance by DESIGNER or until occupancy by OWNER.
- 9. Provide and pay for temporary service for lighting of temporary offices. Remove temporary service at completion of Project.

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 retentions.
- 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 new buildings 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 not permitted.
- 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.
- 2. Provide adequate heat to all parts of building.
- 3. Pay for repairing or replacing any part of building or materials that become damaged because of lack of heat.
- 4. Provide temporary throwaway filters if, at any time, permanent system is used for temporary ventilation.
- 5. 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 to construction office. Locate telephone in job construction office for CONTRACTOR'S use for local and long distane calls.

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

2.04 WATER FOR CONSTRUCTION

A. Water 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 and as required by Contract Documents and local, state, and federal agencies, minimum of one fire extinguisher on each floor of each building, and such other fire protective equipment and devices as would be reasonably effective in extinguishing fires during early stages by personnel at Project site; as approved by site Health and Safety Manager.

2.08 TEMPORARY SITE WORK

- A. Provide and maintain temporary roadways necessary to carry out construction operations in clean, dust free, snow free, ice free, drivable condition.
- B. Provide and maintain temporary site drainage.
- C. Exercise caution to minimize increase in suspended solids and turbidity in surface waters within and adjacent to construction area. Do not deposit spoils in surface waters. Control and minimize sediment runoff and excavation erosion to surface waters.

2.09 DAMAGE TO EXISTING PROPERTY

A. Be responsible for replacing or repairing 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 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 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 wood snow fence with steel stakes at 8-ft centers.
 - Install around Work, parking, laydown, and construction village areas.

2.13 FIELD OFFICES AND BUILDINGS

- A. Erect where directed by OWNER, and maintain in good condition, temporary field office and tool storage building(s) for CONTRACTOR'S use.
 - 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 directed by OWNER.
 - Size to contain 110% of liquid volume being handled, plus 6-in. rainfall.
 - 2. Maintain 1-ft freeboard at design conditions.
 - 3. Containment required at areas where CONTRACTOR handles volatile or hazardous chemicals and agents.
 - 4. Remove upon completion of Work.
 - 5. Clean up and dispose of spillage.

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:
 - 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.
 - Two or more items of same kind shall be identical, by same manufacturer.
 - 4. Material and equipment shall be suitable for service conditions.
 - 5. Equipment capabilities, sizes, and 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 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:
 - 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 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 result of CONTRACTOR'S failure to pursue Work promptly or coordinate various activities properly.

c. Where required equipment or material cannot be provided in 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 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 required, select from among products which comply with requirements of those standards, codes, and regulations.
- one or more equipment manufacturer and "or equipment," 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 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:

- Requirements for substitutions do not apply to CONTRACTOR options on materials and equipment provided for in Specifications.
- Revisions to Contract Documents, where requested by OWNER or DESIGNER, 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 comply with manufacturer's instructions. Obtain and distribute printed copies of such instructions to parties involved in installation, including 2 copies to OWNER.
 - Maintain one set of complete instructions at job site during installation and until completion of Work.

1

- B. Handle, install, connect, clean, condition, and adjust materials and equipment in accordance with manufacturer's written instructions and in conformity with Specifications.
 - Should job conditions or specified requirements conflict with manufacturer's instructions, consult OWNER for further instructions.
 - 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 to avoid conflict with Work and conditions at site.
 - 1. Deliver materials and equipment in undamaged condition, in manufacturer's original containers or packaging, with identifying labels intact and legible.
 - 2. Protect bright machined surfaces, such as shafts and valve faces, with heavy coat of grease prior to shipment.
 - 3. Immediately upon delivery, inspect shipments to ensure compliance with Contract Documents and approved submittals, and 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 or 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.
- Store materials and equipment subject to damage by elements in weathertight enclosures.
- 3. Maintain temperature and humidity within ranges required by manufacturer's instructions.

D. Exterior Storage:

 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.

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

E. Inspection and Maintenance:

- Arrange stòrage in manner providing easy access for inspection, maintenance, and inventory.
- 2. Make periodic inspections of stored materials and equipment to ensure materials and equipment 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 OWNER.
 - a. Notify OWNER 24 hrs 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 DESIGNER of intent to perform maintenance or to submit maintenance report may result in rejection of material or equipment.
- F. Assume responsibility 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, 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 also finished surface, avoid marking or damaging surface.

1.06 INSTALLATION, INSTRUCTIONAL, AND POST STARTUP SERVICES

A. General:

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

B. Installation Services:

- Where installation services called for in 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 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 ready for startup and operation. Use form attached to this Section and furnish 2 copies to OWNER.

C. Instructional Services:

- 1. Where training called for in 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 prestartup and equipment startup, classroom, and on-site equipment instruction, as stated in Specifications.
- 2. Coordinate prestartup 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 hrs 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 prestartup training 14 days prior to actual plant 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," cosigned 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 operating in conformance with design, manufacturer, and Specifications.
- 2. Provide "Certificate of Post Startup Services," cosigned by OWNER and equipment representative, verifying this service has been performed. Use form attached to this Section and furnish 2 copies to DESIGNER.

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 not customarily and routinely carried by maintenance mechanics.
- B. Deliver to OWNER when unit placed into operation and after operating personnel have been properly instructed in operation, repair, and maintenance of equipment.
- C. Tools and lubricating equipment shall be of quality compatible to equipment manufacturer has furnished.

1.08 LUBRICATION

- A. Where lubrication 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 used, reservoir shall be of sufficient capacity to supply unit for 24-hr 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	
ment and that it has been properly	r/manufacturer has inspected this equip- installed, adjusted, and calibrated. I w be operated for test purposes and/or
MANUFACTURER'S REPRESENTATIVE	
Signature	Date
Name (print)	
Title	
Representing	
CONTRACTOR	
Signature	Date
Name (print)	
Title	

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

CERTIFICATE OF INSTRUCTIONAL SERVICES (REFERENCE SECTION 01600)

Project	
I hereby certify that OWNER'S personnel in the as required in the speci	the equipment supplier/manufacturer has instructed startup operation and maintenance of this equipment fications.
CONTRACTOR	
Signature	Date
OWNER	
equipment.	operating personnel received days instruction for startup, operation, and maintenance of this
WARRANTY PERIOD COMME	INCES ON
	(Date)
Signature	Date
Name (print)	
Title	
	·
COMMENTS:	

CERTIFICATE OF POST STARTUP SERVICES (REFERENCE SECTION 01600)

Project	
Equipment	
Specification Section	
Contract	
I hereby certify that the equipment supplier/manuf equipment, made adjustments and calibrations, and conformance with the design, specification, and ma Notation of improper operation shall be detailed an attached to this form.	that it is operating in nufacturer's requirements.
MANUFACTURER'S REPRESENTATIVE	
Signature	Date
Name (print)	
Title	
Representing	
CONTRACTOR	
Signature	Date
Name (print)	
Title	
OWNER	
I hereby certify that the equipment supplier/manufa equipment and made adjustments and calibrations.	acturer has inspected this
Signature	Date
Name (print)	
Title	
COMMENTS	
This form shall be submitted to OWNER upon completi	on of 1-year reinspection

* * * END OF SECTION * * *

as required by the specifications.

SECTION 01669 TESTING HDPE PIPING SYSTEMS

PART 1 GENERAL

1.01 PROJECT/SITE CONDITIONS

- A. Pipe lines shall be pressure tested in presence of Quality Assurance Consultant (QAC).
- B. Furnish water 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 other temporary sectionalizing devices that may be required.
- D. Remove temporary sectionalizing device after tests complete.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.01 GENERAL

- A. Testing:
 - Perform low air pressure testing prior to installation for welded HDPE pipe sections.
 - Perform hydraulic testing on force main sections after installation.
 - B. Commence test procedures when following conditions met.
 - Pipe section to be tested is clean and free of dirt, sand or other foreign material.
 - a. CONTRACTOR responsible for collection, containment, and disposal of flushing water and debris.
 - Plug pipe outlets with test plugs. Brace each plug securely to prevent blowouts.
 - Add water or air slowly.
 - 4. Pressurizing equipment shall include regulator set to avoid over-pressurizing and damaging otherwise acceptable line.

- C. Pressure test in accordance with OSHA requirements.
- Cost of testing procedure including water, personnel, equipment, and materials shall be CONTRACTOR'S D.
- E. Correct and retest leaks or defects.

3.02 LOW PRESSURE AIR TEST

A. General:

Perform air testing on all HDPE gravity, force main, and carrier piping after piping butt fused together. 1. Testing may be performed before placement in trench, or after placement in trench but before backfilling.

B. Preparation:

- Isolate pipe section to be tested by plugging each end with air tight plugs. Plug ends of branches, 1. laterals, and wyes which are to be included in test section.
- Brace plugs to prevent slippage and blowout due to internal pressure. 2.
- One plug shall have inlet tap or other provision for connecting supply air hose. 3. 4.
- Connect one end of air hose to plug used for air inlet; other end to portable air control equipment.
- Air control equipment shall consist of valves and pressure gauges to control rate at which air flow into 5. test section and gauges to monitor air pressure inside pipe. 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 hr.
- 3. After 1 hr, pressurize test section to 10 to 12 psig.
- 4. Record pressure at 10-min intervals for 1 hr. Test section is acceptable for installation if less than 1.0 psig after temperature corrections pressure drop is recorded over entire hr.

HYDROSTATIC PRESSURE TEST OF FORCE MAIN 3.03

- Line to be tested will be filled completely with fresh water or Department approved alternate, have all air bled A. off from its highest point, pressurized and be allowed to stabilize for one (1) hour. During this stabilization period, sufficient liquid shall be added to maintain the test pressure.
- Line shall be pressurized to not less than 1.5 times the system operating pressure or a minimum of 10 psi using B. a force pump of such design and capacity that the required pressure can be applied
- At one (1) hour intervals, the pressure will be checked and recorded. If the pressure drops below the test C. pressure, the line shall be re-pressurized and the test restarted.
- Maintain the test pressure for a minimum of two (2) hours, checking and recording the pressure for each hourly D. interval. The test shall be considered complete after the second (2nd) hourly interval. The test shall be considered successful if there is not visual evidence of leakage and there is no pressure loss during the second

3.04 WORKING PRESSURE AIR TEST

Raise pressure at steady rate to required pressure.

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- B. Measure pressure at both ends of test section to ensure continuity. Acceptable alternative is to measure pressure at one end and release pressure at other end.
- C. Pressurize pipe to 1.5 times maximum working pressure for 3 to 4 hrs. Equalize pressure to initial pressure on hourly basis.
- D. Reduce pressure after equalization by 10 psig and monitor for 4-hr period.
- E. Test shall be acceptable if air pressure maintained within 5% of starting pressure.
- F. If test section fails, locate and repair leaks, and retest.
- 3.05 TEST REPORT
 - A. Prepare and submit test report for each piping system tested. Include following information in 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 retesting.

* * * 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.
 - 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 form for use by 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: 20-1b minimum, white, for typed pages.
- 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.
 - Provide tab index in Table of Contents.
- 6. Cover Label: Label each submittal cover with typed or printed title "OPERATION AND MAINTENANCE INSTRUCTIONS" and 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 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 following:
 - 1. Title: "OPERATION AND MAINTENANCE INSTRUCTIONS."
 - 2. Title of Project: "RESIDUALS MANAGEMENT UNIT 1."
 - 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.
 - 7. Subcontractor's name, address, and telephone number if equipment provided by Subcontractor.
 - 8. CONTRACTOR'S or Subcontractor's purchase order number, manufacturer's shop order number or any other such numbers required for parts and service ordering.
 - 9. Manufacturer's name, address, and telephone number.
 - 10. Name, address, and telephone number for local source of supply for parts and service.
- C. Product List: Immediately after title sheet containing:
 - 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 at minimum a tab index. Provide each tabbed section with table of contents for section, arranged in systematic order.
- E. Product Data Sheets: Provide specification and catalog sheets showing configuration, manufacturer's specifications, models, options, and styles of equipment and major components being provided. Annotate product data sheets to show project specific information and delete inapplicable information. Insert in tabbed section(s).

F. 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.

G. 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 not acceptable, unless they accurately illustrate actual installation.
- H. Specially written information, as required to supplement text for particular installation:
 - 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.
- I. 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.
- 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. 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:

- Routine maintenance operations.
- b. Guide to troubleshooting.
- c. Disassembly, repair, and reassembly instructions.
- d. Alignment, adjusting, and checking instructions.

4. Servicing and Lubrication Schedule:

- 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 to Section 01730. Example of completed form is Form 2 of Section 01730.
- 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 switchgear, motor control centers, panel-boards, 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 reassembly 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.
- Other data as required under pertinent sections of Specifications.
- C. Prepare and include additional data when need for such data becomes apparent during instruction of OWNER'S personnel as requested by OWNER.

1.06 SUBMITTAL SCHEDULE

A. Submit 4 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. DESIGNER'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. CONTRACTOR shall review O&M submittal and complete Form 3, 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 3. Pages for all submittals shall be numbered.
- D. OWNER will be sole judge of completeness of data.
- E. Payments:
 - Amount 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.
 - 2. Amount will be equal to 5% of value of equipment item as shown on Schedule of Values. Amount will be retained from first application made after time established above for submitting operations and maintenance data.
 - 3. Upon receipt of acceptable O&M data, payment of amount retained will be made in next Progress Payment.
- 1.07 INSTRUCTION OF OWNER'S PERSONNEL
 - A. Comply with requirements of Section 01600.

* * * END OF SECTION * * *

EQUIPMENT DATA FORM

PROJECT NAME	
CONTRACT NO.	
CONTRACTOR	
EQUIPMENT NO.	ASSET NO.*
DESCRIPTION	
LOCATION	
MANUFACTURER	
PURCHASED FROM	
VENDOR ORDER NO.	PURCHASE \$
DATE OF PURCHASE	
LOCAL SUPPLIER	
ADDRESS	
PHONE NO.	
MODEL NO.	
NO. OF UNITS SERIAL NOS	
NAMEPLAT	E DATA
ELECTRIC MOTOR	PUMP/HVAC UNIT
	
MANUFACTURER	MANUFACTURER
TYPE [] AC [] DC	TYPE
HORSEPOWER	SIZE
RPM	CAPACITY
VOLTAGE	PRESSURE
AMPERAGE	ROTATION
PHASE	IMPELLER
FRAME	SIZE
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	MATERIAL
DRIVE/REDUCER	OTHER (I & C)
DRIVE/REDUCER	OTHER (I & C)
	•
MANITER CHIEFD	MANTIE A CONTIDED
MANUFACTURER CHAIN	MANUFACTURER
TYPE GEAR V-BELT CHAIN	TYPE
VARIDRIVE	SIZE
SERVICE FACTOR	CAPACITY
RATIO	RANGE

*By Owner

EQUIPMENT DATA FORM Maintenance Summary

EQUIPMENT NO.	ASSET NO.*
DESCRIPTION	MAINT. NO.*
MAINTENANCE OPERATION;	FREQUENCY:
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.	List required frequency of each maintenance operation
9.	
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.	
RECOM	MENDED SPARE PARTS LIS	ST	
PART NO.** DESCRIPTION	UNIT	QUANTITY UNIT COST	
-			
ADDITIONAL DATA AND REMARKS			
*By Owner **Identify parts provided by Note: Attach additional sheets if no			

sheet at top with equipment number and description.

"EXAMPLE"

EQUIPMENT DATA FORM

PROJECT NAMEAnytown	
CONTRACT NO. A	
CONTRACTOR C.M. Jones, Inc.	
EQUIPMENT NO. P-8-5-1, P-8-5-2	ASSET NO.*
DESCRIPTION Sodium Hydroxide Feed Pump	MAINT. NO.*
LOCATION Chemical Feed Building	
MANUFACTURER Viking Pumps	
PURCHASED FROM Wilson Equipment Sales	
VENDOR ORDER NO. AB-7654-A	PURCHASE \$ 800.00
DATE OF PURCHASE February 30, 198-	0.00.00
LOCAL SUPPLIER Wilson Equipment Sales	
ADDRESS 7632 E. Main St., Goodplace, WI	99999
PHONE NO. 317-821-6734	
MODEL NO. CC3670	
NO. OF UNITS 2 SERIAL NOS. M63A769832	-A / M63A769837-B
	, 130311707032 B
	,

NAMEPLATE DATA

ELECTRIC MOTOR

MANUFACTURER Westinghouse

PUMP/HVAC UNIT

MANUFACTURER Viking

MANUFACTURER <u>Westinghouse</u>	MANUFACTURER Viking
TYPE [X] AC [] DC	TYPE Rotary Gear
HORSEPOWER 3/4	SIZE 1-inch
RPM1750	CAPACITY 9.0 qpm
VOLTAGE 460	
AMPERAGE 1.4 F.L.	PRESSURE 14 psiq ROTATION CW (viewed from shaft)
PHASE 3	IMPELLER
FRAME 47B	SIZE <u>Not Applicable</u> MATERIAL <u>Not Applicable</u>
DRIVE/REDUCER	OTHER (I & C)
MANUFACTURER Westinghouse	MANUFACTURER
TYPE GEAR x V-BELT CHAIN	TYPE
VARIDRIVE	SIZE
SERVICE FACTOR	CAPACITY
RATIO 1:1	RANGE
*By Owner	

*By Owner

"EXAMPLE"

EQUIPMENT DATA FORM Maintenance Summary

EQUIPMENT NO. P-8-5-1, P-8-5-2	ASSET NO.*
DESCRIPTION Sodium Hydroxide Feed Pump	MAINT. NO.*
MAINTENANCE OPERATION;	FREQUENCY:
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.	List required frequency of each maintenance operation
1) Lubricate	Reassembly
2) Clean pump	As needed
3) Adjust and clearance	As needed
4) Lubricate bearings (grease pack)	Reassembly
5) Lubricate internals	If stored
*By Owner	

"EXAMPLE"

EQUIPMENT DATA FORM Lubricant/Recommended Spare Parts List

DESCRIPTION Sodium Hydroxide Feed Pump		ASSET NO.*		
		LUBRICANT LIST		
REFERENCE SYMBOL		LUBRICANT TYPE (MILITARY STANDAF	RD)	RECOMMENDED LUB
List symbols in	,	List general		•••
"maintenance opera (Page 2).		lubricant type.		List specific lubricant name, viscosity, and manufacturer.
1,4		Lithium base bal	.1	Texaco TH268
		bearing grease		
5		Machine oil		AGMA 76
	DESCRIPTION	NDED SPARE PARTS UNIT	QUANTITY	UNIT COST
	chanical Seal	1	1	
		1	,	
	ad-O-Ring	1	1	7.82
		1	1	7.82
2-461-001-861 Hez	ad-O-Ring	1	1	7.82
**2-368-001-921 Med 2-461-001-861 Hea DDITIONAL DATA AND *By Owner *Identify parts pr	nd-O-Ring REMARKS			

FORM 3 TO SECTION 01730

Page 1 of 4

CONTRACTOR SUBMITTAL FORM

TO:		DATE:
	(DESIGNER)	
		SPECIFICATION SECTION TITLE:
	(ADDRESS)	
		SECTION NO.
	(CITY, STATE, ZIP)	
	ATTN:	MANUFACTURER/VENDOR
FROM:		
	(CONTRACTOR)	
		NO. OF COPIES SUBMITTED:
	(ADDRESS)	(TO DESIGNER)
	(CITY, STATE, ZIP)	(SIGNATURE OF CONTRACTOR)
GENTLEM	FN •	

We have checked the O&M manual submittal dated ______, 19___, and have found it to be in accordance with the requirements of Specification Section 01730 as noted below.

FORMAT

Size: $8-1/2 \times 11 \text{ or } 11 \times 17$

Paper: 20-1b 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

D : 3 3	Not	Page
Provided	<u>Applicable</u>	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
		<pre> Service/parts supplier ID Product List</pre>
		Table of Contents
		Table of Contents Tabbed Sections:
		Pertinent data sheets
		Annotated as needed
		Text:
		Pertinent to project
		Annotated
		Drawings:
		Illustrate product and compo-
		nents
		Control and flow diagrams
		Special Information:
		Interrelationships of equipment
		and components
		Instructions and procedures
		provided
		Instructions organized in con-
		sistent format
	P	Instructions in logical
		sequence
		Glossary
		Warranty, Bond, Service Contract
SPECIFIC CONTE	ENT (EQUIPMENT/	SYSTEMS ONLY)
		Description of Unit and Components:
	-	Equipment functions
		Normal operating characteristics
		Limiting conditions
		5

CONTRACTOR SUBMITTAL FORM

	Not	Page
<u>Provided</u>	Applicable	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/reassembly/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
-	<i>o</i>	Other Data as Required
SPECIFIC CONTEN	r (ELECTRICAL	AND ELECTRONIC EQUIPMENT ONLY)
		
		Description:
		Equipment functions
		Normal operating characteristics
		Performance curves
	-	Engineering data
		Test data

CONTRACTOR SUBMITTAL FORM

	Not	
	= :	Page
Provided	<u>Applicable</u>	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/reassembly
		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:
 - Each piece of equipment.
 - Each integrated system.
 - B. Demonstration Log:
 - 1. Keep log of individual demonstrations.
 - 2. Data:
 - a. Date and time of demonstration.
 - b. OWNER'S representative.
 - 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 * * *

DIVISION 2

SITEWORK

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. Protect existing utilities. Shall be CONTRACTOR'S responsibility to locate existing utilities. Repair damage 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.

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:
 - 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 road, 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.

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 sites for stockpiles.

3.03 RAILROAD TRACK REMOVAL

- A. Excavate existing railroad ballast within limits of landfill construction. Outside limits of landfill berm construction ballast will remain as road subgrade.
- B. Salvage railroad ties and track and dispose of as approved by OWNER and in compliance with disposal/salvage regulations.
- G. Field GC tests will be conducted on soil below railroad ballast to detect presence of volatile organic compounds such as benzene, ortho-xylene, tetrachloroethene, carbon tetrachloride, chloroform, l,l-Dichloroethene, l,l,l-Trichloroethane, and toluene. These compounds can be detected using analytic equipment such as Photovac-10570 and HNU311. Frequency of tests will be levery 100 ft, approximatley along former centerline of trackbed after ballast is removed. Samples will be collected from upper 6 in. of soil using dedicated disposable plastic scoop. Samples will be analyzed for cmpounds listed above in on-site field laboratory and conducted in accordance with standard site approved analytical procedures.

3.04 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 02105 SITE RESTORATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes

1. Requirements for site restoration by placement of topsoil seeding, fertilizing, and mulching.

1.02 DEFINITIONS

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

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil:

- 1. Fertile friable loam containing liberal amount of humus, neither excessively acid nor excessively alkaline, suitable for growth of grass and plants. Free from hard lumps, plant and roots, waste, gravel, cinders, stone over 1/2 in. in average dimension, weed seeds and quack grass roots, and other undesirable material.
- 2. pH of material shall be between 5.5 and 7.6.
- 3. Organic content shall be not less than 2% or more than 20%.
- 4. Gradation:

Sieve Size	Percent Passing by Weight
2 in.	100
1 in.	85 to 100
1/4 in.	65 to 100
No.200 mesh	20 to 80

5. Topsoil removed and stockpiled under Section 02100 may be used, provided it méets above requirements.

B. Seed Mixture:

- 1. OWNER to approve selection of seed mixture and seed source.
- 2. Fresh, clean, new crop sell included in following varieties and proportioned by weight.

02105-1

- 3. Seed mixture Nos. 1 or 2 meeting requirement of Section 610-2.02 of "Standard Specifications."
 - a. Seed Mixture No. 1: Allow variance of 5% for each component except weed seed and inert maximums listed below.

<u>Name</u>	% 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
Inert Matter	1.36

b. Seed Mixture No.2: Allow variance of 5% for each component except weed seed and inert maximum listed below.

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
Inert Matter	≤1.23

c. Seed Mixture No.3: Allow variance of 5% for each component except weed and inert maximum listed below.

<u>Name</u>	% 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
Inert Matter	≤1.00

C. Fertilizer:

- 1. Meeting requirements of Section 713-03 of "Standard Specifications."
 - a. Mixed commercial fertilizers shall contain total nitrogen. available nitrogen, available phosphoric acid, and soluble potash in ratios stated as Type No. 15-30-15 or as approved by OWNER.

D. Limestone:

- 1. Meeting requirements of Section 713-02 of "Standard Specifications"
- 2. Limestone shall be ground limestone having 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.

E. Mulch:

- Meeting requirements of Section 713 of "Standard Specifications."
- 2. CONTRACTOR to obtain OWNER'S approval on material, method of application, method of binding, and timing of application.
- 3. All slopes steeper than 3H:1V shall be mulched with erosion control material such as American Excelsior "Curlex" or equal.

PART 3 EXECUTION

3.01 PREPARATION

A. Topsoil:

- Do not place topsoil until subgrade approved by DESIGNER.
- 2. Surface of subgrade shall be true to grade, uniform, and free of loose stones.
- 3. Remove weeds and grasses, from topsoil prior to placement.
- 4. Spread and compact topsoil to uniform compacted depth of 6 in. up to finish grade.
- 5. Place or work no topsoil in frozen or muddy condition.
- 6. Place topsoil over areas disturbed during construction.
- 7. Finish grade is established final grade as shown on Drawings. Grades not otherwise indicated are uniform levels or slopes between points where elevations given.

B. Seeding:

 Seed rates shall be in accordance with Section 610-3.02 of "Standard Specifications." Minimum of 160 lbs/acre for mix No. 1, and 105 lbs to 110 lbs/acre for mix Nos. 2 and 3 shall be applied.

- Seed in accordance with Section 610-3.02 of "Standard Specifications."
- Do not seed when wind velocity exceeds 10 mph, on saturated or frozen soil.
- Seed topsoiled areas only.

C. Methods and Equipment:

- 1. Methods and equipment shall be in accordance with Section 610-3.02 of "Standard Specifications."
- 2. OWNER will not pay for additional costs incurred by CONTRACTOR if hydroseeding is method selected by CONTRACTOR.

D. Fertilizer:

- 1. Fertilize in accordance with Section 610-3.01 of "Standard Specifications." Minimum of 800 lbs/acre shall be applied unless soil test verify lower rates required as approved by OWNER.
- Fertilize topsoiled and seeded areas only.

E. Limestone:

- Apply at rates to comply with pH soil requirements.
- Meeting requirements of Section 610-4.01 of "Standard Specifications."

F. Mulching:

- Mulch in accordance with Section 610-3.03 of "Standard Specifications."
- Mulch topsoiled and seeded areas only with minimum of 2 tons/ acre.

G. Watering and Maintenance:

- Water and maintain seeded areas until 2-in. vertical growth of grass obtained.
- If grass dies before 2-in. vertical growth obtained, areas shall be reseeded or resodded at no additional cost to OWNER.

H. Cleanup:

 Protect slopes and embankments against erosion until Work accepted. Repair eroded portions of seeded or sodded areas by refilling, resodding, remulching, and reseeding as required by condition.

* * * END OF SECTION * * *

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SECTION 02110 CLEARING AND GRUBBING

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 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.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

3.01 PERFORMANCE

- A. Complete Work in accordance with requirements of Section 201 of "Standard Specifications."
 - 1. Remove trees, stumps, brush, and vegetation within area covered by Work.
- B. Clear and grub for excavation of channels and ditches where such excavation shown on Drawings.
- C. Chip and grind where possible. Logs too thick to grind will be removed from site as approved by OWNER.

* * * END OF SECTION * * *

SECTION 02210 SITE GRADING

PART 1 GENERAL

1.01 DEFINITIONS

- A. Standard Specifications: "Standard Specifications for Construction and Materials," State of New York Department of Transportation.
- B. Clay Liner Material: Clay liner material shall be used to construct primary and secondary clay liner, and separation berms. 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 DESIGNER.
- D. Granular Material: Stone used to construct primary and secondary leachate collection systems.
- E. Operations Layer: Select fill used to protect liner system.
- F. General Fill: Fill used for remainder of site earth work, including perimeter berm.
- G. Underdrain Filter Type Stone: Stone used to bed final cover drainage tile.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM D422 Standard Method for Particle-Size Analysis of Soils.
 - 2. ASTM D698 Standard Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb (2.49 kg) Rammer and 12-in. (305 mm) Drop.
 - 3. ASTM Dl140 Standard Test Method for Amount of Material in Soils Finer than No.200 (75-um) Sieve.
 - 4. ASTM D1556 Standard Test Method for Density of Soil in Place by Sand Cone Method.
 - 5. ASTM D1557 Standard Test Methods for Moisture Density Relations of Soil and Soil-Aggregate Mixtures Using 10-lb (4.54 kg) Rammer and 18-in. (457 mm) Drop.
 - 6. ASTM D1587 Standard Practice for Thin-Walled Tube Sampling of Soils.
 - 7. ASTM D2166 Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.

- 8. ASTM D2167 Standard Test Method for Density and Unit Weight of Soil In-Place by Rubber Balloon Method.
- 9. ASTM D2216 Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
- 10. ASTM D2434 Test Method for Permeability of Granular Soils (Constant Head).
- 11. ASTM D2435 Test Method for One-Dimensional Consolidation Properties of Soils.
- 12. ASTM D2487 Standard Test Method for Classification of Soils for Engineering Purposes.
- 13. ASTM D2850 Standard Test Method for Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression.
- 14. ASTM D2922 Standard Test Methods for Density of Soil and Soil-Aggregate In-Place by Nuclear Methods (Shallow Depth).
- 15. ASTM D2937 Standard Test Method for Density of Soil In-Place by Drive-Cylinder Method.
- 16. ASTM D3017 Standard Test Method for Water Content of Soil and Rock In-Place by Nuclear Methods (Shallow Depth).
- 17. ASTM D4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- 18. ASTM D4643 Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil Aggregate Mixtures by Microwave.
- 19. ASTM D5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO T194 Standard Method of Test for Determination of Organic Matter in Soils by Wet Combustion.
- C. U.S. Army Corps of Engineers/U.S. Department of Interior:
 - 1. Unified Soil Classification System.
 - 2. Permeability Tests; U.S. Army Corps of Engineers (WES), 1970, "Laboratory Testing Manual," Engineering Manual 1110-2-1906.

Note: The most current version of the specified test method shall be followed by the EARTHWORKS CONTRACTOR or authorized testing laboratory.

1.03 SUBMITTALS

- A. Test results.
- B. Submit in accordance with Section 01340

1.04 QUALITY ASSURANCE

A. Perform quality assurance in accordance with Quality Assurance Manual for Installation of Lining Systems, CWM, Model City Facility, Construction of Residuals Management Unit No. 1.

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 outside slope of perimeter berm down to and including perimeter drainage ditch and continuing to inside edge of perimeter access road. Areas past perimeter access road require topsoil and seeding to return ground to original condition or better.

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 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 separation and perimeter berms, 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 3 ft. thick at surveyed locations. The Cell 7/8 primary and secondary clay liner shall have an allowed survey tolerance of +0.00 to -0.05 feet surveyed at 25 foot intervals along the centerline base grades. The Cells 9/10, 11/13, and 12/14 primary and secondary clay liner shall have an allowed survey tolerance of +0.00 to -0.04 feet surveyed at 25 foot intervals along the centerline base grades.

4. Primary Sumps:

a. Maximum allowable variation from correct sump elevation at any location shall be $\frac{1}{2}$ in.

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.

PART 2 PRODUCTS

2.01 CLAY LINER MATERIAL

- A. OWNER will direct use of clay borrow from designated source. Borrow sources have been prequalified by OWNER and information is available to CONTRACTOR.
- B. Free from roots, woody vegetation, other deleterious material, and rocks greater than 1-in. dia. at surface grade.
- C. Material used for liner shall meet following requirements.
 - 1. Minimum 50% by weight passing No.200 sieve.
 - 2. Minimum plasticity index of 10 or greater.
 - 3. Recompacted permeability less than 1×10^{-7} cm/sec.
 - 4. Minimum compaction of 90% Modified Proctor density.
 - 5. Classified as ML, MH, CL, or CH by Unified Soil Classification System.
 - 6. Organic Content: less than 3%.
 - 7. Sufficient cohesion and friction to provide shear strength ≥ 2587 psf and stable condition as presented by suitable 2-dimensional stability analysis performed by DESIGNER. If the selected clay source test results fail to meet the required shear strength, the DESIGNER shall review the results to determine if they are sufficient for use.
 - 8. Maximum Particle Size: 1/3 the depth of a loose lift except for final 4 in. adjacent to HDPE membrane.
- D. Material testing will be performed continuously throughout Project and used to control placement. Testing will be paid for by OWNER.

2.02 GRANULAR MATERIAL

A. Granular material for leachate collection systems shall be Type IA coarse aggregate in accordance with Section 501 - 2.02 of "Standard Specifications," with the following modified gradation:

SCREEN SIZE	PERCENT PASSING
1/2-inch	99 - 100
1/4-inch	40 - 100
No.8	0 - 30
No.200	< 10.0

- B. Permeability: 8 x 10⁻² cm/sec or greater.
- C. Contains less than 10% (dry weight) material passing No.200 sieve.
- D. Prequalification of granular materials shall be performed in accordance with Quality Assurance Manual.
- E. Testing will be paid for by OWNER.

2.03 OPERATIONS LAYER (SELECT FILL)

- A. Select fill for side slope operations layer may be available onsite.
 - 1. Select fill shall be granular permeable material classified by Unified Soil Classification System as GW or GP.
- B. Base operations layer shall be runner/crusher No.2, as approved by OWNER
 - 1. Gradation: Unwashed

Sieve Size Designation	Percent Passing by Weight
2 in.	100
0.25 in.	20-60
No.40	5-40
No.200	≤10

2.04 GENERAL FILL

- A. General fill shall consist of material taken from onsite (if demonstrated to be free of chemical and radiological contamination) or approved offsite excavations or stockpiles.
- B. Material shall be well-graded granular or cohesive material and free of organics, topsoil, waste, frozen, or other deleterious matter. Cohesive soil material used for the first lift of the general fill placed in the final cover System shall be tested at a frequency of one test per 5,000 cy of material to be placed using Particle size analyses (ASTM D422 without hydrometer) and Atterberg Limits (ASTM D4318). This material shall have a Plasticity Index (PI) ≥ (5).

- C. Sufficient strength for location use as approved by DESIGNER.
- D. Determination of whether general fill has sufficient strength for location shall be made by performing Direct Shear Test (ASTM D3080) with the sample at a density and moisture that mimics the in-place conditions as determined in the field by the CQA Engineer. A shear strength result of 2400 psf or greater will qualify the source to be used anywhere. If less than 2400 psf, the DESIGNER shall be consulted to evaluate its use in a specific application. One test shall be performed on each general fill source; at least one test shall be performed during each construction season.

2.05 GENERAL FILL FOR GCL SUBBASE IN FINAL COVER

- A. General fill for GCL subbase shall consist of material taken from onsite (if demonstrated to be free of chemical and radiological contamination) or approved offsite excavations or stockpiles.
- B. General fill for GCL subbase shall be free of roots, woody vegetation, other deleterious material, rocks greater than 1-inch in diameter at surface grade, or other material that may damage the overlying GCL.

2.06 GENERAL FILL FOR PROTECTIVE COVER SOIL IN GCL FINAL COVER AREAS

- A. General fill for protective cover soil shall consist of material taken from onsite (if demonstrated to be free of chemical and radiological contamination) or approved offsite excavations or stockpiles.
- B. General fill used for protective cover soil shall meet the following requirements:
 - 1. Recompacted permeability less than 1×10^{-5} cm/sec.
 - 2. Minimum compaction of 90% of Modified Proctor density.

2.07 FINAL COVER DRAINAGE TILE FILTER STONE

A. Stone shall comply with current New York State Department of Transportation specifications for underdrain filter stone Type I.

PART 3 EXECUTON

3.01 INSTALLATION

- A. Density testing will be performed by DESIGNER in accordance with ASTM D2922.
- B. Perform installation in accordance with Quality Assurance Manual.

3.02 FILL USAGE

- A. Liner Material: Primary clay liner, secondary clay liner, separation berms, and side slopes.
- B. Granular Fill: Leachate collection layers and sumps.
- C. Operations Layer: Above primary leachate collection system.

- D. General Fill: Perimeter berms, drainage ditches, access road, final cover, and replacement of unsuitable soils on landfill base below 3-ft thick secondary clay soil liner. Subbase use shall not be granular.
- E. Test fill will be performed to determine construction techniques and soil properties necessary to achieve performance requirements for liner material and general fill for protective cover soil in GCL final cover areas as specified by OWNER.

3.03 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 DESIGNER.
- C. Subbase preparation:
 - 1. If CONTRACTOR and Soil CQA do not agree on qualitatively defined excessive pumping or displacement, scarify top 6 to 8 inches of natural subbase 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.
 - 3. Replacement layer shall not be granular general fill.
 - 4. Nonwoven, heat-bonded geotextile such as Typar 3601 (or DESIGNER approved equal), or a geonet may be used concurrent with removal and replacement efforts to stabilize soft or loose zones of the subbase.
 - 5. 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.
 - 6. Final subbase preparation immediately prior to placement of secondary clay liner material shall be as described in Article 3.05 of this section.
 - 7. Provided the clay cutoff wall along the entire length of the Cell boundary and the adjoining 25 feet of the adjacent Cells, as measured from the center line of the Cell separation berm, is keyed into the Glaciolacustrine clay layer, final proof rolling of the subbase and approval from the NYSDEC and CQA Engineer are required to demonstrate that the subbase has met the required 1xl0⁻⁵ cm/sec permeability. If the aforementioned segments of the clay cutoff wall are not keyed into the Glaciolacustrine clay layer, areas of the Cell subbase suspected of having a permeability equal to or greater than 1xl0⁻⁵ cm/sec (i.e., zones of silt, sand, or gravel) shall be removed to a minimum of 2 feet below the final subgrade elevation. Material which meets the 1xl0⁻⁵ cm/sec permeability requirement, shall be placed in these areas up to final subgrade elevations. At least a 3-foot width on the base of the cutoff wall must intersect the Glaciolacustrine clay layer in order for the cutoff wall to be considered "keyed into" the layer.

D. 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 DESIGNER for approval to proceed.
 - b. Utilize existing groundwater monitoring wells and piezometers or install new piezometers to measure potentiometric surface of uppermost aquifer and calculate safety factor. Submit results to DESIGNER for approval to proceed.
 - c. Other methods shall be submitted to DESIGNER for approval prior to being used.
- 3. Sumps shall be backfilled with recompacted 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.

E. Dewatering:

- 1. CONTRACTOR responsible for choosing method of groundwater and surface water control.
- 2. Keep construction site free draining.
- 3. Keep excavations free from water.
- 4. Remove soil disturbed by pressure or flow of groundwater and repair as approved by DESIGNER.
- 5. Protect adjacent utilities, structures, and properties from damage resulting from dewatering operations.
- F. Do not excavate within influence zone of existing utilities footings or foundations, without prior approval of OWNER.

3.04 EXCAVATION

- A. Excavate to elevations and dimensions necessary to complete construction.
- B. Remove unsuitable material from landfill excavation grades as shown on Drawings.
- C. Excavations to remove unsuitable material shall extend to provide suitable base support for liner construction.

- D. Do not excavate for other structures until scheduled for construction.
- E. Visually examine surfaces to receive fill and subgrades within limits of excavation to determine existence of soft areas, softened by flooding, weather or unsuitable materials. Proof-rolling may be used to augment inspection/verification of suspect areas.
- F. Upon completion of excavation, DESIGNER will document grades before CONTRACTOR proceeds with further work.
- G. Protect excavated areas from freezing and water damage.
- H. 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 to provide a firm subbase.

3.05 PLACING FILL

- A. Place fill in accordance with conditions of Quality Assurance Manual.
- B. Final Subbase Preparation:
 - 1. Initial lift of secondary clay liner shall be placed on subbase that has been prepared to repair desiccation cracking and allow a 1 to 2 inch intermixing of the clay liner material with the subbase.
 - 2. When desiccation cracks are less than 2 inches deep, as measured by a blunt wood No.2 pencil, the surface of the subbase shall be wetted sufficiently to soften the subbase soil for a depth of 1 inch; or, the surface shall be roughened by dozer tracking and blading to create a 1 to 2 inch loose soil layer. The clay liner will be placed on this softened or loosened layer.
 - 3. When desiccation cracks are 2 to 6 inches deep, as measured by a blunt wood No.2 pencil, the surface of the subbase shall be wetted sufficiently to create a thin pastelike layer. This paste-like layer shall be back-bladed to smear the paste-like soil across the cracks to partially fill them. Visual surface inspection after back-blading will approve the effort. Soil CQA will document the activities, no measurements or tests are required.
 - 4. When desiccation cracks exceed 6 inches deep, as measured by a blunt wood No.2 pencil, the procedure described for cracks 2 to 6 inches deep may be attempted; however, Soil QAC will be required to investigate an area after back-blading by shallow hand excavation to see if the cracks are substantially filled. Visual inspection with the NYSDEC present is all that is needed for approval to place initial lift of secondary clay liner.
 - 5. First lift testing of the secondary clay liner is modified as follows:
 - a. Survey documentation shall be performed before wetting or loosening.
 - b. Density testing shall be performed with a 4-inch probe depth to limit the influence of the subbase soils.

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

C. Liner Material:

- 1. Lift thickness shall be less than 9 in. and shall be determined by the ability of compaction equipment to achieve minimum 90% Modified Proctor density throughout entire lift or greater to meet permeability requirements with maximum of 20 passes. Compaction equipment shall be equivalent to equipment used for test pad construction. (Maximum loose lift thickness shall not exceed 9 in. prior to compaction for all lifts except initial lift of primary clay liner, unless otherwise modified by the clay test pad certification.)
- 2. Remove boulders, rocks, and cobbles 3 in. or greater than 1/3 lift thickness in size from surface of liner material. Discard away from working area.
- 3. Initial 12 in. clay lift shall be placed above secondary geomembrane and performed under constant supervision of OWNER to prevent damage to geomembrane. Devote necessary laborers to remove rocks larger than 1/3 lift thickness manually when directed by OWNER. Soil shall be worked out ahead of equipment.
- 4. Maintain clay liner surface in condition suitable for geomembrane installation until surface is covered. Clay liner surface shall be free of angular rocks larger than 1 in. dia.
- 5. Final 4 in. of clay liner immediately adjacent to the HDPE geomembrane shall be from one of OWNER designated qualified clay sources or stockpiles with the least amount of stone greater than 1 in. in the least dimension.
- 6. Clay placed within 5 ft of sideslope forming wedge shall be well compacted by hand operated vibratory equipment only. Due care shall be exercised to prevent damage to underlying liner components. Compaction by sheepsfoot or wheel compactor equipment shall not be used within 5 ft of sideslope toe.
- 7. 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.
- 8. Scarify sealed lifts prior to next lift placement.
- 9. Placement of clay liner may occur below 32°F with CQA officer's approval, provided frozen soil not placed. Frozen clay material shall be removed before additional clay lifts 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.

D. Granular Material:

- 1. Place granular material so as to not create folds in underlying FML. CONTRACTOR shall walk out bumps in FML as granular material is placed.
- 2. Folds or creases in FML that cannot be walked out shall be cut out, patched, and tested in accordance with Section 02400 or 02401.

E. Operations Layer:

- 1. Must be placed carefully by machinery and methods so as to not damage primary leachate collection system and primary liner.
- 2. Operations layer placement shall be performed under constant supervision of OWNER.

F. General Fill:

- 1. Shall not be placed above topsoil.
- 2. General fill shall be compacted to 90% of Modified Proctor density. Maximum thickness of lift prior to compaction is 12 in. except for the final cover protective soil layer in GCL final cover areas, which shall be placed in a single 18 in. thick lift (post-compaction).
- 3. General fill placed as the soil separation layer in the GCL final cover system shall be proof rolled prior to the placement of GCL.
- 4. Placement of general fill above geosynthetic components of the final cover system shall begin at the toe-of-slope. This material shall be placed from the toe-of-slope toward the top-of-slope.
- 5. All equipment operated on cover soils above geosynthetics shall have a maximum ground pressure of 4.4 pounds per square inch (psi). If equipment with ground pressure exceeding 4.4 psi is proposed for use, a Short Term Static Analysis of the Final Cover System must be submitted and approved by the NYSDEC.

3.06 FIELD QUALITY CONTROL

- A. In accordance with Quality Assurance Manual.
- B. Moisture Content of Liner Material and Final Cover Protective Soil: Above optimum moisture when placed and compacted as shown by test fill. Moisture content subject to modification by DESIGNER after review of soils results.
- C. Operations on earth work shall be suspended at any time satisfactory results cannot be obtained due to field conditions.
- D. Wetting or drying of liner material to meet compaction requirements shall be CONTRACTOR'S responsibility. Material shall be generated by blading, discing, harrowing, or other methods to dry material.

- E. Assist OWNER in obtaining soil samples and soil testing. Schedule fill placement to facilitate testing. No additional fill material shall be placed until in-place fill approved by QAC.
- F. Maintain stockpile areas in free-draining condition.
- G. Maintain segregation of stockpiled material in following classes:
 - 1. Topsoil.
 - 2. Liner material.
 - 3. Unsuitable material.
- H. Maintain control of loose lift thickness with grade stakes or comparable method. When grade stakes used, they shall be numbered and recovery documented prior to sequential lifts excluding the secondary clay layer. For the secondary clay layer, the QA/QC Engineer (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, except for the final clay lift. For the final clay lift:
 - 1. Compact as close as possible to each stake location (360 degrees around each stake location) to the satisfaction of the CQA Engineer;
 - 2. At final surface preparation, remove each stake carefully and completely;
 - 3. Fill stake holes with granular bentonite in accordance with the QA/QC Manual Section 4.6.1.2; and
 - 4. Provide a final compactive effort over each stake location with a smooth drum roller.

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.

* * * END OF SECTION * * *

SECTION 02220 STRUCTURE EXCAVATION AND BACKFILLING

PART 1 GENERAL

1.01 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - ASTM D1140-54 Standard Test Method for Amount of Material in Soils Finer than No. 200 (75-um) Sieve.
 - ASTM D1556-90 Standard Test Method for Density of Soil in Place by the Sand Cone Method.
 - 3. ASTM D1557-78 Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54 kg) Rammer and 18-in. (457 mm) Drop.
 - 4. ASTM D2922-81 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
 - 5. ASTM D2937-83 Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
 - 6. ASTM D4318-84 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- B. U.S. Army Corps of Engineers/U.S. Department of Interior:
 - 1. Unified Soil Classification System.

1.02 DEFINITIONS

- A. Influence Zone Under Foundations, Pavements, or Sidewalks: Area below foundation, pavement or sidewalk base bounded by I horizontal to 2 vertical slope extending outward from 1 ft beyond outer edges of foundation, pavement or sidewalk.
- B. Influence Zone Around Piping or Electrical Ducts: Area below limits bounded by line 12 in. above pipe or duct and by 1 horizontal to 2 vertical slope extending outward from that line 1 ft beyond outer edge of pipe or duct.

1.03 QUALITY ASSURANCE

A. Testing: Material qualification and testing will be in accordance with site-specific Quality Assurance Manual.

1.04 PROJECT/SITE CONDITIONS

A. Do not block or obstruct roads, or pavements with excavated materials, except as authorized by DESIGNER and OWNER. Trim banks to minimize inconvenience to public travel or tenants occupying adjoining property.

- B. Sheeting, Bracing, and Shoring:
 - Whenever necessary to prevent caving during excavation and protect adjacent structures, property, workers, and public; excavations shall be adequately sheeted, braced, and shored.
 - 2. Sheeting, shoring, and bracing shall conform to safety requirements of federal, state or local public agency having jurisdiction over such matters. Most stringent of these requirements shall apply.
 - 3. Sheeting, shoring, and bracing shall not affect structural integrity of new construction, watertightness or waterproofing of new construction, and shall allow for sufficient clearances necessary to install associated appurtenances adjacent to new construction. Sheeting, shoring, and bracing, shall not penetrate walls or slabs of new construction.
 - 4. When close sheeting is required, drive to prevent soil from entering excavation below or through sheeting.
 - 5. Keep sheeting in-place until structure placed, tested, and backfilled.
 - 6. Remove sheeting, bracing, and shoring in manner not damaging structure or permitting voids within backfill.
 - 7. Fill settled areas remaining after sheeting has been pulled with approved material.
 - 8. Type, design, detail, and installation of shoring, sheeting, and bracing shall be determined by and sole responsibility of CONTRACTOR.

PART 2 PRODUCTS

2.01 STRUCTURAL FILL

- A. Well-graded sand, well-graded sand and gravel, crushed stone or other approved granular material, of 2-in. maximum size, free from organic and deleterious materials. Classified as GW, GP, SW, SP, GM or SM in Unified Soil Classification System.
- B. Plasticity Index: ASTM D4318, 6 or less.
- C. Maximum Fines: ASTM D1140, 10% passing No. 200 sieve.
- D. Uniformity Coefficient: 5 or greater.

2.02 CONTROLLED FILL

A. Natural soils classified as CL or CH in Unified Soil Classification System, percent organics $\leq 3\%$ and free of other deleterious matter.

2.03 EARTH FILL

A. Subsoil or sand free of wood, peat, cinders, organic and deleterious matter or other rubbish.

PART 3 EXECUTION

3.01 PREPARATION

- A. Notify corporations, companies, individuals or authorities owning above or below ground conduits, wires, pipes or other utilities running to property or encountered during excavating operations.
- B. Cap or remove and relocate services in accordance with instructions by owners of said 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.

3.02 EXAMINATION

- A. Proof-roll and examine surfaces to receive fill and subgrades within influence zone to determine existence of soft areas, areas loosened by frost action or softened by flooding, groundwater or weather or existence of unsuitable materials.
- B. Where sensitive soils encountered, requirement for proof-rolling shall be waived, and CONTRACTOR shall perform alternate field testing to determine existence of soft areas.
- C. Method of alternative testing shall be approved by DESIGNER.

3.03 FILL USAGE

- A. Structural: Within influence zone of foundation slabs and limits shown on Drawings.
- B. Controlled or Structural: Within influence zone of pavements and sidewalks or around piping and electrical ducts.
- C. Earth: Other areas not previously specified.

3.04 PREPARATION

- A. Fill settled areas where excavations or trenches were backfilled and holes made by site preparation work.
- B. Remove and replace or recompact natural soils or compacted fill softened by frost, flooding, groundwater or weather.

C. Remove frozen soils within influence zone and replace with structural fill.

D. Dewatering:

- 1. CONTRACTOR shall be responsible for choosing method of ground-water control.
- 2. If CONTRACTOR chooses to use deep wells or wellpoints, wells and wellpoints shall be designed, installed, and operated to prevent removal of in-situ materials.
- 3. Keep construction site free-draining.
- 4. Keep excavations free from water.
- 5. Maintain groundwater minimum of 12 in. below excavations.
- 6. Remove soil disturbed by pressure or flow of groundwater and replace with free-draining material.
- Maintain dewatering systems in manner to prevent uplifting of and damage to structures.
- Protect adjacent utilities, structures, and properties from damage resulting from dewatering operations.
- Dewatering wells shall be drilled, maintained, and abandoned in accordance with federal, state, and local ordinances.
- E. Do not excavate within influence zone of existing footings or foundations, without prior approval of DESIGNER.

3.05 EXCAVATION

- A. Excavate to elevations and dimensions necessary to complete construction. Method of excavation shall be consistent with soil types encountered and result in undisturbed foundation subgrade. Loosened soils shall be recompacted or removed and replaced with fill material meeting these Specifications.
- ${\tt B}_{\rm c}$ Upon completion of excavation, notify DESIGNER before proceeding with further Work.
- C. Protect excavated areas from freezing.

3.06 PLACING FILL

- A. Do not use frozen material or place fill on frozen subgrade.
- B. Fill excavations below bottom of foundation or footing elevations within influence zone with structural fill.
- C. To minimize lateral forces against structure due to wedging action of soil, begin compaction of each layer at structure wall.
- D. Lift Thickness and Compaction: Place and compact fill materials in maximum lift thickness and to minimum densities listed.

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	Lift Thickness	Modified Proctor
Location	<u>(in.)</u>	(3)
Footing, Foundation Slab or Floor Slab Influence Zone	8	95
Sidewalk, Paving, Piping, or Electrical Duct Influence Zones	12	90
Lawn and Landscaped Areas	12	80

- E. Stop backfill at specified or indicated grade to allow for placing of topsoil when required.
- F. Compact backfill in lawns and landscaped areas adjacent to structures to minimum density noted herein, but not more than 90% of maximum dry density as determined by ASTM D1557.
- G. Compact earth fill to 90% modified proctor at or above optimum moisture.
- 3.07 FIELD QUALITY CONTROL
 - A. Degree of Compaction: ASTM D1557, Method D (Modified Proctor).
 - B. Moisture Content: At optimum to +3% when placed and compacted, unless otherwise approved by DESIGNER.
- 3.08 ADJUSTMENT AND CLEANING
 - A. Stockpile excavated material suitable for backfill on designated site. Place no fill where trenches for sewers, water lines or other utilities will be located.
 - B. Place excavated material not suitable for backfilling or site grading and unsuitable materials in designated spoil areas and grade to drain.

* * * END OF SECTION * * *

SECTION 02221 TRENCHING. BACKFILLING, AND COMPACTING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

- Requirements for trenching, backfilling, and compacting leachate force main, electrical conduits, sideslope riser trenches, and geosynthetic anchor trenches.
- Sand bentonite mix will be used for sealing final cover penetrations and other miscellaneous uses as shown on Drawings.

1.02 DEFINITIONS

- A. Standard Specifications: "Standard Specifications for Construction and Materials," State of New York Department of Transportation.
- B. Influence Zone Around Leachate Force Main or Electrical Conduits: Area below limits bounded by line 12 in. above pipe or duct and by one horizontal to two vertical slope extending outward from that line 1 ft beyond outer edge of pipe or duct.
- C. Unsuitable Material: Topsoil, peat, organic soils, and materials containing slag, cinders, foundry sand, debris, and rubble, or soil with less than required bearing capacity as determined by DESIGNER.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM D422-63 Standard Test Method for Particle-Size Analysis of Soils.
 - ASTM D1557-78 Standard Test Methods for Moisture Density Relations of Soils and Soil Aggregate Mixtures Using 10-1b (4.54 kg) Rammer and 18-in.(457 mm) Drop.
 - 3. ASTM D2922-88 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.04 QUALITY ASSURANCE

- A. Testing: Testing shall be provided by OWNER in accordance with this section.
 - One particle size analysis for each source of bedding material and compacted clay backfill. Additional analysis as required by DESIGNER verifying gradation.

- 2. One density test at 100-ft intervals for every 1-ft depth of compacted clay backfill.
- B. 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 in. Minimum width shall be outside diameter of pipe plus 12 in.
 - 3. Where trench width for that portion of trench depth between trench bottom and outside top of pipe barrel, for any reason within CONTRACTOR'S control, exceeds specified limits, CONTRACTOR, at his expense, shall furnish pipe with strength adequate for actual trench width.
 - 4. Maximum width at surface of ground shall not exceed width of trench at top of leachate transfer pipe or electrical conduit by more than 2 ft without permission of OWNER, unless specifically shown on Drawings.
 - 5. Excavate electrical conduit trenches as required so center of conduit shall be minimum of 24 in. below final grade.
 - 6. Excavate sidewall riser trenches to tolerances and dimensions shown on Drawings.

PART 2 MATERIALS

2.01 BEDDING AND HAUNCHING

BEDDING

A. Granular material meeting local New York 2 inch run of crush.

HAUNCHING

- B. Granular material meeting NYSDOT No. 1 or No. 1A Stone Gradation.
- 2.02 COMPACTED CLAY BACKFILL
 - A. Natural soils classified as CL or CH on Unified Soil Classification System.
- 2.03 SAND BACKFILL
 - A. Sand bedding with addition of 5% by weight minimum powdered bentonite. Sand bedding being granular material meeting requirement of Section 703-01 "Standard Specifications" with the following gradation:

Sieve Size	% Passing by Weight
3/8 in.	100
No. 4	95 - 100
No. 50	15 - 50
No. 200	0 - 10

02221-2



- B. Sodium Powdered Bentonite: American Colloid or equal.
 - 1. Uniform gradation: 200 mesh dia.
 - 2. Pure bentonite, no additives: 90% sodium-montmorillonite.
 - 3. Free swell: High-swelling with minimum 16 cu cm/2 grams.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine surfaces to receive fill to determine existence of areas loosened by frost action, softened by flooding or weather or of unsuitable materials.

3.02 FILL USAGE

A. Sand Bedding:

- 1. Under leachate force main and electrical conduits, 3-in. minimum.
- 2. Above force main and electrical conduits, 6-in. minimum.
- 3. Below primary and secondary riser vaults as necessary to achieve a firm smooth surface.

B. General Fill Backfill:

- 1. 18-in. minimum thickness above electrical conduits and leachate transfer pipe force main, including a minimum 6 inches of sand bedding and minimum 12 inches of general fill.
- 2. Earth Fill: In accordance with Section 02220.

C. Sand/Bentonite Backfill:

- 1. At bottom of primary and secondary side slope riser trenches.
- 2. Mix dry powdered bentonite with sand at mixing area not in trench.
- 3. Bentonite shall be thoroughly dispersed throughout sand mixture and approved by DESIGNER prior to placement in trench.
- 4. Place minimum of 3 in. of sand/bentonite backfill across entire bottom of trench.
- 5. As shown on Drawings.

3.03 PREPARATION

- A. Remove and replace or compact natural soils or compacted fills softened by frost, flooding or weather.
- B. Remove unsuitable material from within trenches.
- C. Stabilize trench bottom and replace unsuitable material with additional sand bedding.

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- D. Dewatering:
 - 1. Keep construction site free-draining.
 - 2. Keep excavations free from water.

3.04 EXCAVATION

- A. Excavate to elevations and dimensions necessary to complete construction, and as shown on Drawings.
- B. Do not advance excavation of trenches more than 300 ft ahead of completed pipe installation.
- C. Do not excavate for manholes and other structures until scheduled for construction.
- D. Upon completion of excavation, notify DESIGNER before proceeding with further Work.

3.05 PLACING FILL

- A. Notify DESIGNER before placing fill material.
- B. 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 the frozen surface may damage the HDPE geomembrane liner system. For temporary stormwater diversion berms during construction fill can be placed when temperatures are below 25 degrees Fahrenheit.
- C. Compact clay backfill to minimum 90% of Modified Proctor density, 12-inc. thick maximum lift.
- D. Compact each lift of sand bedding with hand held vibratory compactor. Maximum lift thickness of 6 in.
- E. Compact sand bedding and bentonite mixture into sideslope riser trench by hand tamping. Tamp thoroughly into trench corners. Do not use vibratory compaction because of possibility of segregation of powered bentonite.
- F. Where pipes or electrical ducts must cross, ducts shall be a higher elevation and shall be separated from underlying pipes or ducts by minimum 6 inches of sand bedding.
- G. Where pipes or electrical ducts leave structure, protect by backfilling pipe or duct influence zone down to undisturbed soil with compacted clay backfill.
- H. Do not backfill until new concrete has properly cured.
- I. Place fill simultaneously on both sides of free-standing structures.
- J. Place warning tape, if required, in accordance with Section 15060.
- K. Construct in accordance with Section 15064.

* * * END OF SECTION * * *

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SECTION 02400 SMOOTH POLYETHYLENE GEOMEMBRANE

PART I GENERAL

1.01	SUMMARY

- A. Furnish and install polyethylene geomembrane for landfill base lining system.
- 1.02 RELATED SECTIONS
 - A. Section 01400- General Provisions for Geosynthetics
- 1.03 REFERENCES (Latest Version)
 - A. American Society for Testing and Materials (ASTM):
 - 1. ASTM D638 Standard Test Method for Tensile Properties of Plastics.
 - 2. ASTM D746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - 3. ASTM D751 Standard Test Methods of Testing Coated Fabrics.
 - 4. ASTM D792 Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - 5. ASTM D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
 - 6. ASTM D1204 Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
 - ASTM D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
 - 8. ASTM D1505 Standard Test Method for Density of Plastics by Density-Gradient Technique.
 - 9. ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
 - 10. ASTM D1693 Test Method for Environmental Stress Cracking of Ethylene Plastics
 - 11. ASTM D2663 Standard Test Method for Carbon Black Dispersion in Rubber.
 - 12. ASTM D4218 Test Method for Carbon Black Content in Polyethylene Compounds and Nonwoven Fabrics (Diaphragm Bursting Strength Tester Method).
 - 13. ASTM D3030- Standard Test Method for Volatile Matter (Including Water) of Vinyl Chloride Resins.
 - 14. ASTM D4437 Standard Practice for Determining Integrity of Field Seams used in Joining Flexible Polymeric Sheet Geomembranes.
 - 15. ASTM D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
 - 16. ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes
 - 17. ASTM D5397 Appendix Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembrane using Notched Constant Tension Load Test.
 - 18. ASTM D5596 Test Methods of Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
 - 19. ASTM D5994 Test Method for Measuring the Core Thickness of Textured Geomembranes.

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- B. Geosynthetic Research Institute (GRI):
 - 1. GRI Test GM-5 Ductile/Brittle Transition Time for Notched Polyethylene Specimens Under Constant Stress.
 - a. Test method modified as follows.
 - 1) Test 5 samples taken in cross-machine direction.
 - 2) Test specimens at 30% of room temperature yield stress.
 - 3) Test shall be discontinued upon failure of first specimen or when test duration exceeds specified value.
 - 2. GRI Test GM-4 Three-Dimensional Geomembrane Tension Test.

1.04 QUALITY CONTROL SUBMITTALS

- A. Pre-installation: Submit following to OWNER for approval, prior to geomembrane deployment.
 - 1. Origin (supplier's name and production plant) and identification (brand name and number) of resin.
 - Copies of dated quality control certificates issued by resin supplier.
 - 3. Results of tests conducted by geomembrane manufacturer to verify that resin used to manufacture geomembrane meets requirements of Paragraph 2.01.A.
 - 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 following categories as percent by weight: polyethylene, carbon black, other additives.
 - 6. Manufacturer's specification which includes properties listed in Paragraph 2.01.A., measured using appropriate test methods.
 - 7. Written certification minimum values given in geomembrane manufacturer's specification are guaranteed by geomembrane 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 in Paragraph 2.03.A.
- B. Installation: Submit following as installation proceeds.
 - 1. Quality control documentation recorded during installation.

2. Subgrade surface acceptance certificates signed by Geosynthetic Contractor, for each area that will be covered directly by geomembrane. Submit prior to geomembrane deployment. Deployment of geomembrane will be considered acceptance of subgrade if certificate not submitted.

1.05 FIELD SAMPLES

- A. Geomembrane sampling shall be conducted in accordance with QAM for following.
 - 1. Conformance Testing: Paragraph 3.01.A., of this section.
 - 2. Destructive Seam Testing: Paragraph 3.04.D., of this section.
- 1.06 DELIVERY, STORAGE, AND HANDLING
 - A. Packing and Shipping:
 - 1. Labels on each roll delivered to site shall identify following.
 - a. Manufacturer's name.
 - b. Product identification.
 - c Thickness.
 - d. Roll number.
 - e. Roll dimensions.
 - 2. Ensure geomembrane rolls properly loaded and secured to prevent damage during transit.
 - 3. Protect geomembrane from excessive heat, cold, puncture, cutting or other damaging or deleterious conditions.
 - 4. Ensure personnel responsible for loading, transport, and unloading of geomembrane fully aware of consequences of damage to geomembrane, and familiar with handling and transport constraints imposed by manufacturer.
 - B. Acceptance at Site:
 - Perform inventory and surface inspection for defects and damage, of geomembrane rolls upon delivery.
 - 2. Unroll and inspect any geomembrane roll that shows signs of internal damage.
 - 3. Damage resulting from handling and transport of geomembranes shall be repaired at no cost to OWNER. If irreparable, in opinion of Geosynthetic QAE, damaged materials shall be replaced at no cost to OWNER.
 - C. Storage and Protection:
 - 1. OWNER will provide on-site storage area for geomembrane rolls from time of delivery until installed.

- 2. After Geosynthetic Contractor mobilization, store and protect geomembrane from dirt, water, and other sources of damage.
- 3. Preserve integrity and readability of geomembrane roll labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. Supply geomembranes and resins meeting following requirements.

POLYETHYLENE GEOMEMBRANE PROPERTIES

Prop	erty	Method	Value
Thickness, average	minimum	ASTM D751 ASTM D5199 ASTM D5994	80 mils nominal
Thickness, individual	lowest	ASTM D751 ASTM D5199 ASTM D5994	72 mils minimum

Modifications: Type IV Die. ASTM D638 test specimen shall be used. Grip separation shall be 2.5 in. Rate of grip separation shall be 2 in./min. Use extensometer to measure elongations. Alternatively, gauge length of 1.3 in. for yield values, and 2.0 in. for break values may be used to calculate elongation from grip movement.

Density (geomembrane)	ASTM D1505	0.940 g/cc minimum
Melt Index (resin) g/10	ASTM D1238	0.1 to 1.1 minimum- maximum

ASTM D638

Condition 190/2.16.

Tensile Properties

(each direction)	
 Yield strength Break strength Elongation at yield Elongation at break 	2,200 psi minimum 3,800 psi minimum 12% minimum 560% minimum

Modifications: Type IV Die. ASTM D638 test specimen shall be used. Grip separation shall be 2.5 in. Rate of grip separation shall be 2 in./min. Use extensometer to measure elongations. Alternatively, gauge length of 1.3 in. for yield values, and 2.0 in. for break values may be used to calculate elongation from grip movement:



Tear Strength	ASTM D1004	700 lbs./in. minimum
Puncture Resistance	FTMS 101 Method 2065	1,200 lbs./in. minimum
Low Temperature	ASTM D746	-60°C maximum
Carbon Black Content	ASTM D1603 ASTM D4218	2.0% to 3.0%
Carbon Black Dispersion	Thin section and ASTM D2663 ASTM D5596	A-I or A-2

Note: Prepare sample using microtome to produce thin section of geomembrane no thicker than 20 microns. Examine thin section at 100 times magnification.

Dimensional Stability

ASTM D1204

2.0% maximum change

(each direction)

Modifications: 100°C for 1 hr.

Environmental Stress

GRI GM-5

100 hrs minimum

Crack

ASTM D1693

ASTMD5397 Appendix

Note: Test method modified as noted in article 1.03.B

Multi-axial Elongation

GRI GM-4

20% minimum

- B. Geomembrane shall be manufactured from new polyethylene resin, except as noted in Paragraph 2.01.E., of this section.
- C. Geomembrane manufactured from noncomplying resin shall be rejected.
- D. Resin shall be designed and manufactured specifically for use in geomembrane.
- E. Use of geomembrane recycled during manufacturing process shall be permitted if done from factory regrind if recycled geomembrane does not exceed 2% by weight, and when manufacturer provides resin documentation of reclaimed material.
- F. Geomembrane shall have following characteristics.
 - 1. Contain maximum of 1% by weight of additives, fillers or extenders (not including carbon black).
 - 2. Contain between 2% and 3% by weight of carbon black for ultraviolet light resistance. Shall be added to otherwise pure polyethylene resin as part of resin manufacturing or roll manufacturing process.
 - No pinholes, bubbles or other surface features that compromise geomembrane integrity.
 Free of blisters, nondispersed raw materials, and other signs of contamination by foreign matter.

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2.02 SEAMING AND TESTING EQUIPMENT

A. Welding:

- Maintain on-site minimum of 2 spare operable seaming apparatus, unless otherwise agreed upon at preconstruction meeting.
- 2. Seaming equipment shall not damage geomemorane.
- 3. Protect geomembrane from damage in heavily trafficked areas.
- 4. Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus, or utilize hand-held gauges to measure extrudate temperatures.
- Use fusion-welding apparatus which are self-propelled devices equipped with following.
 - Gauge indicating temperature of heating element.
 - b. Method of monitoring relative pressure applied to geomembrane.
- B. Vacuum Testing: Equipment shall consist of following.
 - 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.
 - Pump assembly equipped with pressure controller and pipe connections.
 - 3. Pressure/vacuum rubber hose with fittings and connections.
 - 4. Bucket of soapy solution.
 - 5. Wide paint brush, or other means of applying soapy solution.
- C. Air Pressure Testing: Equipment shall consist of following.
 - Air pump (manual or motor driven), equipped with 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.
 - Air pressure monitoring device.

2.03 SOURCE QUALITY CONTROL

- A. Ensure geomembrane manufacturer meets conditions of this section.
- B. Tests, Inspections:
 - Geomembranes shall be tested by geomembrane manufacturer for quality control to demonstrate resin meets requirements of these Specifications.
 - Geomembrane manufacturer shall continuously monitor during manufacturing process for inclusions, bubbles or other defects.
 Geomembranes exhibiting defects not acceptable for installation.

- 3. Geomembrane manufacturer shall monitor thickness continuously during manufacturing process. Geomembrane failing to meet specified values shall not be acceptable for installation.
- 4. At minimum, following tests shall be performed in accordance with test methods specified in Paragraph 2.01.A., of this section.
 - a. Density.
 - b. Carbon black content.
 - c. Carbon black dispersion.
 - d. Thickness.
 - e. Tensile properties.
 - f. Tear strength.
 - g. Puncture resistance.

Geomembrane manufacturer shall perform these tests on geomembrane, minimum of once every 40,000 sq ft (4,000 sq m). Samples not meeting Specifications shall result in rejection of rolls represented by tests. At geomembrane manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify noncomplying rolls and to qualify individual rolls.

- 5. Perform environmental stress crack resistance test on geomembrane at minimum of once every resin lot (typically equivalent to 1 rail car or 180,000 lbs).
- 6. Following tests need not be run at 1/40,000 sq ft (4,000 sq m) frequency. Geomembrane manufacturer shall certify tests have been performed for each resin in accordance with test methods specified in Paragraph 2.01.A., of this section.
 - Dimensional stability.
 - b. Low temperature brittleness.
 - c. Multi-axial elongation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Conformance Testing:
 - 1. Geosynthetic QAC shall collect samples of geomembrane to be installed, for conformance testing, as outlined in QAM. Geosynthetic Contractor may request retesting of failed conformance tests, as outlined in QAM. Geosynthetic Contractor shall bear cost of retesting if results lead to material rejection. Geosynthetic QAC shall bear cost of retesting if original conformance tests are found to be in error.

3.02 PREPARATION

A. Surface Preparation:

- 1. Earthwork Contractor shall be responsible for preparing supporting soil for geomembrane placement. Earthwork not included in this section.
- After prepared surface accepted in accordance with QAM, report to OWNER changes in supporting soil condition that may require repair work. Maintain prepared soil surface.
- 3. Do not place geomembrane onto area softened by precipitation or cracked due to desiccation. Observe soil surface daily to evaluate softening and desiccation cracking.
- 4. Repair, at Geosynthetic Contractor's expense, damage to subgrade caused by installation activities.

3.03 INSTALLATION

A. Panel Nomenclature:

- Field panel defined as unit of geomembrane to be seamed in field, i.e., field panel is roll or portion of roll cut in field.
- Identify each field panel with identification code (number or letter-number) consistent with Geosynthetic Contractor's layout plan. Identification code shall be agreed upon by OWNER. Geosynthetic Contractor, and Geosynthetic QAE.

B. Protection:

- Do not use equipment which damages geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons or other means.
- 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 on 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 or anchoring (e.g., sandbags, tires) not damaging 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.

Field Panel Deployment: С.

- Install field panels at locations indicated on Geosynthetic Contractor's layout plan, as approved by OWNER.
- Replace seriously damaged (torn, twisted or crimped) field panels, or portions thereof, at no cost to OWNER. Repair less serious damage in accordance with Paragraph 3.03.H., of this section. Geosynthetic QAC shall determine if material to be repaired or replaced.
- Remove from Work area damaged panels or portions of damaged panels which have been rejected. Repairs shall be made using procedures described in Paragraph 3.03.H., of this section.
- 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°C (50°C) unless otherwise authorized, in writing, by OWNER.
- 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.
- . Do not undertake deployment if weather conditions will preclude material seaming on same day as deployment.
- Do not deploy more geomembrane field panels in one day than can be seamed during that day.

Seam Layout: D.

- When possible, orient seams parallel to line of maximum slope, i.e., oriented along, not across, slope.
- No horizontal seam shall be less than 5 ft (1.5 m) from toe of 2. potential stress concentration unless slope, or areas of otherwise authorized by OWNER.
- In general, maximize lengths of field panels and minimize number of field seams.

Temporary Bonding: Ĕ.

- Requires approval from NYSDEC prior to performing temporary 1.
- Hot air device (Liester) may be used to temporarily bond geo-2. membrane panels to be extrusion welded.
- Do not damage geomembrane when temporarily bonding adjacent 3. 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.
- Do not use solvent or adhesive. 4.
- Refer to Appendix F of the Construction Quality Assurance Plan.

Seaming Methods: F.

Approved processes for field seaming are extrusion fillet welding and fusion 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.

POLYETHYLENE SEAM PROPERTIES

Property	Method	Specified Value
Bonded Seam Strength	ASTM D4437	2,000 psi minimum
Peel Adhesion:		
Fusion Extrusion	ASTM D4437 ASTM D4437	1,500 psi minimum 1,300 psi minimum

Modifications: For shear tests, sheet shall yield before failure of seam. For peel adhesion, seam separation shall not extend more than 10% of seam width into seam. For either test, testing shall be discontinued when sample has visually yielded.

- 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. Place electric generator on smooth base so no damage occurs to geomembrane.
 - c. Place protective layer, e.g. insulating plate or fabric, beneath hot welding apparatus after usage.
 - d. 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 build-up 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.
 - a. Purge heat-degraded extrudate from barrel of extruder under following conditions.
 - 1) Prior to beginning seam.
 - 2) When extruder has been inactive.

- Place electric generator on smooth base so no damage occurs Ъ. to geomembrane.
- Place smooth insulating plate or fabric beneath hot welding c. apparatus after usage.
- Use clean and dry welding rods or extrudate pellets. d.
- Complete grinding process without damaging geomembrane within 1 hr of seaming operation.
- Minimize exposed grinding marks adjacent to extrusion weld. f. Do not allow exposed grinding marks to extend more than 1/4 in. outside finished seam area.

Seaming Procedures: G.

General Seaming Procedures: 1.

- Seaming shall not be allowed at ambient temperature below 32°F (0°C) or above ambient temperature of 104°F (40°C) or а. above sheet temperature of 122°F (50°C).
- Dry conditions, i.e., no precipitation or other excessive moisture, such as fog or dew.
- No excessive winds. С.
- If required, provide firm substrate by using extra piece of geomembrane, or similar hard surface directly under seam d. overlap to achieve proper support for seaming apparatus.
- Align seams with fewest possible number of wrinkles and е. fishmouths.
- Provide adequate illumination if seaming operations are f. carried out at night.
- Extend seams to outside edge of panels placed in anchor g. trench.
- Do not field seam without master seamer being present. h.
- Prior to seaming, ensure that seam area is clean and free of moisture, dust, dirt, debris or foreign material of any kind.
- Cut fishmouths or wrinkles along ridge of wrinkle in order Seam cut fishmouths or wrinkles j. to achieve flat overlap. 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.
- Cold Weather Seaming Procedures: Meet following conditions, in 2. addition to general seaming procedures, if seaming is conducted when ambient temperature is below 32°F (0°C).
 - Geosynthetic QAC shall determine geomembrane surface temperatures at intervals of at least once per 100 ft of seam length to determine if preheating required. For extrusion welding, preheating required if surface temperature of geomembrane below 32°F (0°C).

- b. Preheating may be waived by OWNER based on recommendation from Geosynthetic QAE, if demonstrated welds of equivalent quality may be obtained without preheating at expected temperature of installation.
- c. If preheating required, Geosynthetic QAC shall observe areas of geomembrane preheated by hot air device prior to seaming, to ensure they have not been subjected to excessive melting.
- d. Geosynthetic QAE shall confirm 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. Preheating devices used shall be pre-approved by ${\tt OWNER}$ prior to use.
- f. Additional destructive seam tests (as described in Paragraph 3.04.D., of this section) shall be taken at interval between 500 ft and 250 ft of seam length, at Geosynthetic QAE'S discretion.
- g. Sheet grinding may be performed before preheating, if applicable.
- h. Trial seaming, as described in Paragraph 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: Meet following conditions, in addition to general seaming procedures, if seaming conducted when sheet temperature is 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 (Paragraph 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. At option of Geosynthetic QAC, additional destructive seam tests (Paragraph 3.04.D.) may be required.

H. Repair Procedures:

1. Repair portions of geomembrane exhibiting flaw or failing destructive or nondestructive test.

- 2. Final decision as to appropriate repair procedure shall be agreed upon between OWNER, Geosynthetic Contractor, and Geosynthetic QAE.
- 3. Available repair procedures include following.
 - a. Patching: Piece of same geomembrane extrusion welded into place. Use to repair large holes, tears, nondispersed 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 (less than or equal to 1/16") 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 seam and replace with strip of same geomembrane welded into place. Use to repair large lengths of failed seams.
- 4. For repair methods, satisfy following.
 - a. Grind surfaces of geomembrane to be repaired using extrusion methods, no more than-I hr prior to repair.
 - b. Ensure surfaces are clean and dry at time of repair.
 - c. Ensure seaming equipment used in repairing procedures meets requirements of Project quality assurance plan.
 - d. Extend patches or caps at least 6 in. (150 mm) beyond edge of defect. Round corners of patches with radius of approximately 3 in. (75 mm).
- 5. Do not place overlying layers over repaired locations 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 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, minimize amount of trench open at any time.
- 4. Remove construction-related debris from anchor trench.
- 5. Earthwork Contractor shall backfill and compact anchor trench as soon as practical after geomembrane installation complete. Prevent damage to geosynthetics when backfilling trenches.

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- 6. After Geosynthetic Contractor accepts subgrade, ensure excessive amounts of loose soil do not underlie geomembrane in anchor trench.
- OWNER will ensure anchor trench will be adequately drained to prevent ponding or softening of adjacent soils while trench is open.

3.04 FIELD QUALITY CONTROL

A. Visual Inspection:

- Geosynthetic QAC shall examine seam and nonseam areas of geomembrane for identification of defects, holes, blisters, nondispersed raw materials, and signs of contamination by foreign matter.
- Clean and wash geomembrane surface if Geosynthetic QAC determines amount of dust or mud inhibits examination.
- 3. Do not seam geomembrane panels that have not been examined for flaws by Geosynthetic QAC.
- 4. Nondestructively test each suspect location as in seam and non-seam areas using methods described in Paragraph 3.04.C., of this section as appropriate.

B. Trial Seams:

- 1. Make trial seams on fragment pieces of geomembrane liner to verify conditions adequate for production seaming.
- 2. Make trial seams at beginning of each seaming period, and at least once each 5 hrs, for each production seaming apparatus used that day. Each seamer shall make at least one trial seam each day.
- 3. Make trial seams under same conditions as actual seams.
- 4. Make trial seams only under observation of Geosynthetic QAC.
- 5. Seam overlap shall be as indicated in Paragraph 3.03.F., of this section.
- 6. Make trial seam sample at least 5 ft $(1.6\ \mathrm{m})$ long by 1 ft $(0.3\ \mathrm{m})$ wide (after seaming) with seam centered lengthwise.
- 7. Cut 2 specimens from sample with 1 in. (25 mm) wide die. Specimen locations shall be selected randomly along trial seam sample by Geosynthetic QAC. Test specimens in peel using field tensiometer. Tensiometer shall be capable of maintaining constant jaw separation rate of 2 in./min, and calibrated, with certificate of calibration less than 1 yr old kept with tensiometer. Specimens shall not fail in seam as described in Subparagraph 3.04.D.5., of this section. Document results.
- 8. If specimen fails, repeat entire operation. If additional specimen fails, do not use seaming apparatus and seamer until deficiencies corrected and 2 consecutive successful trial welds achieved.

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9. Cut remainder of successful trial seam into 3 pieces; one to be retained in OWNER'S archives, one to be retained by Geosynthetic Contractor, and one to be retained by Geosynthetic 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 Paragraph 3.04.D., of this section.

C. Nondestructive Seam Testing:

I. General:

- Purpose of nondestructive tests is to check continuity of seams. It does not provide quantitative information on seam strength.
- b. Nondestructively test field seams over their full length using vacuum test (for extrusion seams), air pressure (for double-fusion seams) or other OWNER/NYSDEC-approved method. Document results.
- Perform nondestructive testing as seaming work progresses, not at completion of field seaming.
- d. Nondestructive testing of extrusion welds associated with HDPE pipe boots may be performed using the spark test method.

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 by 1.2 m) with soapy solution.
- Place box over wetted area.
- d. Close bleed valve and open vacuum valve.
- e. Ensure leaktight seal is created.
- For period of not less than 10 sec, apply vacuum and examine geomembrane through viewing window for presence of soap bubbles.
- g. If no bubbles appear within 10 sec, close vacuum valve and open bleed valve, move box over to next adjoining area with minimum 3 in. (75 mm) overlap and repeat process.
- h. Mark and repair areas where soap bubbles appear in accordance with Paragraph 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. Place protective layer between air pump and geomembrane.

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d. Pressurize air channel to pressure of approximately 30 psi (200 kPa). Close valve and allow pressure to stabilize for approximately 2 min. After 2-min stabilization period, ensure pressure is within range listed below.

INITIAL PRESSURE SCHEDULE

Material (mil)	Minimum <u>(psi)</u>	Maximum <u>(psi)</u>
40	24	30
60	27	35
80	30	35
100	30	35

e. 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 Paragraph 3.03.H.

MAXIMUM PERMISSIBLE PRESSURE DIFFERENTIAL AFTER 5 MIN

	Pressure
Material	Differential
<u>(mil)</u>	(psi)
40	4
60	3
80	2
100	2.

- f. Cut opposite end of tested seam area once testing is 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 Paragraph 3.03.H., of this section.
- g. Remove needle or other approved pressure feed device and seal hole in geomembrane.

4. Inaccessible Seams:

- Cap-strip seams that cannot be nondestructively tested.
- b. Cap-strip material shall be composed of same type and thickness geomembrane as geomembrane to be capped.

c. Examine cap-stripping operations with Geosynthetic QAC for uniformity and completeness. Document observations.

D. Destructive Seam Testing:

1. General:

- a. Purpose: Evaluate seam strength.
- b. Perform destructive seam tests as seaming progresses, not at completion of field work.
- c. Failed destructive seam sample shall result if grips of testing machine cannot be closed on sample test flap (available flap is 1/2 in. long or less) due to excessive temporary welding.

Location and Frequency:

- a. Test at minimum frequency of 5 subsamples transverse to each seam. Provide test frequency not less than 1 test location/500 ft (150 m) of seam length performed by each welder. Minimum frequency shall be determined as average taken throughout entire facility.
- b. Test locations shall be determined during seaming, at Geosynthetic QAC'S discretion.
- c. Geosynthetic Contractor shall 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 Geosynthetic QAC.
- b. Geosynthetic 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 Paragraph 3.03.H., of this section.
- d. Nondestructively test continuity of new seams in repaired area in accordance with Paragraph 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 Subparagraph 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. Geosynthetic QAC shall distribute parts as follows.
 - 1) One portion to Geosynthetic Contractor for optional laboratory testing, 12 in. by 12 in. (0.3 m by 0.3 m).
 - One portion to GQA laboratory for testing, 12 in. by 18 in. (0.3 m by 0.5 m).
 - 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 preconstruction meeting.

5. Field Testing:

- a. Test two l in. (25 mm) wide strips described in Subparagraph 3.04.D.4., for peel strength. Use tensiometer as described in Paragraph b below to conduct these tests. Tests shall not fail according to criteria in Subparagraph 3.03.F.l., of this section. Document results.
- b. Use tensiometer capable of maintaining constant jaw separation rate of 2 in./min. Tensiometer shall be calibrated, and certificate of calibration less than 1 yr old kept with tensiometer.
- c. Test field samples under Geosynthetic QAC'S observation.
- d. If test sample passes in accordance with this section, seam qualifies for laboratory testing.
- e. If field test samples fail to pass, follow procedures outlined in Subparagraph 3.04.D.6., of this section.
- f. Final judgement regarding seam acceptability, based on failure criteria in these Specifications, rests with Geosynthetic QAE.
- 6. Destructive Test Failure Procedures: Apply following procedures when sample fails destructive testing, whether test is conducted by laboratory or Geosynthetic Contractor using field tensiometer.
 - a. Geosynthetic Contractor has following options.
 - Repair seam between 2 passing destructive test locations.

- 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 laboratory samples pass tests, repair 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 taken. Passing laboratory destructive tests taken as indicated in Paragraph 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 repaired shall pass destructive testing. Make repairs in accordance with Paragraph 3.03.H.
- c. When sample fails, OWNER may require additional testing of seams welded by same welder or welding apparatus during same time shift.

E. Repair Verification:

- 1. Geosynthetic QAC shall number and log each repair.
- 2. Nondestructively test each repair using methods described in Paragraph 3.04.C., as appropriate. Document results.
- 3. Passing nondestructive test results indicate adequate repair.
- 4. Repairs more than 150 ft long require destructive test sampling, in accordance with Paragraph 3.04.D., of this section.
- 5. Failed destructive or nondestructive tests indicate 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 complete, and prior to placing overlying materials, Geosynthetic QAE shall identify excessive geomembrane wrinkles.
 - 2. Cut and reseam wrinkles identified by Geosynthetic QAC. Test seam produced while repairing wrinkles in accordance with Paragraph 3.03.H.
 - 3. Repair wrinkles identified by Geosynthetic QAC. Repair during coldest part of installation period.

* * * END OF SECTION * * *

SECTION 02401 TEXTURED POLYETHYLENE GEOMEMBRANE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Supply and install 40 mil textured polyethylene geomembrane for the landfill final cover system and 80 mil textured polyethylene geomembrane for the cell 7 through 14 base liner systems.

1.02 REFERENCES (LATEST VERSION)

- 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 D4218 Test Method for Carbon Black Content in Polyethylene Compounds and Nonwoven Fabrics (Diaphragm Bursting Strength Tester Method).
- H. ASTM D4437 Standard Practice for Non-Destructive Testing (NDT) for Determining the Integrity of Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
- ASTM D4833 Standard Test Method of Index Puncture Resistance of Geomembranes and Related Products.
- J. 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 final cover geomembrane with materials which will be installed above and below the geomembrane (i.e., geocomposite/40-mil textured geomembrane and 40-mil textured geomembrane/geosynthetic clay liner).
- K. ASTM D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.

- L. ASTM D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
- M. ASTM D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
- N. ASTM D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes.
- O. ASTM D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.
- P. ASTM D5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.
- Q. 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.
- R. 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.
- S. ASTM D6693 (Type IV) Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- T. ASTM D7466 Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.
- U. GRI GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet.
- V. GRI GM11 Accelerated Weathering of Geomembranes Using a Fluorescent UVA-Condensation Exposure Device.
- W. GRI GM13 Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
- X. GRI GM19 Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.03 QUALITY CONTROL SUBMITTALS.

- A. Pre-installation: Submit following to OWNER for approval, prior to geomembrane 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 tests conducted by geomembrane manufacturer to verify that resin used to manufacture geomembrane meets specifications listed in Article 2.01A.
 - 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 following categories as percent by weight: polyethylene, carbon black, and other additives.
 - 6. Manufacturer's specification, which includes properties, listed in Article 2.01 A measured using appropriate test methods.
 - 7. Written certification that minimum values given in geomembrane manufacturer's specification guaranteed by geomembrane 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.
- B. Installation: Submit following as installation proceeds
 - 1. Quality control documentation recorded during installation.
 - 2. Subgrade surface acceptance certificates signed by GEOSYNTHETIC CONTRACTOR, for each area that will be covered directly by geomembrane. Submit prior to geomembrane deployment. Deployment of geomembrane will be considered acceptance of sub-grade if certificate not submitted.

1.04 FIELD SAMPLES

- A. Geomembrane sampling shall be following: conducted in accordance with QAM for
 - 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. Labels on each roll delivered to site shall identify following:
 - a. Manufacturer's name.
 - b. Product identification.
 - c. Thickness.
 - d. Roll number.
 - e. Roll dimensions.

- 3. Ensure that geomembrane rolls properly loaded and secured to prevent damage during transit.
- 4. Protect geomembrane from excessive heat, cold, puncture, cutting, or other damaging or deleterious conditions.
- 5. Ensure personnel responsible for loading, transport, and unloading of geomembrane fully aware of consequences of damage to geomembrane, and familiar with handling and transport constraints imposed by manufacturer.

B. Acceptance at Site:

- 1. Perform inventory and surface inspection for defects and damage, of all geomembrane rolls upon delivery.
- 2. Unroll and inspect any geomembrane roll that shows signs of internal damage.
- 3. Damage resulting from handling and transport of geomembranes shall be repaired at no cost to OWNER. If irreparable, in option of GEOSYNTHETIC QAE, damaged materials shall be replaced at no cost of OWNER.

C. Storage and Protection:

- 1. OWNER will provide on-site storage area for geomembrane rolls from time of delivery until installed.
- 2. After GEOSYNTHETIC CONTRACTOR mobilization, store and protect geomembrane from dirt, water, and other sources of damage.
- 3. Preserve integrity and readability of geomembrane roll labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. Supply geomembranes and resins which meet 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)	76 mil (min ave)
		36 mil (lowest individual	72 mil (lowest individual
		for any 8 of 10 values)	for any 8 of 10 values)
		34 mil (lowest individual	68 mil (lowest individual
		for any of 10 values)	for any of 10 values)
Asperity Height	ASTM D7466	10 mil	(min ave)
		7 mil (min for	8 of 10 values)
		5 mil (lowe	st individual)
Density	ASTM D1505/D792	0.94 g/o	cm ³ (min)
Melt Index (resin)	ASTM D1238	0.1 to 1.1 g/1	0 min. (range)
Tensile Properties	ASTM D6693 Type IV	84 lb/in (yield)(min ave)	168 lb/in (yield)(min ave)
(5 replicates each		60 lb/in (break)(min ave)	120 lb/in (break)(min ave)

PROPERTY	METHOD*	REQUIRED VALUE	
		(min ave unless otherwise note	
		40 mil	80 mil
direction)		12% (yield elong.)	12% (yield elong.)
		(min ave)	(min ave)
		100% (break elong.)	100% (break elong.)
		(min ave)	(min ave)
Tear Resistance	ASTM D1004	28 lb (min ave)	56 lb (min ave)
Puncture Resistance	ASTM D4883	60 lb (min ave)	120 lb (min ave)
Stress Crack	ASTM D5397		300 hr
Resistance			
Carbon Black	ASTM D1603		2-3%
Content			
Carbon Black	ASTM D5596	9 in categories	1 or 2, 1 in category 3
Dispersion			
Oxidative Induction	ASTM D3895	100 minutes	
Time (OIT)	(Standard OIT)		
, ,	or		or
	ASTM D5885		
	(High Pressure OIT)	400 minutes	
Oven Aging at 85° C	ASTM D5721		
	Standard OIT, %		
	retained after 90 days	55%	
	(ASTM D3895)		
	or		or
	High Pressure OIT, %		
	retained after 90 days		80%
	(ASTM D5885)		
UV Resistance	High Pressure OIT, %		50%
	retained after 1,600		
	hours		
	(ASTM D5885)		

^{*} Test Methods as modified in Article 1.02

- B. Geomembrane shall be manufactured from new polyethylene resin, except as noted in Article 2.01 E of this section.
- C. Geomembrane manufactured from non-complying resin shall be rejected.
- D. Resin shall be designed and manufactured specifically for use in geomembranes.
- E. Use of geomembrane recycled during manufacturing process shall be permitted if done from factory regrind, if recycled geomembrane does not exceed 2% by weight, and when manufacturer provides resin documentation of reclaimed material.
- F. Geomembrane shall have following characteristics:

- 1. Contain maximum of 1% by weight of additives, fillers, or extenders (not including carbon black).
- 2. Contain between 2% and 3% by weight of carbon black for ultra-violet light resistance. This shall be added to otherwise pure polyethylene resin as part of resin manufacturing or roll manufacturing process.
- 3. No pinholes, and free of nondispersed raw materials or other signs of contamination by foreign matter.
- G. Final cover geomembrane interfaces shall be subjected for interface shear strength testing (ASTM D5321) to verify that the minimum required values are met. Refer to RMU-1 Technical Specification 02430 Geotextile/Geonet Composite for testing conditions and minimum required values.

2.02 SEAMING AND TESTING EQUIPMENT

A. Welding:

- 1. Maintain on-site minimum of 2 spare operable seaming apparatus, unless otherwise agreed upon at pre-construction meeting.
- 2. Seaming equipment shall not damage geomembrane.
- 3. Protect geomembrane from damage in heavily trafficked areas.
- 4. Use extrusion welding apparatus equipped with gauges giving temperature of extrudate at nozzle of apparatus, or utilize hand-held gauges to measure extrudate temperatures.
- 5. Use fusion-welding apparatus which are self-propelled devices equipped with following:
 - a. Gauge indicating temperature of heating element.
 - b. Method of monitoring relative pressure applied to 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.
 - 5. Wide paint brush, or other means of applying soapy solution.
- C. Air Pressure Testing: Equipment shall consist of following.
 - 1. Air pump (manual or motor driven), equipped with 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.
 - 4. An air pressure monitoring device.

2.03 SOURCE QUALITY CONTROL

A. Tests, Inspections:

- 1. Geomembranes shall be tested by geomembrane manufacturer for quality control to demonstrate that resin meets these specifications.
- 2. Geomembrane manufacturer shall continuously monitor during manufacturing process for inclusions, bubbles, or other defects. Geomembranes, which exhibit defects, shall not be acceptable for installation.
- 3. Geomembrane manufacturer shall monitor thickness continuously during manufacturing process. No geomembrane shall be acceptable for installation, which fails to meet specified values.
- 4. At minimum, following tests shall be performed in. accordance with test methods specified in Article 2.01 A of this section.
 - a. Density.
 - b. Carbon black content.
 - c. Carbon black dispersion.
 - d. Thickness.
 - e. Tensile properties.
 - f. Tear Strength.
 - g. Puncture resistance.

Geomembrane manufacturer shall perform these tests on geomembrane, at minimum of once every 40,000-ft.² (4000 m²). Samples not satisfying specifications shall result in rejection of rolls represented by tests. At geomembrane 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.

- 5. Perform environmental stress crack resistance test on geomembrane at minimum of once every resin lot (typically equivalent to 1 rail car or 180,000 lbs.).
- 6. Following tests need not be run at 1 per 40,000-ft.² (4000 m²) frequency. Geomembrane manufacturer shall certify that these tests have been performed for each resin (except as noted) in accordance with test methods specified in Article 2.01 A of this section.
 - a. Dimension Stability.
 - b. Low temperature brittleness.
 - c. Multi-axial elongation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Conformance Testing:

1. GEOSYNTHETIC QAC shall collect samples of geomembrane to be installed, for conformance testing, as outlined in Section 9.4 of QAM. GEOSYNTHETIC CONTRACTOR may request retesting of failed conformance tests, as outlined in

QAM. GEOSYNTHETIC CONTRACTOR shall bear cost of retesting if results lead to material rejection. Geosynthetic QAC shall bear cost of retesting if original conformance tests found to be in error.

3.02 PREPARATION

A. Surface Preparation:

- 1. Earthwork contractor shall be responsible for preparing supporting soil for geomembrane placement. Earthwork specifications not included in this section.
- 2. 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.
- 3. Do not place geomembrane onto area, which has become softened by precipitation or cracked due to desiccation. Observe soil surface daily to evaluate softening and desiccation cracking.
- 4. Repair at GEOSYNTHETIC CONTRACTOR'S expense damage to subgrade caused by installation activities.

3.03 INSTALLATION

A. Panel Nomenclature:

- 1. Field panel defined as unit of geomembrane, which is to be seamed in field, i.e., field panel roll or portion of roll cut in field.
- 2. Identify each field panel with identification code (number or letter-number) consistent with GEOSYNTHETIC CONTRACTOR'S layout plan. This identification code shall be agreed upon by OWNER, GEOSYNTHETIC CONTRACTOR, and GEOSYNTHETIC QAE.

B. Protection:

- 1. Do not use equipment, which damages geomembrane by handling, trafficking, excessive heat, leakage of hydrocarbons, or other means.
- 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 on 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 recommended along panel edges.
- 8. Protect geomembrane in areas where excessive traffic expected with geotextiles, extra geomembrane, or other suitable materials.

C. Field Panel Deployment:

- 1. Install field panels at locations indicated on GEOSYNTHETIC CONTRACTOR'S 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. GEOSYNTHETIC QAC shall determine if material to be repaired or replaced.
- 3. Remove from work area damaged panels or portions of damaged panels, which have been rejected. Repairs shall be made using procedures described in Article 3.03 H of this section.
- 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 undertake deployment if weather conditions will preclude material seaming on same day as deployment.
- 7. Do not deploy more geomembrane field panels in l-day than can be seamed during that day.

D. Seam 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.
- 4. For the final cover geomembrane, extrusion welding the textured to textured seams will be the preferred welding method for the diagonal seam locations at the corners. One full destructive test must be performed at each seam location. Seams will be welded diagonally on the panels that occur in corner locations and will be staggered at a minimum distance of 30 feet apart. One seam will be allowed between final cover benches on the slope.

E. Temporary Bonding:

- 1. Requires approval from NYDEC prior to performing and temporary bonding.
- 2. Hot air device (Liester) may be used to temporarily bond geomembrane panels that are to be extrusion welded.
- 3. 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.
- 4. Do not use solvent or adhesive.

- 5. Refer to Appendix F of the Construction Quality Assurance Plan.
- 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 for approval. Alternate procedures shall be used only after being approved in writing by OWNER.
 - 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. Place electric generator on smooth base such that no damage occurs to geomembrane.
 - c. Place protective layer, e.g. insulating plate or fabric, beneath hot welding apparatus after usage.
 - d. 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 and in corners of the perimeter berm and perimeter berm/intercell berm intersections.
 - a. Purge heat-degraded extrudate from barrel of extruder under following conditions:
 - 1) Prior to beginning seam.
 - 2) Whenever extruder has been inactive.
 - b. Place electric generator on smooth base such that no damage occurs to geomembrane.
 - c. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.

- d. Use clean and dry welding rods or extrudate pellets.
- e. Complete grinding process without damaging geomembrane within 1-hr of seaming operation.
- f. Minimize exposed grinding marks adjacent to extrusion weld. Do not allow exposed grinding marks to extend more than 1/4-in. outside finished seam area.

G. Seaming Procedures:

1. General Seaming Procedures

- a. Seaming shall not be allowed 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).
- b. Dry conditions, i.e. no precipitation or other excessive moisture.
- c. No excessive winds.
- d. 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.
- e. Align seams with least possible number of wrinkles and fishmouths.
- f. Provide adequate illumination if seaming operations carried out at night.
- g. Extend seams to outside edge of panels placed in anchor trench.
- h. Do not field seam without master seamer being present.
- i. Prior to seaming, ensure that seam area clean and free of moisture, dust, dirt, debris or foreign material of any kind.
- j. 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.
- 2. Cold Weather Seaming Procedures: Meet following conditions, in addition to general seaming procedures, if seaming conducted when ambient temperature below 32°F (O°C).
 - a. GEOSYNTHETIC QAC shall determine geomembrane surface temperatures at intervals of at least once per 100 ft of seam length to determine if preheating required. For extrusion welding, preheating required if surface temperature of geomembrane below 32°F (0°C).
 - b. Preheating may be waived by OWNER based on recommendation from GEOSYNTHETIC QAE, if demonstrated to GEOSYNTHETIC QAE's satisfaction that welds of equivalent quality may be obtained without preheating at expected temperature of installation.
 - c. If preheating required, GEOSYNTHETIC 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. GEOSYNTHETIC QAE 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. Preheating devices used shall be pre-approved by OWNER prior to use.

- f. 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 GEOSYNTHETIC QAE's discretion.
- g. Sheet grinding may be performed before preheating, if applicable.
- h. 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: 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. At option of GEOSYNTHETIC QAC, additional destructive seam tests (as described in Article 3.04 D) may be required.

H. Repair Procedures:

- 1. Repair portions of geomembrane exhibiting flaw, or failing destructive or nondestructive test.
- 2. Final decision as to appropriate repair procedure shall be agreed upon between OWNER, GEOSYNTHETIC CONTRACTOR, and GEOSYNTHETIC QAE.
- 3. Available repair procedures include following:
 - a. Patching: Piece of same geomembrane extrusion welded into place. Use to repair large holes, tears, nondispersed 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 (less than or equal to 1/16"), 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 seam and replace with strip of same geomembrane welded into place. Use to repair large lengths of failed seams.

- 4. For any repair method, satisfy following:
 - a. Grind surfaces of geomembrane which are to be repaired using extrusion methods, no more than l-hr. prior to repair.
 - b. Ensure surfaces clean and dry at time of repair.
 - c. Ensure seaming equipment used in repairing procedures meets requirements of project quality assurance plan.
 - d. Extend patches or caps at least 6 in. (150 mm) beyond edge of defect. Round corners of patches with radius of approximately 3 in. (75 mm).
 - e. Blisters, lazer holes, undispersed raw materials, and contamination by foreign- matter will be repaired by patching.
- 5. 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.
- 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. After GEOSYNTHETIC CONTRACTOR accepts subgrade, ensure excessive amounts of loose soil do not underlie geomembrane in anchor trench.
- 7. OWNER will ensure that anchor trench will be adequately drained to prevent ponding or softening of adjacent soils while trench open.

3.04 FIELD QUALITY CONTROL

A. Visual Inspection:

- 1. GEOSYNTHETIC QAC shall examine seam and non-seam areas of geomembrane for identification of defects, holes, blisters, nondispersed raw materials, and any sign of contamination by foreign matter.
- 2. Clean and wash geomembrane surface if GEOSYNTHETIC QAC determines that amount of dust or mud inhibits examination.
- 3. Do not seam any geomembrane panels that have not been examined for flaws by GEOSYNTHETIC QAC.
- 4. Nondestructively test each suspect location as in seam and non-seam areas using methods described in Article 3.04 C of this section as appropriate.

B. Trial Seams:

1. Make trial seams on fragment pieces of geomembrane liner to verify those conditions adequate for production seaming.

- 2. Make trial seams at beginning of each seaming period, and at least once each 5 hrs, for each production seaming apparatus used that day. Each seamer shall make at least 1 trial seam each day.
- 3. Make trial seams under same conditions as actual seams.
- 4. Make trial seams only under observation of GEOSYNTHETIG QAG.
- 5. Seam overlap shall be as indicated in Article 3.03 F of this section.
- 6. Make trial seam sample at least 5 ft (1.5 m) long by 1-ft (0.3 m) wide (after seaming) with seam centered lengthwise.
- 7. Cut 2 specimens from sample with 1-in. (25 mm) wide die. These specimen locations shall be selected randomly along trial seam sample by GEOSYNTHETIG QAG. Test specimens in peel using field tensiometer. Tensiometer shall be capable of maintaining constant jaw separation rate of 2 in. per min, and shall be calibrated, with certificate of calibration less than 1-yr. old kept with tensiometer. Specimens should not fail in seam as described in Article 3.04 D.5 of this section. Document results.
- 8. If specimen fails, entire operation shall be repeated. If additional specimen fails, do not use seaming apparatus and seamer until deficiencies corrected and 2 consecutive successful trial welds achieved.
- 9. Cut remainder of successful trial seam into 3 pieces; 1 to be retained in OWNER'S archives, 1 to be retained by GEOSYNTHETIC CONTRACTOR, and 1 to be retained by GEOSYNTHETIC 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. Nondestructive Seam Testing:

1. General

- a. Purpose of nondestructive tests is to check continuity of seams. It does not provide quantitative information on seam strength.
- b. Nondestructively test field seams over their full length using vacuum test (for extrusion seams), air pressure (for double-fusion seams) or other OWNER/NYSDEC-approved method. Document results.
- c. Perform nondestructive 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 box over wetted area.
 - d. Close bleed valve and open vacuum valve.
 - e. Ensure that leak-tight seal created.
 - f. For period of not less than 10 seconds, apply vacuum and examine geomembrane through viewing window for presence of soap bubbles.
 - g. If no bubbles appear within 10 seconds, close vacuum valve and open bleed valve, move box over to next adjoining area with minimum 3 in. (75 mm) overlap and repeat process.

- h. 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. Place protective layer between air pump and geomembrane.
 - d. 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

e. Observe air pressure 5 min after initial 2-minute 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			

- f. 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.
- g. 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.
- b. Cap-strip material shall be composed of same type and thickness geomembrane as geomembrane to be capped.
- c. Examine cap-stripping operations with GEOSYNTHETIC QAC for uniformity and completeness. Document observations.

D. Destructive Seam Testing:

1. General:

- a. Purpose of destructive seam testing 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 entire facility.
- b. Test locations shall be determined during seaming, at GEOSYNTHETIC QAC's discretion.
- c. GEOSYNTHETIC CONTRACTOR 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 GEOSYNTHETIC QAC.
- b. GEOSYNTHETIC 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. Nondestructively 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. GEOSYNTHETIC QAC shall distribute parts as follows:
 - 1) One portion to GEOSYNTHETIC CONTRACTOR for optional laboratory testing, 12-in. by 12-in. (0.3 m by 0.3 m).
 - 2) One portion to Geosynthetic Quality Assurance Laboratory 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.1 of this section. Document 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 l-yr. old kept with tensiometer.
- c. Test field samples only under GEOSYNTHETIC 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 judgement regarding seam acceptability, based on failure criteria in these specifications, rests with GEOSYNTHETIC QAE.
- 6. Destructive Test Failure Procedures: Apply following procedures when sample fails destructive testing, whether that test conducted by laboratory, or by GEOSYNTHETIC CONTRACTOR using field tensiometer.
 - a. GEOSYNTHETIC CONTRACTOR has following options:
 - 1) Repair seam between any 2 passing destructive test locations.
 - Trace welding path to intermediate point (10-ft (3 m)) minimum from point of failed test in each direction) and take small sample with l-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 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. GEOSYNTHETIC QAC shall number and log each repair.

- 2. Nondestructively test each repair using methods described in Article 3.04 C as appropriate. Document results.
- 3. Passing nondestructive 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 nondestructive tests indicate that repair shall be redone and retested until passing test results.
- F. Large Wrinkles: Wrinkle considered to be large when geomembrane can be folded over onto itself.
 - 1. When seaming of geomembrane liner completed, and prior to placing overlying materials, GEOSYNTHETIC QAE shall identify all excessive geomembrane wrinkles.
 - 2. Cut and reseam all wrinkles identified by GEOSYNTHETIC QAC. Test seam produced while repairing wrinkles in accordance with Article 3.03 H.
 - 3. Repair wrinkles identified by GEOSYNTHETIC QAC. Repair during coldest part of installation period.

* * * END OF SECTION * * *

SECTION 02410 GEOTEXTILE

PART I GENERAL

1.01 SECTION INCLUDES

A. Supply and install geotextile for landfill lining and final cover systems.

1.02 RELATED SECTIONS

A. Section 01400- Geosynthetics

1.03 REFERENCES

Use latest version of referenced standards

- A. ASTM D3776 Test Methods for Mass Per Unit Area (Weight) of Woven Fabric.
- B. ASTM D3786 Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics Diaphragm Bursting Strength Tester Method.
- C. ASTM D4355 Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon-Art Type Apparatus).
- D. ASTM D4533 Test Method for Trapezoid Tearing Strength of Geotextiles.
- E. ASTM D4632 Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).
- F. ASTM D4833 Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
- G. ASTM D4751 Determining Apparent Opening Size of a Geotextile.
- H. ASTM D4491 Water Permeability of Geotextiles by Permittivity.
- I. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles

1.04 QUALITY CONTROL SUBMITTALS

A. Pre-installation:

Submit 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.

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- 2. Copies of dated quality control certificates issued by resin supplier.
- Results of tests conducted by geotextile manufacturer to verify that quality of resin used to manufacture geotextile meets geotextile manufacturer's resin specifications.
- 4. Statement indicating that reclaimed polymer added to resinduring manufacturing was done with appropriate cleanliness.
- 5. List of materials which comprise geotextile, expressed in following categories as percent by weight: base polymer, carbon black, other additives.
- 6. Manufacturer's specification for geotextile which includes properties contained in Article 2.01 of this section.
- Written certification that minimum average roll values given in manufacturer's specification guaranteed by geotextile manufacturer.
- 8. For needle-punched, non-woven geotextiles, written certification that geotextile 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 geotextile manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures and results of quality control tests.

B. Installation:

Submit following as installation proceeds:

 Subgrade surface acceptance certificates, signed by GEOSYNTHETIC CONTRACTOR, 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.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping:
 - 1. Geotextiles shall be supplied in rolls wrapped in relatively impermeable and opaque protective covers.
 - Geotextile rolls shall be marked or tagged with following information.
 - a. Manufacturer's name.
 - b. Product identification.
 - c. Roll number.
 - d. Roll dimensions.
 - e. Special instruction as necessary.

B. Storage and Protection:

- 1. OWNER will provide on-site storage area for geotextile rolls from time of delivery until installed.
- 2. After GEOSYNTHETIC CONTRACTOR mobilization, store and protect geotextile from dirt, water, ultraviolet light exposure, and other sources of damage.
- 3. Preserve integrity and readability of geotextile roll labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. Base Lining Systems

- 1. Geotextile shall be provided for various components of the base liner system.
 - a. For all base liner geotextile components except the base liner geocomposite in Cells 7 through 14, supply geotextile Trevira 1145 or equal in which "minimum average roll values," as defined by Federal Highway Administration (FHWA), meet or exceed geotextile property design requirement values specified below. Obtain written approval for these materials from OWNER.

GEOTEXTILE PROPERTIES

Property	<u>Method</u>	<u>Value</u>
Mass per Unit Area	ASTM D3776 ASTM D5261	13 oz/sq yd min.
Grab Strength	ASTM D4632	200 lb min.
Trapezoidal Tear Strength	ASTM D4533	75 lb min.
Puncture Resistance	ASTM D4833	95 lb min.
Burst Strength	ASTM D3786	300 psi min.
U.V. Resistance	ASTM D4355	70% min.

Additional Design criteria value requirements.

Property	Method	<u>Value</u>
Filtration	ASTM D4751	A.O.S. < 0.20 mm
Permeability (K)	ASTM D4491	$K \ge 1x10^{-2} \text{ cm/s}$
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b. For the base liner geocomposite in Cells 7 through 14 supply geotextile Trevira 1120 or equal in which "minimum average roll values," as defined by Federal Highway Administration (FHWA), meet or exceed geotextile property design requirement values specified below. Obtain written approval for these materials from OWNER.

GEOTEXTILE PROPERTIES

Property	<u>Method</u>	<u>Value</u>
Mass per Unit Area	ASTM D3776	5.7 oz/sq yd min.
Grab Strength	ASTM D4632	160 lb min.
Trapezoidal Tear Strength	a ASTM D4533	60 lb min.
Puncture Resistance	ASTM D4833	80 lb min.
Burst Strength	ASTM D3786	275 psi min.
U.V. Resistance	ASTM D4355	67% min.

Additional design criteria value requirements.

Property	Method	<u>Value</u>
Filtration	ASTM D4751	A.O.S.<0.210mm
Permeability (K)	ASTM D4491	$K \ge 1 \times 10^{-2} \text{ cm/s}$

B. Final Cover System:

1. Supply geotextile Trevira 1120 or equal in which "minimum average roll values", as defined by Federal Highway Administration (FHWA), meet or exceed geotextile property values specified below. Obtain written approval for these materials from OWNER.

GEOTEXTILE PROPERTIES

Property	Method	Value
Mass per Unit Area	ASTM D3776 ASTM D5261	5.7 oz/sq yd min.
Grab Strength	ASTM D4632	160 lb. min.
Trapezoidal Tear Strength	ASTM D4533	60 lb. min.
Puncture Resistance	ASTM D4833	80 lb. min.
Burst Strength	ASTM D3786	275 psi min.
U.V. Resistance	ASTM D4355	67% min.

2. Additional design criteria value requirements.

Property	Method	<u>Value</u>
Filtration	ASTM D4751	A.O.S.<0.21 mm
Permeability (K)	ASTM D4491	$K \ge 1 \times 10^{-2}$ cm/s
Clogging Potential	ASTM D5101*	Constant Value≤3

^{*}ASTM D5101 with modified sample and conditions as directed by the DESIGNER.

- C. Geotextiles shall be stock products, i.e., except when specifically authorized in writing by OWNER, supplier shall not furnish products specifically manufactured to meet these specifications.
- D. Geotextile shall be comprised of polymeric yarns, or fibers oriented into stable network which retains its structure during handling and placement.

2.02 SOURCE QUALITY CONTROL

Ensure that geotextile manufacturer meets conditions in this section.

A. Tests, Inspections:

1. Geotextiles shall be tested by geotextile manufacturer to evaluate characteristics for quality control. At minimum, following tests shall be performed in accordance with test methods specified in Article 2.01 of this section.

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- a. Mass per unit area.
- b. Grab strength.
- c. Trapezoidal tear strength.
- d. Burst strength.
- e. Puncture strength.
- 2. At minimum, quality control tests shall be performed for at least one every lot or at minimum, every 100,000 ft² (10,000 m²) of geotextile produced. Samples not satisfying these specifications and manufacturer's specifications shall result in rejection of applicable rolls.
- 3. At OWNER'S discretion and expense, additional testing of individual rolls may be performed to more closely identify noncomplying rolls and to qualify individual rolls.
- 4. Geotextile manufacturer shall certify that U.V. resistance, filtration, and permeability testing has been performed for each product and resin type in accordance with test method specified in Article 2.01 A 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. Conformance Testing:

1. GEOSYNTHETIC QAC shall collect samples of geotextiles to be installed for conformance testing. Sampling and testing shall be conducted as outlined in QAM.

3.02 INSTALLATION

A. Geotextile Deployment:

Handle geotextiles in manner to ensure they are not damaged. Comply with following:

- 1. On slopes, anchor geotextile securely and deploy it down slope in controlled manner to continually keep geotextile in tension.
- 2. Weight geotextile with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material.
- 3. Cut geotextiles 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 geomembrane, cause clogging of drains or filters, or hamper subsequent seaming.

- 6. Visually examine entire geotextile surface before seaming. Ensure no potentially harmful foreign objects, such as needles, are present. Remove 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 and is proposed for an application which requires tensile strength, 2 representative samples will be cut and submitted for wide width testing. The test results will be reviewed by the DESIGNER and accepted by the NYSDEC to determine if the Geotextile has sufficient tensile strength for use.

B. Seaming Procedures:

- 1. In general, horizontal seams or splices not allowed on side slopes greater than 10H:1V (i.e., seams shall be downslope, not across, slope) except as part of patch. Splice is defined as seam connecting ends of 2 rolls.
- 2. Overlap geotextile minimum of 3 in. (75 mm) prior to seaming.
- 3. On slopes steeper than 10:1 (horizontal:vertical), continuously sew geotextiles. Spot sewing not allowed.
- 4. On slopes shallower than 10: 1 (horizontal:vertical), continuously sew geotextiles.
- 5. Ensure at seams that no earth cover material present beneath geotextile.
- When sewing, use polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of geotextile. If polypropylene thread is exposed for more than 30 days, the CQA Engineer shall inspect the integrity of the seam and determine if the seam shall be resewn prior to covering.
- 7. Use sewing thread color that contrasts with color of geotextile being sewn, to allow for ease of inspection.
- 8. Use locking stitch.
- C. Defects and Repairs: Repair holes or tears in geotextile as follows.
 - On slopes, sew into place, in accordance with Paragraph 3.02.B. of this section, patch made from same geotextile, with minimum 12-in. (0.30 m) overlap in all directions.
 - 2. On slopes shallower than 10:1 (horizontal:vertical), sew geotextile patch into place using patch made from same geotextile, with minimum 12 in. (0.30 m) overlap in all directions.
 - 3. Remove soil or other material that may have penetrated torn geotextile.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Ensure following when deploying soil materials located on top of geotextile.
 - 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. thickness over geotextile maintained in traffic areas.
 - 5. Other conditions as required in Sections 02400 and 02401.

** * END OF SECTION * * *

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SECTION 02413 GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

- 1.01 SECTION INCLUDES
 - Supply and install GCL for landfill base liner system A.
- **RELATED SECTIONS** 1.02
 - A. Section 02410-Geotextiles.
- 1.03 REFERENCES

ASTM D3776 - Test Methods for Mass Per Unit Area (weight) of woven fabric

ASTM D4643 - Moisture Content

ASTM D5084 - Hydraulic Conductivity

ASTM D5261 - Test Method for Measuring Mass per Unit Area of Geotextiles.

ASTM D5890 - Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay

GRI GCL-1 - Swell Index.

GRI GCL-2 - Geogrid Junction Strength.

1.04 QUALITY CONTROL SUBMITTALS

- Prior to installation. Submit following to OWNER for approval prior to GCL deployment: Α.
 - 1. Identification of bentonite used for production of GCL.
 - 2. Results of quality control tests conducted by GCL Manufacturer to verify that bentonite supplied met GCL Manufacturer's specifications.
 - Written certification that minimum values given in Specifications are guaranteed by Manufacturer. 3.
 - 4. Quality control certificates, signed by responsible party employed by Manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures, and results of quality control tests. These quality control tests shall be performed in accordance with test methods for at least every 10,000 ft² (1,000 m²) for moisture content swell index, and mass per unit area. Hydraulic conductivity (permeability) tests shall be performed in accordance with test methods for at least every 100,000 ft² (10,000 m²) of GCL produced. At minimum, results shall be submitted for:
 - a. Moisture content (ASTM D4643).
 - b. Permeability (ASTM D5084 or GRI GCL-2).
 - c. Swell index (GRI GCL 1 or ASTM D5890).
 - d. Mass per unit area (ASTM D3776 or ASTM D5261 or ASTM D5993).
- B. Submit in accordance with Section 01300.
- 1.05 QUALITY ASSURANCE
 - A. CONTRACTOR shall assist Geosynthetic QAC inventory GCL rolls and obtain laboratory samples.
 - B. One sample representing each 100,000 sq ft of material delivered shall be tested for:

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- 1. Moisture Content: ASTM D4643
- 2. Mass per unit area: ASTM D3776 or ASTM D5261
- 3. Hydraulic conductivity: ASTM D5084 or GRI GCL-2 (each 250,000 sq ft)
- C. Material not meeting Specification shall be rejected and removed from site at CONTRACTOR'S expense. Retesting at CONTRACTOR'S expense may be performed to limit rejection to specific rolls rather than area of material listed in item B.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect GCL from ultraviolet light exposure, moisture, excessive humidity, puncture, cutting, or other damaging conditions.
- B. Identify rolls of GCL with following:
 - 1. Manufacturer's name.
 - 2. Product identification.
 - 3. Roll number.
 - 4. Roll dimensions.
- C. Handle rolls in accordance with ASTM D4873.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Manufacturers:
 - 1. Bentofix NS* manufactured by Albarrie Nave LTD and distributed by National Seal Corporation or approved equal.
- B. GCL Properties (Two (2) or more layers of GCL may be used as approved by ENGINEER):

GEOSYNTHETIC CLAY LINER			
Property	Method	Value	
Permeability Mass Per Unit Area	ASTM D5084 or GRI GCL-2	1 x 10 ⁻⁹ cm/sec max.	
1. Bentonite Content 2. Geotextile Upper Layer 3. Geotextile Lower Layer (Non-Woven)	ASTM D3776 or ASTM D5261 or ASTM D5993	 1.0 lb/ft² dry weight min. 3.10 oz/yd² min. 6.00 oz/yd² min. 	

PART 3 EXECUTION

3.01 EXAMINATION

A. Geosynthetic QAC shall insure supporting soil surface for GCL is below 100% saturation and free of debris or materials that could damage rolls all samples of GCL to be installed will be collected for archiving.

3.02 INSTALLATION

- A. Overlap GCL seams minimum of 6 in. on edge seams and minimum of 12 in. on end seams after shrinkage and before placing cover.
- B. Do not deploy more GCL in one day that can be covered by end of that day.
- C. Repair perforations or cuts in GCL with additional GCL layer extending 1-ft past edge of perforation or cut in each direction.
- D. Handle rolls to minimize loss of bentonite along edges during deployment.
- E. Upon visual inspection and as directed by the ENGINEER, GCL exposed to moisture or premature hydration prior to placement of overlying material shall be removed and replaced.

3.03 GCL PROTECTION

- A. Materials placed on top of GCL shall comply with following:
 - 1. GCL and underlying materials are not damaged.
 - 2. Minimum slippage of GCL on underlying layers occurs.
 - 3. No excess tensile stress occurs in GCL.

* * * END OF SECTION * * *

SECTION 02413-FC FINAL COVER GEOSYNTHETIC CLAY LINER (GCL)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The GEOSYNTHETICS CONTRACTOR shall furnish all labor, materials, equipment, tools and appurtenances required to complete the installation of all geosynthetic clay liner (GCL) layers as shown on the Drawings.
- B. GCL will be installed as part of the landfill final cover system construction. The following technical specifications present requirements for the manufacturing, testing, transport, storage, and installation of the GCL.

1.02 RELATED SECTIONS

- A. Section 01340 Submittals.
- B. Section 02210 Site Grading.
- C. Section 02410 Geotextiles.

1.03 REFERENCES

- A. ASTM D4354 Standard Practice for Sampling of Geosynthetics for Testing.
- B. ASTM D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
- C. ASTM D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
- D. ASTM D5887 Standard Test Method for Measurement of Index Flux Through Saturated Geosynthetic Clay Liner Specimens Using a Flexible Wall Permeameter.
- E. ASTM D5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners.
- F. ASTM D5889 Standard Practice for Quality Control of Geosynthetic Clay Liners.
- G. ASTM D4643 Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Method.
- H. ASTM D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
- I. ASTM D5890 Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners.

- J. ASTM D5891 Standard Test Method for Fluid Loss of Clay Component of Geosynthetic Clay Liners.
- K. ASTM D5993 Standard Test Method for Measuring Mass per Unit Area of Geosynthetic Clay Liners.
- L. 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., 40-mil textured membrane/GCL interface, and GCL/soil 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 200, 400, and 1000 psf with a minimum displacement distance which is adequate to allow for an extrapolated estimate of residual shear strength.
- M. ASTM D6495 Standard Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners.
- N. ASTM D5084 Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter (Permeability)

Note: The most current version of the specified test method shall be followed by the MANUFACTURER, GEOSYNTHETICS CONTRACTOR, or authorized testing laboratory.

1.04 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.

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1.05 SUBMITTALS

- A. The GEOSYNTHETICS CONTRACTOR shall submit to the DESIGNER, 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 CONTRACTOR's experience on a minimum of five 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 CONTRACTOR 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 MANUFACTURER's Manufacturing Quality Assurance/Manufacturing Quality Control (MQA/MQC) Plan for testing GCL.
 - d. A statement of the GCL MANUFACTURER's experience in manufacturing GCL, including the manufacturing and supplying company's name, address, and employee contact.
 - e. A certification from the GCL MANUFACTURER attesting that the proposed GCL meets the physical, mechanical, and manufacturing requirements specified in Part 2 of this Section.
 - f. Copies of the 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 CQA ENGINEER.
 - 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 of this Section.

2. Prior to Installation:

- 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 prior to covering and after covering, but prior to placement of cover soils over the final cover geocomposite.

3. During Installation Submitted Weekly:

a. Weekly construction progress reports clearly showing GCL panels and GCL roll numbers placed by date.

4. Upon Completion:

- a. Record Panel Layout Diagram.
- b. Summary and log of all laboratory quality control and quality assurance completed by GEOSYNTHETIC CONTRACTOR.
- c. Summary and log of all field quality control work completed by the GEOSYNTHETICS CONTRACTOR.
- d. Certification that GCL installation is complete and in accordance with these specifications.

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e. Statement of material and installation warranties.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. The GEOSYNTHETICS CONTRACTOR shall be responsible for the protection of the GCL against damage during transportation to the site, 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 manufactured GCL shall be supplied dry (unhydrated, moisture content no greater than 35%) 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 roll tarped 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 CQA ENGINEER.
- 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 CONTRACTOR shall protect the work described in this Section before, during, and after installation. Only nondamaged, sufficiently dry material (as determined by the CQA ENGINEER) 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.

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K. If the CQA ENGINEER determines that GCL is damaged, the GEOSYNTHETICS CONTRACTOR shall make all repairs and replacements in a timely manner to prevent delays in the progress of work. Any material damaged by the GEOSYNTHETICS CONTRACTOR, or damaged by others due to improper delivery, installation and/or storage, as determined by the CQA ENGINEER, shall be replaced by the GEOSYNTHETICS CONTRACTOR at no cost to the OWNER.

1.07 QUALITY ASSURANCE SAMPLING, TESTING, AND ACCEPTANCE

- A. The GCL shall be subject to sampling and testing to verify conformance with this specification.
- B. Samples shall be taken across the entire width of the GCL roll. Unless otherwise specified or permitted by the DESIGNER, samples shall be 3 feet long by the roll width. The CQA ENGINEER 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 (ft²) of material delivered to the site. An appropriate number of samples as determined by the CQA ENGINEER will be shipped directly to the Geosynthetics QAL. The CQA ENGINEER shall examine the material properties required by this Section against all results from laboratory conformance testing. Nonconforming material will be rejected and bracketed from subsequent rolls from the same product lot.
- C. 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:
 - 1. Mass per Unit Area of Bentonite (ASTM D5993).
 - 2. Mass per Unit Area Upper and Lower Layer Geotextile (ASTM D5261).
 - 3. Bentonite Moisture Content (ASTM D4643).
 - 4. Index Flux of GCL (ASTM D5887).
 - 5. Grab Tensile Strength of GCL (ASTM D4632).
- D. The GEOSYNTHETICS CONTRACTOR shall, at no additional cost to the OWNER, provide whatever reasonable assistance the CQA ENGINEER may require in obtaining the samples for conformance testing.
- E. The GEOSYNTHETICS CONTRACTOR shall provide MQC data issued by the manufacturer prior to site delivery of the GCL to the CQA ENGINEER. 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.
- F. 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

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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.

PART 2 MATERIALS

2.01 GENERAL

- A. The GCL shall consist of a low permeability sodium bentonite encapsulated between two nonwoven geotextiles with shear reinforcement (sewn or needle-punched). The bentonite and finished product requirements are described in the following Parts and include the minimum MQA and MQC testing.
- B. The GEOSYNTHETICS CONTRACTOR shall obtain a certificate from the GCL manufacturer for MQC testing described in this Part.
- C. The CQA ENGINEER shall obtain nine random samples of the proposed GCL and materials that will be installed above and below the GCL for the Final Cover System, if not previously tested and accepted. These samples will undergo interface shear strength testing for each interface (i.e., 40 mil textured membrane/GCL interface and GCL/soil separation layer interface). Additionally, three random samples of the proposed GCL for the Final Cover System shall be submitted for testing of internal shear strength. 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 Paragraphs C.1 and C.2 of this Part and the reported results shall meet the requirements of Paragraph C.3 of this Part.
 - 1. Slow Strain Rate Testing: 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 0.0004 in./min.
 - 2. Rapid Strain Rate Testing: 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 the maximum rate capable by the testing apparatus to simulate a seismic event.
 - 3. Tests for both internal and interface shear strength shall be performed at normal loads of 200, 400, and 1000 psf with a displacement distance adequate to allow for an extrapolated estimate of residual shear strength. The required peak shear strength and residual shear strength for each of the interfaces are provided in the table below.

GCL INTERFACE AND INTERNAL SHEAR STRENGTH (ASTM D6243)					
Frequency of 1 test per product type.					
FINAL COVER	REQUIRED SLOW	REQUIRED SLOW	REQUIRED RAPID		
SYSTEM	STRAIN RATE PEAK	STRAIN RATE RESIDUAL	STRAIN RATE		
NORMAL	SHEAR STRENGTH	SHEAR STRENGTH	RESIDUAL SHEAR		
STRESSES (psf)	VALUE (psf)*	VALUE (psf)*	STRENGTH VALUE (psf)*		
200	98	64	82		
400	195	128	165		
1000	488	321	412		

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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 with shear reinforcement (sewn or needle-punched).
- B. The following table represents the minimum required MQC testing that must be conducted by the GCL 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		
Mass Per Unit Area					
1. Bentonite Content	ASTM D5993	0.75 lb/ft ² dry weight	1/40,000 sf		
		MARV*			
2. Geotextile Upper Layer	ASTM D5261	$6.0 \text{ oz/yd}^2 \text{ MARV*}$	1 / 40,000 sf		
3. Geotextile Lower Layer	ASTM D5261	$6.0 \text{ oz/yd}^2 \text{ MARV}^*$	1 / 40,000 sf		
Bentonite Moisture Content	ASTM D4643	35% max.	1 / 40,000 sf		
(As Manufactured)					
Index Flux ¹	ASTM D5887	$1.2 \times 10^{-9} \text{ m}^3/\text{m}^2/\text{sec max}.$	1/100,000 sf		
Grab Tensile Strength ²	ASTM D4632	90 lbs MARV*	1/100,000 sf		
Permeability	ASTM D5084	5x10 ⁻⁹ cm/sec	1/100,000 sf		

^{*} Minimum Average Roll Value.

- 1. Index flux test shall be performed according to manufacturer's recommendations and in compliance with the specified ASTM standard. The maximum test value specified in the table above is based on a hydraulic gradient of 1.09. Therefore, at least one of the flux test measurements must be performed at a hydraulic gradient of 1.09. Alternatively, the flux test measurements may be performed at higher hydraulic gradients (if necessary to achieve a measurable leakage rate) and a flux value corresponding to a hydraulic gradient of 1.09 may be extrapolated from the data.
- 2. Tensile testing to be performed in the machine and cross directions.

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

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 CQA ENGINEER.
- B. The GEOSYNTHETIC CONTRACTOR and CQA ENGINEER 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 CQA ENGINEER.
- C. The CQA ENGINEER shall determine the suitability of the subgrade surface prior to GCL placement by continuous visual inspection during proof rolling. In locations where proof rolling is not practical (i.e., slopes steeper than 3H:1V), the CQA ENGINEER shall determine stability of the subgrade by visual inspection of the surface as prepared by "backblading" with a bulldozer. The subgrade surface must not exhibit excessive pumping which would compromise the surface's ability to support the final cover system. The CQA ENGINEER shall indicate to the OWNER any subgrade surface locations which are found to be unsuitable for GCL placement. These areas shall be repaired to meet the criteria described above. An acceptable method of repairing small, localized areas of excessive pumping may include placing geonet (or DESIGNER approved equal) on the subgrade surface over the area of concern and extending the geonet a minimum of 5 feet beyond the area of concern prior to GCL placement. Every effort shall be made to avoid excavation and removal of the soil separation layer and underlying waste.
- D. The subgrade/geosynthetic surface below the GCL shall:
 - 1. Be prepared in accordance with the Plans and Specifications.
 - 2. Have no stones or other protrusions that may be damaging to the GCL as determined by the CQA ENGINEER.
 - 3. Be approved, accepted, and certified by the CQA ENGINEER and GEOSYNTHETICS CONTRACTOR'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 CQA ENGINEER.
- 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 CONTRACTOR shall furnish the roll number and panel number to the COA ENGINEER prior to the installation of each panel.
- D. The GEOSYNTHETICS CONTRACTOR shall maintain the GCL in an "as received" condition up to and including the time that the overlying layer of the Final Cover 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. 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 CQA ENGINEER. The subgrade shall be considered wet if pooled liquids are observed on the surface of the subgrade or moisture/density tests performed at the surface of the subgrade exceed 25%.
- 2. GCL becoming partially hydrated prior to covering with geomembrane shall be evaluated by the CQA ENGINEER to ascertain the condition of the material and to determine if removal and replacement is necessary.
- 3. Deployed GCL that appears excessively hydrated will be visually inspected by the CQA ENGINEER to determine if bentonite may have migrated through the geotextile, which could reduce interface friction between the GCL and other final cover materials. Visual field inspections of the deployed product will be conducted to confirm the following:
 - Lasting impressions do not remain after walking on the GCL;
 - the GCL does not feel wet;
 - bentonite cannot be seen or felt on the outer surface of the geotextile;
 - stitching between the geotextiles is intact.

If bentonite migration through the GCL is suspected based on visual field inspection of the deployed product, this GCL must be replaced or a sample of the GCL may be submitted to the QAL for laboratory examination to determine whether bentonite has migrated through the geotextile. GCL that exhibits migration of bentonite through the geotextile shall be considered unacceptable for use in the final cover and must be replaced by the GEOSYNTHETICS CONTRACTOR.

- E. The EARTHWORKS CONTRACTOR is required to place cover soils as quickly as possible after deployment of GCL and overlying geosynthetics. The time period between deployment of GCL and cover soils shall not exceed 20 days. This period of time may be extended, at the discretion of the DESIGNER, in the event the CQA ENGINEER determines that excessive hydration has not occurred through the visual inspection specified in Article 3.02 D.3 of this section.
- 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 CONTRACTOR. All identified needles must be removed by the CONTRACTOR 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 CQA ENGINEER.
- G. GEOSYNTHETIC CONTRACTOR personnel shall not be allowed to wear shoes that can damage the GCL during deployment or placement of subsequent geosynthetic materials.

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- 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 cross seams between panels are not continuous throughout the lined area.
- 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 CONTRACTOR shall not deploy more GCL in one day than can be covered by end of that day with overlying geomembrane materials. Sufficient overlap beyond the edge of deployed GCL shall be made to provide complete coverage of the GCL and to minimize exposure to potential precipitation.
- K. The GCL rolls shall be handled in a manner that minimizes loss of bentonite along edges during deployment.
- L. The GEOSYNTHETICS CONTRACTOR shall be responsible for protection of the GCL during installation. Unless otherwise approved by the DESIGNER, no rubber tire ATV's, tracked vehicles or any other equipment which may pose a risk of puncturing, tearing, or otherwise damaging the GCL shall be permitted for use directly over the GCL.
- M. The GCL shall not be covered until inspected and approved by the CQA ENGINEER. 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 CONTRACTOR and approved by the CQA 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 GCL MANUFACTURER and the DESIGNER.

PART 4 OUALITY CONTROL

4.01 GENERAL

A. The GEOSYNTHETICS CONTRACTOR, before installation begins, shall appoint an experienced individual who will be onsite at all times during the installation, to represent the

- GEOSYNTHETICS CONTRACTOR in all matters to this 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 CONTRACTOR assumes all responsibility relevant to providing an acceptable product.

4.02 QUALITY CONTROL DURING MANUFACTURING

- A. The 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 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 CONTRACTOR shall provide the CQA ENGINEER 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 CQA ENGINEER 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 CONTRACTOR. This testing may include all properties specified in Part 2 of this Section or other tests deemed reasonable and necessary by the DESIGNER/CQA ENGINEER. The GEOSYNTHETICS CONTRACTOR shall, however, at no additional cost, provide whatever reasonable assistance the CQA ENGINEER may require in obtaining the samples.
- E. The GEOSYNTHETICS CONTRACTOR shall be solely responsible for the quality of the material provided. Should any tests performed on the material yield unsatisfactory results, the GEOSYNTHETICS CONTRACTOR 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 CQA ENGINEER and the GEOSYNTHETICS CONTRACTOR shall visually inspect all material to be included in the work for 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 CQA ENGINEER and GEOSYNTHETICS CONTRACTOR shall also visually inspect the material for any damage incurred as a result of handling or onsite storage.

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- C. Damage to GCL during installation shall be repaired according to Part 3.03 of this Section. If the CQA ENGINEER determines that the damage is considered unrepairable, the damaged material will be replaced at no additional cost to the OWNER.
- D. Prior to installation, The CQA ENGINEER will select three random samples for internal shear strength and three random samples for interface shear strength for each interface described in Part 2, Article 2.01, Paragraph C 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 CONTRACTOR. No material shall be installed before the internal and interface shear test results show that the GCL meets the project specifications.
- E. The GEOSYNTHETICS CONTRACTOR is responsible for verifying that the GCL is free of needles during both manufacturing and installation. If needles are detected or suspected by the CQA ENGINEER, the OWNER may require the GEOSYNTHETICS CONTRACTOR 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 * * *

Revised: July 2011

SECTION 02420 GEONET

PART I GENERAL

- 1.01 SECTION INCLUDES
 - A. Supply and install geonet for landfill lining and final cover systems.
- 1.02 RELATED SECTIONS
 - A. Section 01400 General Provisions for Geosynthetics.
- 1.03 REFERENCES

Use latest version of referenced standards.

- A. ASTM D792 Test Method for Specific Gravity and Density of Plastics by Displacement.
- B. ASTM D1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer (Condition 190/2.16).
- C. ASTM D1505 Test Method for Density of Plastics by the Density-Gradient Technique.
- D. ASTM D1603 Test Method for Carbon Black in Olefin Plastics.
- E. ASTM D1682 Test Methods for Breaking. Load and Elongation of Textile Fabrics. Modifications: Use 4 in. by 8 in. specimens and test at rate of 8 in./minimum. Continue test until first strand completely separates. Report average of 5 tests in machine direction.
- F. ASTM D1777 Method for Measuring Thickness of Textile Materials.
- G. ASTM D3776 Test Methods for Mass Per Unit Area (Weight) of Woven Fabric (Option C).
- H. ASTM D4218 Test Method for Carbon Black Content in Polyethylene Compounds and Nonwoven Fabrics (Diaphragm Bursting Strength Tester Method).
- I. ASTM D4716 -Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products (i.e., geonet). Modifications: Measure between two steel plates at gradient of 1.0 and confining pressure of 15,000 psf for leachate collection applications and 4,000 psf for final cover applications. Apply confining pressure at least 1 hour prior to test.
- J. ASTM D5035 Test Method for Breaking Strength and Elongation of Textile Fabrics (Strip Method). Modifications same as ASTM D1682.
- K. ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
- L. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles.

4/2/02
Revised: Date Approved

1.04 QUALITY CONTROL SUBMITTALS

A. Pre-installation:

Submit following to OWNER for approval, prior to geonet deployment:

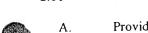
- l. Origin (supplier's name and production plant) and identification (brand name and number) of resin.
- 2. Copies of dated quality control certificates issued by resin supplier.
- 3. Use of geomembrane recycled during manufacturing process shall be permitted if done from factory regrind, if recycled geomembrane does not exceed 2% by weight, and when manufacturer provides resin documentation of reclaimed material.
- 4. List of materials which comprise geonet, expressed in following categories as percent by weight: polyethylene, carbon black, other additives.
- Geonet specification which includes properties listed in Article 2.01 of this section measured using appropriate test methods.
- 6. Written certification that minimum values given in geonet manufacturer's specification guaranteed by geonet manufacturer.
- 7. Quality control certificates, signed by responsible entity employed by manufacturer. Each quality control certificate shall include roll identification numbers, testing procedures and results of quality control tests.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping:
 - Geonet rolls shall be marked or tagged with following information:
 - a. Manufacturer's name.
 - b. Product identification.
 - c. Roll number.
 - d. Roll dimensions.
- B. Storage and Protection:
 - OWNER will provide on-site storage area for geomet rolls from time of delivery until installed.
 - After GEOSYNTHETIC CONTRACTOR mobilization, store and protect geonet from dirt, water, and other sources of damage.
 - 3. Preserve integrity and readability of geomet roll labels.

PART 2 **PRODUCTS**

MATERIALS 2.01



Provide geonet meeting following specifications and capable of retaining its structure during handling, placement, and long-term service.

GEONET PROPERTIES

Property	Method	Value
Thickness	ASTM D1777 ASTM D5199	200 mils min.
Mass per Unit Area 0.10 lb/ft ²	ASTM D3776 ASTM D5261	0.16 lb/ft ² min.
Density (geonet)	ASTM D1505	0.936 g/cc min.
Melt Index max.	(resin) ASTM D1238	1.0 g/10 min.
Tensile Strength	ASTM D1682* ASTM D5035*	30 lb/in min.
Carbon Black Content	ASTM D1603 ASTM D4218	2.0- 3.0%
Transmissivity	ASTM D4716*	$1 \times 10^{-3} \text{ m}^2/\text{sec min.}$

^{*}Test Methods as modified in Article 1.03

B. Geonet provided shall be stock product, i.e., except when specifically authorized in writing by OWNER, supplier shall not furnish products specifically manufactured to meet specifications of this Project.

2.02 SOURCE QUALITY CONTROL

Ensure that geonet manufacturer meets conditions in this section.

A. Tests, Inspection:

- 1. Geonets shall be tested by geonet manufacturer to evaluate characteristics for quality control. At minimum, following tests shall be performed for quality control in accordance with test methods specified in Article 1.03 of this section:
 - a. Density.
 - b. Mass per unit area.
 - c. Thickness.
 - d. Carbon black content.
 - e. Tensile strength.
 - f. Transmissivity.

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- 2. Geonet manufacturer shall perform quality control tests for at least one every lot, or at minimum of every 40,000 ft² (4000 m²) of geonet produced. Samples not satisfying these specifications and manufacturer's specifications shall result in rejection of applicable rolls.
- 3. At geonet manufacturers' discretion and expense, additional testing of individual rolls may be performed to more closely identify noncomplying rolls and to qualify individual rolls.
- 4. Following tests need to be run at one per lot or every 40,000 sq ft frequency. Geonet manufacturer shall certify that these tests have been performed for each resin in accordance with test methods specified in Article 2.01 A of this section.
 - a. Transmissivity.
 - b. Tensile strength.
 - c. Carbon black content.

PART 3 EXECUTION

3.01 EXAMINATIONS

- A. Conformance Testing:
 - GEOSYNTHETIC QAC shall collect samples of geonet to be installed, for conformance testing, as outlined in QAM.

3.02 INSTALLATION

A. Geonet Deployment:

Do not damage geonets while handling. Comply with following:

- On slopes, secure geonet and then roll it down slope in manner to continually keep geonet in tension. If necessary, position geonet by hand after unrolling to minimize wrinkles.
- 2. Weight geonets with sandbags or equivalent in presence of wind. Do not remove weight until replaced with cover material. Handle sandbags with care to prevent rupture or damage of sandbag.
- 3. Do not weld geomet to geomembrane unless otherwise specified in construction plans.
- 4. Cut geonet using scissors or other cutting tools, approved by OWNER. Do not leave tools in geonet.
- 5. Do not damage underlying layers during placement of geonet.
- 6. During geonet deployment, do not entrap in geonet dirt or excessive dust that could cause clogging of drainage system, and stones that could damage adjacent geomembrane. If dirt or excessive dust is entrapped in geonet, hose clean prior to placement of next layer of material.

B. Seams and Overlaps:

Join adjacent geonet in accordance with Design Drawings and specifications. At minimum, meet following requirements.

- 1. Overlap adjacent geonet rolls minimum of 4 in. (100 mm).
- 2. Tie geonet overlaps with plastic fasteners. Use white or yellow tying devices for easy inspection. Do not use metallic devices.
- Tie every 5 ft (1.5m) along slope, every 6 in. (0.15 m) in anchor trench, and every 6 in. (0.15 m) along end-to-end seams on base of landfill.
- 4. In general, no horizontal seams allowed on side slopes.
- 5. In corners of side slopes of rectangular landfills, where overlaps between perpendicular geonet strips required, unroll an extra layer of geonet along slope, on top of previously installed geonets, from top to bottom of slope.
- 6. Stagger joints when more than one layer of geonet is installed.
- When several layers of geonet stacked, deploy rolls in same direction to prevent strands of one layer from penetrating channels of adjacent layer.
- 8. Add extra layer, minimum 10 ft wide, of geonet to form double layer at toe of slope of primary liner on side of cell where sumps are located.

C. Defects and Repairs:

- 1. Repair damage to geonet as follows, if hole or tear width across roll is less than 50% of width of roll.
 - a. Place patch extending 1 ft (0.3 m) beyond edges of hole or tear.
 - b. Secure patch to original geonet by tying every 6 in. (0.15 m). Use tying devices as indicated in Article 3.02 B of this section.
- 2. Repair damage to geonet as follows, if hole or tear width across roll is more than 50% of width of roll.
 - a. On base of landfill, cut out damaged area and join 2 portions of geonet as indicated in Article 3.02 B of this section.
 - b. On sideslopes, remove and replace damaged geonet panel.
- 3. GEOSYNTHETIC QAC shall observe repairs and report noncompliance with above requirements in writing to OWNER.

3.03 INTERFACE WITH OTHER PRODUCTS

A. Do not place soil in direct contact with geonet.

- Ensure following when deploying soil materials near geomet: В.
 - Geonet and underlying lining materials not damaged.
 - Minimal slippage of geonet on underlying layers occurs.
 - No excess tensile stresses occur in geonet. 3.

* * * 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 geocomposite drainage layer for landfill final cover system and landfill baseliner system in Cells 7 through 14.

1.02 RELATED SECTIONS

- A. Section 02410 Geotextiles
- B. Section 02420 Geonet

1.03 REFERENCES (LATEST VERSION)

- A. American Society for Testing and Material (ASTM) D1777 Method for Measuring Thickness of Textile Materials.
- B. ASTM D4716 Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile-Related Products (i.e., geonet).

Testing Conditions for Geocomposite in Leachate Collection Applications: Measure between two steel plates at gradient of 2.0% and confining pressure of 12,000 pounds per square foot (psf). Apply confining pressure at least 100 hours prior to test.

Testing Conditions for Geocomposite in Final Cover Areas with Compacted Clay: Measure between two steel plates at gradient of 2.0% and confining pressure of 4,000 psf. Apply confining pressure at least 100 hours prior to test.

Testing Conditions for Geocomposite in Final Cover Areas with Geosynthetic Clay Liner: Boundary conditions from bottom to top are as follows: steel plate, geomembrane, geocomposite, representative soil, or neoprene steel plate. Geocomposite material to be used upgradient of uppermost surface-water diversion berm invert to be tested at gradients of 5.0% and 33.3%. Geocomposite material to be used downgradient of uppermost surface-water diversion berm invert to be tested at gradient of 33.3%. All geocomposite in final cover areas with geosynthetic clay liner to be tested at confining pressure of 2,500 psf. Apply confining pressure at least 100 hours prior to test.

- C. ASTM D5199 Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
- D. ASTM D5261 Test Method for Measuring Mass per Unit Area of Geotextiles.
- E. ASTM D7005 Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

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

1.04 QUALITY CONTROL SUBMITTALS

- A. Pre-installation: Submit following to OWNER for approval, prior to geocomposite deployment.
 - 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: Submit the following as installation proceeds:
 - 1. Subgrade surface acceptance certificates if applicable, signed by GEOSYNTHETIC CONTRACTOR, 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. Packing and Shipping:
 - 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.
 - d. Roll dimensions.
- B. Storage and Protection:
 - 1. OWNER will provide on-site storage area for geocomposite rolls from time of delivery until installed.

- 2. After GEOSYNTHETIC CONTRACTOR mobilization, store and protect geocomposite from dirt, water, ultraviolet light exposure, and other sources of damage. Preserve integrity and readability of geocomposite roll labels.
- 3. Preserve integrity and readability of geocomposite roll labels.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide geocomposite meeting following specifications and capable of retaining its structure during handling, placement, and long-term services.

GEOCOMPOSITE PROPERTIES

PROPERTY	METHOD	VALUE	
Mass Per Unit	ASTM D5261	$0.16 \text{ lb/ft}^2 \text{ min.}$	
Area Geotextile			
Thickness			
Geotextile	ASTM D1777	(See Section 02410)	
Geonet	ASTM D5199	200 mils min.	
Ply Adhesion	ASTM D7005	2 lb/in min.	
Transmissivity	ASTM D4716 ¹	2.73 x 10 ⁻⁴ m ² /s min. for geocomposite in leachate collection	
		applications	
	ASTM D4716 ¹	$1.00 \times 10^{-4} \text{ m}^2/\text{s}$ min. for geocomposite in final cover areas	
		with compacted clay	
	ASTM D4716 ^{1,2}	2.27 x 10 ⁻³ m ² /s min. for geocomposite in final cover areas	
		with geosynthetic clay liner	
	ASTM D4716 ^{1,3}	$2.00 \times 10^{-4} \text{ m}^2/\text{s}$ min. for geocomposite in final cover areas	
		with geosynthetic clay liner	

Notes:

- 1. Test methods as specified in Article 1.03.
- 2. Transmissivity value to be tested at a gradient of 0.05 (Representative of the 5% slope areas).
- 3. Transmissivity value to be tested at a gradient of 0.33 (Representative of the 33% slope areas).
 - B. 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.
 - C. The CQA Engineer shall obtain nine random samples of the proposed geocomposite and materials that will be installed above and below the geocomposite for the Final Cover System, if not previously tested and accepted. These samples will undergo interface shear strength testing for each interface (i.e., 40-mil textured membrane/geocomposite interface and geocomposite/general fill layer interface). Additionally, three random samples of the proposed geocomposite for the Final Cover System shall be submitted for testing of internal shear strength. 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 D5321, test preparations shall be in accordance with Paragraphs C.1 and C.2 of this Part, and the reported results shall meet the requirements of Paragraph C.3 of this Part.

- 1. Slow Strain Rate Testing: 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 0.0004 inch per minute.
- 2. Rapid Strain Rate Testing: 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 the maximum rate capable by the testing apparatus to simulate a seismic event.
- 3. Tests for both internal and interface shear strength shall be performed at normal loads of 200, 400, and 1,000 psf, with a displacement distance adequate to allow for an extrapolated estimate of residual shear strength. The required peak shear strength and residual shear strength for each of the interfaces are provided in the table below.

GEOCOMPOSITE INTERFACE AND INTERNAL SHEAR STRENGTH (ASTM D5321) Frequency of 1 test per product type.						
FINAL COVER	REQUIRED SLOW	REQUIRED SLOW	REQUIRED RAPID			
SYSTEM	STRAIN RATE PEAK	STRAIN RATE RESIDUAL	STRAIN RATE			
NORMAL	SHEAR STRENGTH	SHEAR STRENGTH	RESIDUAL SHEAR			
STRESSES (psf)	VALUE (psf)*	VALUE (psf)*	STRENGTH VALUE (psf)*			
200	98	64	82			
400	195	128	165			
1000	488	321	412			

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

2.02 SOURCE QUALITY CONTROL

A. Tests, Inspection:

- 1. Geocomposites shall be tested by geocomposite manufacturer to evaluate characteristics for quality control. At a minimum, the following tests shall be performed for quality control in accordance with test methods specified in Article 2.01 of this section.
 - a. Mass per unit area.
 - b. Thickness.
 - c. Geotextile-geonet adhesion (ply adhesion).
 - d. Transmissivity (one test per 100,000 square feet).*
 - * 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 square feet (4,000 square meters) 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 component manufacturers to determine characteristics for quality control. Components must adhere to specifications identified in the Section 02410, Parts 2.01.A & 2.02.A for geotextiles and Section 02420, Parts 2.01.A & 2.02.A for geonets.

PART 3 EXECUTION

3.01 EXAMINATION

A. Conformance Testing:

1. GEOSYNTHETIC QAC shall collect samples of geocomposite to be installed for archiving.

3.02 INSTALLATION

- A. Geocomposite Deployment: Handle geocomposites in a manner to ensure they are not damaged. Comply with following:
 - 1. On slopes, anchor geocomposite securely and deploy it down slope in 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. Cut geocomposite with cutter (hook blade). Protect adjacent materials from potential damage due to cutting of geomembrane.
 - 4. Prevent damage to underlying layers during placement of geocomposite.
 - 5. During deployment, do not entrap in or beneath geocomposite, stones, excessive dust, or moisture that could damage geomembrane, cause clogging of geonet, or hamper subsequent seaming.
 - 6. Visually examine entire geocomposite surface before seaming. Ensure no potentially harmful foreign objects, such as needles, are present. Remove foreign objects encountered or replace geocomposite.
- B. Geonet Seams and Overlap: Join adjacent geonet in accordance with Design Drawings and Specifications: At minimum, meet following requirements.
 - 1. Overlap adjacent geonet minimum of 4 inches (100 millimeters).
 - 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 feet (1.5 meters) along slope, every 6 inches (0.15 meter) in anchor trench, and every 6 inches (0.15 meter) along end-to-end seams on base of landfill.
 - 4. In general, no horizontal seams allowed on side slopes greater than 10H:1V.

- 5. In corners of side slopes of rectangular landfills, where overlaps between perpendicular geonet strips are required, unroll extra layer of geonet along slope, on top of previously installed geonets, from top to bottom of slope.
- 6. Stagger joints when more than one layer of geonet is installed.

C. Geotextile Seaming Procedures:

- 1. In general, no horizontal seams or splices allowed on side slopes greater than 10H:1V (i.e., seams shall be downslope, not across-slope), except as part of patch. Splice is defined as seam connecting ends of two rolls. Horizontal seams that have occurred as part of the manufacturing process are allowed on side slopes. Where present, these manufactured seams shall be continuously capped with a piece of approved geotextile, extending a minimum of 6 inches on either side of the seam and continuously bonded to the geocomposite by leistering.
- 2. Overlap geotextile minimum of 3 inches (75 millimeters) prior to sewing.
- 3. On slopes steeper than 10H:1V, continuously sew top geotextiles. Spot sewing is not allowed.
- 4. On slopes shallower than 10H:1V, top geotextiles to be continuously sewn or continuously heat bonded if approved by DESIGNER and the New York State Department of Environmental Conservation.
- 5. Ensure at seams that no earth cover material is present beneath geotextile.
- 6. When sewing, use polymeric thread with chemical and ultraviolet light resistance properties equal to or exceeding those of geotextile.
- 7. Use locking stitch.
- D. Defects and Repairs: Repair small defects as judged by Geosynthetic Quality Assurance Contractor (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-inch overlap.
 - 3. Sew geotextile in-place.

E. If geonet is damaged:

- 1. Remove damaged geonet.
- 2. Cut patch of new material to remove replaced geonet.
- 3. Secure patch to original geonet by tying every 6 inches (0.15 meter). Use tying devices as indicated in Article 3.02 B of this section.
- 4. Place geotextile patch overlapping damaged area by minimum of 12 inches.
- 5. Sew geotextile in-place.

- F. Replace geocomposite if judged by Geosynthetic QAC to be large defect.
- G. Geocomposite installation procedures:

The geocomposite will be installed in conformation with article 3.02B and 3.02C of this section. Sewn seams are the preferred method of joining. At minimum, meet the following requirements:

- 1. Overlap adjacent geocomposite a minimum of 4 inches (100 millimeters).
- 2. The bottom geotextile layers are to be joined by overlapping.
- 3. Tie geonet overlaps with plastic fasteners. Use white or yellow tying devices for easy inspection. Do not use metallic devices.
- 4. Tie every 5 feet (1.5 meters) along slope, every 6 inches (0.15 meter) in anchor trench, and every 6 inches (0.15 m) along end-to-end (butt) seams.
- 5. In general, no horizontal seams are allowed on side slopes greater than 10H:1V.
- 6. The top geotextile layers are to be joined by sewing.
- 7. For butt seams, seams are to be joined by overlapping sheets utilizing plastic ties on 6-inch centers. The butt seam is to then be capped by heat fusing a 2-foot-wide cap of geotextile over the full length of the seam. A minimum 6-inch overlap of the geotextile to the seam edge is required.
- 8. Horizontal butt seams may be used on final cover installations providing that the seams are staggered a minimum of 5 feet.
- 9. For final cover geocomposite butt seams, seams are to be joined by overlapping sheets and fastening the geonet component with two rows of plastic ties on 6-inch centers. The upper geotextile is to be sewn, if possible. Otherwise, the butt seam is to be capped by heat fusing a 2-foot wide cap of geotextile over the full length of the seam. A minimum 6-inch overlap of the geotextile to the seam edge is required.

3.03 INTERFACE WITH OTHER PRODUCTS

- A. Ensure the following when deploying soil materials located on top of geocomposite.
 - 1. Geocomposite and underlying lining materials not damaged.
 - 2. Minimal slippage of geocomposite on underlying layers occurs.
 - 3. No excess tensile stresses occur in geocomposite.
- B. If textile is bonded to only one side of geonet, do not place soil in direct contact with geonet.

* * * END OF SECTION * * *

SECTION 02601 MANHOLES, RISERS AND HANDHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Provide cast-in-place or precast concrete as shown on Drawings.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM A48-83 Standard Specification for Gray Iron Castings.
 - 2. ASTM A615-90 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 3. ASTM Cl39-73 Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
 - 4. ASTM C270-89 Standard Specification for Mortar for Unit Masonry.
 - 5. ASTM C425-90 Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
 - 6. ASTM C443-85 Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
 - 7. ASTM C478-88 Standard Specification for Precast Reinforced Concrete Manhole Sections.
 - ASTM C497-88 Standard Methods of Testing Concrete Pipe, Manhole Sections or Tile (Metric).
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - AASHTO M198-75 Joints for Circular Concrete Sewer and Culvert Pipe Using Flexible Watertight Gaskets.

1.03 SUBMITTALS

- A. Include results of tests and certification reports with shipment of materials.
- B. Certification from manufacturer for 16 mil epoxy coating on inside of precast manhole sections.
- C. If manufacturer's test data inadequate or unavailable, DESIGNER reserves right to require cores drilled for compressive strength tests.
- D. Submit in accordance with Section 01340.

1.04 QUALITY ASSURANCE

- A. Source Quality Control:
 - Precast Reinforced Concrete Manhole Testing:
 - a. Test risers and tops in accordance with ASTM C497 for compressive strength compliance by compression tests on cores drilled from 5% of lot.
 - b. May reduce number of compression tests to 1% of lot, with minimum of 2 cores/lot, for manhole sections fabricated on sewer pipe machine.
 - c. OWNER will approve testing laboratory.
 - d. Manufacturer's core drilling machine shall conform to ASTM C497. Operator shall take test cores as directed by testing laboratory.
 - e. Stamp risers and tops, meeting strength requirements, with appropriate monogram.

PART 2 MATERIALS

- 2.01 CAST-IN-PLACE VAULT AND MANHOLE BASES
 - A. Concrete: Comply with Section 03300.
- 2.02 PRECAST REINFORCED CONCRETE VAULTS, MANHOLES, BASES, AND HANDHOLES
 - A. ASTM C478.
 - B. Provide flat precast tops as shown on Drawings.
 - C. Reinforced integral floors in vaults and manholes shall have minimum thickness of 6 in. as shown on Drawings.
 - D. Elevations indicated on Drawings designate pipe elevations at location of center of vaults and manholes. Provide for pipe grade differential between center of manhole and manhole wall for each pipe entering manhole.
 - E. Wall Thickness:

	Wall	
Structure	Thickness	
Handhole	4 in.	
Manhole	5 in.	
Vault	7 in.	

- F. Seal precast sections of leachate collection system manholes with 3/4-in, dia PTFE adhesive joint sealant.
 - 1. PTFE Joint Sealant Gasket Material: Gore-Tex, manufactured by W.L. Gore & Associates, Inc., Industrial Products Division, Elkton, Maryland, or equal.
- G. Mark each precast section with the name or trademark of manufacturer and date of manufacture. Marking shall be indented into manhole section or painted thereon with waterproof paint.

2.03 MANHOLE INTERIORS

- A. Interior of precast concrete manhole sections, including pipe penetration holes, and tongue and groove joints, shall have shop-applied epoxy coating with 16 mil nominal dry thickness.
- B. Apply 16 mil epoxy coating in field if cast-in-place bases used.
- C. For riser vaults the interior concrete below top of door opening grating shall be coated with SOLUCOAT 400, Conjure 152/372, or approved equal.

2.04 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.

2.05 FLEXIBLE SEAL

A. Modular mechanical seal system in accordance with Section 15092.

PART 3 EXECUTION

3.01 EXCAVATION AND PREPARATION OF SUBGRADE

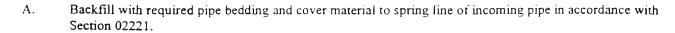
A. Excavate and prepare subgrade in accordance with Section 02220 and as shown on Drawings.

3.02 BASES

- A. Cast-in-Place Base for Precast Vault or Manhole:
 - Set precast vault or manhole bottom barrel section on concrete brick or solid block and plumb.
 - 2. Provide in accordance with Section 03300.
- B. Precast Manhole with Integral Base:
 - 1. Excavate deep enough so bottom manhole barrel section with integral base rests on 3-in, minimum of bedding material, in accordance with Section 02220.

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3.03 BACKFILL



3.04 PIPE TO MANHOLE CONNECTION

- A. Seal annular space between pipe and precast manhole wall with modular mechanical seal system. Link-Seal or approved equal, in accordance with Section 15092.
- B. Seal conduit openings in handholes with waterright caulking seal.

3.05 SETTING FRAMES AND CASTINGS

- A. Set at elevation shown on Drawings.
- B. Install manhole frames with PTFE sealing material to effect water-tight seal between frame and manhole.
- C. In accordance with manufacturer's instructions.

3.06 FIELD QUALITY CONTROL

- A. Precast reinforced concrete risers and tops shall be subject to rejection on account of failure to conform to Specification requirements. In addition, individual sections of risers and tops 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. Surface defects indicating honeycombed or open texture.
 - 4. Damaged ends where such damage prevents making satisfactory joint.
 - 5. Infiltration into pipes exceeding 0.0758 gal/vert ft/hr.
 - 6. Internal dia of section varying more than 1% from nominal dia.
 - 7. Continuous crack having surface width of 0.01 in. or more and extending for length of 12 in. or more, regardless of position.
 - 8. Manhole and Riser Vault Testing:
 - a. Fill manhole or vault base section to depth of 6 in. over inlet and outlet carrier pipes.
 - b. Monitor level for 4 hrs, refill to start line of test, if necessary. If water level does not drop, continue monitoring for 24 hrs (initial 4 hrs. may be included as part of the 24 hr. monitoring period).
 - c. Monitor level for 24 hrs and record change in water level. If water level changes greater than 1 in., penetrations shall be inspected and redone and test rerun.

* * * END OF SECTION * * *

SECTION 02751 LEACHATE LIFT STATION

PART 1 GENERAL

1.01 SUMMARY

- A. Description of System:
 - System consists of pumps, valves, piping, and steel tank inside concrete structure.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. ANSI B16.1-89 Cast Iron Pipe Flanges and Flanged Fittings.
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM A48-83 Standard Specification for Gray Iron Castings.
 - 2. ASTM Al26-84 Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
- C. American Water Works Association (AWWA):
 - AWWA Clll-85 Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings.
 - AWWA C504-87 Standard for Rubber-Seated Butterfly Valves.
 - 3. AWWA C507-85 Ball Valves, 6-in. through 48-in.

1.03 SUBMITTALS

- A. Shop Drawings.
- B. Provide performance data with each pump at time of shipment.
- C. Submit in accordance with Section 01340.
- D. Operation and Maintenance (O&M) Data:
 - Submit in accordance with Section 01730.

1.04 QUALITY ASSURANCE

- A. Supplier's or Manufacturer's Services:
 - 1. Provide letter to DESIGNER issued by representative of tank manufacturer, certifying tank was manufactured to requirements of Specification.

- B. Source Quality Control:
 - Pump manufacturer shall perform following inspections and tests on each pump before shipment from factory.
 - a. Submersible and Nonsubmersible Pumps:
 - Check impeller, motor rating, and electrical connections for compliance to Specifications.
 - 2. Test motor and cable insulation for moisture content or insulation defects.
 - 3. Prior to submergence, run pump dry to establish correct rotation and mechanical integrity.
 - 4. Run pump for 30 min submerged.
 - 5. After operational Test 4, repeat insulation Test 2.
 - 6. Conduct certified performance test.

1.05 WARRANTY

- A. Warrant pump against defects in workmanship and materials for 5-yr period under normal use, operation, and service.
- B. Replace mechanical seal, impeller, pump housing, wear ring, and ball bearings which become defective through normal use and wear on progressive schedule of cost for 5-yr period.
- C. Warranty shall be in published form and apply to similar units with copies supplied to OWNER.

PART 2 PRODUCTS

2.01 PUMP

- A. Manufacturer:
 - Gould or equal.

B. General:

- 1. Construct major parts such as stator casing, oil casing, sliding bracket, volute, and impeller of cast iron.
- 2. Protect cast surfaces coming into contact with leachate by 2 mil thermo-set acrylic enamel coating.
- 3. Use stainless steel exposed bolts and nuts.
- 4. Provide replaceable wear ring.
- 5. Provide pump with mechanical rotating shaft seal system running in oil reservoir having separate, constantly hydrodynamically lubricated lapped seal faces.
 - a. Lower seal unit between pump and oil chamber shall contain one stationary and one positively driven rotating tungstencarbide ring.

- b. Upper seal unit between oil sump and motor housing shall contain one stationary ceramic ring and one positively driven rotating carbon ring.
- c. Each interface shall be held in contact by its own spring system supplemented by external liquid pressures.
- d. Seals shall not require maintenance or adjustment, but be easily inspected and replaceable.
- 6. Machine and fit with nitrile O-rings where watertight sealing required. Machine and fill so sealing accomplished by automatic compression in 2 planes and O-ring contract made on 4 surfaces, without requirement of specific torque limits to affect this. Rectangle cross-sectioned gaskets requiring specific torque limits to achieve compression shall not be considered adequate or equal.
- 7. Tolerances of parts shall be such it allows replacement of parts without additional machining to ensure sealing. Do not use secondary sealing compounds, greases or other devices.
- 8. Provide pumps with characteristics as listed in Table 02751 to this section.

C. Bracket:

- 1. Provide sliding guide bracket as integral part of pumping unit.
- Provide pump casing with machined connecting flange to connect with cast iron discharge connection, bolted to floor of manhole, and designed to receive pump connecting flange without need of bolts or nuts.

2.02 PUMP MOTOR

- A. Provide motor with characteristics as listed in Table 02751 to this section and Section 16150.
- B. Provide motor designed for continuous duty and non-overloading throughout design curve.
- C. House pump motor in oil- or air-filled watertight casing.

D. Cable:

- Entry water seal shall preclude specific torque requirements to ensure watertight and submersible seal. Do not use epoxies, silicones or other secondary sealing systems.
- Separate cable entry junction box and motor by stator lead sealing gland or terminal board which isolates motor interior from foreign materials gaining access through pump top.
- 3. Provide cable suitable for submersible pump applications and indicated by a code or legend permanently embossed on cable.
 - a. SO, 90'C, P-122-66 MSHA.
 - Neoprene or hypalon jacket.

- 4. Size cable to conform to NEC requirements for pump motors and of adequate size to allow motor voltage conversion without replacing cable.
- 5. Fit pump cable end with shrink fit rubber boot.
- 6. Provide continuous from motor to WP junction box, mounted to outside of pump station module without splices.
- E. Integral thermal sensors not required on unit without water jacket. Use thermal sensors to monitor stator temperatures on unit with water jacket. One for each phase in motor. Motor over current protection shall be provided in control panel.

2.03 BALL CHECK VALVES

A. General:

- Do not impede flow of materials such as solids, stringy material, grit or rags suspended in leachate.
- 2. Balls shall roll clear of waterway providing full flow equal to dia of connection pipe.
- 3. Prevent return of wastewater through valve when inlet pressure decreases below delivery pressure.
- Each valve shall be tight-seating and operate without slam or shock.

B. Materials:

- 1. Valve Body: Cast iron with flanged ends meeting requirements of ANSI B16.1.1.
- 2. Ball: Hollow steel with rubber exterior resistant to grease, petroleum products, animal and vegetable fats, acids and alkalides, tearing, and abrasion with specific gravity greater than 1, and removable without removing body from line.
- 3. Provide 1 replacement ball with each ball check valve.
- Flight "HDL VALVE" Type 2016 or equal.
- C. Head loss through valve shall not be greater than 1.15 ft at velocity of 7 ft/sec.
- D. Rate for maximum working pressure of 150 psig.

2.04 PIPING

- A. Pump Discharge Line: 6-in. dia steel pipe and 90-degree elbow.
- 2.05 STEEL ACCESS COVER
 - A. Manufacturers:
 - 1. Neenah Foundry.
 - 2. Bilco.

- 3. Or equal.
- B. 36-in. manway with lift davit.
- C. Weatherproof, lockable.
- 2.06 CARBON STEEL TANK WET WELLS
 - A. Dimensions: 9 ft 0-in I.D. by 6 ft 6-in. high, closed top steel tank.
 - B. Vertical steel tank.
 - 1/4-in. minimum wall thickness.
 - Tank walls, bottom, top, and reinforcing channels, shall be ASTM A36 minimum quality steel.
 - 3. Tank shall be in accordance with American Pipe Institute (API) Standard 650.
 - a. Appendix E: Seismic Design, Zone 1.
 - b. 1/8-in. corrosion allowance.
 - C. Suitable for nonburied installation.
 - D. 1/4 in. flat bottom.
 - E. Pipe penetrations shall be as shown on Drawings.
 - 1. Reinforce pipe penetrations with 1/4 in. thick plate.
 - Provide 150-lb flanges at both ends of pipe penetrations.
 - F. Coating:
 - 1. Interior, including pipes and flanges, shall be sandblasted and coated with 3 coats (5 to 7 mil dry film thickness/coat) "Corrocote" 's', or equal, in accordance with coating manufacturer's recommendation.
 - 2. Exterior shall be sandblasted and coated to 15 mil with "Corrocote" I", or equal, in accordance with coating manufacturer's commendation.
 - a. Corrocote manufactured by Madison Chemical Industries, Inc.; Milton, Ontario, Canada.
 - 3. Do not coat face of discharge connection flange, or pump guide rails.

PART 3 EXECUTION

- 3.01 INSTALLATION
 - A. Install in accordance with manufacturer's written instructions and approved submittals.

TABLE 02751

LIFT STATION PUMP CHARACTERISTICS	SMALL PL'MP	LARGE PL'NIP
Number of Units	Į	1
Materials Being Pumped	Leachate	Leachate
Minimum Solids Size (in.)	3	3
Rated Speed (maximum rpm)	3.500~	3,450
Intake Size (in.)	4	6
Discharge Size (in.)	3	6
Total Dynamic Head (ft)	35	3.5
Rated Capacity (gpm)	280	800
ELECTRIC MOTOR CHARACTERISTICS	•	
Horsepower (HP)	5.0 (Goulds)	30 (ABS)
Rated Speed (rpm)	1,750 (Goulds)	3,450(ABS)
Service Factor	1.15 minimum	1.15 minimum
Housing Type	Submersible	Submersible
NEMA Design	В	В
Insulation Class	F	F
Voltage	230/460	230/460
Phase	3	3
Efficiency at Full Load	89% (minimum)	89% (minimum)

Hydraulic review by OWNER to determine if pump size and type is adequate upon completion of downstream hydraulics (intermediate pump station).

* * * END OF SECTION * * *

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SECTION 02960 SURFACE WATER DRAINAGE DITCHES

PART 1 GENERAL

1.01 SUMMARY

A. Work consists of construction of surface water drainage ditches and access road culvert.

1.02 DEFINITIONS

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

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM C76-89 Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric).
 - 2. ASTM D1557-78 Standard Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-1b (4.54 kg) Rammer and 18-in. (457 mm) drop.
 - 3. ASTM D2922-81 Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Topsoil: In accordance with Section 02105.
- B. Geofabric: In accordance with Section 02410 for base liner.
- C. Riprap: In accordance with Section 703-02 of "Standard Specifications." Coarse aggregate No. 2 or 3.
- D. Culvert: Minimum 12-in. dia galvanized corrugated metal pipe, high density corrugated polyethylene pipe, or reinforced concrete pipe, in accordance with ASTM C76 Class IV pipe. Piping shall be in accordance with Standard Specifications
- E. Provide flared metal end section precast concrete apron and endwall section.

PART 3 EXECUTION

3.01 EXCAVATION

- A. Drainage ditches shall be excavated to grades and widths shown on Drawings.
- B. Notify DESIGNER before placing topsoil, riprap, geofabric or culvert.
- C. Culvert requires overexcavation for 3 in. of gravel bedding, coarse aggregate No. 1ST by "Standard Specifications."

3.02 BACKFILL

- A. Compact soils under culvert and aprons to minimum 90% Modified Proctor density prior to placement of gravel bedding.
- B. Place pipe along lines and grades as shown on Drawings.

3.03 REUSE OF PIPE

A. Pipe may be reused at other subcell locations upon approval by OWNER.

* * * END OF SECTION * * *