EXHIBIT 3

Project Manual

Denton Landfill Cell 3 Design

TCEQ MSW Permit No. 1590A

Denton, Texas

February 2017

PSC Project # 01017216

PARKHILLSMITH&COOPER

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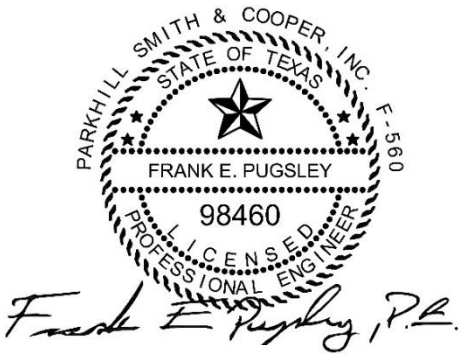

02/16/17

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PARKHILLSMITH&COOPER

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SECTION 01010 - SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Work covered by Contract Documents.
   2. Contractor use of site and Owner occupancy.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Identification: Denton Landfill Cell 3 Design, TCEQ MSW Permit No.1590A.

B. Location: Denton, Texas.

C. Verbal Summary: Without force or effect on requirements of the Contract Documents a brief description of the Project is as follows:
   1. Earthwork excavation, filling, and grading as shown on plans below existing grade. Topsoil from excavated area is to be stockpiled onsite. Contractor must segregate all clay and sand or other materials into individual stockpiles.
   2. Subgrade preparation to the lines and grades shown on the plans.
   3. 2-foot-thick recompacted clay liner.
   4. 60 mil high density polyethylene (HDPE) textured liner.
   5. Geocomposite drainage layer (dual-sided geotextile).
   6. Polyethylene pipe, gravel and geotextile fabric.
   7. Construction testing
   8. Protective soil cover placement.
   9. Erosion control.
   10. Access road.
   11. SLER and GLER markers.
   12. Electrical work. Power and control wiring to each pump and access structure.
   13. Storm drainage channel.
   14. Asphalt overlay of prepared subgrade roadway.
   15. 25-foot fixed litter fence.
   16. Precast screening wall.
   17. Truck scale pit and scale.
   18. Reinforced concrete pavement.
   19. Liquid storage tank.
   20. Pump station, suction, and discharge piping.
   21. Pre-engineered restroom/vending structure and shade structure.
   22. Two pre-engineered shade structures, installed on existing truck scale pit walls.

1.3 CONTRACTOR USE OF SITE

A. Limit use of site to allow Owner occupancy.

B. Construction operations limited to areas adjacent to construction site as designated by Owner.

1.4 PROTECTION OF EXISTING UTLITIES AND STRUCTURES

A. Contractor shall exercise care to prevent damage, and shall be liable for any damage, and for maintenance and protection of such lines and structures as shown on drawings or otherwise brought to Contractor attention. Contractor shall not cut, remove, change, or disturb any existing lines, except as provided by the plans and these specifications, without express permission of Owner of any such line. Utility adjustments or relocations accomplished by Owner of each utility, except for water and sewer or as otherwise shown on Drawings. Contractor shall exactly locate all existing utilities prior to conducting any construction activities.

1.5 OWNER OCCUPANCY

A. Owner will occupy the site during construction for the conduct of normal operations.
B. Cooperate with Owner to minimize conflict, and to facilitate Owner operations.
C. Schedule the Work to accommodate this requirement.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SOIL LINER QUALITY CONTROL PLAN (SLQCP)

A. Technical project specifications contain requirements for liner system installation and testing. The Soil Liner Quality Control Plan (SLQCP) approved by the Texas Commission on Environmental Quality (TCEQ) has also been included in the appendix of the project manual. Project is required to construct and test in accordance with the SLQCP. If a discrepancy exists between project technical specifications and SLQCP, the SLQCP shall take precedence.

END OF SECTION

SECTION 01019 - CONTRACT CONSIDERATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Application for Payment.
   2. Change procedures.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 PROJECT DURATION

A. Definitions
   1. Substantial Completion (Landfill) – point at which liner system is satisfactorily installed and all related work complete.
   2. Final Completion (Landfill) – point at which Geomembrane Liner Evaluation Report (GLER) is accepted as complete by the TCEQ.
B. Substantial Completion (Landfill) – Work associated with project shall be substantially complete within 180 calendar days of Notice-to-Proceed for the liner system.
C. Final Completion (Landfill) – duration of final completion is dependent upon TCEQ review of the GLER. The balance of retainage will be held until the GLER is accepted by the TCEQ.
D. Substantial Completion (Non-landfill) – 180 days. Final – 270 days.

1.3 APPLICATIONS FOR PAYMENT

A. Submit payment application to Engineer through the Engineer Info-Exchange website.
B. Payment Period: As defined in Owner-Contractor agreement.
C. Waiver of liens from subcontractor.
D. Stored material invoices.
E. Receipted invoices for previously-stored materials.

1.4 CHANGE PROCEDURES

A. Engineer will advise of minor changes in the Work not involving an adjustment to Contract Sum/Price or Contract Time.
B. Execution of Change Orders: Engineer will issue Change Orders for signatures of parties as provided in the General Conditions of the Contract.
C. All Change Orders must be approved and signed by Owner. Do not commence with work included in a Change Order until it has been approved and signed by the Owner.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01025 - MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 REQUIREMENTS

A. Unit price or lump sum price bid on each item, as stated in the proposal, shall include furnishing all labor, superintendence, machinery, equipment, and materials necessary or incidental to complete the various items of work in accordance with the plans and specifications.

B. All estimated quantities for unit price bid items stipulated in the bid proposal are approximate and are to be used only (a) as a basis for estimating the cost of the work and (b) for the purpose of comparing the bids submitted for the work. The actual amount of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for unit price work and materials will be the actual amount of work done and material furnished as measured by the Engineer.

C. All measurements and payments based on completed and accepted work performed in strict accordance with the Drawings and Specifications and in accordance with contract bid prices. All incidental work and subsidiary items whether shown or not or listed for measurement or payment will not be paid for separately, but will be included in the payment for the bid items stated in the contract and shall be full compensation for all labor, equipment, materials, testing and incidentals necessary to perform the work in accordance with the Contract Documents.

D. Cost of work or materials shown on the Drawings, called for in the Specifications and on which no separate payment is made, shall be included in the bid price for the various items for which they are associated. A claim by the Contractor for extra compensation for an item required but not shown on the Drawings or described in the Specifications will not be considered.

E. Interconnections between the various items of equipment and the control system will require coordination and in some cases interface devices such as, but not limited to, couplings, flanges, reducers, converters, conduit, relays, contacts, wiring, etc., will be required whether or not these items are shown on the Drawings. General Contractor holds responsibility to provide the necessary coordination and interface devices at no additional cost to the Owner.

1.2 MOBILIZATION/DEMOBILIZATION

A. Payment will be made for mobilizing and demobilizing all equipment, tools, insurance, bonds and all other job-related items to and from the job site. Price will be on a lump sum basis and shall include all equipment, labor, materials, superintendence and all incidentals necessary to become fully mobilized at the start of the project and demobilized when work is complete. This bid item shall not exceed 3 percent of the contract price. Mobilization related expenses include Contractor cost for:

1. Obtaining a construction staging area,
2. Obtaining storage areas for equipment and construction office facilities,
3. Obtaining and setting up construction office facilities,
4. Obtaining and paying for electric power required for construction,
5. Providing sanitary facilities for construction personnel,
6. Obtaining and paying for water needed for construction,
7. Providing and maintaining dust control over the project working area, and
8. All other incidentals required for Contractor to complete mobilization.

1.3 EXCAVATION

A. Payment will be made for providing all necessary labor, equipment, materials, supplies, etc. Payment will be made for the total excavation on a per-cubic-yard of excavation.

1.4 EMBANKMENT FILL

A. Payment will be made for providing all labor, equipment, materials, supplies, etc., necessary to fill areas shown. Payment will be made for the actual measured cubic yardage of embankment fill.

1.5 RECOMPACTED CLAY LINER

A. Payment will be made for providing and installing clay liner, including all necessary labor, equipment, materials, supplies and superintendence. Payment will be made for the actual measured cubic yards of the liner installed and in place up to the back edge of the anchor trench.

1.6 TEXTURED GEOMEMBRANE LINER

A. Payment will be made for providing and installing a 60-mil-thick, textured, high-density polyethylene liner including all labor, equipment, materials, supplies, etc., for complete installation. Price includes cost of anchor trench construction and compaction of backfill in anchor trench after liner installation. Payment will be made for the actual measured square footage of liner installed and in place up to the back edge of the anchor trench. No additional pay quantity will be made for the sacrificial membrane. Payment shall be made on the net quantity of surface area covered. No additional quantity will be paid for material overlap.

1.7 DUAL GEOTEXTILE GEOCOMPOSITE DRAINAGE LAYER

A. Payment will be made for providing and installing the dual geotextile geocomposite drainage layer, including anchor trench and backfill. Price shall include tie-in to existing geocomposite layer, all materials, labor, supplies, equipment and superintendence to install dual geocomposite drainage layer as specified. Payment will be made for the actual measured square footage of the liner installed and in place. Payment shall be made on the net quantity of surface area covered. No additional quantity will be paid for material overlap.

1.8 PROTECTIVE SOIL COVER

A. Contractor will place all protective soil on top of the liner system including the soil berm along the edge liner as shown on the plans. Payment will include all labor, materials, equipment and superintendence as necessary to install the soil. Payment will be made for actual measured cubic yards of the 2-foot-thick protective cover up to outside edge of the anchor trench.

1.9 LEACHATE COLLECTION SYSTEM

A. Payment will be made for providing and installing the gravel drainage material as shown on the plans on a per cubic yard basis. Price shall include all material, labor, supplies, equipment and superintendence necessary to install the gravel drainage material as specified.
B. Payment will be made for providing and installing the 12-inch, high-density polyethylene (PE) piping as shown on the plans on a per-linear-foot basis. This item includes all pipe along

landfill floor to collection sump. Price shall include all material, labor, supplies, equipment and superintendence necessary to install the 12-inch PE piping as specified. Pipe for coupling of existing and proposed 12-inch HDPE piping is incidental to this bid item.

1.10 REINFORCED CONCRETE PAVEMENT

A. Payment will be made for providing materials and constructing the 6-inch, reinforced concrete pond bottom and access drive as shown on the plans on a per square yard basis. Price will include all material, labor, equipment and superintendence necessary to construct the pond bottom as specified.

1.11 ELECTRICAL SERVICE AND POWER DISTRIBUTION FOR PUMPS

A. Payment will be made for providing and installation of the electrical service, power distribution, and control wiring for pumps. Work shall include all electrical racks, concrete associated with electrical racks, panels, enclosures, conduit, wire, pullboxes, supporting devices, service poles, level indicator, and terminations as outlined in Division 16 and shown on project Drawings. Price shall include all material, labor, supplies, equipment, coordination and superintendence necessary to provide a complete and working system. This item will be paid on a lump sum basis.

1.12 EROSION CONTROL

A. Payment will be made for providing, installing and maintaining erosion control measures as shown on the plans on a lump sum basis and shall include the following: preparation of a formal Storm Water Pollution Prevention Plan (SWPPP) by a Texas licensed professional engineer; submitting and obtaining approval of the formal SWPPP from the required governing agencies; furnishing, installing, and maintaining the approved SWPPP complete for the duration of the project; implementing and maintaining best management practices and good-housekeeping for control of drainage run-off over the project area; silt-fences; soil stabilization; hay-bales; and all other incidentals required for Contractor to complete and implement the SW3P requirements.

1.13 LITTER CONTROL BARRIER FENCE

A. Payment will be made for providing and installing a litter control barrier fence along the east property boundary on a linear foot basis. Payment shall include all costs associated with providing all labor, equipment, materials, and supervision necessary to install the shown on the drawings and in accordance with the specifications.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01039 - COORDINATION AND MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coordination and field engineering.
   2. Site mobilization conference and preinstallation meetings.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 COORDINATION

A. Coordinate scheduling, submittals, and Work of the various Sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
D. In finished areas, except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
E. Large Apparatus: Any large piece of apparatus to be installed in any space in the building, but too large to permit access through windows, doorways or shafts, shall be brought to the job by the Contractor involved and placed in the space before the enclosing structure is completed.
F. Items which require electrical connections shall be coordinated with Division 16 for:
   1. Voltage.
   2. Phase.
   3. Ampacity.
   4. No. and size of wires.
   5. Wiring diagrams.
   6. Starter size, details and location.
   7. Control devices and details.
G. Coordinate completion and clean up of Work of separate Section in preparation for Substantial Completion and for portions of work designated for Owner occupancy.

1.3 FIELD ENGINEERING

A. Control datum for survey is shown on Drawings.
B. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

1.4 SITE MOBILIZATION CONFERENCE

A. Engineer will schedule a conference at the Project site prior to Contractor occupancy.
B. Attendance Required: Engineer and the Contractor Project Manager, Jobsite Superintendent.

C. Agenda:
   1. Submission of insurance certificates.
   2. Distribution of Contract Documents.
   3. Submission of list of Subcontractors, list of products, Schedule of Values, and progress schedule.
   4. Designation of personnel representing the parties in Contract and the Engineer.
   5. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders and Contract closeout procedures.
   6. Scheduling.
   7. Use of premises by Owner and Contractor.
   8. Owner's requirements and partial occupancy.
   9. Construction facilities and controls provided by Owner, if any.
   10. Temporary utilities provided by Owner, if any.
   11. Survey layout.
   12. Security and housekeeping procedures.
   13. Schedules and Coordination.
   14. Procedures for testing.
   15. Procedures for maintaining record documents.
   16. Requirements for start-up of equipment.
   17. Inspection and acceptance of equipment put into service during construction period.

D. Engineer or representative will record meeting minutes and distribute copies within three days after meeting to participants and those affected by decisions made.

1.5 BI-WEEKLY MEETINGS

A. Biweekly meetings will be held at work area on a day agreeable to all parties, once liner installation has begun. At minimum, meeting will be attended by Contractor, major subcontractors, and Engineer. Meeting purposes:
   1. Review the work activity and location for the week.
   2. Discuss the Contractor's personnel assignment for the week.
   3. Review the previous week's activity.
   4. Review the work schedule.
   5. Discuss the possible problem areas and situations.
   6. Review of submittals schedule and status of submittals.
   7. Review of off-site fabrication and delivery schedules.
   8. Maintenance of progress schedule.
   9. Corrective measures to regain projected schedules.
   10. Planned progress during succeeding work period.
   11. Coordination of projected progress.
   12. Maintenance of quality and work standards.
   13. Effect of proposed changes on progress schedule and coordination.
   14. Review status of “as-built” drawings prepared by Contractor to ascertain that Contractor is keeping “as-built” drawings CURRENT.
   15. Other business relating to Work.

B. Engineer or his representative will record meeting minutes and distribute copies within three days after meeting to participants and those affected by decisions made.

1.6 PREINSTALLATION MEETING

A. When required in individual specification Section, convene a preinstallation meeting at work site prior to commencing work of the Section.
B. Require attendance of parties directly affecting, or affected by, work of the specific Section.
C. Notify Engineer four days in advance of meeting date.
D. Prepare agenda and preside at meeting.
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.
E. Engineer or representative will record meeting minutes and distribute copies within three days after meeting to participants and those affected by decisions made, with three copies to Engineer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01090 - REFERENCE STANDARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Quality assurance and schedule of references.
B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.
   2. All construction items not governed by these Technical Specifications shall be governed by the Standard Specifications for Public Works Construction by the North Central Texas Council of Governments.

1.2 QUALITY ASSURANCE

A. For products or workmanship specified by association, trade, or Federal Standards; comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
B. Conform to reference standard by date of issue current on date for receiving bids.
C. Obtain copies of standards when required by Contract Documents.
D. Should specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.
E. The contractual relationship duties and responsibilities of the parties in Contract nor those of the Engineer shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.3 SCHEDULE OF REFERENCES

AA	Aluminum Association 818 Connecticut Avenue, N.W. Washington, DC 20006
AABC	Associated Air Balance Council 1000 Vermont Avenue, N.W. Washington, DC 20005
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W. Washington, DC 20001
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
ADC	Air Diffusion Council 230 North Michigan Avenue Chicago, IL 60601

AGA	American Gas Association 1515 Wilson Blvd. Arlington, VA 22209
AGC	Associated General Contractors of America 1957 E Street, N.W. Washington, DC 20006
AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AIA	American Institute of Architects 1735 New York Avenue, N.W. Washington, DC 20006
AISC	American Institute of Steel Construction 400 North Michigan Avenue Eighth Floor Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, DC 20036
AMCA	Air Movement and Control Association 30 West University Drive Arlington Heights, IL 60004
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
APA	American Plywood Association Box 11700 Tacoma, WA 98411
ARI	Air-Conditioning and Refrigeration Institute 1501 Wilson Boulevard Arlington, VA 22209
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017

ASTM	ASTM International 1916 Race Street Philadelphia, PA 19103
AWI	Architectural Woodwork Institute 2310 South Walter Reed Drive Arlington, VA 22206
AWPA	American Wood-Preservers' Association 7735 Old Georgetown Road Bethesda, MD 20014
AWS	American Welding Society 550 LeJeune Road, N.W. Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BHMA	Builders' Hardware Manufacturer Association 60 East 42nd Street, Room 511 New York, NY 10165
BIA	Brick Institute of America 11490 Commerce Park Drive Reston, VA 22091
CDA	Copper Development Association 57th Floor, Chrysler Building 405 Lexington Avenue New York, NY 10174
CLFMI	Chain Link Fence Manufacturers Institute 1101 Connecticut Avenue, N.W. Washington, DC 20036
CPSC	Consumer Product Safety Commission 1111 Eighteenth Street, NW Washington, DC 20207
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195
DHI	Door and Hardware Institute 7711 Old Springhouse Road McLean, VA 22102

EJMA	Expansion Joint Manufacturers Association 25 North Broadway Tarrytown, NY 10591
FGMA	Flat Glass Marketing Association 3310 Harrison White Lakes Professional Building Topeka, KS 66611
FM	Factory Mutual System 1151 Boston-Providence Turnpike P.O. Box 688 Norwood, MA 02062
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
GA	Gypsum Association 1603 Orrington Avenue Evanston, IL 60201
GSI	The Geosynthetic Institute 475 Kedron Avenue Folsom, PA 19033
ICBO	International Conference of Building Officials 5360 S. Workman Mill Road Whittier, CA 90601
IEEE	Institute of Electrical and Electronics Engineers 345 East 47th Street New York, NY 10017
IES	Illumination Engineering Society of North America 345 East 47th Street New York, NY 10017
IMIAC	International Masonry Industry All-Weather Council International Masonry Institute 815 15th Street, N.W. Washington, DC 20005
MBMA	Metal Building Manufacturer's Association 1230 Keith Building Cleveland, OH 44115

MIL	Military Specification Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
ML/SFA	Metal Lath/Steel Framing Association 221 North LaSalle Street Chicago, IL 60601
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NBS	National Bureau of Standards (U.S. Department of Commerce) Gaithersburg, MD 20234
NCMA	National Concrete Masonry Association P.O. Box 781 Herndon, VA 22070
NEBB	National Environmental Balancing Bureau 8224 Old Courthouse Road Vienna, VA 22180
NEC	National Electrical Code (by NFPA)
NECA	National Electrical Contractors Association 7315 Wisconsin Avenue Bethesda, MD 20814
NEMA	National Electrical Manufacturers' Association 2101 'L' Street, N.W. Washington, DC 20037
NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
NFPA	National Forest Products Association 1619 Massachusetts Avenue, N.W. Washington, DC 20036
NPCA	National Paint and Coating Association 1500 Rhode Island Avenue N.W. Washington, D.C. 20005

NRCA	National Roofing Contractors Association 8600 Bryn Mawr Avenue Chicago, IL 60631
NSF	National Sanitation Foundation 3475 Plymouth Road P.O. Box 1468 Ann Arbor, MI 47106
NSWMA	National Solid Wastes Management Association 1730 Rhode Island Ave., N.W. Washington, DC 20036
NWMA	National Woodwork Manufacturers Association 205 W. Touhy Avenue Park Ridge, IL 60068
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor) Government Printing Office Washington, D.C. 20402
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
PPI	Plastic Pipe Institute 105 Decker Court #825 Irving, TX 75062
PS	Product Standard U. S. Department of Commerce Washington, DC 20203
RMA	Rubber Manufacturer's Association 1400 K Street, N.W. Washington, D.C. 20005
SDI	Steel Deck Institute P.O. Box 9506 Canton, OH 44711
S.D.I.	Steel Door Institute 712 Lakewood Center North 14600 Detroit Avenue Cleveland, OH 44107
SGCC	Safety Glazing Certification Council Route 11, Industrial Park Cortland, NY 13045

SIGMA	Sealed Insulating Glass Manufacturers Association 111 East Wacker Drive Chicago, IL 60601
SJI	Steel Joist Institute 1205 48th Avenue North, Suite A Myrtle Beach, SC 29577
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association 8224 Old Court House Road Vienna, VA 22180
SSPC	Steel Structures Painting Council 4400 Fifth Avenue Pittsburgh, PA 15213
TCNA	Tile Council of North America, Inc. Box 326 Princeton, NJ 08540
UL	Underwriters' Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062
WCLIB	West Coast Lumber Inspection Bureau 6980 S.W. Varns Road Box 23145 Portland, OR 97223
WRI	Wire Reinforcement Institute 8361 A Greensboro Drive McLean, VA 22102
WWPA	Western Wood Products Association 1500 Yeon Building Portland, OR 97204
W.W.P.A.	Woven Wire Products Association 2515 N. Nordica Avenue Chicago, IL 60635

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01230 - ALTERNATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for alternates.
B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.

1.2 DEFINITIONS

A. Alternate: An amount proposed by bidders and stated on the Bid Form for certain work defined in the bidding requirements that may be added to or deducted from the base bid amount if Owner decides to accept a corresponding change either in the amount of construction to be completed or in the products, materials, equipment, systems, or installation methods described in the Contract Documents.
   1. Alternates described in this Section are part of the Work only if enumerated in the Agreement.
   2. Cost or credit for each alternate is the net addition to or deduction from the Contract Sum to incorporate alternate into the Work. No other adjustments are made to the Contract Sum.

1.3 PROCEDURES

A. Coordination: Revise or adjust affected adjacent Work as necessary to completely integrate work of the alternate into Project.
   1. Include as part of each alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not indicated as part of alternate.
B. Notification: Immediately following award of the Contract, notify each party involved, in writing, of the status of each alternate. Indicate if alternates have been accepted, rejected, or deferred for later consideration. Include a complete description of negotiated revisions to alternates.
C. Execute accepted alternates under the same conditions as other Work of the Contract.
D. Schedule: A schedule of alternates is included at the end of this Section. Specification Sections referenced in schedule contain requirements for materials necessary to achieve the Work described under each alternate.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Submittal procedures and construction progress schedules.
   2. Proposed products list and shop drawings.
   3. Product data, samples, and design data.
   4. Test reports and certificates.
   5. Manufacturer instructions and field reports.
   6. Geosynthetic liner.

B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.
   2. Section 01010 – Summary of Work.
   3. Section 01700 - Contract Closeout: Contract warranty, manufacturer's certificates and closeout submittals.

1.2 SUBMITTAL PROCEDURES

A. Submit to Engineer for review for limited purpose of checking for conformance with information given and design concept expressed in Contract Documents.

B. Produce copies and distribute in accordance with Submittal Procedures article and for record documents purposes described in Section 01700 – Contract Closeout.

C. Transmit each submittal separately with Contractor standard transmittal letter including Contractor name, address, and phone number. Each submittal shall contain only one specification section.

D. Sequentially number transmittal forms using Section number or Contractors other sequential numbering system.

E. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing sheet and detail number(s), and specification Section number, appropriate to submittal.

F. Apply Contractor stamp, signed or initialed certifying that review, verification of Products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.

G. Schedule submittals to expedite the Project.

H. For each submittal for review, allow 14 calendar days for Engineer Review.

I. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.

J. Allow space on submittals for Contractor and Engineer review stamps.

K. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with provisions.

L. Submittals not requested will not be recognized or processed.

M. Format
   1. Submit all submittals digitally using .PDF file extension. Each submittal shall be a single .PDF file including transmittal letter. Multiple files for the same submittal not accepted.
   2. Submittals in any other format, including .ZIP files, will be rejected.
   3. Hard copies will not be accepted.

4. To ensure each page is legible, .PDF pages of drawings shall be the same size/scale as a hard copy. Where applicable, scale symbols should be provided to indicate scale. Illegible submittals will be rejected.
5. Submittals will be uploaded to the Engineer Info-Exchange Website.

N. Submittal procedures described in this Article apply to the Construction Progress Schedule, Products List, Shop Drawings, Product Data, Samples (actual samples to be submitted, not digital files), Design Data, Test Reports, Certificates, Manufacturer's Instructions and Field Reports, Erection Drawings and any other type of submittal submitted to Engineer.

1.3 MASTER SUBMITTAL REGISTRY

A. Submit Master Submittal Registry for review within 15 calendar days of Notice to Proceed.
B. Submittal Registry shall include an itemized listing of all submittals proposed for the Project, date of when Contractor will submit each, and notification of any critical lead time submittals requiring an expedited review to maintain Project schedule.

1.4 RESUBMITTAL REQUIREMENTS

A. Revise and resubmit submittals, as required, and resubmit to meet requirements as specified and as noted on submittal reviews.
B. Mark as RESUBMITTAL.
C. Re-use original transmittal number and supplement with sequential alphabetical or numeric suffix for each re-submittal.
D. Engineer shall review each submittal and one respective resubmittal at no cost to Contractor. Costs associated with resubmittal reviews beyond one resubmittal is the Contractor's responsibility.

1.5 CONSTRUCTION PROGRESS SCHEDULES

A. Submit initial progress schedule for Engineer's review within 15 days after date established in Notice to Proceed.
B. Revise and resubmit as required.
C. Submit revised schedule with each Application for Payment, identifying changes since previous version.
D. Submit a horizontal bar chart with separate line for each section of Work, identifying first work day of each week.
E. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.
F. Indicate estimated percentage of completion for each item of Work at each submission.
G. Submit separate schedule of submittal dates for shop drawings, product data, and samples, and dates reviewed submittals will be required from Engineer.
H. Revisions To Schedules:
    1. Indicate progress of each activity to date of submittal, and projected completion date of each activity.
    2. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes.
    3. Prepare narrative report to define problem areas, anticipated delays, and impact on Schedule. Report corrective action taken, or proposed, and its effect including effect of changes on schedules of separate contractors.

1.6 SHOP DRAWINGS

A. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.
B. Printable Image Size: Minimum 8 1/2 x 11 inches and maximum 24 x 36 inches.
C. Draw details to a minimum scale of 1/2 inches equal to 1 foot.
D. Draw site plans to same scale indicated on contract drawings.
E. Draw all other plans to a minimum scale of 1/8 inch equal to 1 foot.
F. Construction Documents (electronic or paper format) issued by the Engineer cannot be used in any shape, form or fashion in the creation and development of shop drawings, except that electronic files containing floor plans or site plans which have been purchased from the Engineer per other Division 01 sections may be used as “backgrounds” for Contractor, subcontractors, sub-subcontractors and material suppliers in the Shop Drawing process.
G. Electronic Files
    1. Electronic drawing files are available for purchase from the Engineer upon request. Cost of the files is $100.00 plus applicable taxes per drawing sheet. Only the Contractor or his subcontractors and sub-subcontractors may purchase an electronic file. An electronic file will be provided in AUTOCAD format of the release currently used by the Engineer. File will be provided through Engineer’s Info-Exchange website.
    2. Prior to delivery of the file, purchaser shall sign an Electronic File Transfer Release Form. Payment for an electronic file shall occur upon delivery of file to purchaser.
    3. Electronic file shall be used only for the production of information required by this project and shall not be used in any other form (in whole or part).
    4. In the creation and publication of Shop Drawings, under no circumstances shall the Design Professional’s seal or title block of the drawing be reproduced. All shop drawings must be original works from the Contractor subcontractors, sub-subcontractors and material suppliers.

1.7 PRODUCT DATA

A. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.
B. Include recommendations for application and use, and reference to compliance with specified standards of trade associations and testing agencies.
C. Include notation of special coordination requirements for interfacing with adjacent work and building utilities where applicable.
D. After review, distribute in accordance with Article titled Submittal Procedures above and provide copies for Record Documents described in Section 01700 – Contract Closeout.

1.8 DESIGN DATA

A. Submit for Engineer's knowledge as contract administrator or for Owner.
B. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.9 TEST REPORTS

A. Submit for Engineer's knowledge as contract administrator or for Owner.
B. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.10 CERTIFICATES

A. When specified in individual specification sections, submit certification by manufacturer, installation/application subcontractor, or Contractor to Engineer.
B. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
C. Certificates may be recent or previous test results on material or product, but must be acceptable to Engineer.

1.11 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit manufacturers' printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing.
B. Identify conflicts between manufacturers' instructions and Contract Documents.
C. Indicate special procedures, conditions requiring special attention and special environmental criteria required for application or installation.

1.12 MANUFACTURER'S FIELD REPORTS

A. Submit reports for Engineer’s benefit as contract administrator or for Owner.
B. Submit report within 30 days of observation to Engineer for information.
C. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

1.13 GEOSYNTHETIC LINER

A. Within 15 days after Notice to Proceed, submit one actual sample of the reinforced material for shear testing. Sample must be representative of the type used.
B. Sample size: One roll width, four feet in length (minimum).

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01356 - STORMWATER POLLUTION PREVENTION MEASURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Where required, Contractor shall develop a Stormwater Pollution Prevention Plan (SWPPP), file a Notice of Intent (NOI), and implement stormwater pollution prevention measures shown on Drawings. Contractor is responsible for any fines or penalties assessed by the appropriate regulatory agency for failure to make required inspections, properly document those inspections, and/ adequately implement and adjust the stormwater pollution prevention measures where a SWPPP is implemented.

B. Related Sections:
1. Other Division 01 Specification Sections apply to Work of this Section.

1.2 SUBMITTALS

A. Inspection Reports.

1.3 EROSION AND SEDIMENT CONTROLS

A. General
1. Structural measures shall be implemented to divert flows from exposed soils, temporarily store flows, or otherwise limit run-off and the discharge of pollutants from exposed areas of the site. Structural practices shall be implemented in a timely manner during the construction process to minimize erosion and sediment runoff.

B. Stabilized Ingress/Egress
1. Stabilized access to and from the construction site shall be installed as soon as practical where a SWPPP is required.
2. In all cases, Contractor shall ensure that any soil tracked offsite is cleaned from existing roads, alleys, and any adjacent properties as soon as possible. Contractor or other responsible party shall check for any pollutants (mud, silt, sand, cement, construction materials, etc.) tracked or washed offsite and perform necessary clean-up measures at the end of each work day.

C. Silt Fences/Diversion Berms
1. Where necessary, Contractor shall provide silt fences and/or diversion berms as a temporary structural practice to minimize erosion and sediment runoff. Silt fences and/or diversion berms shall be properly installed to effectively retain sediment immediately after completing each phase of work where erosion would occur in the form of sheet and rill erosion (e.g. clearing and grubbing, excavation, embankment, and grading).

D. Sand/Gravel Bags
1. Contractor may provide sand/gravel bags as a temporary structural practice to minimize erosion and sediment runoff. Bags shall be properly placed to effectively retain sediment immediately after completing each phase of work (e.g., clearing and grubbing, excavation, embankment, and grading) in each independent runoff area (e.g., after clearing and grubbing in an area between a ridge and drain, bags shall be placed as work progresses, bags shall be removed/replaced/relocated as needed for work to progress in

the drainage area). Sand/gravel bags must remain in good condition, or they shall be replaced.

E. Site Stabilization
   1. Contractor shall disturb the least amount of site area as possible.
   2. Stabilization measures may include any of the following measures:
      a. Temporary or permanent seeding or sodding.
      b. Mulching.
      c. Geotextiles.
      d. Vegetative buffer strips.
      e. Paving.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 STORMWATER POLLUTION PREVENTION PLAN

A. A SWPPP is only required if the limits of disturbance exceed 1.0 AC.
   1. NOTE: The limits of disturbance for this project will exceed 1.0 AC in size. Contractor to prepare and submit bid accordingly.

B. If limits of disturbance exceed 1 AC, the Contractor is responsible for meeting requirements of TPDES. (Contractor shall develop SWPPP, file a NOI and implement SWPPP measures).

C. A completed Construction Site Notice form in accordance with the requirements of the State's general permit for storm water discharges from construction sites will be prepared by the Contractor (where a SWPPP is required).

D. The SWPPP (where required) shall be continually updated as necessary to reflect current and changing conditions on site. Additional measures not specifically shown in the SWPPP may be used to control erosion from leaving the site.

END OF SECTION

SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Quality assurance and control of installation.
   2. Tolerances, references, and move-up requirements.
   3. Inspection and testing laboratory services.
   4. Manufacturer field services.
   5. Examination and preparation.

B. Related Sections:
   1. Other Division01 Specification Sections apply to Work of this Section.
   2. Section 01090 - Reference Standards.
   3. Section 01300 - Submittals: Submission of Manufacturers' Instructions and Certificates.
   4. Section 01550 - Material and Equipment: Requirements for material and product quality.

1.2 QUALITY ASSURANCE/CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Comply fully with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Perform work by persons qualified to produce workmanship of specified quality.

E. Verify field measurements are as indicated on Shop drawing or as instructed by Manufacturer.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturer tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing in place.

1.4 REFERENCES

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.

B. Conform to reference standard by date of issue current on date of Contract Documents except where a specific date is established by Code.

C. Obtain copy of standards when required by specification section.

D. Neither contractual relationship, duties nor responsibilities of parties in Contract nor those of the Engineer shall be altered from Contract Documents by mention or inference otherwise in any reference document.

1.5 INSPECTION AND TESTING LABORATORY SERVICES

A. Contractor will perform quality control testing as necessary on the liner system and other aspects of the project to ensure construction meets the project specifications. Once the Contractor meets the specification requirements, the Contractor shall coordinate with the Owner's representative for quality assurance (QA) testing.
B. Owner will appoint, employ, and pay for services of an independent firm to perform inspection and quality assurance testing on general construction and the liner system.
C. Contractor or the independent firm will perform inspections, tests, and other services specified in individual specification Sections and as required by the Engineer.
D. Reports will be submitted by the Contractor or the independent firm to the Engineer, in triplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
E. Retesting required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. **Payment for retesting charged to Contractor.**

1.6 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification Sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance of equipment as applicable, and to initiate instructions when necessary.
B. Submit qualifications of observer to Engineer 30 days in advance of required observations. Observer subject to approval of Engineer.
C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
D. Refer to Section 01300 - Submittals, Manufacturers' Field Reports article.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
B. Verify existing substrate is capable of structural support or attachment of new Work being applied or attached.
C. Examine and verify specific conditions described in individual specification sections.
D. Verify utility services are available, of correct characteristics, and in correct locations.

END OF SECTION

SECTION 01420 - REFERENCES

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. Other Divisions 01 Specification Sections apply to Work of this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.
B. Approved: When used to convey Engineer action on Contractor submittals, applications, and requests; "approved" is limited to Engineer duties and responsibilities as stated in the Conditions of the Contract.
C. Directed: Command or instruction by Engineer; other terms including "requested," "authorized," "selected," "required," and "permitted" have same meaning as "directed."
D. Indicated: Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have same meaning as "indicated."
E. Regulations: Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.
F. Furnish: Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.
B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.
   1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale - Encyclopedia of Associations: National Organizations of the U.S., or in Columbia Books - National Trade & Professional Associations of the United States.

B. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list (information is subject to change and believed accurate as of the date of the Contract Documents):

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; www.aamanet.org.
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute; (Formerly: ACI International); www.abma.com.
9. ACPA - American Concrete Pipe Association; www.concrete-pipe.org.
10. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
11. AF&PA - American Forest & Paper Association; www.afandpa.org.
12. AGA - American Gas Association; www.aga.org.
13. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
14. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
15. AI - Asphalt Institute; www.asphaltinstitute.org.
16. AIA - American Institute of Architects (The); www.aia.org.
17. AISC - American Institute of Steel Construction; www.aisc.org.
18. AISI - American Iron and Steel Institute; www.steel.org.
19. AITC - American Institute of Timber Construction; www.aitc-glulam.org.
20. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
21. ANSI - American National Standards Institute; www.ansi.org.
22. AOSA - Association of Official Seed Analysts, Inc.; www.aosaseed.com.
23. APA - APA - The Engineered Wood Association; www.apawood.org.
24. APA - Architectural Precast Association; www.archprecast.org.
25. API - American Petroleum Institute; www.api.org.
26. ARI - Air-Conditioning & Refrigeration Institute; (See AHRI).
27. ARI - American Refrigeration Institute; (See AHRI).
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASCE - American Society of Civil Engineers; www.asce.org.
30. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
31. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
32. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
33. ASSE - American Society of Safety Engineers (The); www.asse.org.
34. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
35. ASTM - ASTM International; www.astm.org.
36. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
37. AWEA - American Wind Energy Association; www.awea.org.
38. AWI - Architectural Woodwork Institute; www.awinet.org.
39. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
40. AWPA - American Wood Protection Association; www.awpa.com.
41. AWS - American Welding Society; www.aws.org.

42. AWWA - American Water Works Association; www.awwa.org.
43. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
44. BIA - Brick Industry Association (The); www.gobrick.com.
45. BICSI - BICSI, Inc.; www.bicsi.org.
46. BIFMA - BIFMA International; (Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
47. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
48. BWF - Badminton World Federation; (Formerly: International Badminton Federation); www.bissc.org.
49. CDA - Copper Development Association; www.copper.org.
50. CEA - Canadian Electricity Association; www.electricity.ca.
51. CEA - Consumer Electronics Association; www.ce.org.
52. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
53. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
54. CGA - Compressed Gas Association; www.cganet.com.
55. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
56. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
57. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
58. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
59. CPA - Composite Panel Association; www.pbmdf.com.
60. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
61. CRRC - Cool Roof Rating Council; www.coolroofs.org.
62. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
63. CSA - Canadian Standards Association; www.csa.ca.
64. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
65. CSI - Construction Specifications Institute (The); www.csinet.org.
66. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
67. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
68. CWC - Composite Wood Council; (See CPA).
69. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
70. DHI - Door and Hardware Institute; www.dhi.org.
71. ECA - Electronic Components Association; (See ECIA).
72. ECAMA - Electronic Components Assemblies & Materials Association; (See ECIA).
73. ECIA - Electronic Components Industry Association; www.eciaonline.org.
74. EIA - Electronic Industries Alliance; (See TIA).
75. EIMA - EIFS Industry Members Association; www.eima.com.
76. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
77. ESD - ESD Association; (Electrostatic Discharge Association); www.esda.org.
78. ESTA - Entertainment Services and Technology Association; (See PLASA).
79. EVO - Efficiency Valuation Organization; www.evo-world.org.
80. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
81. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
82. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
83. FM Approvals - FM Approvals LLC; www.fmglobal.com.
84. FM Global - FM Global; (Formerly: FMG - FM Global); www.fmglobal.com.

85. FRSA - Florida Roofing, Sheet Metal & Air Conditioning Contractors Association, Inc.; www.floridaroof.com.
86. FSA - Fluid Sealing Association; www.fluidsealing.com.
87. FSC - Forest Stewardship Council U.S.; www.fscus.org.
88. GA - Gypsum Association; www.gypsum.org.
89. GANA - Glass Association of North America; www.glasswebsite.com.
90. GS - Green Seal; www.greenseal.org.
91. HI - Hydraulic Institute; www.pumps.org.
92. HI/GAMA - Hydronics Institute/Gas Appliance Manufacturers Association; (See AHRI).
93. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
94. HPVA - Hardwood Plywood & Veneer Association; www.hpva.org.
95. HPW - H. P. White Laboratory, Inc.; www.hpwhite.com.
96. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
97. IAS - International Accreditation Service; www.iasonline.org.
98. IAS - International Approval Services; (See CSA).
99. ICBO - International Conference of Building Officials; (See ICC).
100. ICC - International Code Council; www.iccsafe.org.
101. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
102. ICPA - International Cast Polymer Alliance; www.icpa-hq.org.
103. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.
104. IEC - International Electrotechnical Commission; www.iec.ch.
105. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
106. IES - Illuminating Engineering Society; (Formerly: Illuminating Engineering Society of North America); www.ies.org.
107. IESNA - Illuminating Engineering Society of North America; (See IES).
108. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
109. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
110. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
111. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
112. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
113. ISA - International Society of Automation (The); (Formerly: Instrumentation, Systems, and Automation Society); www.isa.org.
114. ISAS - Instrumentation, Systems, and Automation Society (The); (See ISA).
115. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
116. ISO - International Organization for Standardization; www.iso.org.
117. ISSFA - International Solid Surface Fabricators Association; (See ISFA).
118. ITU - International Telecommunication Union; www.itu.int/home.
119. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
120. LMA - Laminating Materials Association; (See CPA).
121. LPI - Lightning Protection Institute; www.lightning.org.
122. MBMA - Metal Building Manufacturers Association; www.mbma.com.
123. MCA - Metal Construction Association; www.metalconstruction.org.
124. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
125. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
126. MHIA - Material Handling Industry of America; www.mhia.org.
127. MIA - Marble Institute of America; www.marble-institute.com.

128. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
129. MPI - Master Painters Institute; www.paintinfo.com.
130. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
131. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
132. NACE - NACE International; (National Association of Corrosion Engineers International); www.nace.org.
133. NADCA - National Air Duct Cleaners Association; www.nadca.com.
134. NAIMA - North American Insulation Manufacturers Association; www.naima.orgwww.naima.org.
135. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
136. NBI - New Buildings Institute; www.newbuildings.org.
137. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
138. NCMA - National Concrete Masonry Association; www.ncma.org.
139. NEBB - National Environmental Balancing Bureau; www.nebb.org.
140. NECA - National Electrical Contractors Association; www.necanet.org.
141. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
142. NEMA - National Electrical Manufacturers Association; www.nema.org.
143. NETA - InterNational Electrical Testing Association; www.netaworld.org.
144. NFHS - National Federation of State High School Associations; www.nfhs.org.
145. NFPA - National Fire Protection Association; www.nfpa.org.
146. NFPA - NFPA International; (See NFPA).
147. NFRC - National Fenestration Rating Council; www.nfrc.org.
148. NHLA - National Hardwood Lumber Association; www.nhla.com.
149. NLGA - National Lumber Grades Authority; www.nlga.org.
150. NOFMA - National Oak Flooring Manufacturers Association; (See NWFA).
151. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
152. NRCA - National Roofing Contractors Association; www.nrca.net.
153. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
154. NSF - NSF International; www.nsf.org.
155. NSPE - National Society of Professional Engineers; www.nspe.org.
156. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
157. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
158. NWFA - National Wood Flooring Association; www.nwfa.org.
159. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
160. PDI - Plumbing & Drainage Institute; www.pdionline.org.
161. PLASA - PLASA; (Formerly: ESTA - Entertainment Services and Technology Association); www.plasa.org.
162. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
163. RFCI - Resilient Floor Covering Institute; www.rfci.com.
164. RIS - Redwood Inspection Service; www.redwoodinspection.com.
165. SAE - SAE International; www.sae.org.
166. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
167. SDI - Steel Deck Institute; www.sdi.org.
168. SDI - Steel Door Institute; www.steeldoor.org.
169. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
170. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (See ASCE).
171. SIA - Security Industry Association; www.siaonline.org.
172. SJI - Steel Joist Institute; www.steeljoist.org.

173. SMA - Screen Manufacturers Association; www.smainfo.org.
174. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
175. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
176. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
177. SPIB - Southern Pine Inspection Bureau; www.spib.org.
178. SPRI - Single Ply Roofing Industry; www.spri.org.
179. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
180. SSINA - Specialty Steel Industry of North America; www.ssina.com.
181. SSPC - SSPC: The Society for Protective Coatings; www.sspc.org.
182. STI - Steel Tank Institute; www.steeltank.com.
183. SWI - Steel Window Institute; www.steelwindows.com.
184. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
185. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
186. TCNA - Tile Council of North America, Inc.; www.tileusa.com.
187. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
188. TIA - Telecommunications Industry Association (The); (Formerly: TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance); www.tiaonline.org.
189. TIA/EIA - Telecommunications Industry Association/Electronic Industries Alliance; (See TIA).
190. TMS - The Masonry Society; www.masonrysociety.org.
191. TPI - Truss Plate Institute; www.tpinst.org.
192. TPI - Turfgrass Producers International; www.turfgrasssod.org.
193. TRI - Tile Roofing Institute; www.tileroofing.org.
194. UL - Underwriters Laboratories Inc.; www.ul.com.
195. UNI - Uni-Bell PVC Pipe Association; www.uni-bell.org.
196. USAV - USA Volleyball; www.usavolleyball.org.
197. USGBC - U.S. Green Building Council; www.usgbc.org.
198. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
199. WASTEC - Waste Equipment Technology Association; www.wastec.org.
200. WCLIB - West Coast Lumber Inspection Bureau; www.wclib.org.
201. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
202. WDMA - Window & Door Manufacturers Association; www.wdma.com.
203. WI - Woodwork Institute; www.wicnet.org.
204. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
205. WWPA - Western Wood Products Association; www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.
1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.
4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.
1. COE - Army Corps of Engineers; www.usace.army.mil.
2. CPSC - Consumer Product Safety Commission; www.cpsc.gov.

3. DOC - Department of Commerce; National Institute of Standards and Technology; www.nist.gov.
4. DOD - Department of Defense; www.quicksearch.dla.mil.
5. DOE - Department of Energy; www.energy.gov.
6. EPA - Environmental Protection Agency; www.epa.gov.
7. FAA - Federal Aviation Administration; www.faa.gov.
8. FG - Federal Government Publications; www.gpo.gov.
9. GSA - General Services Administration; www.gsa.gov.
10. HUD - Department of Housing and Urban Development; www.hud.gov.
11. LBL - Lawrence Berkeley National Laboratory; Environmental Energy Technologies Division; www.eetd.lbl.gov.
12. OSHA - Occupational Safety & Health Administration; www.osha.gov.
13. SD - Department of State; www.state.gov.
14. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
15. USDA - Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
16. USDA - Department of Agriculture; Rural Utilities Service; www.usda.gov.
17. USDJ - Department of Justice; Office of Justice Programs; National Institute of Justice; www.ojp.usdoj.gov.
18. USP - U.S. Pharmacopeial Convention; www.usp.org.
19. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CFR - Code of Federal Regulations; Available from Government Printing Office; www.gpo.gov/fdsys.
2. DOD - Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.quicksearch.dla.mil.
3. DSCC - Defense Supply Center Columbus; (See FS).
4. FED-STD - Federal Standard; (See FS).
5. FS - Federal Specification; Available from DLA Document Services; www.quicksearch.dla.mil.
    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org/ccb.
6. MILSPEC - Military Specification and Standards; (See DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (See USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.
1. CBHF; State of California; Department of Consumer Affairs; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; www.bearhfti.ca.gov.
2. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.calregs.com.
3. CDHS; California Department of Health Services; (See CDPH).

4. CDPH; California Department of Public Health; Indoor Air Quality Program; www.cal-iaq.org.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TAS; Architectural Barriers Texas Accessibility Standards; www.tdlr.texas.gov/ab/abtas.htm.
8. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; www.txforestservice.tamu.edu.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01500 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Temporary Utilities: Electricity, water, and sanitary facilities.
   2. Temporary Controls: Barriers, water control, protection of the Work, and security.
   3. Construction Facilities: Progress cleaning and removal of utilities.

B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.
   2. Section 01700 - Contract Closeout: Final cleaning.

1.2 CONSTRUCTION ENTRANCE

A. Contractor shall coordinate with Owner and use operations entrance for site ingress/egress.

1.3 TEMPORARY ELECTRICITY

A. Contractor shall contact electric company to provide service for temporary power, if required.
B. Owner will not pay cost of energy used. Exercise measures to conserve energy.
C. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required by Contractor's operations. Provide flexible power cords as required.
D. Provide main service disconnect and overcurrent protection at convenient location in conformance with National Electrical Code (NEC).

1.4 TEMPORARY WATER SERVICE

A. Contractor shall provide temporary water service for all purposes (potable and non-potable), if required.
B. Owner will not pay cost of water used. Exercise measures to conserve water.
C. Contractor must provide a means at Contractor’s expense to pump the water from the source and load water transport vehicles.
D. Water for construction purposes may be obtained from the City's "gooseneck" re-use water supply at no cost to Contractor.

1.5 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures.
B. Permanent building facilities shall not be used during construction operations. Maintain daily in clean and sanitary condition.

1.6 BARRIERS/TRAFFIC CONTROL

A. Provide barriers to prevent unauthorized entry to construction areas to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations and demolition.

B. Furnish all necessary traffic control signs and flag personnel. The Contractor shall establish a parking area in a location approved by the engineer and Owner.
C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.7 STORM WATER CONTROL

A. Grade site to drain. Maintain excavations free of water.
B. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
C. Protect all lining materials from water before, during, and after installation.

1.8 PROTECTION OF INSTALLED WORK

A. Protect installed Work and provide special protection where specified in individual specification Sections.
B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.

1.9 SECURITY/WORKING HOURS

A. Provide security and facilities to protect Work from unauthorized entry, vandalism, or theft. Cost for security shall be included in bid price.
B. Normal hours of operation for the landfill are 7 a.m. to 4 p.m. Monday - Saturday. Contractor will be allowed to work beyond the landfill normal working hours of operation. Contractor will be responsible for coordinating with Owner and securing the site when doing so.
C. Contractor shall not operate equipment between 7 p.m. and 7 a.m.

1.10 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Keep site clean and orderly.
B. Remove waste materials, debris, and rubbish from site and dispose on existing working face at intervals as required to maintain clean site.

1.11 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary above grade or buried utilities, equipment, facilities and materials as soon as permanent facilities can be utilized.
B. Remove underground installations to a minimum depth of 2 feet. Grade site as indicated.
C. Clean and repair damage caused by installation or use of temporary work.
D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01550 - MATERIAL AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Products and product options.
   2. Product delivery, storage, and handling.
   3. Equipment list and substitutions.

B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.

1.2 PRODUCTS

A. Products: New material, components, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying and erection of Work.

B. Provide interchangeable components of the same manufacturer, for similar components.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery
   1. Deliver materials, products and equipment to project site in undamaged condition in manufacturer original, unopened containers or packaging, with identifying labels intact and legible.
   2. Promptly inspect shipments to assure that products comply with requirements, quantities are correct, and products are undamaged.
   3. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.
   4. Arrange deliveries in accordance with the construction schedule and in ample time to facilitate inspection prior to installation to avoid unnecessary delays in the construction process.

B. Storage
   1. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
   2. For exterior storage of fabricated products, place on sloped supports, above ground.
   3. Provide offsite storage and protection when site does not permit onsite storage or protection.
   4. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.
   5. Store loose granular materials on solid flat surfaces in a well-drained area. Provide cover to stockpile to prevent windblown contaminants from mixing with the stockpile. Granular materials shall not be stored on bare ground or asphalt surfaces.
   6. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
   7. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

8. Materials, products, and equipment may be stored offsite in bonded and insured warehouse approved by Engineer and Owner. Pay all costs incurred for offsite storage facilities. Products properly stored in offsite storage facilities may be included in progress pay request with written approval of the Engineer.

C. Handling
   1. Handle materials, products and equipment in a manner prescribed by manufacturer or specified to protect from damage during storage and installation.

1.4 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.
C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with Article 1.5.

1.5 EQUIPMENT LIST

A. Submit in accordance with Section 01300 - Submittals.

1.6 SUBSTITUTIONS

A. Engineer will consider requests for substitutions only within 30 days after date established in Notice to Proceed.
B. Substitutions may be considered when product becomes unavailable through no fault of Contractor.
C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
D. A request constitutes a representation that the Bidder:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2. Will provide the same warranty for the Substitution as for the specified product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.
   5. Will reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities.
E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
F. Substitution Submittal Procedure:
   1. Submit four copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
   2. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   3. Engineer will notify Contractor, in writing, of decision to accept or reject request.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01560 - ENVIRONMENTAL PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCES

A. Listed publications form a part of this specification to extent referenced. Publications are referred to in the text by the basic designation only.
   1. Code of Federal Regulations (CFR)
      a. 29 CFR 1910-SUBPART G: Occupational Health and Environmental Control.
   2. Corps OF Engineers (COE)
      a. COE EP-1165-2-304: 1976 Flood Plain Regulations for Flood Plain Management.

1.3 DEFINITIONS

A. Sediment: Eroded soil and other debris transported by runoff water or wind.
B. Solid Waste: Rubbish, debris, garbage, and other discarded solid materials resulting from industrial, commercial, and agricultural operations and from community activities.
C. Rubbish: Combustible and noncombustible wastes such as paper, boxes, glass, crockery, metal, lumber, cans, and bones.
D. Debris: Combustible and noncombustible wastes such as ashes and waste materials resulting from construction or maintenance and repair work, leaves, and tree trimmings.
E. Chemical Wastes: This includes salts, acids, alkalies, herbicides, pesticides, organic chemicals, and spent products which serve no purpose.
F. Sanitary Wastes: Sewage.
G. Wastes characterized as domestic sanitary sewage: Garbage.
   1. Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.
H. Oily Waste: Petroleum products and bituminous materials.

1.4 ENVIRONMENTAL PROTECTION REQUIREMENTS

A. During the life of the contract, provide and maintain environmental protection as defined. Plan for and provide environmental protective measures to control pollution that develops during normal construction practice. Plan for and provide environmental protective measures required to correct conditions that develop during construction of permanent or temporary environmental features associated with the project. Comply with Federal, state, and local regulations pertaining to the environment, including but not limited to water, air, and noise pollution.
   1. Best Management Practices (BMPs)
      a. Waste Materials: All waste materials, including construction debris, shall be collected and stored in a securely lidded metal dumpster. No construction material shall be buried on site. The transit dumpster shall comply with ordinance 18.52.010 (enclosure and removal of waste materials during construction.) The dumpster shall be emptied as necessary or as required by ordinance 9.04 (solid waste management) and the trash shall be hauled to a licensed landfill.

b. Hazardous Waste: At a minimum, any products in the following categories shall be considered hazardous: Paint, acids for cleaning masonry surfaces, cleaning solvents, asphalt products, chemical additives for spill stabilization, curing compounds and additives. In the event of a spill which may be hazardous, the Contractor shall take immediate action and contact the fire dept. and TCEQ.

c. Sanitary Waste: All sanitary waste shall be collected from the construction portable units as necessary or as required, chapter 18.08 (building code), by a licensed sanitary waste management contractor. All waste material shall be the responsibility of the Contractor.

d. Spill Prevention - practices used to reduce risk of spills or other accidental exposures of materials to stormwater runoff:
   1) Good Housekeeping
      (a) Store only enough products required to do the job.
      (b) Neatly store materials on-site in an orderly manner.
      (c) Keep products in their original container.
      (d) Do not mix substances with one another unless otherwise recommended by manufacturer.
      (e) Use entire contents of a product before disposing the container.
      (f) Follow manufacturer recommendations for proper use and disposal.
   2) Hazardous Products - practices used to reduce risks:
      (a) Keep products in original container if possible.
      (b) Retain original labels, product information, and (MSDS).
      (c) Dispose surplus product in accordance with manufacturer or local and state recommended methods.
   3) Petroleum Products: All onsite vehicles shall be monitored for leaks and receive regular preventive maintenance to reduce chance of spills. Petroleum shall be stored in clearly-labeled, tightly-sealed containers. Any asphalt substances used onsite shall be applied according to manufacturer recommendation.

e. Spill Control Practices:
   1) Manufacturer recommended methods for spill cleanup shall be clearly posted and site personnel made aware of the procedures.
   2) Materials and equipment necessary for spill cleanup shall be kept in onsite material storage area.
   3) All spills shall be cleaned up immediately after discovery.
   4) Spill area shall be well-ventilated and appropriate clothing worn.
   5) Any spill shall be reported to the appropriate governmental agency.
   6) Measures shall be taken to prevent a spill from reoccurring.

f. Maintenance and Inspection Procedures: All pollution prevention measures shall be inspected at least once a month and following a storm event of 0.5 inches or more, best management practices and pollution control procedures shall be inspected for adequacy. A record of the result of the inspections of the site shall be kept onsite.

g. Remarks: Disposal areas, stockpiles, and haul roads shall be constructed to minimize and control amount of sediment that may enter receiving waters or streambeds. Construction staging areas and vehicle maintenance areas shall be constructed by Contractor to minimize runoff of pollutants.

2. Stormwater Pollution Prevention Plan (SWPPP)
   a. Contractor shall understand and sign certification statement relating to National Pollutant Discharge Elimination System (NPDES).

b. Contractor shall install erosion control measures as follows (recommendations only; Contractor shall make sure the requirements of the NPDES are met.
   1) Silt fencing or temporary berms shall be installed prior to start of construction.
   2) Temporary swales and desilting basins will be placed where necessary to convey stormwater runoff.
   3) Stabilized construction entrance will be provided to help reduce vehicle tracking of sediments. The paved street adjacent to site entrance will be swept daily to remove any excess mud, dirt, or rock tracked from site.
   4) Owner shall be responsible for insuring all erosion control methods are inspected monthly or after every erodible rainfall (1/2 inch or more). Any necessary repairs or cleanup to maintain effectiveness of erosion control shall be made at that time.
   5) Temporary berm shall be provided at toe of slope and lot line at time of grading.

3. Perform preconstruction survey of project site with Engineer assess existing environmental conditions in and adjacent to the site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PROTECTION OF NATURAL RESOURCES

A. Preserve the natural resources within the project boundaries and outside the limits of permanent work. Restore to an equivalent or improved condition upon completion of work. Confine construction activities to within the limits of the work indicated or specified.
   1. Land Resources: Except in areas to clear, do not remove, cut, deface, injure, or destroy trees or shrubs without Engineer permission. Do not fasten or attach ropes, cables, or guys to existing nearby trees for anchorages unless authorized by Engineer. Where such use of attach ropes, cables, or guys is authorized, Contractor shall be responsible for any resultant damage.
      a. Protection: Protect existing trees to remain and may be injured, bruised, defaced, or otherwise damaged by construction operations. Remove displaced rocks from uncleared areas. By approved excavation, remove trees with 30 percent or more of their root systems destroyed.
      b. Replacement: Remove trees and other landscape features scarred or damaged by equipment operations, and replace with equivalent, undamaged trees and landscape features. Obtain Engineers approval before replacement.
      c. Temporary Construction: Remove traces of temporary construction facilities such as haul roads, work areas, structures, foundations of temporary structures, stockpiles of excess or waste materials, and other signs of construction. Grade temporary roads, parking areas, and similar temporarily used areas to conform to surrounding contours.
   2. Water Resources
      a. Oily Wastes: Prevent oily or other hazardous substances from entering ground, drainage areas, or local bodies of water. Surround all temporary fuel oil or

petroleum storage tanks with temporary earth berm of sufficient size and strength to contain the contents of the tanks in the event of leakage or spillage.

3. Fish and Wildlife Resources: Do not disturb fish, wildlife, alter water flows, or otherwise significantly disturb native habitat adjacent to the project and critical to the survival of fish and wildlife, except as indicated or specified.

3.2 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

A. Carefully protect in-place and report immediately to Engineer historical and archaeological items or human skeletal remains discovered in the course of work. Stop work in immediate area of discovery until directed by Engineer to resume work. If historical and archaeological resources such as artifacts (stone tools), features (stone walls), deposits (sea shells and charcoal stained soil), human bones, and other cultural remains are encountered, stop that portion of work and notify Engineer immediately. Within 36 hours, Owner will determine if a change pursuant to Contract should be issued or to direct Contractor to proceed without change. No adjustment in contract price or completion time allowed for delays that do not exceed 36 hours from the time the Contractor is notified to stop work. Owner retains ownership and control over historical and archaeological resources.

3.3 EROSION AND SEDIMENT CONTROL MEASURES

A. Burnoff of ground cover not permitted.

B. Borrow Areas: Manage and control to prevent sediment from entering nearby streams or lakes. Restore areas, including those outside borrow areas, disturbed by borrow and haul operations. Restoration includes grading, topsoil replacement, and establishment of permanent vegetative cover.

C. Protection of Erodible Soils: Immediately finish earthwork brought to a final grade, as indicated or specified. Immediately protect the side slopes and back slopes upon completion of rough grading. Plan and conduct earthwork to minimize the duration of exposure of unprotected soils.

D. Temporary Protection of Erodible Soils: Mechanically-retard and control rate of runoff from the construction site. This includes construction of diversion ditches, benches, and berms to retard and divert runoff to protected drainage courses.

3.4 CONTROL AND DISPOSAL OF SOLID AND SANITARY WASTES

A. Pick up solid wastes, and place in containers regularly emptied. Do not prepare, cook, or dispose of food on project site. Prevent contamination of the site of other areas when handling and disposing of wastes. On completion, leave the areas clean. Control and dispose of waste.

B. Dispose of rubbish and debris in accordance with area requirements specified as directed by Owner. Rubbish may be disposed of in current landfill if all rules for disposal are followed.

C. Garbage Disposal: Place garbage in approved containers and move to pickup point or disposal area, as directed.

3.5 DUST CONTROL

A. Contractor will be fully responsible for dust control along all haul roads and in the project area. Keep dust down at all times, including during nonworking periods. Sprinkle or treat, with dust suppressants, the soil at the site, haul roads, and other areas disturbed by operations.

END OF SECTION

SECTION 01600 - PROGRESS SCHEDULES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Work shall be executed with such progress as required to prevent any delay to other contractors, contract milestones, or general completion of the project.
   2. Contractor shall provide a statement to Engineer describing his computerized scheduling capability for review and approval. This statement shall include the following as a minimum:
      a. Identification, qualifications, and experience of member(s) of Contractor's scheduling staff or any other consultant's staff.
      b. References of not less than two previous projects on which Contractor or Consultant utilized computerized CPM scheduling, which were of not less than one-quarter of the value of the present contract.
      c. Name and description of project management software and computer hardware utilized on this Contract.

B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.

1.2 CONSTRUCTION SCHEDULE

A. Contractor shall show the sequence and interdependence of activities required for complete performance of all the work. Contractor's Construction Schedule shall begin with the date of Notice to Proceed and conclude with the date of Final Completion of the Contract. Float or slack time accrues to the benefit of Owner but is a resource available to both parties as needed to meet contract milestones and the contract completion date. Accordingly, no time extensions will be granted nor delay damages paid until a delay occurs which extends the work beyond the Contract completion date.

B. Pursuant to the Float Sharing requirements of the Contract Documents, (1) use of float suppression techniques such as preferential sequencing, use of lead/lag logic restraints, extended Activity times, or imposed dates and (2) use of Float Time disclosed or implied by the use of alternate float suppression techniques shall be shared to the proportionate benefit of Owner, Contractor, and Contractor's subcontractors.

C. Comments made by Engineer on Contractor's Construction Schedule during review will not relieve Contractor from compliance with requirements of Contract Documents. This review is only for general conformance with the schedule concept of the project and general compliance with the information given in the Contract Documents.

1.3 SUBMITTALS

A. Contractor shall submit the following items as specified in this section:
   1. Overall schedule.
   2. Scheduled reports.
   3. Progress Reports.

1.4 PROGRESS OF THE WORK

A. General: Contractor shall execute work at such times and on such parts of the project, and with such forces, materials, and equipment, to assure completion in the time established by Contract.
B. Activity Coordination: To ensure consistency with General Contractor's breakdown of work and nomenclature, each Subcontractor shall work in concert with the General Contractor throughout all aspects of schedule development.
C. Activities
    1. Work activities comprising Contractor's Construction Schedule shall be of sufficient detail to assure adequate planning and execution of the work, such that the schedules provide an appropriate basis for monitoring and evaluating the progress of the work. Work activity is defined as an activity which requires time and resources (manpower, equipment, and/or material) to complete.
    2. Show information in such detail that duration times of activities will range normally from one to 15 calendar days. However, no activity shall have more than 30 calendar days' duration for any onsite operation. Selected exceptions may be approved by Engineer where sub-networks will be used. The selection and number of the Contractor's construction activities shall be subject to review of the Engineer.
    3. If requested by Engineer, Contractor, at Contractor sole expense, shall provide highly-detailed short-term schedules for specific crucial items (work-arounds, start-up, etc.)

1.5 SCHEDULE

A. Preliminary Network Analysis: Within 15 calendar days after the date of Award of the Contract the Contractor shall submit a preliminary network analysis indicating the Contractor's planned operations for the first 60 days after the notice to proceed. This should also indicate the Contractor's general approach to the remainder of the work and the cost of activities expected to be completed or partially completed before submittal and review of the completed network analysis.
B. Completed Network Analysis: Within 45 calendar days after date of Award of the Contract or ten days after the Notice to Proceed, whichever date is earlier, the Contractor shall submit a completed CPM network analysis including diagrams, mathematical analysis, and computer printouts, as determined in consultation with the Engineer. This analysis is for review and acceptance as a condition precedent to approval of first pay application.
C. Detailed Network Diagram: Contractor's Construction Schedule shall include time-scaled network diagrams based on calendar days. Network diagrams shall be Critical Path Method (CPM) precedence format and show sequence and interdependence of activities required for complete performance of the work. A calendar shall be shown on all sheets.
D. Each activity shall be plotted so the beginning and completion dates of said activity can be accurately determined by graphical comparison with the calendar scale.

1.6 SCHEDULED REPORTS

A. Contractor shall prepare schedule listings of information in network diagram in tabular format, sorted according to early start, within responsibility, or as directed by Engineer.
B. Schedule listings shall show activity numbers, description, responsibility, total duration in work days, percent complete, early-start date, late-start date, early-finish date, and total float for each activity in the network diagram.

C. Overall Schedule and subsequent revisions shall reflect actual progress of project. Contractor shall sign and submit one reproducible and three copies of the initial Overall Schedule and each revision.

D. If initial submittal or a subsequent revision does not meet the requirements specified, Contractor shall revise Overall Schedule and resubmit until acceptable to Engineer. Failure to submit and adequately update the Overall Schedule, and schedule reports, will be considered cause for withholding partial payments otherwise due under the Contract.

1.7 PROGRESS REPORTS

A. Once biweekly on a date mutually agreed upon by the Contractor, Owner's Representative, and Engineer, a meeting will be held when schedule will be reviewed. Immediately prior to the meeting the Contractor shall obtain the necessary information to update the Overall Schedule to reflect progress to date and furnish sufficient copies of the updated schedule at the meeting for review.

B. Schedule provided by Contractor at the biweekly meetings with Engineer and Owner shall be a detailed two-week look ahead schedule for the work to be performed during the current week and subsequent week period. This schedule shall be updated biweekly by the Contractor with copies available for the biweekly meetings. Contractor shall invite his subcontractors to participate in the biweekly meetings, or if requested by Engineer.

C. In updating the schedule, progress will be reviewed for the following items:
   1. To identify those activities started and completed during the previous period.
   2. For remaining duration, from the date of update, required to complete each activity started but not completed.
   3. For review of durations for activities not yet started.
   4. For addition of Change Orders and proposed sequencing changes to the network diagram and schedule listings.

D. At least once a month, and utilizing data accumulated during the previous joint Owner-Engineer-Contractor reviews, Contractor shall revise the network diagram and generate updated schedule reports.

E. Whenever revised scheduling documents are submitted, they shall be accompanied by a written narrative report. The narrative report shall:
   1. Describe amount of progress since the last revision in terms of activities started, continuing, and completed.
   2. Describe problem areas, current and anticipated delay factors, and the estimated impact on performance of other activities and completion dates.
   3. Explain corrective action taken or proposed.

1.8 MAINTAINING SCHEDULE

A. If at any time during the project the Contractor fails to complete an activity by its latest scheduled completion date, which late completion will impact the end date of the work past the Contract substantial completion due date, the Contractor shall submit within seven calendar days plans to reorganize the work force to return to the original schedule for review and approval of owner.

B. Contractor will add equipment, or construction forces, as well as increase working hours, if operations fall behind schedule at any time.

C. Addition of equipment or construction forces, increasing working hours, or other method, manner, or procedure to return to the contractually required completion date will not be justification for an increase in Contract Price or treated as an acceleration.
D. Contractor shall plan, schedule, and coordinate construction operations and activities in a manner that will facilitate progress of work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 01700 - CONTRACT CLOSEOUT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Closeout procedures and final cleaning.
   2. Adjusting and warranties.
   3. Hazardous materials affidavit and Project record documents.
   4. Operations and maintenance data.
   5. Spare parts and maintenance materials.

B. Related Sections:
   1. Other Division 01 Specification Sections apply to Work of this Section.

1.2 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work inspected, and Work is complete in accordance with Contract Documents and ready for Engineer inspection.

B. Provide submittals to Engineer required by governing or other authorities.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.

1.3 FINAL CLEANING

A. Execute final cleaning prior to final inspection.

B. Clean equipment to a sanitary condition.

C. Replace filters of operating equipment.

D. Clean debris from drainage systems.

E. Clean site; sweep pave areas, rake clean landscaped surfaces.

F. Remove waste and surplus materials, rubbish, and construction facilities from the site.

G. Repair, patch and touch-up marred surfaces to match adjacent finishes.

H. Remove waste and surplus materials, rubbish, and construction facilities as Engineer directs.

1.4 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

1.5 HAZARDOUS MATERIALS AFFIDAVITS

A. Contractor, each subcontractor, and each material/product supplier to provide a notarized affidavit declaring that hazardous materials were not incorporated into construction of nor delivered to the Project.

B. Hazardous materials include asbestos, lead polychlorinated biphenyl (PCB), prohibited termite eradication chemicals or any substance of any proportion determined or suspected by an agency of federal or state government to create a health hazard.

C. Provide table of contents listing all affidavits in alphabetical order and assemble with metal prong binder in durable plastic presentation cover.

D. Prepare binder cover with printed title “AFFIDAVITS OF NON-INCORPORATED HAZARDOUS MATERIALS,” title of Project, Project address, Owner names, address and phone and date of Construction Completion.
E. Provide two complete, identical binders of aforementioned information in prescribed format.
F. Submit prior to final Application for Payment.

1.6 PROJECT RECORD DOCUMENTS

A. Maintain onsite two sets of these record documents, record actual revisions to the Work:
   1. Contract Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed shop drawings, product data, and samples.
B. Store Record Documents separate from documents used for construction.
C. Record information concurrent with construction progress.
D. Specifications: Legibly mark and record at each product section description of actual products installed, including:
   1. Manufacturer name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and Modifications.
E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract Drawings.
   6. Changes made by addenda and modification.
F. Submit documents to Engineer with claim for final Application for Payment.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit one copy 15 days prior to final inspection, 8 1/2 x 11-inch text pages, bound in three D-ring binders with durable plastic covers.
B. This copy will be returned after final inspection with Engineer comments. Revise content of documents as required prior to final submittal.
C. Submit two final volumes revised within ten days after final inspection.
D. Prepare binder covers with printed title "OPERATION AND MAINTENANCE INSTRUCTIONS," Project title and subject matter of binder when multiple binders required.
E. Internally subdivide binder contents with permanent page dividers, logically organized as described, with tab titling clearly printed under reinforced laminated plastic tabs.
F. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, type on 24-lb. white paper.
G. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, Contractor, Subcontractors, and major equipment suppliers.

H. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify:
   1. Significant design criteria.
   2. List of equipment.
   3. Parts list for each component.
   4. Operating instructions necessary for Owner to make full and efficient use of equipment including recommended maintenance and seasonal changeover procedures for HVAC systems.
   5. Maintenance instructions for equipment and systems.
   6. Maintenance instructions for finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

I. Part 3: Project documents and certificates, including:
   1. Shop drawings and product data.
   2. Air and water balance reports.
   3. Certificates.
   4. Photocopies of warranties and bonds.

1.8 WARRANTIES

A. Provide duplicate notarized copies.
B. Execute and assemble documents from Subcontractors, suppliers, and manufacturers.
C. Provide Table of Contents and assemble with metal prong binder in durable plastic presentation cover.
D. Submit prior to final Application for Payment.
E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within ten days after acceptance, listing date of acceptance as start of warranty period.

1.9 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification Sections.
B. Deliver to project site and place in location as directed; obtain receipt prior to final payment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 02200 - EXCAVATION AND EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Project site has been excavated to grades shown on Project Drawings. Earthwork shall include the following.
      a. Miscellaneous grading to repair erosion and proof rolling subgrades for geocomposite clay liner.
      b. General excavation and filling for those areas to new contours (also see Section 02210 – Soil Stabilization).
      c. Excavating for leachate collection system.
      d. Excavating and backfilling anchor trenches.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 02227 – Waste Material Disposal.
   3. Section 02231 –Drainage Aggregate.
   4. Section 02250 – Compacted Clay Liner.
   5. Section 02745 – Leachate Collection System.
   6. Section 02778 – HDPE Geomembrane.
   7. Section 02760 – Geotextile Materials.

1.2 REFERENCES

A. The following publications form part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation or title or are used to establish criteria. The latest publication in use at the time of the executed contract shall be the one used on this project.
   1. AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
      a. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft).
      b. ASTM D4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity of Soils.
      c. ASTM D6938 – Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate.
   2. TEXAS COMMISSION ON ENVIRONMENTAL QUALITY
      a. TCEQ, 30 TAC Chapter 330 - Texas Commission on Environmental Quality, Municipal Solid Waste Regulation.

1.3 DEFINITIONS

A. Backfill - a specified material used in refilling a cut, trench, over excavation or other excavation, placed at a specified degree of compaction.

B. Compaction - process of mechanically stabilizing a material by increasing density at a controlled moisture condition. "Degree of Compaction" is expressed as a percentage of the maximum density obtained by the test procedure described in ASTM D698 for general soil types abbreviated in this specification as "95 percent ASTM D698 maximum density."

C. Embankment - a "fill" having a top that is higher than adjoining ground.
D. Excavation - consists of the removal of material encountered to subgrade elevations and reuse or disposal of materials removed.
E. Fill - specified material placed at a specified degree of compaction to obtain an indicated grade or elevation.
F. Hard Material - weathered rock, dense consolidated deposits or conglomerate materials, (excluding manmade materials such as concrete) not included in the definition of "rock" but usually require the use of heavy excavation equipment with ripper teeth or jack hammers.
G. In Situ Soil - existing in place soil.
H. Lift - layer (or course) of soil placed on top of a previously prepared or placed soil.
I. Rock - solid, homogeneous, interlocking crystalline material with firmly cemented, laminated, or foliated masses or conglomerate deposits, neither of which can be removed without systematic drilling and blasting, drilling and the use of expansion jacks or feather wedges, or the use of backhoe-mounted pneumatic hole punchers or rock breakers; also large boulders, buried masonry, or concrete other than pavement, exceeding 1 cubic yard in volume. Removal of "hard material" will not be considered rock excavation because of intermittent drilling and blasting performed merely to increase production.
J. Soil - surface material of earth's crust resulting from chemical and mechanical weathering of rock and organic material.
K. Subgrade - material in excavation (cuts) and fills (embankments) immediately below any subbase, base, liner, or other improvement. As a secondary definition, the level below which work above is referenced.
L. Subgrade - uppermost surface of an excavation or top surface of a fill or backfill immediately below geocomposite clay liner.
M. Topsoil - in natural or undisturbed soil formations, the fine-grained, weathered material on the surface or directly below any loose or partially decomposed organic matter. Topsoil may be a dark-colored, fine, silty, or sandy material with a high content of well-decomposed organic matter, often containing traces of parent rock material. Gradation and material requirements specified herein apply to all topsoil references in this contract. The material shall be representative of productive soils in the vicinity.
N. Unauthorized Excavation - removing materials beyond indicated subgrade elevations or dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be at Contractor expense.
O. Unsatisfactory Material - existing, in situ soil or other material identified as having insufficient strength characteristics or stability to carry intended loads in fill or embankment without excessive consolidation or loss of stability. Unsatisfactory materials also include manmade fills, refuse, frozen material, uncompacted backfills from previous construction, unsound rock or soil lenses, or other deleterious or objectionable material.
P. Working Platform - layer of compacted crushed rock or natural stone that replaces in situ soil to provide stable, uniform-bearing foundation for construction equipment to facilitate further site construction.

1.4 DELIVERY AND STORAGE

A. Deliver and store materials as needed in a manner to prevent contamination or segregation.

1.5 QUALITY ASSURANCE

A. Codes and Standards: Perform earthwork complying with requirements of authorities having jurisdiction.

1.6 CRITERIA FOR BIDDING

A. Base bids on the following criteria:
   1. Surface elevations as indicated.
   2. Character of material to excavate or use for subgrade as indicated. Hard material not considered as rock and removal of such material shall not give cause for a claim for additional compensation regardless of hardness or difficulty in removing. Rock as defined in the paragraph entitled, "Definitions," will not be encountered.
   3. Suitable backfill and fill material in the quantities required is available at the project site.
   4. Blasting not permitted. Remove material by drilling and use of expansion jacks or feather wedges, or use of backhoe-mounted pneumatic hole-punchers or rock-breakers, or as approved by Engineer.

PART 2 - PRODUCTS

2.1 REQUIRED EQUIPMENT

A. Subgrade preparation for areas to receive GCL must include rolling with a self-propelled smooth drum roller.
B. No equipment allowed within limits of lining system without prior approval from Engineer. Submit all equipment to use within limits of liner in accordance with Section 01300 – Submittals, including equipment weights, ground pressures, required lift thickness, etc.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection and Restoration of Surfaces
   1. Protect newly-graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes or filter fabric dams as needed. Conduct work in accordance with requirements specified in Section 01560 - Environmental Protection.
B. Stockpile of Excavated Material
   1. Stockpile excavated material where shown on plans so it will not obstruct the flow of runoff, streams, endanger a partly-finished structure, impair the efficiency or appearance of facilities, or be detrimental to the completed work.

3.2 SURFACE PREPARATION

A. Clearing
   1. Brush, refuse, stumps, roots, and un-merchantable timber shall become property of Contractor and be removed as directed by Engineer. Conduct work in accordance with requirements specified in Section 01560 - Environmental Protection.
B. Stockpiling Topsoil
   1. Strip approved topsoil from the site where excavation or grading indicated and stockpile separately from other excavated material. Locate topsoil as shown on plans so material can be used readily for the finished grading. Protect and store in segregated piles until needed.

C. Unsatisfactory Material
   1. Remove organic matter, sod, muck, rubbish, and unsuitable soils under the limits of construction. Typical depth of removal of such unsuitable material will not be less than 12 inches.
D. Protect structures, utilities, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
E. Provide erosion control measures to prevent erosion or displacement of soils.

3.3 DEWATERING

A. Prevent surface water from entering excavations, ponding on prepared subgrades, and flooding Project site and surrounding area.
B. Protect subgrades from softening and damage by rain or water accumulation.

3.4 GENERAL EXCAVATION

A. Excavate to the indicated slopes, lines, depths and elevations. Engineer will verify the excavation has been performed in accordance with Project Drawings. Stockpile excavated material in area indicated on Project Drawings. Prepare subgrade in accordance with Article 3.6 - Preparation of Subgrade and Compacted Berms.
B. In the process of excavating over existing lining system, waste will not likely be encountered. If waste is encountered, Contractor shall dispose of this waste on active working face, as directed by Owner, and cover any remaining exposed waste with a minimum of 6 inches of clean soil of the same type as that used for protective cover.
C. Unclassified Excavation: Excavation is unclassified and includes excavation to required subgrade elevations regardless of the character of materials and obstructions encountered.
D. Keep excavations free from water while construction is in progress. Notify Engineer immediately in writing if it becomes necessary to remove rock, hard material, or other material defined as unsatisfactory to a depth greater than indicated. Refill excavations cut below required subgrade elevations.

3.5 EXCAVATION FOR ANCHOR TRENCHES AND LEACHATE COLLECTION SYSTEM

A. Excavate trenches to indicated slopes, lines, depths, and elevations. Engineer shall verify trench has been constructed according to Project Drawings.
B. Excavate anchor trenches to uniform widths as shown on Project Drawings. Excavate trench walls vertically from trench bottom to top, except rounded edges will be provided where liner materials enter anchor trenches so as to avoid sharp bends in the geosynthetic materials.
C. If trench is located in clay susceptible to desiccation, only the amount of trench required for one day of installation shall be excavated to minimize desiccation of trench soils.

3.6 PREPARATION OF SUBGRADE AND COMPACTED BERMS

A. Refer to Section 02210 – Soil Stabilization, for side slope requirements.
B. Fine-grade subgrade to smooth, uniform and compacted conditions, to elevations shown on Project Drawings. Remove all stones larger than 3/4 inch in diameter and any other objects which could damage overlying geosynthetic materials.
C. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer.

D. Proof roll subgrade with self-propelled smooth drum roller or by methods acceptable to Engineer to remove clods and non-uniform subgrade.
E. Construct berms to the grades shown. Use suitable fill materials from onsite as directed by Owner and compact to 95 percent standard proctor density (ASTM D698). Control rill development, repairing any that occur, and maintain side slopes for duration of Project.

3.7 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavations as directed by Engineer.

3.8 ANCHOR TRENCH BACKFILL

A. Anchor trench shall be backfilled and compacted in loose lifts not to exceed 8 inches. Compaction shall be achieved using light, rubber-tired equipment or other light compaction equipment. Care shall be taken to prevent damage to the geosynthetic materials. At no time shall construction equipment come into direct contact with the geosynthetic clay liner, geomembrane or geonet. If damage occurs, Contractor shall repair in accordance with the specifications, prior to completion of backfilling.
B. Anchor trench shall be compacted to 95 percent Maximum Dry Density as determined by ASTM D698.

3.9 LEACHATE COLLECTION SYSTEM BACKFILL

A. Excavate trenches for leachate collection and clean out lines to grades and cross sections shown on plans.
B. Backfill with gravel drainage material in accordance with Section 02231 – Drainage Aggregate.

3.10 MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade or backfill layer before compaction to optimum moisture content or higher.
    1. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
    2. Remove and replace, or scarify and air-dry satisfactory soil material too wet to compact to specified density.
        a. Stockpile or spread and dry removed wet satisfactory soil material.

3.11 GRADING

A. General: Uniformly grade areas to a smooth surface, free from irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated. Provide a smooth transition between existing adjacent grades and new grades. Correct and control wind and water erosion.
B. Site Grading: Grade to finished grades indicated within 0.10 foot. No rock will protrude above the finished grade elevation. Protruding rock will be removed below grade and the void backfilled and compacted to ASTM D698 (95 percent). Grade areas to drain where possible. Existing grades to remain but disturbed by Contractor operations shall be restored to preconstruction condition.

C. Protection of Surfaces: Protect newly-graded areas from traffic, erosion, and settlements that may occur as required in Section 01560 - Environmental Protection, and as specified in Article 3.1.B - Protection and Restoration of Surfaces. Repair or reestablish damaged grades, elevations, or slopes before work will be accepted.

3.12 FIELD QUALITY CONTROL

A. Contractor will allow Engineer to inspect and test each subgrade and each fill or backfill layer. Do not proceed until test results for previously completed work verify compliance with requirements.
   1. Liner Subgrade: Proof roll to smooth surface such no ruts or other surface indentions exceed 1 inch in depth.
   2. Trench Backfill: In each compacted initial and final backfill layer, perform at least one field in-place density test for each 150 feet or less of trench, but no fewer than two tests.
   3. Access Roadway: One in field density per 200 linear feet of roadway. Density requirement shall be 95 percent maximum dry density in accordance with ASTM D698.

B. When test results report that subgrades, fills, or backfills are below specified density, scarify and moisten or aerate, or remove and replace soil to depth required, recompact and retest until required density is obtained.

3.13 PROTECTION

A. Protecting Graded Areas: Protect newly-graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions.
   1. Scarify or remove and replace material to depth directed by Engineer; reshape and recompact at optimum moisture content to the required density.

C. Settling: Where settling occurs during Project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to the greatest extent possible.

3.14 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Transport surplus satisfactory soil to designated storage areas on Owner property. Stockpile or spread soil as directed by Engineer.
   1. Remove waste material, including unsatisfactory soil, trash, and debris, and dispose of it on the active face as directed by Engineer.

END OF SECTION

SECTION 02227 WASTE MATERIAL DISPOSAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Offsite waste material disposal consisting of trees, stumps, logs, brush, roots, grass, vegetation, humus, rubbish, large rocks exceeding a dimension of 6 inches in any direction, demolished equipment not retained by Owner, and other objectionable matter from operations such as clearing and grubbing, demolition, excavation, and grading. Unless otherwise specified, Contractor is responsible for removal and disposal of waste material in accordance with applicable regulations.

B. Related Sections:
   1. Division 01 Specification Section applies to Work of this Section.

C. Payment:
   1. No separate payment will be made for handling or disposing waste materials. Include cost of work in contract bid prices.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 ONSITE DISPOSAL

A. Waste materials resulting from this construction project, acceptable under the City of Denton Landfill Permit, may be disposed of at the working face at no cost.

3.2 OFFSITE DISPOSAL AREA

A. Waste material removed from work site shall be disposed of in accordance with applicable regulations and in a manner as not to damage Owner or other persons.

3.3 ONSITE TEMPORARY STOCKPILE AREA

A. Material may be temporarily stockpiled at a designated area approved by Owner. Grade and slope stockpile for drainage with a maximum 4:1 slope (horizontal to vertical).

3.4 BURNING

A. No burning permitted.

3.5 EQUIPMENT FLUIDS

A. Contractor equipment fluids shall be collected during servicing, removed, and disposed offsite in accordance with environmental regulations. Flammable or toxic waste shall be contained and not allowed to spill on the ground. Used filters, batteries, machine parts, tires, and other waste material shall also be removed from the site and disposed offsite in accordance with environmental regulations.

END OF SECTION

SECTION 02231 - DRAINAGE AGGREGATE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furnishing and installing the drainage aggregate in the leachate collection system trench and sump, and in the groundwater underdrain trench.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 SUBMITTALS

A. Submit aggregate testing results to Engineer no later than seven days prior to site delivery.

1.3 REFERENCE STANDARDS

A. ASTM D422 - Standard Method for Particle-Size Analysis.
B. ASTM D2434 — Standard Test Method for Permeability of Granular Soils (Constant Head).
C. JLT-5-105-89 — Degradation of Landfill Drainage Materials Due to Carbonate Content.

PART 2 - PRODUCTS

2.1 DRAINAGE MATERIAL

A. Gradation requirements are noted in Appendix A. Drainage aggregate shall conform to ASTM C33 size 57 (or larger). Leachate collection trench D85 size must be greater than 0.85 inch.
B. Permeability: Greater than or equal to 1x10-2 cm/sec as determined by ASTM D2434.
C. Degradation: As noted in Appendix A (not required for underdrain aggregate).

2.2 SOURCE QUALITY CONTROL (BY MANUFACTURER)

A. Perform one permeability test (ASTM D2434) and one degradation test (JLT-5-105-89 or ASTM D3042) for each aggregate source.
B. Perform one gradation test (ASTM D422) for each 3,000 cubic yards of aggregate placed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Place aggregate around leachate collection pipes and in leachate collection sump to lines, grades, and dimensions shown on the Plans.
B. Place only where underlying drainage geocomposite installation is completed and approved. Place without damaging underlying drainage geocomposite and geomembrane.

END OF SECTION

SECTION 02250 - COMPACTED CLAY LINER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Construction of the Compacted Clay Liner
B. Related Sections:
   1. Section 02200 — Earthwork.
   2. Soils and Liner Quality Control Plan (SLQCP)

1.2 REFERENCE STANDARDS

A. ASTM D422: Standard Test Method for Particle Size Analysis of Soils.
B. ASTM D698: Standard Test Method for Moisture-Density Relations of Soils and Soil Aggregate Mixtures, using 5 -°7lb. Hammer and 12-inch Drop.
C. ASTM D1140: Standard Test Method for Amount of Material in Soils Finer than the No. 200 Sieve.
D. ASTM D2216: Standard Test Method for Laboratory Determination of Water (moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.
E. ASTM D2487: Classification of Soils for Engineering Purposes.
F. ASTM D2922: Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods.
G. ASTM D3017: Standard Test Method for Moisture Content of Soils in Place by Nuclear Method.
H. ASTM D4318: Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
I. ASTM D5084: Method of Test for Permeability of Fine Grained Soils.
J. EM 1110-2-1906: U.S. Army Corp of Engineers, Falling-Head Permeability Test with Permeameter Cylinder

PART 2 - PRODUCTS

2.1 SOIL FOR COMPACTED CLAY LINER

A. Obtain clay for liner construction from onsite stockpile and excavations.
B. Clay for liner construction shall be classified according to United Soil Classification System (USCS) as ML, MH, CH, or CL (ASTM D2487) based on liquid limit, plasticity index (PI), and percent passing the No. 200 sieve.
C. Reasonably free of calcareous concentrations and nodules, refuse, roots, or other deleterious substances at CQA monitor discretion.
D. In Place Permeability: Less than or equal to 1 x 10-7 cm/sec as determined by ASTM D2434.

PART 3 - EXECUTION

3.1 INSTALLATION

A. In preparation for clay liner material placement, subgrade, including any earth fill required to raise grade, shall be compacted to not less than 90 percent of maximum dry density as determined by modified proctor methods (ASTM D1557). Compacted lift thicknesses shall

not exceed 6 inches for earth fill. Subgrade shall be firm and non-yielding. Any visible soft or yielding areas must be over-excavated and replaced with properly-compacted earth materials.

B. Grade elevations must be determined by Owner at points not less than one per 5,000 square feet prior to placement of subgrade clay liner material. Elevations establish initial elevations used to verify final clay liner thickness meets minimum requirement.

C. Clay liner material must be processed using appropriate equipment like heavy disc units and/or pulverizers to reduce clay clod sizes to approximately 1 inch maximum. Thoroughly mix with clean water to adjust moisture content to within -1 percentage point dry of optimum to 4 percentage points above optimum. This process intends to produce a uniform material, free of large, dry, soil clods and can be compacted to required density and permeability.

D. Clay liner material must be placed in uniform loose lifts not exceeding 8 inches thick so final compacted lift thickness does not exceed 6 inches. Compactor pad feet must fully penetrate lift compacted.

E. Minimum acceptable density shall be 95 percent of maximum dry density (ASTM D698). Any area failing to meet moisture and density requirement, must be reworked, as needed, to obtain acceptable moisture and density conditions as verified through area retests.

F. Clay liner material compaction requires special compaction equipment with sufficient weight to achieve modified proctor density and pad-footed rollers of sufficient length to fully penetrate loose lifts and extend into underlying lift. Self-propelled, pad-footed compactors like Caterpillar 815B prove successful for clay liner construction (40,000 lbs minimum). Do not use bulldozers or other low-pressure/high-vibration machines to compact clay liner.

G. Do not place successive lifts of clay liner material until area is tested and determined to meet moisture and density requirements.

H. Contractor must protect completed lift from drying by adding clean water until next lift of clay liner material can be placed. If lift dries and cracks, entire area affected must be scarified, moisture adjusted, recompacted, and retested for compliance.

I. Any clay liner section which becomes excessively wet from rainfall must be scarified and allowed to dry to within required moisture range then recompact and retest.

J. Clay liner segments to be constructed on sideslopes must be constructed monolithically with bottom clay liner segments to create a single liner unit. Clay liner material for sideslopes shall be spread, processed, and compacted parallel to slope.

K. Final clay liner surface shall be bladed smooth and/or rolled with steel-wheel roller to produce final surface free of ruts. Owner shall check final surface for final grade elevations at points initially set. Clay liner thickness shall meet minimum requirement at each location to be acceptable.

L. Clay liner and any clay liner lifts shall not be penetrated by survey stakes. Clay liner may be marked with paint for temporary survey purposes.

M. Construct liner as a single monolithic section unless Engineer-approved otherwise in writing.

3.2 FIELD QUALITY CONTROL QUALITY ASSURANCE

A. Allow Owner to perform quality control tests as specified in SLQCP.

B. An individual lift or section may be sampled upon completion (but prior to subsequent lift or section placement). Use an approved sampler or investigative tool. Properly backfill resulting penetration with compacted clay liner material enriched with bentonite. Allow complete testing of compacted clay liner samples prior to clay liner acceptance.

C. Compacted clay liner thickness: Minimum 24 inches across bottom and up sideslopes. Thickness of clay liner on sideslopes is measured perpendicular to slope face.

D. Determine as-built thickness of clay liner by survey methods. Survey completed subgrade surface prior to the placement of clay liner on pre-established grid.

E. Upon completion of clay liner and prior to installation of subsequent elements, survey top of clay liner to ensure specified thickness of clay liner is achieved. Also verify by survey the top of clay liner is graded to specified grades, slopes, and thickness tolerance of 0 to +0.2 feet.

F. This work must be performed by a surveyor registered in the State of Texas and employed by Owner.

END OF SECTION

SECTION 02260 - PROTECTIVE SOIL COVER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Protective soil cover specification and installation.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCES

A. Publications listed form part of this Specification to extent referenced and are referred to in text by basic designation only.
   1. Texas Commission on Environmental Quality (TCEQ) - TCEQ, 30 TAC Chapter 330 - TCEQ, Municipal Solid Waste Regulations.
   2. Owner - MSW Permit - Owner's TCEQ MSW Permit.

1.3 WEATHER LIMITATION

A. Protective soil cover shall be constructed when atmospheric temperature is above 35 degrees F. When temperature falls below 35 degrees F, Contractor shall protect all areas of completed protective soil cover by approved methods against detrimental effects of freezing. Areas of completed protective soil cover damaged by freezing, rainfall, or other weather conditions shall be corrected to meet specified requirements. Protective soil cover placement shall not occur on rainy days or when rain is imminent.

1.4 SUBMITTALS

A. Submit list of all equipment proposed for use in placing and maintaining protective cover. No equipment allowed within limits of liner system without Engineer approval.
B. Submit in accordance with Section 01300 - Submittals, including equipment weight, ground pressure information, required lift thickness information, etc. Unapproved equipment operating on liner system floor or side slopes not allowed.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material used is coarse sand stockpiled onsite near project limits. All material shall be free of debris and rocks larger than 2 inches in diameter.

2.2 EQUIPMENT

A. Tracked equipment used to place soil cover on horizontal portion of liner system must be low ground pressure type (5.0 psi maximum track pressure).
B. Equipment that exerts ground pressures of higher than 5.0 psi on lining system not approved unless Contractor can certify these conditions can be met with specific lift thickness of protective cover. Submit calculations to document certification.

C. Only low ground pressure equipment (<5.0 psi) equipment allowed on sideslope of lining system. Submit list of equipment to use on sideslopes, including equipment weights, ground pressures, required lift thicknesses, etc. for Engineer approval prior to placing equipment on sideslopes. Contractor holds responsibility to demonstrate equipment used on sideslopes will not damage liner or cause "sliding" failure.

PART 3 - EXECUTION

3.1 STOCKPILING MATERIAL

A. If necessary, materials shall be stockpiled in manner and at locations designated. Prior to stockpiling, Contractor shall clear, drain, and level storage sites. Approved material available from excavation or grading shall be stockpiled in manner and at locations designated.

3.2 GRADE CONTROL

A. Finished and completed protective soil cover shall conform to grades, lines, cross sections, and dimensions shown.

3.3 LAYER THICKNESS

A. Completed thickness of protective soil cover shall be as indicated. Protective soil cover will be placed so top surface, during spreading operations, is 2 feet minimum above geocomposite material.

3.4 COMPACTION

A. Compaction control is not required; however, it should be stable for construction and disposal equipment.

3.5 THICKNESS CONTROL

A. Thickness of select-material subbase course shall be measured at intervals providing at least one measurement for each 5,000 square feet or major fraction thereof of protective soil cover. Thickness measurement shall be made by survey. Contractor will provide survey control during construction. Owner will provide final thickness survey after Contractor notifies protective soil cover is placed and ready for Owner verification survey. Any areas of inadequate thickness requiring a resurvey will be done at Contractor expense.

3.6 GRAIN SIZE ANALYSIS

A. Pre-construction and conformance testing for protective cover soils will include maximum size gradation with minimum conformance testing frequency of one grain-size analysis (ASTM D422) per 5,000 cubic yards of in-place material.

3.7 PLACEMENT

A. Contractor will take measures to protect completed liner system after installation is complete. No portion of liner system will remain exposed for more than 15 days after installation is complete and system accepted by Owner and Engineer.

B. Place protective cover material with machinery that, in Engineer opinion, will not damage any portion of liner or leachate collection system or cause "sliding" of any part of system. Equipment used to place protective cover must not exert ground pressure load greater than 5 psi on liner or leachate collection system and must be approved by Engineer prior to utilization on system.

3.8 MAINTENANCE

A. Protective soil cover shall be maintained in a satisfactory condition until accepted.

END OF SECTION

SECTION 02665 - PIPING, VALVES, AND MISCELLANEOUS ITEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. All leachate discharge piping, valves, and fittings required for Project. "Piping," as used herein, shall include all piping, valves, fittings, and accessories as shown on Plans and/or as specified.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 SUBMITTALS

A. Submit all manufacturer data for all pipes, valves, and fittings including all pipe thickness class calculations.

PART 2 - MATERIALS

2.1 PIPE

A. HDPE Pipe: All buried leachate piping should be HDPE (PE 3408).
   1. An approved pipe is Driscoplex 6400 by Performance Pipe, or approved equal. Pipe shall match IPS dimensions.
   2. HDPE shall be DR11.
   3. Minimum cell classification number of 3454646 per ASTM D3350-01.
   4. Pipe shall be supplied in roll form (where possible) to minimize joints in the line.

B. Polyvinyl Chloride (PVC) Pipe: All exposed leachate piping should be Schedule 80 PVC.
   1. PVC Schedule 80 pipe shall be manufactured from Type 1, Grade 1 PVC compound with a cell classification of 12454 per ASTM D1785.
   2. PVC pipe shall be marked with manufacturer name, nominal pipe size, material designation code, and pressure rating.
   3. Pipe shall match IPS dimensions.

C. Flexible hoses shall not be used.

2.2 PIPE FITTINGS

A. General - pipe fittings shall be type and design especially suitable for use with type of piping with which installed. Pressure rating of fittings shall not be less than that of pipe.
   1. Fittings: HDPE and PVC fittings shall be sized to meet IPS requirements. HDPE fittings shall be butt-fused where possible. Flanged fittings shall be used where shown on Plans. PVC fittings shall be solvent weld or flanged where shown on Plans. Contractor is responsible for providing fittings for transition from valves, pumping units, etc.

2.3 PIPE INSULATION

A. Acceptable product is TechLite 379 pipe insulation, or approved equal.
B. Insulation shall be approved for outside use.

2.4 VALVES AND MISCELLANEOUS ITEMS

A. Valves for Leachate System
   1. General: All valves shall be designed for a working pressure of at least 150 psi unless otherwise noted.
   2. PVC Ball Valves:
      a. Provide true union ball valves (Sch 80 PVC) where shown on Plans. Ball valve shall be capable of servicing 150 psi at 73 degrees F.
      b. Provide EPDM O-rings.
      c. Valve shall have two-way blocking capability.
      d. Include flanged connections.
      e. Include Teflon seats.
      f. Acceptable manufacturer is ASAHI/America or approved equal.
   3. Sewage Combination Air Valves.
      a. A.R.I. Combination Air Valve D-025,T,2 for sewage, or approved equal.
      b. Valve size is 2-inch. Valve shall be threaded.
      c. Material schedule:
         1) Body – stainless steel SAE 316.
         2) Inner Parts – stainless steel SAE 316.

PART 3 - EXECUTION

3.1 GENERAL

A. All pipe and accessories shall be unloaded, handled, laid, jointed, tested for defects, leakage, and disinfected in the manner herein specified.

3.2 INSPECTION

A. Pipe, fittings, valves, and accessories shall be inspected upon delivery and during work progress and any material found defective will be rejected by Engineer, and Contractor shall remove such defective material from the site of work.

3.3 RESPONSIBILITY FOR MATERIALS

A. Contractor responsible for all material furnished by him and shall replace, at own expense, all such material found defective in manufacture or damaged in handling after delivery.

3.4 HANDLING PIPE AND ACCESSORIES

A. All pipe, fittings, valves, and other accessories shall, unless otherwise directed, be unloaded at point of delivery, hauled to, and distributed at site of work by Contractor. In loading and unloading, they shall be lifted by hoists/slid or rolled on skidways to avoid shock or damage to materials. Under no circumstances shall they be dropped. Pipe handled on skidways must not be skidded or rolled against pipe already on the ground.
B. Pipe, fittings, and accessories shall be placed along site to be kept as free as possible from dirt, sand, mud, and other foreign matter.

3.5 ALIGNMENT AND GRADE

A. All pipe shall be laid and maintained to lines shown on Plans or as established on ground by Engineer.
B. Wherever necessary to deflect pipe from a straight line either in a vertical or horizontal plane to avoid obstructions, to plumb valves, or where vertical or horizontal curves are shown or permitted, degree of deflection at each joint shall not exceed maximum deflection recommended by manufacturer of particular type of pipe laid. Engineer shall approve degree of deflection.

3.6 MANNER OF HANDLING PIPE AND ACCESSORIES INTO TRENCH

A. After trench grade is complete, all bell holes dug, and the grade inspected, pipes and accessories may be placed in trench. All pipe, fittings, and valves shall be carefully lowered into trench, piece-by-piece, by means of derricks, ropes, or other suitable tools or equipment, to prevent damage to material in any way. Under no circumstances shall pipe or accessories be dropped or dumped in to trench.

3.7 CLEANING AND INSPECTING

A. Before lowering into trench, pipe shall be again inspected for defects and while suspended, pipe shall be lightly hammered to detect cracks. Any defective, damaged, or unsound pipe and materials shall be rejected.
B. All foreign matter or dirt shall be removed from inside of pipe and from all bells, spigots, or parts of pipe used in forming joint, before pipe is lowered into trench, and kept clean by approved means during and after laying.
C. When pipe laying is not in progress, open ends of pipe shall be closed by approved means and no trench water allowed to enter pipe.

3.8 LAYING AND JOINTING HDPE PIPE

A. General - unless otherwise directed, pipe shall be laid to minimize welds.
    1. Cutting of pipe for inserting valves, fittings, or closure pieces shall be done in neat and workmanlike.
    2. Jointing shall be completed for all pipe laid each day, to not leave open joints in trench overnight. At times when pipe laying is not in progress, open ends of pipe shall be closed by approved means, and no trench water permitted to enter pipe.
    3. No pipe shall be laid in water, or when the trench conditions or weather are unsuitable for such work, except by permission of Engineer.
    4. Flanged joints shall be used where shown on Plans. Welded joints shall be installed in accordance with manufacturer specifications.
    5. Defective welds shall be repaired as directed by Engineer.
B. **“Snake” line in trench as recommended by manufacturer to allow for expansion and contraction in varying temperature.**

3.9 SETTING VALVES, VALVE BOXES, AND FITTINGS

A. Valves and fittings shall be set at locations shown on Plans or at locations as established by Engineer, and shall be set and jointed to pipe in manner heretofore specified for pipe installations. All valves buried in ground shall have valve box set over valve. All valves shall be

thoroughly inspected and checked for operation before installation. Concrete blocking shall be provided for all buried valves and fittings.

B. Valve boxes shall be firmly supported and maintained centered and plumb over wrench nut of valve, box cover flush with surface of ground or level as directed and backfilled with gravel and densified native material as shown on Drawings.

3.10 EXCAVATION AND TRENCHING

A. Trench shall be excavated to lines and grades as established by Engineer and as shown on Plans. Minimum depth of cover for all pipe shall be 24 inches unless otherwise specifically shown on Drawings.

B. Trench shall be excavated to an even grade so bottom of pipe will rest on bottom of trench over entire pipe length. To obtain a true even grade, trench shall be fine graded by hand.

C. Any part of trench excavated below grade shall be corrected by filling with approved material and compacting thoroughly.

D. If ledge rock, rock fragments, or other unyielding material is encountered in trench bottom, it shall be removed to 6 inches below grade, refilled with selected material, and thoroughly compacted.

E. Wherever necessary to prevent caving, trench shall be adequately supported. Contractor is entirely responsible for assuring trenches are adequately supported to protect both workers and the public.

F. Trench digging machinery may be used to make trench excavations except in places where operation of same would cause damages to pipelines, fences, or other existing structures either above or below ground; in such instances, hand methods shall be employed. Contractor shall locate all existing underground lines he has been advised of, whether or not they are shown on Drawings, sufficiently in advance of trenching operations to prevent any damage thereto. Operators of all oil or gas pipelines shall be notified prior to excavation around such lines so operators may be present during excavation. Extensive care shall be used to prevent damage to these lines and Contractor fully responsible for damage to any such line.

G. All excavated material shall be piled to not endanger work or existing structures. Contractor shall expose of excess trench excavation, not used for backfilling, by spreading in a thin layer on Owner's property adjacent to trench.

H. No classification of excavated materials shall exist and "excavation" shall include all materials encountered in excavating trenches or structural excavations.

I. All new and existing lines shall be properly supported to prevent settlement or line damage both during and after construction.

3.11 BACKFILLING

A. Backfill material shall be free from cinders, ashes, refuse, vegetable or organic material, boulders, rocks, or stones, or other unsuitable material. Selected materials from trench excavations shall be used for backfilling except where special bedding material is required.

B. Pipe Bedding Zone - all pipe shall be backfilled by hand from bottom of trench to top of conduit with selected backfill material free from rocks or boulders greater than 3/8 inch or other unsuitable material. Material shall be placed in 3-inch layers, moistened if necessary, and thoroughly compacted under and on each side of pipe. Backfill material shall be deposited in trench for its full width on each side of pipe, fitting, and appurtenances simultaneously.

C. Backfilling Over Pipe - from top of conduit to finished grade, trench shall be backfilled by hand or by approved mechanical methods using materials free from rocks or boulders greater than 2 inches in size. Material shall be moistened and placed in lifts not exceeding 6 inches thick

and compacted by tamping to a density of not less than 90 percent of maximum density at ±2 percent of optimum moisture as determined by ASTM D698. Contractor shall use special care in placing this portion of backfill to avoid injuring or moving pipe.

1. When trench lies within traveled right-of-way, backfill over pipe shall be compacted to 95 percent.

3.12 LINE TESTING (LEACHATE DISCHARGE PIPING)

A. After pipe is laid and joints completed, each section (run) of piping shall be tested as specified herein. Contractor shall bear all costs of providing equipment, materials, labor, and other incidentals required to test pipe lines as specified. Contractor shall provide suitable means for filling lines and developing required pressure in lines. Testing procedure shall be:

1. Duration of hydrostatic test shall be minimum of four hours.
2. Pressure - pipeline shall be tested so pressure at lowest point in test section is at least 100 but not greater than 120 percent of pipe pressure class of pipe, and minimum pressure at highest point in test section is no less than 85 percent of pipe pressure class of pipe.
3. HDPE Pipe:
    a. Allow heat fusion joints to cure before pressure testing.
    b. Test medium shall beat the same temperature as the pipe.
    c. Test pressure in line shall be from 1 to 1 1/2 the design operating pressure at the lowest point in the system.
    d. Test shall be performed start to finish in eight hours max.
    e. Completely fill the test section with water and bleed off trapped air.
    f. During the expansion phase, pressurize to test pressure and add water during each of the first three hours to return to the test pressure.
    g. Now reduce the pressure by 10 psi and conduct a one, two, or three hour test period and record the leakage.
    h. For a 4-inch or smaller line, the following leakage amounts are allowed.
        1) One-hour testing - .13 gallon per 100 feet of pipe.
        2) Two-hour testing - .25 gallon per 100 feet of pipe.
        3) Three-hour testing - .40 gallon per 100 feet of pipe.
    i. **Contractor shall coordinate this testing procedure with manufacturer of pipe used in Project**.

END OF SECTION

SECTION 02741 - HOT-MIX ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.
   2. Hot-mix asphalt patching.
   3. Asphalt surface treatments.
   4. Pavement-marking paint.
   5. Cold milling of existing hot-mix asphalt pavement.
   6. Construction Detours.
   7. Asphalt Stabilized Base.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 DEFINITIONS

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D8 for definitions of terms.

B. TxDOT: Texas Department of Transportation - Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges, 2004.

1.3 REFERENCES

A. AASHTO T 102 - Spot Test of Asphaltic Materials.

B. AASHTO T 245 - Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.

C. AASHTO M 248 - Standard Specification for Ready-Mixed White and Yellow Traffic Paints.

D. AI MS-2 (1994) - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types.

E. AI MS-22 - Construction of Hot Mix Asphalt Pavements.

F. ASTM C29/C29M - (1991; Rev. A) Unit Weight and Voids in Aggregate.

G. ASTM C88 - (1990) Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

H. ASTM C117 - (1995) Materials Finer than 75-Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.

I. ASTM C127 - (1988; R 1993) Specific Gravity and Absorption of Coarse Aggregate.

J. ASTM C128 - (1993) Specific Gravity and Absorption of Fine Aggregate.

K. ASTM C131 - (1996) Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

L. ASTM C136 - (1996; Rev. A) Sieve Analysis of Fine and Coarse Aggregates.

M. ASTM C188 - (1995) Density of Hydraulic Cement.

N. ASTM D70 - (1982; R 1990) Specific Gravity of Semi-Solid Bituminous Materials.

O. ASTM D75 - (1987; R 1992) Sampling Aggregates.

P. ASTM D242 - (1995) Mineral Filler for Bituminous Paving Mixtures.

Q. ASTM D546 - (1994) Sieve Analysis of Mineral Filler for Road and Paving Materials.

R. ASTM D692 - (1994; Rev. A) Coarse Aggregate for Bituminous Paving Mixtures.

S. ASTM D854 - (1992) Specific Gravity of Soils.

T. ASTM D946 - (1982; R 1993) Penetration-Graded Asphalt Cement for Use in Pavement Construction.

U. ASTM D979 - (1996) Sampling Bituminous Paving Mixtures.
V. ASTM D995 - (1995; Rev. B) Mixing Plants for Hot-Mixed, Hot-Laid Bituminous Paving Mixtures.
W. ASTM D1073 - (1994) Fine Aggregate for Bituminous Paving Mixtures.
X. ASTM D1075 - (1996) Effect of Water on Cohesion of Compacted Bituminous Mixtures.
Y. ASTM D1188 - (1996) Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens.
Z. ASTM D1559 - (1989) Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
AA. ASTM D2027 - Standard Specification for Cutback Asphalt (Medium-Curing Type).
BB. ASTM D2041 - (1995) Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
CC. ASTM D2172 - (1995) Quantitative Extraction of Bitumen from Bituminous Paving Mixtures.
DD. ASTM D2726 - (1996; Rev. A) Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures.
EE. ASTM D2950 - Standard Test Method for Density of Bituminous Concrete in Place by Nuclear Methods.
FF. ASTM D3381 - (1992) Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
GG. ASTM D3405 - Standard Specification for Joint Sealants, Hot-Applied, for Concrete and Asphalt Pavements.
HH. ASTM D3549 - Standard Test Method for Thickness or Height of Compacted Bituminous Paving Mixture Specimens.
II. TEX-126-E - Molding, Testing and Evaluating Bituminous Black Base Materials.
JJ. TEX-204-F - Design of Bituminous Mixtures.
KK. TEX-224-F - Determining Flakiness Index.
LL. TxDOT Item 300 - Asphalt, Oils and Emulsions.
MM. TxDOT Item 301 - Asphalt Antistripping Agents.
NN. TxDOT Item 320 - Equipment for Asphalt Concrete Pavement.
OO. TxDOT Item 340 - Specification for Dense-Graded Hot-Mix Asphalt (Method).
PP. TxDOT Item 662 - Work Zone Pavement Markings.
QQ. TxDOT Item 666 - Reflectorized Pavement Markings.
RR. TxDOT Item 672 - Raised Pavement Markers.

1.4 SUBMITTALS

A. Product Data for each type of product indicated. Include technical data and tested physical and performance properties.
B. Job-Mix Designs: Submit a job-mix design, for approval prior to preparing and placing bituminous mixture. Design mix using procedures contained throughout this section with materials as specified. Formulas shall indicate physical properties of the mixes as shown by tests made by a commercial laboratory approved by Engineer, using materials identical to those to be provided on Project. Submit formulas with material samples. Job-mix formula for each mixture shall be in effect until modified in writing by Contractor and approved by Engineer. Provide a new job-mix formula for each source change. Job mix shall be for Project. Job mixes developed for other projects, although they may have similar requirements, will be subject to review and approved/denied by Engineer.
C. Qualification Data: Submit qualifications for product manufacturers.
D. Material Test Reports
    1. Specific gravity test of asphalt.

2. Coarse aggregate tests.
3. Weight of slag test.
4. Percent of crushed pieces in gravel.
5. Fine aggregate tests.
6. Specific gravity of mineral filler.
7. Bituminous mixture tests.
8. Aggregates tests.
9. Bituminous mix tests.
10. Pavement courses.

E. Product Submittals: Pavement marking materials.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM D3666 for testing indicated, as documented according to ASTM E548.

B. Mock-Up Test Section: Prior to full production of binder and wearing course[s], prepare a quantity of bituminous mixture according to job-mix formula. Construct a test section 200 feet long by not less than 10 feet wide and of the same compacted depth specified for construction of course test section represents. Test section may be placed within required project/plan limits as specified, but Contractor will be required to remove and replace based on required testing samples or as approved by Engineer. Underlying grade or pavement structure upon test section to be constructed shall be same as remainder of course represented by test section. Equipment used in construction of the test section shall be same type and weight to be used on remainder of course represented by test section. Test not less than two samples of mixture produced at plant for gradation, asphalt cement content, stability, flow, air voids, voids in mineral aggregate, and in weight. Obtain not less than three cores from test strip for density and thickness tests. Check test section for smoothness and finish surface texture. If test section proves unsatisfactory, make necessary adjustments to mix design, plant operation, transportation, laydown, and/or rolling procedures. Additional test sections, as required, shall be constructed and evaluated for conformance to specified requirements. When test sections do not conform to specified requirements, remove and replace bituminous pavement. A marginal quality test section placed in an area of little or no traffic may be left in place. If a second test section also does not meet specified requirements, remove both sections at Contractor expense. Full production shall not begin without Engineer approval.

C. Required Data
1. Job-mix formula shall show:
a. Source and proportions, percent by weight, of each ingredient of the mixture;
b. Correct gradation, percentages passing each size sieve listed in specifications for mixture to use, for aggregate and mineral filler from each separate source and from each different size to be used in mixture and for composite mixture;
c. Amount of material passing the No. 200 sieve determined by dry sieving;
d. Number of blows of hammer compaction per side of molded specimen;
e. Temperature viscosity relationship of the asphalt cement;
f. Stability, flow, percent voids in mineral aggregate, percent air voids, unit weight;
g. Asphalt absorption by the aggregate;
h. Effective asphalt content as percent by weight of total mix;
i. Temperature of the mixture immediately upon completion of mixing;
j. Asphalt viscosity grade and/or penetration range; and
k. Curves for the asphalt stabilized base and hot mix asphalt paving courses.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Inspect materials delivered to site for damage and store with minimum of handling. Store aggregates to prevent segregation, contamination or intermixing of different aggregate sizes. Unless otherwise approved, do not store mixture long enough to affect quality of mixture, nor longer than 12 hours. If temperature of any HMAC, measured while passing through lay down machine, is ±25 degrees F from mixing temperature, load is rejected.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp or if the following conditions are not met:
   1. Prime and Tack Coats: Minimum surface temperature of 60 degrees F.
   2. Asphalt Base Course: Minimum surface temperature of 40 degrees F and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 degrees F at time of placement.

1.8 MIXING PLANT

A. Provide mixing plant capable of meeting the needs of Project.
B. At no time shall plant hinder progress of Project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aggregate General: Use materials and gradations that have performed satisfactorily in previous installations.
   1. Coarse Aggregate – Coarse aggregate shall conform to ASTM D692.
      a. Coarse aggregate shall be material retained on No. 4 sieve and consist of clean, tough, durable fragments of crushed stone or crushed gravel of uniform quality. Mixing or combining of crushed gravel and crushed stone not permitted. Coarse aggregate shall be crushed to extent it produces minimum of 55 percent crushed faces when tested in accordance with ASTM D692. Course aggregate shall be crushed to extent it produces minimum 85 percent crushed faces for Type “C” HMAC.
      b. Coarse aggregate shall have a maximum loss of 20 percent when subjected to five cycles of Magnesium Sulfate Soundness Test ASTM C88. Amount of organic matter, clays, loams, or particles coated therewith, or other undesirable materials, shall not exceed 2 percent. When subjected to Los Angeles Abrasion test, coarse aggregate shall not have a loss greater than 40 percent by weight.
      c. Coarse aggregate may be enhanced by addition of recycled asphaltic pavement (RAP). Material shall be clean without any foreign materials to produce crushed aggregate in conformance with specifications.
   2. Fine Aggregate – fine aggregate shall conform to ASTM D1073.
      a. Fine aggregate shall be part of material passing No. 10 sieve and be uniform quality throughout. A maximum 15 percent of total virgin aggregate may be field sand or other crushed fine aggregate. Screenings shall be same or similar material as specified for course aggregate.

b. Sand shall be composed of durable stone particles free from injurious foreign matter. Screenings shall be same or similar material as specified for coarse aggregate.

3. Mineral Filler
   a. Mineral filler shall conform to ASTM D242 and consist of thoroughly dry stone dust, Portland cement, or other material dust approved by Engineer. Mineral filler shall be free of foreign and other injurious matter and shall meet the following gradation:
      1) Percent by Weight Retained on No. 30 Sieve - 95-100.
      2) Percent by Weight Retained on No. 80 Sieve - 75 minimum.
      3) Percent by Weight Retained on No. 200 Sieve - 55 minimum.

B. Asphalt
   1. Performance grade 64-22 or better, AASHTO Performance Graded Binder Specification (MP1).
   2. Contractor shall notify Engineer of asphaltic material source for approval prior to production of asphaltic mixture.
   3. Optimum asphalt content shall be determined by the Test Method Tex 204-F.
   4. Asphalt content will be ±0.3 percent of design during production. When asphalt content falls outside these parameters immediate action is required.
   5. If asphalt content falls to 0.5 percent, immediately cease production until Contractor has provided sufficient evidence of problem being corrected.

C. Prime Coat: Surface shall be primed using an application of 0.20 to 0.30 gallons per square yard of MC asphalt conforming to ASTM D2027 – MC 30.

D. Tack Coat: Asphaltic material for tack coat shall meet requirements for slow rate cure SS-1 emulsified asphalt, medium rate cure MS-1 emulsified asphalt, or PG grade asphalt as used in HMAC Surface Course. All vertical joints shall be tack coated.

E. Joint Sealant: ASTM D3405 or AASHTO M 301, hot-applied, single-component, polymer-modified bituminous sealant.

F. Emulsified Asphalt Sealer: All ASB surface courses shall be sprayed with an emulsified asphalt sealer consisting of a 15/85 mixture of MS-2, or 20/80 SS-1, liquid anionic asphalt and distilled water. Emulsified asphalt sealer shall be applied after HMAC surface has cooled to below 70 degrees F and applied at a rate of 0.10 to 0.12 gallons per square yard of surface.

G. Mix Design
   1. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2 - Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types, and complying with:
      a. Provide mixes with history of satisfactory performance in geographical area where Project is located.
   2. Base Course/Temporary Pavement
      a. Hot mix base shall consist of compacted mixture of graded gravel aggregate and asphalt cement mixed hot in mixing plant according to TxDOT Standard Specifications, 2004, Item 340 Dense-Graded Hot-Mix Asphalt (Method), Type B (fine base), using Texas gyratory compaction method (TX206-F).
      b. Contractor shall provide current mix design using approved materials indicating gradation and optimum asphalt content. Aggregate mixture shall conform to the following master gradation:

Sieve Size	1”	7/8”	5/8”	3/8”	#4	#10	#40	#80	#200
Percent Retained by Weight	0	95-100	75-95	60-80	40-60	27-40	10-25	3-13	1-6

1) Material passing #40 sieve shall be known as soil binder and meet these requirements:
   (a) Liquid Limit shall not exceed 45.
   (b) Plasticity Index shall not exceed 15.
   (c) Linear Shrinkage shall not exceed 5.

c. Mineral aggregate shall not contain more than 0.5 percent moisture prior to entering the pugmill for mixing with asphalt.

d. ASB mixture shall consist of uniform mixture of mineral aggregate and asphaltic material. Mineral aggregate shall conform to gradation requirements specified. Percent asphaltic material shall be determined in accordance with Test Method Tex.-204-F, with target density of 96.5 percent lab-molded density. Asphalt content tolerances will be ±.3 percent. Outside these parameters, corrective action must be taken immediately with over .5 percent requiring immediate cease of production. No more than 20 percent RAP allowed in ASB designs. Percent asphaltic material shall be determined in accordance with Test Method Tex.-236F. Asphalt for mixture shall meet requirements of TxDOT Item - Asphalt, Oils, and Emulsions, and must be a performance graded (PG) 64-22 or better. Grade of asphalt and source must be approved by Engineer prior to use. Contractor shall submit mix design prepared by qualified lab for Engineer approval. Engineer will approve asphalt content to use in mixture after design tests have been made with aggregate to be used. Asphalt content of production mixture during production shall not vary from design more than 0.2 percent dry weight based on total mixture.

3. Surface Course

a. Hot-mix asphalt concrete surface shall consist of minimum 1 1/2-inch-thick compacted mixture of coarse aggregate, fine aggregate, mineral filler and asphalt cement mixed hot in mixing plant according with specifications. Unless otherwise specified, materials and construction shall conform to TxDOT Item 340 Dense Graded Hot Mix Asphalt Method.

b. Mix designs will be in accordance with TX204-F with a lab molded density of 96.0 percent using Texas gyratory compaction method. With target VMA (voids in mineral aggregate) to be determined according to type of HMAC utilized. Designs will need to be resubmitted annually or when material properties change.

c. Contractor’s plant and equipment are subject to Engineer approval, and shall be appropriate and in suitable condition to produce HMAC surface consistently in compliance with specifications. Approval of source and character of materials shall be obtained from Engineer prior to use. Combined mineral aggregate, after final processing by mixing plant and prior to addition of asphalt and mineral filler, shall have a sand equivalent value of not less than 45 when tested in accordance with Test Method Tex 203-F. Percent of flat and elongated slivers of stone for any aggregate shall not exceed 25 percent when tested in accordance with Test Method Tex 224-F.

d. Asphaltic mixtures with aggregates which exhibit stripping characteristics shall be conditioned with either lime or liquid anti-stripping agent approved by Engineer. Anti-stripping agents shall meet requirements of TxDOT Item - Asphalt Anti-Stripping Agents, and be added at manufacturer recommended dosage and temperature range.

e. Contractor shall provide a current HMAC mix design using approved materials, indicating gradation and optimum asphalt content as determined by Test Method Tex 204-F.

1) If approved by Engineer, Contractor may furnish an alternate mix design based on specific proposed materials. Otherwise, aggregate mixture shall conform to following master gradation:

Type "C" (Course Graded Surface Course)	
Percent passing 7/8"	100
Percent passing ¾"	95-100
Percent passing 3/8"	70-85
Percent passing No. 4	43-63
Percent passing No. 8	32-44
Percent passing No. 30	14-28
Percent passing No. 50	7-21
Percent passing No. 200	2-7
VMA	Design min. 12%

2) Lab-molded density will be ±1.0 percent of design before corrective action is required. ±1.5 percent will require immediate cease in production operations with removal and replacement of HMAC laid at that location. Production will cease until Contractor sufficiently proves corrective actions have been taken. Asphalt content will be ±.3 percent before corrective action is required. ±.5 percent will require immediate cease in production in operations with removal and replacement of HMAC laid at location. Production will cease until Contractor has sufficiently proven they have taken corrective actions.

3) Material passing No. 40 sieve shall be known as soil binder and shall meet the following requirements:
   (a) Liquid Limit shall not exceed 45.
   (b) Plasticity Index shall not exceed 15.
   (c) Linear Shrinkage shall not exceed 5.

4) Mineral aggregate shall not contain more than 0.5 percent moisture prior to entering pugmill for mixing asphalt. HMAC mixture shall consist of uniform mixture of mineral aggregate and asphalt materials.

5) If approved by Engineer, Contractor may provide an alternate mix design based on proposed materials. Contractor's materials and mix design shall meet all performance criteria addressed in specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify subgrade is dry and in suitable condition to support paving and imposed loads.
B. Proof-roll subbase using heavy, pneumatic-tired rollers to locate areas unstable or requiring further compaction.
C. Proceed with paving only after unsatisfactory conditions have been corrected.
D. Surface shall be clean and free of loose dirt, rock, or any other foreign matter.

3.2 PRIME COAT

A. Application: Immediately following surface preparation, apply prime coat by means of bituminous distributor. Apply bituminous material at a pressure range of 25 - 75 psi within temperature limits specified, and at rate of not less than 0.20 gallon nor more than 0.30 gallon of bituminous material per square yard. Apply bituminous material so uniform distribution is obtained over entire surface to be treated with slight puddling on surface.
B. Curing: Following application of bituminous material, allow surface to cure without being disturbed for not less than 48 hours, or longer as necessary, to attain penetration into foundation course and evaporation of volatiles from bituminous material. Furnish and spread enough sand to effectively blot up and cure excess bituminous material. Maintain primed surface until succeeding layer of pavement is placed by protecting surface against damage and by repairing and repriming deficient areas.
C. Temperature: Maintain application temperature between 68 and 149 degrees F.
D. Protection: Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades to prevent traffic over freshly treated surfaces.

3.3 TACK COAT

A. Application: Apply tack coat when surface to be treated is dry. Immediately following preparation of surface for treatment, apply bituminous material by means of bituminous distributor, within limits of temperature specified and at a rate of not less than 0.05 gallon nor more than 0.15 gallon of diluted emulsion per square yard. Apply bituminous material so uniform distribution is obtained over entire surface to be treated. Treat lightly coated areas and spots missed by distributor with bituminous material. Following application of bituminous material, allow surface to cure without being disturbed for time necessary to permit setting of tack coat. Apply bituminous tack coat only as far in advance of placing the overlying layer as required for that day's operation. Maintain and protect treated surface from damage until the succeeding course of pavement is placed.
B. Temperature: Maintain application temperature between 122 and 185 degrees F.
C. Material Test: Perform spot test for asphalt in accordance with AASHTO T102 on each shipment.
D. Traffic Controls: Keep traffic off surfaces freshly treated with bituminous material. Provide sufficient warning signs and barricades so traffic will not travel over freshly treated surfaces.

3.4 ASPHALT STABILIZED BASE COURSE (ASB)

A. ASB shall not be placed when air temperature as reported by the National Weather Service is below 45 degrees F and falling.
B. ASB shall be placed at temperature 255 to 285 degrees F during June, July, and August. During other months, ASB shall be placed at temperatures 275 to 325 degrees F.
C. Any ASB material above or below specified temperature range, may be rejected. No payment will be made for any rejected material.
D. ASB shall be placed and compacted in 2-inch lifts unless otherwise directed by Engineer. Material shall be placed so when properly compacted, finished course is smooth, of uniform density, and in conformance with required cross-sections and grades.

E. ASB shall be compacted thoroughly and uniformly with approved rollers to density of 90.1 to 97.3 percent in place air voids with a lab molded target of 96.5 percent ±1 percent. All results will be calculated using maximum theoretical rice gravity. Lab molding will take place in accordance to asphalt manufacturer recommended temperature.
   1. Rolling patterns shall be set by using a thin lift nuclear gauge to ensure maximum compaction. All roller marks shall be removed and compaction completed prior to the ASB mixture cooling below 185 degrees F.

3.5 JOINTS

A. Construct joints to ensure continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
   1. Clean contact surfaces and apply tack coat to all joints.
   2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
   3. Offset transverse joints, in successive courses, a minimum of 24 inches.
   4. Construct transverse joints as described in AI MS-22 - Construction of Hot Mix Asphalt Pavements.
   5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
   6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
   1. Complete compaction before mix temperature cools to 185 degrees F.
B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
   1. 95 to 98 percent of Marshall density with 2 to 5 percent air voids.
D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Thickness: Compact each course to produce thickness indicated within these tolerances:
   1. Base Course: ±1/2 inch.

2. Surface Course: +1/4 inch, (no minus).

B. Surface Smoothness: Compact each course to produce a surface smoothness within following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
   1. Base Course: 1/4 inch.
   2. Surface Course: 1/8 inch.
   3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Contractor shall perform field tests and inspections and prepare test reports.
   1. Testing agency will conduct and interpret tests and state in each report whether tested work complies with or deviates from specified requirements.

B. Additional testing and inspecting, at Contractor expense, will be performed to determine compliance of replaced or additional work with specified requirements.

C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D3549.

D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D979 or AASHTO T 168.
   1. Reference maximum theoretical density determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D2041, and compacted according to job-mix specifications.
   2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D1188 or ASTM D2726.
      a. One core sample will be taken for every 2000 square yards or less of installed pavement.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

G. Owner may elect to take confirmation tests at Owner expense. Contractor shall cooperate with Owner's testing agency. Failing tests taken at Owner direction shall be charged to Contractor. Failing test charges shall include pro-rata technician charges, actual failing test charge, pro-rata mileage charge, and other pro-rated charges.

3.9 DISPOSAL

A. Dispose of excess materials in accordance with requirements of Section 01700 – Execution Requirements.
   1. Do not allow excavated materials to accumulate onsite.

END OF SECTION

SECTION 02745 - LEACHATE COLLECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Materials and installation for leachate collection piping trench (other than aggregate).
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 02231 - Drainage Aggregate.
   3. Section 02760 – Geotextile Materials.

1.2 QUALITY ASSURANCE

A. Quality assurance shall be in accordance with Appendix A.

1.3 REFERENCES

A. ASTM D3350 - Polyethylene Plastics Pipe and Fittings Materials.

1.4 SUBMITTALS

A. Pipe Product Data:
   1. Unit Weight.
   2. SDR.
   3. Diameter.
   4. Physical dimensions.
   5. Method of jointing with instructions.
   6. Recommended bedding and instillation details.
B. Manufacturer's certificate of compliance. Certified lab data from manufacturer to verify the physical properties of the materials comply with this specification.

PART 2 - PRODUCTS

2.1 LEACHATE COLLECTION PIPE

A. Leachate collection pipe shall be high density polyethylene (HDPE) SDR-17 pipe with an integrally-formed smooth interior for leachate collection.
B. All pipe and fitting resins shall be manufactured by the same company, manufacturing the pipe itself, in accordance with these specifications, to ensure complete resin compatibility and total product accountability. Fittings supplied under this specification shall be molded or manufactured from a polyethylene compound with a cell classification equal to or exceeding the compound used in the pipe.
C. Materials - Resins used in the manufacture of the leachate collection pipe shall conform to cell classification PE 324420C or better per ASTM D3350.
D. Minimum parallel plate pipe stiffness values for leachate piping shall be 50 psi.
E. Polyethylene pipe and fittings not meeting specification requirements, shall be rejected.
F. Perforations shall be factory-machined and -trimmed by manufacturer or pipe supplier in the shop under controlled conditions. No pipe perforation allowed in the field. All perforated pipe shall be free of trimmings and debris when delivered and prior to installation.

2.2 SOURCE QUALITY CONTROL

A. HDPE pipe shall contain no recycled compound except what is generated in manufacturer's plant from same raw material. Pipe shall be homogenous throughout and free of visible cracks, holes, foreign inclusions, or other deleterious defects, as well as identifiable in color, density, melt flow, and other physical properties throughout. Polyethylene resin used shall have all ingredients compounded prior to extrusion of pipe.
B. Contractor shall submit certification that pipe, fittings, and equipment is represented by quality assurance data.

2.3 DELIVERY, STORAGE, AND HANDLING

A. HDPE pipe shall be stored on clean, level ground to prevent undue scratching and gouging. Pipe shall be protected from direct sunlight. If pipe must be stacked for storage, stack according to pipe manufacturer recommendations. Pipe handling shall be done so as not to damage by dragging over sharp objects or cut by chokers or lifting equipment.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

A. Install all HDPE pipe in accordance with manufacturer recommendations and requirements of specifications.
B. Perforations shall be constructed by manufacturer as detailed in Drawings. No field perforating of HDPE pipe allowed. Perforated leachate pipe shall be laid in trench as detailed in Drawings. Engineer allowed to observe the perforated leachate pipe prior to backfilling.
C. Pipe shall be kept clean before installation by proper storage and handling. Cover any open pipe ends with fabric or a pipe cap.
D. Sections of HDPE pipe with cuts or gouges in excess of 10 percent of the wall thickness of pipe shall be removed.

3.2 PIPE JOINING

A. Joining method shall be butt-fusion method and performed by qualified persons in strict accordance with pipe manufacturer recommendations. Butt-fusion equipment used in joining procedures shall be capable of meeting all conditions recommended by pipe manufacturer, including but not limited to temperature requirements, alignment, and fusion pressures. Pipe will be fused at approximately 500 degrees F with 150 psi fusion pressure. Bead height for 18-inch riser shall not exceed 1/4 inch.

3.3 REPAIR OF DAMAGED SECTIONS

A. Remove sections of HDPE pipe with cuts or gouges in excess of 10 percent of the wall thickness of pipe. Rejoin new pipe sections using butt-fusion joining method. Engineer intends to reduce number of joints. Engineer shall reject pipe installations where, in his opinion, installation methodology of Contractor does not meet this objective.

3.4 HANDLING OF FUSED PIPE

A. Fused segments of polyethylene pipe shall be handled to avoid pipe damage. When lifting fused sections of pipe, chains or cable type chokers must be avoided. Nylon slings are required. Spreader bars are recommended when lifting long fused sections. Care shall be exercised to avoid cutting or gouging the pipe.

3.5 FIELD QUALITY CONTROL

A. Contractor shall test each leachate transmission line section prior to backfilling and entire piping system after completed. Conduct pressure tests with water at a maximum pressure of 100 psi. Initially, a pressure of 100 psi shall be applied and allowed to stand for two hours with makeup pressure to allow pipe to reach equilibrium. Following this period, pressure should be returned to 100 psi for final test and allowed to stand for four hours. A passing test occurs with no leaks or pressure drops during final test. If no pressure drop occurs during the initial two hours, this period may be counted as part of the final test. CQA Monitor will observe all hydrostatic testing.

PART 4 - MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

A. Measurement for the work covered under this section will be made by the lump sum basis.

4.2 PAYMENT

A. Leachate Collection System: Payment for work covered under this Section shall be made at Lump Sum price bid for "Leachate Collection Trench," which payment shall constitute full compensation for materials, labor, equipment, tools, and incidentals necessary to complete work specified herein.

END OF SECTION

SECTION 02751 - CONCRETE PAVEMENT AND SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Exterior concrete pavement and sidewalks.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 03300 - Cast-in-Place Concrete, for general building applications of concrete.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with blended hydraulic cement, expansive hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.3 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.
B. Design Mixes: Submit concrete mix design in accordance with Section 03300 - Cast-in-Place Concrete.
C. Material Certificates: Signed by manufacturer certifying that the following materials comply with requirements:
   1. Cementitious materials and aggregates.
   2. Steel reinforcement and reinforcement accessories.
   3. Admixtures.
   4. Curing compounds.
   5. Bonding agent or adhesive.
   6. Joint fillers.
D. Submit a plan showing location of pavement joints.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Experienced installer who completed pavement work similar in material, design, and extent to that indicated for this Project and whose work resulted in construction with a record of successful inservice performance.
B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.
   1. Manufacturer must be certified according to National Ready Mix Concrete Association's Plant Certification Program.
C. Testing Agency Qualifications: Independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated, as documented according to ASTM E548.
D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.
E. ACI Publications: Comply with ACI 301 - Specification for Structural Concrete, unless modified by the requirements of the Contract Documents.
F. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixes.

1.5 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
   1. Use flexible or curved forms for curves of a radius 100 feet or less.
B. Form-Release Agent: Commercially-formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces.

2.2 STEEL REINFORCEMENT

A. Plain-Steel Welded Wire Fabric: ASTM A185, fabricated from as-drawn steel wire into flat sheets.
B. Reinforcement Bars: ASTM A615/A615M, Grade 60 (Grade 420), deformed.
C. Plain Steel Wire: ASTM A82, as drawn.
D. Joint Dowel Bars: Plain steel bars, ASTM A615/A615M, Grade 60(Grade 420). Cut bars true to length with ends square and free of burrs.
E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI - Manual of Standard Practice, from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete, and:
   1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.

2.3 CONCRETE MATERIALS

A. General: Use same brand and type of cementitious material from the same manufacturer throughout Project.
B. Portland Cement: ASTM C150, Type I or II.
   1. Fly Ash: ASTM C618, Class F or C.
   2. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.
   3. Fly ash may be used for pavement concrete with prior approval of Owner. Maximum cement reduction shall not exceed 20 percent by weight per cubic yard of concrete, and fly ash replacement shall be 1.25 pounds per pound of cement.
C. Aggregate: ASTM C33, uniformly-graded, from single source, with coarse aggregate as:
   1. Class: 4S.
   2. Maximum Aggregate Size: 1 inch nominal.
   3. Do not use fine or coarse aggregates containing substances that cause spalling.
D. Water: ASTM C94.

2.4 ADMIXTURES

A. General: Admixtures certified by manufacturer to contain no more than 0.1 percent water-soluble chloride ions by mass of cement and to be compatible with other admixtures.
B. Air-Entraining Admixture: ASTM C260.

2.5 CURING MATERIALS

A. Water: Potable.
B. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
C. White Waterborne Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B.
D. Products: Subject to compliance with requirements, provide one of the following:
    1. Evaporation Retarder:
        a. Finishing Aid Concentrate; Burke Group, LLC (The).
        b. Eucobar; Euclid Chemical Co.
        c. E-Con; L&M Construction Chemicals, Inc.
        d. SikaFilm; Sika Corporation.
    2. White Waterborne Membrane-Forming Curing Compound:
        a. Aqua Resin Cure; Burke Group, LLC (The).
        b. L&M Cure R-2; L&M Construction Chemicals, Inc.
        c. 1200-White; W.R. Meadows, Inc.

2.6 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber.
B. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.7 CONCRETE MIXES

A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by laboratory trial mixes or field experience.
B. Proportion mixes to provide concrete with the following properties:
    1. Compressive Strength (28 Days): 4,000 psi for pavement and 3,000 psi for sidewalks.
    2. Slump Limit: 4 inches.
C. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
D. Add air-entraining admixture at manufacturer prescribed rate to result in concrete at point of placement having an air content of 2.5 to 4.5 percent.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Comply with requirements and with ASTM C94.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. Scarify subgrade and compact to a minimum dry density (ASTM D698) at 0 to 4 percent above optimum moisture content.
B. Where P.1 of subgrade materials is 20 or greater, subgrade shall be lime stabilized in accordance with Item 301.2 of NCTCOG Specifications. Apply hydrated lime at a minimum rate of 6 percent by weight.
C. Apply emulsified asphalt 55-1 at 0.25 gallon per square yard if subgrade is treated with lime.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSl - Manual of Standard Practice, for fabricating reinforcement and with recommendations in CRSl - Placing Reinforcing Bars, for placing and supporting reinforcement.
B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
D. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

3.4 JOINTS

A. General: Construct construction, isolation, contraction joints, and tool edgings true-to-line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
    1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.
B. Construction Joints: Set construction joints at side and end terminations of pavement and locations where pavement operations stop for more than .5 hour, unless pavement terminates at isolation joints.
    1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
    2. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
    3. Provide tie bars at sides of pavement strips where indicated.
    4. Use bonding agent where fresh concrete is placed against hardened or partially-hardened concrete surfaces.
C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.
    1. Locate expansion joints at intervals of 20 feet, unless otherwise indicated.
    2. Extend joint fillers full width and depth of joint.
    3. Terminate joint filler less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
    4. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
D. Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt-coat half of dowel length to prevent concrete bonding to one side of joint.
E. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
    1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with groover tool to the following radius. Repeat grooving of

contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

a. Radius: 1/4 inch.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof, abrasive, or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

F. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

1. Radius: 1/4 inch.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to embed or cast. Notify other trades to permit installation of work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subgrade or subbase to provide a uniform, dampened condition when concrete is placed. Do not place concrete around manholes or other structures until they are at the required finish elevation and alignment.

D. Comply with requirements and with recommendations in ACI 304R for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery, at Project site, or during placement.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.

1. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand-spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices.

H. Screed pavement surfaces with a straightedge and strike off. Commence initial floating using bull floats or darbies to form open-textured and uniform surface plane before excess moisture or bleed water appears on surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading dry-shake surface treatments.

I. Cold-Weather Placement: Cold-weather concreting shall be in accordance with Section 03300 - Cast-in-Place Concrete.

J. Hot-Weather Placement: Hot-weather concreting shall be in accordance with Section 03300 - Cast-in-Place Concrete.

3.6 CONCRETE FINISHING

A. General: Concrete surface wetting during screeding, initial floating, or finishing operations is prohibited.

B. Float Finish: Begin floating operation when bleed-water sheen disappears and concrete surface stiffens sufficiently to permit operations. Float surface with power-driven floats or hand-floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, fill low spots. Refloat surface immediately to uniform granular texture.
   1. Medium-to-Fine-Textured Broom Finish: Draw soft bristle broom across float-finished concrete surface perpendicular to line of traffic to provide uniform, fine-line texture.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly-placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pound per square foot x h before and during finishing operations. Apply according to manufacturer-written instructions after placing, screeding, and bull-floating or darbying concrete, but before float finishing.
C. Begin curing after finishing concrete but not before free water disappears from concrete surface.
D. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination:
   1. Curing Compound: Apply uniformly in continuous operation by power-spray or roller according to manufacturer-written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:
   1. Elevation: 1/4 inch.
   2. Thickness: +3/8 inch, -1/4 inch.
   3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
   4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
   5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
   6. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
   7. Joint Spacing: 3 inches.
   8. Contraction Joint Depth: +1/4 inch (no minus).
   9. Joint Width: +1/8 inch (no minus).

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner or Owner-designated agent will engage a qualified testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement. Contractor is responsible for all concrete testing cost. Sampling and testing for quality control may include those specified.
B. Testing Services - shall be performed according to these requirements:
   1. Sampling Fresh Concrete: Representative samples of fresh concrete shall be obtained according to ASTM C172, except modified for slump to comply with ASTM C94.
   2. Slump: ASTM C143; one test at point of placement for each compressive-strength test but not less than one test for each day's pour of each type of concrete. Additional tests required when concrete consistency changes.

3. Air Content: ASTM C231; pressure method; one test for each compressive-strength test, but not less than one test for each day's pour of each type of air-entrained concrete.
4. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 degrees F and below and when 80 degrees F and above, and one test for each set of compressive-strength specimens.
5. Compression Test Specimens: ASTM C31/C31M; and as specified in Section 03300 – Cast-in-Place Concrete.
6. Compressive-Strength Tests: As specified in Section 03300 – Cast-in-Place Concrete. Test results shall be reported in writing to Owner, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both seven- and 28-day tests.

C. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Owner but not used as sole basis for approval or rejection.

D. Additional Tests: Testing agency shall make additional tests of concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met, as directed by Owner. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement broken, damaged, defective, or does not meet Section requirements.

B. Drill test cores where directed by Owner when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with Portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION

SECTION 02760 - GEOTEXTILE MATERIALS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Furnish and install geotextile separator.
   2. Furnish and install geocomposite drainage layer.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 02200 - Excavation and Earthwork.
   3. Section 02227 - Waste Material Disposal.

1.2 REFERENCES

A. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

B. ASTM D4716 - Standard Test Method for Constant Head Hydraulic Transmissivity (in- place flow) of Geotextiles and Geotextile Related Products.

C. ASTM D4632 - Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).

D. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

E. ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.

F. ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Non-woven Fabrics - Diaphragm Bursting Strength Tester Method.

G. ASTM D4355 - Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water (Xenon - ARC Type Apparatus).

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

I. ASTM D4595 - Standard Test method for wide width tensile strength of geotextiles.

1.3 SUBMITTALS

A. In addition to requirements of Section 01300 - Submittals, provide these for geotextiles:
   1. Samples of the material to use.
   2. Written instructions for storage, handling, and installation.
   3. Written instructions for repair of geotextiles.
   4. Manufacturer certificates of compliance with specified product requirements. This submittal includes Manufacturer's Quality Control (MQC) testing. Perform MQC testing at a frequency of one test per 10,000 square feet of geotextile produced for this Project for all product requirements listed in Part 2 of this section. Submit results to CQA monitor with each shipment of material.

1.4 PROJECT CONDITIONS

A. When weather threatens to endanger the integrity and quality of installation due to rain, high winds, cold temperatures, or other weather elements, installation of geotextiles shall be halted at direction of, or with concurrence of, Owner, until the weather conditions aresatisfactory.

B. Contractor shall maintain natural surface water drainage diversions around work area and provide for disposal of water collecting in work area as the result of precipitation falling within the area or from inadequate diversion structures or practices.

C. Vehicles not allowed on liner area unless sufficient protective soil cover is placed over liner (see SLQCP).

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to appropriate specifications for requirements for delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with Contract Documents, the following manufacturers are acceptable:
   1. Geotextiles:
      a. Manufacturers may qualify by providing references for a minimum of 5,000,000 SF of geotextile installations.
   2. Drainage Composites:
      a. GSE.
      b. Tenax.
      c. Other manufacturers may qualify by providing products meeting project specification, and references for a minimum of 10,000,000 SF of geonet/geotextile drainage composite installations.

B. Submit requests for substitution in accordance with Section 01600 - Material and Equipment.

2.2 MATERIALS

A. Geotextile Filter Fabric:
   1. Geotextile filter fabric materials shall conform to physical values described in SLQCP and Table 02760A – Geotextile Filter Fabric Properties.

Table 02760A - GEOTEXTILE FILTER FABRIC PROPERTIES

Property	Test Method	Typical Test Value
Fabric Weight (oz/yd)[2]	ASTM D5261	oz.
Thickness (mils)	ASTM D5199	75
Grab Tensile Strength	ASTM D4632	180
(lbs) Grab Elongation (%) (MD/CD)[1]	ASTM D4632	50/80
Puncture Resistance (lbs)	ASTM D4833	80
Permeability (cm/sec)	ASTM D4491	0.3

[1] MD/CD = MD - Machine Direction/CD - Cross Direction
[2] Minimum Average Roll Value (MAR)

   2. Geotextile materials shall consist of non-woven material. Geotextile placed above drainage material shall have a minimum weight of 8 ounces per square yard.
   3. Geotextile shall be manufactured free of holes, undispersed raw materials, any sign of contamination by foreign matter, or variation in thickness of more than 10 percent. Any such defect shall be cause for rejection of defective geotextile. Minor defects may be repaired in accordance with manufacturer recommendations if repair is approved by Engineer.

B. Double-Sided Geonet/Geotextile Drainage Composites:
   1. Geocomposite:
      a. Geocomposite shall be manufactured by heat-bonding non-woven, polyester or polypropylene geotextile to both sides of formed, solid rib, HDPE drainage net.
      b. No burn through either component permitted. No glues or adhesives permitted.
      c. Geonet shall consist of non-foamed, extruded HDPE material forming two or three sets of strands arranged to form a 3D structure providing planar water flow.
   2. Geonet/geotextile drainage composite materials shall conform to specifications described in SLQCP and meet:
      a. Geotextile on both sides of geonet shall be minimum 8 ounces per square yard non-woven material meeting/exceeding physical properties of Table 02760B – Geonet Core Properties.

Table 02760B - GEONET CORE PROPERTIES

Property	Test Method	Test Value
Thickness (mils)	ASTM D5199	275-300
Carbon Black Content (%)	ASTM D1603/4218	2.0 to 3.0
Tensile Strength (machine direction) (lb/in)	ASTM D5035/7179	55
Creep Reduction Factor	GRI-GC8	1.2

      b. Double-sided geocomposite for use in LCS shall have a minimum Transmissivity (m2/sec) conforming to these values (ASTM D4716):

Table 02760C – GEOCOMPOSITE VALUES

Confining Pressure (psf)	(m2/sec)
2,140	8.10E-04
9,250	5.42E-04
12,175	4.04E-04

      c. Double-sided geocomposite for use in groundwater underdrain applications shall have a minimum thickness of 175 mil, 6 oz geotextile, and transmissivity of 9E-05 m2/sec.
   3. Submit manufacturer quality control certificate of materials and performance characteristics for every 50,000 square feet of material delivered to the site and for each lot.

C. Resin:
   1. Resin shall be new, first quality, compounded polyethylene resin.
   2. Natural resin shall meet the following minimum requirements:

Table 02760D - RESIN PROPERTIES

Property	Test Method	Test Value
Density (g/cm')	ASTM D1505	>0.94
Melt Flow Index (g/10 min)	ASTM D 1238	≤1.0

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS - GEOTEXTILES

A. Geotextile Filter Fabric:
   1. Take care to keep geotextile clean and free from debris prior to installation. If geotextile is not free of soil and debris before geotextile installation, Contractor shall clean just prior to installation.
   2. On slopes, geotextile shall be anchored into a trench as detailed on Contract Drawings.
   3. Adjacent rolls of geotextile shall be overlapped approximately 12 inches and sewn tightly along the roll length, or as recommended by manufacturer, whichever is more stringent. Roll ends shall be overlapped and sewn in same manner or as recommended by the manufacturer, whichever is more stringent. Any other proposed method of attachment shall be approved by Owner.
   4. Installer shall handle all geotextile rolls to ensure they are not damaged in any way and the following shall be complied with:
      a. Repair holes or tears in geotextile by placing a patch of same material over defective area with patch extending a minimum of 24 inches beyond edges of repair area. Sew into place using polymeric thread with chemical resistance and strength properties equal to or exceeding those of geotextile.

B. Geotextiles shall be deployed, seamed, and protected in accordance with manufacturer recommendations.
   1. Position geotextile by hand if necessary, after unrolling to minimize wrinkles.
   2. In wind, all geotextile in place shall be weighted with sandbags or equivalent. Sandbags shall be installed during placement and remain until replaced with cover material.
   3. Contractor shall place all cover materials to ensure geotextile and underlying materials are not damaged.

3.2 CONSTRUCTION METHODS - GEONET/GEOTEXTILE DRAINAGE COMPOSITES

A. Drainage Composite:
   1. Take care to keep drainage composite clean and free from debris prior to installation. If drainage composite is not free of soil and debris before drainage composite installation, Contractor shall clean just prior to installation.
   2. Geocomposite roll should be installed in direction of slope and in intended direction of flow.
   3. On slopes, drainage composite shall be anchored into trench as detailed on Contract Drawings.
   4. Use only full length rolls at top of slopes, or partial rolls so there are no horizontal seams on the slopes.
   5. Adjacent edges of the geocomposite along the length shall be placed so edges butt against each other and secure by plastic ties approximately every 5 feet along roll length. Roll ends shall be shingled down in direction of slope, with minimum overlap of 12 inches, and tied every 6 inches. Plastic ties shall be white or a bright color for easy inspection. Metallic ties not allowed.
   6. Installer shall handle all geonet/geotextile drainage composite rolls to ensure they are not damaged in any way, and the following shall be complied with:
      a. Geonet/geotextile drainage composite shall be positioned by hand, if necessary, after unrolling to minimize wrinkles.
      b. In wind, all geonet/geotextile drainage composite in place shall be weighted with sandbags or equivalent. Sandbags shall be installed during placement and remain until replaced with protective cover material.

c. Contractor shall place all protective cover materials to ensure geonet/geotextile drainage composite and underlying materials are not damaged.

7. Geonet/geotextile drainage composite shall be deployed, seamed, and protected in accordance with manufacturer recommendations.
8. Repair holes or tears in drainage geocomposite by placing a patch extends 2 feet beyond edges of hole or tear and tie every 6 inches. If a tear extends more than 50 percent of width of geocomposite section, remove entire width of damaged portion and join two remaining sections as described.
9. Repair any damage to underlying geomembrane caused by placement of drainage geocomposite at no additional cost to Owner.

3.3 GEOSYNTHETIC INSTALLATION ACCEPTANCE

A. Installer shall retain all ownership and responsibility for the installed geosynthetics until final acceptance by Owner. Owner will accept installation upon completion and all required documentation from Installer is received and approved.

END OF SECTION

SECTION 02778 - HDPE GEOMEMBRANE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Furnishing and installing textured HDPE geomembrane
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 02200 – Excavation and Earthwork.

1.2 REFERENCES

A. ASTM D0638 - Standard Test Method for Tensile Properties of Plastics.
B. ASTM D0746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
C. ASTM D0792 - Standard Test Methods for Specific Gravity and Density of Plastics by Displacement.
D. ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
E. ASTM D1204 - Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature.
F. ASTM D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
G. ASTM D1505 - Test Method for Density of Plastics by the Density Gradient Technique.
H. ASTM D1593 - Specification for Non-rigid Vinyl Chloride Plastic Sheeting.
I. ASTM D1603 Test Method for Carbon Black in Olefin Plastics.
J. ASTM D3015 - Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds.
K. ASTM D3083 - Standard Specification for Flexible Plastic Sheeting for Pond, Canal, and Reservoir Lining.
L. ASTM D3895 - Standard Test Method for Copper Induced Oxidative Induction Time of Polyolefins by Thermal Analysis.
M. ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
N. Federal Test Method Standards: 101C Puncture Resistance.
O. Geosynthetic Research Institute (GRI):
   1. Test Method GM 4 - Multiaxial Burst Test.
   2. Test Method GM 5 - Notched Constant Tensile Load Test.

1.3 QUALITY ASSURANCE

A. Comply with the SLQCP.

1.4 SUBMITTALS

A. In addition to the requirements of Section 1300 - Submittals, submit information for:
   1. Resin.
      a. Statement of production date or dates.
      b. Certification stating that the resin meets the product requirements of these specifications.
      c. Certification stating that all resin is from the same manufacturer.
      d. Copy of quality control certificates issued by manufacturer.

e. Test reports from manufacturer.

2. Geomembrane Roll data
   a. Statement of production date or dates.
   b. Laboratory test results and certification stating that the Geomembrane meets the product requirements of these specifications.
   c. Certification stating that all geomembrane rolls are furnished by one supplier, and that all rolls are manufactured from one resin type obtained from one resin supplier.
   d. Copy of quality control certificates issued by manufacturer.
   e. Test reports from the manufacturer
   f. Typical results of complete notched constant tensile load test (GRI-GM-5) for specified resin and sheet thickness.
   g. Statement certifying that no reclaimed polymer is added to the resin.
   h. Statement listing percentages of processing aids, antioxidants, and other additives other than carbon black added to or in the resin.
   i. Geomembrane delivery, storage, and handling instructions.
   j. Geomembrane installation instructions.
   k. Sample warranties for review.
3. Extrudate beads and/or rod.
   a. Statement of production date or dates.
   b. Laboratory certification stating that the extrudate meets the product requirements (outlined below).
   c. Certification stating that all extrudate is manufactured by one manufacturer and resin is supplied from one supplier.
   d. Copy of quality control certificates issued by manufacturer.
   e. Test reports from the manufacturer.
   f. Certification stating that the extrudate bead or rod resin is the same type, from the same manufacturer, and compatible with the resin used to manufacture the geomembrane supplied for this project.
4. Drawings
   a. Installation layout drawings. Submit drawings showing the panel layout indicating both fabricated and field seams. Upon acceptance, use these drawings for Geomembrane installation.
5. Installation Contractor
   a. A list of completed facilities, totaling a minimum of 2,000,000 square feet, for which the installer has installed polyethylene geomembrane. For each installation, the following information shall be provided
      1) Name and purpose of facility, location, and date of installation.
      2) Name of owner, design engineer, manufacturer, and name and telephone number of contact at the facility who can discuss the project.
      3) Thickness and quantity of the installed geomembrane.
      4) Resume of the field installation supervisor and master seamer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Geomembrane for the landfill cell shall be 60miI High-Density Polyethylene (HDPE) (Textured both sides)
B. Gasket material shall be neoprene, closed cell medium, 1/4-inch thick, 2 inches wide with adhesive on one side, or other compatible gasket materials as required.
C. Metal battens or banding and hardware shall be stainless steel.

D. Water cut-off mastic shall be Neoprene Flashing Cement as supplied by Manufacturer, or as required.
E. Sealant shall be General Electric Silicone, RTV 103, or equivalent.

2.2 GEOMEMBRANE RAW MATERIALS

A. Geomembrane shall be manufactured of polyethylene resins produced in the United States and shall be compounded and manufactured specifically for the intended purpose.

2.3 ROLLS

A. Geomembrane shall be a minimum 20.0-foot seamless width.
   1. Acceptable manufacturers include:
      a. Poly-Flex, Inc.
      b. GSE Environmental
      c. Approved equal.
   2. Carbon black shall be added to the resin if the resin is not compounded for ultra- violet resistance.
B. Surface of the smooth geomembrane shall not have striations, roughness, pinholes, or bubbles.
C. Geomembrane shall be supplied in rolls. Labels on each roll shall identify the thickness of the material, the length and width of the roll, lot and roll numbers, and name of manufacturer.
D. Contractor shall supply one additional roll to the city for their future use. It shall be properly handled and stored as directed by City.

2.4 QUALITY CONTROLL SPECIFICATIONS

A. Raw Materials
   1. Resin: All resins for use in geomembrane must pass a candidate pre-approval process before being eligible for use. Each incoming railcar shall be sampled by compartment with the following testing performed and compared to Manufacturer specifications.
      a. Density: ASTM D1505.
      b. Melt Index: ASTM D1238.
      c. Oxidative Induction Time (OIT): ASTM D3895.
   2. Additives: All incoming materials are to be tested and approved prior to use with the following testing performed and compared to Manufacturer specifications.
      a. Carbon Black Content: ASTM D1603.
      b. Oxidative Induction Time (OIT): ASTM D3895.
B. Finished product - during production:
   1. Inspection
      a. Performed on each roll during manufacturing.
      b. Sheet surface appearance shall be monitored for flaws.
      c. A full-width sample shall be cut from the end of each roll for thickness measurement thickness.
   2. Roll Identification
      a. Four tags per roll shall be used:
         1) Outside the core.
         2) On the core plug.
         3) On the roll surface.
         4) On the production roll sample.
   3. Out-of-Spec Material
      a. Any roll not meeting specifications for any noted inspections shall be separated from other rolls and placed on hold.

C. Manufacturer's Quality Control and Quality Assurance Testing
   1. Sampling: Full-width samples shall be taken as retains from the end of each roll to the manufacturer's laboratory.
   2. Testing: Geomembrane quality control testing shall meet the following frequency requirements:

Property	Test Method	HDPE Requirements	LLDPE Requirements
Density, g/cc	ASTM D1505 or ASTM D792	0.935 – 0.940	0.915 – 0.926
Melt Index, g/10 min.	ASTM D1238 Condition E	<0.4	<0.6

   3. Welding Rod - sample of welding rod shall be tested at the frequency of once per 25 rolls of welding rod. Perform these tests on the sample:
      a. Diameter - ASTM D5199.
      b. Density - ASTM D1505.
      c. Melt Index - ASTM D1238.
      d. Carbon Black Content - ASTM D1603.
   4. Reporting: Test results shall be reviewed by QC manager. Material not meeting specifications shall be identified and placed on hold. Transfer test data to the product data file for roll certification.

PART 3 - EXECUTION

3.1 PREPARATION OF SUBGRADE

A. Verify in writing to Engineer, the surface where geomembrane will be installed is acceptable.
B. Grade changes rounded to minimum 6-inch radius.
C. Further information provided in the SLQCP.

3.2 PREPARATION

A. Repair damage caused to subgrade during deployment.
B. Round edges of anchor trenches or cushion with geotextiles.
C. Perform trial seam welds as follows:
   1. Perform trial welds on samples of geomembrane to verify the performance of welding equipment, seaming methods, and conditions.
   2. Frequency of trial welds:
      a. Minimum of two trial welds per day with one prior to the start of work and one at mid shift.
      b. When directed by CQA Monitor.
      c. Every two hours when using a wedge weld to weld across seams.
      d. Minimum one trial weld per person per shift.
      e. When ambient temperature changes more than 10 degrees F since previous trial weld.
   3. Make trial welds in the same surroundings and environmental conditions as production welds, (i.e., in contact with subgrade).
   4. Make trial weld sample at least 2 feet long, 3 feet long for double wedge welding machines, and 12 inches wide with the seam centered lengthwise.
   5. Cut two, 1-inch wide test strips from opposite ends of the trial weld.
   6. Quantitatively test specimens, first for peel adhesion, and then for bonded seam strength (shear) (ASTM D4437).

7. A specimen is considered passing when the following results are achieved. For double-wedge welding, both welds must pass in peel.
   a. Break is a film tearing bond (FTB).
   b. Break is ductile.
   c. Peel strength is 62 percent of the specified shield yield strength or greater for wedge welded seams and 70 pounds per inch or greater for extrusion welded seams and no greater than 10 percent of the seam width peels.
   d. Shear strength is 95 percent of the specified sheet yield strength for shear test for all weld types. When testing set grips back 2 inches from the edge of the weld. Minimum elongation between the grips must be 2 inches.
8. Trial weld sample is considered passing when all specimens pass peel and shear tests.
9. Repeat trial weld in entirety when any trial weld samples fail in either peel or shear.
10. When repeated trial weld fails, do not use welding apparatus and welder until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

3.3 INSTALLATION

A. Deployment.
1. Give careful consideration to timing and temperature during deployment. Ideally, deployment, welding, and covering would all occur at the same temperature. In a practical sense, Contractor should strive to perform these activities within as narrow a temperature range as practical, and avoid these activities during peak hot or cold conditions.
2. Assign each panel a unique identifying code number or letter consistent with Contractor-submitted panel layout drawing. Coding is subject to approval by CQA Monitor.
3. Deploy no more panels in one shift than can be welded or secured during same day.
4. Do not deploy in the presence of excessive moisture, precipitation, ponded water, or high winds.
5. Do not damage geomembrane by handling, by trafficking, or leakage of hydrocarbons or any other means.
6. Do not wear damaging shoes or engage in activities that could damage geomembrane.
7. Unroll geomembrane panels using methods to not damage, stretch, or crimp geomembrane. Protect underlying surface from damage.
8. Use methods that minimize wrinkles and differential wrinkles between adjacent panels.
9. Place ballast on geomembrane to prevent uplift from wind. Use ballast that will not damage geomembrane.
10. Protect geomembrane in area of heavy traffic by placing protective cover, compatible with and will not damage flexible membrane.
11. Repair damage to subgrade or other underlying materials prior to completing deployment of geomembrane.
12. Do not allow vehicle traffic directly on flexible membrane.
13. Remove heavily wrinkled or folded material.
14. Visually inspect geomembrane for imperfections. Mark faulty or suspect areas for repair.
15. Install material to account for shrinkage and contraction while avoiding wrinkles. Install material stress-free with no bridging before covering. Add material as needed to avoid bridging.
16. Before wrinkles fold over, attempt to push out. For wrinkles that cannot be pushed out, cut them out and repair cuts prior to burial or at the direction of CQA monitor.

B. Seam Layout.
   1. Orient seams parallel to line of a maximum slope, (i.e., orient down not across slope).
   2. Minimize number of field seams in corners, odd-shaped geometric locations, and outside corners.
   3. Keep horizontal seams (seams running approximately parallel to slope contours) at least 5 feet away from toe or crest of slope.
   4. Use seam numbering system compatible with panel number system. Each seam must have a unique number.
   5. Shingle panels on all slopes and grades so upgradient panel is on top.

C. Seam Welding Personnel.
   1. Provide at least one welder (master welder) with experience welding over 5 million square feet of geomembrane using the same type of welding apparatus in use at site.
   2. Qualify personnel performing welding operations by experience and by successfully passing field welding tests performed onsite.
   3. Master welder will provide direct supervision over other welders.

D. Seam Welding Equipment.
   1. Extrusion welder must be equipped with gauges showing temperatures in extruder apparatus and at nozzle. Temperature at nozzle may be measured by external temperature gauges.
   2. Hot wedge welder shall be automated variable speed vehicular mounted devices with pressure controlled by spring, pneumatic, or other system that allows for variation in sheet thickness. Rigid frame fixed position equipment is not acceptable.
   3. Maintain adequate quantity of welding apparatus to avoid delaying the project.
   4. Use power source capable of providing constant voltage under combined line load.

E. General welding procedures:
   1. Do not commence welding until trial weld test sample, made by that equipment, passes test.
   2. Clean surface of grease, moisture, dust, dirt, debris, or other foreign material.
   3. Overlap panels a minimum of 3 inches for extrusion and 4 inches for hot wedge welding.
   4. Do not use solvents or adhesives unless product is approved in writing by Engineer.
   5. Provide adequate material on weld to allow peel testing of both sides of double wedge weld.
   6. Extend welding to the outside edge of all panels.
   7. If required, provide a firm substrata by using flat board, conveyor belt, or similar hard surface directly under the weld overlap to achieve firm support.
   8. Provide adequate illumination if welding operations are carried out at night.
   9. Cut fishmouths or wrinkles along ridge of wrinkle to achieve a flap overlap. Extrusion weld the cut fishmouths or wrinkles where overlap is more than 3 inches. Where less than 3-inch overlap, patch with an oval or round patch extending a minimum of 6 inches beyond the cut in all directions.
   10. Log this following every two hours:
      a. Temperature directly on the geomembrane surface being welded.
      b. Extrudate temperatures in barrel and at nozzle (extrusion welder).
      c. Operating temperature of hot wedge (hot wedge welder) and any pressure adjustments made.
      d. Preheat temperature.
      e. Speed of hot wedge welder in feet per minute
   11. Weld only when ambient temperature, measured 6 inches above the geomembrane is between 40 and 104 degrees F unless other limits are accepted, in writing, by Design Engineer.

12. If Installer wishes to use methods to allow seaming at ambient temperatures below 40 or above 104 degrees F, Installer shall demonstrate and certify such methods produce seams entirely equivalent to seams produced at ambient temperatures above 40 and below 104 degrees F, and overall quality of geomembrane is not adversely affected. In addition, a change order to the contract between Owner and Installer is required, specifically stating the seaming procedure does not cause any physical or chemical modification to geomembrane to generate any short or long term damage to the geomembrane. Then, temperatures in the noted quality assurance procedure shall be modified accordingly.

F. Defects and Repairs
1. Examine all welds and nonweld areas of the geomembrane for defects, holes, blister, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the flexible membrane shall be clean at the time of the examination.
2. Repair and nondestructively test each suspect location both in weld and nonweld areas. Do not cover geomembrane at locations repaired until test results with passing values are available.

G. Extrusion Welding
1. Use procedures to tack bond adjacent panels together not damaging flexible membrane. Perform CQA tests not detrimental to final welding.
2. Purge welding apparatus of heat-degraded extrudate before welding.
3. Bevel top edges of geomembrane a minimum of 45 degrees and full thickness of flexible membrane before extrusion welding.
4. Clean seam welding surfaces of oxidation by disc grinder or equivalent not more than one hour before extruding weld. Change grinding discs frequently. Do not use clogged discs.
5. Do not remove more than 4 mils of material when grinding.
6. Grind across, not parallel to, welds.
7. Cover entire width of grind area with extrudate.
8. When restarting welding, grind ends of all welds that are more than one hour old.

H. Interface Extrudate Welding
1. Mount components necessary to weld on mobile unit.
2. Include the following accessories on mobile unit:
   a. Variable speed control.
   b. Wheels with nonskid surface.
   c. Directional control.
   d. Automatic hot air system for preheating welding surfaces.
   e. Extruder system with appropriate die.
   f. Adjustable contact pressure rollers.
3. Test and set "hot air system" using scrap material each day prior to commencing welding.
4. Adjust hot air velocity to preclude wind effects.
5. Adjust contact pressure rollers to prevent surface ripples in panels.
6. Protect against moisture build-up between panels.

I. Hot Wedge Welding.
1. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.
2. Protect against moisture build-up between panels.
3. If welding across cross seams, conduct field test welds at least every two hours, otherwise, once prior to start of work and once at mid-day.
4. Bevel edges of top and bottom panels on cross seams.
5. Do not weld on flexible membrane until equipment passes trial weld test.
6. Extrusion-weld a patch over or spot weld all seam intersections as described in Article 3.3E.

3.4 FIELD QUALITY CONTROL AND QUALITY ASSURANCE

A. Conformance Testing (Performed by Construction Quality Assurance Laboratory)
   1. Allow 14 days for conformance testing following date material is available to CQAC.
   2. Perform conformance testing on flexible membrane rolls.
   3. Obtain samples at specified frequency. CQA Monitor will obtain samples.
   4. Forward samples to Construction Quality Assurance Laboratory.
   5. Test samples for conformance with design specifications and guaranteed properties.
   6. Perform, as a minimum, following tests to determine flexible membranecharacteristics:
      a. Density: ASTM D792, Method A or ASTM D1505.
      b. Thickness: Measured with appropriate micrometer.
      c. Tensile Strength: ASTM D638.
      d. Carbon Black Content: ASTM D1603.
      e. Carbon Black Dispersion: ASTM D3015.
      f. Where optional procedures are noted in the test method, specification requirements prevail.
      g. Additional tests may be performed at discretion of CQAC.
   7. Sampling Procedures
      a. Sample across the entire width of the roll excluding the first 3 feet.
      b. Cut sample 3 feet long by width of roll.
      c. Mark machine direction on the samples with an arrow. CQA Monitor responsible for markings
      d. Sample at a rate of one per batch or one per 100,000 square feet of material supplied, whichever results in greatest number.

B. Nondestructive Testing (Performed by Installer).
   1. Nondestructively test all field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), spark testing, or other approved methods. Perform testing as the seaming progresses and not at the completion of all the field seaming. Complete all required repairs in accordance with this specification.
   2. Vacuum testing.
      a. Equipment, composed of:
         1) Vacuum box assembly consisting of rigid housing, transparent viewing window, soft neoprene gasket attached to the bottom, port hole or valve assembly, and vacuum gauge.
         2) Vacuum pump assembly equipped with a pressure control.
         3) Rubber pressure/vacuum hose with fittings and connections.
         4) Soapy solution and applicator.
      b. Test Procedures
         1) Place box over wetted seam area (soapy solution).
         2) Ensure a leak-tight seal is created.
         3) Energize vacuum pump and reduce vacuum box pressure to approximately 5 psi gauge (measured in inches of Hg).
         4) Examine geomembrane through viewing window for presence of soap bubbles caused by seam leaks for not less than ten seconds.
         5) Mark and repair all areas where soap bubbles appear in accordance with repair procedures described in this specification.
   3. Air pressure testing for seaming processes producing a double seam with enclosed channel
      a. Equipment, composed of:
         1) Air pump (manual or motor-driven) equipped with pressure gauge capable of generating and sustaining a pressure over 30 psi, and mounted on a cushion to protect geomembrane.
         2) Rubber hose with fittings and connections.

3) Sharp, hollow needle or other approved pressure feed device.
4) Pressure gauge with an accuracy of 1 psi.

b. Test Procedures
1) Seal both ends of welded seam to be tested.
2) Insert needle or other approved pressure feed device into tunnel created by the weld.
3) Energize air pump to a minimum pressure of 30 psi or 1/2 psi per mil of liner thickness, whichever is greater, close valve, and sustain pressure for at least five minutes.
4) Allow a two-minute relaxation period when pressure may drop no more than 2 psi.
5) If loss of pressure after relaxation period exceeds 2 psi within five minutes or does not stabilize, locate faulty area and repair in accordance with repair procedures described in this specification.
6) Puncture opposite end of seam to release air. If blockage is present, locate and test seam on both sides of blockage.
7) Remove needle or other approved pressure feed device and seal penetration holes.

4. Spark Testing for penetrations or other difficult areas not accessible for vacuum testing.
a. Equipment and Materials.
1) 24 gauge copper wire
2) Low-amperage electric detector, 20,000 to 30,000 volt, with brush-type electrode capable of causing visible arc up to 3/4 inch from copper wire

b. Procedures.
1) Place copper wire within 1/4 inch of extrusion seam or clamp seal edge
2) Pass electrode over seam or clamp area and observe for spark. Perform repair if spark is detected.

C. Destructive Testing (performed by CQAC and the Installer)
1. Location and Frequency of Testing.
a. Collect destructive test samples at a minimum frequency of one test location per 500 feet of seam length.
b. Determine test locations during welding. Locations may be prompted by suspicion of excess crystallinity, contamination, offset welds, or suspected defect. CQA Monitor responsible for choosing the locations. Monitor will not notify installer in advance of selecting locations where weld samples are taken.

2. Sampling Procedures.
a. Cut samples at locations designated by CQA Monitor as the welding progresses. Verify laboratory test results are obtained before flexible membrane is covered by another material.
b. CQA Monitor will number each sample then mark sample number and location in compliance with the CQA program.

3. Immediately repair all holes in geomembrane resulting from destructive test sampling. Repair in accordance with repair procedures described in Article 3.5. Test continuity of repair in accordance with this Section.

4. Size of Samples: minimum 12 inches wide by 44 inches long with seam centered lengthwise. Die-cut four 1-inch-wide strips from sample and test for shear and peel in the field. Cut remaining sample into three parts for distribution:
a. One portion for Installer: 12 x 12 inches.
b. One portion for Construction Quality Assurance Laboratory: 12 x 18 inches.
c. One portion to Owner for archive storage: minimum 12 x 12 inches.

5. Testing Procedures (Performed by Installer).
    a. Test four, 1-inch wide strips specified in Article 3.4.C.4 by tensiometer for peel and shear, respectively. Two test strips must meet peel and two must meet shear requirements for welded seams specified in Article 3.2.C.7.
    b. If any field test sample fails, follow outlined failed weld procedures.

D. Laboratory Testing (Performed independently by Construction Quality Assurance [CQA] Laboratory and Installer).
1. Test "seam strength" and "peel adhesion" (ASTM D4437).
2. Minimum acceptable values obtained for these tests are specified in Article 3.2.C.7.
3. Test at least five specimens for each test method. Four of five specimens must meet minimum requirements. None of the peel may peel 100 percent or entire sample will be considered as failing.
4. Select specimens alternately by test from the samples (i.e., peel, shear, peel, shear...).
5. Provide test results no more than 48 hours after receiving samples.
6. For double-wedge-welded samples, test both sides in peel.

E. Failed Weld Procedures - follow with destructive test failure. Procedures apply when test failure is determined by Construction Quality Assurance Laboratory, Installer, or by field tensiometer. Follow one of the following two options:
    a. First Option: Reconstruct seam between any two passing test locations.
    b. Second Option.
        1) Trace weld at least 10 feet minimum in both directions from location of failed test or to end of welds in question.
        2) Obtain a small sample at both locations for an additional field test.
        3) If additional test samples pass field tests, take laboratory samples.
        4) If laboratory samples pass, reconstruct weld or cap between the two test sample locations that bracket the failed test location.
        5) If any sample fails, repeat the process to establish the zone where weld must be reconstructed.

F. Acceptable Welded Seams.
1. Bracketed by two locations from which samples have passed destructive tests.
2. For reconstructed seams exceeding 50 feet, take sample from within the reconstructed weld passes destructive testing.
3. When a sample fails, provide additional testing for seams welded by the same welder and welding apparatus or welded during the same time shift.

G. Seams that cannot be Nondestructively Tested.
1. If weld is accessible to testing equipment prior to final installation, nondestructively test weld prior to final installation.
2. If weld cannot be tested prior to final installation, cap strip the weld. Welding and cap-stripping operations must be observed by CQA Monitor and installer for uniformity and completeness.

3.5 REPAIR PROCEDURES

A. Remove damaged geomembrane and replace with acceptable geomembrane materials if damage cannot be satisfactorily repaired.

B. Repair, removal, and replacement is at Contractor expense if damage results from Contractor, Installer, or Contractor's subcontractor activities.

C. Repair any portion of geomembrane exhibiting a flaw or failing destructive or nondestructive test. Agreement upon appropriate repair method will be determined between Owner and CQAC. Do not commence welding on liner until trial weld test sample, made by that equipment and operator, passes trial test. Repair procedures available include:
1. Patching: Used to repair large holes (over 3/8-inch diameter), tears (over 2 inches long), undispersed raw materials, and contamination by foreign matter.

2. Abrading and re-welding: Used to repair small sections of seams.
3. Spot welding or seaming: Used to repair small tears (less than 2 inches long), pin holes or other minor, localized flaws.
4. Capping: Used to repair large lengths of failed seams.
5. Removing the seam and replacing with a strip of new material.

D. In addition, satisfy these procedures:
1. Abrade flexible membrane surfaces to be repaired (extrusion welds only) no more than one hour prior to repair.
2. Clean and dry all surfaces at time of repair.
3. Extend patches or caps at least 6 inches beyond the edge of defect and round all corners of material to be patched and patches to a radius of at least 3 inches.
4. Unless otherwise instructed by Engineer, cut flexible membrane below large caps to avoid water or gas collection between the sheets.

E. Verification of repair.
1. Number and log each patch repair.
2. Non-destructively test each repair using methods specified in Article 3.4.
3. Reconstruct repairs until tests indicate passing results.

3.6 GEOMEMBRANE ACCEPTANCE

A. Contractor retains all ownership and responsibility for geomembrane until acceptance by Owner.

B. Owner will accept geomembrane installation when:
1. All required documentation from manufacturer, fabricator, and installer are received and accepted.
2. Installation is finished.
3. Test reports verify completion of all field seams and repairs.
4. Written certification documents and drawings have been received by Owner.
5. Owner received acceptance of the GLER by TCEQ.

3.7 MANUFACTURERS

A. HDPE Geomembrane shall be manufactured by:
1. Poly-Flex, Inc.
2. GSE Environmental.
3. Approved equal.

3.8 WORKMANSHIP AND EXPERIENCE

A. Manufacturer shall have at least five years continuous experience in manufacturing polyethylene geomembrane and/or experience totaling 10,000,000 square feet of manufactured polyethylene geomembrane.

B. Installation Contractor shall be manufacturer or dealer trained to install manufacturer's geomembrane.

C. Installation shall be performed under constant direction of field installation supervisor who shall remain onsite and be responsible, throughout liner installation, for liner layout, seaming, testing, repairs, and all other activities by Installer. Field installation supervisor shall have installed or supervised installation of a minimum of 2,000,000 square feet of polyethylene geomembrane. Seaming shall be performed under direction of a master seamer (who may also be the field installation supervisor) with a minimum of 2,000,000 square feet of polyethylene geomembrane, using same type of seaming apparatus specified for this project. Field installation supervisor and/or master seamer shall be present whenever seaming is performed.

Treatment plant manufacturer shall, wherever possible, transfer original supplier warranty to Owner for any items purchased by the manufacturer to this system.

END OF SECTION

SECTION 02824 - LITTER FENCE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Provide labor, equipment, and materials necessary to install and complete the litter fence specified herein and as shown on Drawings, approximately 2,400 LF x 25 feet high.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 SUBMITTALS

A. Submit drawings, data, bonding, insurance certificate, information and a registered engineered stamped drawings in Texas within ten days of "Notice to Award."

B. Manufacturer's descriptive literature and catalog information on poles, net material, and hardware as applicable.

C. Netting sample with rope border including independent lab test results using testing methodology ISO 1806 indicating a minimum average single mesh breaking strength of 116.7 lbs.

D. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

E. List of five references for other similar type installations by Contractor. Must include names, contact information, phone numbers, and email addresses.

PART 2 - PRODUCTS

2.1 BARRIER NETTING

A. Netting: Polyester netting shall made using four-needle Rachel, knotless construction, manufactured with UV-treated yarn and additionally coated with a black resin dye and bonding treatment.

B. Size: 2 1/2-inch stretch mesh, 1-inch single bar measure. 116.7 average single mesh break strength, determined in accordance with ISO standard1806.

C. Attachment Twine: Black #48 braided polyester twine, 375 lb tensile strength, impregnated with UV inhibitor.

D. Rope Boarder and Interior Riblines: Black, 3/8-inch braided synthetic cover, parallel synthetic core, 3,500 lb. tensile strength. Rope boarder shall be attached to net using a black, UV, dye-treated #48 braided polyester twine with a minimum 375 lb. tensile strength. Attachment twine shall not be continuously tied to net, but tied at 6 inches on center for the full length of the rope border.

E. The netting shall include manufacturer ten-year limited warranty.

2.2 WOOD POLES

A. Wood poles are to be full-length Penta or CCA pressure-treated wood poles in accordance with current AWPA standards. All poles shall conform to and be installed in accordance with the ANSI 05-1 2002 and AWPA 2005 specifications.
B. Wood poles shall be new and burn-branded in accordance with ANSI 05-1 2002. Owner will inspect poles prior to installation to assure correct size is installed.
C. Wood poles shall be sized to withstand 50 percent solid wind loading in accordance with ACSE 7-05. Stamped engineered drawing shall be provided with submittal.
D. Minimum acceptable unguyed poles shall be a class H-3 40-foot pole for 50 percent solid.
    1. Note: Transverse guying of poles towards origin of litter, if at all possible, can reduce required capacity of poles. Transverse guying or changes to pole size must be approved by City Engineer.

2.3 HARDWARE

A. All hardware shall be considered “pole line hardware” and hot-dipped galvanized unless specified differently, and shall conform to ANSI, ASTM, IEEE, and/or NEMA. Hardware components shall be matched to meet or exceed load capacity of cable.
B. Bolts: All bolts will be 5/8-inch-diameter with minimum tensile strength of 13,550 lbs.
C. Cable Clamps: Three-bolt cable clamps are required at each pole to support all horizontal cables. One-bolt clamps are required to support vertical cable on every pole at every horizontal cable intersection except for top and bottom horizontal cable.
D. Vertical Rollers: Used to terminate vertical cables at top and bottom of each pole. Rollers shall be 1 7/8 inch in diameter and 7/8-inch-thick with an 11/16-inch-hole in the center.
E. 2 1/4- x 3/16-inch Square Washers: Used to reinforce both sides of bolt holes in poles.
F. Guy Wires: Anchored using a Maclean Power Systems single helix-hub assembly or approved equal. Anchors shall be a minimum 10-inch strait hub, single helix anchor attached to 3/4-inch x 7-foot anchor rods with twin-eye nut-end. All guy wires shall include a high-visibility, yellow, guy guard.
G. All end horizontal cables shall terminate at pole using a 5/8-inch **t**himble eye-nut.
H. Attachment clips shall be 9/32-inch cadmium-plated steel, carabineer attachment snap. Zinc- or nickel-coated clips are not to be used.
I. All cable shall be5/16-inch, 1 by 7 EHS (extra high strength), galvanized steel strand with a minimum breaking strength of 11,200 lbs.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. New Wood Poles, Net Materials, and Accessories
    1. Protect, support, and handle to prevent damage to poles, net materials, and accessories.
    2. Use implements, tools, facilities, and equipment suitable for proper and safe protection and handling of poles, fence materials, and accessories.
    3. Remove poles, net materials, and accessories damaged beyond repair, in opinion of Engineer.

3.2 PREPARATION

A. New Poles, Net Materials, and Accessories
   1. Inspect before poles, net materials, and accessories are installed.

3.3 EXCAVATION AND BACKFILL

A. Excavate and backfill for Litter Fence in accordance with Article 3.4.B - Wood Pole Installation.

3.4 INSTALLATION

A. Qualifications: Contractor shall have a minimum of five years' experience installing netting of a similar type construction, and submit five references for similar installations.

B. Wood Pole Installation
   1. Poles shall inclined 5 degrees toward plane of netting and must be otherwise placed plumb and true with spacing not to exceed 50 feet on center; embedment shall be a minimum of 9 feet, 6 inches in depth. Poles shall be trimmed so top cable hardware runs 6 inches below top of pole. In no instance shall table cable hardware be installed closer than 6 inches from top of pole.
   2. Poles borings shall be of sufficient size and orientation to ensure entire area of boring can be properly backfilled and compacted with pole leaning 5 degrees toward landfill.
   3. Poles shall be backfilled using suitable excavated spoil materials placed in compacted lifts not to exceed 18 inches in depth. Excess spoils materials to place in a mound around base of pole to provide excess material for settling and for positive drainage away from pole base. Poles shall not be backfilled with concrete or other non-porous materials.
   4. Poles shall be guyed at all end conditions and any turns in line of netting to prevent deformation of pole. Additionally, each pole shall be transverse guyed in direction of landfill.

C. Hardware Installation
   1. Install all hardware using through-bolted connections properly reinforced on each side of pole with square washers.
   2. Spring-lock washers shall be installed at each bolted connection.
   3. Guy hooks shall be used to attach guy cables to poles.
   4. Attachment clips are to be attached to rope boarder at 2 feet on center. Clips shall be installed to attach to support cable and rope boarder only. Clip shall not be attached to encompass net or attachment twine. Continuously sewn rope boarders and riblines that require clipping net with rope boarder, not allowed.
   5. Vertical cables shall be installed on each pole.
   6. Horizontal cables shall be installed parallel to the ground and each other. Minimum of two horizontal cables shall be used to support netting.
   7. Cables shall be tensioned to force of 1,000 to 1,500 lbs, and terminated using 5/16-inch preformed cable grips. Turnbuckles and/or cables clamps shall not be used to secure cable.
   8. Cross or X-bracing cables shall not be used between poles.
   9. Net panels shall be individually made for each pole span. Multi-span net panels not allowed.

10. Rope border shall be installed at net perimeter and all horizontal cable locations. Rope boarders shall be constructed using 3/8-inch rope with black synthetic cover and minimum tensile strength of 3,500 lbs.

D. Installation Clean-Up - clean-up debris and unused material, and remove from site.

PART 4 - PAYMENT

4.1 GENERAL

A. Lump sum payment shall constitute full compensation for furnishing all labor, materials, equipment, and incidentals; and for performing all operations necessary to complete all work covered under this Section shall be completed on a lump sum basis, unless otherwise specifically required or allowed. Lump sum payment items shall be included in the Base Bid and not measured.

B. Base bid payment shall constitute full compensation for all labor, materials, and equipment necessary for furnishing and installing all chain link fence and accessories, including all QC documentation, manufacturer services, and all other work pertaining to furnishing and installing litter fence and accessories as required in this Section.

PART 5 - SOURCES

5.1 MATERIALS

A. Company must provide all approved materials including but not limited to, poles, cable, hardware, netting, attachment snaps, bolts, clamps, anchors, etc.

5.2 INSTALLATION

A. Company must provide approved installation of the materials.

5.3 ENGINEERING

A. A certified engineer must provide signed and stamped engineered drawings.

END OF SECTION

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. All work required for constructing all concrete structures, foundations, equipment pads, etc.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 02200 – Excavation and Earthwork: Excavation or filling for concrete structures and other miscellaneous concrete work shall conform to lines and grades as shown on Plans or as established in the field and shall be as specified herein.

1.2 SCOPE

A. Concrete for this project shall conform to requirements of this Section. Contractor shall furnish all materials, equipment, tools, labor, superintendence, and incidentals necessary to perform the work in accordance with the drawings and these specifications.

1.3 REFERENCES

A. Latest editions of these specifications and references govern Work of this Section and constitute minimum requirements. Where specific requirements in this Section of the Specifications are more stringent, they shall supersede corresponding requirements of these referenced Specifications and latest edition of each governing standard applies:
   1. American Concrete Institute (ACI)
      a. ACI 301 - Specifications for Structural Concrete Buildings.
      b. ACI 301 - Manual of Standard Practice for Detailing Reinforced Concrete Structures.
      c. ACI 318 - Building Code Requirements for Reinforced Concrete.
      d. ACI 347 - Recommended Practice for Concrete Formwork.
      e. ACI 613 - Recommended Practice for Concrete Formwork.
      f. ACI 614 - Recommended, Practice for Measuring, Mixing, and Placing Concrete.
      g. ACI Comm - Selection and Use of Aggregates for Concrete 621.
      h. SP-7 ACI - Manual of Concrete Inspection.
      i. ACI 305R - Hot Weather Concreting.
   2. American Society for Testing Materials (ASTM)
      a. ASTM A82 - Cold Drawn Steel Wire for Concrete Reinforcement.
      b. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
      c. ASTM A616 - Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
      d. ASTM A706 - Low-Alloy Steel Deformed Bars for Concrete Reinforcement.
      e. ASTM C31 - Making & Curing Concrete Compression and Flexure Test Specimens in the Field.
      f. ASTM C33 - Concrete Aggregates.
      g. ASTM C39 - Compressive Strength of Molded Concrete Cylinders.

h. ASTM C40 - Organic Impurities in Fine Aggregates for Concrete.
i. ASTM C42 - Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
j. ASTM C94 - Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
k. ASTM C136 - Standard Method of Test for Sieve or Screen Analysis of Fine and Coarse Aggregate.
l. ASTM C138 - Standard Method of Test for Weight per Cubic Foot, Yield and Air Content (Gravimetric) of Concrete.
m. ASTM C143 - Standard Method of Test for Slump of Portland Cement Concrete.
n. ASTM C150 - Standard Specification for Portland Cement.
o. ASTM C171 - Sheet Material for Concrete Curing.
p. ASTM C172 - Standard Method of Sampling Fresh Concrete.
q. ASTM C173 - Air Content of Freshly Mixed Concrete by the Volumetric Method.
r. ASTM C192 - Standard Method of Making and Curing Concrete Compression and Flexure Test Specimens in the Laboratory.
s. ASTM C231 - Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method.
t. ASTM C260 - Air-Entraining Admixture for Concrete.
u. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
v. ASTM C494 - Chemical Admixtures for Concrete.
w. ASTM C618 - Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Admixture in Portland Cement Concrete.

3. Portland Cement Association (PCA)
   a. Design and Control for Concrete Mixtures.
4. American Welding Society (AWS)
   a. AWS D12.1 Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction.
5. U.S. Army Corps of Engineers
   a. CRD C-572 Specification of Water Stops.
6. Texas Department of Transportation
   a. Standard Specifications for Construction of Highways, Streets and Bridges.

1.4 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.
   1. Fiber reinforcement.
   2. Admixtures.
   3. Curing materials.

B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments. Submitted compressive test results must be less than six months old.
   1. Indicate amounts of mix water to be withheld for later addition at Project site.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
B. Manufacturer Qualifications: Firm experienced in manufacturing ready-mixed concrete products complying with ASTM C94 requirements for production facilities and equipment.
   1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
C. Testing Agency Qualifications: Independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated, as documented according to ASTM E548.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.

PART 2 - PRODUCTS

2.1 CEMENT

A. Portland cement shall conform to the latest revisions of ASTM C150, Type II, and be of an approved brand. Only one brand of cement permitted in any one structure. Plant tests and certificates of conformity with specification shall be furnished with each cement carload.

2.2 FINE AGGREGATE

A. Fine aggregate shall consist of hard, strong, durable, and uncoated particles of natural sand, washed, and screened. Aggregate shall be free from injurious amounts of clay, soft or flaky materials, loam, or organic impurities and grading shall conform to:

Percentage Passing Square Openings				
No. 4	**No. 16**	**No. 50**	**No. 100**	**No. 200**
95-100	45-70	15-30	3-8	0-3

B. Fineness modulus shall not vary more than ±0.20 from that of approved sample, which shall be between 2.20 and 2.90.

2.3 COARSE AGGREGATE

A. Coarse aggregate shall consist of hard, tough, durable, and uncoated particles of washed and screened gravel or crushed stone. It shall be free of vegetation, soft, friable, thin, or elongated particles.
B. Maximum size of coarse aggregate shall be governed by conditions of concrete placement and not be greater than 3/4 of the distance between reinforcing bars. In no case shall maximum size be greater than 2 inches. All aggregates shall be approved before use.

2.4 WATER

A. Water shall be clean, clear, free from oil, acid, or organic matter and free from injurious amounts of alkali, salts, or other chemicals.

2.5 FORMS

A. Forms shall be of wood or metal, of sufficient strength to support concrete without bulging between supports, and sufficiently watertight to hold concrete mortar. Forms shall be constructed so finished concrete shall be of form and dimensions shown on Plans. All formwork for exposed surfaces shall be of such material and so constructed to produce smooth, even surface when concrete is placed. All forms shall be oiled before use. In general, wall forms may be removed after concrete is in place 24 hours. All exposed edges shall have a 3/4-inch chamfer whether or not shown on details. Immediately upon removal of forms, any honeycombed sections shall be repaired as directed.

2.6 CONCRETE MIX

A. Class "A" concrete shall contain not less than 5.5 sacks of cement per cubic yard. No more water shall be used than required to produce a workable mix and in no case will water content exceed 5 gallons per sack of cement. Proportioning of concrete constituents shall produce dense and workable mixture, and mix be approved before placing any concrete.
B. The minimum 28-day compressive strength for Class A concrete shall be 4000 psi.
C. Pipe embedment concrete shall contain not less than four sacks of cement per cubic yard. No more water than 8 gallons of water per sack of cement shall be used. Proportioning of concrete constituents shall produce dense and workable mixture, and mix approved before any concrete is placed.
D. Cement stabilized backfill shall contain a minimum two sacks of cement per cubic yard. No more water than 10 gallons per sack of cement shall be used.

2.7 EXPANSION JOINTS

A. Where pre-molded expansion joint material is shown on Plans, such material shall be 1/2- or 3/4–inch bituminous type preformed joint filler, AASHTO M-33 as shown on Drawings. Contractor shall submit on proposed expansion joint material and submit documentation that certifies it meets AASHTO M-33 requirements.

PART 3 - EXECUTION

3.1 MIXING

A. All aggregates shall be accurately weighed or measured by volume. Concrete shall be mixed in an approved batch mixer equipped with accurate water measuring tank, and mixed for one-and-one-half minutes after all materials are in mixer. "Ready Mixed" or "Transit Mix" concrete may be used. If used, it shall conform to specifications and "Standard Specifications for Ready Mixed Concrete," ASTM C94.
B. Each mixer and agitator shall attach in a prominent place, a metal plate(s), plainly marked, for various uses for which equipment is designed, capacity of drum or container in terms of volume of mixed concrete and speed of rotation of mixing drum, blades or paddles. Stationary mixers shall be equipped with an acceptable timing device that will not permit batch to be dispatched until specified mixing time is elapsed. Truck mixers shall be equipped with means so number of revolutions of drum blades or paddles are readily verified.
C. When loaded to capacity, mixer shall be capable of combining concrete ingredients within specified time into a thoroughly-mixed and uniform mass and of discharging concrete with

a satisfactorily degree of uniformity. No mixer or agitator shall be used if slump test results of individual samples taken at approximately one- and three-quarter points of placement differ by more than 2 inches. Mixers and agitators shall be inspected frequently for changes in condition due to accumulations of hardened concrete or mortar or wear of blades.

D. Truck mixers shall have adequate water supply and metering devices. No water can be added to the concrete after the initial mixing without the permission of Engineer.

E. After mixing, concrete shall be transported to forms to prevent separation or segregation of aggregates and placed without undue delay. It shall be deposited as nearly as practicable in final position to avoid re-handling or flowing of concrete. As concrete is placed, it shall be vibrated with a submerged vibrator.

F. Mixing at mixing speed shall begin immediately after all ingredients are in mixer. For complete mixing in truck, each batch shall be mixed not less than 70 or more revolutions of drum. For partial mixing in truck, each batch shall be mixed not less than 50 nor more than 100 revolutions of drum. Mixing speed shall be as designated by manufacturer. All revolutions after prescribed mixing time shall be at agitating speed. Agitating speed shall be not less than one nor more than four revolutions per minute. Drum shall be kept in continuous motion from the time mixing is started until the discharge is completed.

G. Maximum time interval between introduction of mixing water to cement and aggregates and placing of concrete in forms shall not exceed:

AIR OR CONCRETE TEMPERATURE	MAXIMUM TIME
(Whichever is higher)	
90°F or above (air only)	45 minutes
75°F to 89°F	60 minutes
35°F to 74°F	90 minutes

H. Concrete shall not be placed when ambient temperature is less than 40 degrees F and falling but may be placed if temperature is 40 degrees F and rising. Concrete shall not be placed when temperature will drop below 35 degrees F within 24 hours after placement as projected by National Weather Service unless properly protected. Concrete temperature at time of placement in forms shall not be less than 50 degrees F nor more than 90 degrees F. When placing concrete in freezing weather, means shall be provided for keeping concrete at a temperature of at least 50 degrees F for not less than 72 hours after placing or until concrete has thoroughly hardened. Concrete shall not be placed when weather conditions are unsuitable for such work.

3.2 TRANSPORTING

A. Concrete shall be handled from mixer to place of final deposit to prevent segregation and when practicable, deposited in final position without re-handling or flowing. All equipment used in transporting concrete shall be maintained in a clean condition. Concrete shall not be delivered from hoists, by spout, by trough, or dumped into carts with a free fall of more than 4 feet. Every precaution shall be taken to prevent separation or loss of ingredients while transporting concrete. Runways for carts/buggies shall not bear upon reinforcing or fresh concrete. Concrete pumping and conveying shall be done only after Engineer approval and with equipment that will insure continuous flow without segregation.

3.3 PLACING

A. Do not place concrete until all reinforcement is securely and properly fastened in correct position. Form ties shall be checked and retightened where necessary. Forms and reinforcement shall be inspected and approved by Engineer before beginning placement of concrete. All embedded items shall be in place and cleanout openings closed before inspection. A procedure for inspection of forms reinforcing, inserts, etc., prior to all concrete placement will be instituted and coordinated by Engineer. At least 24 hours prior to concrete placement, Contractor shall submit an inspection sheet to Engineer. Inspection sheet, to be developed, shall show location and quantity of concrete to be placed, time and date schedule for placement, and be signed by Contractor representative. Signing of this sheet will certify all items necessary have been inspected and area is ready for final review by Engineer. If Engineer determines corrections are excessive, placement should be rescheduled and Engineer notified 12 hours before scheduled placement after corrections are made. Engineer representative will be on the job during concrete placement and concrete shall not be placed unless Engineer or representative is present.

B. Concrete shall be placed to prevent segregation, thoroughly embed all reinforcement and fixtures, fill all angles in forms, and prevent formation of aggregate pockets or honeycomb. Placement in walls columns or other deep forms shall be done through form openings, spaced at frequent intervals, or through tremies so free fall shall not exceed 4 feet. Points of depositing concrete shall be spaced so surfaces can be kept level without using vibrators or other equipment to cause it to flow into place.

C. Concrete shall be placed with aid of approved mechanical vibrating equipment. Vibration shall be applied to concrete and be of sufficient intensity and duration to cause flow or settlement of concrete, thoroughly compacting, and complete embedment of reinforcement and fixtures. Supplemental forking and spading by hand may be required to secure dense uniform surfaces and complete filling of corners and angles.

D. Excessive spading or vibrating causing undue water gain or segregation not permitted. If moderate working causes excessive water gain, mix shall be adjusted. Excess water shall be removed when it appears. When concrete in floors or slabs are deposited on the ground, subgrade shall be thoroughly compacted and moistened before placement. A grill tamp shall be used on floor slabs. Completed sections shall conform to details on contract drawings and concrete shall be dense, uniform, and free of aggregate pockets or honeycomb.

E. Concrete in vertical walls shall be placed in continuous horizontal layers approximately 18 inches deep. Not more than one hour shall elapse between the placing of successive layers of concrete in any portion of a structure included in a continuous placement.

F. Contractor shall adhere to ACI 306 and ACI 605 requirements for cold and hot weather concreting respectively.

G. Concrete shall generally not be placed during high winds with blowing dust that will contaminate surface and cause entrapment of sand and dust particles in finished surfaces.

3.4 SLUMP

A. Slump of all concrete shall be 3 to 6 inches with condition of placement governing slump to use. In all cases, Engineer shall specify slump to be used prior to placement. When a 3-inch slump is specified, allowable tolerance shall be .5-inch. When specified tolerance is greater than 3 inches, tolerance shall be 1 inch. In general, flat work will require a slump of approximately 3 inches and concrete for vertical members, (i.e. walls columns, etc.), shall be 5 inches. Slump for concrete to be added to CMU units shall be 6 inches.

3.5 WEATHER

A. Mixed concrete from plant shall be transported in truck mixers. Elapsed time from addition of cementitious material to mix until concrete is deposited in place at worksite shall not exceed 90 minutes when concrete is hauled in truck mixers. Re-tempering concrete by adding water or by other means not permitted. With transit mixers, additional water may be added to batch materials and additional mixing performed to increase slump to meet specified requirements provided addition of water is performed within 45 minutes after initial mixing operations and water/cementitious ratio specified in approved mix design is not exceeded and approved by Engineer

B. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

C. Cold Weather

1. Unless authorized in writing by Engineer, mixing and concreting operations shall be discontinued when descending air temperature in shade and away from artificial heat reaches 40 degrees F and not resumed until an ascending air temperature in shade and away from artificial heat reaches 35 degrees F.
2. Aggregate shall be free of ice, snow, and frozen lumps before entering mixer. Temperature of mixed concrete shall not be less than 50 degrees F at time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in concrete.
3. When concreting is authorized during cold weather, water and/or aggregates may be heated to not more than 150 degrees F. Apparatus used shall heat mass uniformly and be arranged to preclude possible occurrence of overheated areas which might be detrimental to the materials.

D. Hot Weather

1. During periods when maximum daily air temperature exceeds 90 degrees F, Contractor shall perform all concrete placement during nighttime hours unless temperature controls are implemented and approved by Engineer. During periods of hot weather when maximum daily air temperature exceeds 85 degrees F, the following precautions shall be taken:
    a. Forms and/or underlying surface shall be sprinkled with water immediately before placing concrete. Concrete shall be placed at coolest temperature practicable and in no case shall concrete temperature when placed exceed 90 degrees F. Aggregates and/or mixing water shall be cooled as necessary to maintain concrete temperature at or not more than specified maximum. If concrete temperature exceeds 95 degrees F as measured in accordance with ASTM C1064, it shall be rejected.
    b. Finished surfaces of newly-laid concrete surface shall be kept damp by applying water-fog or mist with approved spraying equipment until concrete surface is covered by curing medium. If necessary, wind screens shall be provided to protect concrete from an evaporation rate in excess of 0.2 pounds per square feet per hour as determined in accordance with Figure 2.1.5 in ACI 305R - Hot Weather Concreting, which takes into consideration relative humidity, wind velocity, and air temperature. When conditions cause problems with plastic cracking, particularly if any plastic cracking begins to occur, Contractor shall immediately take additional measures as necessary to protect concrete surface. Such measures shall consist of wind screens, more effective fog sprays, and similar measures commencing immediately behind

concrete placement. If these measures are not effective in preventing plastic cracking concreting, operations shall be immediately stopped.

c. Contractor shall submit a Hot Weather Concrete Construction Plan and have it reviewed by the Engineer 30 calendar days prior to concrete placements when the ambient temperature exceeds 85 degrees F. This plan shall conform to ACI 305R and other requirements specified herein and include, but not be limited to, demonstration of how concrete temperature during batching and mixing will be kept below 90 degrees F, how concrete will be protected from rapid evaporation of surface moisture, proper use of water reducers with re-dosing charts and procedures, and curing procedures.

d. Concrete placement shall be limited to nighttime hours when average daily air temperature is or is forecasted to exceed 90 degrees F.

e. Prior to start of concreting operation for each day of placement, Contractor shall provide Engineer with a Temperature Management Program for concrete to be placed to assure uncontrolled cracking is avoided. As a minimum, program shall address:

1) Anticipated tensile strains in fresh concrete as related to heating and cooling of concrete material.

2) Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity.

3) Anticipated timing of initial sawing of joints, when specified.

E. Documentation of Weather Data

1. Contractor shall provide continuous and accurate record of air temperature, relative humidity, concrete temperature, and wind velocity at project site with portable weather station, adjacent to the concrete work area(s). Data shall be collected and documented by Contractor continuously for full duration of project. Contractor quality control staff shall document weather data in daily Quality Control Reports, use, and implement data to eliminate potential for plastic cracking of concrete by estimating evaporation rate from Figure 305R.

2. Protection of Concrete from Plastic Cracking

a. Finished surfaces of newly-laid concrete shall be kept damp by applying water-fog or mist with approved spraying equipment until concrete is finished and covered by curing medium. When evaporation rate is less than 0.2 pounds per square foot per hour, one coat of liquid concrete curing compound shall be applied at a minimum rate of 150 square feet per gallon. When evaporation rate is 0.2 to 0.4 pounds per square foot per hour, one coat of liquid concrete curing compound shall be applied, at a minimum rate of 100 pounds per square feet per gallon. When evaporation rate is greater than 0.4 but less than 0.6 pounds per square foot per hour, two coats of liquid concrete curing compound shall be applied, each coat at 100 square feet per gallon. When evaporation rate is 0.6 pounds per square foot per hour, concreting operations shall be terminated or not initiated. Evaporation rates shall be determined in accordance with Figure 305R which takes into consideration relative humidity, wind velocity and air temperature.

b. Forms and/or underlying surface shall be sprinkled with water immediately before placing concrete. Concrete shall be placed at coolest temperature practicable and in no case shall temperature of concrete, when placed, exceed 90 degrees F. Aggregates and/or mixing water shall be cooled as necessary to maintain concrete temperature at or not more than specified maximum.

Chilled water shall be used to ensure concrete temperature is below 90 degrees F.

c. When conditions are such that problems with plastic cracking can be expected, particularly if any plastic cracking begins to occur, Contractor shall immediately take additional measures as necessary to protect concrete surface. Such measures shall consist of requirements as shown in Table 3. If these measures are not effective in preventing plastic cracking, concreting operations shall be immediately stopped, and all cracked Portland cement concrete shall be removed and replaced by Contractor at no additional cost to the City of Denton.

d. Based on results of Contractor's Quality control data as collected and documented from portable weather station, the following criteria shall apply:

Table 3 – CURING COMPOUND REQUIREMENTS FOR CONCRETE

Evaporation Rate (pounds per square foot per hour)	Minimum Curing Requirements
Less than 0.20	One coat membrane, each at 150 square feet per gallon.
0.20 to 0.40	One coat membrane, each at 100 square feet per gallon.
0.40 to 0.60	Two coats membrane, each at 100 square feet per gallon.
Greater than 0.60	Paving operations shall be terminated or not initiated if conditions are anticipated or measured.

3.6 FINISHING

A. Exposed Vertical Surfaces: Such surfaces shall have all tie rod holes filled, fins and rough edges removed, and all defects removed or patched. Following this, surfaces shall be rubbed with carborundum stones and clean, clear water until a smooth surface, uniform in color and texture is obtained. This finishing shall be done as soon as is practical after removal of forms.

B. Unexposed Vertical Surfaces: Such surfaces shall be finished as specified for exposed vertical surfaces except that no rubbing will be required.

C. Access Ramps: Access ramps and drivable surface on spillways shall be troweled, after floating, then lightly brushed to provide a "non-skid" surface.

3.7 EMBEDDED ITEMS

A. All bolts, pipe, pipe sleeves, inserts, or other fixtures required by Plans or Specifications to be embedded in concrete, shall be set accurately in place and maintained in such positions during concreting operations.

3.8 TESTS

A. Test certificates for cement shall be furnished as specified. Contractor shall furnish results of tests made by a competent commercial laboratory on each material source proposed to be used before start of construction, and material shall not be shipped until Engineer examines such results and source of material approved. Laboratory mix designs and conformation cylinders not required for this Project. However, proposed mix for each class of concrete shall be submitted to Engineer for approval prior to placing any concrete. Cost of all preconstruction tests shall be borne by Contractor. Additional test certificates shall be furnished on aggregate if material source is changed.

B. Seven- and 28-day compressive tests shall be conducted on all cylinders. Set of four cylinders shall be taken for each placement of 50 cubic yards, or portion thereof.

3.9 REINFORCING

A. Bar Reinforcing: Except where plain bars are specifically shown on Plans, all bar reinforcing shall be deformed bars. Deformed bar reinforcing shall conform to ASTM A615 Grade 60 requirements. Plain steel bars including 1/4-inch diameter bars shall conform to requirements of ASTM A307, grade 60. Weldable reinforcing bars shall conform to ASTM A706.

B. Welded Wire Fabric: As designated on Drawings and shall conform to requirements of the Texas State Department of Transportation - Standard Specifications for Construction of Highways, Streets and Bridges, Item 440.2 - Materials.

C. Storing Reinforcing: Reinforcing stored at site shall be protected from accumulation of grease, mud, or other foreign matter and from rust-producing conditions. Bars shall be free from loose flaky rust, scale, oil, mud, or structural defects when incorporated in structures.

D. Fabrication and Placing: Reinforcement shall be accurately fabricated to dimensions and shapes shown on Plans in accordance with ACI Manual of Standard Practice unless variations are specifically shown on Plans.

E. Reinforcement shall be accurately placed and adequately supported by concrete, metal, or other approved chairs, spacers, or ties and secured against displacement. Reinforcement shall be placed in specified positions within the following tolerances:
   1. Depth in structural slabs, flexural members, walls and columns: $\pm$1/4 inch.
   2. Longitudinal location of bends and ends of bars: $\pm$2 inches except required concrete cover at ends of members shall not be reduced.

F. Unless noted otherwise on Contract Drawings, concrete cover for reinforcing shall be in accordance with requirements of ACI Building Code Requirements for Reinforced Concrete (ACI 318).

G. Splices shall be made as shown on Contract Drawings by lapping bars the required amount and securely wiring together. Where details of splices are not shown or where unanticipated splices required, they shall be made in a location approved by Engineer and length of lap as required by the ACI Building Code Requirements for Reinforced Concrete (ACI 318).

H. Reinforcing bars partially embedded in concrete shall not be field bent, except as indicated on Contract Documents or permitted by Engineer.

I. Torch cutting of reinforcing bars not allowed.

J. Mats of wire fabric shall overlap each other sufficiently to maintain a uniform strength and fastened securely at ends and edges.

3.10 JOINTS

A. Construction and expansion joints shall be constructed at locations and in accordance with details shown on Drawings. If necessary to stop placement of concrete between joints or if Contractor desires for convenience to construct joints other than those shown, such joints shall be made only at locations approved by Engineer and all such joints constructed in accordance with Plans and Specifications.

B. All horizontal joints shown on Plans shall be made truly horizontal and chamfered. Vertical joints shall be truly vertical.

C. Before concreting operations are resumed at any construction joint or wherever fresh concrete is to be bonded to hardened concrete, hardened concrete surface shall be cut or

chipped to remove laitance and expose aggregate. Surface of concrete shall be thoroughly cleaned, saturated, then sloshed with a coating of neat cement grout against which fresh concrete shall be placed before grout has attained initial set. Care shall be taken to insure first layer of new concrete contains sufficient mortar for adequate bond.

D. All joints shall be constructed in workman-like manner with joints truly vertical or horizontal, as required, and at right angles to axis of member where joint occurs. Expansion joint material shall be accurately positioned and nailed onto existing concrete to lines and dimensions shown on Drawings so expansion joint material is accurately held in place during placement of new concrete.

3.11 CURING AND PROTECTING

A. All concrete shall be cured by applying a liquid membrane coating to all exposed surfaces, provided materials and method of application are first approved by Engineer. Coating shall conform to ASTM C309 and care taken to prevent mechanical injury to concrete work during curing period and until the work is accepted. Any work damaged prior to acceptance shall be repaired to the satisfaction of Engineer.

B. All concrete work shall be protected until it has set up sufficiently to prevent damage by vandals.

C. Suitable means shall be provided to prevent concrete from freezing for not less than 72 hours after placing. Any concrete damaged by freezing shall be removed and replaced by Contractor at his expense. Addition of any admixture of chemicals to concrete to prevent freezing not allowed, unless specifically approved by Engineer.

3.12 DEFECTIVE WORK

A. Any defective work disclosed after forms are removed shall be immediately removed and replaced. If any dimensions are deficient, any section is not constructed to proper grade, or surface of concrete is bulged, uneven, or shows honeycomb, which in Engineer opinion cannot be repaired satisfactorily, entire section shall be removed and replaced at Contractor expense.

3.13 FORMWORK REMOVAL

A. Forms may be removed within 24 hours only upon Engineer approval. Adequate reshoring shall be placed when forms are removed and backfilling begun, and remain in place until designated 28-day compressive strength attained. Attained strength shall be determined from standard test cylinders molded, cured, and broken in accordance with ASTM C31. Concrete strength shall be assumed to be average strength of two cylinders tested. If Contractor wishes to determine concrete strength prior to 28-day tests, Contractor shall bear cost as well as responsibility of obtaining additional cylinders as well as tests.

B. Contractor holds responsibility in all forms of removal to prevent damage or marring of concrete surfaces.

3.14 BACKFILLING

A. Backfill behind and adjacent to all concrete work shall be made from good quality topsoil. This material shall be free from organic material such as leaves, grass, roots, and other unsuitable materials and free of rocks or stones. Contractor shall provide a smooth, even slope between existing ground and top of curb or other concrete structure.

B. Care shall be taken during backfill and cleanup process not to scrape, chip, crack, or otherwise damage concrete including tire marks from equipment or trucks. Any damaged concrete will be removed and replaced at Contractor expense.

END OF SECTION

SECTION 11300 – BOOSTER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Variable Speed Packaged Pumping System.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCE STANDARDS

A. The work in this section is subject to the requirements of applicable portions of the following standards:
   1. Hydraulic Institute.
   2. ANSI – American National Standards Institute.
   3. ASTM – American Society for Testing and Materials.
   4. IEEE – Institute of Electrical and Electronics Engineers.
   5. NEMA – National Electrical Manufacturers Association.
   6. NEC – National Electrical Code.
   7. ISO – International Standards Organization.
   8. UL – Underwriters Laboratories, Inc.

PART 2 - PRODUCTS

2.1 VARIABLE SPEED PACKAGED PUMPING SYSTEM

A. Furnish and install a prefabricated and tested variable speed packaged pumping system to maintain constant water delivery pressure.
B. Packaged pump system shall be a standard product of a single pump manufacturer. Entire pump system including pumps and pump logic controller, shall be designed, built, and tested by the same manufacturer.
C. Complete packaged water booster pump system shall be certified and listed by UL (Category QCZJ – Packaged Pumping Systems) for conformance to U.S. and Canadian Standards.
D. Complete packaged pumping system shall be NSF61 / NSF372 Listed for drinking water and low lead requirements.
E. Packaged pump system shall be ASHRAE 90.1 – 2010 compliant without the need of a remote mounted sensor. Control logic used to simulate a remote mounted sensor shall be proportional pressure control with squared or linear adaptation. An actual flow rate or calculated flow rate based on performance curves (5^{th} order polynomial) loaded into the controller; shall be used to adjust setpoint pressure in proportional pressure control.

2.2 PUMPS

A. Pumps shall be of the in-line vertical multi-stage design.
B. Head-capacity curve shall have a steady rise in head from maximum to minimum flow within the preferred operating region. Shut-off head shall be a minimum of 20 percent higher than the head at the best efficiency point.

C. Large In-line Vertical Multi-Stage Pumps (Nominal flows 130 to 500 gallons per minute) shall have the following features:
   1. Pump impellers shall be secured directly to the smooth pump shaft by means of a split cone and nut design.
   2. Suction/discharge base shall have ANSI Class 125 or Class 250 flange connections in a slip ring (rotating flange) design as indicated in the drawings or pump schedule.
   3. Pump Construction.
      a. Suction/discharge base, pump head: Ductile Iron (ASTM 65-45-12).
      b. Shaft couplings, flange rings: Ductile Iron (ASTM 65-45-12).
      c. Shaft: 431 Stainless Steel.
      d. Motor Stool: Cast Iron (ASTM Class 30).
      e. Impellers, diffuser chambers, outer sleeve: 304 Stainless Steel.
      f. Impeller wear rings: 304 Stainless Steel.
      g. Intermediate Bearing Journals: Silicon Carbide.
      h. Intermediate Chamber Bearings: Leadless Tin Bronze.
      i. Chamber Bushings: Graphite Filled PTFE.
      j. O-rings: EPDM.
   4. Shaft seal shall be a balanced O-ring cartridge type with the following features:
      a. a. Collar, Drivers, Spring: 316 Stainless Steel
      b. b. Shaft Sleeve, Gland Plate: 316 Stainless Steel
      c. c. Stationary Ring: Silicon Carbide
      d. d. Rotating Ring: Silicon Carbide
      e. e. O-rings: EPDM
   5. Silicon Carbide shall be imbedded with graphite.
   6. Shaft seal replacement shall be possible without removal of any pump components other than the coupling guard, motor couplings, motor and seal cover. Entire cartridge shaft seal shall be removable as a one-piece component. Pumps with motors equal to or larger than 15 HP shall have adequate space within motor stool so that shaft seal replacement is possible without motor removal.

2.3 INTEGRATED VARIABLE FREQUENCY DRIVE MOTORS

A. Each motor shall be Integrated Variable Frequency Drive design consisting of a motor and a Variable Frequency Drive (VFD) built and tested as one unit by the same manufacturer.
B. VFD shall be PWM (Pulse Width Modulation) design using current IGBT (Insulated Gate Bipolar Transistor) technology.
C. VFD shall convert incoming fixed frequency three-phase AC power into a variable frequency and voltage for controlling the speed of motor. Motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for centrifugal pump control and to eliminate need for motor derating.
D. VFD shall utilize an energy optimization algorithm to minimize energy consumption. Output voltage shall be adjusted in response to the load, independent of speed.
E. VFD shall automatically reduce switching frequency and/or output voltage and frequency to motor during periods of sustained ambient temperatures higher than normal operating range. Switching frequency shall be reduced before motor speed is reduced.
F. Integral RFI filter shall be standard in the VFD.
G. VFD shall have a minimum two skip frequency bands, field adjustable.
H. VFD shall have internal solid-state overload protection designed to trip within range of 125 – 150 percent of rated current.
I. Integrated VFD motor shall include protection against input transients, phase imbalance, loss of AC line phase, over-voltage, under-voltage, VFD over-temperature, and motor over-temperature. Three-phase integrated VFD motors shall be capable of providing full output voltage and frequency with a voltage imbalance of up to 10 percent.

J. Integrated VFD motor shall have, as a minimum, these input/output capabilities:
   1. Speed Reference Signal: 0-10 VDC, 4-20mA.
   2. Digital remote on/off.
   3. Fault Signal Relay (NC or NO).
   4. Fieldbus communication port (RS485).

K. Motor shall be Totally Enclosed Fan Cooled (TEFC) with a standard NEMA C-Face, Class F insulation with a temperature rise no higher than Class B.

L. Cooling design of motor and VFD shall be so a Class B motor temperature rise is not exceeded at full rated load and speed at a minimum switching frequency of 9.0 kHz.

M. Motor drive end bearings shall be adequately sized so minimum L10 bearing life is 17,500 hours at minimum allowable continuous flow rate for the pump at full rated speed.

2.4 PUMP SYSTEM CONTROLLER

A. Pump system controller shall be a standard product developed and supported by the pump manufacturer.

B. Controller shall be microprocessor based capable of having software changes and updates via personal computer (notebook). The controller user interface shall have a color display with a minimum screen size of 3-1/2 x 4-5/8 inches for easy viewing of system status parameters and for field programming. The display shall have a back light with contrast adjustment. Password protection of system settings shall be standard.

C. Controller shall provide internal galvanic isolation to all digital and analog inputs as well as all fieldbus connections.

D. Controller shall have the ability to be connected to a battery to maintain power on controller during periods of loss of supply power.

E. Controller shall have built in data logging capability. Logged vales shall be graphically displayed on the controller and able to be exported. A minimum 3,600 samples per logged value with the following parameters available for logging:
   1. Estimated flow-rate.
   2. Speed of pumps.
   3. Inlet pressure.
   4. Process Value (usually discharge pressure of differential pressure depending on application).
   5. Power consumption.
   6. Controlling parameter (process value).

F. Controller shall display the following as status readings from a single display on the controller (this display shall be the default):
   1. Current value of the control parameter, (typically discharge pressure).
   2. Most recent existing alarm (if any).
   3. System status with current operating mode.
   4. Status of each pump with current operating mode and rotational speed as a percentage.
   5. Estimated flow-rate, (not requiring flow meter connection).

G. Controller shall have as a minimum the following hardware inputs and outputs:
   1. Three analog inputs (4-20mA or 0-10VDC).
   2. Three digital inputs.
   3. Two digital outputs.
   4. Ethernet connection.
   5. Field Service connection to PC for advanced programming and data logging.

H. Pump system programming (field adjustable) shall include these as a minimum:
   1. Water shortage protection (analog or digital).
   2. Sensor Settings (suction, discharge, differential pressure analog supply/range).
   3. PI Controller (proportional gain and integral time) settings.
   4. High system pressure indication and shut-down.

5. Low system pressure indication and shut-down.
6. Low suction pressure/level shutdown (via digital contact).
7. Low suction pressure/level warning (via analog signal).
8. Low suction pressure/level shutdown (via analog signal).
9. Flow meter settings (if used, analog signal).

I. System controller shall be able to accept up to seven programmable set-points via a digital input, (additional input/output module may be required).

J. Controller shall have advanced water shortage protection. When analog sensors (level or pressure) are used for water shortage protection, there shall be two indication levels. One level is for warning indication only (indication that the water level/pressure is getting lower than expected levels) and the other level is for complete system shut-down (water or level is so low that pump damage can occur). System restart after shut-down shall be manual or automatic (user selectable).

K. System pressure set-point shall be capable of being automatically adjusted by using an external set-point influence. Set-point influence function enables the user to adjust the control parameter (typically pressure) by measuring an additional parameter.
1. Example: Lower the system pressure set-point based on a flow measurement to compensate for lower friction losses at lower flow rates.

L. Controller shall be capable of receiving a remote analog set-point (4-20mA or 0-10 VDC) as well as a remote system on/off (digital) signal.

M. Controller shall adjust ramp time of a change in set point on both an increase or decrease change in set point.

N. Pump system controller shall store up to 24 warning and alarms in memory. Time, date, and duration of each alarm shall be recorded. A potential-free relay shall be provided for alarm notification to the building management system. Controller shall display these alarm conditions:
1. High System Pressure: Low system pressure.
2. Low suction pressure (warning and alarm): Individual pump failure.
3. VFD trip/failure: Loss of sensor signal (4-20 mA).
4. Loss of remote set-point signal (4-20mA): System power loss.

O. Pump system controller shall be mounted in a UL Type 3R rated enclosure. A self-certified NEMA enclosure rating not considered equal. Entire control panel shall be UL 508 listed as an assembly. Control panel shall include a main disconnect, circuit breakers for each pump, and control circuit and control relays for alarm functions. Control panel options shall include, but not be limited to:
1. Pump Run Lights: System Fault Light.
2. Audible Alarm (80 db[A]): Surge Arrestor.
3. Emergency/Normal Operation Switches: Service Disconnect Switches.
4. Nine Configurable Digital Outputs available for monitoring.

P. Controller shall be capable of receiving a redundant sensor input to function as a backup to the primary sensor (typically discharge pressure).

Q. Controller shall have a pump “Test Run” feature such that pumps are switched on during periods of inactivity (system is switched to the “off” position but with electricity supply still connected). Inoperative pumps shall be switched on for two to three seconds every 24 hours, 48 hours, or once per week and at specific time of day (user selectable).

R. Controller shall be capable of changing the number of pumps available to operate or have the ability limit the maximum power consumption by activation of a digital input for purposes of limited generator supplied power.

S. Controller shall be capable of displaying instantaneous power consumption (watts or kilowatts) and cumulative energy consumption (kilowatt-hours).

T. Controller shall be capable of displaying instantaneous specific energy use (kW/gpm), (optional flow meter must be connected).

U. Actual pump performance curves (5th order polynomial) shall be loaded (software) into pump system controller. Pump curve data shall be used for:
   1. Display and data logging of calculated flow rate (not requiring flow measurement).
   2. Proportional pressure control.
   3. Pump outside of duty range protection.
   4. Pump cascade control based on pump efficiency.

V. Controller is capable of displaying an estimated flow-rate on the default status screen.

W. Controller shall have proportional pressure control to compensate for pipe friction loss by decreasing pressure set-point at lower flow-rates and increasing pressure set-point at higher flow-rates by using actual flow rate or calculated flow rate. Proportional pressure control that uses pump speed or power consumption only shall not be considered equal to proportional pressure control that uses actual or calculated flow rate.

X. Controller shall communicate common field-bus protocols, (BACnet, Modbus, Profibus, and LON), via optional communication expansion card installed inside controller.

Y. Controller shall have Ethernet connection with built-in server allowing for connection to a network with read/write access to controller via web browser and internet.

Z. Controller shall have a programmable Service Contact Field to populate with service contact information including contact name, address, phone number(s), and website.

2.5 SEQUENCE OF OPERATION

A. System controller shall operate equal capacity variable speed pumps to maintain a constant discharge pressure or differential pressure (system set-point), depending on application. System controller shall receive an analog signal [4-20mA] from factory installed pressure transducer on discharge manifold, indicating actual system pressure.
   1. Standard Cascade Control (Pumping Efficiency Based): Pump system controller shall adjust pump speed as necessary to maintain system set-point pressure as flow demand increases. Utilizing the pump curve information (5th order polynomial), pump system controller shall stage on additional pumps when pump hydraulic efficiency will be higher with additional pumps in operation. Exception: When flow and head are outside the operating pump(s) allowable operating range, controller shall switch on an additional pump thus distributing flow and allowing all pump(s) to operate in allowable operating range. When system pressure is equal to system set-point, all pumps in operation shall reach equal operating speeds. Pump system controller shall have field adjustable Proportional Gain and Integral time (PI) settings for system optimization.
   2. Optional Cascade Control (Pump Start Speed Based): As flow demand increases, pump speed shall be increased to maintain system set-point pressure. When operating pump(s) reaches 96 percent of full speed (adjustable), an additional pump will be started and will increase speed until system set-point is achieved. When system pressure is equal to system set-point all pumps in operation shall reach equal operating speeds. Pump system controller shall have field adjustable Proportional Gain and Integral time (PI) settings for system optimization.

B. System controller shall switch pumps on and off to satisfy system demand without the use of flow switches, motor current monitors or temperature measuring devices.

C. All system pumps can alternate automatically based on demand, time and fault. If flow demand is continuous (no flow shut-down does not occur), system controller can alternate the pumps every 24 hours, 48 hours, or once per week. Interval and actual time of pump changeover shall be field adjustable.

D. System controller can control a pressure maintenance pump, (jockey pump), in system in pressure boosting applications. Pressure maintenance pump set point can be any value above or below pump system's set point. Pressure maintenance pump cano be staged on as back-up pump when capacity of pump system is exceeded.

2.6 LOW FLOW STOP FUNCTION (CONSTANT PRESSURE APPLICATIONS)

A. System controller can stop pumps during periods of low- or zero-flow without wasting water or adding unwanted heat to liquid. Temperature-based, no-flow shut-down methods with potential to waste water and add unwanted temperature rise to pumping fluid are not acceptable and shall not be used.
   1. Standard Low-Flow Stop and Energy Saving Mode: If a low- or no-flow shutdown is required (periods of low or zero demand), install a bladder-type diaphragm tank with precharge pressure of 70 percent of system setpoint. Tank shall be piped to discharge manifold or system piping downstream of pump system. When only one pump is in operation, system controller can detect low flow (less than 10 percent of pump nominal flow) without additional flow-sensing devices. When low flow is detected, system controller shall increase pump speed until discharge pressure reaches stop pressure (system setpoint +50 percent of programmed on/off band, adjustable). Pump shall remain off until discharge pressure reaches start pressure (system set-point -50 percent of programmed on/off band, adjustable). Upon low-flow shut-down, restart pump in one of two ways:
      a. Low-Flow Restart: If low flow condition still exists, pump shall start and speed again be increased until stop pressure is reached and pump again is switched off.
      b. Normal-Flow Restart: If pump system controller determines low-flow condition no longer exists, start pump and increase speed until system pressure reaches system set-point.
   2. [OPTIONAL] Low-Flow Stop and Energy Saving Mode: Pump system controller can receive a digital signal from a flow switch or analog signal from a flow meter to indicate low-flow condition. Install bladder-type diaphragm tank with precharge pressure of 70 percent of system setpoint. Pipe tank to discharge manifold or system piping downstream of pump system. When low-flow is detected (signal from flow switch or meter), system controller shall increase pump speed until discharge pressure reaches stop pressure (system setpoint +50 percent of programmed on/off band). Pump shall remain off until discharge pressure reaches start pressure (system setpoint -50 percent of programmed on/off band). Pump shall remain in energy-saving on/off mode during low- flow indication. When low flow is no longer present (low flow indication ceases), pump(s) shall resume constant pressure operation.
   3. Changing from standard low-flow stop to optional low-flow stop (and vice-versa) via user interface is possible.

2.7 SYSTEM CONSTRUCTION

A. Suction and discharge manifold construction shall be in a way to ensure minimal pressure drops, minimize corrosion potential, and prevent bacteria growth at intersection of piping into manifold. Manifold construction including sharp-edge transitions or interconnecting piping protruding into manifold, is not acceptable. Manifold construction shall be so water stagnation cannot exist in manifold during operation to prevent bacteria growth inside manifold.
B. Suction and discharge manifolds material shall be 316 stainless steel. Manifold connection sizes shall be:
   1. 3-inch and smaller: Male NPT threaded.
   2. 4- to 8-inch: ANSI Class 150 rotating flanges.
   3. 10-inch and larger: ANSI Class 150 flanges.
C. Pump Isolation valves shall be provided on suction and discharge of each pump. Isolation valve sizes 2 inches and smaller shall be nickel-plated brass, full-port ball valves. Isolation valve sizes 3 inches and larger shall be full-lug-style butterfly valve. Valve disk shall be

stainless steel. Valve seat material shall be EPDM and body cast iron, coated internally and externally with fusion-bonded epoxy.

D. Spring-loaded, non-slam-type check valve shall be installed on discharge of each pump. Valve shall be wafer-style-type fitted between two flanges. Head loss through check valve shall not exceed 5 psi at pump design capacity. Check valves 1-1/2 inches and smaller shall have a POM composite body and poppet, stainless steel spring with EPDM, or NBR seats. Check valves 2 inches and larger shall have body material of stainless steel or epoxy-coated iron (fusion-bonded) with EPDM- or NBR-resilient seat. Spring material shall be stainless steel. Disk shall be stainless steel or leadless bronze.

E. For systems requiring diaphragm tank, connection of no smaller than 3/4-inch shall be provided on discharge manifold.

F. Pressure transducer shall be factory-installed on discharge manifold (or field-installed as specified on plans). Systems with positive inlet gauge pressure shall have factory-installed pressure transducer on suction manifold for water shortage protection. Pressure transducers shall be made of 316 stainless steel. Transducer accuracy shall be ±1.0 percent full scale with hysteresis and repeatability of no greater than 0.1 percent full scale. Output signal shall be 4-20 mA with a supply voltage range of 9-32 VDC.

G. Bourdon tube pressure gauge, 2.5 inches diameter, shall be placed on suction and discharge manifolds. Gauge shall be liquid filled with copper alloy internal parts in stainless steel case. Gauge accuracy shall be 2/1/2 percent. Gauge can withstand a pressure of 30 percent above maximum span without requiring recalibration.

H. Systems with flooded-suction inlet or suction-lift configuration shall have factory-installed water shortage protection device on suction manifold.

I. Base frame shall be constructed of corrosion-resistant, 304 stainless steel. Rubber vibration dampers shall be fitted between each pumps and baseframe to minimize vibration.

J. Depending on system size and configuration, control panel shall be mounted::
   1. On a 304 stainless steel fabricated control cabinet stand attached to the system skid;
   2. On a 304 stainless steel fabricated skid, separate from the main system skid; or
   3. On its own base (floor-mounted with plinth).

2.8 TESTING

A. Entire pump station shall be factory-tested for functionality. Functionality testing shall include:
   1. Dry run protection,
   2. Minimum pressure and maximum pressure alarms (where applicable),
   3. Setpoint operation, and
   4. Motor rotation.

B. System shall undergo factory hydrostatic test at end of production cycle. System shall be filled with water and pressurized 1.5 times nameplate maximum pressure. Systems with 150 lb. flange connections shall be tested at 350 psig and systems with 300 lb. flange connections shall be tested at 450 psig. Pressure shall be maintained a minimum of 15 minutes with no leakage (slight leakage around pump(s) mechanical seal is acceptable) prior to shipment.

2.9 WARRANTY

A. Warranty period shall be a non-prorated period of 24 months from date of installation,

PART 3 - EXECUTION (Not Used)

END OF SECTION

SECTION 13130 – PIT TYPE TRUCK SCALE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Load receiver, lever system, electronic instrumentation, and painting.
   2. All labor, materials, equipment, and incidentals required and install scales in locations as shown on Drawings.

B. Scope:
   1. Furnish and install one mechanical motor truck scales with dual tandem axle capacity of 80,000-pound dual tandem axle rating, 40 tons per section on 4-foot centers, a gross 60-ton capacity, and weighing platform of 70 x 12 feet wide. Platform shall be installed "at grade." Above-grade installation not acceptable.
   2. Scale platform assembly consists of reinforcing rods for concrete deck, weighbridge steel, and cast-iron lever system, delivering weight force to single tension load cell.
      a. Scale weighbridge, lever system, load cell, instrumentation, platform reinforcing rods and channels along with pit coping, foundation bolts, nuts and bumper plates should be furnished by manufacturer.

C. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 QUALIFICATIONS

A. All scale components shall be supplied by a single manufacturer, fully experienced, reputable, and qualified in manufacture of items to furnish. Design, construct, and install equipment in accordance with best practices and methods and comply with these Specifications and manufacturer instructions.

B. Equipment to consist of parts designed to act as a unit by a manufacturer experienced in design, construction, and operation of equipment for required purpose.

1.3 SUBMITTALS

A. Shop drawings shall be submitted to Engineer for approval in accordance with Division 01 and include dimensioning, methods, and locations of supports, and technical specifications for all equipment to be furnished.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Fairbanks Scales: Kansas City, Missouri.
   1. Local Representative:
      Nicol Scales, LP
      Ted Tobolka
      7239 Envoy Court.
      Dallas, Texas 75247
      214.428.8181

2.2 MATERIALS

A. Load Receiver

1. Scale is Fairbanks Type S Series truck scale with cast-iron levers. Truck scale shall have reinforced concrete deck. Concrete deck shall have a 60,000-pound dual tandem axle rating on 4-foot centers. Minimum 80,000 pound CLC ratings.
2. Scales shall each have three 24-inch manholes (one on each scale), provided by manufacturer.
3. Weighbridge shall be I-beam design and protected with one coat of epoxy ester primer, applied to a minimum 3 mil thickness.
4. All in-house welding on structure shall be gas-to-metal, submerged, or shielded arc. All welding procedures to be in compliance with the American Welding Society D1.1-88 Structural Welding Code.
5. Deck surface shall be a 6-inch-thick concrete poured on site, using 4,000-psi compressive strength concrete. Line deck along bottom with corrugated steel, reinforcing mat set into place the length and width of scale deck, and deck channel with studs welded to the steel to form a composite structure when concrete is added. Reinforcing mat and deck channel studs are to relieve surface tension in concrete caused by expansion and contraction. Approximately 13 cubic yards of concrete is required per scale deck.
6. Scale shall be completely self-checking. DO NOT use check rods. Scale deck and weighbridge shall be free-floating.

B. Lever System

1. Rust-resistant, cast-iron construction for long lever life and double-web design to allow load transmission on lever true centerline, reducing side-loading which can cause wear.
2. Parallel link suspension to transmit weight from weighbridge main girders to cast-iron levers, allowing platform to be free-floating and self-aligning, reducing effects of inertial shock caused by truck traffic, and absorbing effects of platform motion on pivots and bearings, reducing critical component wear and guaranteeing longer, more accurate scale life.
3. Adjustable vertical connections lie between all levers in system. In addition, elevation adjustment screws (two at each main lever) for vertical alignment of scale deck with concrete walls, preventing shock caused by trucks hitting a deck not properly aligned with approach walls. This vertical adjustment also insures proper distribution of load over each load point. Shimming to achieve this elevation alignment not deemed acceptable.
4. Removable bearing block on each lever stand to provide easy replacement without stand removal of load bearings.
5. Pivots and bearings directly supporting platform weight and load applied to platform shall be parallel with traffic direction, providing protection against damaging side-loading shocks.
6. Support pivots over entire length by self-aligning bearings, eliminating stress, while prolonging pivot and bearing life.
7. Pivots and bearings shall be high carbon steel and properly heat-treated to a minimum Rockwell hardness of 58-62 to reduce wear. All pivots and bearings will be machined for easy field replacement.
8. Lever system shall be protected with one coat of epoxy ester primer, applied to a minimum of 3 mil thickness.
9. Cast-iron lever system shall deliver reduced weight force to a single tension load cell, helping reduce damage caused by lightning/power surges and other environmental problems which can lead to load cell damage.

10. Load cell, junction boxes, and scale checking must be accessible and held in position by easily accessible hardware, meeting the following criteria:
    a. Load cell shall be Fairbanks Model 1111 S-type tension design with isolation modules and manufactured assemblies. (one load cell required per truck scale).
    b. No Junction Boxes utilized in operation or installation of scales.

C. Electronic Instrumentation, Weight Displays:
1. FB460 Digital Indicator or equal (Standard) one unit per scale system.
2. Indicator designed to operate in a single load cell environment.
3. Simple five-button controls.
4. Front panel calibration.
5. Programmable output functions to allow interface to Customer Landfill Software System.
    a. Display: 0.8 inch high, six digit, 11 annunciations.
    b. Enclosure: Stainless Steel Nema 4X.
    c. Units: lb/Kg.
    d. Capacity Selectable: 0 to 999,990.
    e. Grad. Size: 0.001 to 50 pounds.
    f. Approvals: NTEP.

D. Painting - Type "S" motor truck combination scale paint process shall meet these requirements:
1. Clean weighbridge steel to an SSPC-SP6 finish. Give weighbridge surfaces one minimum 3-mil coat of Robinson Coatings 14-R- 862 epoxy ester primer, or equal.
2. Paint shall meet the following specifications:

Red primer Coat	
Product	14-R-862 Red Epoxy Ester Primer
Type	Epoxy Modified
Color	Red
Substrate	Steel
Application	Spray
Viscosity	45 sec @ 78°F
Solids	63% by weight
V.O.C.	3.30 lb/gal
Reduction	As Required
Clean Up	Xylene of Appropriate Solvent Film
Gloss	50-60 Matte
Preparation	SSPC SP6
Total dry mil thickness: 3 mils red primer	

2.3 WARRANTIES

A. All scale system components manufactured and/or supplied by Fairbanks Scales shall be warranted for two years from date of approved inspection and testing. All lever systems shall be warranted 15 years from date of approved inspection and testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Scale system installation shall be strictly in accordance with manufacturer's technical data and printed instructions.

3.2 INSPECTION ANDTESTING

A. Contractor shall test and certify scale system to be accurate within manufacturer-acceptable limits. Contractor shall provide any temporary power required for testing

END OF SECTION

SECTION 16000 - ELECTRICAL GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Requirements of the General Conditions, Special Conditions, and General Requirements of these specifications are applicable and part of every section in Division 16 - Electrical. Contractor shall furnish all labor, material, service, equipment, appliances, and shall perform all operations in connection with the installation and testing of electrical work in accordance with Contract Drawings and Specifications. Any material found defective will be rejected by Engineer, and Contractor shall remove such defective material from site of work.
   3. Contractor is responsible for all such material furnished by him and he shall replace, at his own expense, all such materials found defective in manufacture or damaged after delivery.

1.2 REQUIREMENTS OF REGULATORY AGENCIES AND STANDARDS

A. Regulatory Agencies: Installation, materials, equipment, and workmanship shall conform to applicable provisions of:
   1. National Electrical Code (NEC).
   2. National Electrical Safety Code (NESC).
   3. Terms and conditions of electrical utility and other authorities having lawful jurisdiction pertaining to work required.

1.3 MODIFICATIONS

A. All modifications required by these applicable codes, rules, regulations, and authorities shall be made by Contractor without additional charge to Owner.

B. Underwriter's Laboratories, Inc. (UL): All materials, appliances, equipment or devices shall conform to applicable standards of UL. Label of, or listing by UL is required.

C. Standards: Where referenced in these Specifications or on Drawings, publications and standards of these organizations shall apply:
   1. American Society of Testing and Materials (ASTM).
   2. Institute of Electrical and Electronic Engineers (IEEE).
   3. Insulated Power Cable Engineers Association (IPCEA).
   4. National Electrical Manufacturers Association (NEMA).
   5. National Fire Protection Association (NFPA).
   6. American National Standards Institute (ANSI).
   7. Illuminating Engineering Society of North America (IESNA).

D. If Contractor observes any conflict or variation in Plans and/or Specifications, he shall notify Engineer in writing no later than 10 days prior to date of bid opening. Failure to clarify such variations will result in Electrical Contractor bearing all costs arising from electrical work done contrary to Specifications or Drawings.

E. Electrical Contractor shall coordinate all conduit runs, control wiring, and electrical connections to equipment items furnished by Mechanical Contractor, General Contractor, Instrumentation Contractor, Owner, and other contractors under Specifications.

1.4 SUBMITTALS

A. Materials List: Within 15 days after Award of Contract, Contractor shall submit to Engineer a list of all equipment to be furnished. Where substitutions are proposed, complete data must be furnished showing performance, quality, and dimensions. Written approval of Engineer must be obtained before purchasing any substitute equipment.

B. Shop Drawings: As per section 01300 – Submittal Procedures, submit for approval all Shop Drawings after material list is approved, and prior to ordering. Show complete outlines, dimensions, electrical services, control diagrams, electrical characteristics of a special nature or critical to the installation, and pertinent data required for installation. All descriptive data, technical data, and Shop Drawings shall bear signed certification that they have been carefully examined and found correct with respect to dimension, space available, non-interference with other trades, and equipment complies with all specification requirements. Where catalog data are submitted, proposed items shall be clearly "flagged," or otherwise identified, so no confusion exists. In addition to specific references or requests, submit Shop Drawings motor starters, switches, control devices, control systems, and sensing equipment.

C. Substitutions: Submit proposed substitutions of electrical equipment, control devices, and other equipment with other submittal data. This request shall be accompanied by complete descriptions of substitutes offered, including catalog cuts. Entire burden of proof of equality shall be placed on Contractor and Engineer decision shall be final.

D. Test Data: Provide one copy of all data obtained during tests required in Specifications. Data shall be organized, typed, and indicate each test result. This shall be submitted for Engineer Review within three days of performing required tests.

PART 2 - PRODUCTS

2.1 EQUIPMENT REQUIREMENTS

A. Electrical requirements for equipment specified or indicated on Drawings are based on information available at time of design. If equipment furnished for installation has electrical requirements other than indicated on electrical drawings, Contractor shall make any required changes to wire and conduit size, controls, over current protection and installation, as required to accommodate equipment supplied, without additional charge to Owner. Complete responsibility and costs for such adjustments shall be assigned to this Specification where equipment is furnished.

2.2 MATERIALS

A. All similar materials and equipment shall be the product of the same manufacturer unless specified otherwise. Where no specific material, apparatus, or appliance is mentioned, any first-class product, with Engineer approval, may be used. Materials and equipment shall be standard products of manufacturers regularly engaged in production of such material and shall be manufacturer's current and standard design. Equipment affected by altitude shall perform satisfactorily for function intended at altitude of project site.

PART 3 - EXECUTION

3.1 GENERAL

A. Fabrication, erection, and installation of complete electrical system shall be done in accordance with accepted good practice by qualified personnel experienced in such work and orderly proceed so not to impede project progress. Electrical Contractor shall check all areas and surfaces where electrical equipment material is to be installed, removed, or relocated, and report any unsatisfactory conditions before starting work. Commencement of work signifies Contractor acceptance of existing conditions. In acceptance or rejection of the finished installation, no allowance will be made for lack of skill on the part of workmen.

3.2 TEMPORARY POWER AND LIGHTING

A. Furnish and install temporary electrical facilities, if required, for construction and safety operations. No part of the permanent electrical systems or existing electrical system may be used for temporary service unless approved by Engineer. Provide separate electrical metering for temporary power.

3.3 PERFORMANCE TESTS

A. Thoroughly test all control circuits, fixtures, services, and all circuits for proper operating condition and freedom from grounds and short circuits before requesting acceptance. All equipment, appliances, and devices shall be operated under load conditions. After completing interior wiring system installation and when Engineer may direct, conduct operating tests for approval. When requested, test all wire, cable, devices, and equipment after installation to assure all material possesses original characteristics as required by governing codes and standards listed in specifications.

B. Perform such tests as required by specifications or as requested to prove acceptability. Furnish all instruments and labor for testing.

3.4 RECORD DRAWINGS

A. During work progress, maintain a clean, full set of project plans to use in recording accurate red-lined changes to system installation. Upon completion of installation, submit full set of red-lined drawings with all record data to Engineer.

3.5 OPERATING INSTRUCTIONS AND MANUALS

A. Without additional charge to Owner, furnish complete instruction to Owner in care, adjustment, and operation of all parts of electrical equipment and systems. Upon completion of work, prepare and deliver to Owner, four complete sets of Operating and Maintenance manuals for the systems and major equipment installed. Include catalog data, shop drawings, wiring diagrams, performance curves and rating data, spare parts lists, and manufacturer operating maintenance data. A copy of testing data collected during field tests shall also be included in manuals.

B. Noted requirements are in addition to specific instructions and manuals specified for individual systems or equipment.

3.6 DRAWINGS

A. General: Electrical drawings show general arrangement of all conduit, equipment, etc. and shall be followed as closely as actual building construction and work of other trades will permit.

Structural drawings shall be considered part of the work insofar these drawings furnish Contractor with information relating to building design and construction. Because of the small scale of electrical drawings, indicating all offsets, fittings, and accessories required is not possible. Contractor shall investigate structural and finish conditions affecting work and arrange his work accordingly, providing such fittings, elbows, pull boxes, and accessories as may be required to meet such conditions.

B. Field Measurements: Contractor shall verify dimensions governing electrical work at facility. No extra compensation shall be claimed or allowed on account of differences between actual dimensions and those indicated on Drawings.

C. Coordination Drawings: In locations where several trades' work must be sequenced and positioned with precision to fit into available space, prepare coordination drawings (shop drawings) showing actual physical dimensions (at accurate scale) required for installation, if Engineer deems necessary. Prepare and submit these coordination drawings, if required, prior to purchase-fabrication-installation of any elements involved in coordination.

3.7 LOCATION OF EQUIPMENT AND OUTLETS

A. Approximate locations of cabinets, conduits, controllers, power outlets, etc., are indicated on Drawings, although not intended to give complete and detailed information. Determine exact location after thoroughly examining general building plans and by actual measurements during construction, subject to Engineer approval.

3.8 EXISTING ELECTRICAL

A. Existing electrical system information has been obtained from the most up-to-date source and documents, but accuracy is not guaranteed. Contractor shall familiarize himself with existing conditions before preparing bid.

B. Only existing electrical affected by this Contract is shown on Drawings. Existing electrical not shown in Drawings is to remain in place and in operation. All existing electrical damaged during construction shall be repaired or replaced.

C. Contractor is responsible for damage to existing walls or ceilings from electrical construction. Repairing of damage to existing building shall be done by proper trades involved.

3.9 ELECTRIC UTILITY SERVICE

A. Denton Municipal Electric is the local electric utility company providing service to existing facility. Design and installation of overhead and underground facilities will be done by Denton Municipal Electric.

B. Contractor shall be familiar and comply with requirements of latest version of Service Requirements book from each service provider. Any equipment in the Service Requirements book stated to be provided or installed by Customer, Contractor shall provide and install.

C. Contractor shall coordinate with service provider to establish exact location and spacing requirements of the service pole.

END OF SECTION

SECTION 16111 - CONDUIT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Metal and nonmetal conduit.
   2. Liquidtight flexible metal conduit.
   3. Fittings and conduit bodies.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16130 - Boxes.
   3. Section 16190 – Supporting Devices.

1.2 SCOPE

A. Inspect conduit, fittings, conduit bodies, and accessories upon delivery and during work progress. Any material found defective will be rejected by Engineer, and Contractor shall remove such defective material from site of work.

B. Contractor is responsible for all materials furnished by him and shall replace, at his own expense, all such materials found defective in manufacture or damaged after delivery.

1.3 REFERENCES

A. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated.
B. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated.
C. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable assemblies.
D. ANSI/NFPA 70 - National Electrical Code.
E. NECA - Standard of Installation.
F. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally-Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
G. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
H. NEMA VE1 – Metal Cable Tray Systems
I. NEMA VE2 – Cable Tray Installation Guidelines

1.4 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01400 – Quality Control. Accurately record actual routing of all conduits.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle Products to site under provisions of General Conditions. Accept conduit onsite and inspect for damage. Protect conduit from corrosion and entrance

of debris by storing above grade and providing appropriate covering. Protect PVC conduit from sunlight.

1.7 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings. Verify routing and termination locations of conduit prior to rough-in. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

PART 2 - PRODUCTS

2.1 CONDUIT REQUIREMENTS

A. Conduit Minimum Size: 3/4 inch unless otherwise specified.
B. Rigid Metallic Conduit (RGS): Galvanized Rigid Steel, ANSI C80.1. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit.
C. Liquidtight Flexible Metal Conduit: Interlocked steel construction with PVC jacket. Flexible conduit shall be used only for connection to devices and structures subject to vibration. Maximum length of flexible conduit shall be 3 feet.
D. Rigid Nonmetallic Conduit: NEMA TC 2; Schedule 80 PVC. PVC Fittings and Conduit Bodies: NEMA TC

2.2 UNDERGROUND INSTALLATIONS

A. At 18 inches below grade and lower utilize Rigid Nonmetallic Conduit. If underground conduit run is not encased in concrete, place 4 inches of sand below and above conduit, and install a 2-inch red detectable ribbon 6 inches above top of conduit for entire length of underground run.
B. Any conduit located less than 18 inches below grade shall be PVC-coated Rigid Metallic Conduit, or Rigid Nonmetallic Conduit encased in concrete.
C. When transferring from below grade to above grade, use PVC-coated Rigid Metallic Conduit.

2.3 ABOVEGROUND INSTALLATIONS

A. Wet and Damp Locations: Use Rigid Metallic Conduit.
B. Dry Locations: Use Electrical Metallic Tubing, zinc-coated, where conduit will be concealed. Use Rigid Metallic Conduit where conduit will be exposed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install conduit in accordance with NECA - Standard of Installation. Install nonmetallic conduit in accordance with manufacturer instructions. Arrange supports to prevent misalignment during wiring installation. Support conduit using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and splint hangers. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits. Fasten conduit supports to building structure and concrete surfaces with galvanized hardware. Do not support conduit with wire or perforated pipe straps. Remove wire used for temporary supports.

B. Arrange conduit to maintain headroom and present neat appearance. Route exposed conduit parallel and perpendicular to walls. Maintain adequate clearance between conduit and piping. Maintain 12-inch clearance between conduit and surfaces with temperatures exceeding 104 degrees F. Remove all sharp edges from ends after cutting. Do not use "pipe" cutters for cutting conduit. Bring conduit to shoulder of fittings; fasten securely.

C. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full, even coat of cement to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.

D. Use conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes. Install no more than equivalent of three 90-degree bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Conduit bends shall be made so as not to alter the cross-sectional area of the conduit.

E. Use suitable caps to protect installed conduit against entrance of dirt and moisture. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system. Provide suitable fittings to accommodate expansion and deflection where conduit crosses, control and expansion joints. Provide suitable pull string in each empty conduit except sleeves and nipples.

F. All conduits identified on a conduit schedule shall be tagged at each end with metal tags engraved or stamped to identify conduit according to identification on "schedule."

3.2 PAYMENT

A. Payment will be made for all work covered in this section at Contract unit price per unit or included in the lump sum price per job for items, as shown on Proposal. Either payment shall be complete compensation for the complete performance of work in accordance with Drawings and specification provisions.

END OF SECTION

SECTION 16123 - WIRE AND CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Power wire and cable.
   2. Underground feeder and branch circuit cable.
   3. Service entrance and control cable.
   4. Wiring connectors and connections.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16111 - Conduit.
   3. Section 16130 - Boxes.

1.2 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of General Conditions.
B. Product Data: Provide for each cable assembly type.
C. Test Reports: Indicate procedures and values obtained.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.
B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

1.5 PROJECT CONDITIONS

A. Verify field measurements are as shown on Drawings.
B. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wires and cables as required meeting Project Conditions.
C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

A. Coordinate work with other trades.
B. Determine required separation between cable and other work.
C. Determine cable routing to avoid interference with other work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Power Wire and Cable: Cable as manufactured by Carol Cable, Triangle PWC, Inc., Capital Wire & Cable Corp. or equal.
B. Control Cable: Belden or equal

2.2 POWER WIRE AND CABLE

A. Description: Single or multi-conductor insulated wire.
B. Conductor: Copper.
C. Insulation Voltage Rating: 600 volts.
D. Insulation: ANSI/NFPA 70; Type THHN/THWN, 90 degrees C insulation for service entrance, feeders, and branch circuits.

2.3 CONTROL CABLE

A. Analog I/O wiring shall be 16 AWG, twisted pair shielded, Belden 8719 or equal.
B. Discrete I/O wiring shall be 16AWG, 600V, stranded copper, THWN. Use multi-conductor cable when possible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify mechanical work likely to damage wire has been completed.

3.2 INSTALLATION

A. Install products in accordance with manufacturer instructions.
B. Use copper conductor not smaller than 12 AWG for power and lighting circuits.
C. Use copper conductor not smaller than 16 AWG for control circuits.
D. Pull all conductors into raceway at same time.
E. Use suitable wire-pulling lubricant for building wire 8 AWG and larger or runs longer than 50 feet.
F. Use suitable cable fittings and connectors.
G. Neatly train and lace wiring inside boxes, equipment, and panelboards.
H. Clean conductor surfaces before installing lugs and connectors.
I. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
J. Use split bolt connectors for copper conductor splices and taps, 8 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
K. Use solderless pressure connectors with insulating covers or spring wire connectors for copper conductor splices and taps, 10 AWG and smaller.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Identify each conductor with destination terminal block.

3.4 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of General Conditions.
B. Inspect wire for physical damage and proper connection.
C. Measure tightness of bolted connections.
D. Utilize accurate torque wrench to tighten bolts and nuts on MCC.
E. Verify continuity of each branch circuit conductor.
F. Verify that all non-grounded conductors have an open circuit to ground.

3.5 PAYMENT

A. Payment will be made for all work covered in this section at Contract unit price per unit or included in the lump sum price per job for items, as shown on Proposal. Such payment shall be complete compensation for complete performance of work in accordance with Drawings and specification provisions.

END OF SECTION

SECTION 16130 - BOXES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall and ceiling outlet boxes.
   2. Pull and junction boxes.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16140 - Wiring Devices: Wall plates in finished areas.

1.2 REFERENCES

A. NECA - Standard of Installation.
B. NEMA FB 1 - Fittings and Supports for Conduit and Cable Assemblies.
C. NEMA OS 1 - Sheet-steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR CLOSEOUT

A. Section 01700 - Contract Closeout: Submittals for Project closeout.
B. Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.4 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.
B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.1 OUTLET BOXES

A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
B. Equipment Supporting Boxes: Rated for weight of equipment supported; include .5-inch male fixture studs where required.
C. Cast Boxes: NEMA FB 1, Type FD, cast feralloy. Provide gasketed cover by box manufacturer.
D. Wall Plates for Finished Areas: As specified in Section 16140 – Wiring Devices.

2.2 PULL AND JUNCTION BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
B. Surface-Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface-mounted junction box:
   1. Material: Galvanized cast iron.
   2. Cover: Furnish with flange, neoprene gasket, and stainless steel cover screws.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify locations of outlets in all locations areas prior to rough-in.

3.2 INSTALLATION

A. Install boxes in accordance with NECA - Standard of Installation.
B. Install in locations as shown on Drawings and required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements.
C. Set wall-mounted boxes at elevations to accommodate mounting heights specified for outlet device.
D. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Adjust box location up to 10 feet if required to accommodate intended purpose.
E. Orient boxes to accommodate wiring devices oriented as specified in Section 16140 – Wiring Devices.
F. Maintain headroom and present neat mechanical appearance.
G. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
H. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
I. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
J. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
K. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
L. Align adjacent wall-mounted outlet boxes for switches, thermostats, and similar devices. All such devices shall be mounted at the same elevation.
M. Use flush-mounting outlet box in finished areas.
N. Locate flush-mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
O. Do not install flush-mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic-rated walls.
P. Secure flush-mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
Q. Use stamped steel bridges to fasten flush-mounting outlet box between studs. In lieu of bridges, provide boxes with brackets that limited box travel by contacting adjacent wall.
R. Install flush-mounting box without damaging wall insulation or reducing effectiveness.
S. Use adjustable steel channel fasteners for hung ceiling outlet box.
T. Do not fasten boxes to ceiling support wires.
U. Support boxes independently of conduit.
V. Use gang box where more than one device is mounted together. Do not use sectional box.
W. Use gang box with plaster ring for single device outlets.
X. Use cast outlet box in exterior locations exposed to weather and wet locations. Non-metallic boxes shall not be used.
Y. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.3 INTERFACE WITH OTHER PRODUCTS

A. Coordinate installation of outlet box for equipment connected.

3.4 ADJUSTING

A. Section 01700 - Contract Closeout: Adjusting installed work.
B. Adjust flush-mounting outlets to make front flush with finished wall material.
C. Install knockout closures in unused box openings.

3.5 CLEANING

A. Section 01700 - Contract Closeout: Cleaning installed work.
B. Clean interior of boxes to remove dust, debris, and other material.
C. Clean exposed surfaces and restore finish.

END OF SECTION

SECTION 16140 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wall switches, receptacles, device plates, and covers.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16130 - Boxes.

1.2 REFERENCES

A. NECA - Standard of Installation.
B. NEMA WD 1 - General Requirements for Wiring Devices.
C. NEMA WD 6 - Wiring Device -- Dimensional Requirements.
D. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.
B. Product Data: Provide manufacturer catalog information showing dimensions, colors, and configurations.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified with minimum three years' documented experience.

1.5 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.
B. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.1 WALL SWITCHES

A. Manufacturers:
   1. Hubbell 1221-I.
   2. Leviton 1221-I.
   3. General Electric 5951-2G
B. Description: NEMA WD 1, 20 amp, Heavy-duty, AC only general-use snap switch.
C. Body and Handle: nylon ivory handle.
D. Utilize equivalent series of manufacturer numbers for three- and four-way and two-pole applications.

2.2 RECEPTACLES

A. Manufacturers:
   1. Hubbell.
   2. Leviton.
   3. Cooper/Eaton.
B. Description: NEMA WD 1, Heavy-duty, receptacles with triple wipe contacts and grounding contacts integral with the backstop (no rivets).
C. Device Body: Ivory plastic.
D. Configuration: NEMA WD 6, type as specified and indicated.
E. Convenience Receptacle: Type 5-20.
F. GFCI Receptacle: Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements. Hubbell 5352-I or equivalent.

2.3 WALL PLATES

A. Weatherproof Cover Plate: Gasketed cast metal with gasketed device cover on exterior devices.
B. Surface-Mounted Plates: Galvanized steel plates

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01039 - Coordination and Meetings: Verification of existing conditions prior to beginning work.
B. Verify that outlet boxes are installed at proper height.
C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
D. Verify branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

3.2 PREPARATION

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean debris from outlet boxes.

3.3 INSTALLATION

A. Install in accordance with NECA - Standard of Installation."
B. Install devices plumb and level.
C. Install switches with OFF position down.
D. Install receptacles with grounding pole on top.
E. Connect wiring device grounding terminal to branch circuit equipment grounding conductor.
F. Connect wiring devices by wrapping conductor around screw terminal.
G. Use jumbo size plates for outlets installed in masonry walls.
H. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.

3.4 FIELD QUALITY CONTROL

A. Section 01400 - Quality Control: Field inspection, testing, adjusting, and balancing.
B. Inspect each wiring device for defects.

C. Operate each wall switch with circuit energized and verify proper operation.
D. Verify each receptacle device is energized.
E. Test each receptacle device for proper polarity.
F. Test each GFCI receptacle device for proper operation.

3.5 ADJUSTING

A. Section 01700 - Contract Closeout: Adjusting installed work.
B. Adjust devices and wall plates to be flush and level.

3.6 CLEANING

A. Section 01700 - Contract Closeout: Cleaning installed work.
B. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

SECTION 16170 - GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Grounding electrodes and conductors.
   2. Equipment grounding conductors and bonding.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCES

A. Section 01400 - Quality Control: Requirements for references and standards.
B. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (International Electrical Testing Association).
C. NFPA 70 - National Electrical Code.

1.3 GROUNDING SYSTEM DESCRIPTION

A. Metal underground water pipe.
B. Metal frame of the building.
C. Rod electrode.

1.4 PERFORMANCE REQUIREMENTS

A. Maximum Grounding System Resistance: 10 ohms.

1.5 SUBMITTALS FOR REVIEW

A. Section 01300 - Submittals: Procedures for submittals.
B. Product Data: Provide for grounding electrodes and connections.

1.6 SUBMITTALS FOR CLOSEOUT

A. Section 01700 - Contract Closeout: Procedures for submittals.
B. Project Record Documents: Record actual locations of components and grounding electrodes.
C. Certificate of Compliance: Indicate approval of installation by authority having jurisdiction.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing specified Products with minimum three years' documented experience, and with service facilities within 100 miles of Project.

1.8 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by UL as suitable for purpose specified and indicated.

PART 2 - PRODUCTS

2.1 ROD ELECTRODES

A. Material: Copper.
B. Diameter: 3/4 inch.
C. Length: 10 feet.

2.2 MECHANICAL CONNECTORS

A. Material: Bronze.

2.3 EXOTHERMIC CONNECTIONS

A. Manufacturers: Cadweld.

2.4 WIRE

A. Material: Stranded copper.
B. Grounding Electrode Conductor: Minimum size to meet NFPA 70 requirements or as indicated on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Section 01039 - Coordination and Meetings: Verification of existing conditions prior to beginning work.
B. Verify final backfill and compaction is complete before driving rod electrodes.

3.2 INSTALLATION

A. Section 01400 - Quality Control: Manufacturer's instructions.
B. Install rod electrodes. Install additional rod electrodes as required to achieve a minimum resistance to ground of 10 ohms.
C. Provide bonding to meet Regulatory Requirements.
D. Bond together metal siding not attached to grounded structure; bond to ground.
E. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
F. Provide bonding of reinforcing steel in concrete foundation, building steel, steel water pipes, and any supplemental electrodes (rods) in accordance with NEC and Drawings.

3.3 FIELD QUALITY CONTROL

A. Section 01400 - Quality Assurance: Field inspection, testing, adjusting.
B. Inspect and test in accordance with NETA ATS, except Section 4.
C. Perform inspections and tests listed in NETA ATS, Section 7.13.

END OF SECTION

SECTION 16190 - SUPPORTING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Conduit and equipment supports.
   2. Anchors and fasteners.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCES

A. NECA - National Electrical Contractors Association.
B. ANSI/NFPA 70 - National Electrical Code.

1.3 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.
B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 PRODUCT REQUIREMENTS

A. Materials and Finishes: Provide adequate corrosion resistance.
B. Provide materials, sizes, and types of anchors, fasteners, and supports to carry loads of equipment and conduit. Consider weight of wire in conduit when selecting products.
C. Anchors and Fasteners:
   1. Concrete Structural Elements: Use expansion anchors, powder-actuated anchors, and preset inserts.
   2. Steel Structural Elements: Use beam clamps, spring steel clips, and steel ramset fasteners.
   3. Concrete Surfaces: Use self-drilling anchors and expansion anchors.
   4. Sheet Metal: Use sheet metal screws.
   5. Wood Elements: Use wood screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer instructions.
B. Provide anchors, fasteners, and supports in accordance with NECA - Standard of Installation.
C. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.
D. Obtain permission from Engineer before drilling or cutting structural members.

E. Fabricate supports from structural steel as indicated on drawings. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use lock washers under all nuts.
F. Install surface-mounted cabinets and panelboards with minimum of four anchors.
G. In wet and damp locations, use steel channel supports to stand cabinets and panelboards 1 inch off wall.
H. Install conduit supports a maximum spacing specified in the NEC.
I. Items mounted on hollow metal walls shall be provided with full blocking or heavy gauge strapping that spans the entire width between structural members.

END OF SECTION

SECTION 16195 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Nameplates and labels.
   2. Wire and cable markers.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

PART 2 - PRODUCTS

2.1 NAMEPLATES AND LABELS

A. Nameplates and Labels: Engraved three-layer laminated plastic, white letters on black background.
B. Locations:
   1. Each electrical distribution and control equipment enclosure.
   2. Field disconnects, start stop stations, control panels, transformers.
C. Letter Size:
   1. Use 1/4-inch letters for identifying individual equipment and loads.
   2. Use 1/4-inch letters for identifying grouped equipment and loads.
   3. Use 3/8-inch letters for identifying Main Disconnect equipment.

2.2 BOX MARKERS

A. All junction boxes in accessible location shall have the box cover labeled to indicate which circuit and panel they are served from.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 APPLICATION

A. Install nameplate and label parallel to equipment lines.
B. Secure nameplate to equipment front using screws or rivets.
C. Identify underground conduits with underground warning tape. Install one tape per trench at 3 inches below finished grade. Identify all conduit at exposed locations into all boxes, cabinets, etc.

D. Identify all conductors at every termination indicating endpoints of termination and tag identification as required.

E. Color-coding for phase identification:

120/208 volts	Phase	277/480 volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray
Green	Ground	Green

F. Conductor phase and voltage identification shall be made by color-coded insulation for all conductors smaller than No. 6 AWG. For conductors No. 6 AWG and larger, identification shall be made by color-coded insulation, or conductors with black insulation may be furnished and identified by colored electrical tape. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.

END OF SECTION

SECTION 16441 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fusible and non-fusible switches.
   2. Fuses.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.

1.2 REFERENCES

A. NEMA KS 1 - Enclosed Switches.
B. NFPA 70 - National Electrical Code.
C. UL 198C - High-Interrupting Capacity Fuses; Current Limiting Type.
D. UL 198E - Class R Fuses.

1.3 SUBMITTALS

A. Submit under provisions of Section 01300 – Submittal Procedures.
B. Product Data: Provide switch ratings and enclosure dimensions.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum three years documented experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.
B. Furnish products listed and classified by UL as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Square D
B. General Electric
C. Siemens

2.2 ENCLOSED SWITCHES

A. Fusible or non-fusible as indicated.
B. Switch Assemblies: NEMA KS 1, Type HD load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
C. Fuse Clips: Designed to accommodate NEMA FU1, class R fuses.
D. Enclosures: NEMA KS 1.
    1. Interior Dry Locations: Type 1.
    2. Exterior Locations: Type 3R or 4.
E. Current rating of switch to be equal to or greater than that of the circuit it is interrupting.

2.3 FUSES

A. Manufacturers:
    1. Bussman
    2. Littlefuse
    3. Gould Shawmut
B. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
C. Voltage: Provide fuses with suitable voltage ratings for phase-to-phase voltages.
D. Service Entrance: Class L, Bussman Low-peak or equivalent.
E. General Purpose Loads: Class RK1, Bussman Low-peak or equivalent.
F. Motor Loads: Class RK5, Bussman Fusetron or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with NECA - Standard of Installation.
B. Install fuses in all fusible disconnects.
C. Apply adhesive tag inside of door of all disconnects indicating NEMA class fuse and size installed.
D. Provide a disconnect switch for all equipment where indicated or required by the N Electrical Code. Coordinate with other disciplines to determine where disconnects are furnished with equipment.

END OF SECTION

SECTION 16461 – DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dry-type two-winding transformers.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16111 - Conduit: Flexible conduit connections.
   3. Section 16170 - Grounding and Bonding.
   4. Section 16190 - Supporting Devices.

1.2 REFERENCES

A. NEMA ST 1 - Specialty Transformers.
B. NEMA ST 20 - Dry Type Transformers for General Applications.
C. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of Section 01300 – Submittal Procedures.
B. Product Data: Provide outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, tap configurations, insulation system type, and rated temperature rise.
C. Test Reports: Indicate loss data, efficiency at 25, 50, 75, and 100 percent rated load, and sound level.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of Installation. Maintain one copy of each document onsite.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this Section with minimum ten years' experience.

1.6 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70. Furnish products listed and classified by UL as suitable for purpose specified and shown.

1.7 DELIVERY, STORAGE, AND HANDLING

A. All equipment onsite shall be stored, protected, and handled to insure when placed in operation, it is in original condition. Deliver transformers individually wrapped for protection and mounted on shipping skids. Accept transformers onsite. Inspect for damage. Store in a clean, dry space. Maintain factory wrapping or provide additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic. Handle in accordance with

manufacturer written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer, internal components, enclosure, and finish.

PART 2 - PRODUCTS

2.1 TWO-WINDING TRANSFORMERS

A. Manufacturers: As specified or equal approved by Engineer. Description: NEMA ST 20, factory-assembled, air cooled dry type transformers. Insulation system and average winding temperature rise for rated KVA as follows:
   1. 1-15 KVA: Class 185 with 80 degrees C rise.
   2. 16-500 KVA: Class 220 with 80 degrees C rise.

B. Case temperature: Do not exceed 35 degrees C rise above ambient at warmest point. Winding Taps: Transformers Less than 15 KVA: Two 2-1/2 percent above and below rated voltage, full-capacity taps on primary winding. Transformers 15 KVA and Larger: NEMA ST 20.

C. Sound levels shall conform to NEMA ST 20. Basic impulse level shall be 15 KVA. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap. Dry-type transformer shall be mounted as an integral part to the MCC.

D. Coil Conductors: Continuous windings with terminations brazed or welded or brackets.

E. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.2 SOURCE QUALITY CONTROL

A. Provide production testing of each unit in accordance with NEMA ST20.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify condition under provisions of General Provisions.

3.2 INSTALLATION

A. Install Products in accordance with manufacturer instructions. Set transformer plumb and level. Provide grounding and bonding in accordance with Section 16170 – Grounding and Bonding.

3.3 FIELD QUALITY CONTROL

A. Perform field inspection and testing under provisions of General Conditions. Check for damage and tight connections prior to energizing transformer. Measure primary and secondary voltages and make appropriate tap adjustments.

3.4 PAYMENT

A. Payment will be made for all work covered in this section at Contract unit price per unit or will be included in the lump sum price per job for items, as shown on Proposal. Such payment shall be complete compensation for complete performance of work in accordance with Drawings and specification provisions.

END OF SECTION

SECTION 16470 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16190 - Supporting Devices.

1.2 REFERENCES

A. NECA - Standard of Installation.
B. NEMA AB 1 - Molded Case Circuit Breakers.
C. NEMA PB 1 - Panelboards.
D. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards.
E. Rated 600 Volts or Less.
F. NFPA 70 - National Electrical Code.

1.3 SUBMITTALS

A. Submit under provisions of Section 01300 – Submittal Procedures.
B. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.

1.4 MANUFACTURER INSTALLATION INSTRUCTIONS

A. Indicate application conditions and limitations of use stipulated by Product testing agency.
B. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of General Conditions. Record actual locations of Products; indicate actual branch circuit arrangement.

1.6 OPERATION AND MAINTENANCE DATA:

A. Submit under provisions of General Conditions.
B. Maintenance Data: Include spare parts data listing; and recommended maintenance procedures and intervals.

1.7 QUALITY ASSURANCE

A. Perform Work in accordance with NECA Standard of installation.

1.8 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing of products specified in this section with minimum five years' experience.

1.9 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70. Furnish products listed and classified by UL as suitable for purpose specified and indicated.

1.10 GENERAL CONDITIONS

A. Provide two of each panelboard key if required.

1.11 FIELD QUALITY CONTROL

A. Field inspection and test for grounds on each circuit after installation is completed. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Independently-mounted panelboards shall be manufactured by:
   1. Siemens.
   2. Square D.
   3. Or equal.

2.2 DISTRIBUTION PANELBOARDS

A. Panelboards 240/480 VAC, one-phase, three-wire, 60 Hertz.
   1. Service Conditions.
      a. Temperature: 105 degrees F.
      b. Altitude: 4,000 feet.
   2. Bus: Copper.
      a. Provide copper ground bus in each panelboard.
      b. Minimum integrated short circuit rating: 20 amperes RMS symmetrical at 480 VAC.
      c. Molded Case Circuit Breakers: NEMA AB1, bolt-on type. Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide circuit breaker accessory trip units and auxiliary switches as indicated.
      d. Provide nameplate and locate near top of front trim on exterior surface listing panel type. Ratings as required by UL.
      e. Enclosure: NEMA 4.
      f. Enclosure provided with provisions for locking cover of panel closed with a padlock.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with NEMA PB 1.1. Install panelboards plumb. Provide supports in accordance with Drawings and Section 16190 – Supporting Devices. Height: 6 feet maximum to top of panelboard. Provide filler plates for unused spaces in panelboards. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads. Label spare slots in erasable pencil on directory. Provide black-on-white engraved plastic nameplates.

END OF SECTION

SECTION 16670 - SURGE PROTECTIVE DEVICE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Surge Protective Device (SPD), (former Transient Voltage Surge Suppression devices, abbreviated as TVSS). SPD will be used in this Specification and on all Drawings.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16123 - Wire and Cable.
   3. Section 16170 - Grounding and Bonding.

1.2 REFERENCES

A. Specified system shall be designed, manufactured, tested, and installed in compliance with:
   1. Canadian Standards Association (CSA).
   2. American National Standards Institute.
   3. National Electrical Manufacturer Association (NEMA).

B. Institute of Electrical and Electronic Engineers:
   1. ANSI/IEEE C62.11.
   2. C62.41.
   3. C62.45.

C. Federal Information Processing Standards Publication 94:
   1. FIP PUB 94.

D. National Fire Protection Association:
   1. NFPA 20.
   2. NFPA 70.
   3. NFPA 75.
   4. NFPA 780.

E. Underwriters Laboratories - UL 1449 3rd. Ed., UL 1283: MIL-STD-220A.

1.3 SYSTEM DESCRIPTION

A. Includes electrical and mechanical requirements for a high-energy transient voltage surge suppression system. Specified system shall provide effective high energy surge current diversion, sine wave tracking for electrical line noise filtering and be suitable for application in ANSI/IEEE C62.41 Category A, B, and C environments, as tested by ANSI/IEEE C62.11, C62.45, and MIL-STD-220A.

B. System shall be connected in parallel with the protected system; no series connected elements used which limit load current or kVA capability.

1.4 SUBMITTALS FOR REVIEW

A. Submit under provisions of Section 01300 – Submittal Procedures.

B. Provide dimensions and materials of each component. Include isolation switch data.

C. Documentation of specified system's UL 1449 Listing and clamping voltage ratings of all protection modes included as required product data submittal information.

D. Documentation of the specified system's UL 1283 Complimentary Listing included as required product data submittal information.
E. Independent fuse coordination tests from nationally-recognized, independent testing laboratory.

1.5 PROJECT CLOSEOUT SUBMITTALS

A. Manufacturer shall furnish an installation manual with installation, start up, trouble-shooting guide and operating instructions for the specified system.
B. Electrical and mechanical drawings provided by manufacturer showing unit dimensions, weights, component and connection locations, mounting provisions, connection details, and wiring diagram.
C. Record actual location of SPD.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of SPD equipment with minimum five years' experience.

1.7 REGULATORY REQUIREMENTS

A. Product Listing: UL listed under UL 1449 (Rev 09/2009) Standard for Surge Protective Device (SPD); surge ratings permanently affixed to SPD.
B. Complimentary listed to UL 1283 Standard for EMI/RFI Facility Filters.

1.8 FIELD QUALITY CONTROL

A. Inspect each wiring device for defects.
B. Verify all connections a properly bonded.

1.9 WARRANTY

A. Manufacturer shall provide full, five-year warranty from date of shipment against any failure when installed in compliance with manufacturer-written instructions, UL listing requirements, and any applicable national or local electrical codes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Erico Critec.
B. MVC.
C. Square D.
D. Or approved equal.
E. All manufacturers shall submit independent test data from nationally-recognized testing laboratory for current protection, protection modes, and compliance with UL 1449 ratings.

2.2 ENVIRONMENTAL REQUIREMENTS

A. Storage temperature range shall be -67 to +187 degrees F.
B. Operating temperature range shall be -40 to +122 degrees F.

C. Operation shall be reliable in an environment with 0 to 95 percent non-condensing relative humidity.
D. SPD shall not generate any appreciable audible noise.
E. Unit shall not generate any appreciable magnetic fields and shall be suitable for use directly inside computer rooms.

2.3 ELECTRICAL REQUIREMENTS

A. Nominal system operating voltage, phase, connection type, and number of wired shall match that required on Plans.
B. Maximum Continuous Operating Voltage (MCOV) shall be greater than 115 percent of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS overvoltage (swell) conditions.
C. Operating frequency range of the system shall be at least 47 to 63 Hertz.
D. All protection modes (including Neutral-to-Ground) of SPD, shall be internally fused at component level with fuses I x I x T capability to allow suppressor's maximum rated transient current to pass through suppressor without fuse operation. If rated I x I x T characteristic of fusing is exceeded, fusing capable of opening in less than one millisecond and clear both high and low impedance fault conditions. Fusing shall be capable of interrupting up to 100-kA symmetrical fault current with 600 VAC applied. This over-current protection circuit shall be monitored and provide indication of suppression failure/operability. Conductor level fuses or circuit breakers internal or external to SPD, not acceptable. Contractor to furnish submittal documentation on proper fuse coordination of actual fault tests from nationally recognized testing laboratory for product approval.
E. SPD unit shall be supplied with factory-installed disconnect and over-current protection that eliminated external fusing requirement.

2.4 PROTECTION MODES

A. Protection Modes:
    1. Line-to-Neutral Protection.
    2. Neutral-to-Ground Protection.
    3. Line-to-Ground Protection.
    4. Line-to-Line Protection.
B. SPD surge current capacity shall be 100 kA per phase.
C. SPD system shall provide a joule rating meeting/exceeding ANSI/IEEE C62.41 Category C requirements delivery capability.
D. Typical response time of all suppression components shall be less than one nanosecond.

2.5 SURGE SUPPRESSION COMPONENTS

A. TVSS unit shall display combined total number of transient voltage surges detected from L-N, L-G, N-G, and L-L since counter was last reset.
B. Provide dry contacts to monitor ON/OFF and alarm status.
C. Alarm silence, reset, and test functions.
D. Indication of full or partial loss of protection.
E. Individually-fused suppression modules.
F. AC Tracking Filter: EMI/RFI filtering up to –50dB from 100 kHz to 100 MHz.
G. Unit to include isolation switch, module status indicator lights, form C summary alarm contact.

PART 3 - EXECUTION

3.1 INSTALLATION

A. SPD shall be installed as a Type 2 device.
B. Contractor shall follow SPD manufacturer-recommended installation practices and comply with all applicable codes.
C. Manufacturer shall furnish an installation manual with installation, start up, trouble-shooting guide, and operating instructions for specified system.
D. Manufacturer shall provide electrical and mechanical drawings which show unit dimensions, weights, component and connection locations, mounting provisions, connection details, and wiring diagram.
E. No sharp bend allowed in wiring from SPD unit to ground.
F. Install SPD so wiring between SPD and Point of Connection is kept to a minimum.

END OF SECTION

SECTION 16990 - ELECTRICAL SYSTEM TESTING AND START-UP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Testing procedures and methods required prior to acceptance of electrical systems by Owner. Electrical system start-up procedures.

B. Related Sections:
   1. Division 01 Specification Sections apply to Work of this Section.
   2. Section 16000 - Electrical General Provisions
   3. Section 16441 - Enclosed Switches

1.2 REFERENCES

A. National Electrical Code - NEC
B. National Electrical Manufacturer's Association - NEMA
C. American Society for Testing and Materials - ASTM
D. Institute of Electrical and Electronic Engineers - IEEE
E. American National Standards Institute - ANSI
F. ANSI C2 - National Electrical Safety Code
G. ANSI Z244-1 - American National Standard for Protection
H. Manufacturer instruction manuals applicable to each particular apparatus.

1.3 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01400 – Quality Control. Calibration of all equipment utilized in electrical system tests must be documented and capable of being verified. Accuracy of test instruments shall be directly traceable to the National Bureau of Standards. Analog field instruments shall be calibrated within 6 months of use. Digital field instruments shall be calibrated within 12 months of use. Leased instruments shall be calibrated within 12 months of use where the accuracy is guaranteed by the lessor.
B. Accurately record field data obtained during tests in a manner acceptable to Owner. Provide three copies of tests summary to Owner in a form acceptable to Owner.
C. A copy of all test reports shall be included in the Operating and Maintenance Manuals that will be provided to the Owner by Contractor at project close out.

PART 2 - TEST REQUIREMENTS

2.1 CABLE TESTS

A. Visually inspect cables for physical damage and proper connection in accordance with single line diagram. Verify all cables are permanently numbered. Check cable color-coding with applicable Engineer specifications and the NEC standards.
B. After installation and before rated voltage is applied to any power cable #8 AWG or larger, make a DC insulation check for each cable with megohmmeter. Applied potential shall be 1,000 Volts DC for one minute. Minimum acceptable resultant value shall be 100 megohms. Individually test each conductor with all other conductors and shields grounded at both ends.

Properly corona suppress terminations by guard ring, field reduction sphere, or other suitable method. If any power cable fails, replace entire length of cable.

2.2 GROUNDING SYSTEMS

A. Inspect ground system for compliance with Plans and Specifications. Perform three-point fall-of-potential test per IEEE Standard No. 81, Section 9.04 on main grounding electrode. Resistance to ground shall be no greater than 5 ohms. Contractor responsible for installing additional electrodes as required to lower resistance to 5 ohms, if greater, at no additional expense to Owner.
B. Contractor shall perform a three-point fall-of-potential test at each location indicated by Engineer at completion of the Project.

2.3 FIELD DEVICE TESTS

A. Visually inspect field devices for physical damage and proper installation. Calibrate devices per manufacturer recommendations. Verify proper operation of all field devices prior to start-up.

PART 3 - EXECUTION

3.1 GENERAL

A. Purpose of start-up procedures is to assure equipment and systems utilized are ready for operation and use by City of Denton.
B. Contractor shall perform start-up with Engineer and City of Denton representative (if desired) present.
C. Contractor shall be responsible for recording the results and providing a report to Engineer.

3.2 PROCEDURE

A. Field devices and other equipment utilized will be operated as required for efficient system operation. Contractor shall demonstrate field devices work as specified. Upon effectively demonstrating satisfactory operation of all electrical systems, Contractor will energize all equipment not adversely affected for seven days. Any controls or other equipment found defective shall be replaced prior to acceptance by Owner.
B. Contractor shall provide "Certification of Proper Operation" to Engineer upon start-up completion.

END OF SECTION

APPENDIX A

SOIL AND LINER QUALITY CONTROL PLAN

ATTACHMENT 10

DENTON LANDFILL

SOILS AND LINER QUALITY CONTROL PLAN

DENTON COUNTY, TEXAS

Prepared for

City of Denton

March 2000

Revised April 2000

Prepared by

EMCON
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Project 801584

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TABLES

1 INTRODUCTION

1.1 Purpose

This Soils and Liner Quality Control Plan (SLQCP) has been prepared to provide the Owner, Design Engineer, Construction Quality Assurance (CQA) Professional of Record (POR), and the Contractor the means to govern the construction quality and to satisfy the environmental protection requirements under current Texas Natural Resource Conservation Commission (TNRCC) Municipal Solid Waste Division Rules (MSWDR) and the current TNRCC Liner Construction and Testing Handbook. More specifically, the SLQCP addresses the soils and geosynthetics components of the liner system.

This SLQCP is divided into the following parts:

- Section 1 - Introduction
- Section 2 - Construction Quality Assurance for Earthwork and Drainage Aggregates
- Section 3 - Construction Quality Assurance for Geosynthetics
- Section 4 - Quality Assurance for Piping
- Section 5 - Liners Constructed Below Groundwater
- Section 6 - Documentation

1.2 Definitions

Whenever the terms listed below are used, the intent and meaning shall be interpreted as indicated.

ASTM

This means the American Society for Testing and Materials.

Ballast Evaluation Report (BER)

Certification report for the constructed ballast, prepared and sealed by the Professional of Record and submitted to the TNRCC.

Construction Quality Assurance (CQA)

A planned system of activities that provides the Owner and permitting agency assurance that the facility was constructed as specified in the design (EPA, 1986). Construction quality assurance includes observations and evaluations of materials, and workmanship necessary to determine and document the quality of the constructed facility. CQA refers to measures taken by the CQA organization to assess if the installer or contractor is in compliance with the plans and specifications for a project.

Construction Quality Assurance Professional of Record (POR)

The POR is an authorized representative of the Owner and has overall responsibility for CQA and confirming that the facility was constructed in general accordance with plans and specifications approved by the permitting agency. The POR must be registered as a Professional Engineer in Texas and experienced in geotechnical testing and its interpretations. Experience and education should include geotechnical engineering, engineering geology, soil mechanics, geotechnical laboratory testing, CQA, QC testing, and hydrogeology. The POR must show competency and experience in certifying like installations, and be approved by the permitting agency, and be presently employed by or practicing as a geotechnical engineer in a recognized geotechnical/environmental engineering organization. The credentials of the POR must meet or exceed the minimum requirements of the permitting agency.

The POR may also be known in applicable regulations and guidelines as the CQA Engineer, Resident Project Representative, or the Geotechnical Professional (GP).

Construction Quality Assurance (CQA) Monitors

These are representatives of the POR who work under direct supervision of the POR. The CQA monitor is responsible for quality assurance monitoring and performing onsite tests and observations. The CQA monitor is on site full-time during construction and reports directly to the POR. The CQA monitor performing daily quality assurance/quality control (QA/QC) observation and testing shall be NICET-certified in geotechnical engineering technology at level 2 or higher for soils and flexible membrane liner (FML) testing; a CQA monitor with a minimum of four years of directly related experience; or a graduate engineer or geologist with one year of directly related experience. Field observations, testing, or other activities associated with CQA may be performed by the CQA monitor(s) on behalf of the POR.

Any references to monitoring, testing, or observations to be performed by the POR should be interpreted to mean POR or CQA monitors working under the POR's direction.

Contract Documents

These are the official set of documents issued by the Owner. The documents include bidding requirements, contract forms, contract conditions, specifications, contract drawings, addenda, and contract modifications.

Contract Specifications

These are the qualitative requirements for products, materials, and workmanship upon which the contract is based.

Contractor

This is the person or persons, firm, partnership, corporation, or any combination, private or public, who, as an independent contractor, has entered into a contract with the Owner, and who is referred to throughout the contract documents by singular number and masculine gender.

Design Engineer

These individuals or firms are responsible for the design and preparation of the project construction drawings and specifications. Also referred to as "designer" or "engineer."

Earthwork

This is a construction activity involving the use of soil materials as defined in the construction specifications and Section 2 of this plan.

Flexible Membrane Liner (FML)

This is a synthetic lining material, also referred to as geomembrane, membrane, liner, or sheet.

Geomembrane Liner Evaluation Report (GLER)

Certification report for the geomembrane liner, prepared and sealed by the POR that is submitted to the TNRCC for approval.

Geosynthetics Contractor

This individual is also referred to as the "contractor" or "installer", and is the person or firm responsible for geosynthetic construction. This definition applies to any person installing FML or geotextile, even if not his primary function.

Nonconformance

This is a deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of non-conformances include, but are not limited to, physical defects, test failures, and inadequate documentation.

Operator

The organization that will operate the disposal unit (City of Denton).

Operator's Representative

This is the person that is an official representative of the operator responsible for planning, organizing, and controlling the design and construction activities.

Panel

This is a unit area of the FML which will be seamed in the field.

Quality Assurance (QA)

This is a planned and systematic pattern of procedures and documentation to ensure that items of work or services meet the requirements of the contract documents. QA includes quality control. QA will be performed by the POR and CQA monitor.

Quality Control (QC)

These actions provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the contract documents. QC will be performed by the contractor.

Soil and Liner Evaluation Report (SLER)

Construction report for the soil liner prepared and sealed by the POR and submitted to the TNRCC.

2 CONSTRUCTION QUALITY ASSURANCE FOR EARTHWORK AND DRAINAGE AGGREGATES

2.1 Introduction

This section of the SLQCP addresses the construction of the soil and drainage components of the liner system and outlines the SLQCP program to be implemented with regard to materials selection and evaluation, laboratory test requirements, field test requirements, and treatment of problems.

The scope of earthwork and related construction quality assurance includes the following elements:

- Subgrade preparation
- Soil liner stockpile
- Soil liner placement
- General fill
- Drainage aggregates
- Anchor trench backfill
- Protective cover
- Surface water removal
- Liner tie-in construction
- Excavation dewatering

2.2 Composite Liner

The proposed landfill is designed to include a base and sidewall liner. In general, the liner is designed and constructed to protect the underlying groundwater. The liner is a composite system with the components detailed in the construction plans and

specifications. The excavation base will be constructed to facilitate the collection and removal of leachate. The leachate flow will be directed to the exterior perimeter of the landfill where it will be collected from leachate sumps.

2.3 Earthwork Construction

The following subsections describe general construction procedures to be used for various earthwork components within the landfill. The earthwork construction specifications will contain more detail for specific considerations during landfill development. The earthwork specifications will include details for compaction of soils, cross sections showing typical slopes, widths, and thicknesses for compacted lifts.

2.3.1 Subgrade

Subgrade refers to a surface which is exposed after stripping topsoil or excavating to establish the grade directly beneath the soil liner.

The prepared subgrade must conform to the Excavation Plan of the permit. Prior to beginning liner construction, the subgrade area will be stripped to a depth sufficient to remove all loose surface soils or soft zones within the exposed excavation. The liner subgrade area will be proofrolled with heavy, rubber tired construction equipment to detect unstable areas. Unstable areas will be undercut to firm material and refilled with suitable compacted general fill. The fill will be free of organics, foreign objects, and other deleterious matter, compacted sufficiently to provide a firm base for soil liner placement. The subgrade preparation will be in accordance with project specifications.

Because the subgrade consists of in-situ soil and voids are expected to be minor, visual examination of the subgrade preparation by the CQA monitor will generally be sufficient to evaluate its suitability as a foundation for the subgrade. The CQA monitor may find that physical testing is necessary to evaluate the prepared subgrade or fill placed in large voids.

The CQA monitor will approve the prepared subgrade prior to the placement of soil liner or structural fill. Approval will be based on a review of test information, if applicable, and CQA monitoring of the subgrade preparation.

Surveying will be performed to verify that the finished subgrade is to the lines and grades specified in design with a vertical tolerance of -0.2 feet to +0.0 feet.

2.3.2 Soil Liner

The soil liner will consist of a minimum 2-foot-thick compacted soil (measured perpendicular to the subgrade surface) that will extend along the floor and side slopes of the landfill. All soils used in soil liners will have the following minimum values verified by testing in a soil laboratory: Plasticity Index equal to or greater than 15; Liquid Limit equal to or greater than 30; percent passing the No. 200 mesh sieve equal to or greater than 30 percent; percent passing the 1 inch screen equal to 100 percent; and, the permeability of the soil liner shall not exceed 1×10^{-7} cm/sec.

The soil liner material will consist of relatively homogeneous clay, sandy clay, or clayey sand. The soil will be free of debris, rock greater than 1 inch in diameter, plant materials, frozen materials, foreign objects, and organics. A permeability test will be conducted for each different sample of borrow soil. The permeability test specimens will be prepared by laboratory compaction to a dry density of approximately 95 percent of the standard Proctor maximum dry density at a moisture content approximately equal to the optimum moisture content. One Proctor moisture-density relationship and remolded permeability test will be required for each different material as determined by a change in the liquid limit or plasticity index of more than 10 points.

The soil liner material should be placed in maximum 8-inch loose lifts to produce compacted lift thickness of approximately 6 inches. The material will be compacted to a minimum of 95 percent of the maximum dry density determined by standard Proctor (ASTM D 698) at a moisture content equal to optimum moisture or greater. The CQA monitor, earthwork contractor, and/or Owner shall identify the clay material during excavation, and the clay material will be stockpiled separately, if stockpiling is required.

Because of some variability of the onsite materials, additional stockpile testing will be performed if different physical properties of the borrow soil (color, texture, etc.) are observed by the CQA monitor, and the materials vary by more than ten points in either liquid limit or plasticity index from previously evaluated materials.

The clay materials to be used for liner materials may require processing to achieve the required moisture content for compaction. The physical characteristics of the clay materials shall be evaluated through visual observation before and during construction. To add moisture to the material properly, the clod-sizes will first be crushed into manageable sizes of 1 inch in diameter or less. Rocks within the liner should be less than 1 inch in diameter and will not total more than 10 percent by weight. The prepared liner will be observed such that rock content will not be a detriment to the integrity of the overlying geomembrane.

Clod-size reduction may be achieved using a disc harrow or soil pulverizer. In order to efficiently break down the clods and pieces of shale, multiple passes of the processing equipment in two directions are recommended. Water will be applied as necessary to the

material and worked into the material with the processing or compacting equipment. If necessary to achieve even moisture distribution or break down clod, the material will be watered and processed in the stockpile prior to placing in the liner to allow the soil adequate time to hydrate. Water used for the soil liner must be clean and not contaminated by waste or any objectionable material. Collected onsite stormwater may be utilized if it has not come into contact with the solid waste.

The soil liner must be compacted with a pad/tamping-foot (preferable) or prong-foot (sheepsfoot) roller. The lift thickness shall be controlled so that there is total penetration through the loose lift under compaction into the top of the previously compacted lift; therefore, the lift thickness must not be greater than the pad or prong length. This is necessary to achieve adequate bonding between lifts and reduce seepage pathways. Adequate cleaning devices must be in place and maintained on the compaction roller so that the prongs or pad feet do not become clogged with clay soils to the point that they cannot achieve full penetration during initial compaction. The footed roller is necessary to achieve this bonding and to reduce the individual clods and achieve a blending of the soil matrix through its kneading action. In addition to the kneading action, weight of the compaction equipment is important. The minimum weight of the compactor should be 40,000 pounds, and a minimum of 4 passes are recommended for the compaction process. A pass is defined as one pass (1 direction) of the compactor, not just an axle, over a given area. The recommended minimum of five passes is for a vehicle with front and rear drums. The Caterpillar 815B and 825C are examples of equipment typically used to achieve satisfactory results.

The soil liner shall not be compacted with a bulldozer or any track-mobilized equipment unless it is used to pull a pad-footed roller.

CQA testing of the soil liner will be performed as the liner is being constructed. Testing of the soil liner is addressed in this section.

Soil liner construction and testing will be conducted in a systematic and timely fashion on each lift. Delays will be avoided in liner completion. Construction and testing of the soil liner should generally not exceed 60 working days from beginning to completion. The TNRCC will be notified during construction if delays in excess of 60 days are anticipated. Reasons for any liner construction taking more than 60 days to complete should be fully examined in the SLER submittal.

The finished surface of the soil liner must be rolled with a smooth, steel-wheeled roller to obtain a hard, uniform, and smooth surface. The surface of the soil liner shall then be carefully inspected by the CQA monitor for any gravel, rock pieces, and deleterious materials which might impact the integrity of the geomembrane to be placed upon it. All voids created by removing gravel, rock pieces, or other deleterious materials will be

backfilled with liner material to the density specifications outlined for soil liner construction and tested at the discretion of the CQA monitor.

Surveying will be performed to observe that the finished soil liner has been constructed to the design lines and grades, within a vertical tolerance of 0.0 feet to +0.2 feet.

The POR on behalf of the Owner shall submit to the TNRCC a SLER for approval of each soil liner area.

Testing and evaluation of the soil liner during construction will be in accordance with the TNRCC MSWDR and the most current Liner Construction and Testing Handbook. The construction methods and test procedures documented in the SLER will be consistent with the SLQCP, the TNRCC MSWDR, and the most current version of the Liner Construction and Testing Handbook.

The soil liner shall be prevented from losing moisture during the SLER approval process. Preserving the moisture content of the installed soil liner will be dependent on the earthwork contractors means and methods, and is subject to POR approval.

During the construction of continuous floor liners, the new liner segment will not be constructed by "butting" the entire thickness of the new liner directly against the edge of the old liner. The tie-in will be constructed either by a sloped transition (typical 5 horizontal to 1 vertical) or a stair-stepped transition (typically 1 lift thickness per step).

2.3.3 General Fill

General fill material placed below the composite liner will be placed in uniform lifts which do not exceed 12 inches in loose thickness and are compacted to at least 90 percent of standard Proctor (ASTM D 698) at a moisture content ranging from 2 percentage points below optimum to 5 percentage points above optimum (-2 to +5).

2.3.4 Drainage Aggregate Around Pipes

The coarse aggregate selected for placement around the leachate collection pipes and for temporary hydrostatic relief systems further referenced in Section 5 will consist of normal or lightweight materials that comply with the project specifications. The LCS aggregate shall have a calcium carbonate content less than 15 percent (in accordance with the J&L method or ASTM D 3042 modified to use a solution of hydrochloric acid having a pH of 4). The drainage aggregate shall meet the gradation for ASTM C-33, size number 57 (nominal 1 inch to No. 4). Coarse aggregates not complying with the size number 57 gradation may also be approved if demonstrated to have a hydraulic conductivity of at

least 1.0×10^{-2} cm/sec and meet the filter gradation requirements given below for the specific leachate collection pipe perforation design:

For circular holes:

$$\frac{\text{85 Percent Size of Filter Material}}{\text{Hole Diameter}} > 1.7$$

For slots:

$$\frac{\text{85 Percent Size of Filter Material}}{\text{Slot Width}} > 2.0$$

The coarse aggregate shall be tested for gradation (ASTM D 422) at the supply source or from the on-site stockpile prior to acceptance. Gradation testing shall be conducted at a minimum frequency of 1 test per 3,000 cubic yards or per lined area. The aggregate shall be free of organics, angular rocks, foreign objects, or other deleterious materials. The physical characteristics of the aggregate shall be evaluated through visual observation and laboratory classification testing before construction and visual observation during construction. The coarse aggregate may be tested during construction at the discretion of the CQA monitor. The test results for the coarse aggregate will be included in the GLER.

2.3.5 Drainage Layer Aggregate (Option to Geocomposite Drainage Layer)

An aggregate drainage layer may be used as an alternate to a geocomposite drainage layer. The aggregate will consist of granular materials having a coefficient of permeability of at least 1.0×10^{-2} cm/sec and comply with any other specified project requirements. The drainage aggregate should be tested by the CQA monitor for gradation (ASTM D 422) and permeability (ASTM D 2434) at a minimum of 1 test per 3,000 cubic yards or per lined area. The aggregate shall be free of organics, foreign objects, or other deleterious materials. The physical characteristics of the aggregate shall be evaluated through visual observation and laboratory testing before construction and visual observations during construction. The aggregate may be tested during construction at the discretion of the CQA monitor. If the aggregate material includes significant angular stone or has a nominal maximum size greater than $^3/_8$–inch, the geomembrane will be protected with a cushion geotextile.

The aggregate drainage layer will be placed using low ground-pressure equipment as outlined in Section 3.6. The drainage layer shall be placed by spreading a minimum of 12 inches of material in front of the spreading equipment. Under no circumstances shall the construction equipment come in direct contact with the installed geosynthetics.

The thickness of the drainage layer shall be verified with surveying procedures at a minimum of 1 survey point per 5,000 square feet of constructed area by a registered Texas surveyor with a minimum of 2 reference points. The test results for the drainage layer aggregate (if used) will be included in the GLER. During construction, the CQA monitor will:

- Verify that grade control is performed prior to work.
- Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls and mark damaged geosynthetics and verify that damage is repaired.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications. (See Section 3.6)
- The POR will coordinate with the project surveyor to perform a thickness verification survey of the granular drainage materials upon completion of placement operations and verify corrective action measures as determined by the verification survey.

2.3.6 Protective Cover

Protective cover will be placed over the drainage layer in accordance with the project plans and specifications. The geosynthetics of the composite liner system will be covered with a minimum of 2 feet of protective cover (including general fill, or drainage aggregate, where applicable). The protective cover shall be free of organics, foreign objects, or other deleterious materials. The physical characteristics of the protective cover shall be evaluated through visual observation (and laboratory testing if justified by the design requirements) before construction and visual observation during construction. Additional testing during construction will be at the discretion of the CQA monitor. The protective cover material will have a permeability of 1.0×10^{-4} cm/sec or greater unless passageways (i.e., chimney drains) are provided to allow moisture to drain to the leachate collection system.

The protective cover layer will be placed using low ground pressure equipment as outlined in Section 3.6. The protective cover shall be placed by spreading in front of the spreading equipment with a minimum of 12 inches of soil between the spreading equipment and the installed geosynthetics. Under no circumstances shall the construction equipment come in direct contact with the installed geosynthetics.

The thickness of the protective cover shall be verified with surveying procedures at a minimum of 1 survey point per 5,000 square feet of constructed area by a registered

Texas surveyor with a minimum 2 reference points. The survey results for the protective cover will be included in the GLER.

During construction the CQA monitor will:

- Verify that grade control is performed prior to work.
- Verify that underlying geosynthetic installations are not damaged during placement operations or by survey grade controls and mark damaged geosynthetics and verify that damage is repaired.
- Verify that the cover soil for sideslopes is pushed from the toe up the slope.
- Monitor haul road thickness over geosynthetic installations and verify that equipment hauling and materials placement meet equipment specifications. (See Section 3.6)
- The POR will coordinate with the project surveyor to perform a thickness verification survey of the protective cover materials upon completion of placement operations and verify corrective action measures as determined by the verification survey.

2.3.7 Anchor Trench Backfill

The anchor trench backfill material will be placed as outlined in the project specifications. It is recommended that the requirements follow the general fill/structural fill requirements as defined in Section 2.3.3. In place moisture/density tests may be taken at the discretion of the CQA monitor to evaluate the quality of the backfill. The test results will not be required as part of the GLER, however. Slightly rounded corners will be provided in anchor trenches where the geomembrane enters the trench so as to avoid sharp bends in the geomembrane.

2.3.8 Surface Water Removal

The excavation may encounter water from storm events. Soil liner will not be placed in standing water. The excavation area will therefore have a temporary sump area to collect water entering the excavation and be graded to allow drainage at planned areas. Portable pumps will be on site to dewater the sumps. Temporary levees will be constructed to divert surface flow away from the excavation.

2.3.9 Excavations Below Groundwater

Groundwater may be encountered in the sandy units of soils at this facility. Sloped underdrain trenches are planned to provide temporary dewatering for construction and relief of hydrostatic pressure on the bottom of the liner. Construction of liners below groundwater is discussed in more detail in Section 5 of this document.

2.3.10 Liner Tie-In Construction

Newly constructed liners will be tied-in with any adjoining existing liners. Additionally, terminations will be constructed for future tie-ins along edges where the liner will be extended in the future. The tie-ins with existing clay liners will be constructed utilizing a sloped or stair-stepped transition approximately 10 feet wide (for a 2-foot-thick clay liner) as illustrated in the Liner Construction and Testing Handbook published by TNRCC. In general, terminations for future tie-ins will be constructed by extending the clay liner approximately 10 feet past the limits for the cell under construction. Waste and daily/intermediate cover will not be deposited closer than 10 feet to the edge of any cell or 20 feet from the leading edge of a constructed clay liner (whichever is greater) where a future tie-in will be constructed. Red-colored markers (i.e., SLER markers) will be placed along the outside edge of the constructed clay liners and tied to the site grid system in accordance with 30 TAC Chapter 330.55(b)(10)(A)(v) & (B)(v).

2.4 Construction Testing

2.4.1 Standard Operating Procedures

CQA monitors will perform field and laboratory tests in accordance with applicable standards specified in the project technical specifications. Standard operating procedures for soil testing will be prepared that describe test procedures and methods used by site testing personnel for the following ASTM test methods. In some instances the standard operating procedure will be prepared or modified by the POR during construction.

The following test standards apply as called out in this manual and in the technical specifications:

Standard	Test Description
ASTM D 698	Moisture-density relations of soils and soil-aggregate mixtures, using 5½-lb hammer and 12-inch drop
ASTM D 422	Particle size analysis of soils
ASTM D 1556	Density of soil-in-place by the sand cone method
ASTM D 2167	Density and unit weight of a soil in place by the rubber balloon method
ASTM D 2922	Density of soil and soil-aggregate in place by nuclear methods (shallow depth)
ASTM D 3017	Water content of soil and rock in place by nuclear methods (shallow depth)
ASTM D 2216	Laboratory determination of water (moisture) content of soil, rock, and soil-aggregate mixtures
ASTM D 2434	Method of test for permeability of porous granular material
ASTM D 5084	Method of test for permeability of fine-grained soils
ASTM D 4318	Atterberg limits
ASTM D 1140	Amount of material in soils finer than the No. 200 sieve
ASTM D 2487	Classification of soils for engineering purposes
ASTM D 2488	Description and identification of soils (visual-manual procedure)
EM 1110-2-1906	U.S. Army Corps of Engineers permeability test

2.4.2 Test Frequencies

The latest LCTH of the TNRCC will establish the minimum test frequencies for the soil liner construction quality assurance. The test frequencies for soil liner from the current LCTH (July 1, 1994) are listed in Table 2.1. Extra testing must be conducted whenever work or materials are suspect, marginal, or of poor quality. Extra testing may also be performed to provide additional data for engineering evaluation. The minimum number of tests is interpreted to mean minimum number of passing tests, and any tests that do not meet the requirements will not contribute to the total number of tests performed to satisfy the minimum test frequency.

Table 2.1
Recommended Tests and Observations on Compacted Clay Liner

Parameter	Frequency	Test Method
Moisture density relationship	1 for each soil type, minimum 1 per cell.	ASTM D 698
Field Density and Moisture	1 each 8,000 SF per 6 inches	ASTM D 1556, D 2167 or D 2922; and ASTM D 2216 or ASTM D 3017
Sieve Analysis (passing no. 200)	1 per 100,000 SF with a minimum of 1 per 6 inches	ASTM D 1140
Atterberg Limits (liquid and plastic limit)	1 per 100,000 SF with a minimum of 1 per 6 inches	ASTM D 4318
Permeability (Hydraulic Conductivity)	1 per 100,000 SF with a minimum of 1 per 6 inches	ASTM D 5084 (Falling head, flex wall) Corps of Engineers EM 1110-2-1906 (Falling head permeameter)
Thickness Verification	1 each 5,000 SF with a minimum of 2 reference points by a registered Texas surveyor	Survey subgrade and top of clay liner. Additionally, survey top of each drainage or protective cover layer

2.5 Reporting

The POR on behalf of the Owner shall submit to the TNRCC a SLER for approval of each soil liner area. Section 6 describes the documentation requirements.

3 CONSTRUCTION QUALITY ASSURANCE FOR GEOSYNTHETICS

3.1 Introduction

This section describes CQA procedures for the installation of geosynthetic components.

The scope of geosynthetic related construction quality assurance includes the following elements:

- 60-mil high density polyethylene (HDPE) geomembrane
- Geotextiles
- Drainage geocomposite

The overall goal of the geosynthetics quality assurance program is to assure that proper construction techniques and procedures are used, the geosynthetic contractor implements his QC plan in accordance with this SLQCP, and that the project is built in accordance with the project construction drawings and technical specifications. The QA program is intended to identify and define problems that may occur during construction and to observe that these problems are avoided and/or corrected before construction is complete. A construction report and GLER, prepared after project completion, will document that the constructed facility meets design intent and specifications.

3.2 Geosynthetics Quality Assurance

3.2.1 General

The composite liner system provides the primary means for preventing leachate infiltration into groundwater. A geomembrane is a component of the composite liner. Proper geomembrane installation is a crucial work element which greatly affects the performance of the composite liner system. Construction QC for the geosynthetics installation will be performed by the geosynthetics installation contractor. Construction QA for the geosynthetics installation will be performed by the POR to assure the geosynthetics is constructed as specified in the design. Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, a QA program will include the following:

- A review of the contractor's QC submittals
- Material conformance testing
- Construction testing
- Construction monitoring

The contractor's QC submittals will include resin and geomembrane testing. The required tests are summarized in Table 3.2.

Conformance testing refers to activities that take place prior to material installation. Construction testing includes activities that occur during geosynthetics installation.

All quality assurance testing will be conducted in accordance with this SLQCP, the project construction drawings and specifications, and the most current version of the LCTH. Where there is a discrepancy, the most stringent requirement will govern, unless otherwise specified by the Owner. Field testing will be observed by the CQA monitor. Documentation must meet the requirements of this SLQCP.

Table 3.2
Required Contractor's Quality Control Testing Submittals for Geomembranes

Test	Type of Test	Standard Test Method	Frequency of Testing (Minimum)
Resin	Specific Gravity/Density	ASTM D 792, Method A or ASTM D 1505	Per 100,000 SF and every resin lot
	Melt Flow Index	ASTM D 1238	Per 100,000 SF and every resin lot
Manufacturer's Quality Control	Thickness	ASTM D 5199 (smooth) or D5994[A] (textured)	Per Roll of Geomembrane
	Specific Gravity/Density	ASTM D 1505/D 792	Per 200,000 pounds
	Carbon Black Content	ASTM D 1603	Per 20,000 pounds
	Carbon Black Dispersion	ASTM D D 5596	Per 45,000 pounds
	Tensile Properties	ASTM D 638 / Type IV	Per 20,000 pounds
	Tear	ASTM D 1004	Per 45,000 pounds
	Puncture	ASTM D 4833	Per 45,000 pounds
	Stress Crack Resistance	D 5397	Per GRI-GM 10
	Oxidative Induction Time	D 3895 or D 5885	Per 200,000 pounds
	Oven Aging @ 85	D 5721 and D 3895 or D5885	Per each formulation

[A] ASTM D 1593 may also be used for thickness of textured geomembrane at the option of the POR

3.3 Geomembrane

3.3.1 Delivery

Upon delivery of FML, the CQA monitor will observe that:

- The geomembrane is delivered in rolls and is not folded. Folded geomembrane is not acceptable because the highly crystalline structure of the geomembrane will be damaged if it is folded. Any evidence of folding (other than from the manufacturing process) or other shipping damage is cause for rejection of the material.

- Equipment used to unload and store the rolls or pallets does not damage the geomembrane.

- The geomembrane is stored in an acceptable location in accordance with the specifications and stacked not more than 5 rolls high. The geomembrane is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, or other damage.

- All manufacturing documentation required by the specifications has been received and reviewed for compliance with the specifications. This documentation will be included in the GLER.

- The geosynthetics receipt log form has been completed for all materials received.

Damaged geomembrane may be rejected and removed from the site or stored at a location separate from accepted geomembrane. Geomembrane that does not have proper manufacturer's documentation must be stored at a separate location until all documentation has been received, reviewed, and accepted.

3.3.2 Conformance Testing

Tests. One geomembrane sample will be obtained for every resin lot of material supplied and for each 100,000 square feet of geomembrane installed. The material will be sampled at the site by the CQA monitor or at the manufacturing plant by the third party laboratory. The samples will be forwarded to the third-party laboratory for the following conformance tests:

- Specific gravity/Density (ASTM D 1505 or alternate ASTM D 792, Method A if approved by the POR)

- Carbon black content (ASTM D 1603)
- Carbon black dispersion (ASTM D 5596 or alternate ASTM D 3015/NSF 54 if approved by POR)
- Thickness (ASTM D 5199 for smooth FML and for textured FML use ASTM D 5994 or alternate ASTM D 1593 if approved by POR)
- Tensile properties (ASTM D 638/Type IV)

The density of the geomembrane must be greater than 0.94 g/cc; the carbon black content must be between 2 percent and 3 percent; and recycled or reclaimed material must not be used in the manufacturing process.

The design engineer may require additional test procedures, and will inform the third party laboratory in writing. The POR must review all test results and report any nonconformance to the design engineer prior to product installation. In addition to the conformance thickness tests shown above, field thickness measurements must be taken at maximum 5-foot intervals along the leading edge of each geomembrane panel. No single measurement may be less than 10 percent below the required nominal thickness for the panel to be accepted (i.e., for 60-mil geomembrane a minimum thickness of 54 mils is required) and the average must be at least 60 mils.

Sampling Procedure. Samples will be taken across the entire roll width. Unless otherwise specified, samples should be approximately 15 inches long by the roll width. The CQA monitor must mark the machine direction and the manufacturer's roll identification number on the sample. The CQA monitor must also assign a conformance test number to the sample and mark the sample with that number.

3.3.3 Geomembrane Installation

Surface Preparation. The soil surface must be graded to within 0.0 and +0.2 feet of the grades shown on the drawings. Prior to any geomembrane installation, the subgrade should be inspected by the CQA and geosynthetics contractor. The POR or CQA monitor must observe the following:

- All lines and grades for the soil liner have been verified by the contractor.
- The soil liner has been prepared in accordance with the earthwork specification.
- The soil liner has been rolled and compacted to be free of surface irregularities, loose soil, and protrusions.

- The soil liner surface does not contain stones or other objects that could damage the geomembrane.
- The anchor trench dimensions have been checked, and the trenches are free of sharp objects and stones.
- There are no excessively soft areas that could result in geomembrane damage.
- The geomembrane will not be placed during inclement weather such as rain or high winds.
- The soil liner is not saturated, and no standing water is present.
- The soil liner has not desiccated.
- All construction stakes and hubs have been removed and the resultant holes have been backfilled. There are no rocks, debris, or any other objects on the soil liner surface.
- The geosynthetics contractor has certified in writing that the surface on which the geomembrane will be installed is acceptable.

Panel Placement. Prior to the installation of the geomembrane, the contractor must submit drawings showing the panel layout, indicating panel identification number, both fabricated (if applicable) and field seams, as well as details not conforming to the drawings.

The CQA monitor must maintain an up-to-date panel layout drawing showing panel numbers that are keyed to roll numbers on the placement log. The panel layout drawing will also include seam numbers and destructive test locations.

During panel placement, the POR or CQA monitor must:

- Record roll numbers, panel numbers, and dimensions on the panel or seam logs. Measure and record thickness of leading edge of each panel at 5-foot maximum intervals. No single thickness measurement can be less than 10 percent below the required nominal thickness.
- Observe the sheet surface as it is deployed and record all panel defects and repair of the defects (panel rejected, patch installed, extradite placed over the defect, etc.) on the repair sheet. All repairs must be made in accordance with the specifications and located on a repair drawing.

- Observe that support equipment is not allowed on the geomembrane during handling. (See Section 3.6) EXHIBIT 3

- Observe that the surface beneath the geomembrane has not deteriorated since previous acceptance.

- Observe that there are no stones, construction debris, or other items beneath the geomembrane that could cause damage to the geomembrane.

- Observe that the geomembrane is not dragged across a surface that could damage the material. If the geomembrane is dragged across an unprotected surface, the geomembrane must be inspected for scratches and repaired or rejected, as necessary.

- Record weather conditions including temperature, wind, and humidity. The geomembrane must not be deployed in the presence of excess moisture (fog, dew, mist, etc.). In addition, geomembrane should not be placed when the air temperature is less than 40°F, or when standing water or frost is on the ground, unless this requirement is waived by the design engineer. Excessive wind is that which can lift and move the geomembrane panels.

- Observe that people working on the geomembrane do not smoke, wear shoes that could damage the liner, or engage in activities that could damage the liner.

- Observe that the method used to deploy the sheet minimizes wrinkles but does not cause bridging and that the sheets are anchored to prevent movement by the wind (the contractor is responsible for any damage to or from windblown geomembrane). Excessive wrinkles should be walked-out or removed at the discretion of the CQA monitor.

- Observe that no more panels are deployed than can be seamed on the same day.

- Observe that there are no horizontal seams on side slopes, and the textured material extends a minimum of approximately 5 feet out past the toe of the slope.

The CQA monitor must inform both the contractor and the POR of the above conditions.

Field Seaming. The contractor must provide the POR with a seam and panel layout drawing and update this drawing daily as the job proceeds. No panels should be seamed until the panel layout drawing has been accepted by the POR. A seam numbering system must provide a unique number for each seam and be agreed to by the POR and contractor prior to the start of seaming operations. One procedure is to identify the seam by adjacent

panels. For example, the seam located between Panels 306 and 401 would be Seam No. 306/401.

Prior to geomembrane welding, each welder and welding apparatus (both wedge and extrusion welders), must be tested, at a minimum, at daily start-up and at midday break, in accordance with the specifications to determine if the equipment is functioning properly. The GLER should include the names for each seamer and the time and the temperatures for each seaming apparatus used each day. One trial weld should be taken prior to the start of work. The trial weld sample must be 3 feet long and 12 inches wide, with the seam centered lengthwise. The minimum number of specimens per trial weld test must be two coupons for shear and two coupons for peel. Both the inner and outer welds of dual track fusion welds must be tested for each peel test coupon (or additional coupons will be required). The CQA monitor must observe all welding operations, quantitative testing of each trial weld for peel and shear, and recording of the results on the trial weld form. It is very important that the trial weld be completed under conditions similar to those under which the panels will be welded. The trial weld break must be ductile and exhibit film tear bond (FTB) in accordance with National Sanitation Foundation (NSF) Standard 54, definition 2.15. Additionally, there should be no apparent weld separation (i.e., greater than 1/8 inch). The peel strength shall be at least 62 percent of the manufacturer's parent sheet strength but not less than 78 ppi, and the minimum shear strength shall be at least 95 percent of the manufacturer's parent sheet strength, but not less than 120 ppi. For dual-track fusion welds, both sides (the inner and outer weld) must meet the minimum requirements for a satisfactory peel test. If, at any time, the CQA monitor believes that an operator or welding apparatus is not functioning properly, a weld test must be performed. If there are wide changes in temperature (±30°F), humidity, or wind speed, the test weld should be repeated. The test weld must be allowed to cool to ambient temperature before testing.

Construction QA documentation of trial seam procedures shall include, at a minimum, the following:

- Documentation that trial seams are performed by each welder and welding apparatus prior to commencement of welding and prior to commencement of the second half of the workday.
- The welder, the welding apparatus number, time, date, ambient air temperature, and welding machine temperatures.

During geomembrane welding operations, the CQA monitor must observe the following:

- The contractor has the number of welding apparatuses and spare parts necessary to perform the work.
- Equipment used for welding will not damage the geomembrane.

- The extrusion welder is purged prior to beginning a weld until all the heat-degraded extradite is removed (extrusion welding only).
- Seam grinding has been completed less than one hour before seam welding, and the upper sheet is beveled (extrusion welding only).
- The ambient temperature, measured 6 inches above the geomembrane surface, is between 41° and 104° Fahrenheit.
- The end of old welds, more than five minutes old, are ground to expose new material before restarting a weld (extrusion welding only).
- The contact surfaces of the sheets are clean, free of dust, grease, dirt, debris, and moisture prior to welding.
- The weld is free of dust, rocks, and other debris.
- The seams are overlapped a minimum of 3 inches for extrusion and hot-wedge welding, or in accordance with manufacturer's recommendations, whichever is more stringent. Panels should be overlapped (shingled) in the down-grade direction.
- No solvents or adhesives are present in the seam area.
- The procedure used to temporarily hold the panels together does not damage the panels and does not preclude CQA testing.
- The panels are being welded in accordance with the plans and specification. Seams should be oriented parallel to the line of maximum slope with no horizontal seams on side slopes. In corners and odd-shaped geometric locations, the number of field seams should be minimized.
- There is no free moisture in the weld area.
- Measure surface sheet temperature every two hours.
- Observe that at the end of each day or installation segment, all unseamed edges are anchored with sandbags or other approved device. Penetration anchors shall not be used to secure the geomembrane.

3.3.4 Construction Testing

Nondestructive Seam Testing. The purpose of nondestructive testing is to detect discontinuities or holes in the seam. It also indicates whether a seam is continuous and non-leaking. Nondestructive tests for geomembrane include vacuum testing and air pressure testing. Nondestructive testing must be performed over the entire length of the seam.

Nondestructive testing is performed entirely by the contractor. The CQA monitor's responsibility is to observe and document that testing performance is in compliance with the specifications and document any seam defects and their repairs.

Nondestructive testing procedures are described below.

- For welds tested by vacuum method, the weld is placed under suction utilizing a vacuum box made of rigid housing with a transparent viewing window, a soft neoprene rubber gasket attached to the open bottom perimeter, a vacuum gauge on the inside, and a valve assembly attached to the vacuum hose connection. The box is placed over a seam section which has been thoroughly saturated with a soapy water solution (1 oz. soap to 1 gallon water). The rubber gasket on the bottom perimeter of the box must fit snugly against the soaped seam section of the liner, to ensure a leak-tight seal. The vacuum pump is energized, and the vacuum box pressure is reduced to approximately 3 to 5 psi gauge. Any pinholes, porosity, or non-bonded areas are detected by the appearance of soap bubbles in the vicinity of the defect. Dwell time must not be less than ten seconds.

- Air pressure testing is used to test double seams with an enclosed air space. Both ends of the air channel should be sealed. The pressure feed device, usually a needle equipped with a pressure gauge, is inserted into the channel. Air is then pumped into the channel to a minimum pressure of 30 psi or ½ psi per mil of geomembrane thickness, whichever is greater. The air chamber must sustain the pressure for five minutes without losing more than 4 psi. Following a passed pressure test, the opposite end of the tested seam must be punctured to release the air. The pressure gauge must return to zero; if not, a blockage is most likely present in the seam channel. Locate the blockage and test the seam on both sides of the blockage. The penetration holes must be sealed after testing.

During nondestructive testing, the CQA monitor must perform the following work:

- Review technical specifications regarding test procedures.

- Observe that equipment operators are fully trained and qualified to perform their work.

- Observe that test equipment meets project specifications.
- Observe that the entire length of each seam is tested in accordance with the specifications.
- Observe all continuity testing and record results on the appropriate log.
- Observe that all testing is completed in accordance with the project specifications.
- Identify the failed areas by marking the area with a waterproof marker compatible with the geomembrane and inform the contractor of any required repairs, then record the repair area on the repair log.
- Observe that all repairs are completed and tested in accordance with the project specifications.
- Record all completed and tested repairs on the repair log and the repair drawing.

Destructive Seam Testing. Destructive seam tests for geomembrane seams will be performed at intervals of at least one test per 500 lineal feet or in accordance with the most current TNRCC Technical Guide. The CQA monitor must perform additional tests if he suspects a seam does not meet specification requirements. Reasons for performing additional tests may include, but are not limited to the following:

- Wrinkling in seam area
- Non uniform weld
- Excess crystallinity
- Suspect seaming equipment or techniques
- Weld contamination
- Insufficient overlap
- Adverse weather conditions
- Possibility of moisture, dust, dirt, debris, and other foreign material in the seam
- Failing tests

There are two types of destructive testing required for the geomembrane installation: peel adhesion (peel) and bonded seam strength (shear) in accordance with ASTM D 4437. The purpose of peel and shear tests is to evaluate seam strength and to evaluate long-term performance. Shear strength measures the continuity of tensile strength through the seam and into the parent material. Peel strength determines weld quality. Test welds must be allowed to cool naturally to ambient temperature prior to testing.

The CQA monitor selects locations where seam samples will be cut for laboratory testing. Select these locations as follows:

- A minimum of one random test within each 500 feet of seam length. This is an average frequency for the entire installation; individual samples may be taken at greater or lesser intervals.
- Sample locations should not be disclosed to the contractor prior to completion of the seam.
- A maximum frequency must be agreed to by the contractor, POR, and the Owner at the preconstruction meeting. However, if the number of failed samples exceeds 5 percent of the tested samples, this frequency may be increased at the discretion of the POR. Samples taken as the result of failed tests do not count toward the total number of required tests.

Sampling Procedures. The contractor will remove samples at locations identified by the CQA monitor. The CQA monitor must:

- Observe sample cutting.
- Mark each sample with an identifying number which contains the seam number and destructive test number.
- Record sample location on the panel layout drawing and destructive seam log.
- Record the sample location, weather conditions, and reason sample was taken (e.g., random sample, visual appearance, result of a previous failure, etc.).

For each destructive test obtain one sample approximately 45 inches long by 12 inches wide, with the weld centered along the length. Cut two 1-inch-wide coupons from each end of the sample. The contractor must test two of these coupons in shear and two in peel (one shear and one peel from each end) using a tensiometer capable of quantitatively measuring the seam strengths. For double wedge welding, both sides of the air channel shall be tested in peel. The CQA monitor must observe the tests and record the results on the destructive seam test log. A geomembrane seam sample passes the field testing when the break is FTB and the seam strength meets the required strength values for peel and

shear given previously for trial seams under field seaming and below for third party laboratory testing. As previously discussed, both welds have to pass for dual-track welds. Also, it is recommended that additional samples be obtained as discussed in the following paragraph if there is apparent separation of the weld (i.e., greater than 1/8 inch) during peel testing.

If one or both of the 1-inch specimens fail in either peel or shear, the contractor can, at his discretion: (1) reconstruct the entire seam between passed test locations, or (2) take two additional test samples 10 feet or more in either direction from the point of the failed test and repeat this procedure. For tracking purposes the additional samples should be identified by assigning an identifying letter to the initial destructive test sample number (e.g., DS-6A and B). Only satisfactory tests count toward the required minimum number, and additional tests (i.e., A and B) count as one test, if passing. If the second set of tests pass, the contractor can reconstruct or cap-strip the seam between the two passed test locations. If subsequent tests fail, the sampling and testing procedure is repeated until the length of the poor quality seam is established. Repeated failures indicate that either the seaming equipment or operator is not performing properly, and appropriate corrective action must be taken immediately.

If the field test coupons are satisfactory, divide the remaining sample into three parts: one 12-inch by 12-inch section for the contractor, one 12-inch by 16-inch section for the third party laboratory for testing, and one 12-inch by 12-inch section for the owner to archive. The laboratory sample will be shipped to the third party laboratory for over-night deliver and next day testing.

If the laboratory test fails in either peel or shear, the contractor must either reconstruct the entire seam between passing test locations or recover additional samples at least 10 feet on either side of the failed sample for retesting. Sample size and disposition must be as described in the preceding paragraph. This process is repeated until passed tests bracket the failed seam section. All seams must be bounded by locations from which passing laboratory tests have been taken. Laboratory testing governs seam acceptance. In no case can field testing of repaired seams be used for final acceptance.

Third Party Laboratory Testing. Destructive samples must be shipped to the third party laboratory for seam testing. Testing for each sample shall include 5 bonded seam shear strength tests and 5 peel adhesion tests (10 for dual-track welds). For dual-track welds each peel test specimen (coupon) shall be tested on both sides of the air channel (i.e., the inner and outer welds). All of the specimens must fail in FTB (National Sanitation Foundation (NSF) Standard 54, definition 2.15). At least four of the five specimens tested in peel and shear shall meet the minimum strength requirements. The minimum peel test strength value will be 62 percent of the manufacturer's parent sheet strength and not less than 78 ppi. The minimum shear test strength value will be 95 percent of the manufacturer's parent sheet strength and not less than 120 ppi. For dual-

track welds if either weld exhibits greater than 10 percent separation or does not meet the required strength, that coupon is considered out of compliance and two out of compliance coupons cause the weld to fail. The third party laboratory must provide test results within 24 hours, in writing or via telephone, to the GP. Certified test results are to be provided within 5 days. The CQA monitor must immediately notify the GP in the event of a calibration discrepancy or failed test results.

Passing Criteria for Welds

A passing extrusion or fusion welded seam will be achieved in peel when:

- Failure for all 5 specimens is by FTB.
- Yield strength for 4 of 5 specimens (10 tests for dual-track welds) is not less than the above minimum peel strength value and the average of all 5 specimens is not less than the minimum value.

A passing extrusion or fusion weld will be achieved in shear when:

- Failure for all 5 specimens is by FTB.
- Yield strength for 4 of 5 specimens is not less than the above minimum shear strength value and the average for all 5 specimens is not less than the minimum value.

3.3.5 Repairs

Any portion of the geomembrane with a detected flaw, or which fails a nondestructive, or destructive test, or where destructive tests were cut, or where nondestructive tests left cuts or holes, must be repaired in accordance with the specifications. The CQA monitor must locate and record all repairs on the repair sheet and panel layout drawing. Repair techniques include the following:

- Patching - used to repair large holes, tears, large panel defects, undispersed raw materials, contamination by foreign matter, and destructive sample locations.
- Extrusion - used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than $\frac{3}{8}$-inch in the largest dimension.
- Capping - used to repair failed welds or to cover seams where welds or bonded sections cannot be nondestructively tested.

- Removal - used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles, fishmouths, intersections, etc.) from the installed geomembrane. Areas of removal shall be patched or capped.

Repair procedures include the following:

- Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one hour prior to the repair.
- Clean and dry all surfaces at the time of repair.
- Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of material to be patched and the patches to a radius of at least 3 inches. Bevel the top edges of patches prior to extrusion welding.

3.3.6 Wrinkles

During placement of cover materials over the geomembrane, temperature changes or creep can cause wrinkles to develop in the geomembrane. Any wrinkles which can fold over must be repaired either by cutting out excess material or, if possible, by allowing the liner to contract by temperature reduction. In no case can material be placed over the geomembrane which could result in the geomembrane folding. The CQA monitor must monitor geomembrane for wrinkles and notify the contractor if wrinkles are being covered by soil. The CQA monitor is then responsible for documenting corrective action to remove the wrinkles.

3.3.7 Folded Material

All folded geomembrane must be removed. Remnant folds evident after deployment of the roll which are due to manufacturing process are acceptable.

3.3.8 Geomembrane Anchor Trench

The geomembrane anchor trench will be left open until seaming is completed. Expansion and contraction of the geomembrane should be accounted for in the liner placement. Prior to backfilling, the depth of penetration of the geomembrane into the anchor trench must be verified by the CQA monitor at a minimum of 100-foot spacings along the anchor trench. The anchor trench should be filled in the morning when temperatures are coolest to reduce bridging of the geomembrane.

3.3.9 Geomembrane Acceptance

The contractor retains all ownership and responsibility for the geomembrane until acceptance by the Owner. In the event the contractor is responsible for placing cover over the geomembrane, the contractor retains all ownership and responsibility for the geomembrane until all required documentation is complete, and the cover material is placed. After panels are placed, seamed, tested successfully, and any repairs are made, the completed installation will be walked by the Owner's and contractor's representatives. Any damage or defect found during this inspection will be repaired properly by the installer. The installation will not be accepted until it meets the requirements of both representatives. In addition, the geomembrane will be accepted by the POR only when the following has been completed:

- The installation is finished.
- All seams have been inspected and verified to be acceptable.
- All required laboratory and field tests have been completed and reviewed.
- All required contractor-supplied documentation has been received and reviewed.
- All as-built record drawings have been completed and verified by the POR. The as-built drawings show the true panel dimensions, the location of all seams, trenches, pipes, appurtenances, and repairs.
- Acceptance of the GLER by TNRCC.

3.3.10 Bridging

Unless approved by the POR, bridging must be removed.

3.4 Geotextiles

3.4.1 Delivery

During delivery the CQA monitor must observe the following:

- Equipment used to unload the rolls will not damage the geotextile.
- Rolls are wrapped in impermeable and opaque protection covers.
- Care is used when unloading the rolls.

- All documentation required by this SLQCP and the specifications has been received and reviewed for compliance with the specifications.
- Each roll is marked or tagged with the manufacturer's name, project identification, lot number, roll number, and roll dimensions.
- Materials are stored in a location that will protect the rolls from precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

Any damaged rolls must be rejected and removed from the site or stored at a location separate from accepted rolls, designated by the Owner. All rolls which do not have proper manufacturer's documentation must also be stored at a separate location until all documentation has been received and approved.

3.4.2 Testing

The geotextile manufacturer shall conduct manufacturer quality control (MQC) testing and certify that the materials delivered to the site comply with project specifications. The material certification shall be reviewed by the POR and approved for the project prior to acceptance of any of the material. The MQC testing should include the following tests with at least one test for each 100,000 square feet of geotextile delivered.

- Grab tensile strength/elongation (ASTM D4632)
- Mass per unit area (ASTM D5261)
- Thickness (ASTM D5199)
- Puncture resistance (ASTM D4833)
- Mullen burst (ASTM D3786)
- Trapezoidal Tear Strength (ASTM D4533)
- Hydraulic tests (ASTM D4491)
- Apparent opening size (ASTM D4751)

Where optional procedures are noted in the test method, the specification requirements prevail. The POR will review all test results and report any nonconformance.

3.4.3 Geotextile Installation

Surface Preparation. Prior to geotextile installation, the CQA monitor must observe the following:

- All lines and grades have been verified by the surveyor.
- The supporting surface does not contain stones that could damage the geotextile or the underlying geomembrane.
- There are no excessively soft areas that could result in damage to the geotextile or the underlying geomembrane.
- All construction stakes and hubs have been removed.

Geotextile Placement. During geotextile placement, the CQA monitor must:

- Observe the geotextile as it is deployed, and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Observe that equipment used does not damage the geotextile by handling, equipment transit, leakage of hydrocarbons, or other means.
- Observe that people working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- Observe that the geotextile is securely anchored in an anchor trench.
- Observe that the geotextiles are anchored to prevent movement by the wind.
- Observe that the panels are overlapped in accordance with the specifications.
- Examine the geotextile after installation to ensure that no potentially harmful foreign objects are present.
- Observe that seams (where required) are continuously sewn or thermal bonded in accordance with the manufacture's recommendations and the project specifications.

The CQA monitor must inform both the contractor and POR if the above conditions are not met.

3.4.4 Repairs

Repair procedures include:

- Patching – used to repair large holes, tears, large defects, and destructive sample locations.
- Removal – used to replace areas with large defects where the preceding method is not appropriate.

Holes, tears, and defects must be repaired in the following manner. Soil or other material which may have penetrated the defect must be removed completely prior to repair. If located on a slope, the defect must be patched using the same type of geotextile and double-seamed into place. Should any tear, hole, or defect exceed 30 percent of the width of the roll, the roll should be cut off and the defect removed or the roll removed and replaced. If the defect is not located on a slope, the patch must be made using the same type of material seamed into place with a minimum of 24 inches overlap in all directions. Seams shall be either thermal bonded or sewn in accordance with the manufacture's recommendations.

3.5 Drainage Geocomposite - Geonet and Geotextile

3.5.1 Delivery

Upon delivery the CQA monitor must observe the following:

- The drainage geocomposite is wrapped in rolls with protective covering.
- The rolls are not damaged during unloading.
- Protect the drainage geocomposite from mud, soil, dirt, dust, debris, cutting, or impact forces.
- Each roll must be marked or tagged with proper identification.

Any damaged rolls shall be rejected and removed from the site or stored at a location, separate from accepted rolls, designated by the Owner. All rolls which do not have proper manufacturer's documentation shall also be stored at a separate location until all documentation has been received and approved.

3.5.2 Testing

The drainage geocomposite manufacturer (or supplier) shall conduct QC testing and certify that all materials delivered to the site comply with project specifications. The minimum testing frequency shall be one test sample per 100,000 square feet of geocomposite (or geonet/geotextile). The material certifications shall be reviewed by the POR to verify that the geocomposite meets the values given in the plans or specifications.

Geonet shall be tested by the manufacturer for thickness, tensile strength, and carbon black content. Geotextile will be tested for mass per unit weight, grab tensile strength, and AOS. The finished geocomposite shall be tested for peel adhesion and transmissivity.

Where optional procedures are noted in the test method, the specification requirements shall prevail. The CQA monitor will review all test results and shall report any nonconformance to the POR and to the contractor.

3.5.3 Installation

Surface Preparation. Prior to geocomposite installation, the CQA monitor must observe the following:

- All lines and grades have been verified by the surveyor (where required).
- The subgrade has been prepared in accordance with the earthwork specifications.
- When placed over a geomembrane, the geomembrane installation, including all required documentation, has been completed.
- The supporting surface does not contain stones that could damage the geocomposite or the geomembrane.

Geocomposite Placement. During placement, the CQA monitor must:

- Observed the geonet as it is deployed and record all defects and disposition of the defects (panel rejected, patch installed, etc.). All repairs are to be made in accordance with the specifications.
- Verify that equipment used does not damage the geonet or underlying geomembrane by handling, trafficking, leakage of hydrocarbons, or by other means.

- Verify that people working on the geonet do not smoke, wear shoes that could damage the geonet, or engage in activities that could damage the geonet or underlying geomembrane.

- Verify that the geonet is anchored to prevent movement by the wind (the contractor is responsible for any damage resulting to or from wind blown geonet).

- Verify that the geonet remains free of contaminants such as soil, grease, fuel, etc.

- Observe that the drainage geocomposite is laid smooth and free of tension, stress, folds, wrinkles, or creases.

- Observe that on slopes the geocomposite is secured in the liner anchor trench and then rolled down the slope.

- Observe that adjacent rolls of drainage geocomposite are overlapped, tied, and seamed in accordance with the specifications and manufacture's recommendations.

- Observe that tying is with plastic fasteners in accordance with the manufacture's recommendations. In the absence of other specifications the geonet panels will be tied approximately every 5 feet along the roll length (edges) and every 1 foot along the roll width (ends).

- Observe that geotextile component is overlapped and either heat bonded or sewn together.

3.5.4 Repairs

Repair procedures include:

- Holes or tears in the drainage geocomposite will be repaired by placing a patch extending 2 feet beyond the edges of the hole or tear.

- Secure patch to the originally installed geocomposite by tying every 6 inches.

- Where the hole or tear width across the roll is more than 50 percent of the roll width the damaged area will be cut out across the entire roll and the two portions of the drainage geocomposite will be jointed.

3.6 Equipment on Geosynthetic Materials

Construction equipment on the composite liner system will be minimized to reduce the potential for liner puncture. The CQA monitor will verify that small equipment such as generators are placed on scrap liner material (rub sheets) above geosynthetic materials in the composite liner system. Aggregate drainage layers and/or protective cover will be placed using low ground pressure equipment. The CQA monitor will verify that the geosynthetics are not displaced while the soil layers are being placed.

Unless otherwise specified by the POR, all lifts of protective soil material placed over geosynthetics shall conform with the following guidelines:

Equipment Ground Pressure (psi)	Minimum Lift Thickness (in.)
< 5.0	12
5.1 - 8.0	18
8.1 - 16.0	24
>16.0	36

No equipment will be left running and unattended over the lined area.

3.7 Reporting

The POR on behalf of the Owner shall submit to the TNRCC a GLER for approval of the flexible membrane liner, leachate collection system, and protective cover. Section 6 describes the documentation requirements.

4 QUALITY ASSURANCE FOR PIPING

4.1 Introduction

This section describes CQA procedures for the installation of pipe (HDPE or PVC) for the leachate collection system. This plan stresses careful documentation during the quality assurance process, from the selection of materials through installation.

The goal of the pipe quality assurance program is to assure that proper construction techniques and procedures are used, and that the project is built in accordance with the project construction drawings and specifications. The quality assurance program is intended to identify and define problems that may occur during construction and to observe that these problems are corrected before construction is complete. A construction report, prepared after project completion, will document that the constructed facility meets design standards and specifications.

4.2 Pipe and Fittings

4.2.1 General

Construction must be conducted in accordance with the project construction drawings and specifications. To monitor compliance, a quality assurance program will be implemented that includes: (1) a review of the contractor's QC submittals, (2) material conformance testing, and (3) construction monitoring. Conformance testing refers to activities that can take place prior to material installation.

4.2.2 Delivery

The CQA monitor will observe:

- That upon delivery, the pipe and pipe fittings are in compliance with the requirements of the construction specifications.
- That a storage location is selected in which the pipe and pipe fittings are protected from excessive heat, cold, construction traffic, hazardous chemicals,

solvents, and theft. If the pipe and pipe fittings are stored at a location where other construction materials are present, the CQA monitor will assure that stacking or insertion of the other construction materials onto or into the pipe and pipe fitting is prohibited. The CQA monitor will periodically examine the storage area to observe that the pipe fittings are undamaged, and have been protected.

- That upon transporting pipe and fittings from the storage location to the construction site, the contractor will use pliable straps, slings, or rope to lift the pipe. Steel cables or chains will not be allowed to transport or lift the pipe.

- That the contractor will provide that a pipe greater than 20 feet in length will be lifted with at least two support points. The contractor will not drop, impact, or bump into the pipe, particularly at the pipe ends. Pipe and fitting ends must be cleaned of all dirt, debris, oil, or any other contaminant which may prohibit making a sound joint.

The CQA monitor will document all activities associated with the handling and storage of this material in order to maintain compliance with this portion of the CQA plan.

4.2.3 Conformance Testing

Prior to the installation of pipe, the pipe manufacturer will provide to the Owner and the POR a QC certificate for each lot or batch of pipe provided. The QC certificate will be signed by a responsible party employed by the pipe manufacturer, such as the QC manager. The QC certificate and documentation will include:

- A description of the pipe delivered to the project, including but not limited to the strength classification, diameter, perforations, and production lot.

- Properties sheet including, at a minimum, all specified properties, measured using test methods indicated in the specifications, or equivalent.

- A certification that property values given in the properties sheet are minimum values and are guaranteed by the pipe manufacturer.

- A list of quantities and descriptions of materials other than the base resin which comprise the pipe.

- The sampling procedure and results of testing for actual samples manufactured in the same lot as the pipe delivered to the project.

The CQA monitor will observe that:

- The property values certified by the pipe manufacturer meet all of the specifications.
- The measurements of properties by the pipe manufacturer are properly documented and that the test methods used are acceptable.
- Verification that the QC certificates have been provided at the specified frequency for all lots or batches of pipe, and that each certificate identifies the pipe lot/batch related to it.
- The certified properties meet the specifications.

4.2.4 Pipe and Fitting Installation

Surface Preparation. Prior to pipe installation, the CQA monitor must observe the following:

- All lines and grades have been verified by the contractor and project surveyor.
- The pipe trenches are swept clean of any deleterious material which may damage the pipe or geomembrane or may clog the pipe.
- Pipe perforations for leachate collection system are drilled in the pipe outside of the drainage trench where the pipe is to be laid. The drill cuttings shall be completely removed from the pipe prior to being placed in the drainage trench.
- Pipe perforations are to the correct size and spacing according to the project specifications. Perforations can be either factory installed slots or factory predrilled holes or field drilled holes.

Pipe and Fitting Placement. During pipe and fitting installation, the CQA monitor must:

- Observe all pipe, pipe fittings, and joints as the pipe is being laid. The CQA monitor will observe that pipes and fittings are not broken, cracked, or otherwise damaged or unsatisfactory. Prior to fusing, (if fusion welding is utilized) the pipe installer will provide for a fusion surface area which is clean and free of moisture, dust, dirt, debris of any kind, and foreign material.
- If fusion welding is utilized, verify welder credentials and that the procedure is consistent with the pipe manufacture's recommendations.

5 LINER SYSTEM BALLAST

5.1 Applicability

In the areas of the landfill excavation which have been identified to extend below the highest measured water table, the leachate collection system and protective cover soil above the liner system as well as the waste placed above the liner system will provide ballast (weight) to protect the liner system from uplift forces due to inward and upward seepage forces of the groundwater. As described in Section 5.4, at the time when the required depth of ballast has been achieved, a BER will be submitted to the TNRCC.

Design criteria to address groundwater impacts on the liner system have previously been addressed in Section 6 of Attachment 4, of the Permit Amendment Application for MSW 1509-A. Discussions in Section 6 of Attachment 4 included a review of strata identified at the site, seepage control/site dewatering activities, a discussion of potential dewatering systems, a protocol for dewatering, discussions of dewatering methods for the site, as well as discussion of protection of the liner system from hydrostatic forces. A copy of Section 6 of Attachment 4 is presented in Appendix A.

Since design criteria is addressed in Attachment 4, this SLQCP will not further cover that criteria, rather this document will address methods to be utilized during construction to verify that the liner does not undergo uplift during construction. This document will also present procedures that will employ to ensure that the ballast conforms to appropriate design criteria.

5.2 Calculation of Ballast Thickness

The actual thickness of ballast required must be calculated and submitted with the SLER or GLER, which has as-built documentation of the short-term hydrostatic pressure controls (as applicable) and construction of the leachate collection system and protective cover over the geomembrane. Typical procedures for calculating anticipated hydrostatic uplift forces and thickness of waste ballast required are included in Appendix B.

5.3 Verification

The POR or his representative shall verify that the ballast meets the established criteria and uplift of the liner system did not occur during construction. The verification, including but not limited to inspections, compaction, weight and density of material, thickness, and top of elevations; shall be documented in the BER which will be submitted to the TNRCC for approval (see Section 6).

5.3.1 Surveying During Construction

To document that short-term uplift has not occurred during construction of the liner, the POR shall verify that the elevations of the soil liner are consistent with the soil liner elevations shown on the construction drawings. The POR shall also verify that the protective cover elevations have not increased from those submitted with the GLER. The protective cover elevations will be taken once between the GLER approval and waste placement to document no short-term uplift has occurred. Survey measurements to check against uplift will be taken at a minimum frequency of one measurement per 10,000 square feet by a registered Texas surveyor.

5.3.2 Observations for Indications of Seepage

The POR or his representative shall observe the liner subgrade and soil liner for the presence of seepage during construction. To aid in the documentation that short-term uplift has not occurred during ballast placement, the POR shall provide a summary of where seepage, if any, was observed, the methods and procedures used to control the seepage and observations that all seepage has been controlled.

5.3.3 Soil Ballast Construction

The in-place thickness and density of the soil liner and protective cover will be monitored during construction and compared with the values used to calculate the required ballast thickness. In-place moisture/density tests are optional. If in-place moisture/density tests are performed, they will be taken after protective cover soil placement at a frequency of at least 1 test per 2 acres. If the survey or density tests indicate the soil ballast criteria is not met, additional ballast will be placed to compensate for the difference to provide the required factor of safety against uplift.

5.3.4 Groundwater Elevations

The landfill monitor well and piezometer system will be monitored at the frequency specified in the Groundwater Sampling and Analysis Plan (GSAP). If the observations

indicate the groundwater level is higher than the previously determined seasonal high water table in the liner area, the design seasonal high water table will be adjusted upward and the thickness of ballast will be increased accordingly.

5.3.5 Waste Ballast Placement

If waste is used for ballast, landfill personnel working under the supervision of the landfill manager will be on site full time during the placement of the first 5 feet of waste over the liner system. The site operator will verify and document (on a daily basis) that this lower 5 feet of waste does not contain large bulky items which could damage the liner system or which cannot be compacted to the required density. The site operator will also document (on a daily basis) that the waste used for ballast has been properly compacted with compaction equipment which weighs in excess of 40,000 pounds. This documentation will be maintained on logs or other appropriate methods determined by the site operator and maintained in the operating record.

Additionally, the landfill manager will complete and sign Waste-As-Ballast Placement Record to be attached to the BER (see Section 6 for BER required documentation). One form will be required for each area (or combination of areas) described by approved liner evaluation reports. The form to be used in the BER is included in Appendix C. The POR will verify the compacted waste height using survey procedures with a minimum of 1 survey point every 10,000 square feet of top area by a registered Texas surveyor.

5.4 Documentation

The verifications that the liner did not undergo uplift during construction, including the method of dewatering, confirmation that the weight and thickness of soil liner met criteria for ballast, type (soil or waste) of ballast to be used, and a revised calculation of the required ballast thickness if groundwater (i.e., seasonal highwater) levels changed since permitting will be submitted with the SLER or GLER for TNRCC approval. Once all the ballast is in place, the documentation will be provided in the BER. The BER will contain the documentation substantiating that the appropriate depth of ballast has been placed over the liner system. The documentation requirements for the SLER and BER are provided in Section 6 of this SLQCP. The dewatering system (where required) will be operated until TNRCC determines that it is no longer necessary.

6 DOCUMENTATION

The QA plan depends on thorough monitoring and documentation of all construction activities. Therefore, the POR and CQA monitor will document that all quality assurance requirements have been addressed and satisfied. Documentation will consist of daily recordkeeping, testing and installation reports, nonconformance reports (if necessary), progress reports, photographic records, design and specification revisions, to be included in the SLER, GLER, and BER. Standard report forms will be provided by the POR prior to construction.

6.1 Preparation of SLER and GLER

The POR, on behalf of the Owner, shall submit to the TNRCC a SLER for approval of each soil liner area prior to construction of the geomembrane liner over the soil liner. After construction of the geosynthetics portion of the liner, the POR will submit a GLER to the TNRCC for approval.

Testing, evaluation and submission of the SLERs and GLERs for the liner system during construction shall be in accordance with TNRCC MSWDR and the most current version of the Liner Construction and Testing handbook. The construction methods and test procedures documented in the SLER and GLER will be consistent with this SLQCP, the TNRCC MSWDR, and the most current version of the LCTH.

At a minimum, the SLER and GLER will contain:

- A summary of all construction activities.
- A summary of all laboratory and field test results.
- Sample and test location drawings.
- A description of significant construction problems and the resolution of these problems.
- As-built record drawings.

- A statement of compliance with the construction contract documents and design intent, signed, and stamped by a professional engineer(s) registered in the state of Texas.

The as-built record drawings will accurately site the constructed location of all work items, including the piping, and anchor trenches. All surveying and base maps required for the development of the record drawings will be prepared by the contractor. The POR must review and verify that as-builts are correct. As-builts will be included in the final construction report.

6.2 Ballast Evaluation Report

If part of the liner extends below the potentiometric surface, a BER will be completed and filed with the TNRCC documenting that enough ballast has been placed in a lined area to offset the potential hydrostatic uplift forces which may exist below the liner system. At a minimum, the information listed below will be included as applicable with the BER.

- A summary of in-place moisture/density test results and survey measurements to verify that the liner and protective cover weights met or exceeded the initial assumed values. The values for the soil liner will also be submitted earlier in the SLER.

- The top of protective cover elevations immediately after construction compared to the elevations obtained between GLER approval and waste placement, to document the liner did not undergo uplift prior to placement of waste (whether waste ballast is required or not).

- If waste is used for ballast, verification from the landfill manage that the weight of the compaction equipment being used to compact the waste ballast is no less than 40,000 pounds, and that this compaction equipment was utilized during the entire period of placing waste ballast.

- If waste is used for ballast, documentation of the observations that the initial five feet of waste used for ballast on the liner system is free of brush and large bulky items, which could damage the liner system or cannot be compacted to the required density.

- A Waste-As-Ballast Placement Record (TNRCC Form 10073) completed and signed by the landfill manager.

- Survey of the top of waste to document that the required waste ballast thickness has been placed.

- Water level measurements taken in the site monitor well/piezometer system adjacent to the liner construction area to verify that the groundwater level has not exceeded the design seasonal high water table.

- Final ballast thickness calculation using equations from Appendix B and the as-built minimum densities and thicknesses for each component.

6.3 Reporting Requirements

The SLER, GLER, and BER will be signed and sealed by the POR and signed by the site operator and submitted to the MSW Permits Section of the Permits Division of the TNRCC for approval. If no response is received, either oral or written, within 14 days of receipt at the Permits Division of TNRCC, the report will be considered approved.