
Part 1 General Conditions

1.1 COMMON

- .1 Specification covers the requirements for materials, fabrication and erection of piping and components. Erection shall consist of complete installation of piping systems as defined by the piping drawings and documents. It includes installation of all piping, piping components, and related examination, inspection and testing. It includes fabrication in place or in the field fabrication shop for all piping not furnished as pipe spools.
- .2 Fabrication and erection of piping shall be in accordance with the applicable requirements and Canadian and Provincial Acts and Regulations.
- .3 Contractor shall be responsible for obtaining and providing registrations, data reports, certifications, permits and other authorizations required for compliance with codes and regulations. Contractor shall provide such assistance as may be required to enable The City to obtain certification and acceptance of piping systems by the Authority Having Jurisdiction.
- .4 Contractor is to have a current Certificate of Authorization for pressure piping installation registered with the Authority Having Jurisdiction. Provide proof of registration to the Contract Administrator.
- .5 All equipment shall comply with the provincial or municipal laws and regulations governing the location where the equipment is to be installed. The Contractor is responsible to register the equipment with the relevant Canadian and Provincial Authorities, including paying all fees and arranging for any necessary inspections.

1.2 REFERENCED STANDARDS

- .1 American Society of Mechanical Engineers (ASME)
 - .1 ASME B1.20.1, Pipe Threads, General Purpose
 - .2 ASME B16.5, Pipe Flanges and Flanged Fittings
 - .3 ASME B31.3, Process Piping
- .2 American Society for Testing and Materials (ASTM)
 - .1 ASTM A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications
 - .2 ASTM A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both
 - .3 ASTM D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
 - .4 ASTM D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
 - .5 ASTM D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
 - .6 ASTM F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
 - .7 ASTM F2880, Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3/4 in. to 65 in.
- .3 Canadian Standards Association (CSA)

- .1 CSA B51, Boiler, Pressure Vessel, and Pressure Piping Code

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for all piping, fittings, valves and other components:
 - .1 Physical dimensions, weight, materials of construction, general specifications and accessories.
 - .2 Connections, piping, and fittings, strainers, control assemblies and ancillaries, identifying factory and field assembled components and recommended installation.
 - .3 Installation and operation manuals.
 - .4 Warranty coverage.

Part 2 Products

2.1 LEACHATE PIPING

- .1 General
 - .1 Application: gravity drainage piping from cell manholes to existing leachate gravity collection main.
 - .2 This requirement outlined below shall amend and supplement Standard Specifications CW 2130
 - .3 The Work to be done by the Contract under this Specification shall include the furnishing of all superintendence, overhead, labour, materials, equipment, tools, supplies, and all things necessary for and incidental to the satisfactory performance and completion of all Work hereinafter specified.
- .2 Materials
 - .1 Handling and Storage of Materials
 - .1 All materials shall be handled and stored in a careful and Workman-like manner, to the satisfaction of the Contract Administrator.
 - .2 Testing and Approval
 - .1 All materials supplied under this Specification shall be subject to inspection and testing by the Contract Administrator or by the Testing Laboratory designated by the Contract Administrator. There shall be no charge to the City for any materials supplied for testing purposes.
- .3 Pipe
 - .1 Leachate pipe shall be DR11 HDPE pipe.
 - .2 High Density Polyethylene Pipe shall be manufactured from pressure rated black polyethylene compound material that meets or exceeds ASTM D3350 cell classification 345464C with PE 4710 Polyethylene resin.
 - .3 Pipe shall have a hydrostatic design basis (HDB) of 1600 psi at 73°F and hydrostatic strength (HDS) of 800 psi at 73°F.
 - .4 Polyethylene pipe shall be iron pipe size (ips) or Ductile Iron.
 - .5 The pipe shall be manufactured of Type III high density (S.G. =0.941 to 0.955) resin compound of the type qualified as PE 4710.

- .6 Pipe shall conform to the current CSA Standards B137.0, Definitions, General Requirements and Methods of Testing for Thermoplastic Pressure Piping, and B137.1, Polyethylene Pipe, Tubing and Fittings for Cold Water Pressure Services or ASTM F714 Polyethylene Pipe based on Outside Diameter.
 - .7 The pipe shall be made from virgin compound (with the exception that it may contain clean rework compound generated in the manufacturer's own plant from resin compound of the same class and type from the same raw material supplier) having 100,000 hours of stress resistance at a minimum pressure of 11MPa for PE 4710 resin. The minimum wall thickness of the pipe shall be not less than 19.9mm.
 - .8 The pipe shall be permanently and legibly marked as per the applicable standard in such a way as not to lower the quality of the pipe.
 - .9 High Density Polyethylene pipe identification shall be placed on each length of pipe and shall include pipe size, manufacturer's trademark or name, date of manufacture, series or DR rating, Canadian Standards Association, NSF International Certification or Water Quality Association (WQA) complete with certification trademark logo and the CSA;ASTM specification to which the pipe is certified. Certification of polyethylene pipe using NSF shall be to both NSF 61 and NSF 14 requirements. Certifiers must be accredited by the Standards Council of Canada (SCC) and by the American National Standards Institute (ANSI).
 - .10 Pipeline flange connection materials shall consist of a polyethylene stub end, an epoxy coated ductile iron or all stainless steel back-up ring drilled in accordance with the current AWWA Standard C110, Standard for Gray-Iron and Ductile Iron Fittings, a reinforced rubber gasket and all stainless steel nuts, bolts and washers. Pipe lengths shall not exceed 12 m.
- .4 Joints
- .1 Thermal butt fusion, socket fusion in accordance with the pipe manufacturer's recommendations and using equipment
 - .2 Flanged with appropriate full face rubber gasket epoxy coated ductile iron back-up ring and all stainless steel nuts and bolts when used with polyethylene pipe.
- .5 Fittings
- .1 HDPE pipe fittings shall be manufactured of the same equivalent series rating and in accordance with the same specifications as the HDPE pipe.

2.2 COMPRESSED AIR PIPING

- .1 Design Summary:
 - .1 Fluid: Compressed Air
 - .2 Design Pressure: 310 kPa (125 psig)
 - .3 Design Temperature: 60°C (140°F)
- .2 Aboveground – Stainless Steel:
 - .1 Pipe:
 - .1 Stainless steel, ASTM A312-TP316L, Schedule 40S, seamless
 - .2 Fittings:
 - .1 Forged stainless steel, ASME B16.11, Class 3000, ASTM A182-F316L, NPT
 - .3 Flanges:
 - .1 Class 150, RF, stainless steel ASTM A182-F316L, ASME B16.5

- .4 Bolting:
 - .1 ASTM A193-B8M bolts w/ ASTM A194-8M nuts
- .5 Ball Valves:
 - .1 1500 psig WOG, NPT, ASTM A351-CF8M (316) stainless steel body and ball, two-piece, full port, RPTFE seat, lockable lever handle
 - .2 Acceptable Product: M.A. Stewart Model G2 or approved equal
- .3 Belowground – HDPE:
 - .1 Pipe:
 - .1 HDPE, PE4710, DR11, Cell Classification 445484C, ASTM D3035
 - .2 Fittings:
 - .1 Butt fusion, HDPE, PE4710, DR11, Cell Classification 445484C, ASTM D3261, F2620
 - .3 Flanges
 - .1 Stub Ends: HDPE, PE4710, DR11, Cell Classification 445484C, ASTM F2880
 - .2 Flange: Lap-joint, Class 150, RF, stainless steel ASTM A182-F316L, ASME B16.5
 - .4 Bedding:
 - .1 Well-graded sand (SW or SW-SM) with no particles larger than 9.5 mm as indicated below.

Metric Sieve Size (mm)	Percent Passing by Weight
9.5	100
4.75	95-100
2.00	80-100
1.18	50-85
0.60	25-60
0.30	10-30
0.15	2-10
0.075	0

- .2 Bedding shall be free from any substance that would harm the pipe or otherwise impair performance of the material as bedding for the pipe.
- .3 Bedding shall be used to fill the entire pipe surround to an elevation of at least 300 mm above the top of the pipe.
- .4 Bedding material passing the 0.30-mm sieve shall have a Liquid Limit not exceeding 25% and a Plastic Index not exceeding 6.
- .5 Backfill:
 - .1 Final backfill shall be material excavated from the work, or borrowed or imported materials, approved for use as final backfill.
 - .2 Borrow fill materials shall meet the requirements specified herein for suitable backfill materials.
- .6 Marking Tape and Tracer Wire:
 - .1 Plastic Marking Tape shall be of a type specifically manufactured for marking and locating underground utilities. The tape shall be acid and alkali-resistant polyethylene film 150 mm wide with minimum thickness of 4 mil (0.10 mm). Tape shall have a minimum tensile strength of 12 MPa lengthwise and 10 MPa crosswise. Tape shall bear a continuous printed

inscription describing the service. Plastic piping shall also be provided with 14 AWG tracer wire.

- .4 Hose:
 - .1 Application: connections between compressed air risers and manholes
 - .2 Smooth nitrile tube, braided synthetic reinforcing, nitrile cover, 2171 kPa (315 psig) rated c/w stainless steel fittings.
 - .3 Acceptable Product: Polar Bear HMP or approved equal.

Part 3 Execution

3.1 FABRICATION AND ERECTION – GENERAL

- .1 Flange bolt holes shall straddle the vertical centerlines or horizontal north-south, east-west centerlines defined on the piping drawings.
- .2 Threads shall be clean cut with no burrs or stripping.
- .3 All threads on piping and fittings shall be thoroughly cleaned of cuttings, dirt and oil before applying pipe dope or tape.
- .4 Pipe, pipe spools, and in-line components shall be inspected internally for foreign material during final installation. Material shall be removed prior to installation.
- .5 Bolting - The use of washers or other packing to use up excessive length of flange bolts is not acceptable. The length of machine and stud bolts shall be such that nuts are fully engaged with a minimum of two full threads protruding and that studs are centered
- .6 Control valves and other components removed from piping during pressure testing and line flushing shall be replaced with spool pieces or blanks, as appropriate.
- .7 Lines containing butterfly valves shall be checked to ensure that the interior of mating pipe and flanges are free of any obstructions such as internal protrusions before installing the valves. The mating flanges at butterfly valves shall be sufficiently separated for ease of installation. The valve shall not be forced or wedged into position which could damage the valve. Butterfly valves shall be installed and the disk set in the open position prior to tightening the bolts. After the bolts are tight, the operation of the valve shall be checked through a complete open and shut cycle to ensure that the disk has not been jammed during installation.
- .8 Field-routed piping shall be located such that it does not obstruct operating aisles, walkways, or equipment operation, maintenance, or removal.
- .9 All products shall be installed according to manufacturer's installation instructions.
- .10 Provide threaded plug in end of all vent and drain valves, material to match valve body.
- .11 Piping shall be properly supported to prevent excessive deflection during handling and installation.
- .12 Install piping, fittings, valves, and all equipment as per manufacturer's instructions and recommendations.

3.2 FABRICATION AND ERECTION – UNDERGROUND COMPRESSED AIR PIPING

- .1 Excavation Design
 - .1 The sides of a trench or excavation shall be supported by a retaining structure designed and stamped by a Professional Engineer or shall be cut back in accordance with Manitoba OH&S Regulations.

- .2 Preparation
 - .1 The Contractor shall perform all survey work and calculations, and the setting of all marks and stakes necessary to ensure that the work conforms to the required lines, grades, and dimensions. Relate all such layout to the coordinate grid system, elevation datum, and related survey control monuments and bench marks.
 - .2 The location and approximate depth below grade of all known existing utilities shall be determined and plainly identified prior to commencing work. Positions of existing services or other obstructions, where shown in the Contract Documents, are not guaranteed as to accuracy and/or completeness, and the Contractor shall verify their positions in accordance with the requirements specified on the excavation permit. Position of services shall be shown on the "As-built" drawings.
- .3 Protection
 - .1 Trenching Safety
 - .1 Before the start of trenching or excavation, plan for and assemble all materials and equipment required to stabilize the trench or excavation sidewalls to ensure the safety of personnel working in the trench or excavation, and to protect existing facilities and structures in the vicinity of the work. The systems, methods, and techniques used shall be suitable for the intended application.
 - .2 Slope Stabilization
 - .1 Stabilize the sides of excavations as necessary to prevent slope failure or any other earth movement that might injure personnel, or damage existing buildings, structures, or other facilities in the vicinity of the work.
 - .2 Cutting back of the walls or slopes of an excavation shall be in accordance with the requirements of the Manitoba OH&S Regulations.
 - .3 Existing or Complete Utilities
 - .1 Support uncovered pipes and other existing work affected by the excavation until they are properly supported by backfill. Report immediately to the Contract Administrator any unknown utility lines or any damages to utility lines or other subsurface facilities.
- .4 Control of Water
 - .1 General
 - .1 Prevent or control water flow into trenches and excavations, or water accumulation in trenches and excavations, to ensure that the bottoms and sides remain firm and stable throughout construction operations.
 - .2 Surface Water
 - .1 Plan and conduct excavation operations so as to minimize the disruption of water drainage in the vicinity of the work. Provide diversion ditches, dikes, and other suitable measures to control and direct runoff around and away from the excavation. Protect the sides of excavations from erosion and sloughing caused by water runoff. Promptly remove water accumulations in excavations. The systems and equipment for control of surface water shall be of sufficient capacity to at least accommodate the runoff rate that can be expected from the 2 year (50 percent annual chance) rainfall event.
 - .3 Groundwater
 - .1 When the bottom of the trench must be carried to an elevation below the groundwater level or to such proximity to the ground water level that the

excavation bottom will become soft due to its being saturated by groundwater, measures shall be taken to lower the ground water level sufficiently to maintain the stability of the excavation bottom. Design the groundwater control system using accepted professional methods of design and engineering consistent with the best modern practice. The system shall include trenches and sumps with pumps, well points, and such other equipment, appurtenances, and related earthwork necessary to achieve the groundwater control needs of the work.

- .4 Disposal of Removed Water
 - .1 Convey water removed by the water control systems to an existing stormwater drainage system with sufficient capacity to accommodate the flow rates involved without damage. Secure permits or other approval required from authorities having jurisdiction over such stormwater discharge.

- .5 Excavation
 - .1 General
 - .1 The Contractor shall excavate, by hand, by hydrovac, or by other appropriate measures, any trial excavations deemed necessary by the Contractor for locating the position of underground services.
 - .2 When in the course of excavation, the Contractor encounters existing services or any other obstructions, he shall immediately seek instruction from the Contract Administrator as to the course of action. Services or other obstruction shall be physically marked on the ground.
 - .3 Unless otherwise shown in the contract documents, the minimum trench width shall be the external diameter of the pipe plus 500 mm.
 - .4 Carefully excavate trenches to the minimum depths and widths necessary for installing the pipeline and associated appurtenances. In the pipe embedment zone (pipe surround), the trench sidewalls shall be as nearly vertical as practical. From the top of the pipe embedment zone to the surface, the trench sidewalls shall be either sloped sufficiently to prevent sloughing or cave-in, or shall be properly supported in accordance with OH&S requirements.
 - .2 Unstable Subgrade
 - .1 When soft, yielding, or otherwise unstable soil conditions are encountered at the required trench bottom elevation, over excavate the trench to a depth of no less than 300 mm below the required trench bottom elevation. When the over excavated pipe trench bottom is above the groundwater surface (i.e., it is dry), backfill the over excavation with common fill or bedding material or any suitable backfill material, and compact to at least 95% Standard Proctor Density. When the unstable trench bottom is near or below the groundwater surface (i.e., it is saturated), backfill the over excavation with bedding material. This bedding material shall be completely separated from the trench soils and the pipe bedding material by a geotextile filter cloth.
 - .3 Rock Excavation
 - .1 Remove rock by mechanical methods (such as ripping, wedging, or impacting) to reduce the rock to manageable sized fragments.
 - .2 When the bottom of the structure is to rest on rock or other unyielding material, clean the bearing surface of loose material, and cut to a firm, level bed that is stepped, keyed, or serrated.

- .3 Whenever rock, stone, masonry, or other hard, unyielding material is encountered at or above the required trench bottom elevation, remove it to provide a clearance of not less than 150 mm below, and 300 mm on each side of pipes and associated fittings, valves, and other appurtenances.
- .4 Over-excavation
 - .1 When a trench has been over-excavated for any reason other than saturated unstable soil conditions, the over-excavated part shall be filled with common fill or bedding materials compacted to a minimum 95% Standard Proctor Density.
- .5 Excavation and Construction of Appurtenances
 - .1 If the excavation sidewalls are to be used to form the sides of the structure, take special care during excavation to secure a true surface conforming to the lines and dimensions indicated on the plans for the structure. Corners and edges of the excavation shall be true and square, not rounded or undercut.
 - .2 When concrete is to be placed against the bottom or sides of an excavation, take care not to disturb the native soils that the concrete bears against. Excavate to final line and grade just before the concrete or masonry is to be placed. Cut to a firm and stable surface that is either level, stepped, or serrated. Remove loose or deteriorated rock, debris, and thin strata.
- .6 Stockpiling
 - .1 Stockpile excavated materials in an orderly manner at a distance from the banks of the excavation sufficient to avoid overloading the bank. Stockpiled material shall be kept a minimum of 1000 mm from the edge of the excavation, with slopes not less than 45° from the vertical. If depth of excavation exceeds 6 m, stockpiled material shall be placed in accordance with the instructions of a Professional Engineer.
 - .2 Protect stockpiles containing suitable backfill material from contamination with unsuitable material or other material that may adversely affect the quality of the backfill and render it unfit for use. Arrange stockpiles so as not to obstruct drainage or other construction operations in the vicinity of excavation.
 - .3 Dispose of excavated materials that are unsuitable for use as backfill or are surplus to that needed for backfilling in a safe and proper manner, at a location designated by Contract Administrator.
- .6 Pipe Laying and Assembly
 - .1 Handling
 - .1 Pipe shall be protected during handling against impact shocks and free fall. Care shall also be taken to prevent damages to and entry of foreign materials into the pipe system during handling, assembly, backfill and compaction. Proper facilities shall be provided for lowering the sections to prevent disturbance of the bed and sides of the trench.
 - .2 Installation of Polyethylene Piping
 - .1 Heat fusion bonding to ASTM F2620 shall be used to join polyethylene pipe in the field. When such methods are used, the pipe manufacturer's instructions shall be strictly followed, and the installation shall be by qualified personnel only.
 - .3 Coordination With System Testing

- .1 Coordinate bedding and backfilling with the applicable piping system installation testing requirements to ensure that required testing and visual examinations are accomplished before the pipeline is obscured by backfill.
- .7 Bedding
- .1 Haunching
 - .1 After placing the pipe and assembling joints in accordance with the applicable system installation specifications. Bedding material shall be placed and compacted under the sides of the pipe to the pipe spring line. Take care during placement and compaction of this material to ensure sound support is developed for the sides of the pipe while avoiding either vertical or lateral displacement of the pipe from its intended position. Place haunching area material and compact to the required density in uniform lifts of not more than 150 mm loose thickness using manual or mechanical tamping techniques.
 - .2 Place and compact bedding to the top of the pipe embedment zone in uniform horizontal lifts of not more than 150 mm loose thickness, then compact by hand, pneumatic tamper, or other appropriate means. Bring up the level of backfill uniformly on opposite sides of the pipe along the full length of each pipe section. Take care not to damage the pipe or any protective coating it may have.
 - .3 When installing polyethylene pipe, polyvinyl chloride (PVC) pipe, corrugated steel pipe (CSP), or any other flexible type pipe, give special attention to proper compaction of the materials in the pipe haunch area and sides to ensure that adequate side support of the pipe is developed while avoiding any vertical or lateral displacement of the pipe. For flexible type pipe, the material directly above the pipe in the pipe embedment zone shall be compacted using light weight hand operated equipment to avoid distorting the pipe. Manufacturer's recommendations shall be followed.
 - .4 Bedding shall be placed to a height of at least 300 mm above the top of the pipe unless otherwise indicated in the contract documents, the minimum bedding thickness shall be 150 mm below the bottom of the pipe. Excavate small depressions of the minimum size necessary in the prepared trench bottom to allow removal of the pipe handling slings, the assembly of pipe joints, etc.
- .8 Common Fill
- .1 Place common fill material in 200 mm maximum loose thickness lifts to restore the required finished surface grade.
 - .2 When slabs, roads and pavement are to be restored or constructed over the filled pipe trench, the final backfill shall be placed to the required subgrade elevation of these structures.
- .9 Installing Marking Tape and Tracer Wire
- .1 During backfill for all pipelines, install appropriate plastic marking tapes above the pipeline at a depth of 600-1200 mm below the required finished grade. Tracer wire for plastic pipe shall be installed at depth on top of the pipe.
- .10 Compaction
- .1 General
 - .1 Compact bedding and backfill materials using vibratory or impact type compacting equipment suitable for use in confined areas, and operated at the frequency and amplitude recommended by the equipment

- manufacturer for the type of material and lift thickness involved in the work.
- .2 The Contractor shall exercise care when operating equipment adjacent to structures so as not to cause damage or displacement. If the Contractor's placement and compaction operation result in damage in the structures, the Contractor shall be required to repair all damages at no additional cost.
- .2 Moisture Content
 - .1 At the time of compaction, the moisture content of the material shall be such that the specified compacted density will be obtained and the completed backfill will be in a firm and stable condition. Adjust the moisture content as necessary to achieve a condition suitable for compaction.
 - .2 For cohesive materials, the moisture content at the time of compaction shall be within 2 percentage points of optimum.
 - .3 Compacted Density
 - .1 Bedding: Compact bedding material placed in the pipe embedment zone to a density of not less than 95% of Standard Proctor Density.
 - .2 Backfill: Compact the backfill to not less than 95% of Standard Proctor Density.
 - .3 Compaction Records: Contractor must retain records of bedding and backfill compaction. Failure to produce records or records that indicate less than minimum standard proctor density will require contractor to remove and reinstall bedding and backfill at their cost.
- .11 Restoration and Clean Up
 - .1 After completing backfill placement and compaction, restore or replace shrubbery, turf, fences, and other features, surfaces, and structures disturbed during the work, except as otherwise noted in the contract documents. Return restored features and facilities to a condition equal to or superior to that which existed before the work began.
 - .2 Remove off the jobsite and properly dispose of surplus piping materials, soils, temporary structures, and other debris resulting from the work. Leave the site in a neat and clean condition, ready to receive topsoil, seeding, or whatever final surface treatment is indicated.
 - .3 If the work involves borrowing materials or stockpiling of unsuitable or surplus materials, the borrow pits and/or stockpiles shall be well graded to facilitate proper draining.

3.3 INSPECTION AND TESTING – LEACHATE PIPING

- .1 All tests and television inspection shall be carried out from manhole to the existing leachate main or as directed by the Contract Administrator.
- .2 Deflection testing may be conducted in conjunction with the television inspection however the sewer jet shall not be in operation during the television inspection.
- .3 Deflection Testing
 - .1 Leachate pipe shall be tested for deflection using a rigid mandrel sized to pass a maximum deflection (deformation of the pipe diameter) of 5%. No allowance shall be made for pipe wall thickness tolerances or out of round due to heat, shipping, or other external cause.

- .2 The inspection shall be conducted no earlier than thirty (30) calendar days after the backfill has been placed to final grade, and provided in the opinion of the Contract Administrator that sufficient water densification or rainfall has occurred to thoroughly settle the soil throughout the entire trench depth. If densification cannot be achieved in the time after installation of the pipe and backfill prior to the project completion date, then the mandrel size shall be increased to pass a maximum deflection of 4%.
- .3 The mandrel shall be carefully pulled through the sewer by the Contractor. Any sections of sewer that does not allow the mandrel to pass shall be considered to have failed the deflection test and shall be uncovered, repaired or replaced at the Contractor's sole expense and the section tested again.
- .4 **Television Inspection**
 - .1 Television inspection shall be between manholes and the existing leachate collection main or other appropriate locations as directed by the Contract Administrator.
 - .2 The Contract Administrator shall be present at all times during the television inspection of the sewer and will indicate to the Contractor what data shall be logged and retained for his records.
 - .3 The television inspection shall be performed by persons skilled and qualified in the use of CCTV inspection equipment.
 - .4 The Contractor shall provide an air conditioned viewing room large enough to accommodate a minimum of three people for the purpose of viewing the monitor (minimum size 17 inch diagonal) while the inspection is in progress.
 - .5 The image shall be clear and sharp enough to enable those viewing the monitor to easily see the interior condition of the sewer being inspected. The Contractor shall deliver to the Contract Administrator a complete typed television inspection report and one VHS format videotape recording of the inspected sewer.
- .5 **Infiltration Test**
 - .1 Prior to testing, the pipe shall be cleaned as described in 3.3.7 of this Section and all accumulated water removed from the sewer.
 - .2 Over a continuous 24 hour period, the Contract Administrator shall observe the amount of accumulated infiltration.
 - .3 Zero leakage is permitted throughout the specified test period for all piping
- .6 **Exfiltration Test**
 - .1 The Contractor shall install water tight bulkheads in a suitable manner to isolate the section of sewer being tested from the remainder of the sewer system.
 - .2 The test section shall be filled with water and left to stand for 24 hours prior to commencing the test, in order to allow for absorption into the pipe walls.
 - .3 Following the absorption period, the lines shall be filled until there is a head of 1 metre over the interior crown of the pipe measured at the highest point of the test section or water in the manhole is 1.0 metre above static ground water level whichever is greater, or to the level determined by the Contract Administrator. The Contract Administrator shall observe the drop in water level over a 2 hour period.
 - .4 Zero leakage is permitted throughout the specified test period for all piping
 - .5 Any sections of sewer that contain defects or deficiencies shall be considered to have failed the inspection and shall be uncovered, repaired or replaced at the Contractor's sole expense and the section televised again.
- .7 **Cleaning**

- .1 The pipe and manholes shall be thoroughly cleaned upon completion of the Work and prior to deflection testing or television inspection.
- .2 The pipe and manhole(s) shall be cleaned with high velocity sewer cleaning equipment which shall remove all foreign materials from the sewer and related structures.
- .3 All dirt, sand, rocks, grease and other solid or semisolid material resulting from the cleaning operation shall be removed at the downstream manhole of the section being cleaned and disposed of as directed by the Contract Administrator. Passing material from manhole section to manhole section will not be permitted.
- .8 Acceptance of the cleaning shall be made upon the successful completion of the television inspection and shall be to the satisfaction of the Contract Administrator. If the television inspection shows the cleaning to be unsatisfactory, the Contractor shall be required to again and televise the sewer until the cleaning is shown to be satisfactory.

3.4 INSPECTION AND TESTING – COMPRESSED AIR PIPING

- .1 Inspection and testing standard: ASME B31.3, Category D Fluid Service
- .2 Test: Service
- .3 Inspect and test all piping, valves, and all equipment as per the manufacturer's instructions and recommendations.
- .4 Zero leakage is permitted throughout the specified test period for all piping.
- .5 Give the Contract Administrator a minimum of 2 business days' notice prior to testing. Timing of testing to be coordinated with the The City.
- .6 Cleaning
 - .7 Clean interior and exterior of all systems prior to start-up of new systems.
 - .1 Leave Work area clean at end of each day.
 - .2 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 32 19.03 – Engineered Clay Liner.
- .2 Section 31 23 33.02 – Fill.

1.2 MEASUREMENT AND PAYMENT

- .1 Excess Soil Excavation and Stockpiling:
 - .1 Measurement Basis: By cubic metre of excavated material by subtracting survey readings taken before and after excavation.
 - .2 Payment Basis: Unit price. Includes general excavation, loading, hauling, stockpiling and shaping in on-Site stockpiles of excess soil.
 - .1 Over-excavating: No payment will be made for over-excavated work or for replacement materials.

1.3 REFERENCES

- .1 Definitions:
 - .1 Common Excavation: Excavation of materials, of whatever nature, not included under definition of rock excavation.
 - .2 Unclassified Excavation: Excavation of deposits, of whatever nature, encountered in the Works.
 - .3 Unsuitable Materials:
 - .1 Weak, chemically unstable, and compressible materials.
 - .2 Refuse, asphalt, concrete or granular materials.
 - .3 Material containing loam, roots, or organic matter.
 - .4 Frozen material or material containing snow or ice.
 - .5 Clays that are classified as inorganic clays of high plasticity in accordance with applicable ASTM specifications.
 - .6 Soft and/or organic clays and silts of low strength.
 - .7 Frost susceptible silts or clays.
 - .8 Swelling clays.
 - .9 Rock and lumps of material with dimensions greater than 100 mm.
 - .10 Trees, stumps, branches, roots, or other wood or lumber.
 - .11 Wire, steel, cast iron, cans, drums, or other foreign material.
 - .12 Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.
 - .13 Waste Material: Excavated material unsuitable for use in work or surplus to requirements.
 - .4 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.

- .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .2 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
 - .3 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
 - .4 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
 - .5 ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75- μ m) Sieve.
 - .6 ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - .2 City of Winnipeg Standard Construction Specifications:
 - .1 CW1120 - Existing Services, Utilities and Structures.
 - .2 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.
 - .3 CW3170 - Earthwork and Grading.
 - .4 CW2030 – Excavation Bedding and Backfill.

1.4 **COORDINATION**

- .1 Coordinate interruptions of utility services to existing facilities which become necessary either directly or indirectly due to work required under the Contract through Contract Administrator. Down time for service disruptions may be limited as to duration and time (weekend, nights, or holidays). Perform the Works during the period designated.
- .2 Coordinate and sequence excavation operations to minimize the need for temporarily stockpiling excavated materials until required for backfilling. Make every effort to balance cut and fill operations and to ensure that excavated material designated for backfill is immediately placed as backfill in the Works. Keep the time during which excavations remain open to the practicable minimum.

1.5 **SCHEDULING**

- .1 Sequence and schedule excavation activities with work of other Sections.
- .2 Do not commence excavation operations until the Safe Work Plan has been reviewed by the City and Contract Administrator and implemented.
- .3 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.6 **AMBIENT CONDITIONS**

- .1 Protect open excavations against damage due to surface runoff and runoff. Take necessary precautions to prevent erosion of excavated or disturbed surfaces.
- .2 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing fill to the requirements of this Section.
- .3 After occurrence of heavy rains, do not operate equipment on approved excavations until the material has dried sufficiently to prevent occurrence of excessive rutting.

- .4 Where excavations have been softened or eroded, remove soft and yielding material or otherwise objectionable or damaged areas and replace with fill as specified by Contract Administrator.
- .5 Do not obstruct flow of surface drainage or natural watercourses.
- .6 Provide dust and particulate control as specified in Section 01 50 00.
- .7 Remove, replace, and compact softened, eroded, or otherwise objectionable or damaged areas or previously placed material, as determined by Contract Administrator at no additional cost to the City.

Part 2 Products

Not Used

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 73 00 – Execution Requirements.
- .2 Verify that survey bench marks and intended elevations for the Works are as shown on the Drawings.
- .3 Do not allow or cause any of the work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, measurements, tests, or approvals.
- .4 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of successive lifts.
- .5 Obtain approval from Contract Administrator prior to placing fill against structures or around exposed buried utilities.
- .6 Ensure areas to be backfilled are free from debris and water.
- .7 Do not permit traffic in restored/repared area without approval from Contract Administrator.

3.2 PREPARATION

- .1 Identify required lines, levels, contours, and datum locations.
- .2 Locate, identify, and protect utilities that remain from damage. Confirm locations of buried utilities and structures by careful test excavations or other suitable means.
- .3 Arrange for utility company to identify utilities.
- .4 Protect plant life, trees, and other features remaining as a portion of final landscaping.
- .5 Protect bench marks, survey control points, existing structures, fences, paving, and curbs from excavating equipment and vehicular traffic.
- .6 Maintain and protect from damage wells, utilities, and structures encountered. In event of disturbance or damage to well, utility, or structure, immediately notify Contract Administrator. Repair or replace well, utility, or structure damaged by Contractor operations.
- .7 Protect existing surface features which may be affected during progress of work.

- .8 Protect existing structures where temporary unbalanced earth pressures may develop on walls or other structures utilizing bracing, shoring, or other approved method to counteract imbalance.
- .9 Protect monitoring wells and other structures and pipelines from uplift and displacement or disturbance during excavation operations.
- .10 Employ procedures for excavation and trenching that avoid disturbance of utilities and structures.
- .11 Protect excavations and trenches from contamination.
- .12 Obtain direction from Contract Administrator before moving or otherwise disturbing utilities or structures.
- .13 Remove surface features or obstructions including, but not necessarily limited to, trees, shrubs, bush, and other vegetation from surfaces to be excavated, as required to construct the Works. Dispose of such obstructions as directed by Contract Administrator.
- .14 Remove debris, snow, ice, water, soft soils, organic materials, or frozen ground from areas to be backfilled.
- .15 Compact subgrade to required density for subsequent backfill materials.
- .16 Proof roll subgrade surface to identify soft spots. Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved native fill and compact to density equal to or greater than specified requirements for subsequent fill material.
- .17 Utilize excavated material suitable for backfill prior to importing fill materials.

3.3

TRENCHING

- .1 Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with work.
- .2 The banks of trenches shall be as nearly vertical as allowable and in accordance with the Workplace Safety and Health Act and other applicable regulations and standards.
- .3 In no case during performance of the Works shall trenching advance ahead of the active installation more than necessary to facilitate proper placement.
- .4 Accurately excavate and grade the bottom of trenches to provide uniform bearing and support for each section of the pipe on full thickness of approved bedding material at every point along its entire length.
- .5 Hand trim, make firm, and remove loose material and debris from trenches. Where natural or fill material at bottom of excavation is disturbed, compact disturbed soil to density at least equal to undisturbed soil or to the density specified for the succeeding layer of backfill, whichever is greater, or remove disturbed soil and refill the space as directed by Contract Administrator. Underpin adjacent structures at risk of damage during excavation work, including service utilities and pipe chases.
- .6 Do not disturb soil within the branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .7 Open trenches shall be Contractor's sole responsibility.
- .8 Temporarily stockpile excavated material that is approved for backfilling adjacent to the Works.
- .9 Dispose of surplus material, including all excavated waste, as directed by Contract Administrator.
- .10 Do not obstruct flow of surface drainage or natural watercourses.

3.4 EXCAVATION

- .1 Perform excavation in accordance with Province of Manitoba "W210 The Workplace Safety and Health Act" and "Guidelines for Excavation Work".
- .2 Excavate to lines, grades, elevations, and dimensions shown on the Drawings or as directed by Contract Administrator.
- .3 Slope banks with machine to safe angle, as determined by a competent person.
- .4 Grade top perimeter of excavation to prevent surface water from draining into excavation.
- .5 Trim excavation. Remove loose matter.
- .6 Remove lumped subsoil, boulders, and rock. Remove debris and other obstructions encountered. Stockpile in location(s) approved by Contract Administrator.
- .7 Notify Contract Administrator of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- .8 Stockpile excavated material in designated on-Site areas as directed by Contract Administrator. **The Contractor must coordinate with the Contract Administrator and the City the location of the stockpiles, as most of the excavated material is expected to be used as final cover in a neighbouring waste disposal cell. These locations for stockpiling are within a distance of 500 metres, considered within the free haul distance.**
- .9 Repair or replace items designated to remain, damaged by excavation.
- .10 Hand trim, make firm, and remove loose material and debris from excavations. Where natural or fill material at bottom of excavation is disturbed, compact disturbed soil to density at least equal to undisturbed soil or to the density specified for the succeeding layer of backfill, whichever is greater, or remove disturbed soil and refill the space as directed by Contract Administrator.
- .11 Material generated as a result of excavation, grading, and construction activities associated with completing the Work that are deemed unsuitable for use by Contract Administrator will be loaded, hauled, and placed in an area on the Site designated by Contract Administrator. This includes water or frost impacted material as a result of Contractor negligence.
- .12 Do not disturb soil within the branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw.
- .13 Open excavations shall be Contractor's sole responsibility. Secure using temporary fencing in accordance with the Workplace Safety and Health Act.

3.5 OVER EXCAVATION

- .1 Correct unauthorized over-excavated areas at no cost to the City.
- .2 Notify Contract Administrator when soil at base of excavation appears unsuitable; proceed as directed by Contract Administrator. Where, in Contract Administrator's opinion, the undisturbed condition of the soils is inadequate to support installations, over-excavate to adequate supporting soils as directed by Contract Administrator and refill the excavated space with approved material to the proper elevation, as specified for backfilling.
- .3 When directed by Contract Administrator and except as otherwise specified, the excavation and removal of inadequate material as specified, and supply and installation of such material in excess of limits shown on the Drawings, will be paid for by Change in

Work. Use over-excavated material in the Work or stockpile on the Site as approved by Contract Administrator.

- .4 Should unauthorized excavation be carried below the lines and grades as shown on the Drawings and in excess of the specified depth and tolerance because of Contractor's operations including errors, methods of construction, or to suit his convenience, correct unauthorized excavation as follows:
 - .1 Fill under concrete structures with concrete.
 - .2 Fill under unauthorized over-excavation areas by extending the indicated bottom elevation of the base of the material specified to be placed to the unauthorized excavation bottom without altering the required top elevation and compact as specified unless otherwise directed by Contract Administrator.
- .5 Additional excavation to remove weakened or disturbed soil caused by unsuitable construction methods or procedures or to suit Contractor's convenience and subsequent additional backfill and compaction to correct deficiencies shall be to Contractor's account at no additional cost to the City.

3.6 **STOCKPILING**

- .1 Obtain Contract Administrator's approval for locations of all stockpiles. Obtain Contract Administrator's approval prior to placing surplus excavated materials in such stockpiles.
- .2 Coordinate placement of excavated material stockpiles with the City of Winnipeg Landfill Operations department.
- .3 Construct stockpile sites so that they are level, well drained, free of foreign materials, and of adequate bearing capacity to support the weight of the materials to be placed thereon prior to adding new materials to the stockpile area.
- .4 Stockpiles shall be constructed with two access points, one on each end.
- .5 Existing stockpiles shall be stripped of topsoil prior to stockpiling additional excavated material.
- .6 Protect the perimeters of the soil stockpiles in the stockpile area with silt fence approved by Contract Administrator following the stockpiling of the material.
- .7 Provide and maintain access to stockpiles.
- .8 Prevent intermixing of soil types or contamination or segregation.
- .9 Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- .10 Materials that are wet within the work area or require dewatering prior to placement in the stockpiles to be temporarily placed within bermed areas constructed by Contractor in the stockpile area. Control all runoff water from the bermed area including operation of pumps, placement of additional silt fencing, and construction of settling ponds as required to control the runoff and dewater the materials.
- .11 All stockpiles will be constructed with 3:1 side slopes providing adequate slope stability and drainage.
- .12 Upon completion of stockpiling and restoration, the remaining soil stockpiles will receive a final shaping to a maximum 3:1 slope by Contractor. All perimeter silt fencing will remain in place.
- .13 Maintain area surrounding stockpiles in neat and tidy condition.

3.7 UTILITIES

- .1 Excavate trenches for utilities to lines, grades, elevations, and dimensions shown on the Drawings.
- .2 Any interruption or damage to an existing service due to Contractor's negligence is Contractor's responsibility. Immediately notify the City and Contract Administrator and mitigate condition before end of working day. Repair promptly. Contractor shall submit repair plan to Contract Administrator and employ a certified trade, as necessary, to make the repair.

3.8 TOLERANCES

- .1 Correct surface irregularities by loosening and adding or removing material until the surface is within the specified tolerances.
- .2 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.
- .3 The final locations of all excavations will be constructed to within a tolerance of +/- 25 mm. All grading will be performed to maintain slopes and positive drainage as shown on the Drawings.

3.9 ADJUSTING

- .1 Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.

3.10 PROTECTION

- .1 Prevent displacement or loose soil from falling into excavation; maintain soil stability.
- .2 Protect bottom of excavations from freezing.
- .3 Protect structures, utilities, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth operations.
- .4 Verify that survey bench marks and intended elevations for Works are as shown on the Drawings.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 32 19.01 – Geotextile.
- .2 Section 31 23 33.01 – Excavation.
- .3 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

- .1 Leachate Collection System Granular Drainage Blanket (25mm):
 - .1 Measurement Basis: By square metre measured in place.
 - .2 Payment Basis: Unit price. Includes supplying granular drainage blanket for the bottom 150mm layer, stockpiling, placement, and grading.
- .2 Leachate Collection System Granular Drainage Blanket (25-75mm):
 - .1 Measurement Basis: By square metre measured in place to the elevations shown on the Drawings.
 - .2 Payment Basis: Unit price. Includes supplying granular drainage blanket for the top 150mm layer, stockpiling, placement, and grading.

1.3 REFERENCES

- .1 Definitions:
 - .1 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.
- .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM C117 - Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
 - .3 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .4 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .5 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
 - .6 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft³ (600 kN-m/m³)).
 - .7 ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75- μ m) Sieve.
 - .8 ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - .9 ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³ (2,700 kN-m/m³)).

- .10 ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- .11 ASTM D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
- .12 ASTM D2974 - Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
- .13 ASTM D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- .14 ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
- .15 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .16 ASTM D4791 - Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
- .17 ASTM D4972 – Standard Test Method for pH of Soils.
- .18 ASTM D6473 - Standard Test Method for Specific Gravity and Absorption of Rock for Erosion Control.
- .19 ASTM D6928 - Standard Test Method for Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus.
- .20 ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- .2 City of Winnipeg Standard Construction Specifications:
 - .1 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.
 - .2 CW3170 - Earthwork and Grading.
 - .3 CW2030 – Excavation Bedding and Backfill
- .3 International Centre for Agricultural Research in the Dry Areas (ICARDA):
 - .1 Methods of Soil, Plant, and Water Analysis.

1.4 SEQUENCING

- .1 Coordinate interruptions of utility services to existing facilities which become necessary either directly or indirectly due to work required under the Contract, through Contract Administrator. Down time duration and time (weekend, nights, or holidays) for service disruptions may be limited. Perform work of this Section during scheduled times.
- .2 Coordinate and sequence excavation operations to minimize temporary stockpiling of excavated materials until required for backfilling. Make every effort to balance cut and fill operations and ensure excavated material designated for backfill is immediately placed in the Works. Minimize time excavations remain open.

1.5 SCHEDULING

- .1 Do not allow or cause work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.6 SUBMITTALS

- .1 Materials Source: Submit name of proposed imported fill material source at least 14 days prior to commencing transport of materials to the Site.

- .2 Provide schedule of service disruptions to utilities no later than 3 weeks prior to proposed date of disruption. Contract Administrator will review schedule with the City and respond within 7 days.
- .3 Geotechnical Data: Submit geotechnical data at least 7 days prior to commencing transport to the Site.
 - .1 Aggregate Materials: Submit grain size distribution curves, density, and moisture content for each aggregate material. Show average distribution and minimum and maximum variation in gradation for each grain size distribution curve.
- .4 Test Reports: Submit test reports certifying compliance with specified requirements at least 7 days prior to commencing transport to the Site.
- .5 Samples: Submit 45 kg Sample of Leachate Collection System Granular Drainage in airtight bag or container.
- .6 Suppliers' Certificates: Submit certificate indicating that each type of imported fill material meets or exceeds specified requirements.
- .7 Weigh Tickets: At the end of each work day submit delivery weigh tickets of imported fill materials delivered to the Site.
- .8 Field Quality Control: Submit field data on same day testing is performed. Submit laboratory data within 24 hours of completion of test.
- .9 Qualification Statements:
 - .1 Independent Geotechnical Testing Firm: At least 14 days prior to commencing transport of soil materials to the Site, submit name and qualifications of independent geotechnical testing firm to provide geotechnical testing services for work of this Section.
 - .2 Independent Analytical Laboratory: At least 14 days prior to commencing transport of soil or aggregate materials to the Site, submit name and qualifications of independent testing laboratory to provide chemical analysis for work of this Section.
- .10 Certificates: Certify that products meet or exceed specified requirements.

1.7 QUALIFICATIONS

- .1 Geotechnical Testing Firm: Company specializing in performing work of this Section and complying with ASTM D3740 to perform testing of fill materials including density, moisture content, permeability, and particle size analysis for both soil and aggregate samples.

1.8 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver, handle, and transport fill materials in a manner and with equipment that will prevent intermixing of soil, aggregate, segregation, or contamination.
- .2 Minimize stockpiling requirements. Transport material from source directly to final position where possible.
- .3 Stockpile fill materials in on-Site locations approved by Contract Administrator.

1.9 AMBIENT CONDITIONS

- .1 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing fill to the requirements of this Section.
- .2 Do not operate equipment on approved excavations after heavy rain until material has dried sufficiently to prevent excessive rutting.

Part 2 Products

2.1 MATERIALS

- .1 Imported from an approved source or native material.
- .2 Free of unsuitable materials including:
 - .1 Frozen material or material containing snow or ice.
 - .2 Trees, stumps, branches, roots, or other wood or lumber.
 - .3 Wire, steel, cast iron, cans, drums, or other foreign material.
 - .4 Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.
- .3 Compactable to specified density at specified moisture content.

2.2 COMMON FILL

- .1 Native Backfill: Clean excavated soil, free of organics including roots, weeds, topsoil, foreign material, and stones greater than 150 mm; and approved by Contract Administrator. To be used as backfill, as approved by Contract Administrator.

2.3 GRANULAR DRAINAGE BLANKET

- .1 Material for bottom 150 mm of Granular Drainage Blanket shall be 25 mm subrounded clear stone, natural, manufactured, or processed clean, dry, unfrozen, sound, non-cohesive, dense granular material, with a uniformity coefficient (D_{60}/D_{10}) less than 2.0. Contractor shall provide the proposed material gradation to Contract Administrator for approval. Acceptable gradation:

31.5 mm sieve	100% passing
25.0 mm sieve	0-100% passing
19.0 mm sieve	0 - 2% passing
9.5 mm sieve	0 - 1% passing

- .2 Material for top 150 mm of Granular Drainage Blanket shall be 25 mm to 75 mm crushed clear stone, natural, manufactured, or processed clean, dry, unfrozen, sound, non-cohesive, dense granular material, with a uniformity coefficient (D_{60}/D_{10}) less than 2.0. Contractor shall provide the proposed material gradation to Contract Administrator for approval. Acceptable gradation:

75.0 mm sieve	100% passing
50.0 mm sieve	0 - 100% passing
37.5 mm sieve	0 - 15% passing
31.5 mm sieve	0 - 15% passing
25.0 mm sieve	0 - 5% passing
19.0 mm sieve	0 - 2% passing
9.5 mm sieve	0 - 1% passing

- .3 Mineral composition: Calcium Carbonate (CaCO_3): Less than 30 percent.

2.4 BEDDING

- .1 Crushed stone or gravel consisting of hard, durable particles free from clay lumps, cementation, organic material, frozen material and other deleterious material.

.2	Acceptable Gradation:		
	25 mm sieve	100%	passing
	19 mm sieve	85 - 100%	passing
	9.5 mm sieve	50 - 75%	passing
	4.75 mm sieve	35 - 55%	passing
	0.075 mm sieve	2 - 8%	passing

2.5 SOURCE QUALITY CONTROL

- .1 Testing and Analysis of Coarse Aggregate:
 - .1 Maximum Dry Density and Optimum Moisture Content, ASTM D698: One sample per 1,000 m³ or portion thereof of material required.
 - .2 Grain Size, ASTM C117 and ASTM C136: One sample per 1,000 m³ of material required.
 - .3 Carbonate content, ASTM D4373, ICARDA/NARC or other method approved by Contract Administrator: One sample per 1,000 m³ (minimum one sample) of material required.
 - .4 Los Angeles degradation: to ASTM C131: One sample.
- .2 If tests indicate materials do not meet specified requirements, change material or material source and retest.
- .3 Provide materials of each type from the same source throughout the Works.
- .4 In the event of changes to approved sources of materials during performance of the Works, immediately advise Contract Administrator of revised locations and obtain approval of such locations and materials prior to use in the Works.
- .5 Acceptance of material at source does not preclude future rejection if it fails to conform to requirements specified, lacks uniformity, or if its field performance is found to be unsatisfactory.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that survey bench marks and intended elevations for the Works are as shown on the Drawings.
- .2 Verify manholes are anchored to their own foundations to avoid flotation after backfilling.
- .3 Verify that excavations, dimensions, and elevations are as shown on the Drawings.
- .4 Verify that prepared soil base is ready to receive the work of this Section.

3.2 PREPARATION

- .1 Locate, identify, and protect utilities that remain from damage. Confirm locations of buried utilities and structures by careful test excavations or other suitable means. Provide support for aboveground utility poles and lines. Provide documentation to Contract Administrator.
- .2 Identify required lines, levels, contours, and datum locations.
- .3 Notify Contract Administrator of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.

- .4 Maintain and protect existing utilities designated to remain.
- .5 Obtain direction from Contract Administrator before moving or otherwise disturbing utilities or structures.
- .6 Protect plant life, trees, lawns, and other features remaining as portion of final landscaping.
- .7 Protect benchmarks, survey control points, hydrants, existing structures, fences, paving, and curbs from excavating equipment and vehicular traffic.
- .8 Maintain and protect from damage wells, utilities, and structures encountered. In event of disturbance or damage to well, utility, or structure, immediately notify Contract Administrator. Repair or replace well, utility, or structure damaged by Contractor operations.
- .9 Protect monitoring wells and other structures and pipelines from uplift and displacement or disturbance during excavation operations.
- .10 Protect existing structures where temporary unbalanced earth pressures may develop on walls or other structures utilizing bracing, shoring, or other approved method to counteract imbalance.
- .11 Protect excavations and trenches from contamination.
- .12 Employ procedures for excavation and trenching that avoid disturbance of utilities and structures.
- .13 Remove surface features or obstructions including, but not necessarily limited to, trees, shrubs, bush, and other vegetation from surfaces to be excavated, as required to construct the Works. Dispose of such obstructions as directed by Contract Administrator.
- .14 Proof roll subgrade surface to identify soft spots. Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved native fill and compact to density equal to or greater than specified requirements for subsequent fill material.
- .15 Utilize excavated material suitable for backfill prior to importing fill materials.
- .16 Compact subgrade to required density for subsequent backfill materials.

3.3

BACKFILLING

- .1 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of successive lifts of fill materials.
- .2 Do not cause excavations to be backfilled until Contract Administrator has approved excavation as complete and completed field measurements for payment purposes, and sampling and testing for analytical purposes.
- .3 Obtain approval from Contract Administrator prior to placing fill against structures or around exposed buried utilities. Place fill against structures or around exposed buried utilities in presence of Contract Administrator.
- .4 Remove debris or water from areas to be backfilled.
- .5 Ensure areas to be backfilled are free from debris, snow, ice, water, soft soils, organic materials, or frozen ground.
- .6 Proof roll subgrade surface to identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.
- .7 Cut out soft areas of subgrade not capable of compaction in place. Backfill with approved native fill and compact to density equal to or greater than requirements for subsequent fill material.

- .8 Compact subgrade to density requirements for subsequent backfill materials.
- .9 Backfill areas to contours and elevations as shown on the Drawings. Use unfrozen and unsaturated materials.
- .10 Employ a placement method that does not disturb or damage other work.
- .11 Do not use backfill material which is determined unsuitable by Contract Administrator.
- .12 Use fill types as specified. Completely use select native fill approved for backfilling before using imported fill.
- .13 Backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- .14 Except as specified otherwise, place backfill continuously and in uniform layers not exceeding specified compacted thickness up to grades shown on the Drawings.
- .15 All equipment used by Contractor for placement of drainage blanket material shall be approved by Contract Administrator and shall conform to the requirements in the table below.

Equipment Ground Pressure		Minimum Lift Thickness
kPa	psi	Mm
<70	<10	=<300
70-140	10-20	600
>140	>20	900

- .16 Place fill materials as shown on the Drawings.
- .17 Protect geomembrane and geotextiles during placement operations.
- .18 Do not operate heavy compaction equipment closer than 1 m to foundations, underground utilities, or monitoring wells.
- .19 Backfill around exposed utilities by placing layers simultaneously on all sides to equalize loading. Do not dump directly against monitoring wells, utilities, or foundations.
- .20 Make gradual grade changes. Blend slope into level areas.
- .21 Backfill around installations as follows:
 - .1 Place bedding and surround material as specified in this Section.
 - .2 Place layers simultaneously, on both sides of installed work to equalize loading and minimize movement.
 - .3 Where temporary unbalanced earth pressures are liable to develop on walls or other structures:
 - .1 Obtain approval from Contract Administrator to backfill.
 - .2 If approved by Contract Administrator, erect bracing or shoring to counteract unbalance, and leave in place until removal is approved by Contract Administrator.
 - .3 Place material under, around, and over installations until 0.6 m of cover is provided. Do not dump material directly on installations.
- .22 Remove sheeting and shoring required during excavation during backfilling operations. Do not remove bracing until backfilling has reached the respective level of such bracing. Pull sheeting in increments that will ensure compacted backfill is maintained at an appropriate elevation above toe of sheeting.

3.4 COMPACTION

- .1 Granular drainage blanket material does not require compaction.

3.5 TOLERANCES

- .1 Top of Granular Drainage Blanket, and Backfill: Plus 25 mm.
- .2 Correct surface irregularities by loosening and adding or removing material until the surface is within the specified tolerances.
- .3 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.
- .4 All grading will be performed to maintain slopes and positive drainage as shown on the Drawings.

3.6 FIELD QUALITY CONTROL

- .1 Perform laboratory material tests according to ASTM D698.
- .2 Perform in place compaction tests according to the following:
 - .1 Density Tests: ASTM D6938.
- .3 Testing by Contractor:
 - .1 Select samples of uncompacted fill intended for the Works and samples of compacted fill in the Works.
 - .2 Perform tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Testing of imported fill will include analyses for the presence of contaminants, grain size analyses, moisture content determination, bulk wet density, maximum dry density, and hydraulic conductivity. Testing for backfill will include moisture content determination, maximum dry density, and bulk wet density.
- .4 Testing by Contract Administrator:
 - .1 Contract Administrator will select samples of uncompacted fill intended for the Works and samples of compacted fill in the Works.
 - .2 Contract Administrator will perform quality assurance tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Quality assurance testing will include analysis for moisture content determination, bulk wet density, maximum dry density, and hydraulic conductivity.
 - .3 Testing by Contract Administrator will in no way relieve Contractor of responsibility to test all material prior to notifying Contract Administrator of materials' suitability for the work involved.
- .5 Methods of Testing:
 - .1 Maximum dry density and optimum moisture content will be determined in the laboratory according to ASTM D698.
 - .2 Bulk wet density will be determined in the field according to ASTM D6938.
 - .3 Moisture content will be determined in the field according to ASTM D6938. One in every ten moisture content determinations done by ASTM D6938 shall be verified according to ASTM D2216.
 - .4 Particle size analysis will be performed according to ASTM D422 or ASTM C117 and ASTM C136, whichever is appropriate to material being tested.
- .6 Frequency of Testing:
 - .1 Native Backfill:
 - .1 At least one in-place density and moisture for each lift for each 1,000 m² of area.

- .2 At least one maximum dry density and optimum moisture content for each change of material.
- .2 Imported Backfill (if necessary):
 - .1 At least one in-place density and moisture for each lift for each 1,000 m² of area.
 - .2 At least one maximum dry density and optimum moisture content for each change of material.
 - .3 One hydraulic conductivity will be made for each 400 m² of fill placed.
- .3 Leachate Collection System Granular Drainage Blanket: At least one particle size analysis per material gradation.
- .7 Failure to Meet Specified Requirements: If tests indicate that material specifications have not been achieved or cannot be obtained with equipment in use, procedure being followed, or material being incorporated, remove and replace work and modify operations so that equipment, procedures, and materials will produce required results. Additional testing required by Contract Administrator will be at no additional cost to the City.
- .8 Proof roll compacted fill surfaces under slabs on grade and around structures.

3.7 ADJUSTING

- .1 Finish compacted surfaces to within 25 mm of grades shown on the Drawings but not uniformly high or low. Correct surface irregularities by loosening and adding or removing material until the surface is within specified grade.
- .2 Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.

3.8 CLEANING

- .1 Clean and reinstate work areas and areas affected by equipment outside areas specified to be excavated, to specified restoration condition.
- .2 Upon completion of backfilling, remove excess material and debris from work areas and travel routes.

3.9 PROTECTION

- .1 Reshape and re-compact fills subjected to vehicular traffic.
- .2 Protect pipe and bedding from damage or displacement until backfilling operation is complete.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 32 19.02 – Geomembrane.
- .2 Section 31 23 33.01 – Excavation.
- .3 Section 31 23 33.02 – Fill.
- .4 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

- .1 Non-Woven Geotextile Cushion:
 - .1 Measurement Basis:
 - .1 Item measured by the square meter in place for the surface area of non-woven geotextile installed.
 - .2 No separate measurement will be made for any required overlapping, anchoring, or seams of non-woven geotextile.
 - .2 Payment Basis: Unit price. Includes supply, installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.
- .2 Non-Woven Geotextile Filter:
 - .1 Measurement Basis:
 - .1 Item measured by the square meter in place for the surface area of non-woven geotextile installed.
 - .2 No separate measurement will be made for any required overlapping, anchoring, or seams of non-woven geotextile.
 - .2 Payment Basis: Unit price. Includes supply, installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.

1.3 REFERENCES

- .1 Definitions:
 - .1 AOS: Apparent Opening Size.
 - .2 Geotextile: Synthetic fabric for use in geotechnical filter, separation, stabilization, or erosion control applications.
 - .3 MARV: Minimum Average Roll Value, means the average value for a specified parameter less two standard deviations.
- .2 Reference Standards:
 - .1 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
 - .2 ASTM D4355 - Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in an Xenon Arc Type Apparatus.
 - .3 ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
 - .4 ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
 - .5 ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

- .6 ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- .7 ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products.
- .8 ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.
- .9 ASTM D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.
- .10 ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

1.4 COORDINATION

- .1 Coordinate the installation of geotextile with geomembrane and granular drainage blanket installation.

1.5 PRE-INSTALLATION MEETINGS

- .1 Convene 1 week prior to commencing work of this Section.
- .2 Purpose of Meeting:
 - .1 Define the responsibilities of each party.
 - .2 Establish lines of authority and lines of communication.
 - .3 Establish Site-specific quality control and monitoring procedures.
 - .4 Define installation procedures.
 - .5 Define method of acceptance of completed geotextile.
 - .6 Define installation schedule.
 - .7 Discuss submittals.
 - .8 Review personal protective equipment (PPE) and applicable regulations.
 - .9 Review Construction Safety Plan and procedures.
 - .10 Review methods for measuring production.
 - .11 Review procedures for incremental acceptance.
 - .12 Review methods for protecting installed work.
 - .13 Establish rules for writing on the geotextile (i.e., who is authorized to mark on the material and in what colours).

1.6 SUBMITTALS

- .1 Manufacturer's Qualifications: Submit no later than 14 days prior to ordering, list of previous projects including name of project, description of project, area, client's name and address, contacts, and telephone numbers; engineer's name, address, contact, and telephone number; installer's name, address, contact, and telephone number; and date installed.
- .2 Manufacturer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.
- .3 Installer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.
- .4 Submit samples as follows at least 4 weeks prior to commencing the Works.
 - .1 Minimum length of 2 m of roll width of geotextile.

- .5 Product Data: Submit no later than 30 days prior to ordering.
- .6 Interface Shear Testing: Submit 10 days prior to ordering.
- .7 Manufacturers Installation Instructions: Submit at least 14 days prior to installation. Include written installation, handling, storage, and repair instructions.
- .8 Daily Field Installation Report: Submit no later than 1 day following date covered by report, include:
 - .1 Total amount and location of geotextile placed.
 - .2 Identifiers of rolls.
 - .3 Changes in layout drawings.
 - .4 Record of defects caused during transportation and handling.
 - .5 Observations of weather conditions, and results.
 - .6 Observations of anchor trench excavation, backfilling, and compaction.
 - .7 Observations of repairs, including locations and name of repairer.
 - .8 Observations of placement around appurtenances and connection to appurtenances.
 - .9 Installer Qualifications: submit a copy of manufacturer's approval letter or license to Contract Administrator no later than 14 days prior to installation.
 - .10 Submit copies of manufacturer's test data and certificate at least 4 weeks prior to commencing the Works.
- .9 Manufacturer's Certificates: Certificates pertaining to rolls of material delivered to the Site shall accompany rolls. Each roll shall be identified by a unique manufacturing number.
- .10 Quality Control Certificate:
 - .1 Include results of at least the following tests:
 - .1 Unit weight, tensile strength, elongation at break, Mullen Burst strength, puncture strength, permittivity, apparent opening size, and ultraviolet stability.
 - .2 Include manufacturer's records for storage, handling, and shipping of geotextile.
 - .3 Sign quality control certificates by a responsible party employed by geotextile manufacturer. Materials and rolls which are in non-compliance with minimum required properties will be rejected.

1.7 CLOSEOUT SUBMITTALS

- .1 Record Documents: Indicate panel layout, including panel identifier, date placed, installer's name, location of seams, and location and details of repairs.
- .2 Warranties: Completed original warranty forms filled out in City of Winnipeg's name and registered with manufacturer.

1.8 QUALITY ASSURANCE

- .1 Provide manufacturer's quality assurance plan or manual to ensure that geotextile is manufactured and will perform as specified in this Section and according to the noted references.
- .2 Provide installer's quality assurance plan or manual to ensure that the geotextile will be installed as specified in this Section and according to the noted references.

1.9 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 20 projects, 3 million square metres of installation, and 3 years documented experience.
- .2 Installer: Trained and qualified to install the type of geotextile to be used for the Project and an approved or licenced installer of geotextile manufacturer with minimum five projects, 1 million square metres of installation, and 2 years documented experience.

1.10 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver geotextile bearing manufacturer's seals and labels intact. Clearly label each roll to show geotextile identification, date of manufacture, lot number, analysis of contents, and special instructions. Manufacturer is responsible for initial loading and shipping of geotextile. Methods of unloading geotextile shall be approved by manufacturer prior to shipment.
- .2 Store and handle geotextile according to manufacturer's recommendations and to in manufacturer's original covers, and protect from moisture, dust, light, and heat.
- .3 Use appropriate handling equipment when moving geotextile from one place to another.
- .4 Notify Contract Administrator 3 days in advance of delivery to the Site. Perform joint inspection with Contract Administrator upon delivery. Defects or damage from shipping and handling will be grounds for rejection of a portion of geotextile or of entire geotextile roll at discretion of Contract Administrator. Remove roll from the Site and replace with new material.

1.11 AMBIENT CONDITIONS

- .1 Install geotextile in dry conditions and according to manufacturer's written installation instructions.
- .2 Suspend installation operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing geotextile to the requirements of this Section.
- .3 Weather conditions for seaming: comply with manufacturer's installation instructions.

1.12 WARRANTY

- .1 Part D- Supplemental Conditions: Warranty.
- .2 Provide 1 year manufacturer's warranty.
- .3 Include coverage for:
 - .1 Defective product found to be not in compliance with the requirements of this Section.
 - .2 Replacement of the geotextile with new material including costs associated with geotextile installation.

Part 2 Products

2.1 NON-WOVEN GEOTEXTILE (CUSHION)

- .1 TE-E116 as manufactured by Titan Environmental or approved alternate supplied in a minimum roll width of 4.6 m.
- .2 Rot proof, mildew proof, and not subject to attack by insects or rodents.

- .3 Capable of retaining its structure during handling, placement, and long term service.
- .4 Non-woven, needle punched fabric to act as a cushion between the HDPE geomembrane and granular drainage blanket.

2.2 NON-WOVEN GEOTEXTILE (FILTER)

- .1 TE-E180 as manufactured by Titan Environmental or approved alternate supplied in a minimum roll width of 4.6 m.
- .2 Rot proof, mildew proof, and not subject to attack by insects or rodents.
- .3 Capable of retaining its structure during handling, placement, and long term service.
- .4 Non-woven, needle punched fabric to act as a filter between the waste and granular drainage blanket.

2.3 SOURCE QUALITY CONTROL

- .1 Manufacturer Quality Control:
 - .1 Sample and test geotextile material, at a minimum, once every 10,000 m² for unit weight, tensile strength, elongation, hydraulic burst strength, puncture strength, and trapezoid tear strength to demonstrate that the material conforms to requirements specified in this Section. Test for UV stability and apparent opening size, at a minimum, once every month.
 - .2 In general, perform sampling on sacrificial portions of the material such that repair of the material is not required.
 - .3 If geotextile sample fails to meet the quality control requirements of this Section, sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Continue sampling and testing of rolls until a pattern of acceptable test results is established.
 - .4 At geotextile manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify non-complying rolls and/or to qualify individual rolls.

Part 3 Execution

3.1 EXAMINATION

- .1 Obtain Contract Administrator's approval prior to installing geotextile and prior to placing subsequent materials on geotextile.

3.2 INSTALLATION

- .1 Notify Contract Administrator at least 24 hours in advance of intention to commence placement of geotextile.
- .2 Do not permit placement of overlay materials until Contract Administrator has inspected and approved installation of geotextile.
- .3 Obtain approval of Contract Administrator prior to installation of geotextile.
- .4 Place geotextile on prepared base as indicated.
- .5 Unfold or unroll geotextile according to manufacturer's written instructions, directly on prepared base, in conditions which will prevent damage to both geotextile and granular

- material. Unsuitable conditions include, but are not limited to moderate to high wind conditions.
- .6 Overlap dimensions and the method of joining adjacent sheets shall, as a minimum, be in strict conformance with manufacturer's written instructions. Ballast geotextile according to manufacturer's written instructions and as indicated.
 - .7 Do not entrap stones in geotextile during placement of cushion layer of geotextile.
 - .8 Do not expose geotextile to sunlight for more than 30 days during the construction period, or less if recommended by manufacturer.
 - .9 Position and deploy geotextile to minimize handling. Lay smooth and free of tension, stress, folds, or creases. Protect properly placed geotextile from displacement, contamination by surface runoff, or damage, until and during placement of overlaid materials.
 - .10 Place geotextile on sloping surfaces in one continuous length from top of slope to lower extent of geotextile.
 - .11 Do not permit passage of vehicular traffic directly on geotextile at any time.
 - .12 Protect installed geotextile from displacement, damage or deterioration before, during and after placement of material layers.
 - .13 Place geotextile by unrolling onto graded surface and retain in position as specified.
 - .14 Remove and replace damaged or deteriorated geotextile as directed by Contract Administrator.
 - .15 Placement and compaction of drainage aggregate according to Section 31 23 33.02.

3.3

CONFORMANCE TESTING AND PERFORMANCE EXPECTATIONS

- .1 Conformance Testing:
 - .1 Samples of geotextiles may be removed by Contract Administrator and sent to laboratory for testing to ensure conformance with requirements of this Section.
 - .2 Testing will be carried out prior to installation of geotextile.
 - .3 Samples will be taken at a minimum frequency of one sample per 10,000 m² with a minimum of one sample per lot.
 - .4 Contract Administrator may increase the frequency of sampling in the event that test results do not comply with requirements of this Section. Additional testing will be performed at the Contractor's expense.
 - .5 As a minimum, the following conformance tests will be performed on each geotextile sample:
 - .1 Mass per unit area.
 - .2 Tensile strength.
 - .3 Grab strength.
 - .4 Tear strength.
 - .5 Puncture strength.
 - .6 AOS and permittivity tests will be performed at a frequency of one per lot.
 - .6 Any geotextile material that is not certified according to this Section, or that conformance testing indicates non-compliance with this Section, will be rejected by Contract Administrator. Replace rejected material with suitable material, at no additional cost to Contract.

3.4 FIELD QUALITY CONTROL

- .1 Contract Administrator may inspect geotextile in place for tears, overlaps, and consistency before placing materials thereon. Damaged sections, as judged by Contract Administrator, will be marked and their removal recorded. Repair minor damage and minor defects as specified in manufacturer's procedures when approved by Contract Administrator to Contract Administrator's satisfaction.
- .2 Contract Administrator may verify that weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement.

3.5 PROTECTION

- .1 Protect finished work from damage.
- .2 Maintain sufficient ballast on geotextile to prevent uplift.
- .3 Do not permit traffic or construction equipment directly on geotextile.

3.6 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling.
- .2 Remove and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal or recycling paper, plastic, polystyrene, corrugated cardboard, and packaging material.
- .4 Fold up metal banding, flatten and remove to appropriate recycling facilities.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 32 19.01 – Geotextiles.
- .2 Section 31 32 19.03 – Engineered Clay Liner.
- .3 Section 31 23 33.02 – Fill.
- .4 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

- .1 HDPE Geomembrane (smooth):
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place of the base area covered with smooth HDPE geomembrane.
 - .2 No separate measurement will be made for any required overlapping of geomembrane.
 - .2 Payment Basis: Unit price, Includes supply, installation, seaming, testing, overlaps, repairs, and manufacturer's field services.
- .2 HDPE Geomembrane (textured):
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place of the sidewall area covered with textured HDPE geomembrane, from the top of anchor trench.
 - .2 No separate measurement will be made for any required overlapping or anchoring of geomembrane.
 - .2 Payment Basis: Unit price, Includes supply, installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.

1.3 REFERENCES

- .1 Definitions
 - .1 HDPE: High Density Polyethylene.
 - .2 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.
 - .3 Wrinkles: Corrugations in HDPE liner which will fold over during placement of materials overlying HDPE.
 - .4 Minimum Average Roll Value (MARV): Average of test values calculated according to specified standard at minimum frequency specified in GRI Standard GM13.
 - .5 IAGI: International Association of Geosynthetic Installers.
 - .6 Conform to ASTM D4439 for interpretation of terms used in this Section.
- .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM D422-63 - Standard Test Method for Particle-Size Analysis of Soils.

- .2 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- .3 ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- .4 ASTM D1004 - Standard Test Method for Tear Resistance (Graves Tear) of Plastic Film and Sheeting.
- .5 ASTM D1238 - Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
- .6 ASTM D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
- .7 ASTM D1603 - Standard Test Method for Carbon Black Content in Olefin Plastics.
- .8 ASTM D3895 - Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry.
- .9 ASTM D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
- .10 ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
- .11 ASTM D4439 - Standard Terminology for Geosynthetics.
- .12 ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
- .13 ASTM D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
- .14 ASTM D5397 - Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
- .15 ASTM D5596 - Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
- .16 ASTM D5721 - Standard Practice for Air-Oven Aging of Polyolefin Geomembranes.
- .17 ASTM D5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
- .18 ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.
- .19 ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
- .20 ASTM D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Method.
- .21 ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
- .22 ASTM D7007 - Standard Practices for Locating Leaks in Geomembranes Covered with Water or Earth Materials

- .23 ASTM D7238 - Standard Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.
- .24 ASTM D7466 - Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.
- .2 Geosynthetic Research Institute (GRI):
 - .1 Test Method GM6 - Pressurized Air Test for Dual Seamed Geomembranes.
 - .2 Test Method GM9 - Cold Weather Seaming of Geomembranes.
 - .3 Test Method GM13 - Test Methods, Test Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
 - .4 Test Method GM20 - Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts.
 - .5 Test Method GM29 - Field Integrity Evaluation of Geomembrane Seams (and Sheet) using Destructive and/or Nondestructive Testing.
- .3 International Association of Geosynthetic Installers (IAGA).

1.4 COORDINATION

- .1 Coordinate the installation of HDPE liner with surface preparation work and non-woven geotextile installation.

1.5 PRE-INSTALLATION MEETINGS

- .1 Convene 1 week prior to commencing work of this Section.
- .2 Purpose of Meeting:
 - .1 Define the responsibilities of each party.
 - .2 Establish lines of authority and lines of communication.
 - .3 Establish Site-specific quality control and monitoring procedures.
 - .4 Establish Site preparation requirements.
 - .5 Define subgrade acceptance procedures.
 - .6 Define installation procedures.
 - .7 Define method of acceptance of completed geomembrane.
 - .8 Define installation schedule.
 - .9 Discuss submittals.
 - .10 Review PPE and applicable regulations.
 - .11 Review Site specific Health and Safety Plan and procedures.
 - .12 Review methods for measuring production.
 - .13 Review procedures for incremental acceptance.
 - .14 Review methods for protecting installed work.
 - .15 Establish rules for writing on the geomembrane (i.e., who is authorized to mark on the liner and in what colours).

1.6 SUBMITTALS

- .1 Bid submissions:
 - .1 Identify the material selected for use.

- .2 Identify name of proposed installation supervisor and project experience.
- .3 Identify the Quality Control program to be followed during HDPE liner installation.
- .2 Manufacturer's Qualifications: Submit no later than 14 days prior to ordering. In accordance with Article 1.9.
- .3 Manufacturer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.
- .4 Installer's Quality Assurance Plan or Manual: Submit no later than 30 days prior to ordering.
- .5 Samples: Submit the following at least 4 weeks prior to beginning work.
 - .1 Minimum 2 m length of standard width HDPE geomembrane.
- .6 Shop Drawings: Indicate installation layout, dimensions and details, including field seams, anchor trenches and protrusion details.
- .7 Product Data: Submit no later than 14 days prior to ordering.
- .8 Manufacturer's Installation Instructions: Submit at least 14 days prior to installation. Include written installation, handling, storage and repair instructions.
- .9 Daily Field Installation Report. Submit no later than 1 day following date covered by report. Include:
 - .1 Subgrade surface acceptance form signed by manufacturer's representative.
 - .2 Total quantity, type, and location of HDPE placed.
 - .3 Identifiers of rolls and fabricated blankets correlated with manufacturer's number.
 - .4 Quality control tests of materials used during the day.
 - .5 Total quantity and location of seams completed, identification of seamer, and welding equipment used.
 - .6 Changes in layout drawings.
 - .7 Observations of test seams, including seaming unit number and identification of names of seamers, weather conditions, speed, temperature setting, and results.
 - .8 Location and results of non-destructive testing.
 - .9 Location and results of destructive testing.
 - .10 Reasons for and observations of repairs and retesting, including locations, type of repair, name of repairer, and seaming equipment or product used.
 - .11 Observations of anchor trench excavation, backfilling, and compaction.
 - .12 Observations of field seaming operations, including weather conditions, cleaning, overlaps, rate of seaming, names of seamers, and units used.
 - .13 Observations of seams around appurtenances, and connection to appurtenances.
- .10 Installer Qualifications: Submit no later than 14 days prior to installation the following:
 - .1 A copy of the manufacturer's approval letter or license.
 - .2 A copy of the IAGI's Certified Contractor Status.
 - .3 IAGI's Certificates and Certified Welding Technician Certificates for each seamer.
 - .4 In accordance with Article 1.9.
- .11 Record Documents: indicate panel layout, including panel identifiers, date placed, installer's name, location of seams, and location and details of repair, and liner quality control/quality assurance documentation.

- .1 Written installation report shall be signed and certify that the geomembrane is installed in accordance with the manufacturer's recommendations, is ready for operation, and that the warranty is in effect.
- .2 One draft hard copy and electronic copy and three final hard copies and one final electronic copy are required to be submitted to Contract Administrator.
- .12 Submit copies of manufacturer's test data at least 4 weeks prior to commencing the Works.
- .13 Submit certificates, including test results, at least 2 weeks prior to delivery to the Site.
- .14 Submit certificates based on GRI GM13 test frequency as follows:
 - .1 Certificates pertaining to rolls of geomembrane delivered to the Site shall accompany rolls. Each roll shall be identified by a unique manufacturing number. Quality control certificate shall include results of at least the following tests: density, carbon black content, thickness, tensile strength, puncture resistance, and tear resistance. Quality control certificates shall be signed by a responsible party employed by manufacturer.
 - .2 Certificates pertaining to raw materials and manufactured rolls shall be provided by geomembrane manufacturer. Contract Administrator will review test results for completeness and for compliance with minimum properties specified for both raw materials and manufactured rolls. Materials and rolls which are in non-compliance with minimum properties specified will be rejected.

1.7 CLOSEOUT SUBMITTALS

- .1 Record Documents: Indicate panel layout, including panel identifier, date placed, installer's name, location of seams, and location and details of repairs.
- .2 Warranties: Completed original warranty forms filled out in City of Winnipeg's name and registered with manufacturer.

1.8 QUALITY ASSURANCE

- .1 Perform work of this Section according to applicable ASTM standards.
- .2 Provide manufacturer's quality assurance plan or manual to ensure that the HDPE liner is manufactured and will perform as specified in this Section and according to the noted references.
- .3 Provide an installer's quality assurance plan or manual to ensure that the HDPE liner will be installed as specified in this Section and according to the noted references.

1.9 QUALIFICATIONS

- .1 Manufacturer: company specializing in manufacturing products specified in this Section with minimum 20 projects, 3,000,000 m² installed, and 3 years documented experience.
- .2 Installer:
 - .1 Company specializing in installing products specified in this Section with minimum five projects, 1,000,000 m², 3 years documented experience, certified/licensed by manufacturer, and a holder of the IAGI's Certified Contractor Status.
 - .2 Seamers: Certification by the IAGI's and Certification as a Certified Welding Technician is required for all personnel performing seaming operations.
 - .3 Master Seamer: Same certification requirements as seamer, with at least 1,000,000 m² of HDPE liner of the same generic type as HDPE liner used for

project using the same type of seaming method. The master seamer will provide direct supervision over all seamers and will be present during all seaming operations.

1.10 DELIVERY, STORAGE, AND HANDLING

- .1 Package and label HDPE rolls or blankets prior to shipment to the Site. The label shall indicate HDPE liner manufacturer, type of HDPE liner, thickness, lot number, roll number, and roll dimensions. Manufacturer is responsible for initial loading and shipping of HDPE liner. Methods of unloading HDPE liner shall be approved by manufacturer prior to shipment.
- .2 When transported to the Site, handle HDPE rolls or blankets by appropriate means so that no damage is caused, as recommended by HDPE liner manufacturer.
- .3 During delivery and storage, protect HDPE rolls from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.
- .4 Take adequate measures to keep HDPE materials away from possible deteriorating sources (i.e., vandalism, theft).
- .5 Use appropriate handling equipment when moving rolled or folded HDPE from one place to another. Lift rolls by inserting bar, sized to limit deflection detrimental to HDPE liner, through roll core. Attach slings or lifting chains at both ends of bar. Use a spreader bar to support and spread slings. Bar and support pipe shall be long enough to prevent damage to edges of liner during Hoisting.
- .6 Notify Contract Administrator 3 days in advance of HDPE liner delivery to the Site. Perform joint inspection with Contract Administrator upon delivery. Defects or damage from shipping and handling will be grounds for rejection of a portion of HDPE liner or of the entire HDPE roll at the discretion of Contract Administrator. Remove roll from the Site and replace with new material.

1.11 AMBIENT CONDITIONS

- .1 Suspend installation operations whenever climatic conditions, as determined by Contract Administrator or manufacturer's representative, are unsatisfactory for placing HDPE liner to the requirements of this Section.
- .2 Weather Conditions for HDPE Placement:
 - .1 Comply with manufacturer's recommendation.
 - .2 Do not unroll, unfold, or place HDPE at an ambient temperature below 0 degrees C or above 40 degrees C, unless Contractor obtains written approval from HDPE liner manufacturer and Contract Administrator.
 - .3 Install on dry ground.
 - .4 HDPE liner placement shall take into account Site drainage, wind direction, landfill cap construction, access to the Site and production schedule of the Works.
 - .5 HDPE liner placement shall not proceed if subgrade conditions have deteriorated due to moisture, or in the presence of high winds, as determined by Contract Administrator, which might damage the HDPE liner.
 - .6 Adequately ballast deployed HDPE liner at all times to limit the risk of wind damage.
- .3 Weather Conditions for HDPE Liner Seaming:
 - .1 Comply with manufacturer's recommendations.

- .2 Make no weld below 1 degree C unless:
 - .1 Contractor strictly follows the guidelines for field seaming of HDPE liner in cold weather, as identified in GRI Test Method GM9.
 - .2 Contractor obtains written approval from HDPE liner manufacturer to weld at temperature below 0 degrees C according to GRI Test Method GM9.
 - .3 Between 1 degree C and 10 degrees C, seaming is possible if HDPE liner is preheated by either sun or hot air device, and if there is not excessive cooling resulting from wind.
 - .4 Make no weld below minus 15 degrees C.
 - .5 In all cases, HDPE liner must be dry while being welded.

1.12 WARRANTY

- .1 Part D- Supplemental Conditions: Warranty.
- .2 Provide minimum 1 year manufacturer's warranty against manufacturing defects.
- .3 Include coverage for:
 - .1 Defective product found to be not in compliance with the requirements of this Section.
 - .2 Replacement of the HDPE liner with new material including costs associated with HDPE liner installation.
- .4 Fill out original warranty forms in The City's name and register with manufacturer.

Part 2 Products

2.1 HDPE LINER

- .1 Manufactured from virgin resin with no more than 10 percent rework. Rework shall be of same formulation as the parent material. No post consumer resin permitted.
- .2 Design and manufacture rolls specifically for the purpose of fluid containment.
- .3 Free of holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
- .4 Melt Flow Index: to ASTM D1238 (190/2.16), less than or equal to 1.0 g/10 min.
- .5 Textured membrane shall have uniform texturing appearance of same texturing as shear tested Sample, free from agglomerated texturing and defects that may affect the specified properties.
- .6 Complying with the properties listed in this Section.
- .7 Textured HDPE Liner:
 - .1 1.5 mm textured (double-sided) HDPE.
 - .2 Conform to the following standard specifications:

Property	Unit	Test Method	Minimum Average Value ⁽¹⁾
Thickness	mm	ASTM D5994	1.5
• Lowest of 10 coupon values			1.35
• Lowest of 8 of 10 coupon values			1.33
Density	g/cm ³	ASTM D1505/D792	0.94
Tensile Strength at Yield	kN/m	ASTM D6693, Type IV	22.1
Tensile Strength at Break	kN/m	ASTM D6693 Type IV	15.8
Elongation at Yield	percent	ASTM D6693 Type IV	12
Elongation at Break	percent	ASTM D6693 Type IV	100
Stress Crack Resistance ⁽³⁾	hour	ASTM D5397 (Appendix)	200
Carbon Black Content	percent	ASTM D1603/ASTM D4218	2 to 3 (range)
Carbon Black Dispersion for 10 Different Views	--	ASTM D5596	Cat 1 or 2
• 9 in Categories 1 or 2 and 1 in Category 3			
Puncturing Resistance	N	ASTM D4833	400
Tear Resistance	N	ASTM D1004	187
Asperity Height	mm	ASTM D7466	0.254
Oxidation Induction Time (OIT)			
• Standard	minute	ASTM D3895	100
• High Pressure	minute	ASTM D5885	400
Oven Aging at 85 degrees C	NA	ASTM D5721	NA
• Standard OIT retained after 90 days; or	percent	ASTM D3895	55
• High Pressure OIT retained after 90 days	percent	ASTM D5885	80
UV Resistance ⁽²⁾	NA	ASTM D7238	NA
• Standard OIT; or	percent	ASTM D3895	NR ⁽⁴⁾
• High Pressure OIT retained after 1,600 hours	percent	ASTM D5885	50

Notes:

- 1 - Except as indicated.
- 2 - 20-hour UV cycle at 75 degrees C, followed by 4 hours condensation at 60 degrees C.
- 3 - Mean value determined by manufacturer's quality control testing.
- 4 - Not recommended.

.8 Smooth HDPE Liner:

- .1 1.5 mm HDPE.
- .2 Conform to the following standard specifications:

Property	Unit	Test Method	Minimum Average Value ⁽¹⁾
Thickness • Lowest of 10 coupon values	mm	ASTM D5994	1.5 1.35
Density	g/cm ³	ASTM D1505/D792	0.940
Tensile Strength at Yield	kN/m	ASTM D6693, Type IV	22
Tensile Strength at Break	kN/m	ASTM D6693 Type IV	40
Elongation at Yield	percent	ASTM D6693 Type IV	12
Elongation at Break	percent	ASTM D6693 Type IV	700
Carbon Black Content	percent	ASTM D1603/ASTM D4218	2 to 3 (range)
Carbon Black Dispersion for 10 Different Views • 9 in Categories 1 or 2 and 1 in Category 3	--	ASTM D5596	Cat 1 or 2
Puncturing Resistance	N	ASTM D4833	480
Tear Resistance	N	ASTM D1004	187
Oxidation Induction Time (OIT) • Standard • High Pressure	minute minute	ASTM D3895 ASTM D5885	100 400
Oven Aging at 85 degrees C	NA	ASTM D5721	NA
• Standard OIT retained after 90 days; or • High Pressure OIT retained after 90 days	percent percent	ASTM D3895 ASTM D5885	55 80
UV Resistance ⁽²⁾ • Standard OIT; or • High Pressure OIT retained after 1,600 hours	NA percent percent	ASTM D7238 ASTM D3895 ASTM D5885	NA NR ⁽⁴⁾ 50

Notes:

1 - Except as indicated.

2 - 20-hour UV cycle at 75 degrees C, followed by 4 hours condensation at 60 degrees C.

3 - Mean value determined by manufacturer's quality control testing.

4 - Not recommended.

2.2 EXTRUDATE ROD

- .1 Solid core rod free of voids and contamination by moisture or foreign matter.

2.3 SOURCE QUALITY CONTROL

- .1 Manufacturer shall perform test for parameters shown in Subparagraph 2.1.7.2 and 2.1.8.2 at a minimum frequency specified in GRI Test Method GM13.

Part 3 Execution

3.1 EXAMINATION

- .1 Obtain Contract Administrator's and manufacturer's approval in writing prior to installing HDPE liner and prior to placing subsequent layers on HDPE liner.
- .2 Coordinate activities such that Contract Administrator can observe testing. Contract Administrator will observe all testing and collect samples for destructive testing.

3.2 PREPARATION

- .1 Surface Preparation:
 - .1 Do not begin installation of HDPE liner until a proper subbase has been prepared and approved by Contract Administrator and HDPE liner manufacturer's representative. The prepared surface shall be free from abrupt changes in grade, water, loose earth, exposed rocks, rubble, protrusions, vegetation, and other foreign matter which may be damaging to HDPE liner. Compact the subgrade uniformly to a minimum of 98 percent SMDD and smooth with a drum roller for HDPE liner.
 - .2 Do not place HDPE liner in an area which has become softened by precipitation and which will not support liner installation equipment without rutting.
 - .3 Do not place HDPE liner in an area which has become dry and desiccated and which will not provide continuous contact between HDPE liner and compacted clay.

3.3 INSTALLATION

- .1 Maintain area of installation free of water and snow accumulations.
- .2 Prepare excessively soft supporting material as directed by Contract Administrator.
- .3 Do not proceed with panel placement and seaming when ambient temperatures are below minus 5 degrees C or above 40 degrees C, during precipitation, in presence of excessive moisture (e.g., fog, dew), nor in presence of high winds.
- .4 Place according to panel layout submittal and seam panels according to manufacturer's recommendations on graded surface in orientation and locations indicated. Minimize wrinkles, avoid scratches and crimps to geomembranes, and avoid damage to supporting material.
- .5 Designate each roll or blanket with an individual panel number and correlate with manufacturer's identification number. Mark each designation in each roll as it is deployed.
- .6 Protect installed membrane from displacement, damage or deterioration before, during and after placement of material layers.
- .7 Require workers to wear shoes which will not damage HDPE liner.
- .8 Minimize pulling of HDPE liner panels to reduce permanent tension.
- .9 Minimize dragging of textured HDPE liner to prevent damage to texturing.
- .10 Label each panel with panel number and material roll number.
- .11 Take the following precautions to minimize the risk of damage by wind during panel placement:
 - .1 Orientate work according to the direction of prevailing winds if possible, unless otherwise specified.
 - .2 Provide adequate securement of HDPE liner panels to prevent uplift by wind, using sand bags, tires, or any other means which will not damage HDPE liner. Along the edges, ensure loading is continuous, to avoid possible wind flow under the panels.

- .3 Replace damaged, torn or permanently twisted panels to approval of Contract Administrator. Remove rejected damaged panels from site.
- .12 Keep field seaming to minimum. Locate field seams up and down slopes, with no horizontal field seam less than 1.5 m beyond toe or crest of slope.
- .13 Keep seam area clean and free of moisture, dust, dirt, debris and foreign material.
- .14 Make field seam samples according to requirements specified in PART 2, HDPE LINER on fragment pieces of geomembrane and test to verify that seaming conditions are adequate.
- .15 Test field seams as seaming work progresses by non-destructive methods over their full length, according to ASTM D4437. Repair seams which do not pass non-destructive test. Reconstruct seam between failed location and any passed test location, until non-destructive testing is successful.
- .16 Repair minor tears and pinholes by patching until non-destructive testing is successful. Patches to be round or oval in shape, made of same geomembrane material, and extend minimum of 75 mm beyond edge of defect.

3.4 INSTALLATION AROUND APPURTENANCES

- .1 Install HDPE liner around wells, vents, leachate collection pipe, or other appurtenances protruding through HDPE liner as shown on the Drawings.
- .2 Obtain Contract Administrator's written approval for materials to be used to seal gaps between the liner skirt and appurtenances.
- .3 Perform installation on rough surfaces carefully to minimize HDPE liner damage. Additional loosely placed HDPE liner sections may be used by HDPE liner installer as protection for HDPE liner, if approved by Contract Administrator.
- .4 Ensure clamps, clips, bolts, nuts, or other fasteners used to secure HDPE liner around each appurtenance have a lifespan equal to or exceeding HDPE liner.
- .5 Plan required seams for skirts such that appurtenance does not prevent access for seaming or seam testing.

3.5 FIELD SEAMING

- .1 Overlap the HDPE panels a minimum of 100 mm for extrusion welds and a minimum of 125 mm inches for hot wedge welds.
- .2 The overlap shall be sufficient to leave a loose flap of geomembrane at a minimum 25 mm wide adjacent to both sides of the seam.
- .3 Panel Preparation: Prior to seaming, clean the seam area and ensure it is free of moisture, dust, dirt, debris of any kind, and foreign material.
- .4 Seaming Equipment and Products: Seam HDPE liner using extrusion (repairs and details only) or hot wedge welding equipment and installation methods recommended by manufacturer. For extrusion welding, use an extrudate composition identical to that of the liner material, or weld all panels together using the hot wedge welding system. Include thermometers on the extrusion welding equipment to measure temperature of the extrudate in the machine extruder and at the nozzle. Use wedge welding equipment capable of continuously monitoring and controlling the wedge temperature.
- .5 Orient seams downslope so that direction of seaming will not hinder flow of water over top of HDPE liner. Specifically for hot welded seams, overlap the HDPE liner on the downslope side of the seam. Extend seaming to the outside edge of panels to be placed in the anchor trench.

- .6 If the supporting soil is yielding, provide a firm substrate by using a homogeneous board, a conveyor belt, or similar hard surface directly under the seam overlap to effect proper rolling pressure.
- .7 Seaming Wrinkles: Cut fishmouths and corrugations so as to effect a flat overlap. Seam the cut fishmouths or wrinkles as well as possible, and then install patch of the same generic HDPE liner extending a minimum of 150 mm beyond the cut in all directions.
- .8 Do not cross-slope seam less than 1.5 m from the toe of slope unless slope is less than 10 percent. Cross-slope seams may be utilized if cut at an angle of approximately 45 degrees and staggered a minimum of 1.0 m.
- .9 Label each seam with date, seamer, equipment seaming temperature and speed, and time seam started and completed.
- .10 Seaming Tie-ins: Seaming of HDPE liner tie-ins shall not proceed unless all panels to be seamed are at a uniform temperature (i.e., early in the morning or late in the day) so as to avoid excessive distortion in the liner due to HDPE liner contraction and expansion.

3.6 REPAIR PROCEDURES

- .1 All repairs shall be completed within 24 hours from identification, except by approval of Contract Administrator.
- .2 Clean and dry surfaces at the time of repair.
- .3 Repair pinholes by applying a patch, and defective seams by re-seaming, flap welding, or applying a patch, as approved by Contract Administrator.
- .4 Repair tears, blisters, larger holes, undispersed raw materials, and contamination by foreign matter, or corrugations determined by Contract Administrator to be excessive, by patches.
- .5 Patches:
 - .1 Abrade surfaces as appropriate.
 - .2 Label each patch with date, number, and seamer and equipment.
 - .3 Ensure patches are round or oval in shape.
 - .4 Make of the same generic HDPE liner.
 - .5 Patches straddling textured and non-textured liners shall be textured.
 - .6 Extend patch a minimum of 100 mm beyond the edge of defects.

3.7 FIELD QUALITY CONTROL

- .1 Test quality of resin and HDPE to ensure consistency of raw material and geomembrane quality according to manufacturer's recommendations.
- .2 Inspect each panel after placement and prior to seaming for damage. Mark damaged panels or portions of damaged panels which have been rejected, as judged by Contract Administrator, and record their removal from the work area.
- .3 Verify that weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement.
- .4 Field Seaming Operations: Verify as follows:
 - .1 Seaming personnel have the specified qualifications.
 - .2 Overlaps meet specified requirements.
 - .3 Seaming area is clean and dry, as specified.

- .4 A hard substrate such as a board or a piece of conveyor belt is used if the supporting soil is soft or uneven.
 - .5 Seaming equipment is available and meets specified requirements.
 - .6 Weather conditions for seaming are acceptable, as specified.
 - .7 Seaming procedures as specified are followed.
 - .8 Panels are properly positioned to prevent wrinkling.
 - .9 Equipment for testing seams is available on the Site and operational.
 - .10 Field tensiometer has been correctly calibrated.
- .5 Test Seams:
- .1 Perform test seams in shear and peel according to ASTM D4437 or ASTM D6392 to verify that the seaming conditions are adequate. Conduct test seams at the discretion of Contract Administrator and at least two times each day (at the beginning of the day and at least 4 hours thereafter), when welder settings are changed, when welding operations have stopped for two hours or more and when there is a change in ambient conditions including a temperature change of 10 degrees C or greater, for each seaming equipment used that day. Perform test seaming under the same conditions as production seaming. Provide 1.2 m test seams for extrusion welds and 3.0 m test seams for hot wedge welds. Perform test seams on scrap HDPE liner not to be incorporated into the Works.
 - .2 Cut 25 mm wide coupons from the test seam and assign to peel or shear test alternatively as they are cut across panel. Test coupons in shear and peel using a calibrated field tensiometer.
 - .1 Minimum strength of HDPE liner test seams when tested in shear shall be 90 percent of the specified tensile strength at yield of the unseamed HDPE liner.
 - .2 Minimum strength of HDPE liner test seams when tested in peel shall be 60 percent of the specified tensile strength at yield of the unseamed HDPE liner.
 - .3 In addition, the test coupons must not delaminate. Passing test results must be obtained from four or five coupons when tested in shear, and four or five coupons when tested in peel. For HDPE liner test seams performed using a hot wedge welder, perform peel tests on both the inside and outside welds; both welds must pass the peel test. If a test seam fails, reject the seaming equipment for field seaming until the deficiencies are corrected and a successful test seam is produced.
 - .3 A passing test seam will be an indicator of the adequacy of the seaming unit and seamer working under prevailing Site conditions, but not necessarily an indicator of field seam adequacy.
 - .4 Coordinate completion of test seams such that Contract Administrator can observe such seams. Contract Administrator will observe all test seams. Retain a Sample from each test and label with the date, ambient temperature, number of seaming unit, seamer, and pass or fail description. One half of the Sample will be retained by Contract Administrator.
- .6 Non-destructive Seam Testing:
- .1 Non-destructively test field seams over their full length by pressure testing to ASTM D5820. Pressure test results will be written on liner near seam. Number or otherwise designate each seam. Record location, date, test unit, name of tester, and outcome of all non-destructive testing.

- .2 Passing non-destructive test of field seams, meeting or exceeding requirement to ASTM D5820, indicates the adequacy of field seams, subject to the results of destructive seam testing, as identified in Paragraph 3.8 G.
- .3 Coordinate activities such that Contract Administrator can observe all testing. Contract Administrator will observe all testing. Non-destructive testing performed in absence of Contract Administrator shall be repeated. Conduct testing as the seaming work progresses. Number and mark all defects found during testing immediately after detection. Repair, retest, and remark all defects found to indicate completion of the repair and acceptability. If pressure testing is performed, following testing, repair hole resulting from pressure needle.
- .7 Destructive Seam Testing: Collect 600 mm long HDPE liner field seam samples at a frequency of approximately one sample per 150 linear metres of field seam at locations directed by Contract Administrator, or more frequently if requested, and at least two samples from each panel taken from extra material, such that panel is not damaged and blanket geometry is not altered. Field test five coupons in peel and five coupons in shear according to ASTM D4437, using a calibrated field tensiometer. Perform peel tests on the inside and outside weld. If at least four of each of the five coupons do not delaminate and pass the tensile strength requirements, based on the field testing, then collect additional 600 mm long sample from the same location and provide to Contract Administrator for quality assurance laboratory shear and peel testing. Minimum shear strength of HDPE liner field seams when tested in shear shall be 90 percent of the specified tensile strength at yield of the unseamed HDPE liner for both the field and laboratory tests. Minimum strength of HDPE liner field seams when tested in peel shall be 60 percent of the specified tensile strength at yield of the unseamed HDPE liner for both the field and laboratory tests. If either field or laboratory tests fail, isolate the defective seam and re-test as follows:
 - .1 Collect additional 600 mm long samples from field seam for testing using a field tensiometer, within 3 m of each side of the failing sample as determined by Contract Administrator, until passing test locations are identified. Collect additional 600 mm long sample from each passing field test location and provide to Contract Administrator for laboratory shear and peel testing.
 - .2 Repair the field seam between the passing test locations (based on field tensiometer results) by extrusion welding or patching.
 - .3 Non-destructively test the patch or extrusion weld and repair, as required, until non-destructive test standards are achieved.
 - .4 If the additional laboratory shear or peel tests fail, then additional destructive seam field Samples will be collected and field tested to isolate the failing seam, then laboratory tested.
 - .5 Repeat the above-noted procedure until passing field and laboratory test results are achieved, thereby delineating extent of defective seam.
- .8 Contract Administrator may increase the frequency of sampling in the event that test results do not comply with requirements of this Section according to GRI GM20. Additional testing will be performed at the expense of Contractor.
- .9 Verification of Seams in Special Locations:
 - .1 Non-destructively test seams in special locations (i.e., appurtenances) if the seam is accessible to testing equipment. Contract Administrator will observe all seam testing operations. If the seam cannot be tested in place, it will be observed by Contract Administrator and Contractor for uniformity and completeness.
 - .2 In the case of visual inspections, record the seam number, date of inspection, name of tester, and outcome of the inspection.

- .3 Promptly repair, retest, and re-mark defective seams to indicate completion of the repair.
- .10 Defects and Repairs:
 - .1 Identification: Inspect seams and non-seam areas of HDPE liner for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
 - .2 Evaluation: Non-destructively test each suspect location, both in seam and non-seam, using the methods described in Paragraph 3.8.7. Mark and repair each location which fails the non-destructive testing.
 - .3 Verification of Repairs: Non-destructively test each repair using the method described in Paragraph 3.8.7. Tests which pass the non-destructive test standards will serve as an indication of an adequate repair. Re-repair and test failed test locations until a passing test results. Record the number of each repair, date, location, repair personnel initials, and test outcome. Contract Administrator will observe non-destructive testing of repairs.
- .11 HDPE Liner Acceptance: HDPE liner placement will be accepted by Contract Administrator when:
 - .1 Installation is finished.
 - .2 Documentation of installation is completed and submitted to Contract Administrator.
 - .3 Verification of the adequacy of field seams and repairs, and associated testing, is complete.
- .12 Quality Assurance Testing: quality assurance laboratory engaged by Contract Administrator will perform laboratory tests on HDPE liner Samples as identified in this Section to determine if HDPE liner seams meet specified requirements. Copies of test reports will be supplied to Contractor on request. Retesting of previously failed HDPE liner seams will be at no additional cost to Contract.

3.8 MANUFACTURER'S FIELD SERVICES

- .1 Manufacturer shall provide a qualified representative to observe placement of HDPE liner, subgrade preparation, liner installation, and backfilling operations. Manufacturer's representative shall guide the installer into proper installation techniques but shall not assume liability or responsibility in the overall installation.
- .2 Manufacturer's representative shall have extensive knowledge of HDPE liner product, specifically as it pertains to proper construction techniques for waste management applications.
- .3 Manufacturer's representative shall remain on the Site until, in his opinion, Contractor and/or installer can adequately complete the installation in strict accordance with specifications and the installation procedure specified in this Section.

3.9 PROTECTION

- .1 Protect finished work from damage.
- .2 Do not permit traffic or construction equipment directly on HDPE liner.
- .3 Cover overlying materials as indicated.
- .4 Place granular drainage blanket material from lower elevations to higher elevations. Push granular drainage blanket layer by traveling only on previously placed material, never

directly on HDPE liner or overlying geotextile cushion, and by avoiding sudden turns or accelerations.

3.10 WASTE MANAGEMENT AND DISPOSAL

- .1 Separate waste materials for reuse and recycling.
- .2 Remove and dispose of all packaging materials at appropriate recycling facilities.
- .3 Collect and separate for disposal or recycling paper, plastic, polystyrene, corrugated cardboard, and packaging material.
- .4 Fold up metal banding, flatten and remove to appropriate recycling facilities.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 32 19.02 – Geomembrane.
- .2 Section 31 23 33.01 – Excavation.
- .3 Section 31 23 33.02 – Fill.
- .4 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

- .1 Engineered Clay Liner:
 - .1 Measurement Basis: Item measured by the square metre in place using the surface area of the engineered clay liner to the inside crest of slope.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, placing, grading, compaction, and finishing of clay for construction of engineered clay liner.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.

1.3 REFERENCES

- .1 Definitions:
 - .1 SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined according to ASTM D698.
- .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM D422 - Standard Test Method for Particle-Size Analysis of Soils.
 - .2 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (600 kN-m/m³).
 - .3 ASTM D1140 - Standard Test Methods for Amount of Material in Soils Finer Than the No. 200 (75-µm) Sieve.
 - .4 ASTM D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
 - .5 ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 - .6 ASTM D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
 - .7 ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 - .2 City of Winnipeg Standard Construction Specifications:
 - .1 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.

1.4 SEQUENCING

- .1 Sequence and schedule engineered clay liner activities with work of other Sections.
- .2 Perform construction of the engineered clay liner subsequent to excavation and approval of cell excavation by Contract Administrator. Excavation of base grades involves removing the existing soils to finished subgrade as shown on the Drawings.
- .3 Construct the engineered clay liner in such a manner so as to facilitate placement of the HDPE liner so that no portion of the completed engineered clay liner remains exposed for greater than 72 hours.
- .4 If the surface of the engineered clay liner material already in place becomes too dry or too smooth to bond properly with the HDPE liner, as determined by Contract Administrator, disc or scarify the engineered clay liner material surface. Proof roll the engineered clay liner surface to a smooth finish removing indentations from the sheepsfoot roller.
- .5 Obtain approval from Contract Administrator and manufacturer's representative or installer, for surface acceptance prior to placing HDPE liner.
- .6 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.5 SCHEDULING

- .1 All engineered clay liner work is to be completed by the deadline as outlined in the Contract Documents.
- .2 Do not allow or cause work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.6 AMBIENT CONDITIONS

- .1 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing engineered clay liner material to the requirements of this Section.
- .2 After occurrence of heavy rains, do not operate equipment on previously placed material or on approved graded areas until the material has dried sufficiently to prevent the occurrence of excessive rutting.
- .3 Do not place engineered clay liner material in a frozen state or against frozen ground or previously placed material.
- .4 Do not place engineered clay liner material on snow, ice, water or other objectionable material or on improperly graded areas or previously placed material.
- .5 Remove, replace, and compact softened, eroded, or otherwise objectionable or damaged areas or previously placed material, as determined by Contract Administrator at no additional cost to City of Winnipeg.

Part 2 Products

2.1 LOW PERMEABILITY MATERIAL SOURCE

- .1 Low permeable soil for construction of the engineered clay liner is to be obtained from excavation of the works, on-Site stockpiles, or supplied by Contractor from source approved by Contract Administrator.

- .2 Low permeable soil material shall be excavated and temporarily stockpiled, if necessary, and hauled to work area in volumes required to construct the engineered clay liner or excavated and placed directly for construction of the engineered clay liner.
- .3 Use low permeable soil that is free of unsuitable materials, is of sufficient low permeability, and is stable when placed and compacted as specified.
- .4 Low permeable soil must have a maximum particle size no greater than 12.5 mm.
- .5 Contract Administrator will direct excavation operations in areas of unsuitable materials. Material that is unsuitable for engineered clay liner construction to be excavated and stockpiled in locations approved by Contract Administrator.

2.2 UNSUITABLE MATERIALS

- .1 Unsuitable materials means materials which are not approved for use as determined by Contract Administrator and include the following:
 - .1 Refuse, asphalt, concrete, or granular materials.
 - .2 Material containing loam, roots, or organic matter.
 - .3 Frozen material or material containing snow or ice.
 - .4 Clays which are classified as inorganic clays of high plasticity in accordance with applicable ASTM specifications.
 - .5 Soft and/or organic clays and silts of low strength.
 - .6 Frost susceptible silts or clays.
 - .7 Swelling clays.
 - .8 Rock and lumps of material with dimensions greater than 12.5 mm.
 - .9 Trees, stumps, branches, roots, or other wood or lumber.
 - .10 Wire, steel, cast iron, cans, drums, or other foreign material.
 - .11 Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.
- .2 Material generated as a result of excavation, grading, and construction activities associated with completing the Works that are deemed unsuitable for use by Contract Administrator will be loaded, hauled, and placed in an area on the Site designated by Contract Administrator. This includes water or frost impacted material as a result of Contractor negligence.

2.3 MATERIAL SPECIFICATIONS

- .1 Use low permeable soil that will achieve a remoulded permeability of less than 1×10^{-7} cm/s as determined in accordance with ASTM D5084.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that survey bench marks and intended elevations for Works are as shown on the Drawings.
- .2 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.
- .3 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of initial and successive lifts.

- .4 Ensure areas to be backfilled are free from debris and water.
- .5 Do not permit traffic in restored/repaired area without approval from Contract Administrator.
- .6 Verify that excavations, dimensions, and elevations are as shown on the Drawings.
- .7 Verify that prepared soil base is ready to receive the work of this Section.

3.2 SUPPORT OF EXCAVATIONS

- .1 Install and maintain sheathing, shoring, bracing and sloping necessary to support excavations to prevent any movement which may damage adjacent structures, pavements, or utilities, or delay the work, or endanger life or health. Perform the Works in accordance with the Occupational Health and Safety Act and Regulations for Construction Projects, Ministry of Jobs, Skills, Training and Labour and any other regulations and agencies.

3.3 PREPARATION

- .1 Protect excavations and trenches from contamination.
- .2 Prior to placing the low permeable material for construction of the engineered clay liner, proof roll the base of subgrade following excavation and rough grading and obtain approval from Contract Administrator. Ensure a minimum of two passes are conducted over each area of the base with suitable compaction equipment approved by Contract Administrator.

3.4 SEGREGATION AND PROTECTION

- .1 The engineered clay liner material will be subject to monitoring and testing by Contract Administrator to verify its suitability. Engineered clay liner material that fails material specifications identified in clause 2.3 shall be removed by Contractor and placed in the designated area for surplus excavated material in the stock pile area as directed by the Contract Administrator.
- .2 If required, stockpiled clay material will be covered with polyethylene sheeting and/or watered, as directed by Contract Administrator, in order to restrict moisture loss of the engineered clay liner material.

3.5 BONDING

- .1 During the work, whenever the surface of the engineered clay liner material already in place becomes too dry or too smooth to bond properly with the succeeding layer, as determined by Contract Administrator, and whenever engineered clay liner material placement resumes after suspension, disc or scarify the engineered clay liner material surface in place to a depth of 150 mm and compact at the specified moisture content.
- .2 Obtain approval from Contract Administrator of prepared surfaces prior to resumption of engineered clay liner material placement after suspension of work and prior to covering surfaces with permanent material.

3.6 PLACING

- .1 Place the engineered clay liner material to a minimum thickness of 150 mm to lines and grades shown on the Drawings.
- .2 Place engineered clay liner material in continuous layers of uniform thickness following the grades shown on the Drawings. Place the layers at a thickness before compaction

equal to 135 percent of the length of the wedge of the sheep's foot compactor, to a maximum thickness of 150 mm.

- .3 Ensure the engineered clay liner material is free from lenses, pockets, streaks and layers of pervious material.
- .4 Prior to work stoppages or following completion of the final layer, the engineered clay liner surface shall be proof rolled to a smooth finish with a minimum 13.5 tonne smooth drum compactor.

3.7 MOISTURE CONTENT

- .1 Maintain the moisture content throughout each layer of the engineered clay liner material as uniformly as practicable and control the moisture content to between 2 percent and 4 percent wet of optimum moisture content.
- .2 In case of engineered clay liner material which is too dry or too wet, including uncompacted engineered clay liner material, adjust the moisture content by methods approved by Contract Administrator.
- .3 The engineered clay liner will be watered at the completion and/or start of every work day and on hot sunny days, as directed by Contract Administrator. The engineered clay liner will be watered as required to prevent shrinkage cracks greater than 50 mm in depth.

3.8 COMPACTION

- .1 Compact each layer to a minimum density of 95 percent and an average density of 98 percent SMDD as determined by applicable ASTM specifications.
- .2 Obtain approval by Contract Administrator for the type, size, and efficiency of compaction equipment.
- .3 As a minimum, compaction equipment will be a 18 tonne wedge-shape sheep's foot roller with depth of wedge equal to three-quarters the lift thickness, minimum 180 mm length. The final lift will be back-bladed following compaction by the sheep's foot roller and compacted with a minimum 13.5 tonne smooth drum compactor.
- .4 Compaction equipment must pass over the completed area a minimum number of five passes before testing.

3.9 TOLERANCES

- .1 Construct the engineered base liner such that the finished compacted thickness is not less than 150 mm or as adjusted by Contract Administrator.
- .2 Correct surface irregularities by loosening and adding or removing material until the surface is within the specified tolerance.
- .3 Repair the engineered clay liner where disturbed by Contractor activities such that the finished compacted engineer clay liner is returned to original condition.
- .4 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.
- .5 Survey Requirements:
 - .1 Engineered clay liner thickness to be confirmed by Contract Administrator prior to geomembrane installation.
 - .2 Engineered clay liner as-built survey data is to be made available to the Contract Administrator prior to geomembrane installation.

3.10 FIELD QUALITY CONTROL

- .1 Testing by Contract Administrator:
 - .1 Contract Administrator may select samples of uncompacted fill intended for the Works and samples of compacted fill in the Works.
 - .2 Contractor shall provide assistance to Contract Administrator to collect samples.
 - .3 Contract Administrator may perform tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Testing of imported fill may include analysis for the presence of contaminants, grain size analysis, moisture content determination, bulk wet density, maximum dry density, and permeability. Testing for backfill may include moisture content determination, maximum dry density, bulk wet density, and hydraulic conductivity. Copies of test reports will be supplied to Contractor on request.
 - .4 Contractor shall repair all locations sampled.
 - .5 Testing by Contract Administrator will in no way relieve Contractor of his responsibility to test all material prior to notifying Contract Administrator of the materials' suitability for the work involved.
- .2 Methods of Testing:
 - .1 Maximum Dry Density of fill containing more than 12 percent by weight passing No. 200 sieve will be determined in accordance with ASTM D698.
 - .2 Bulk density will be determined in the field in accordance with ASTM D1556 or with ASTM D2167 or with ASTM D6938, whichever is most suitable to obtain representative density of soil tested.
 - .3 Particle size analysis will be performed in accordance with ASTM D422 or ASTM D1140, whichever is appropriate to material tested.
 - .4 Moisture content of fill in place will be determined in accordance with ASTM D6938.
 - .5 Compaction testing of fill in place will be determined in accordance with ASTM D6938.
 - .6 Hydraulic conductivity will be determined according to ASTM D5084 on a representative sample remoulded in the laboratory to the field bulk wet density and moisture for samples of uncompacted fill intended for the Works.
 - .7 Hydraulic conductivity will be determined according to ASTM D5084 on a representative undisturbed Shelby Tube sample in the laboratory for samples of compacted fill utilized for the Works.
- .3 Frequency of testing:
 - .1 Contract Administrator may take a minimum of thirteen field density and moisture contents per lift per hectare of engineered clay liner installation.
 - .2 Contract Administrator may take a minimum of six Shelby Tube samples on the finished base engineered clay liner, and a minimum of two samples from the finished sidewall engineered clay liner.
- .4 Failure to Meet Specified Requirements: If tests indicate that material specifications have not been achieved or cannot be obtained with equipment in use, the procedure being followed, or the material being incorporated, remove and replace work and modify operations so that the equipment, procedures, and materials will produce the required results. Additional testing required by Contract Administrator will be paid for by Contractor.
- .5 Rework and recompact areas which do not meet the specified permeability density, as directed by Contract Administrator, at no additional cost to the Contract.

3.11 ADJUSTING

- .1 Finish engineered clay liner to within +/-30 mm of grades shown on Drawings but not uniformly high or low. Correct surface irregularities by loosening and adding or removing material until the surface is within specified grade.
- .2 All sharp rocks/objects, regardless of size, shall be removed from the final surface of the clay liner to avoid damaging the HDPE geomembrane.
- .3 Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.

3.12 CLEANING

- .1 Clean and reinstate work areas and areas affected by equipment outside areas specified to be excavated, to specified restoration condition.
- .2 Upon completion of backfilling, remove excess material and debris from work areas and travel routes.

3.13 PROTECTION

- .1 Immediately prior to temporary suspension of placement operations of engineered clay liner material, fine grade the surfaces of the engineered clay liner under construction to a uniform grade so as to leave the area free of ruts, depressions, or areas that would pond or collect water. Provide suitable equipment on Site at all times for this purpose.
- .2 Do not disturb completed final graded portions of the engineered clay liner already in place when placing and compacting engineered clay liner material.
- .3 Protect open excavations against damage due to surface runoff and runoff. Take necessary precautions to prevent erosion of excavated or disturbed surfaces.
- .4 Protect compacted clay from desiccation and erosion.
- .5 Do not permit traffic or construction equipment directly on completed engineered clay liner.

END OF SECTION

Part 1 General

1.1 SCOPE

- .1 The manufacturer shall furnish air powered well pumps for use in a landfill leachate collection system to remove accumulated leachate from manholes.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for pumps and include:
 - .1 Physical dimensions, weight, materials of construction, general specifications and accessories.
 - .2 Performance curves indicating rated flow range and air consumption.
 - .3 Connections, piping, and fittings, strainers, control assemblies and ancillaries, identifying factory and field assembled components and recommended installation.
 - .4 Installation and operation manuals.
 - .5 Warranty coverage.

1.3 CLOSEOUT SUBMITTALS

- .1 Operation and Maintenance Data: submit operation and maintenance data for pumps.
 - .1 Include:
 - .1 Manufacturer's name, type, model, year, capacity and serial number.
 - .2 Details on operation, servicing and maintenance.
 - .3 Recommended spare parts list and addresses of representatives.

1.4 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with manufacturer's written instructions.

Part 2 Products

2.1 MANHOLE PUMPS (P-5, P-6, P-7, P-8)

- .1 Operating Conditions:
 - .1 Pumps shall be capable of meeting the capacity requirements based on pumping elevations. Refer to drawings.
 - .2 Air Supply Pressure: 552 kPa (80 psig)
 - .3 Capacity:
 - .1 Cell 32 Manhole Pump (P-5): 38 L/min (10 usgpm)
 - .2 Cell 33 Manhole Pump (P-6): 38 L/min (10 usgpm)
 - .3 Cell 34a Manhole Pump (P-7): 38 L/min (10 usgpm)
 - .4 Cell 34b Manhole Pump (P-8): 38 L/min (10 usgpm)
- .2 Process Description:

- .1 A pneumatic displacement pump alternately fills and discharges. During the fill cycle, the pump chamber is vented to atmosphere and liquid fills the pump through the inlet check valve under hydrostatic pressure. During the discharge cycle, air pressure is applied to the pump chamber, which closes the inlet check valve and displaces the liquid within the pump through the discharge check valve and discharge tubing.
- .2 In an automatic controllerless pneumatic displacement pump, cycling between the fill and discharge cycles is controlled by an internal float that rises and falls with the liquid level inside the pump. At the top of the float travel, the internal air valve mechanism is actuated to apply air pressure. When the liquid is fully discharged from the pump chamber, the float reaches the bottom of its travel, which closes the air supply to the pump and opens the air exhaust line, venting the pressurized air and allowing the pump to fill again. The pump only cycles when there is sufficient liquid in the well to raise the float above the pump actuation point.
- .3 The maximum drawdown level in the well is determined by the pump position and its actuation point. The maximum flow rate of the pump is determined by the pump depth, submergence (liquid head above pump inlet), and the air pressure and volume supplied to the pump.
- .4 Pump design and performance shall meet the following requirements and must be able to operate under the following conditions:
 - .1 Temperature up to 180° F (82° C)
 - .2 Air pressures up to 120 psi (8.4 kg/cm²)
 - .3 Free floating or dissolved common fuels (diesel, gasoline, JP1-JP6, #2 heating oils)
 - .4 pH range 4 - 9
 - .5 BTEX (Benzene, Toluene, Ethyl Benzene, Xylene) and MTBE
 - .6 Landfill liquids – leachate and condensate
- .3 Equipment Design Requirements:
 - .1 Standard product design shall include complete pump assembly, including casing, end caps, tubing/hose fittings, O-rings, check valves, inlet, and float/actuator assembly, to meet the following specifications:
 - .1 The pump and all related components at the well shall operate on compressed air. No electricity shall be required at the well head.
 - .2 Pumps shall have integral on/off level control; no bubbler tubes or in-well sensors shall be required to provide on/off level control.
 - .3 Pump system shall be controllerless, requiring no surface-mounted controllers, in-line control devices, or factory-set control cycle timers within or external to the pump.
 - .4 Pumps shall be available in both top and bottom filling versions. Manufacturer shall stock Inlet Conversion Kits that allow field conversions from top to bottom fill or vice versa.
 - .5 Pumps shall be designed and constructed to allow disassembly of all major pump components in as little as two minutes using only a nut driver or socket wrench to remove the pump inlet bolts, allowing for quick, easy field cleaning and maintenance. The internal float mechanism shall be removable using only standard pliers to release the lower actuator rod stop.
 - .6 Pumps shall be designed and constructed to fit in standard 4" diameter well casing, with a minimum required submergence of 678 mm 26.7".

- .7 Pumps shall not require an additional downwell air line to evacuate liquid from the pump to the surface (to reduce the pump's weight for removal from the well).
- .2 Pump casing shall be Fiberglass Reinforced Plastic to eliminate denting and corrosion, and to withstand temperatures to 180° F (82° C).
 - .1 Pump casing shall not be unfinished standard pipe stock. Casing ends shall be machined to assure precise fit of end cap O-rings for proper seal and easy disassembly and reassembly without O-ring damage. The entire ID of the pump casing shall be precision worked for a smoother surface to reduce accumulation of mineral scale.
 - .2 For ease of pump disassembly, the intake and head o-rings shall be located no farther than 0.187" from the ends of the pump casing.
 - .3 The fluid inlet check valve shall be a poppet type (or ball type for top-loading pumps) and the discharge check valve shall be a rotating ball. Valves shall exhibit a self-cleaning action and be able to pass coarse solids and viscous liquids without clogging. The inlet and discharge check balls shall be located in a housing that allows passage of solids up to 1/8" diameter. The fluid discharge shall have a ball-type check valve that is affixed above the casing of the pump and is serviceable using hand tools. No flapping or sliding valves subject to clogging or improper seating are allowed.
 - .4 Pump head and frame shall be constructed of 304 Stainless Steel.
 - .5 Pumps shall have a 3" intake screen constructed of 316 stainless steel with holes rather than slots for fluid to pass.
 - .6 The fluid intake check valve seat shall be constructed of 304 stainless steel.
 - .7 The discharge tube shall be a minimum of 1" 304 stainless steel to maximize flow rate and reduce clogging/fouling.
 - .8 All non-metallic internal components of the pump shall be constructed of PVDF for maximum strength at elevated temperatures, and chemical resistance.
 - .9 Air and liquid fittings shall be available in sizes to accommodate either tubing or hose.
 - .10 Internal floats shall have proven performance and compatibility with landfill leachate and condensate at elevated temperatures.
 - .11 Pumps shall be designed such that the pump casing can be removed by removing four bolts.
 - .12 Stainless steel castings shall be incorporated into the pump intake assembly to reduce the number of components needed.
 - .13 Air intake and exhaust seats shall not be machined into the pump head. The seats shall be separate components so that they can be replaced without necessitating replacement of the entire pump head.
 - .14 Pump weight shall be less than 17 lbs (7.71kg) to facilitate removal from wells.
- .3 The following accessories shall be provided with the pump:
 - .1 Pumps shall be equipped with air and liquid tubing as follows:
 - .1 Tubing shall be constructed of a material that is suitable for landfill leachate and is rated for temperatures to 180° F (82°C).

- .2 Multiple-tube assemblies shall be jacketed in a continuous Nylon 12 sheath to prevent hang-ups, loops, and kinks during installation or removal. Loose or cable-tied tubing is not allowed.
 - .2 Cycle counters shall be available to allow monitoring of pump operation, and fluid flow.
 - .3 Filter/regulator kit comprised of a 5-micron final air filter with autodrain to remove moisture and a pressure regulator to allow air pressure adjustment.
 - .4 Leachate-compatible quick-release pump fittings made of 316 stainless steel with Hastelloy C retaining clips and dual O-ring seals to allow quick disconnection and reconnection of tubing/hose without the need to shorten pump tubing/hose length or remove and replace tubing clamps when removing pump from service.
- .4 Operation and Performance Parameters:
- .1 Pumps shall be capable of the following benchmark flow rates:
 - .1 Pumps shall deliver flow up to 14 usgpm at a depth of 20 feet with 10 feet of submergence, when equipped with 1" discharge fittings and tubing, and operating at 100 psi.
 - .2 Pumps shall have a maximum lift of at least 250 feet.
 - .3 Pumps shall function properly over an operating pressure range of 5 to 120 psi.
 - .4 Pumps shall automatically conserve air and minimize air consumption costs by operating only when the liquid level in the well is high enough for pumping to occur based on the pump location in the well and the pump's specified actuation point.
 - .5 Pump design shall prevent air from entering discharge tubing or hose under normal operating conditions.
 - .6 Pumps shall be capable of operation in wells under pressure or vacuum without requiring any pump modifications.
- .5 Acceptable Product:
- .1 QED Environmental Systems Inc. AutoPump Model AP4+ Long Bottom Inlet or approved equal

Part 3 Execution

3.1 INSTALLATION

- .1 Install pumps in accordance with manufacturer's written instructions.

3.2 PIPING

- .1 Pipe system as indicated on the drawings.

3.3 INSPECTION, TESTING AND COMMISSIONING

- .1 Inspect, test and commission new equipment in accordance with manufacturer's recommendations including demonstration and training of operation and maintenance of the equipment with the The City.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 23 33.01 – Excavation.
- .2 Section 31 23 33.02 – Fill.
- .3 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

- .1 HDPE Manhole:
 - .1 Measurement Basis:
 - .1 Item measured by the lump sum.
 - .2 Payment Basis: Lump sum price, Includes excavation and trenching for the installation of the HDPE manhole and non-perforated leachate collection system pipe connection; supply and placement of bedding and concrete; supply, installation, and connection to existing leachate pipe of HDPE manhole; supply and installation of all fittings and piping internal to the HDPE manhole, supply, placement, and compaction of backfill around the HDPE manhole and leachate collection system connection pipe.

1.3 REFERENCES

- .1 Definitions
 - .1 Bedding: Specialized material placed under manhole prior to subsequent backfill operations.
- .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM A48/A48M - Standard Specification for Gray Iron Castings.
 - .2 ASTM A536 - Standard Specification for Ductile Iron Castings.
 - .3 ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 - .4 ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - .5 ASTM F1759 - Design of High Density Polyethylene (HDPE) Manholes for Subsurface Applications.
 - .2 OSHA – Occupational Safety and Health Administration.

1.4 COORDINATION

- .1 Coordinate work of this Section with connection to leachate collection system piping, and trenching.

1.5 PRE-INSTALLATION MEETINGS

- .1 Convene minimum one (1) week prior to commencing work of this Section.
 - .1 Pre-installation meeting to overview installation sequence, scheduling, dewatering methods, lifting and conveyance equipment, and health and safety requirements.

1.6 SCHEDULING

- .1 Schedule work of this Section after excavation and aggregate bedding work and prior to connecting piping work.
- .2 Complete daylighting and verification of existing utilities prior to fabrication of products associated with this Section.
- .3 Connection to existing leachate system will require a system shutdown to cut and connect to existing buried piping. Coordinate shut down with the City and Contract Administrator such that shut down is required for no more than 24 hours.
- .4 Perform excavation activities for the installation of the HDPE manhole and non-perforated HDPE pipe connection to the landfill cell following excavation activities associated with the construction of the landfill cell.
- .5 Coordinate installation of HDPE manhole and non-perforated HDPE pipe connection to the landfill cell with backfill and engineered clay liner construction.

1.7 SUBMITTALS

- .1 Product Data: Submit data for polyethylene manholes, and accessories.
- .2 Manufacturer's Certificate: Certify that products meet or exceed the requirements of this section.
- .3 Manufacturer Instructions: Submit detailed instructions on installation requirements, including storage and handling procedures.
- .4 Qualifications Statement: Submit qualifications for manufacturer.
- .5 The manufacturer shall submit calculations for review by the Contract Administrator indicating that the manholes meet the requirements of ASTM F1759. The data shall contain information related to the following areas as necessary: Ring Compressive Strain, Combined Ring Compressive and Ring Bending Strain, Ring Buckling, Axial Stain, Axial Buckling, Thickness of the bottom based on depth and groundwater. Thickness should be based on acceptable stress and deflection limits. Submit anti-flotation calculations for review by Contract Administrator.
- .6 Shop Drawings of HDPE manhole design shall be submitted signed and sealed by a professional engineer licensed in the Province of Manitoba.
- .7 Prior to delivery to site, submit results of hydrostatic testing.

1.8 CLOSEOUT SUBMITTALS

- .1 Project Record Documents: Record actual locations of manholes and connections and record invert elevations.
- .2 Warranties: Completed original warranty forms filled out in City of Winnipeg's name and registered with manufacturer.

1.9 QUALITY ASSURANCE

- .1 Perform work of this Section according to applicable ASTM standards.
- .2 Hydrostatic leak testing shall be conducted with water over a period of at least 1 hour and show the structure is leak free.

1.10 QUALIFICATIONS

- .1 Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 3 years documented experience.

1.11 DELIVERY, STORAGE, AND HANDLING

- .1 Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.
- .2 Storage:
 - .1 Store manholes in areas protected from weather, moisture, and damage.
 - .2 Do not store directly on ground.
- .3 Take precautions to prevent damage to interior or exterior surfaces when handling.
- .4 Use only equipment and accessories rated for handling products.
- .5 Minimize the need to handle products prior to installation.
- .6 Do not drag products.

1.12 EXISTING CONDITIONS

- .1 Field Measurements:
 - .1 Verify field measurements prior to fabrication.
 - .2 Daylight and survey existing leachate utility line to confirm required inverts prior to fabrication and shop drawing review.
 - .3 Indicate field measurements on Shop Drawings.

1.13 WARRANTY

- .1 Provide minimum 1 year manufacturer's warranty against manufacturing defects.
- .2 Fill out original warranty forms in City's name and register with manufacturer.

Part 2 Products

2.1 POLYETHYLENE MANHOLES

- .1 Manufacturers:
 - .1 ISCO Industries or approved equivalent.
- .2 Material:
 - .1 High-density polyethylene (HDPE).
 - .1 HDPE3408/3608 material, cell classification ASTM D3350.
 - .2 ASTM D1248, Type III, Class C, Category 5, Grade P34.
- .3 Manhole Steps: HDPE. In accordance with OSHA requirements.
- .4 Manhole Frames and Covers:
 - .1 Lockable access cover
 - .2 Aluminum warning sign stating "Danger Confined Space Enter by Permit Only" in red and black letters on a white background to be bolted to the manhole cover.
- .5 Base Pad:
 - .1 Cast-in-place reinforced concrete. Class N.
 - .2 Increase thickness of concrete base to prevent flotation, as approved by Contract Administrator.
 - .3 Provide anchorage to concrete base.

- .4 Provide anti-flotation calculations in accordance with Article 1.7.
- .5 Bedding in accordance with Section 31 23 33.02

Part 3 Execution

3.1 EXAMINATION

- .1 Section 01 73 00 – Execution Requirements.
- .2 Verify that excavation base is ready to receive work and excavations and that dimensions and elevations are as shown on the Drawings.

3.2 PREPARATION

- .1 Conduct operations not to interfere with, interrupt, damage, destroy, or endanger integrity of surface structures or utilities in immediate or adjacent areas.
- .2 Correct over-excavation with bedding material.
- .3 Remove large stones or other hard matter impeding consistent backfilling or compaction.
- .4 Protect manhole from damage or displacement while backfilling operation is in progress and ensure manhole remains plumb.

3.3 INSTALLATION

- .1 Excavation:
 - .1 Excavate for manholes as specified in Section 31 23 33.01 in locations and to depth indicated.
 - .2 Provide clearance around sidewalls of manhole for construction operations.
 - .3 If groundwater is encountered, prevent accumulation of water in excavations; place manhole in dry trench. Prevent surface water run-on during excavation and backfill works associated with this Section.
 - .4 Where possibility exists of watertight manhole becoming buoyant in flooded excavation, anchor manhole to avoid flotation as approved by Contract Administrator and manufacturer.
- .2 Bedding:
 - .1 Place bedding material at base of excavation, and level materials in continuous layers not exceeding 200 mm.
 - .2 Compact bedding material to 95 percent maximum density.
 - .3 Maintain optimum moisture content of bedding material to attain required compaction density.
 - .4 Non-perforated leachate collection system pipe connection to landfill shall be placed on compacted native low-permeability material and backfilled with native low-permeability material in continuous layers not exceeding 200 mm.
- .3 Base Pad:
 - .1 Form and place cast-in-place reinforced concrete base pad.
 - .2 Place manholes plumb and level and anchor to foundation slab.
 - .3 Complete second concrete base pad pour.
- .4 Backfill: In accordance with Section 31 23 30.02

- .5 Installation Standards: Install work of this Section according to ASTM standards.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 31 32 19.01 – Geotextile.
- .2 Section 31 32 19.02 – Geomembrane.
- .3 Section 31 23 33.02 – Fill.
- .4 Section 33 05 13.19 – Polyethylene Manholes.

1.2 MEASUREMENT AND PAYMENT

- .1 Leachate Collection System (Perforated):
 - .1 Measurement Basis: Item measured by the lineal metre in place for the length of the perforated leachate collection pipe installed.
 - .2 Payment Basis: Unit price. Includes supply and delivery, fusion, installation of perforated leachate collection system pipe, HDPE fittings, and end caps.
- .2 Leachate Cleanout Pipe (Non-Perforated):
 - .1 Item measured by the lineal metre in place for the length of the non-perforated leachate cleanout pipe installed.
 - .2 Payment Basis: Unit price. Includes supply and delivery, fusion, installation of leachate cleanout pipe, HDPE fittings, and end caps.
- .3 Payment for non-perforated leachate collection pipe connection to HDPE manhole will be made under Section 33 05 13.19.

1.3 REFERENCES

- .1 Definitions:
 - .1 HDPE: High density polyethylene.
- .2 Reference Standards:
 - .1 ASTM International:
 - .1 ASTM D1248 - Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
 - .2 ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
 - .3 ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - .4 ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.

1.4 SEQUENCING

- .1 Sequence and schedule leachate collection system activities with work of other Sections.
- .2 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.5 SCHEDULING

- .1 Include detailed sequence of leachate collection system installation in Detailed Work Schedule.
- .2 Do not allow or cause work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.6 AMBIENT CONDITIONS

- .1 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for installation of leachate collection system to the requirements of this Section.
- .2 After occurrence of heavy rains, do not operate equipment on previously placed material or on approved graded areas until the material has dried sufficiently to prevent the occurrence of excessive rutting.
- .3 Remove, replace, and compact softened, eroded, or otherwise objectionable or damaged areas or previously placed material, as determined by Contract Administrator at no additional cost to City of Winnipeg.

1.7 SUBMITTALS

- .1 Product Data:
 - .1 Piping and fitting dimensions including test reports and material property sheets.
- .2 Manufacturer's Certificate: Quality control certificates pertaining to each lot of pipe produced.
- .3 Manufacturer's Instructions: Indicate special procedures required to install products specified.

1.8 QUALITY ASSURANCE

- .1 HDPE Pipe:
 - .1 Pipe Resin: ASTM D1248 for material indicating a Type 3, Category 5, Class C, Grade PE3608 (ASTM D3350 Cell Classification 344464C) with long-term hydrostatic strength (LTHS) of 11 MPa (1,600 psi) when tested and analyzed by ASTM D2837.
 - .2 Raw Material: Containing a minimum 2 percent carbon black, well dispersed by recompounding to protect the pipe from degradation by ultraviolet light.
 - .3 Pipe shall not contain any recycled compound except that generated in the manufacturer's own plant from resin of the same specification from the same raw material Supplier.
 - .4 Pipe Sizes: ASTM F714. Pipe sizes are specified in metric units; however, equivalent IPS pipe sizes shall be used.
 - .5 Hydrostatic Design Stress: 5,513 kPa for PE3608 materials.

1.9 DELIVERY, STORAGE, AND HANDLING

- .1 Deliver and store piping with labelling in place.
- .2 Deliver, store, and handle pipe and products according to applicable requirements of the specified references, the manufacturer's instructions, and as specified herein.

- .3 Use every precaution to prevent damage to the pipe. Do not permit metal tools or heavy objects to unnecessarily come in contact with the pipe. Avoid excessive transportation and possible damage to the pipe.
- .4 Prevent animals from entering pipe when stored on site and during installation by temporarily sealing the pipe ends.

Part 2 Products

2.1 LEACHATE COLLECTION SYSTEM (PERFORATED)

- .1 200 mm diameter HDPE SDR17.
- .2 Perforated pipe perforations as shown on the Drawings.

2.2 LEACHATE COLLECTION SYSTEM CLEANOUT PIPE (NON-PERFORATED)

- .1 200 mm diameter HDPE SDR17.

2.3 LEACHATE COLLECTION SYSTEM (NON-PERFORATED)

- .1 200 mm diameter HDPE SDR17.
- .2 For connection to HDPE manhole in accordance with Section 33 05 13.19.

2.4 FITTINGS

- .1 Polyethylene fittings and/or elbows shall be factory made unless otherwise shown on the Drawings. Fabricated sweeps shall be large radius multi-segmented. The ends of the fitting shall not be trimmed to match the pipe section to which they are going to be joined. All polyethylene fittings will have the same or higher pressure rating as the pipe when installed according to the latest technical specifications.

2.5 JOINTS

- .1 Thermal butt-fusion or electrofusion.

2.6 FLANGES

- .1 Flanges to be complete with one-piece moulded polyethylene stub ends, backup ring, and flange adapter, as shown on the Drawings. Flanged connections to have the same pressure ratings as the pipe or greater. Provide blind flange plates, neoprene gaskets, and stainless steel bolt sets for all blind flange installations.

2.7 GEOMEMBRANE BOOT

- .1 HDPE geomembrane pipe boot manufactured by supplier of geomembrane products specified in Section 31 32 19.02
- .2 HDPE geomembrane pipe boot shall have sufficient geomembrane skirt to facilitate field extrusion welding and non-destructive seam testing to HDPE geomembrane liner without obstruction from HDPE pipe.
- .3 Provide two neoprene gaskets and stainless steel band clamps to secure HDPE geomembrane boot to HDPE leachate collection system pipe.

Part 3 Execution

3.1 EXAMINATION

- .1 Verify that survey bench marks and intended elevations for Works are as shown on the Drawings.
- .2 Do not allow or cause any of work performed to be covered up or enclosed prior to required inspections, tests, or approvals.
- .3 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of products associated with this Section.
- .4 Ensure areas to be backfilled are free from debris and water.
- .5 Do not permit traffic in restored/repaired area without approval from Contract Administrator.
- .6 Verify that excavations, dimensions, and elevations are as shown on the Drawings.
- .7 Verify that prepared soil base is ready to receive the work of this Section.

3.2 INSTALLATION OF HDPE PIPE

- .1 Keep HDPE pipe clean, both externally and internally to avoid contaminating clear stone bedding and drainage materials.
- .2 Do not bend HDPE pipe in a radius smaller than that recommended by the manufacturer when staged on Site or when being installed.
- .3 Join HDPE pipe by thermal fusion performed in an area near the installation location to avoid excessive transportation and possible damage to the pipe.
- .4 Water will not be allowed to flow through the pipe during construction. Keep the work area dry and do not lay pipe in water.
- .5 Prior to initiating thermal fusion in the field on any pipe on a given day, Contractor may be requested to provide a test weld and operating data to Contract Administrator, including welding temperature, machine number, date of last service and clearance certificate.
- .6 Place HDPE pipe for leachate collection system on non-woven geotextile true to line and grade.
- .7 Install non-perforated leachate collection system cleanout riser pipe according to the Drawings and include all required fittings/bends, piping, blind flange plates, backup ring and stainless steel bolt sets, fusing, neoprene gasket, and drainage blanket material mounding or build up.

3.3 CLEANING

- .1 Upon completion of the Works and prior to acceptance, flush with water all pipelines installed under this Contract and remove and dispose of all accumulated debris and other foreign matter to the satisfaction of Contract Administrator.

END OF SECTION