

Part 1 General

1.1 RELATED REQUIREMENTS

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

1.2 MEASUREMENT AND PAYMENT

- .1 Excavate to Stockpile:
 - .1 Measurement Basis: By cubic metre of excavated material hauled and stockpiled, by subtracting survey readings taken prior to construction from survey readings after excavation (to , as well as subtracting the surveyed volume of excavated material to Perimeter Berm.
 - .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.
- .2 Excavate and Stockpile Temporary Roadway:
 - .1 Measurement Basis: By cubic metre of excavated roadway 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.
- .3 Perimeter Ditching:
 - .1 Measurement Basis: The total length in metres of ditching excavated, as measured along the bottom centre-line of the ditch.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, scarifying, placing, grading, and finishing of the ditch base and slopes to provide positive drainage along the perimeter ditching.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.
 - .2 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.
- .3 Complete Disposal Area Approach before Excavate and Stockpile Temporary Roadway, such that site operations has unrestricted access to the disposal area at all times.

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 run on. 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.

Part 2 Products

Not Used

Part 3 Execution

3.1 EXAMINATION

- .1 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.
- .2 Obtain approval from Contract Administrator for completed excavations and previously placed material prior to placement of successive lifts.
- .3 Obtain approval from Contract Administrator prior to placing fill against structures or around exposed buried utilities.
- .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.

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. Contractor is responsible to 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 23 33.01 – Excavation.
- .2 Section 31 32 19.01 – Geotextile.
- .3 Section 31 32 19.02 – Geomembrane.
- .4 Section 31 32 19.03 – Compacted Clay Liner.
- .5 Section 40 27 00 – Leachate Collection System.

1.2 MEASUREMENT AND PAYMENT

- .1 Granular Drainage Blanket:
 - .1 Measurement Basis: The total number of tonnes as measured on a certified weigh scale. Only material placed within the limits shown on the Drawings will be included in the payment.
 - .2 Payment Basis: Unit price. Includes processing, transportation, supply, delivery, and placement of granular drainage blanket. Tendered price shall include any stockpiling, grading, or other work required for the installation of the granular drainage blanket.
 - .3 Granular drainage blanket includes sumps and leachate collection trenches.
 - .4 Repair to the underlying geosynthetic materials as a result of the Contractor's installation of the granular drainage blanket shall be incidental to the Work.
- .2 Perimeter Berm Construction:
 - .1 Measurement Basis: The total cubic metres in place, as measured by volumetric comparison of pre-excavation survey versus grades shown on the Drawings.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, scarifying, placing, grading, compaction, and finishing of soils for construction of the Compacted Clay Liner.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.
 - .2 Payment includes any aeration and/or moisture conditioning of soil to achieve satisfactory compaction conditions.
- .3 Plateau Area Grading and Surface Preparation:
 - .1 Measurement Basis: The total square metres prepared for Stabilization Geotextile Fabric installation, as measured from the top crest of the anchor trenches.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, scarifying, placing, grading, compaction, and preparation of the surface for the installation of the Stabilization Geotextile Fabric.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.
 - .2 Payment includes any aeration and/or moisture conditioning of soil to achieve satisfactory compaction conditions.

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 D 75 - Practice for Sampling Aggregates
 - .2 ASTM C117 - Standard Test Method for Materials Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing.
 - .3 ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.
 - .4 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
 - .5 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .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 American Association of State Highway and Transportation Officials:
 - .1 AASTHO T88 – Standard Test Method for Particle Size Analysis of Soils.
- .3 City of Winnipeg Standard Construction Specifications:
 - .1 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.
 - .2 CW3120 – Installation of Subdrains.
 - .3 CW3170 - Earthwork and Grading.
 - .4 CW2030 – Excavation Bedding and Backfill
- .4 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.
- .3 Sequence and schedule Plateau Area Grading and Surface Preparation activities with Work of other Sections.
- .4 Sequence and schedule Perimeter Berm and Ditching activities with Work of other Sections.
- .5 Sequence and schedule Granular Drainage Blanket activities with Work of other Sections.
- .6 Obtain approval from Contract Administrator and HDPE Liner manufacturer's representative or installer, prior to placing Granular Drainage Blanket.

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 75 kg Sample of Granular Drainage Blanket material 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, where applicable.

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 Low permeable soil for construction of the Perimeter Berm and Plateau Area is to be obtained from excavation of the Works, on-Site stockpiles, or supplied by Contractor from source approved by Contract Administrator. If supplied by Contractor from an alternate source, Contractor is responsible for all material testing required to confirm that the material will perform to the specifications of this Contract.
- .2 Low permeable soil material shall be excavated and temporarily stockpiled, if necessary, and hauled to the work area in volumes required to construct the Compacted Clay Liner or excavated and placed directly for construction of the Compacted 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 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.

2.2 COMMON FILL

- .1 Native Backfill: Clean excavated clay 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 The Granular Drainage Blanket shall be clean stone meeting the gradation requirements below. Contractor shall provide particle size analysis of a representative sample of the proposed material to Contract Administrator for approval.

100.0 mm sieve	100% passing
75.0 mm sieve	95 -100% passing
40.0 mm sieve	60 - 100% passing
20.0 mm sieve	0 – 10% passing
14.0 mm sieve	0 – 5% passing
0.080 mm sieve	0 - 2% passing
- .2 Stone characteristics: 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.
 - .1 Stone must be less than 5 percent (5%) crushed.
- .3 Mineral composition: Calcium Carbonate ($CaCO_3$): Less than 2 percent.
- .4 Quarried limestone and dolomite shall not be acceptable as granular drainage blanket material.

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 that excavations, dimensions, and elevations are as shown on the Drawings.
- .3 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 Maximum drop height for Granular Drainage Blanket on the HDPE liner is 2 metres.
- .12 Do not use backfill material which is determined unsuitable by Contract Administrator.
- .13 Use fill types as specified. Completely use select native fill approved for backfilling before using imported fill.
- .14 Backfill systematically, as early as possible, to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.
- .15 Except as specified otherwise, place backfill continuously and in uniform layers not exceeding specified compacted thickness up to grades shown on the Drawings.
- .16 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

- .17 Place fill materials as shown on the Drawings.
- .18 Protect geomembrane and geotextiles during placement operations.
- .19 Do not operate heavy compaction equipment closer than 1 m to foundations, underground utilities, or monitoring wells.
- .20 Backfill around exposed utilities by placing layers simultaneously on all sides to equalize loading. Do not dump directly against monitoring wells, utilities, or foundations.
- .21 Make gradual grade changes. Blend slope into level areas.
- .22 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.
- .23 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 PLACING FILL MATERIAL

- .1 Place the Perimeter Berm and Plateau Area material to a maximum lift thickness of 150 mm to lines and grades shown on the Drawings.
- .2 Place Perimeter Berm and Plateau Area 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/foot/pad on the compactor, to a maximum thickness of 150 mm.
- .3 Ensure the Perimeter Berm material is free from lenses, pockets, streaks and layers of pervious material.

3.5 MOISTURE CONTENT

- .1 Maintain the moisture content throughout each layer of the Perimeter Berm material as uniformly as practicable and control the moisture content to between -2 percent and +2 percent of optimum moisture content.
- .2 In case of Perimeter Berm material which is too dry or too wet, including uncompacted Perimeter Berm material, adjust the moisture content by methods approved by Contract Administrator.
- .3 The Perimeter Berm will be watered at the completion and/or start of every work day and on hot sunny days, as required to maintain the moisture content and/or as directed by Contract Administrator.

3.6 COMPACTION

- .1 Granular Drainage Blanket material does not require compaction.
- .2 Perimeter Berm compaction:
 - .1 Compact each layer to a minimum dry density of 98 percent SMDD as determined by applicable ASTM specifications.
 - .2 Compaction equipment must pass over the completed area a minimum number of five passes before testing.

3.7 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 Construct the Perimeter Berm such that the finished compacted thickness is not less than 150 mm or as adjusted by Contract Administrator.
- .4 Repair the Perimeter Berm where disturbed by Contractor activities such that the finished Perimeter Berm is returned to original condition.
- .5 Payment will not be made for material placed outside the tolerance limits unless directed by Contract Administrator.

- .6 All grading will be performed to maintain slopes and positive drainage as shown on the Drawings.
- .7 Survey Requirements:
 - .1 Perimeter Berm elevations and grades shall be surveyed and approved by the Contract Administrator prior to HDPE Liner installation.

3.8 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.
 - .4 Particle size analysis will be performed according to AASTHO T88 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 measurement per 4,000 m² of material placed, or for each change of material.
- .3 Granular Drainage Blanket: At least two particle size analyses.
- .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.

3.9 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.

3.10 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.

3.11 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 - Supply:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place of the base area covered with non-woven geotextile cushion.
 - .2 No separate measurement will be made for any required overlapping, anchoring, or seams of non-woven geotextile cushion.
 - .2 Payment Basis: Unit price, includes supply and delivery to a designated storage location at the BRRMF.
- .2 Non-Woven Geotextile Cushion - Installation:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place of the base area covered with non-woven geotextile cushion.
 - .2 No separate measurement will be made for any required overlapping, anchoring, or seams of non-woven geotextile cushion.
 - .2 Payment Basis: Unit price, includes installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.
- .3 Non-Woven Geotextile Filter - Supply:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place of the sidewall area covered with non-woven geotextile filter, from the top of anchor trench.
 - .2 No separate measurement will be made for any required overlapping or anchoring of non-woven geotextile filter.
 - .2 Payment Basis: Unit price, includes supply and delivery to a designated storage location at the BRRMF.
- .4 Non-Woven Geotextile Filter - Installation:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place of the sidewall area covered with non-woven geotextile filter, from the top of anchor trench.
 - .2 No separate measurement will be made for any required overlapping or anchoring of non-woven geotextile filter.
 - .2 Payment Basis: Unit price, includes installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.

- .3 No additional payment will be made for unloading, loading, or transporting the supplied materials from the designated storage location at the BRRMF to Cell 34.
- .5 Stabilization Geotextile Fabric- Supply:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place, from the top of anchor trench.
 - .2 No separate measurement will be made for any required overlapping or anchoring of woven geotextile fabric.
 - .2 Payment Basis: Unit price, includes supply and delivery to a designated storage location at the BRRMF.
- .6 Stabilization Geotextile Fabric - Installation:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place, from the top of anchor trench.
 - .2 No separate measurement will be made for any required overlapping or anchoring of woven geotextile fabric.
 - .2 Payment Basis: Unit price, includes installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.
 - .3 No additional payment will be made for unloading, loading, or transporting the supplied materials from the designated storage location at the BRRMF to Cell 34.

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

City of Winnipeg Standard Construction Specifications:

- .11 CW3110 - Sub-Grade, Sub-Base and Base Course Construction.
- .12 CW3120 – Installation of Subdrains.
- .13 CW3130 – R5 – Supply and Installation of Geotextile Fabrics

1.4 COORDINATION

- .1 Coordinate the installation of geotextile with geomembrane and granular drainage blanket installation.
- .2 Obtain approval from Contract Administrator and HDPE Liner manufacturer's representative or installer, prior to placing Non-Woven Geotextile Filter.
- .3 Coordinate the installation of geotextile with Plateau Area Grading works.

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 14 days prior to ordering.
- .3 Installer's Quality Assurance Plan or Manual: Submit no later than 14 days prior to ordering.

- .4 Submit samples as follows at least 2 weeks prior to commencing the Works.
 - .1 Minimum length of 2 m of roll width of geotextile.
- .5 Product Data: Submit no later than 14 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 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 2 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.
- .5 TEXEL160E as manufactured by Texel Geosynthetics is an approved alternate.

2.2 NON-WOVEN GEOTEXTILE (FILTER)

- .1 TE-8 as manufactured by Titan Environmental or approved alternate.
- .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.
- .5 TEXEL080E as manufactured by Texel Geosynthetics is an approved alternate.

2.3 STABILIZATION GEOTEXTILE FABRIC

- .1 Swamp Grid 40 as manufactured by Titan Environmental or approved alternate supplied in a minimum roll width of 3.95 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 Woven, needle punched fabric to act as a separation and stabilization fabric between the Plateau Area surface and tire derived aggregate (TDA).

2.4 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, geomembrane, 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 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 – Geotextile
- .2 Section 31 32 19.03 – Compacted 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 - Supply:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place, 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 and delivery to a designated storage location at the BRRMF.
- .2 HDPE Geomembrane - Installation:
 - .1 Measurement Basis:
 - .1 Item measured by the square metre in place, from the top of anchor trench.
 - .2 No separate measurement will be made for any required overlapping or anchoring of geomembrane.
 - .2 Payment Basis:
 - .1 Unit price, includes installation, seaming, testing, anchoring, overlaps, repairs, and manufacturer's field services.
 - .2 Payment will be made following HDPE Liner acceptance (see Section 3.7.13).
- .3 No additional payment will be made for maintaining, preparing, and/or welding the area for tie-in to existing or future cells.
- .4 No additional payment will be made for unloading, loading, or transporting the supplied materials from the designated storage location at the BRRMF to Cell 34.

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 Extrusion Weld: a bond between two HDPE materials, which is achieved by extruding a bead of HDPE over the leading edge of the seam between the upper and lower sheet using a hand-held apparatus.

- .5 Fusion Weld: a bond between two HDPE materials which is achieved by fusing both HDPE surfaces in a homogeneous bond of the two surfaces using a power driven apparatus capable of heating and compressing the overlapped portions of the geomembrane sheets.
- .6 HDPE geomembrane: HDPE liner.
- .7 Minimum Average Roll Value (MARV): Average of test values calculated according to specified standard at minimum frequency specified in GRI Standard GM13.
- .8 IAGI: International Association of Geosynthetic Installers.
- .9 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 Channel Test for Dual Seamed Geomembranes.
 - .2 Test Method GM9 - Cold Weather Seaming of Geomembranes.
 - .3 Test Method GM10 – Specification for Stress Crack Resistance of HDPE Geomembrane Sheet.
 - .4 Test Method GM13 - Test Methods, Properties and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes.
 - .5 Test Method GM14 – Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
 - .6 Test Method GM19 – Seam Strength and Related Properties of Thermally Bonded Homogeneous Polyolefin Geomembranes/Barriers
 - .7 Test Method GM20 - Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts.
 - .8 Test Method GM29 - Field Integrity Evaluation of Geomembrane Seams (and Sheet) using Destructive and/or Nondestructive Testing.
- .3 International Association of Geosynthetic Installers (IAGI).

1.4 **COORDINATION**

- .1 Coordinate the installation of HDPE liner with compacted clay liner surface finishing work and non-woven geotextile installation.
- .2 Installation of HDPE liner over the compacted clay liner shall not occur until authorized by Contract Administrator. Compacted clay liner requires permeability testing and confirmation of regulatory compliance prior to being covered.

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 Geomembrane Manufacturer, Supplier, and Contractor may be separate companies or a single company.
- .6 Company (companies) to provide all quality control certification required by these specifications.
- .7 If requested by the Contract Administrator, submit a minimum 2 m length sample of standard width HDPE geomembrane.
- .8 Shop Drawings: Indicate installation layout, dimensions and details, including field seams, anchor trenches and protrusion details.
- .9 Product Data: Submit no later than 14 days prior to ordering.
- .10 Manufacturer's Installation Instructions: Submit at least 14 days prior to installation. Include written installation, handling, storage and repair instructions.
- .11 Field Installation Report. Submit no later than 48 hours following the completion of the HDPE liner installation. Include:
 - .1 Subgrade surface acceptance form signed by manufacturer's representative or IAGI certified supervisor.

- .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 throughout the installation.
- .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.
- .12 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 Section 1.9.
- .13 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 electronic copy and one final electronic copy are required to be submitted to Contract Administrator.
- .14 Submit copies of manufacturer's test data at least 2 weeks prior to commencing the Works.
- .15 Submit certificates, including test results, at least 2 weeks prior to delivery to the Site.
- .16 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 Perform Work of this Section according to the Manufacturer's Quality Assurance Plan or Manual submitted under **Section 1.6.3**.
- .3 Perform Work of this Section according to the Installer's Quality Assurance Plan or Manual submitted under **Section 1.6.4**.

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 liner rolls or blankets by appropriate means so that no damage is caused, as recommended by HDPE liner manufacturer.
- .3 The on-site storage location for HDPE liner shall be level, smooth, elevated and dry (not wooden pallets). The Contractor shall provide a suitable storage site that will protect the HDPE liner from punctures, abrasions, excessive moisture and dirt. The entire length of the HDPE liner rolls must be stored a minimum of 200 mm above the ground at all times.
- .4 During delivery and storage, protect HDPE rolls from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.
- .5 Take adequate measures to keep HDPE materials away from possible deteriorating sources (i.e., vandalism, theft).
- .6 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.

- .7 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 Installer's supervisor, 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°C or above 40°C, unless Contractor obtains written approval from 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 5°C unless:
 - .1 Contractor strictly follows the guidelines for field seaming of HDPE liner in cold weather, as identified in GRI Test Method GM9.
 - .3 Between 1°C and 10°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°C.
 - .5 In all cases, HDPE liner must be dry while being welded.

1.12 **WARRANTY**

- .1 Part D- Supplemental Conditions: Warranty.
- .2 Provide a manufacturer's warranty against manufacturing defects of the membrane for a period of ten years from the date of installation.
- .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.
- .5 The Contractor shall guarantee the HDPE membrane against defects in installation and workmanship for a period of five (5) years from the date of final acceptance.

Part 2 Products

2.1 HDPE GEOMEMBRANE

- .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 Not more than 10 defects per 450 m².
- .5 Melt Flow Index: to ASTM D1238 (190/2.16), less than or equal to 1.0 g/10 min.
- .6 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.
- .7 Textured membrane to be manufactured by extrusion or impingement of the texturing onto both sides of the sheet, such that the texturing is additional to the nominal thickness of the sheet specified. The texturing to be consistent throughout the same roll and among rolls.
- .8 Complying with the properties listed in this Section.
- .9 Textured HDPE Geomembrane:
 - .1 1.5 mm (60 mil) 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

Property	Unit	Test Method	Minimum Average Value ⁽¹⁾
<ul style="list-style-type: none"> 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)			
<ul style="list-style-type: none"> Standard High Pressure 	minute minute	ASTM D3895 ASTM D5885	100 400
Oven Aging at 85°C	NA	ASTM D5721	NA
<ul style="list-style-type: none"> 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⁾	NA	ASTM D7238	NA
<ul style="list-style-type: none"> Standard OIT; or High Pressure OIT retained after 1,600 hours 	percent percent	ASTM D3895 ASTM D5885	NR ⁽⁴⁾ 50

Notes:

1 - Except as indicated.

2 - 20-hour UV cycle at 75°C, followed by 4 hours condensation at 60°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 During installation of the liner, the Contract Administrator may order a stop of work due to inclement weather, the use of improper installation procedures, or for any reason that in their sole opinion may result in a defective liner.

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 Installer's supervisor. 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 above 40°C, during precipitation, in presence of excessive moisture (e.g., fog, dew), nor in presence of high winds.
- .4 Welding may be permitted below 5°C subject to approval of Contract Administrator and if seam is protected, to prevent excessive cooling from wind or other adverse conditions. Procedures such as controlled preheating of the seam area may be required. Such work will be subject to an extended trial seam testing program under the same ambient temperature and procedures, including preheating, as the production seams. Additional destructive testing may also be taken at the discretion of the Contract Administrator.
- .5 Place according to panel layout submittal and seam panels according to Installer's recommendations on graded surface in orientation and locations indicated. Minimize wrinkles, avoid scratches and crimps to geomembranes, and avoid damage to supporting material.
- .6 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.
- .7 Protect installed membrane from displacement, damage or deterioration before, during and after placement of material layers.
- .8 Require workers to wear shoes which will not damage HDPE liner. Smoking shall not be permitted on the liner.
- .9 Minimize pulling of HDPE liner panels to reduce permanent tension. Contractor shall coordinate installation activities to cover the HDPE liner within an adequate time and temperature range to mitigate potential pulling of HDPE liner panels due to contraction from ambient temperatures.
- .10 Minimize dragging of textured HDPE liner to prevent damage to texturing.
- .11 Label each panel with panel number and material roll number.
- .12 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.
- .13 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.
- .14 Keep seam area clean and free of moisture, dust, dirt, debris and foreign material.
- .15 Make field seam samples according to requirements specified in **Section 3.5** on fragment pieces of geomembrane and test to verify that seaming conditions are adequate.
- .16 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.
- .17 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 Only methods and equipment previously approved by the Contract Administrator may be used. Approved seaming methods are extrusion welding for patching and double wedge fusion welding for general seaming.
- .2 All HDPE liner seams shall be welded.
- .3 Overlap the HDPE panels a minimum of 75 mm for extrusion welds and a minimum of 125 mm for fusion welds.
- .4 The overlap shall be sufficient to leave a loose flap of geomembrane adjacent to both sides of the seam/weld to allow for destructive testing in accordance with the specified ASTM/GRI procedures.
- .5 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.
- .6 Seaming Equipment and Products: Seam HDPE liner using extrusion (repairs and details only) or fusion 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 fusion 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.

- .7 Orient seams downslope so that direction of seaming will not hinder flow of water over top of HDPE liner. Specifically for fusion 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.
- .8 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.
- .9 Seaming Wrinkles: Cut fishmouths and corrugations so as to affect 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.
- .10 Horizontal seams on slopes shall not be permitted, unless no other option is available and only as approved by the Contract Administrator.
- .11 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.
- .12 Label each seam with date, seamer, equipment seaming temperature and speed, and time seam started and completed.
- .13 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 Review quality of resin and HDPE to ensure consistency of raw material and geomembrane quality according to manufacturer's certificates.

- .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°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 fusion welds. Perform test seams on scrap HDPE liner not to be incorporated into the Works.
 - .2 When double fusion seaming method is used, air pressure testing is to be employed. Central air channel to be pressurized to at least 210 kPa (30 psi) after a 2 minute stabilization period. A pressure gauge shall be used at one end of channel. Maximum pressure drop at either end not to exceed 21 kPa (3 psi) over five-minute period or seam will be rejected.
 - .3 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 (double wedge fusion and extrusion) when tested in shear shall be 525 N/25mm, as identified in GRI Test Method GM19a.
 - .2 Minimum strength of HDPE liner test seams when tested in peel shall be 398 N/25mm (double wedge fusion) and 340 N/25mm (extrusion), as identified in GRI Test Method GM19a.
 - .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 fusion 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.
- .4 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.
 - .5 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 Paragraphs 3.7.5 and 3.7.7.
 - .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:
 - .1 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 the panel is not damaged and blanket geometry is not altered.
 - .2 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.
 - .3 Minimum strength of HDPE liner field seams (double wedge fusion and extrusion) when tested in shear shall be 525 N/25mm, as identified in GRI Test Method GM19a.
 - .4 Minimum strength of HDPE liner test seams when tested in peel shall be 398 N/25mm (double wedge fusion) and 340 N/25mm (extrusion), as identified in GRI Test Method GM19a.
 - .5 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 Section 3.7.6. 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 Section 3.7.6. 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 Quality Control Report
- .1 Contractor to provide written certification to Contract Administrator, for review and acceptance, confirming required quality control has been done and certifying quality of the geomembrane, prior to delivering to job site. Quality control certificate required for each batch of resin and each production shift. Certificate to include:
 - .1 Product Identification
 - .2 Roll Numbers
 - .3 Sampling Procedures
 - .4 Test Methods

- .5 Test Results (including Environmental Stress Cracking or single-point Notched and Constant Tensile Load Time to Failure test data)
 - .6 Signature of Responsible Party
- .12 Leak Detection Testing
- .1 Leak detection testing (LDT) will be completed to ensure that the installed HDPE Liner is free of defects due to workmanship or equipment. The test will be completed following the installation of the geotextile cushion fabric and Granular Drainage Blanket.
 - .1 The Contractor is required to provide equipment and assistance to complete the test.
 - .2 The City will provide a water truck to wet the drainage layer as required throughout the duration of the test.
 - .3 The Contractor shall expose locations as marked by the LDT field person. Assisting is required by means of labourers and equipment to efficiently expose all areas marked by the LDT field person. Marked locations must be exposed immediately as the LDT tester needs to verify equipment accuracy.
 - .4 The Contractor shall repair all leaks identified by the leak detection testing as directed by the Contract Administrator at no additional cost.
 - .5 The Contractor shall repair leaks at the tie-in locations at no additional cost.
 - .6 The Contractor is required to handle the water in the leachate collection system and pump it out, if required by Contract Administrator.
 - .7 Work under this section is considered incidental.
- .13 HDPE Liner Acceptance: HDPE liner placement will be accepted by Contract Administrator when:
- .1 Installation is finished.
 - .2 Documentation of installation (Quality Control Report) is completed and submitted to, and accepted by the Contract Administrator.
 - .3 Verification of the adequacy of field seams and repairs, and associated testing, is complete.
 - .4 Installation of Granular Drainage Blanket is complete, subsequent leak detection testing is conducted, and all defects are repaired.
- .14 Quality Assurance Testing: quality assurance laboratory engaged by Contract Administrator may perform laboratory tests on HDPE liner samples as identified in this Section to confirm Contractor QA/QC testing. 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 their opinion, Contractor and/or installer can adequately complete the installation in strict accordance with specifications and the installation procedure specified in this Section.
- .4 The role of the Manufacturer's representative may be assigned to an IAGI certified installation company and GCI-ICP certified inspectors, at the discretion of the Contract Administrator.

3.9

PROTECTION

- .1 Protect finished work from damage.
- .2 Do not permit traffic or construction equipment directly on HDPE liner, unless approved by Installer's supervisor.
- .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.
- .5 Protect displacement of slack wrinkles in the HDPE liner when pushing granular drainage blanket layer.

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 Compacted Clay Liner:
 - .1 Measurement Basis: Item measured by the square metre in place using the surface area of the Compacted Clay Liner to the inside crest of side slopes.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, scarifying, placing, grading, compaction, and finishing of soils for construction of the Compacted Clay Liner.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.
 - .2 Payment includes any aeration and/or moisture conditioning of soil to achieve satisfactory compaction conditions.
- .2 Compacted Clay Liner (Cell 33-34 Interface):
 - .1 Measurement Basis: Item measured by the cubic metre in place.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, scarifying, placing, grading, compaction, and finishing of soils for construction of the Compacted Clay Liner.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.
 - .2 Payment includes any aeration and/or moisture conditioning of soil to achieve satisfactory compaction conditions.
- .3 Compacted Clay Liner Surface Finishing:
 - .1 Measurement Basis: Item measured by the square metre in place using the surface area of the Compacted Clay Liner to the inside crest of side slopes.
 - .2 Payment Basis: Unit price. Includes temporary stockpiling, loading, and hauling, scarifying, placing, grading, compaction, and finishing of Compacted Clay Liner surface for installation of the overlying HDPE Geomembrane liner.
 - .1 Payment includes any temporary stockpiling required under Contractor's method of construction.
 - .2 Payment includes any aeration and/or moisture conditioning of soil to maintain Compacted Clay Liner conditions until the overlying HDPE Geomembrane liner is installed.

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- μ m) 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 Compacted Clay Liner activities with Work of other Sections.
- .2 Perform construction of the Compacted 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 and maintain the Compacted Clay Liner Surface Finishing in such a manner so as to facilitate installation of the HDPE liner over the completed Compacted Clay Liner Surface Finishing as soon as practicable.
- .4 Obtain approval from Contract Administrator and HDPE Liner manufacturer's representative or installer, for acceptance of the Compacted Clay Liner Surface Finishing prior to placing HDPE Liner.
- .5 Do not allow or cause any of the Work performed to be covered up or enclosed prior to required inspections, tests, or approvals.

1.5 SCHEDULING

- .1 All Compacted 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.
- .3 Prior to commencement of construction of the Compacted Clay Liner, the Contract Administrator shall be permitted to schedule a survey of the prepared subgrade for documentation and payment purposes. Survey of the prepared subgrade shall be conducted prior to the scarification identified in Section 3.3.2
- .4 The Contract Administrator shall be permitted to collect Shelby Tube samples from the completed Compacted Clay Liner for hydraulic conductivity analysis. Analysis results confirming achievement of a hydraulic conductivity of 1×10^{-7} cm/s or less is recommended prior to covering the Compacted Clay Liner with the HDPE Liner.

1.6 AMBIENT CONDITIONS

- .1 Suspend operations whenever climatic conditions, as determined by Contract Administrator, are unsatisfactory for placing Compacted 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 Compacted Clay Liner material in a frozen state or against frozen ground or previously placed material.
- .4 Do not place Compacted 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 Compacted Clay Liner is to be obtained from excavation of the Works, on-Site stockpiles, or supplied by Contractor from source approved by Contract Administrator. If supplied by Contractor from an alternate source, Contractor is responsible for all material testing required to confirm that the material will perform to the specifications of this Contract.
- .2 Low permeable soil material shall be excavated and temporarily stockpiled, if necessary, and hauled to the work area in volumes required to construct the Compacted Clay Liner or excavated and placed directly for construction of the Compacted 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 used in the construction of each of the Compacted Clay Liner lifts must have a maximum individual particle (clod) size of no greater than 50 mm before proceeding with placement of the next lift.
- .5 Contract Administrator will direct excavation operations in areas of unsuitable materials. Material that is unsuitable for Compacted 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 coincide with those shown on the Drawings.
- .2 Do not allow or cause any of the 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 subgrade 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 Compacted Clay Liner, scarify the base of subgrade following excavation and rough grading and obtain approval from Contract Administrator.

3.4 SEGREGATION AND PROTECTION

- .1 The Compacted Clay Liner material will be subject to monitoring and testing by the Contract Administrator to verify its suitability. Compacted Clay Liner material that fails material specifications identified in the Section 2.3.1 shall be removed by the 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 to restrict moisture loss of the Compacted Clay Liner material.

3.5 BONDING

- .1 During the work, whenever the surface of the Compacted 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 Compacted Clay Liner material placement resumes after suspension, disc or scarify the Compacted 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 Compacted Clay Liner material placement after suspension of work and prior to covering surfaces with permanent material.

3.6 PLACING

- .1 Place the Compacted Clay Liner material to a minimum thickness of 150 mm to lines and grades shown on the Drawings.
- .2 Place Compacted 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/foot/pad on the compactor, to a maximum thickness of 150 mm.
- .3 Ensure the Compacted Clay Liner material is free from lenses, pockets, streaks and layers of pervious material.
- .4 Remove rocks and boulders larger than 75 mm in size from each loose lift prior to compaction and stockpile at the location as directed by the Contract Administrator. This may require labourer(s) to pick rocks.
- .5 Remove all wind-blown litter and debris from each loose lift prior to and during compaction. This may require labourer(s) to pick litter during compaction activities.
- .6 Prior to work stoppages or following completion of the final layer, the Compacted Clay Liner Surface Finishing shall be proof rolled to a smooth finish with a smooth drum compactor.

3.7 MOISTURE CONTENT

- .1 Maintain the moisture content throughout each layer of the Compacted Clay Liner material as uniformly as practicable and control the moisture content to between +2 percent and +4 percent of optimum moisture content.
- .2 In case of Compacted Clay Liner material which is too dry or too wet, including uncompacted Compacted Clay Liner material, adjust the moisture content by methods approved by Contract Administrator.
- .3 The Compacted Clay Liner will be watered at the completion and/or start of every work day and on hot sunny days, as required to maintain the moisture content and/or as directed by Contract Administrator.

- .4 The Compacted Clay Liner will be watered as required to prevent shrinkage cracks greater than 50 mm in depth. This condition shall be maintained until the HDPE Liner is installed over the Compacted Clay Liner Surface Finishing.

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 Compaction equipment must be a CAT 815 sized compactor, or of equal capacity meeting the criteria below, and having the following features/capabilities; must be heavy, footed with feet that fully penetrate a loose lift of soil and must be capable of obtaining required densities in materials used on this project. Specifications for the "equal" compaction equipment must be provided and approved by the Contract Administrator prior to delivery to site.
- .3 Compaction equipment shall, at a minimum, meet the below criteria:
 - .1 Minimum weight: 18,000 kg (40,000 lbs.)
 - .2 Minimum foot length: 180 – 200 mm
- .4 Compaction equipment must pass over the completed area a minimum number of five passes before testing.
- .5 The final lift will be back-bladed following compaction by the wedge/foot/pad roller and compacted with a smooth drum roller, removing indentations from the compaction equipment such that the finished surface is smooth and meets the requirements of the HDPE Liner subgrade, as indicated by the HDPE Liner Manufacturer's Quality Assurance Plan or Manual and HDPE Liner Installer's Quality Assurance Plan or Manual (See Section 31 32 19.02, Parts 1.6.3 and 1.6.4).

3.9 TOLERANCES

- .1 Construct the Compacted Clay 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 and the tolerances of the HDPE Liner Manufacturer's Quality Assurance Plan or Manual and HDPE Liner Installer's Quality Assurance Plan or Manual (See Section 31 32 19.02, Parts 1.6.3 and 1.6.4).
- .3 Repair the Compacted Clay Liner where disturbed by Contractor activities such that the finished Compacted 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 Compacted Clay Liner thickness to be confirmed by Contract Administrator prior to HDPE Liner installation.
 - .2 Compacted Clay Liner as-built survey data is to be made available to the Contract Administrator prior to HDPE Liner 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 Compacted Clay Liner samples. Contract Administrator will supply a drill rig to collect Shelby Tube samples for hydraulic conductivity analysis, as per Section 1.5.4.
 - .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, at no expense to the City.
 - .5 Testing by Contract Administrator in no way relieves Contractor of his responsibility to test all material prior to notifying Contract Administrator of the materials' suitability for the Work.
- .2 Methods of Testing:
- .1 Maximum Dry Density of fill containing more than 12 percent by weight passing No. 200 sieve shall be determined in accordance with ASTM D698.
 - .2 Bulk density shall 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 shall be performed in accordance with ASTM D422 or ASTM D1140, whichever is appropriate to material tested.
 - .4 Moisture content of fill in place shall be determined in accordance with ASTM D6938.
 - .5 Compaction testing of fill in place shall be determined in accordance with ASTM D6938.
 - .6 Hydraulic conductivity shall 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 the constructed Compacted Clay Liner.
- .3 Frequency of testing:
- .1 Contract Administrator will take a minimum of thirteen field density and moisture content measurements per lift per hectare of Compacted Clay Liner installation.
 - .2 Contract Administrator will take a minimum of six Shelby Tube samples on the completed base of the constructed Compacted Clay Liner, and a minimum of two samples from the finished slopes of the constructed Compacted 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 hydraulic conductivity, as directed by Contract Administrator, at no additional cost to the Contract.

3.11

ADJUSTING

- .1 Finish Compacted Clay Liner Surface Finishing 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 Compacted Clay Liner Surface Finishing to avoid damage to the HDPE liner, in accordance with the HDPE Liner Manufacturer's Quality Assurance Plan or Manual and HDPE Liner Installer's Quality Assurance Plan or Manual (See Section 31 32 19.02, Parts 1.6.3 and 1.6.4).
- .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 Compacted Clay Liner material, fine grade the surfaces of the Compacted 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 Compacted Clay Liner already in place when placing and compacting Compacted 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 Liner from desiccation and erosion. If the surface of the Compacted Clay Liner material already in place becomes cracked or eroded, as determined by Contract Administrator or HDPE Liner Installer, disc or scarify the Compacted Clay Liner material surface and rework the Compacted Clay Liner surface to a smooth finish meeting the requirements of the HDPE Liner subgrade, as indicated by the HDPE Liner Manufacturer's Quality Assurance Plan or Manual and HDPE Liner Installer's Quality Assurance Plan or Manual (See Section 31 32 19.02, Parts 1.6.3 and 1.6.4). Moisture content of the constructed Compacted Clay Liner shall be maintained in accordance with Section 3.7.
- .5 Do not permit traffic or construction equipment directly on completed Compacted Clay Liner.

END OF SECTION

Part 1 General

1.1 RELATED REQUIREMENTS

- .1 Section 33 23 33.01 – Excavation.
- .2 Section 31 32 19.01 – Geotextile.
- .3 Section 31 32 19.02 – Geomembrane.
- .4 Section 31 23 33.02 – Fill.

1.2 MEASUREMENT AND PAYMENT

- .1 Leachate Collection System Pipe (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 Collection System Cleanout Pipe:
 - .1 Item measured by the non-perforated leachate cleanout pipe installed, extending from the base of the cell floor to at least one metre beyond the HDPE liner anchor trench in the perimeter berm, following the surface of the liner system.
Leachate Collection System Cleanout Pipe includes supply and installation of protective bollards.
 - .2 Payment Basis: Lump sum price. Includes supply and delivery, fusion, installation of leachate cleanout pipe, HDPE fittings, end caps, and protective bollards.
- .3 Leachate Collection System Pipe (Non-Perforated):
 - .1 Item measured by the lineal metre in place for the length of the non-perforated leachate cleanout pipe installed, extending from the base of the leachate sump to the leachate header pipe.
 - .2 Payment Basis: Unit price. Includes supply and delivery, fusion, installation of non-perforated leachate collection system pipe, connections, HDPE fittings, and end caps.
- .4 Leachate Collection System Connection:
 - .1 Item measured by the acceptance of the connection between the non-perforated leachate collection system pipe extending from Cell 34 to the leachate header pipe (gravity main) on the west side of Payette Road.
 - .2 Payment Basis: Lump sum price, includes excavation; supply, installation, and connection to existing leachate header pipe; supply and installation of all fittings and piping for connection to leachate header pipe; supply and installation of 3 clean out pipes and 6 protective bollards; supply, placement, and compaction of backfill around the clean out and leachate collection system connection pipes; and all other work required to meet the requirements of the Workers Compensation Board (WCB).

1.3 REFERENCES

- .1 Definitions:
 - .1 HDPE: High density polyethylene.

- .2 Reference Standards:
 - .1 American Society for Testing and Materials (ASTM)
 - .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 D1603, Test Method for Environmental Stress Cracking of Ethylene Plastics
 - .4 ASTM D1693, Test Method for Carbon Black in Olefin Plastics
 - .5 ASTM D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
 - .6 ASTM D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
 - .7 ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
 - .8 ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
 - .9 ASTM F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings
 - .10 ASTM F2880, Standard Specification for Lap-Joint Type Flange Adapters for Polyethylene Pressure Pipe in Nominal Pipe Sizes 3/4 in. to 65 in.

City of Winnipeg Standard Construction Specifications:

- .11 CW2130 – Gravity Sewers

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 Coordination with City site operations is required for Leachate Collection System Connection.
- .3 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 Perform work of this Section according to applicable ASTM standards.
 - .2 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.
 - .3 Raw Material: Containing a minimum 2 percent carbon black, well dispersed by recompounding to protect the pipe from degradation by ultraviolet light.
 - .4 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.
 - .5 Pipe Sizes and Fittings: ASTM F714. Pipe sizes are specified in metric units; however, equivalent IPS pipe sizes shall be used.
 - .6 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)

- .1 219 mm (8 in.) O.D. diameter HDPE SDR11.
- .2 Perforated pipe perforations as shown on the Drawings.
- .3 Drill perforations into the pipe after manufacture, prior to delivery to the site, in rows of holes parallel to the axis of the pipe. Details on the hole diameter and spacing are

provided on the Drawings. The allowable tolerance on the hole diameter is 1.5 mm (1/16 inch). The allowable tolerance on the hole spacing is 6 mm (1/4 inch). All drill cuttings, pipe filings and debris to be removed prior to delivery to site. Verify cleanliness of pipe interior to Contract Administrator prior to installation.

2.2 LEACHATE COLLECTION SYSTEM CLEANOUT PIPE (NON-PERFORATED)

- .1 219 mm (8 in.) O.D. diameter HDPE SDR11.

2.3 LEACHATE COLLECTION SYSTEM (NON-PERFORATED)

- .1 219 mm (8 in.) O.D. diameter HDPE SDR11.
- .2 For connection to leachate header pipe (gravity main) on the west side of Payette Road.

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.

2.8 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.

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 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.

3.3 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.

3.4 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, they 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.

3.5 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 perforated pipe for leachate collection system and non-perforated pipe for leachate collection system cleanout riser pipe on non-woven geotextile cushion true to line and grade.

- .7 Install perforated leachate collection pipe with all perforations on the lower half of the pipe circumference.
- .8 Install all 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 bedding materials.

3.6 INSPECTION AND TESTING – LEACHATE PIPING

- .1 All tests and television inspection shall be carried out from Cell 34 to the existing leachate header pipe 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 Cell 34 and the existing leachate header pipe 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 digital recording of the inspected sewer.
- .5 Exfiltration Test
 - .1 The Contractor shall install water tight bulkheads in a suitable manner to isolate the Leachate Collection System Connection from the remainder of the leachate collection 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 0.5 metre over the interior crown of the pipe measured at the highest point of the test section, or to the level determined by the Contract Administrator. The Contract Administrator shall observe the exfiltration of water over a 24 hour period.
- .4 Zero leakage is permitted throughout the specified test period for all piping.
- .5 Any sections of the leachate collection system 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 tested again.

3.7 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.

3.8 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.
- .2 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 clean again and televise the sewer until the cleaning is shown to be satisfactory.

END OF SECTION