

Part 1 General

1.1 MEASUREMENT PROCEDURES

- .1 METHOD OF MEASUREMENT – Measurement of "Clearing and Grubbing" described in the Specifications shall be on an area basis for the total number of hectares to the nearest 0.1 hectares "Clearing and Grubbing" is completed as indicated on the plans and drawings and described in the Specifications.
- .2 BASIS OF PAYMENT – Payment for "Clearing and Grubbing" shall be at the Contract Unit Price for "Clearing and Grubbing" measured as specified herein which shall be payment in full for those operations described in the Specifications and for those operations incidental to the Work for which no price or prices or provisions for payment are included in the Contract.

1.2 DEFINITIONS

- .1 Clearing consists of cutting off trees and brush vegetative growth to not more than specified height above ground and disposing of felled trees, previously uprooted trees and stumps, and surface debris.
- .2 Grubbing consists of excavation and disposal of stumps and roots to not less than specified depth below existing ground surface.

Part 2 Products

2.1 None

Part 3 Execution

3.1 PREPARATION

- .1 Inspect site and verify with Departmental Representative, the extent of Clearing and Grubbing.

3.2 CLEARING

- .1 Clearing includes felling of trees into sections and satisfactory disposal of trees and other vegetation designated for removal, including downed timber, snags, brush, rubbish, occurring within cleared areas.
- .2 Clear as indicated by Departmental Representative, by cutting at height of not more than 1000 mm above ground.

3.3 UNDERBRUSH CLEARING

- .1 Clear underbrush from areas as indicated to within 300 mm of ground surface.

3.4 GRUBBING

- .1 Remove and dispose of roots larger than 7.5 cm in diameter, matted roots, and designated stumps from indicated grubbing areas.
- .2 Grub out stumps and roots to not less than 300 mm below ground surface. Within the excavation footprint of the pipeline, roots to be removed prior to or during excavation activities to a minimum of 0.1 m below base of pipe.
- .3 Grub out visible rock fragments and boulders, greater than 300 mm in greatest dimension.
- .4 Fill depressions made by grubbing with suitable material and to make new surface conform with existing adjacent surface of ground.

3.5 REMOVAL AND DISPOSAL

- .1 Remove cleared and grubbed materials for off site disposal.

END OF SECTION

Part 1 General

1.1 MEASUREMENT AND PAYMENT

- .1 METHOD OF MEASUREMENT – Measurement of "Reservoir Earthworks" described in the Specifications shall be based on the number of cubic metres of material excavated from its native state to construct the reservoir structure. Reservoir excavation and reservoir berm construction shall be measured by surveying a grid over the work area on the exposed material prior to construction or utilizing the elevations stated in the Specifications. AutoCad Civil 3D will be used for calculations. Excavation beyond the lines specified will not be included for payment unless otherwise specified by the Departmental Representative. All topsoil stripping and stockpiling, depositing and compaction of excavated material to construct berms, proof-rolling, redepositing of topsoil, and any required dewatering shall be incidental to "Reservoir Earthworks".
- .2 BASIS OF PAYMENT – Payment for "Reservoir Earthworks" shall be at the Contract Unit Price for "Reservoir Earthworks" measured as specified herein which shall be payment in full for those operations described in the Specifications and for those operations incidental to the Work for which no price or prices or provisions for payment are included in the Contract.

1.2 REFERENCES

- .1 American Society for Testing and Materials International (ASTM)
 - .1 ASTM C117-04, Standard Test Method for Material Finer than 0.075 mm (No.200) Sieve in Mineral Aggregates by Washing.
 - .2 ASTM C136-05, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
 - .3 ASTM D422-63 2002, Standard Test Method for Particle-Size Analysis of Soils.
 - .4 ASTM D698-00a1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kN-m/m³).
 - .5 ASTM D1557-02e1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³) (2,700 kN-m/m³).
 - .6 ASTM D4318-05, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.1-88, Sieves, Testing, Woven Wire, Inch Series.
 - .2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.
- .3 Canadian Standards Association (CSA International)
 - .1 CAN/CSA-A3000-03, Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
 - .1 CSA-A3001-03, Cementitious Materials for Use in Concrete.

- .2 CSA-A23.1/A23.2-04, Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

1.3 DEFINITIONS

- .1 Unclassified excavation: excavation of deposits of whatever character encountered in Work.
- .2 Topsoil:
 - .1 Material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
 - .2 Material reasonably free from subsoil, clay lumps, brush, objectionable weeds, and other litter, and free from cobbles, stumps, roots, and other objectionable material larger than 25 millimeters in any dimension.
- .3 Waste material: excavated material unsuitable for use in Work or surplus to requirements.
- .4 Unsuitable materials:
 - .1 Weak, chemically unstable, and compressible materials.

1.4 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Quality Control: in accordance with Section 01 45 00 - Quality Control:
 - .1 Submit condition survey of existing conditions as described in EXISTING CONDITIONS article of this Section.
 - .2 Submit for review by Departmental Representative proposed dewatering methods as described in PART 3 of this Section.
 - .3 Submit to Departmental Representative written notice at least 7 days prior to excavation work, to ensure cross sections are taken.
 - .4 Submit to Departmental Representative written notice when bottom of excavation is reached.
 - .5 Submit to Departmental Representative testing inspection results as described in PART 3 of this Section.
- .3 Preconstruction Submittals:
 - .1 Submit construction equipment list for major equipment to be used in this section prior to start of Work.
 - .2 Submit records of underground utility locates, indicating: location plan of existing utilities as found in field, clearance record from utility authority.

1.5 EXISTING CONDITIONS

- .1 Examine soil report available in Appendix A.
- .2 Buried services:
 - .1 Before commencing work establish location of buried services on and adjacent to site.

- .2 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.
- .3 Prior to beginning excavation Work, notify applicable authorities having jurisdiction to establish location and state of use of buried utilities and structures. Authorities having jurisdiction to clearly mark such locations to prevent disturbance during Work.
- .4 Confirm locations of buried utilities by careful soil hydrovac methods.
- .5 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered.
- .6 Record location of maintained underground lines.
- .3 Existing buildings and surface features:
 - .1 Conduct, with Departmental Representative, condition survey of existing buildings, trees and other plants, lawns, fencing, service poles, wires, rail tracks, pavement, survey bench marks and monuments which may be affected by Work.
 - .2 Protect existing buildings and surface features from damage while Work is in progress. In event of damage, immediately make repair as directed by Departmental Representative.

Part 2 Products

2.1 BEDDING, BACKFILL, AND GRANULAR BEDDING (PIPELINE)

- .1 Select Zone 2A material used for backfill in the Initial Backfill Zone, as shown on the drawings, shall be suitable excavated material, selected by the Departmental Representative from excavated trench material which contains no frozen soil, roots, or other objectionable material with no particles larger than 40 mm in its largest dimension. It shall contain no objectionable material including excess moisture that might cause pipe damage, excessive settlements or inadequate compaction.

Selected Zone 2A material that is non-cohesive, contains no lumps larger than 40 mm in diameter and can be compacted to the required density, as determined by the Departmental Representative, may be substituted for Imported Zone 3A.
- .2 Random Zone 2B material used for backfill in the Random Backfill Zone, as shown on the drawings, shall consist of suitable excavated material as determined by the Departmental Representative. All material shall be of an acceptable quality, free from boulders, particles larger than 100 mm in maximum dimension, ice, snow, wood or other extraneous material.
- .3 Imported Zone 3A material, to be used in the Bedding Zone and for pipe haunching as shown on the drawings, shall be sand and gravel with a maximum particle size of 40 mm including relatively well graded sands and gravels containing small percentages of fines, generally granular and non-cohesive, either wet or dry.

Imported Zone 3A shall meet the following gradation limits:

<u>Sieve Size (mm)</u>	<u>Percent Passing (by mass)</u>
40.0	100

10.0	45 - 100
4.75	35 - 80
2.00	24 - 60
0.425	10 - 35
0.075	0 - 10

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- .1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to sediment and erosion control plan, specific to site, that complies with requirements of authorities having jurisdiction.
- .2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- .3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 PREPARATION/PROTECTION

- .1 Protect existing features in accordance with Section 01 56 00 - Temporary Barriers and Enclosures and applicable local regulations.
- .2 Keep excavations clean, free of standing water, and loose soil.
- .3 Protect buried services that are required to remain undisturbed.

3.3 STRIPPING AND REPLACEMENT OF TOPSOIL

- .1 Topsoil shall be stripped as directed by the Departmental Representative to a minimum depth of 100 mm in areas of excavation and shall be stockpiled within the easement for replacement after the completion of backfilling operations.
- .2 Stockpile in locations as directed by Departmental Representative.
 - .1 Stockpile height not to exceed 2 m and should be protected from erosion.
- .3 Topsoil shall be replaced along the pipeline alignment as well as on the reservoir berms.
- .4 Grade to eliminate rough spots and low areas and ensure positive drainage.
- .5 Mechanical seeding of topsoil shall be conducted within the reservoir fence area, within the AAFC yard, and within the roadway right-of-ways.

3.4 DEWATERING

- .1 Keep excavations free of water while Work is in progress.
- .2 Provide for Departmental Representative review details of proposed dewatering methods, including dikes, well points, and sheet pile cut-offs.

- .3 Avoid excavation below groundwater table if quick condition or heave is likely to occur.
 - .1 Prevent piping or bottom heave of excavations by groundwater lowering, sheet pile cut-offs, or other means.
- .4 Protect open excavations against flooding and damage due to surface run-off.
- .5 Dispose of water in accordance with Section 01 35 43 - Environmental Procedures and in manner not detrimental to public and private property, or portion of Work completed or under construction.
 - .1 Provide and maintain temporary drainage ditches and other diversions outside of excavation limits.
- .6 Provide flocculation tanks, settling basins, or other treatment facilities to remove suspended solids or other materials before discharging to storm sewers, watercourses or drainage areas.

3.5 EXCAVATION (TRENCH AND RESERVOIR)

- .1 Advise Departmental Representative at least 7 days in advance of excavation operations for initial cross sections to be taken.
- .2 Trench walls located 300 mm above the top of the pipe shall be excavated with side slopes consistent with the stability of the soil and consistent with the current Manitoba Workplace Safety and Health Regulations from Manitoba Labour and Immigration. Where excavation of side slopes is not possible due to limitations on available right-of-way, existing utilities, structures, roads, pavements or other works, then the trench shall be excavated with walls as nearly vertical as possible, and with shoring or bracing, where required to prevent falling, slipping or caving in of the trenches. Bracing and shoring shall be constructed at the Contractor's expense and in accordance with the current Manitoba Workplace Safety and Health Regulations. Placing and removal of shoring, bracing, sheet piling or cages shall be undertaken in a manner that permits proper backfilling.
- .3 Excavate to lines, grades, elevations and dimensions as indicated.
- .4 For trench excavation, unless otherwise authorized by Departmental Representative in writing, do not excavate more than 30 m of trench in advance of installation operations and do not leave open more than 15 m at end of day's operation.
- .5 Keep excavated and stockpiled materials safe distance away from edge of trench as directed by Departmental Representative.
- .6 Restrict vehicle operations directly adjacent to open trenches.
- .7 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .8 Notify Departmental Representative when bottom of excavation is reached.
- .9 Obtain Departmental Representative approval of completed excavation.
- .10 Remove unsuitable material from trench bottom including those that extend below required elevations to extent and depth as directed by Departmental Representative.
- .11 Hand trim, make firm and remove loose material and debris from excavations.

- .1 Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
- .12 Shape bed true to grade to provide continuous uniform bearing surface for pipe.
- .13 Shape transverse depressions in bedding as required to suit joints.

3.6 BEDDING AND HAUNCHING (PIPELINE)

- .1 Prior to the installation of the pipe, all rocks or boulders at invert level shall be removed, replaced with Imported Zone 3A (or approved Select Zone 2A), and compacted.
- .2 The trenching equipment shall be equipped with spoon or other attachment capable of carving a smooth wall circular bed for the pipe, to the radius of the pipe being laid and a minimum of 1/3 of the pipe diameter below the trench bottom. As an alternative, bedding shall cover the full width of the trench bottom and have a minimum depth on completion of compaction of 100 mm for excavated road crossings and 75 mm for all other areas.
- .3 The pipe shall be haunched by placing and hand compacting/tamping Imported Zone 3A (or approved Select Zone 2A) material to the spring line of the pipe. Imported Zone 3A (or approved Select Zone 2A) material shall be shovel placed and hand tamped in separate layers, each of which shall be no greater than 100 mm thick.

3.7 INITIAL BACKFILL ZONE (PIPELINE)

- .1 After the pipe has been bedded and haunched to the springline, Select Zone 2A material shall be placed to a point at least 300 mm over the top of the pipe and compacted. Methods used for placement and compaction shall ensure a uniform density of at least 95 percent Standard Proctor Maximum Dry Density.

3.8 RANDOM BACKFILL ZONE (PIPELINE)

- .1 After the completion and approval of the pipe bedding and initial backfill zones, the trench shall be backfilled with Random Zone 2B as described in these specifications.
- .2 Minimum cover over the crown of the pipe to natural ground line shall be 900 mm after consolidation and settlement. In isolated locations where backfill above natural groundline is required for 1000 mm minimum cover, the Contractor shall do so at the direction of the Departmental Representative at no additional cost to the Owner. The top width of backfill above natural ground shall be a minimum of 5000 mm with side slopes not exceeding 10:1.
- .3 Random Zone 2B material shall be placed by rolling the material in from the end of the trench and compacting it by the routing of machinery during backfill operations.
- .4 The Contractor shall leave sufficient material mounded over the trench to allow for consolidation and settlement. After one seasonal freezing and thawing cycle, the Contractor shall return to the site at the direction of the Departmental Representative to further consolidate and grade the backfill. The Contractor shall be responsible for the correction of erosion of backfill material caused by water flowing in the ditch where the pipeline is located. The Contractor shall be responsible for the correction of settlement, erosion and consolidation, and such work shall be considered as part of the Contractor's obligation for rectification of defects during the one year period following completion.

- .5 The Contractor shall be required to prevent off site movement of sediment.

3.9 COMPACTION (RESERVOIR EXCAVATED BASE AND BERMS)

- .1 Compaction equipment to be capable of obtaining required material densities.
- .2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Departmental Representative before use.
- .3 Equipped with device that records hours of actual work, not motor running hours.
- .4 Compact to density of not less than 98% maximum dry density in accordance with ASTM D698 ASTM D1557.
- .5 Shape and roll alternately to obtain smooth, even and uniformly compacted sub-base.
- .6 Apply water as necessary during compaction to obtain specified density.
- .7 In areas not accessible to rolling equipment, compact to specified density with mechanical tampers approved by Departmental Representative.
- .8 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

3.10 PROOF ROLLING (RESERVOIR EXCAVATED BASE AND BERMS)

- .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm maximum.
- .2 Obtain written approval from Departmental Representative to use non standard proof rolling equipment.
- .3 Proof roll at level in sub-base as indicated.
 - .1 If non standard proof rolling equipment is approved, Departmental Representative will determine level of proof rolling.
- .4 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.
- .5 Where proof rolling reveals areas of defective subgrade:
 - .1 Remove sub-base and subgrade material to depth and extent as directed by Departmental Representative.
 - .2 Replace sub-base material and compact.
- .6 Where proof rolling reveals areas of defective sub-base, remove and replace in accordance with this section at no extra cost.

3.11 TESTS FOR COMPACTION

- .1 Samples and/or tests of backfill materials, both before and after placement and compaction, will be taken by the Departmental Representative at frequent intervals. For these samples and tests, corrections, adjustments and modifications of methods, materials, and moisture content will be made in order to secure the desired compaction.

When possible, samples will be taken at locations where backfill operations are temporarily inactive. However, interference with backfill operations shall not be the basis of a claim by the Contractor for additional payment.

END OF SECTION

Part 1 General

1.1 REFERENCES

- .1 ASTM International
 - .1 ASTM D4595-09, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
 - .2 ASTM D4751-04, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
- .2 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-4.2 No. 11.2-2004, Textile Test Methods - Bursting Strength - Ball Burst Test (Extension of September 1989).
 - .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Complete Geomembranes.
 - .1 No.2-M85, Methods of Testing Geosynthetics - Mass per Unit Area.
 - .2 No.3-M85, Methods of Testing Geosynthetics - Thickness of Geotextiles.
 - .3 No.6.1-93, Methods of Testing Geotextiles and Geomembranes - Bursting Strength of Geotextiles Under No Compressive Load.
 - .4 No.7.3-92, Methods of Testing Geotextiles and Geomembranes - Grab Tensile Test for Geotextiles.
 - .5 No. 10-94, Methods of Testing Geosynthetics - Geotextiles - Filtration Opening Size.

1.2 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for geotextiles and include product characteristics, performance criteria, physical size, finish and limitations.

1.3 DELIVERY, STORAGE AND HANDLING

- .1 Deliver, store and handle materials in accordance with with manufacturer's written instructions.
- .2 Storage and Handling Requirements:
 - .1 Store materials in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Store and protect geotextiles from direct sunlight and UV rays.
 - .3 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIAL

- .1 Geotextile: non-woven synthetic fibre fabric, supplied in rolls.
 - .1 Width: 4.5 m minimum.
- .2 Physical properties:
 - .1 Thickness: to CAN/CGSB-148.1, No.3, minimum 3.05 mm.
 - .2 Mass per unit area: to CAN/CGSB-148.1, No.2, minimum 407 g/m².
 - .3 Tensile strength and elongation (in any principal direction): to ASTM D4595.
 - .1 Tensile strength: minimum 1470 N, wet condition.
 - .2 Elongation at break: maximum 50%.
 - .3 Seam strength: equal to or greater than tensile strength of fabric.
- .3 Factory seams: sewn in accordance with manufacturer's recommendations.
- .4 Thread for sewn seams: equal or better resistance to chemical and biological degradation than geotextile.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for geotextile material installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Place geotextile material by unrolling onto graded surface in orientation, manner and locations indicated.
- .2 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .3 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .4 Overlap each successive strip of geotextile 600 mm over previously laid strip.
- .5 Join successive strips of geotextile by sewing.
- .6 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.
- .7 After installation, cover with overlying layer within 4 hours of placement.
- .8 Replace damaged or deteriorated geotextile to approval of Departmental Representative.

3.3 PROTECTION

- .1 Vehicular traffic not permitted directly on geotextile.

END OF SECTION

Part 1 General

1.1 MEASUREMENT AND PAYMENT

- .1 METHOD OF MEASUREMENT – Measurement of "Geomembrane" as indicated on the plans and drawings and described in the Specifications shall be in square metres installed. Supply and installation of all required installation equipment, seaming, quality control testing, key trench, and all other such works shall be incidental to "Geomembrane".
- .2 BASIS OF PAYMENT – Payment for " Geomembrane" shall be at the Contract Unit Price for "Geomembrane" measured as specified herein which shall be payment in full for those operations described in the Specifications and for those operations incidental to the Work for which no price or prices or provisions for payment are included in the Contract.

1.2 REFERENCES

- .1 ASTM International
 - .1 ASTM D413-98(2007), Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
 - .2 ASTM D638-10, Standard Test Method for Tensile Properties of Plastics.
 - .3 ASTM D746-07, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
 - .4 ASTM D792-08, Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
 - .5 ASTM D1004-09, Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
 - .6 ASTM D1204-08, Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
 - .7 ASTM D1238-10, Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
 - .8 ASTM D1593-09, Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting.
 - .9 ASTM D1603-06, Standard Test Method for Carbon Black in Olefin Plastics.
 - .10 ASTM D1693-08, Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
 - .11 ASTM D882-10, Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
 - .12 ASTM D1203-10, Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods.
 - .13 ASTM D1790-08, Standard Test Method for Brittleness Temperature of Plastic Sheeting by Impact.

1.3 ACTION AND INFORMATIONAL SUBMITTALS

- .1 Submit in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Product Data:
 - .1 Submit manufacturer's instructions, printed product literature and data sheets for geomembranes and include product characteristics, performance criteria, physical size, finish and limitations.
- .3 Shop Drawings:
 - .1 Submit shop drawings and indicate installation layout, dimensions and details, including fabricated and field seams, anchor trenches and protrusion details.
- .4 Certificates:
 - .1 Submit electronic copies of manufacturer's mill test data 4 weeks minimum before beginning Work.
 - .2 Submit certificates, including test results 2 weeks before delivery to job site.

1.4 QUALITY ASSURANCE

- .1 Test quality of resin and membrane to ensure consistency of raw material and geomembrane quality in accordance with manufacturer's recommendations.
- .2 Test seams in strength and peel at beginning of each seaming period, and at least once every 4 hours if welding operation is interrupted, for each seaming apparatus and seamer used that day.
 - .1 Also test at least two samples from each panel, with samples taken from extra material, such that panel is not damaged and blanket geometry is not altered.
- .3 If seam test specimen fails in seam, repeat on new specimen.
 - .1 If new specimen fails in seam, material will not be used for seaming until deficiencies are corrected and two consecutive successful test seams are achieved.
- .4 Test seams by non-destructive methods over their full length, using vacuum test unit or air pressure test.
 - .1 Vacuum chamber to contain glass viewport and seal for sealing chamber to seam area. With chamber sealed in place and after partly filling chamber with water, apply vacuum of 17.2 kPa. Seam failure is detected by presence of air bubbles through water.
 - .2 Use air lance to apply air at 343 kPa through nozzle directed at edge of overlap seam. Seam failure is indicated by inflation or lifting of any part of geomembrane.
- .5 Provide test results to Departmental Representative, for each shift's production, including documentation of non-destructive testing and repairs at end of each shift.

1.5 DELIVERY, STORAGE AND HANDLING

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

- .2 Delivery and Acceptance Requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.
- .3 During delivery and storage, protect geo-membranes from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.
- .4 Storage and Handling Requirements:
 - .1 Store materials in dry location and in accordance with manufacturer's recommendations in clean, dry, well-ventilated area.
 - .2 Replace defective or damaged materials with new.

Part 2 Products

2.1 MATERIALS

- .1 Geomembrane: extruded synthetic sheet.
 - .1 Supplied in:
 - .1 Rolls of 6.86 m minimum width.
 - .2 Composed of high density polyethylene resin.
 - .2 Physical properties:
 - .1 Specific gravity of resin: to ASTM D792, Method A, minimum 0.93.
 - .2 Thickness: to ASTM D1593, minimum 1.50 mm.
 - .3 Tensile strength and elongation at yield: to ASTM D6693.
 - .1 Tensile strength at yield: minimum 22 N/mm.
 - .2 Elongation at yield: minimum 12%.
 - .4 Tensile strength and elongation at break: to ASTM D6693:
 - .1 Tensile strength at break: minimum 40 N/mm.
 - .2 Elongation at break: minimum 700%
 - .5 Tear resistance: to ASTM D1004, Die C, minimum 187 N.
 - .6 Puncture resistance: to ASTM 4833, minimum 480 N.
 - .7 Carbon black content: to ASTM D1603, minimum 2%, maximum 3% by mass.
 - .8 Seam strength (at yield point): 280 N and film tear bond.
 - .9 Geomembrane: free of striations, roughness, pinholes, bubbles, blisters, un-dispersed raw materials and any sign of contamination by foreign matter.
- .3 Seams: welded in accordance with manufacturer's recommendations.
 - .1 Physical properties for resin used for welding are same as those for resin used in manufacture of membrane.

Part 3 Execution

3.1 EXAMINATION

- .1 Verification of Conditions: verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for geomembranes installation in accordance with manufacturer's written instructions.
 - .1 Visually inspect substrate in presence of Departmental Representative.
 - .2 Inform Departmental Representative of unacceptable conditions immediately upon discovery.
 - .3 Proceed with installation only after unacceptable conditions have been remedied.

3.2 INSTALLATION

- .1 Maintain area of installation free of water and snow accumulations.
- .2 Do not proceed with panel placement and seaming when ambient temperatures are below minus 5 degrees C or above 40 degrees C, during precipitation, in presence of excessive moisture (i.e. fog, dew), nor in presence of high winds.
- .3 Place and seam panels in accordance with manufacturer's recommendations on graded surface in orientation and locations indicated. Minimize wrinkles, avoid scratches and crimps to geomembranes and avoid damage to supporting material.
- .4 Protect installed membrane from displacement, damage or deterioration before, during and after placement of material layers.
- .5 Replace damaged, torn or permanently twisted panels to approval of Departmental Representative. Remove rejected damaged panels from site.
- .6 Keep field seaming to minimum. Locate field seams up and down slopes, with no horizontal field seam less than 1.5 m beyond toe of slope.
- .7 Keep seam area clean and free of moisture, dust, dirt, debris and foreign material.
- .8 Make field seam samples in accordance with requirements described in PART 2 on fragment pieces of geo-membrane and test to verify that seaming conditions are adequate.
- .9 Test field seams as seaming work progresses by non-destructive methods over their full length. 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.
- .10 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.

3.3 PROTECTION

- .1 Do not permit vehicular traffic directly on membrane.

END OF SECTION