

Part 1 General

1.1 SOURCE APPROVAL

- .1 Source of materials to be incorporated into work or stockpiled requires approval.
- .2 Inform Departmental Representative of proposed source of aggregates and provide access for sampling at least two (2) weeks prior to commencing production.
- .3 If, in opinion of Departmental Representative, materials from the proposed source do not meet, or cannot reasonably be processed to meet specified requirements, locate an alternative source or demonstrate that material from source in question can be processed to meet specified requirements.
- .4 Should a change of material source be proposed during work, advise Departmental Representative one (1) week in advance of proposed change to allow sampling and testing.
- .5 Acceptance of a material at source does not preclude future rejection if it is subsequently found to lack uniformity, or if it fails to conform to requirements specified, or if its field performance is found to be unsatisfactory.

1.2 PRODUCTION SAMPLING

- .1 Aggregate will be subject to continual sampling by Departmental Representative during production.
- .2 Provide Departmental Representative with ready access to source and processed material for purpose of sampling and testing.
- .3 Bear the cost of sampling and testing of aggregates which fail to meet specified requirements.

1.3 METRIC SIEVES

- .1 CGSB 8-GP-2M sieve sizes shall replace ASTM E11 sieves as follows:

CGSB 8-GP-2M Sieves (um)	ASTM E11 Sieves (mm)
125 000	125.0
80 000	75.0
63 000	63.0
50 000	50.0
40 000	37.5
25 000	25.0
20 000	19.0
16 000	16.0
12 500	12.5
10 000	9.5
5 000	4.75
2 500	2.36
2 000	2.00
1 600	1.70
1 250	1.18
800	0.850
630	0.600
400	0.425
315	0.300
160	0.150
80	0.075
45	0.045

Part 2 Products

2.1 MATERIALS

.1 Native Backfill:

.1 Selected material from excavation or other sources, approved by Departmental Representative for use intended, unfrozen and free from rocks larger than 75 mm, cinders, ashes, sods, organics, refuse or other deleterious materials.

.2 Granular Base Material (20mm Crushed Gravel):

.1 Base material shall be clean, hard, durable, free from clay lumps, cementation shale, organic, frozen and other deleterious materials.

.2 Gradations to be within limits specified when tested to ASTM C136:

<u>Sieve Designation (µm)</u>	<u>% Passing</u>
20 000	100
16 000	84-94
10 000	63-86
5 000	40-67
1 250	20-43
630	14-34
315	9-26
160	5-18
80	2-10

.3 Type 1 fill (Washed Rock)

.1 Clean, hard, durable, gravel or stone free from clay lumps, cementation, shale, organic material, frozen material and other deleterious materials.

.2 Gradation to be within limits specified when tested to ASTM C136 and ASTM C117 giving a smooth curve without sharp breaks when plotted on semi-log charts.

<u>Designation, (µm)</u>	<u>% Passing</u>
50 000	100
25 000	80-100
20 000	20-100
5 000	0-10

.4 Pipe Zone Material (Class "B" Bedding) (Native Fill Sand):

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

.2 Graduations to be within limits specified when tested to ASTM C136 and ASTM C117 and to have a smooth curve without sharp breaks when plotted on semi-log charts.

<u>Sieve Designation (µm)</u>	<u>% Passing</u>
5 000	100
1 250	66-100
630	52-100
315	35-78
160	18-43
80	7-13

.5 40mm Screened Rock Bedding Material:

.1 Clean, hard, durable gravel or stone free from clay, loam, or any other deleterious materials.

.2 Gradations to conform to the following grading:

<u>Sieve Designation (µm)</u>	<u>% Passing</u>
50 000	100
40 000	95-100
20 000	5-10
10 000	0-5
5 000	0-5

.6 Granular Sub-Base Material (75mm Pitrun Gravel):

.1 Clean, hard, durable, gravel free from clay, loam, or any other deleterious materials.

.2 No oversize material will be tolerated.

.3 Gradations to conform to the following grading:

<u>Sieve Designation (µm)</u>	<u>% Passing</u>
80 000	100
50 000	80-100
25 000	50-75
5 000	25-55
80	2-10

Part 3 Execution

3.1 PROCESSING

.1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.

.2 Blend aggregates if required to obtain gradation requirements specified by aggregate splitting, elimination of fines, or blending with sand.

.3 Blending to increase percentage of crushed particles or decrease percentage of flat and elongated particles is permitted.

.4 Wash aggregates, if required to meet specifications. Use only equipment approved by Departmental Representative.

.5 When operating in stratified deposits use excavation equipment and methods that will produce uniform, homogeneous aggregate.

3.2 HANDLING

- .1 Handle and transport aggregates to avoid segregation, contamination and degradation.

3.3 STOCKPILING

- .1 Stockpile aggregates on site in locations indicated or designated. Do not stockpile on completed pavement surfaces where damage to pavement may result.
- .2 Stockpile aggregates in sufficient quantities to meet project schedules.
- .3 Stockpiling sites shall be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
- .4 Except where stockpiled on acceptably stabilized areas, provide compacted sand base not less than 300 mm in depth to prevent contamination of the aggregate or, if permitted, stockpile aggregates on ground but do not incorporate bottom 300 mm of pile into work.
- .5 Separate aggregates by substantial dividers or stockpile far enough apart to prevent intermixing.
- .6 Reject intermixed or contaminated materials. Remove and dispose of rejected materials as directed by Departmental Representative within 48 h of rejection.
- .7 Stockpile materials in uniform layers of 750 mm maximum.
- .8 Complete each layer over entire stockpile area before beginning next layer.
- .9 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
- .10 Coning of piles or spilling of material over edges of pile will not be permitted.
- .11 Conveying stackers will not be permitted.
- .12 During winter operations, prevent ice and snow from becoming mixed into stockpile or in material being removed from stockpile.

3.4 STOCKPILE CLEANUP

- .1 Leave stockpile site in a tidy, well drained condition, free of standing surface water.
- .2 Remove any unused aggregates from site.

3.5 FILL TYPES AND COMPACTION

- .1 Unless otherwise specified, compact to the following densities at $\pm 3\%$ of Optimum Moisture Content:
 - .1 Native Backfill: 98% Standard Proctor Density.
 - .2 Subgrade Preparation: 100% Standard Proctor Density.
 - .3 Borrow Material: Compact each layer to 98% Standard Proctor Density.
 - .4 Granular Base Material: 98% Modified Proctor Density.
 - .5 Pipe Zone Material: 95% Standard Proctor Density.
 - .6 Type 1 fill (washed rock): Consolidated.
 - .7 Granular Sub-base Material: 98% Modified Proctor Density

END OF SECTION

Part 1 General

1.1 SITE CONDITIONS

- .1 Known underground and surface utility and buried objects are indicated on site plan. Actual location of utilities must be confirmed prior to commencement of any work.

1.2 PROTECTION

- .1 Prevent damage to legal survey markers, fencing, trees, landscaping, natural features, bench marks, existing buildings, existing concrete, existing pavement, surface or underground utility lines which are to remain. Make good any damage.
- .2 Maintain road access and egress to adjacent developed properties.

Part 2 Products

2.1 MATERIALS

- .1 Obtain approval of excavated or graded material used as fill for grading work. Protect approved material from contamination.
- .2 Material used for fill not to contain organic matter, frozen lumps, weeds, sod, roots, logs, stumps or any other unsuitable material.
- .3 Where there is a shortage of material, make arrangement to haul material from the sewage lagoon site.

Part 3 Execution

3.1 STRIPPING OF TOPSOIL

- .1 Strip topsoil in accordance to Section 32 91 19.13 Topsoil Placement and Grading.

3.2 PREPARATION OF EXISTING GRADE

- .1 Grade soil, eliminating uneven areas and low spots, ensuring positive drainage. Remove soil contaminated with toxic materials. Dispose of removed materials as directed by Departmental Representative.
- .2 Cultivate entire area which is to receive topsoil to depth of 100 mm. Repeat cultivation in those areas where equipment used for hauling and spreading has compacted soil.
- .3 Remove surface debris, roots, vegetation branches and stones in excess of 50 mm diameter.

3.3 PLACING AND SPREADING OF TOPSOIL

- .1 Placing and spreading of topsoil to Section 32 91 19.13 – Topsoil Placement and Grading.

3.4 FINISH GRADING

- .1 Fine grade and loosen topsoil. Eliminate rough spots and low areas to ensure positive drainage. Prepare loose friable bed by means of cultivation and subsequent raking.

3.5 COMPACTION EQUIPMENT

- .1 Compaction equipment must be capable of obtaining required densities in materials on project.

3.6 SEEDING

- .1 Refer to Section 32 92 19.13 Mechanical Seeding.

3.7 SURPLUS MATERIAL

- .1 Remove surplus material as directed by the Departmental Representative.
- .2 Remove material unsuitable for fill, grading or landscaping from site.

3.8 TESTING

- .1 Inspection and testing of soil compaction will be carried out by designated testing laboratory.
- .2 Costs of tests will be paid by Owner.
- .3 Necessary re-tests will be paid by Contractor.

3.9 CLEAN UP

- .1 Leave site clean and free of debris and surplus material.
- .2 At completion of works and in preparation for final acceptance, perform final cleaning.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Rock excavation: excavation of material from solid masses of igneous, sedimentary or metamorphic rock which, prior to its removal, was integral with its parent mass, and boulders or rock fragments having individual volume in excess of one cubic metre (1 m³).
- .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation including dense tills, hardpan, frozen materials and partially cemented materials which can be ripped and excavated with heavy construction equipment.
- .3 Topsoil: material capable of supporting good vegetative growth and suitable for use in top dressing, landscaping and seeding.
- .4 Native backfill: material excavated from the trench from which all boulders, roots, stumps or other debris which would prevent consolidation of backfill have been removed.
- .5 Pipe zone: that portion of the trench between the bottom of the pipe bedding and a level 300 mm above the top of the installed pipe.

1.2 WORK INCLUDED

- .1 The following work is included:
 - .1 Anchor trench excavation and backfill;
 - .2 Pipeline excavation; and
 - .3 Pipe zone.

1.3 RELATED SECTIONS

- .1 Geomembranes – refer to Section 31 32 19.02
- .2 Geotextiles – refer to Section 31 32 19.01

1.4 PROTECTION OF EXISTING FEATURES

- .1 Existing buried utilities and structures:
 - .1 Size, depth and location of existing utilities and structures as indicated are for guidance only. Completeness and accuracy are not guaranteed.

- .2 Prior to commencing any excavation work, notify applicable owner or authorities, establish location and state of use of buried utilities and structures. Clearly mark such locations to prevent disturbance during work.
- .3 Confirm locations of buried utilities by careful test excavations.
- .4 Maintain and protect from damage, water, sewer, gas, electric, telephone and other utilities and structures encountered. Obtain direction of Departmental Representative before moving or otherwise disturbing utilities or structures.
- .5 Record location of maintained, re-routed and abandoned underground lines.
- .2 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 and paving, survey bench marks, culverts and monuments which may be affected by work.
 - .2 Protect existing buildings and surface features which may be affected by work from damage while work is in progress and repair damage resulting from work.

Part 2 Products

2.1 MATERIALS

- .1 Native Backfill: to Section 31 05 16 - Aggregate Materials
- .2 Pipe Zone Material: to Section 31 05 16 – Aggregate Materials.
- .3 Anchor Trench Backfill:
 - .1 Native backfill material in trench.
 - .2 Unsuitable materials are materials other than organic material that are in the opinion of the Departmental Representative not suitable for use in subgrade of roads or in embankments, or fills. Frozen material is considered unsuitable material.

Part 3 Execution

3.1 SITE PREPARATION

- .1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

3.2 STOCKPILING

- .1 Stockpile fill materials in areas designated by Departmental Representative. Stockpile granular materials in manner to prevent segregation.
- .2 Protect fill materials from contamination.

3.3 COMPACTION

- .1 Refer to Section 31 05 16 – Aggregate Materials.

3.4 DEWATERING

- .1 Keep excavations free of water while work is in progress.
- .2 Protect open excavations and all installed structures against flooding and damage due to surface run-off.
- .3 Dispose of water in a manner not detrimental to public and private property, or any portion of work completed or under construction.
- .4 No additional payment for dewatering in this section. Contractor shall provide pumps and hose necessary to dewater the work site for the duration required to do the work.

3.5 EXCAVATION

- .1 Excavate to lines, grades, elevations and dimensions indicated.
- .2 Remove obstructions encountered during excavation.
- .3 Do not disturb soil within 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. Seal cuts with approved tree wound dressing.
- .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 10 m at end of day's operation.
- .5 Dispose of surplus and unsuitable excavated material off site.
- .6 Do not obstruct flow of surface drainage except in the areas where erosion control and sedimentation measures are implemented and approved by Departmental Representative. Any obstruction or disruption to the natural water course shall require regulatory approvals prior to work.
- .7 Earth bottoms of excavations to be undisturbed soil, level, free from loose, soft or organic matter.
- .8 Notify Departmental Representative when soil at bottom of excavation appears unsuitable and proceed as directed by Departmental Representative.
- .9 Obtain Departmental Representative approval of completed excavation.
- .10 Remove unsuitable material from trench bottom to extent and depth directed by Departmental Representative.

- .11 Where required due to unauthorized over-excavation, correct as follows:
 - .1 Fill areas with Type 1 fill.
 - .2 Compact as specified in Section 31 05 16 – Aggregate Materials.
- .12 Hand trim, make firm and remove loose material and debris from excavations. Where material at bottom of excavation is disturbed, compact foundation soil to density at least equal to undisturbed soil.
- .13 Fills and exposed cut areas on gravel or paved roads shall be compacted as specified in Section 31 05 16 – Aggregate Materials.

3.6 PIPE ZONE MATERIAL

- .1 Place pipe zone materials in accordance with details or as directed by Departmental Representative.
- .2 Shape bed true to grade and to provide continuous, uniform bearing surface for barrel of pipe. Do not use blocks when bedding pipe.
- .3 Shape transverse depressions as required to receive bell, if bell and spigot pipe is used.
- .4 Compact full width of bed to Section 31 05 16 – Aggregate Materials.
- .5 Pipe zone material to a minimum 300 mm above pipe.
- .6 Fill excavation below bottom of specified pipe zone adjacent to manholes or structures with bedding material.

3.7 BACKFILLING

- .1 Native backfill material may be used for backfilling pipe trenches and substructure excavation.
- .2 Do not proceed with backfilling operations until Departmental Representative has inspected and approved installations.
- .3 Areas to be backfilled to be free from debris, snow, ice, water and frozen ground.
- .4 Do not use backfill material which is frozen or contains ice, snow or debris.
- .5 Roll material down trench side slopes. Do not push material into trench and allow it to drop vertically.
- .6 Make every effort to plan backfilling so that exposure of backfill material to wet weather will be kept at a minimum.

- .7 Grade surface, eliminate uneven areas and low spots ensuring positive drainage. Remove any soil contaminated during backfill operations.
- .8 Remove excess material off site.
- .9 Place backfill material in uniform layers not exceeding 150 mm compacted thickness up to grades indicated. Compact each layer before placing succeeding layer.
- .10 Do not backfill around or over cast-in-place concrete within 24 hours after placing.
- .11 Compaction density to be as per Section 31 05 16 – Aggregates Materials.

3.8 INSPECTION AND TESTING

- .1 Refer to Section 01 45 00 – Quality Control.

3.9 EROSION AND SEDIMENTATION CONTROL

- .1 Contractor shall supply and install temporary erosion and sedimentation control measure. These materials may include or limited to silt fencing, geotextile lining, strawbales, sand bags.
- .2 Erosion and sedimentation control measures shall be as per manufacturer standards to ensure proper usage and function.
- .3 The measures shall be maintained throughout the project. The sedimentation measures shall remain and be maintained during post construction until after vegetation has been established.

3.10 RESTORATION

- .1 Upon completion of work, remove surplus materials and debris, trim slopes, and correct defects noted by Departmental Representative.
- .2 Clean and reinstate areas affected by work.
- .3 Final restoration of the site including topsoil and seeding shall be conducted as shown with the drawings.

END OF SECTION

Part 1 General

1.1 DEFINITIONS

- .1 Rock excavation: excavation of material from solid masses of igneous, sedimentary or metamorphic rock which, prior to its removal, was integral with its parent mass, and boulders or rock fragments having individual volume in excess of one cubic meter (1 m³)
- .2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation including dense tills hardpan, frozen materials and partially cemented materials which can be ripped and excavated with heavy construction equipment.
- .3 Waste/unsuitable material: materials other than organic material that are in the opinion of the Departmental Representative not suitable for use in subgrade of roads, embankments or fills. Frozen material, coal, sandy and silty soil are considered unsuitable material.
- .4 Borrow material: material obtained from areas outside right-of-way and required for construction of embankments or for other portions of work.
- .5 Embankment: material derived from usable excavation and placed above original ground or stripped surface up to subgrade elevation.
- .6 Subgrade elevation: elevation immediately below road surface structure.
- .7 Organic material: peat moss or other organic soil underlying the topsoil that has not previously been stripped.

1.2 BURIED SERVICES

- .1 Check with utility companies to locate or advise regarding buried pipes, cables, ducts or services. Make good and pay for repair to services damaged during excavation, where such services are located within 1 m. of stake out set by utility company.

Part 2 Products

2.1 NOT USED

Part 3 Execution

3.1 COMPACTION EQUIPMENT

- .1 Compaction equipment must be capable of obtaining required densities in materials on project.

3.2 WATER DISTRIBUTORS

- .1 Apply water with equipment capable of uniform distribution.

3.3 SUBGRADE PREPARATION

- .1 In areas where excavation is to subgrade or in any case no more than 150 mm below that elevation, the subgrade will be scarified to a depth of 150 mm and the scarified material windrowed to the side.
- .2 The exposed surface shall then be brought to its optimum moisture content and compacted. Refer to Section 31 05 16 – Aggregate Materials for compaction requirements.
- .3 The windrowed material shall then be brought to its optimum moisture content, shaped to line and grade, and compacted. Refer to Section 31 05 16 – Aggregate Materials for compaction requirements.
- .4 Remove soft or other unstable material that will not compact properly and fill resulting depressions with approved material.
- .5 Shape and compact entire roadbed to within 15 mm of design elevations but not uniformly high or low.
- .6 Do scarifying, blading, compacting or other methods of work as necessary to provide thoroughly compacted roadbed shaped to grades and cross sections indicated or directed.
- .7 Finish back and side slopes of common material to neat condition, suitable for seeding or sodding, true to line and grade.
 - .1 Remove boulders encountered in cut slopes and fill resulting cavities.
 - .2 Hand finish slopes that cannot be finished satisfactorily by machine.

3.4 GRANULAR BASE

- .1 Granular Base Material to Section 32 05 16 - Aggregate Materials.

3.5 PIT RUN GRAVEL

- .1 Pit run gravel to Section 32 05 16 – Aggregate Materials.

3.6 MAINTENANCE

- .1 Maintain finished surfaces in a condition conforming to this section until acceptance.

END OF SECTION

Part 1 General

1.1 SAMPLES

- .1 Submittals - refer to Section 01 45 00 – Quality Control.

1.2 DELIVERY AND STORAGE

- .1 Geotextile shall be handled and stored in accordance with the manufacturer's recommendations.
- .2 Store materials so that they do not come in contact with substances that may affect their physical or chemical properties.
- .3 The integrity and legibility of the product labels shall be preserved during storage, delivery and handling.

Part 2 Products

2.1 MATERIAL

- .1 The geotextile material shall be non-woven needle-punched polypropylene. The geotextile material shall be a minimum weight of 339 g/m². The material specifications shall be based on a minimum average roll values not typical values.
- .2 The geotextile for the protection layer exhibit the properties described in the GRI GT12 Standards – “Test Methods and Properties for Non-woven Geotextiles used as Protection (or Cushioning) Materials”.
- .3 The rolls must be tagged to identify lot, batch, unique roll number, roll dimensions, manufacturer and material type. Provide QC testing certificate for each roll delivered, in accordance with the following minimum required properties:

Property	ASTM Test Method	Unit	MARV
Mass per unit area	D-5261	oz/yd ²	10
Grab tensile strength	D-4632	kN	1.11
Grab tensile elongation	D-4632	%	50
Trapezoid tear	D-4533	kN	0.44
Puncture strength	D-4833	kN	0.73
Apparent Opening Size	D-4751	US Sieve	100
Permitivity	D-4491	sec ⁻¹	1.2
UV resistance	D-4355	%	70*

* Based on 500 hours.

Part 3 Execution

3.1 METHOD OF PLACEMENT

- .1 The non-woven geotextile cushion layer shall be placed in locations indicated.
- .2 All geotextiles shall be handled in a manner to ensure they are not damaged. The following special handling requirements shall be adhered to.
- .3 The geotextiles shall be sufficiently anchored and deployed in such a manner to continually keep the geotextile sheet in sufficient tension to reduce folds or wrinkles.
- .4 Geotextiles shall be weighted with sandbags or the equivalent.
- .5 Geotextiles shall be cut using an approved cutter. If the material is being cut in place, special care must be taken to protect other underlying geosynthetic materials from damage.
- .6 Care shall be taken not to entrap stones or excessive dust that could damage the geomembrane.
- .7 The geotextile installer shall use appropriate mechanical equipment when deploying the geotextile panels in order to mitigate the impact and defects on the installed portions of the geomembrane and geotextile.
- .8 If, in the opinion of the Departmental Representative, the mechanical equipment is causing a detrimental impact to the liner or geotextile, the Contractor shall deploy other means or equipment to place the geotextile.

3.2 FIELD SEAMS

- .1 Geotextiles shall have a minimum overlap of 600 mm along panel seams. Minimum overlaps in other area shall be installed as indicated on the construction drawings.
- .2 Geotextiles shall be seamed by thermal bonding or by sewing. No horizontal seams shall be allowed on side slopes.
- .3 On slopes steeper than ten (10) horizontal to one (1) vertical, geotextiles shall be overlapped a minimum of 100 mm prior to sewing.
- .4 On bottoms and slopes shallower than ten (10) horizontal to one (1) vertical, geotextiles can either be sewn as indicated above or thermally bonded. If thermally bonded, the geotextile shall be overlapped a minimum of 600 mm prior to seaming.

3.3 DEFECTS AND REPAIRS

- .1 Any holes or tears in the geotextile shall be repaired as follows:
 - .1 On Slopes - A patch made of the same geotextile shall be seamed into place. If the hole or tear width across the roll is more than 50% the width of the roll, the damaged area shall be cut out and the two (2) portions of the geotextile shall be joined.
 - .2 Horizontal Areas - A patch made from the same geotextile shall be spot-seamed in place with a minimum of 300 mm overlap in all directions.
- .2 All defects shall be repaired and documented.

3.4 PROTECTION

- .1 No vehicles permitted directly on geotextile.

END OF SECTION

Part 1 General

1.1 QUALITY CONTROL

- .1 Quality Control – Refer to Section 01 45 00 – Quality Control.
- .2 The materials supplied shall be in accordance with the specifications. Any proposed variance or deviation shall be requested in writing prior to the commencement of installation.
- .3 The Contractor shall submit certificates of compliance with the requirements of standards and testing methods; and affidavits that materials meet the requirements of the specifications in every respect.
- .4 Product Quality Control - refer to Clause 2 of this section.
- .5 Installation Quality Control - refer to Clause 3 of this section.
- .6 Identification
 - .1 Rolls must be tagged to identify the thickness of the material, the length and width of the roll, batch and roll number and the name of the manufacturer.
- .7 The manufacturer shall have at least two (2) years continuous experience in the manufacture of HDPE geomembranes.

1.2 SUBMITTALS

- .1 Refer to Section 01 45 00 – Quality Control.

1.3 GEOMEMBRANE INSTALLATION GUARANTEE PERIOD

- .1 The Contractor shall guarantee against geomembrane installation defects for a period of two (2) years from date of issue of Contract Completion Certificate. Submit warranty to Owner on date specified.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- .1 Geomembrane shall be handled and stored in accordance with the manufacturer's recommendations.
- .2 Store materials so that they do not come in contact with substances that may affect their physical or chemical properties.
- .3 The integrity and legibility of the product labels shall be preserved during storage, delivery and handling.

Part 2 Products

2.1 60 MIL GEOMEMBRANE

- .1 The primary liner shall be premium grade high density polyethylene (HDPE) geomembrane with a nominal thickness of 1.5 mm (60 mil.). Non-Textured.
- .2 The 60 mil HDPE geomembrane liner material shall adhere to the GRI GM13 Rev. 6 – June 23, 2003 testing standards and requirements including the following ASTM tests:

Property	ASTM Test*	Certificate Required
Thickness	D5199	- Manufacturer Test
Density	D1505/D792	- Manufacturer Test
Tensile Properties	D6693 Type IV	- Manufacturer Test
Tear Resistance	D1004	- Manufacturer Test
Puncture Resistance	D4833	- Manufacturer Test
Stress Crack Resistance	D5397	- "letter of certification" of Manufacturer Test
Accelerated Heat Aging	D5721	- Manufacturer Test
Carbon Black Content	D1603	- Manufacturer Test
Carbon Black Dispersion	D5596	- Manufacturer Test
Melt Flow Index	D1238	- Manufacturer Test
Notched Load	D5397	- Manufacturer Test
Oxidative Induction Time	D5885 or D3895	- "letter of certification" or Manufacturer Test
Oven Aging	D5721 or D3895 or D5885	- "letter of certification" or Manufacturer Test
UV Resistance	D3895 or D5885 or GRI GM11	- "letter of certification" or Manufacturer Test

*ASTM tests that have been revised or superseded by ASTM shall be permissible.

- .3 The installation contractor shall retain a "letter of certification" from the 60 mil HDPE geomembrane manufacturer certifying the specified additional ASTM testing properties above.
- .4 The primary geomembrane shall be suitable for the intended purpose at the site ambient temperature range.
- .5 60 mil HDPE geomembrane liner shall be manufactured from the same resin source. Provide resin lot numbers issued by the manufacturer to the Owner or designated representative seven (7) days prior to deployment.

2.2 EXTRUDATE ROD OR BEAD

- .1 Extrudate material shall be made from same type of resin as the HDPE liner.
- .2 Shall be free of contamination by moisture or foreign matter.

Part 3 Execution

3.1 INSTALLATION CONTRACTOR

- .1 The Installation Contractor shall be an approved Contractor trained and licensed to install the manufacturer's membrane.
- .2 Installation shall be performed under the constant supervision of an experienced geomembrane Supervisor, who shall direct the laying and seaming of the liner. Seaming shall be done by an experienced seamer, experienced in seaming HDPE using the type of equipment being used on this project.
- .3 The Installation Contractor shall provide a written report on the completed installation which shall certify that the liner is installed in accordance with the requirements of the specifications, is ready for operation, and that the warranty is in effect as of the date of the Contract Completion Certificate.
- .4 Provide information regarding the installer's Field Installation Quality Control Program and qualifications of field personnel.

3.2 INSTALLATION QUALITY CONTROL

- .1 The following elements are required of the installation quality control plan:
 - .1 Visual Inspection
 - .1 Sub-grade surface prior to installation.
 - .2 Geomembrane damage in shipping.
 - .3 Geomembrane defects, texture.
 - .4 Seams, anchors, penetrations.
 - .5 Geomembrane during deployment for imperfections and mark faulty or suspect areas.
 - .2 Qualifying Weld Test are required
 - .1 At the start of each seaming period.
 - .2 If welding has ceased for four hours or more.
 - .3 If a new operator or new machine starts welding.
 - .4 If there is a significant change in weather condition.
 - .3 Qualifying Weld Tests
 - .1 Minimum length is 1 m for extrusion welding.
 - .2 Minimum length is 2 m for hot shoe welding.
 - .3 Cut 25 mm specimens from each end of the test seam
 - .4 Test for shear - D6392-99 (minimum of 1 test).

- .5 Test for peel - D6392-99 (minimum of 4 tests).
- .4 Production Weld Tests (Destructive Seam Testing)
 - .1 One test coupon properly identified per 150 m of production weld.
 - .2 Each coupon shall be cut into 10 specimens 25 mm wide.
 - .3 Test 5 specimens shear test - Seam Strength D6392-99.
 - .4 Test 5 specimens for peel - Seam Strength D6392-99.
- .5 All field welds shall be tested using the applicable pressure or vacuum test.
- .6 All extrusion welds shall be vacuum box tested.

3.3 PREPARATION

- .1 The Contractor shall be responsible for preparing and maintaining the sub-grade in a condition suitable for installation of the HDPE geomembrane after subgrade acceptance
- .2 Any disturbance or destruction of the subgrade, floors, slopes, earthen berms, landscaped areas including material laydown area shall be restored to its original state.
- .3 Inspect the underlying layer daily before placing HDPE liner.
- .4 The underlying subgrade shall be clean and free from debris and soil, smooth and free of cuts, erosion rills, or protrusions.
- .5 Installer shall verify weather conditions are suitable for HDPE liner placement each day of installation prior to deployment.
- .6 Ensure adequate sand bags are prepared prior to initial liner deployment.

3.4 METHOD OF PLACEMENT

- .1 No equipment or tools shall damage the HDPE liner or underlying surfaces by handling, trafficking, or other means.
- .2 Only all terrain vehicles with low ground pressure wheels (as accepted by Owner) are allowed to travel on geomembrane.
- .3 Place ballast (sand bags) on HDPE liner which will not damage HDPE liner to prevent uplift.
- .4 No personnel working on the HDPE liner shall wear damaging shoes, or engage in other activities that could damage the geomembrane. Smoking will not be permitted on the geomembrane.
- .5 The method used to unroll the panels shall not cause any damage to the HDPE liner and shall not damage the supporting soil and/or underlying geosynthetics.

- .6 The Contractor shall submit a panel layout proposal, to the Owner or designated representative for review, prior to the geomembrane placement.
- .7 The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels). Mark and document all defects for repairs. Defects are defined as any abnormalities that may affect the physical properties of the HDPE liner material.
- .8 The geomembrane installer shall use appropriate mechanical equipment when deploying the geomembrane panels in order to mitigate the impact and defects on the installed portions of the geomembrane liner and sub-grade.
- .9 If, in the opinion of the Owner or designated representative, the mechanical equipment is causing a detrimental impact to the liner, the Contractor shall deploy other means or equipment to place the liner.

3.5 MATERIAL DEPLOYMENT

- .1 Material shall be deployed with consideration of thermal shrinkage. Slack in material shall be incorporated into the liner installation to prevent material from pulling away from the subgrade (bridging). Incorporation of slack shall be per installer's standard installation practice.
- .2 HDPE liner deployment shall proceed between ambient temperatures of 0°C to 40°C. Placement can proceed below 0°C only after it has been verified that the material can be seamed according to the specification and is approved by the Owner or designated representative or designated representative. At the beginning of each day of liner deployment, Liner Installer shall verify geomembrane has not pulled away from the sub-grade (bridging) or anchor trench.
- .3 Bridging in material is considered as a defect and shall be corrected and repaired to meet slack requirements.
- .4 If bridging occurs at any time during the two (2) year Geomembrane Installation Guarantee Period, the Contractor shall make good any such defects at the Contractor's expense.
- .5 Deploy HDPE liner completely down the side and across the bottom of the anchor trench ensuring that there are no sharp projections along the edge of the trench.
- .6 The anchor trench shall not be backfilled and compacted with clay until the deployed material the deployed material has undergone a minimum of two (2) days of thermal cycle.
- .7 When transporting welded geomembrane sheets, care must be taken such that the underside is not excessively scratched or gouged and that the excess material from the overlap of the seam does not collect dirt, sand or gravel.

3.6 FIELD SEAMS

- .1 Orient seams parallel to the slope. Seams placed perpendicular to the direction of the slopes are not allowed.
- .2 Geomembrane seaming shall not be done during any precipitation, in presence of excessive moisture (e.g.: fog, rain, dew) or in the presence of excessive winds. Geomembrane must be wiped cleaned so that the surfaces are dry, and free of dirt, dust and other foreign material prior to seaming.
- .3 Base butt seams and T-Seams shall be at least two (2) meters from the toe of slope. Repair wrinkles or “fish mouths” in seams by relieving them and cap-stripping. Patch if required.
- .4 Butt seams on the slopes will not be accepted.
- .5 Seams shall be wedge-welded double fusion joints wherever possible. Extrusion welds may be used for patches, repairs, overlays, and connections. Solvents shall not be used without prior approval of the Owner or designated representative.
- .6 Finished panel overlap shall be a minimum of 150 mm for wedge fusion joints and 75 mm for extrusion welding.
- .7 If grinding of the surfaces to be seamed is required, the grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement.
- .8 Clean overlapped areas to be seamed and maintain state of cleanliness until the weld is complete. Inspect panel for flaws and repair as required.
- .9 Lap overlap sheets smoothly on each other, avoiding wrinkles, especially differential wrinkles. Hold sheets in place with sand bags.
- .10 The field seams shall meet the specifications of GRI GM19 “Seam Strength and Related Properties of Thermally Bonded Polyefin Geomembranes”.

3.7 FIELD SEAM TESTING - NON-DESTRUCTIVE

- .1 The Contractor shall non-destructively test all field seams over their full length. All test equipment, including but not limited to the following shall be furnished by the Contractor.
- .2 Vacuum Box Testing - Single Wedge Fusion Seams and Extrusion Seams
 - .1 Test Equipment
 - .1 A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft rubber gasket attached to the bottom, port hole or valve assembly, and a vacuum gauge.

- .2 A steel vacuum tank and pump assembly equipped with a pressure controller and pump connections.
 - .3 A rubber pressure/vacuum hose with fittings and connections.
 - .4 A 20 litre spray bottle.
 - .5 A soapy solution.
- .2 The following procedures shall be followed by the Contractor
 - .1 Excess sheet overlap shall be trimmed away.
 - .2 Clean the window, gasket surfaces and check for leaks.
 - .3 Wet a strip of geomembrane the same size as the vacuum box, with a soapy solution.
 - .4 Place the box over the wetted area and compress.
 - .5 Close the bleed valve and open the vacuum valve.
 - .6 Ensure that a leak tight seal is created.
 - .7 Energize the vacuum pump and reduce the tank pressure to approximately 10 kPa.
 - .8 For a period of approximately 10 seconds, examine the geomembrane through the viewing window for the presence of soap bubbles.
 - .9 If no bubbles appear after 10 seconds, close the vacuum valve and open the bleed valve, move the box over the next adjoining area with a minimum 75 mm overlap and repeat the process.
 - .10 All areas where soap bubbles appear shall be marked and repaired and then re-tested.
- .3 The following procedures shall apply to locations where seams cannot be non-destructively tested:
 - .1 If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.
 - .2 If the seam cannot be tested prior to final installation, the seaming operations shall be observed for uniformity and completeness.
- .3 Air Pressure Testing (for double fusion seam only)
 - .1 The following procedures are applicable to those processes, which produce a double seam with an enclosed space.
 - .1 Equipment
 - .1 An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 300 kPa and 500 kPa and mounted on a cushion to protect the geomembrane.

.2 A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

.2 Procedure

.1 Seal both ends of the seam to be tested.

.2 Insert needle or other approved pressure feed device into the tunnel created by the double wedge fusion weld.

.3 Energize the air pump to a pressure between 400 to 450 kPa for 80 mil HDPE. Close valve and sustain pressure for approximately five (5) minutes.

.4 If loss of pressure exceeds 30 kPa, or pressure does not stabilize, locate faulty area, repair and re-test.

.5 Remove needle or other approved pressure feed device, release pressure at opposite end of the seam and seal.

3.8 FIELD SEAMING TESTING - DESTRUCTIVE

.1 The Contractor shall provide a minimum of one destructive test sample per 150 m of seam length from a location specified by the Owner or designated representative. The Contractor shall not be informed in advance of the sample location. At the end of each day the Contractor must notify the Owner or designated representative as to the total length of seaming completed and the individual totals for each welding machine.

.2 Sampling Procedure

.1 In order to obtain test results prior to completion of liner installation, samples shall be cut by the Contractor as the seaming progresses. Sampling times shall be taken within twenty-four (24) hours and tested within forty-eight (48) hours of the completion of production welding. Location of samples shall be determined by the Owner or designated representative. The Owner or designated representative will witness the obtainment of all field test samples with their location, roll, and seam number. The Contractor shall also record in written form the date, time, location, roll, seam number, ambient temperatures, and pass or fail description. A copy of the information must be attached to each sample portion as well as detailed on each test data log. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested.

.3 Size and Disposition of Samples

.1 The samples shall be 300 mm wide by 600 mm long with the seam centered lengthwise. Each equal length piece shall be labelled with the date, time, location, roll, seam number, ambient temperatures, and pass or fail description.

.4 Test Method

.1 Seam specimens are 25.4 mm wide, grip separation rate is 50.8 mm/min.

- .2 Both shear seam strength and peel tests shall be run on five (5) replicate specimens. A breach through the weld or at the weld sheet interface shall be considered a Non-Film Tear Bond (failure) in both seams strength (shear) and peel strength tests.
- .3 Test Shear Seam Strength to ASTM D6392-99.
- .4 Test Peel Strength to ASTM D6392-99.
- .5 Record ambient temperature at testing location.
- .5 Procedures for Destructive Test Failure
 - .1 One or more of the following procedures shall apply whenever a sample fails the field destructive test. The Contractor shall reconstruct the seam between the failed location and any passed test location.
 - .1 The Contractor can retrace the welding path to an intermediate location (at a minimum of 3 m from the location of the failed test), at the Owner or designated representative's discretion, and take a small sample for an additional field test. If this test passes, then the seam shall be reconstructed between that location and the original failed location. If the test fails, then the process is repeated.
 - .2 Over the length of seam failure, the Contractor shall either cut out the old seam, reposition the panel and reseam or add a cap strip, as required by the Owner or designated representative.
 - .3 After reseaming, additional destructive field test(s) may be taken within the reseamed area at the discretion of the Owner or designated representative. The reseamed sample shall be found acceptable if test results are approved by the Owner or designated representative. If test results are not acceptable, this process shall be repeated until the reseamed length is judged satisfactory by the Owner or designated representative. The Contractor shall be responsible for all costs of action resulting from test failure.
- .6 Submission of Samples
 - .1 All destructive seam samples shall be turned over to the Owner or designated representative at the completion of geomembrane liner installation.
 - .2 Delivery of samples shall be well organized and to the satisfaction of the Owner or designated representative.

3.9 DEFECTS AND REPAIRS

- .1 All seams and non-seam area of the geomembrane shall be inspected by the Contractor and the Owner or designated representative for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The geomembrane surface shall be brushed, blown, or washed by the Contractor if the amount of dust or mud inhibits inspection. This inspection should be done immediately after placement of the liner panel and again at the completion of construction as a minimum.
- .2 Evaluation

.1 Each suspect location in seam and non-seam areas shall be non-destructively tested as appropriate in the presence of the Owner or designated representative. Each location that fails the non-destructive testing shall be marked, and repaired accordingly.

.3 Repair Procedures

.1 Defective seams shall be restarted/reseamed as described in these specifications.

.2 Small holes shall be repaired by extrusion cap welding. If the hole is larger than 6 mm, it shall be patched.

.3 If grinding of the surfaces are required, the grinding marks shall be oriented perpendicular to the seam direction and no marks shall extend beyond the extrudate after placement.

.4 Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded prior to patching.

.5 Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by patches.

.6 Surfaces of HDPE which are to be patched shall be abraded and cleaned no more than 15 minutes prior to the repair. No more than 10% of the thickness shall be removed.

.4 Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 150 mm beyond the edge of defects. All patches shall be of the same compound and thickness as the geomembrane specified. All patches shall have their top (or outside) edge beveled with an angle grinder either prior to or after patch is placed on the geomembrane. Patches shall be applied using approved methods only.

.5 Restart/Reseaming Procedures

.1 The extrusion welding process shall restart by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least 2 inches. Reseaming over an existing seam without regrinding shall not be permitted.

.6 Verification of Repairs

.1 Each repair shall be non-destructively tested, except when the Owner or designated representative requires a destructive seam sample obtained from a repaired seam. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and re-tested until passing test results are achieved.

.7 Recording of Results

.1 Daily documentation of all non-destructive and destructive testing shall be provided to the Owner or designated representative by the Contractor. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully re-tested.

3.10 FINISH

.1 Remove and dispose of all waste material

END OF SECTION

Part 1 General

1.1 NOT USED

- .1 Not Used.

Part 2 Products

2.1 STONE

- .1 Hard, dense, durable quarry stone, sub-angular, free from seams, cracks or other structural defects, to meet following size distribution for use intended:
 - .1 Hand placed rip-rap (Class M):
 - .1 Minimum size of individual stones 0.001 m^3 .
 - .2 Not less than 75% of total volume of stones with individual volume of 0.0025 m^3 or more.
 - .3 Supply rock spalls or cobbles to fill open joints.

2.2 GEOTEXTILE FILTER

- .1 Geotextile: non-woven, needle-punched, polypropylene fibre fabric, 271 grams/square metre.

Part 3 Execution

3.1 PLACING

- .1 Fine grade area to be rip-rapped to uniform, even surface. Fill depressions with suitable material and compact to provide firm bed.
- .2 Place geotextile on prepared surface in accordance with manufacturer's instructions and as indicated. Place rip-rap on geotextile so as to avoid puncturing geotextile. Do not drive vehicles directly on geotextile.
- .3 Place rip-rap to thickness and details as indicated.
- .4 Place stones in manner approved by Departmental Representative to secure surface and create a stable mass. Place larger stones at bottom of slopes.

- .5 Hand placing:
 - .1 Use larger stones for lower courses and as headers for subsequent courses.
 - .2 Stagger vertical joints and fill voids with rock spalls or cobbles.
 - .3 Finish surface even, free of large openings and neat in appearance.

3.2 INSTALLATION OF GEOTEXTILE

- .1 Place and cover geotextile material in accordance with manufacturer's recommendations.
- .2 Place geotextile material of the type as indicted on the drawings by unrolling onto graded surface in orientation, manner and locations indicated and retain in position with granular material.
- .3 Exposed edges (not including the overlap seams) of the geotextile shall be keyed into the ground.
- .4 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.
- .5 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.
- .6 Overlap each successive strip of geotextile 600 mm over previously laid strip.
- .7 Protect installed geotextile material from displacement, damage or deterioration before, during and after placement of material layers.
- .8 After installation, cover with overlying layer within 4h of placement.
- .9 Replace damaged or deteriorated geotextile to approval of Departmental Representative.

END OF SECTION