Indian and Northern Affairs Canada

Specifications for Resolution Island Cleanup Project
Tier II Landfill

Prepared for

Indian and Northern Affairs Canada

Prepared by

UMA Engineering Ltd.

17007 - 107 Avenue

Edmonton Alberta T5S 1G3

Telephone: 780-486-7000

Fax: 780-486-7070

and

EBA Engineering Consultants Ltd.

14940 - 123 Avenue

Edmonton Alberta T5V 1B4

Telephone: 780-451-2121

Fax: 780-454-5688

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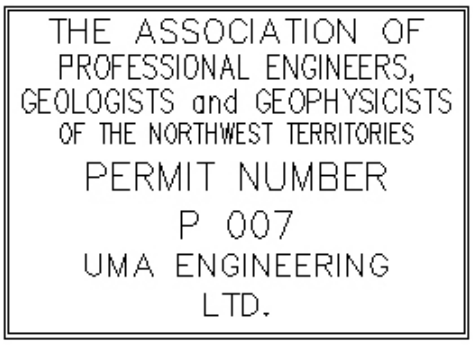

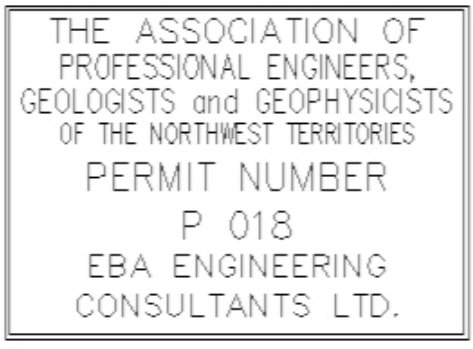

SPECIFICATIONS FOR
INDIAN AND NORTHERN AFFAIRS CANADA
RESOLUTION ISLAND CLEANUP PROJECT
TIER II LANDFILL

UMA Engineering Ltd. Consulting, Engineering, and Management Services	EBA Engineering Consultants Ltd.

Dated: June 5, 2003

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TIER II LANDFILL

LIST OF DRAWINGS

1.0 DESCRIPTION OF WORK

.1 Work under this contract covers the construction of a Tier II Landfill for the disposal of Tier II contaminated soil at the Resolution Island Pole Vault site, as indicated on the Drawings and Specifications.

.2 Specific cleanup work at the Resolution Site includes, but is not limited to, the following:

- .1 Mobilization and demobilization of all personnel, equipment, support facilities and materials required to complete the work.
- .2 Construction and Closure of a Tier II Landfill including:
  - .1 Excavation of fractured rock.
  - .2 Construction of exterior berms.
  - .3 Supply and installation of geomembranes and geotextiles as indicated on the Drawings.
  - .4 Placement and compaction of Tier II and Tier I contaminated soil in the landfill.
  - .5 Placement and compaction of additional granular fill within and over the landfill.
  - .6 Grading to promote drainage away from the landfill.
  - .7 Supply and installation of groundwater monitoring wells as indicated on the Drawings.
  - .8 Supply of ground temperature measurement ancillary materials. Installation of thermistor strings at locations as indicated on the Drawings. Thermistors strings to be provided by Queen's University.
- .3 Construction of test embankment (optional - to be confirmed by INAC) including:
  - .1 Placement and compaction of granular fill material.
  - .2 Supply of ground temperature measurement ancillary materials. Installation of thermistor strings at locations as indicated on the Drawings. Thermistors strings to be provided by Queen's University.
- .4 Drilling, blasting and processing for the production of Type 1 granular fill material.
- .5 Supply and hauling of granular fill material from borrow sources to the Tier II landfill area.
- .6 General site grading of work areas at the Resolution Island site, including:
  - .1 Areas disturbed during demolition of the Main PCB storage area, borrow extraction operations, and any other areas disturbed as part of this Work.
  - .2 Construction and reclamation of haul roads and borrow areas as required for construction.
- .7 Provision of survey information as required for setting out of work and Record Drawings purposes.
- .8 Installation of permanent survey control monuments in the work area as designated on the Drawings.

2.0 DOCUMENTS REQUIRED

.1 Maintain at job site, one copy of each of the following:

.1 Contract Drawings
.2 Specifications
.3 Addenda
.4 Change Orders
.5 Other modifications to Contract.
.6 Field test reports.
.7 Copy of approved work schedule.
.8 Standards listed in specific sections of the Specification including NIOSH, OSHA, WHMIS, TDGA, etc.
.9 Permits, licenses, and land use regulations.
.10 Labour and Materials Payment and Performance Bonds.
.11 Up to date Record Drawings.

3.0 SITE CONDITIONS

.1 Limited subsurface investigation was carried out.

.2 Geotechnical Reports are included in the Contract Package.

.3 The Geotechnical Reports are engineering reports giving properties of the soils and recommendations for design as prepared for use by INAC. The recommendations given in the reports are not to be construed as requirements of the Contract unless they are contained in sections of the Specifications or are specifically referenced therein.

.4 Information is supplied to assist in evaluating and carrying out the Contract requirements. However, INAC will use these reports as a guide as to what will be considered good construction practice.

.5 The Geotechnical Reports by their nature cannot reveal all conditions that exist or can occur on the site, and the Contractor is assumed to be knowledgeable of the limitations of testing procedures. Should subsurface conditions be found to vary substantially from the Geotechnical Reports, changes in the design will be made with the resulting credits or expenditures accruing to INAC.

.6 Geotechnical data is provided for information only is based on conditions at the time of investigation and at the test pit locations shown and may not be indicative of the entire site or the present conditions. INAC and INAC's Consultants and Consultants' employees disclaim any responsibility for the accuracy, true location and extent of geotechnical investigations that have been prepared by others. They further disclaim responsibility for interpretation of that data by bidders, such as in projecting rock profiles, soil stability and present level and extent of underground water, etc.

.7 The information presented on the Drawings and in the Specifications is based upon site conditions as reported during field investigation programs of 2002.

4.0 OWNER'S REPRESENTATIVES

.1 INAC: Within the context of these Specifications, the term INAC refers to the Owner, Indian and Northern Affairs Canada, or the Owner's authorized representative. Direct all primary communication to INAC.

5.0 WORK SCHEDULE

.1 Schedule to expeditiously complete all work by September 30, 2005. Maintain intermediate milestones as follows:

.1 Complete placement of 3½ of 4 landfill berms, approximately 13,000 cu.m. by September 30, 2003.
.2 Complete construction and instrumentation of test embankments: September 30, 2003. (Optional construction activity to be confirmed by INAC.)
.3 Complete placement of bottom and side slope geomembrane and 50% of Tier II contaminated soil by September 30, 2004.

.2 Develop and maintain a work schedule for the construction of the Tier II landfill. The schedule shall include work of sub-contractors, activity sequencing, procurement of materials, installation and testing.

.3 Keep INAC advised of planned work activities at least 24 hours in advance of operations.

6.0 CODES AND STANDARDS

.1 Perform work in accordance with the Specifications and meet or exceed all codes, standards and regulations applicable to the Work and issued under the authority of the Government of Canada and the Government of Nunavut. Advise INAC of any discrepancies in the codes, standards and regulations applicable to the Work.

.2 Codes, standards and regulations applicable to the work and which form part of the Contract have been referenced in various Sections of the Contract Specifications.

.3 Additional codes, standards and regulations applicable to the work, but which are not part of the Contract Documents, shall be considered by the Contractor. Non-reference of any such codes does not relieve the Contractor from his responsibility to comply with such codes, standards or regulations.

.4 In any case of conflict between the requirements specified in the codes, standards or regulations applicable to the work, the most stringent requirement shall apply.

7.0 PERMITS

.1 INAC shall be responsible for obtaining and paying for any permits and licenses associated with the work outlined in this contract.

.2 Pay all costs associated with complying with the requirements for the permits and licenses noted in Clauses 7.1 above.

.3 Register, obtain, and pay for all required licences and permits for individual trades people employed for work as referenced in the Contract Specifications.

.4 Register, obtain and pay for all required licenses and permits associated with blasting.

8.0 PROJECT MEETINGS

.1 Project meetings will be held at least once per week with INAC and INAC's support personnel during the construction season to review work progress, upcoming scheduled activities, and other project issues.

9.0 SITE SUPERVISION

.1 Designate a competent and qualified supervisor to be on site at all times during construction, to have full authority to make decisions for the Contractor, to be knowledgeable of the requirements of the contract, and to act upon INAC's instructions.

.2 The Contractor shall be thoroughly familiar with and knowledgeable about the scope of work and requirements of the Specifications.

10.0 SETTING OUT OF WORK

.1 Install permanent survey control monuments as indicated on the Drawings or where approved by INAC, in accordance with Section 02510 – Instrumentation of the Specifications.

.2 Employ certified and experienced survey personnel to provide all survey control required for the work.

.3 Provide INAC with additional survey information on the north end of the Tier II Landfill as indicated on the Drawings.

.4 Set grades and lay out work in detail from control points and grades given by INAC and shown on the Drawings.

.5 Notify INAC immediately of any discrepancies between existing ground elevations and design ground lines.

.6 Assume full responsibility for and execute complete layout of work to locations, lines and elevations indicated.

.7 Provide devices, instruments, and labour needed to lay out and construct work.

.8 Supply fluorescent orange paint, stakes, marker posts, flagging, and other survey markers required for laying out the work.

.9 Provide to INAC, on request, all survey information.

.10 Protect existing survey stakes, benchmarks and monuments. Re-establish benchmarks and monuments disturbed by the Contractor at no cost to INAC.

11.0 ADDITIONAL DRAWINGS

.1 INAC may furnish additional drawings to assist proper execution of work. These drawings will be issued for clarification only. Such drawings shall have the same meaning and intent as if they were included with plans referred to in Contract documents.

.2 Contractor will be responsible for printing and distributing Drawings and Specifications for his own requirements.

12.0 MATERIALS AND EQUIPMENT

.1 Provide material and equipment of specified design and quality, performing to published ratings, and for which replacement parts are readily available.

.2 No substitutions will be permitted without prior written approval of INAC.

13.0 INDEMNIFICATION

.1 Indemnify and save harmless INAC, INAC's Consultants and Consultants' employees against liability occasioned in any way through provision of the goods and services of the Contractor. Pay all royalties and fully indemnify INAC, INAC's Consultants and Consultants' employees against all suits or actions arising from the claim of any persons who are, or claim to be, patentees of any apparatus or process used on or in connection with the work.

14.0 WORK METHODOLOGY PLAN

.1 Submit five copies of a preliminary draft of the Work Methodology Plan to INAC for review 30 days prior to commencement of work.

.2 The Work Methodology Plan is to demonstrate how the Tier II landfill construction and associated activities will be carried out. **The Plan must include the names and qualifications of the drilling subcontractor, blasting sub-contractor and surveyors.**

.3 Specific information to be included in the Work Methodology Plan is identified in the relevant sections of the Specifications.

15.0 TESTING LABORATORY SERVICES

.1 INAC will appoint and pay for services of a testing laboratory required for the testing of granular materials including compaction testing.

.2 Contractor's Responsibilities

.1 Furnish labour and facilities to:
.1 Provide access to work to be inspected and tested.
.2 Facilitate inspections and tests.
.3 Make good work disturbed by inspection and test.
.4 Provide field laboratory as described below.
.5 Provide storage on site for laboratories exclusive use to store equipment.
.2 Notify Engineer a minimum of 72 hours in advance of operations to allow for assignment of personnel and scheduling of tests.

.3 Field Laboratory

.1 Supply a field laboratory, complete with furniture, for the use by INAC's staff.
.2 The building will have a minimum floor area of 50 square metres with heating and lighting system, a minimum of three 110 and 220 volt, 60 cycle electric outlets, laboratory area complete with sink, work benches, garbage cans, shelving and clothes rack, desk, one 0.75 m x 1.5 m table, 2 chairs, filing cabinet, and be suitable for the type of testing specified in the Contract documents.

.4 INAC's Responsibilities

.1 Provide the following granular material testing equipment.
.1 Dispatch LEB-76 Laboratory oven.
.2 One rack of sieves; Gilson 8" metric sieves, or equivalent. Sieve sizes: 0.080, 0.160, 0.425, 1.25, 2.5, 5.0 10.0, 25.0 50.0, 75.0, and 100.0 mm.
.3 One wash sieve.
.4 Pan and tares:
.5 - 2 each 13 x 9 x 2" Gilson SC163;
- 2 each 26 x 18 x 3.5 Gilson SC149;
- 2 each 9.3 x 5.3 x 2.7" Gilson SC153;
- 25 aluminum pie plates 8" minimum diameter (for use in oven);
- One sieve brush: Gilson TSA 170;
- One electronic scale: Melter PC 8000;
- One polyethylene tarp for sample splitting: 1.8 m x 1.8 m minimum size;
- One sieve shaker: Gilson SS8R;
- One pair of oven mitts.

16.0 PROJECT RECORD DOCUMENTS

.1 INAC will provide to the Contractor, two sets of white prints for Record Drawings purposes.

.2 Maintain Project Record Drawings and record accurately deviations from Contract documents on one set of prints.

.3 Record changes in red.

.4 Record the following information:

.1 Location and elevation (survey coordinates) of groundwater wells and thermistors.
.2 Liner elevation at the Tier II landfill.
.3 A minimum of five berm cross sections, or a cross section for every 20 metres of lineal extent, whichever is greater, of the Tier II landfill prior to placement of contaminated soil.
.4 Intermediate construction survey of the Tier II landfill prior to placement of Type 1 granular fill.
.5 Final construction survey of the Tier II landfill following placement of Type 1 granular fill.
.6 Survey coordinates and elevation of post-construction closure sampling locations as indicated by INAC.
.7 Field changes of dimension and detail.
.8 Changes made by Change Order or Field Order

.5 At completion of project and prior to final inspection, neatly transfer notations to second set and submit both sets to INAC. Information on completed areas should be forwarded at the end of the construction season.

.6 Reference survey coordinates and elevation to survey control points. In the event that monuments have been removed or destroyed, re-establish control monuments.

.7 At the completion of each season, submit to INAC all survey information.

END OF SECTION

1.0 GENERAL

1.1 Description

.1 This Section specifies requirements for the earthworks required for the construction of the Tier II landfill and embankment test sections, including the supply and placement of granular fill materials.

.1 the grading of designated areas including granular borrow areas, depressions created by the removal of contaminated soil, and general site areas requiring regrading and reshaping;
.2 the supply and placement of granular fill materials.

.2 Individual Drawings should be referred to for a description of the designated area(s), contours, elevations or cover soil thicknesses.

1.2 Definitions

.1 Reshaping: The levelling and grading, to a maximum depth of 600 mm, of designated areas to blend in with the natural terrain and provide positive drainage. Reshaping does not require the supply and placement of additional granular fill material. Excavation of the terrain to a depth greater than 600 mm during reshaping operations shall be considered as unclassified excavation.

.2 Scarifying: The disturbance or loosening of a soil to a minimum depth of 30 cm to allow for compaction or aeration.

.3 Regrading: The supply and placement of granular fill in designated areas to blend in with the natural terrain and provide positive drainage.

.4 Unclassified Excavation: Excavation of materials of whatever nature encountered in the work to a depth greater than 600 mm.

.5 Granular Fill: Type 1 (600 mm maximum size), Type 2 (150 mm maximum size), Type 3 (75 mm maximum size), and Type 4 (50 mm maximum size) material.

.6 Berm: Type 3 and Type 1 granular fill placed above the original ground up to the design elevation.

.7 Cover: Type 2 and Type 1 granular fill placed over the top liner of the Tier II landfill.

.8 Tier I Contaminated Soil: Used in cover and berm as Type 2 granular fill.

.9 Type 1: Granular fill used for thermal and erosion protection on the Tier II landfill.

.10 Surficial Boulders: visible rocks with a nominal diameter of 300 mm or greater.

.11 Fractured Rock. Rock material that can be removed by means of heavy-duty mechanical excavating equipment.

.12 Quarry. Designated area for blasting and production of Type 1 Granular fill.

.13 Waste Material: Excavated material unsuitable for use in work or surplus to requirements.

.14 Borrow Material: Material obtained from approved areas and required for regrading requirements.

.15 Specific classifications of granular materials are described in Clause 2.1 of this Section.

.16 Maximum Dry Density is determined by the Laboratory Compaction test carried out with standard compactive effort in accordance with ASTM D698. It is applicable if less than 30% of the material is retained on the ASTM 19 mm sieve.

.17 Corrected maximum dry density is applicable if more than 30% of the material is retained on the ASTM 19 mm sieve. It is defined as:

.1 $$D = \frac{D1 \times D2}{(F1)(D2) + (F2)(D1)}$$

.2 Where:

D = corrected maximum dry density kg/m³
F1 = fraction (decimal) of total field sample passing ASTM 19.0 mm sieve
F2 = fraction (decimal) of total field sample retained on ASTM 19.0 mm sieve (equal to 1.00 - F1)
D1 = maximum dry density, kg/m³ of material passing ASTM 19.0 mm sieve determined in accordance with Method C of ASTM D698 or latest edition thereof.
D2 = bulk density, kg/m³ of material retained on ASTM 19.0 mm sieve, equal to 1000 G where G is bulk specific gravity (dry basis) of material when tested to ASTM C127-84, or latest edition thereof.

1.3 Aggregates

.1 Source Approval

.1 Potential borrow areas are indicated on the Drawings.
.2 Source of materials to be incorporated into the work requires approval of INAC.
.3 The existing airstrip and apron at the Resolution Island site are not to be used as a borrow source.
.4 Inform INAC of proposed source of aggregates and provide access for sampling and samples at least seven days prior to commencing production.

.5 If, in the opinion of INAC, materials from the proposed source do not meet, or cannot be reasonably processed to meet specified requirements, locate an alternate source in conjunction with INAC, or demonstrate that material from source in question can be processed to meet specified requirements.
.6 Should a change of material source be proposed during work, advise INAC seven days in advance of proposed change to allow sampling and testing.
.7 Acceptance of a material at source does not preclude future rejection if it is subsequently shown to lack uniformity, or if it fails to conform to the requirements specified, or if its field performance is found to be unsatisfactory.
.8 Test pit information and the results of laboratory analyses of soil samples obtained from the site are included with the Geotechnical Report information included in the Appendix.

.2 Production Sampling

.1 Aggregate will be subject to continual sampling by INAC during production.
.2 Provide INAC with access to source and processed material for purpose of sampling and testing.

.3 Materials

.1 Aggregate quality: sound, hard, durable material free from soft, thin, elongated or laminated particles, organic material or other deleterious substances.
.2 Flat and elongated particles are those whose greatest dimension exceeds five times their least dimension.
.3 Fine aggregates satisfying requirements of applicable section shall be one or a blend of natural sand or manufactured sand.
.4 Coarse aggregates satisfying requirements of applicable section shall be crushed rock or gravel composed of naturally formed particles of stone.

.4 Development of Aggregate Source

.1 Prior to excavating materials for aggregate production, strip organic and surface materials. Stockpile or dispose of organic and unsuitable materials as directed by INAC.
.2 Strip an area ahead of excavating operation sufficient to prevent contamination of aggregate by deleterious materials.
.3 When excavation is complete, dress sides of excavation to achieve gentle slopes which fit local topography, and provide swales or ditches as required to prevent surface standing water.
.4 Trim off and dress slopes of waste material piles and leave site in neat condition.
.5 Trim, backblade and restore borrow areas to a condition acceptable to INAC.

.5 Development of Quarries

.1 Potential quarry sources require approval of INAC.
.2 Submit to INAC and all regulatory bodies having jurisdiction for approval, written proposal of operations for quarrying by blasting.
.3 Indicate proposed method of carrying out work, types and quantities of explosives to be used, loading charts, drill hole patterns, type of caps, blasting techniques, blast protection measures for items such as flying rock, vibration, dust and noise control in the Work Methodology Plan. Include details on protective measures, time of blasting and other pertinent details.
.4 Submit records to INAC at the end of each shift. Maintain complete and accurate record of drilling and blasting operations.
.5 Use excavation methods that minimize fracturing beyond excavation limits.
.6 Take care in locating drill holes, orienting the drills and while drilling so that accurate positioning and alignment of drill holes is achieved.
.7 Use controlled blasting techniques to satisfy excavation requirements stated herein and achieve the specified Type 1 gradation.
.8 Modify the initial explosive type and quantity, blasting sequence and delay pattern where required to achieve the requirements specified herein.
.9 If, in a specific area, a plan that was previously adopted does not produce conditions in accordance with the requirements stated herein, submit a revised blasting plan to INAC prior to continuing drilling and blasting in adjacent areas.
.10 Provide means to prevent any damage from fly rock where required.
.11 Submit complete details of any proposed blast to INAC twenty-four (24) hours prior to commencement of drilling for each blast. Include the following:
    .1 the location, depth and area of the blast.
    .2 the type, strength, quantity, column load and distribution of explosives to be used per hold, per day and per blast.
    .3 the sequence and pattern of the delay; and
    .4 the description and purpose of any special methods to be adopted.
.12 Remove any unsuitable materials and dispose of or mix with other materials as directed by INAC.

.6 Processing

.1 Process aggregate uniformly using methods that prevent contamination, segregation and degradation.
.2 Blend aggregate if required to obtain gradation requirements specified. Use approved methods and equipment.
.3 Blending to decrease percentage of flat and elongated particles is permitted.
.4 When operating in stratified deposits use excavation equipment and methods that will produce uniform, homogeneous aggregate.

.5 Dry aggregate, as required, to provide ease of handling during freezing temperatures.

.7 Handling

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

.8 Stockpiling

.1 If required, stockpile aggregates in locations indicated or designated by INAC.
.2 Stockpiling sites shall be level, well drained, and of adequate bearing capacity and stability to support stockpiled materials and handling equipment.
.3 Separate aggregate stockpiles far enough apart to prevent intermixing.
.4 Reject intermixed or contaminated materials. Remove and dispose of rejected materials as directed by INAC within 48 hours of rejection.
.5 Stockpile materials in uniform layers of a 1 m maximum thickness.
.6 Complete each layer over the entire stockpile area before beginning next layer.
.7 Uniformly spot-dump aggregates delivered to stockpile in trucks and build up stockpile as specified.
.8 Coning of piles or spilling of materials over edges of pile will not be permitted.
.9 Prevent ice and snow from becoming mixed into stockpile.
10. If stockpiles will remain over the winter, the height of the stockpile should be limited to that which can be stripped and thawed in the subsequent summer.

1.4 Site Conditions

.1 Suspend operations whenever climatic conditions are unsatisfactory for grading to conform with this Specification.

.2 Do not operate equipment in work areas until the material has dried sufficiently to prevent excessive rutting.

.3 Areas to be graded are to be free from debris and excessive snow, ice or standing water.

.4 Soft ground conditions may be prevalent at the site during periods of maximum thaw of the permafrost. Schedule and carry out work to minimize disturbance to permafrost soils.

1.5 Protection

.1 Prevent damage to benchmarks, existing buildings, surface or underground service or utility lines which are to remain. Immediately repair any damage to the above or replace the above in the event of damage.

.2 Protect all monitoring wells. Repair or replace any monitoring wells damaged by the operations.

.3 Protect archaeological sites from construction and construction traffic.

.4 Prevent damage to surroundings and injury to persons during blasting operations. Post guards, sound warnings, and display signs when blasting to take place.

1.6 Qualifications

.1 Retain licensed explosive expert to program and supervise blasting work, and to determine precautions, preparations and operations techniques.

1.7 Work Methodology Plan

.1 The Construction of the Tier II landfill Work Methodology Plan, as described in Section 01005 – Clause 14, is to address, but is not necessarily limited to:

.1 Method and equipment to be used for the transport, placement and compaction of the various types of granular fill material within the Landfill, including the method and equipment to be used to saturate the containment berms.
.2 Method and equipment to be used for the installation and protection of liner materials within the landfill.
.3 Methods and equipment to be used for the construction of the berms.
.4 Methods and equipment to be used for the removal of fractured rock at the landfill area.
.5 Methods and equipment to be used for quarrying Type 1 Granular Fill as outlined in Clause 1.3.5 of this Section.
.6 Method and equipment to be used for the placement of Tier II contaminated soil.
.7 Method and equipment to be used for the installation of monitoring wells and thermistors within the landfill, including a description of the type of materials to be used.
.8 Record keeping and reporting methods.
.9 Work schedule.
.10 Any other items that are pertinent to the work.

2.0 PRODUCTS

2.1 Granular Materials

.1 Fill materials require the approval of INAC.

.2 Fill materials shall be pit-run or screened stone, gravel or sand consisting of hard durable particles free from clay lumps, cementation, organic material, snow, ice and other deleterious materials. It is anticipated that there will be no requirement for crushing of granular materials to satisfy gradation specifications. There is a requirement to select, blend and/or screen granular materials to satisfy gradation specifications.

.3 Type 1 Granular fill: Type 1 granular fill is to be used for final cover on the Tier II Landfill.

.1 Type 1 Material shall have a maximum size of 600 mm and a minimum average rock size (D50) of 200 mm.
.2 Obtain Type 1 granular fill from blast area or from other sources approved by INAC, provided the final product meets the requirements stated herein.
.3 The parent rock from which all Type 1 materials are derived shall consist of sound, hard, durable material free from soft, thin, elongated or laminated particles and shall contain no deleterious substances.
.4 Specific quarrying and/or processing procedures may be required to achieve the specified maximum size.

.4 Type 2 Granular Fill:

.1 Type 2 Granular Fill is to be well-graded gravel, and is to be used for landfill berm and cover and regrading requirements.
.2 Gradations to be within the following limits when tested to ASTM C136 and ASTM C117, sieve sizes to CAN/CGSB-8.1:

Sieve Designation (mm)	% Passing by Weight
150	100
25	70 - 100
5	45 - 80
0.425	5 - 45
0.08	2 - 25

.5 Type 3 Granular Fill:

.1 Type 3 Granular Fill is to be a non-saline, well-graded sand with gravel used for the construction of the Tier II landfill containment system.
.2 Adjust the water content of Type 3 Granular fill to achieve a minimum degree of saturation of 90%.
.3 Maintain the water content after placement to ensure that the material does not dry out.

.4 The material shall have a porewater salinity of less than 5 ppt in accordance with ASTM D4542.

.5 Gradations to be within the following limits when tested to ASTM C136 and ASTM C117; sieve sizes to CAN/CGSB-8.1.

Sieve Designation (mm)	% Passing by Weight
75	100
12.5	75-100
5	70-95
2	60-90
0.425	30-70
0.08	10-40

.6 Type 4 Granular Fill

.1 Type 4 Granular Fill is to be a well graded sand with some gravel for use as embedment material for geomembranes.

.2 The material shall be composed of rounded particles. Crushed particles will not be allowed.

.3 Gradations to be within the following limits when tested to ASTM C136 and ASTM C117; sieve sizes to CAN/CGSB-8.1.

Sieve Designation (mm)	% Passing by Weight
50	100
12.5	80-100
5	65-100
2	50-70
0.425	20-45
0.08	5-20

.7 Materials classified as unsuitable will include:

.1 Non-uniform material of widely varying moisture density characteristics.

.2 Soils with moisture content exceeding optimum moisture by 5% or more.

.3 Soils containing organic material, snow, ice or other deleterious material.

2.2 Liner Materials

.1 Geotextile as per Section 02498 - Geotextiles

.2 Geomembrane as per Section 02499 - Geomembranes.

3.0 EXECUTION

3.1 Site Preparation

.1 Unless specifically indicated on the Drawings, do not remove existing topsoil or organic materials from embankment construction areas other than exposed surface boulders over 300 mm in diameter that are located in areas to receive granular fill. Dispose of boulders by placing on embankment side slopes.

.2 Remove fractured rock from Tier II construction area to the extent possible using heavy duty mechanical excavating equipment. Frozen material is not classified as rock. BLASTING is not permitted.

.3 Borrow Excavation:

.1 Obtain from potential borrow areas shown on Drawings, or provide from own sources, all required fill material.
.2 Advise INAC of selected borrow areas seven days in advance of excavation operations for appropriate testing to be performed.
.3 Notify INAC whenever unsuitable materials are encountered in borrow areas.
.4 Stripping, stockpiling and replacement or placement to a new location of organic material and stripping and disposal of waste material found when excavating existing granular fills to be as directed by INAC.
.5 Final grading of borrow area upon completion to be tidy, in a well drained condition, free of standing water to the satisfaction of INAC.
.6 Upon completion of final grading, leave all slopes in a stable condition and spread all stripped organics.
.7 Transport aggregate from borrow areas to the work areas via existing access routes where available. Maintain and provide for dust control on the access route between the borrow area and the work areas.

3.2 Placement and Compaction of Granular Fill Material

.1 Haul granular fill material from borrow sites to designated areas.

.2 Do not place granular fill on snow, surface ice or appreciable organics.

.3 Maintain natural drainage patterns, unless otherwise directed, and fill depressions to avoid any ponding of water adjacent to embankments.

.4 All fill material shall be placed in an unfrozen state. Fill material to be free from debris, snow and ice. Do not place granular fill if the outside air temperature is below 0°C, unless otherwise directed by INAC.

.5 Maintain a crowned surface during construction to ensure ready runoff of surface water. Do not place material in free standing water. Drain low areas, before placing material.

.6 Do not dump fill material over the side slopes of berms.

.7 Place and compact fill material in horizontal lifts.

.8 Cease construction at any sign of movement or bulging in the embankments to allow assessment by INAC.

.9 For fill depths greater than 500 mm, place granular material in lifts not exceeding 250 mm in loose thickness. For fill depths greater than 200 mm and less than 500 mm, place material in two lifts of equal depth. For fill depths less than 200 mm, place material in one lift.

.10 Compact Type 2 and Type 4 granular fill material to 95 percent of Maximum Dry Density in accordance with ASTM D698 or as determined from a Control Strip density. The method for determining the maximum dry density will be established by INAC.

.11 Compaction equipment must be capable of obtaining required densities uniformly in materials on project.

.12 Control strip density:

.1 A control strip is a lift of granular material placed over a minimum 300 m^2 area that requires regarding.
.2 To determine the Control Density, moisture and density readings will be taken by INAC during the compaction process until a maximum dry density is obtained.
.3 The density and moisture content of the Control Strip will be measured by INAC after each pass of the compaction equipment to determine the type of equipment and number of passes required to obtain the specified density.
.4 A new Control strip will be required, if, as established by INAC, the material type, moisture content, or subgrade of the area to be regarded is significantly different than that of the Control Strip.
.5 Proof-roll areas compacted in accordance with the Control Strip Density upon completion of grading and compaction or as requested by INAC.
.6 Use a fully loaded tandem axle truck for the proof-rolling operation. The speed of the vehicle is not to exceed 4 kilometres per hour during proof-rolling. INAC may authorized alternative proof-rolling equipment.
.7 Make sufficient passes with the proof-rolling equipment to subject every point on the surface to three separate passes of a loaded tire.
.8 Where proof-rolling reveals areas of defective granular fill, remove and recompact the granular fill, and modify the compaction process as required.
.9 The Control Strip Density method for compaction is not intended to relax the specified compaction requirements, but to reduce compaction testing requirements.

.13 Compact Type 3 Granular Fill Material to a minimum of 95% of Maximum Dry Density wet of optimum water content to achieve a minimum of 90 percent degree of saturation in accordance with ASTM D698. Moisture condition the granular fill prior to compaction to the required water content to achieve the specified degree of saturation. LIMIT THE LIFT THICKNESS TO A MAXIMUM OF 250 mm. Do not allow the Type 3 material to dry out after compaction. TYPE 3 MATERIAL MUST NOT BE LEFT EXPOSED FOR MORE THAN 1 DAY.

.14 If the Type 3 Granular Fill is left exposed for more than 1 day, or has dried out prematurely due to weather conditions, scarify the surface, adjust the moisture content and recompact at INAC's discretion.

.15 Compaction equipment must be capable of obtained required densities uniformly in materials on project. Hand equipment must be available for compaction in areas where large equipment cannot access and around instrumentation.

.16 Apply water as necessary during compaction of Type 2 and Type 4 fill to obtain specified density. If material is excessively moist, aerate by scarifying with suitable equipment until moisture content is corrected.

.17 Shape finished surface to required cross-section and grade, or as directed by INAC.

3.3 Tier II Landfill

.1 Lay out work in detail from survey control points.

.2 Construct perimeter berms of Type 3 and Type 1 granular fill to the dimensions shown on the Drawings in accordance with Clause 3.3 of this Section. Place and compact granular fill to build the exterior portion of the berm by constructing in horizontal layers.

.3 Liner Systems

.1 Where installation of a geomembrane/geotextile liner system is indicated on the Drawings, place base layer of Type 2 and/or Type 4 granular fill to the depths as indicated on the Drawings in accordance with Clause 3.3 of this Section, and compact to 95% of Maximum Dry Density (ASTM D698).

.2 Notify INAC when base layer preparations are complete. Do NOT begin installation of the geomembrane/geotextile liner system until INAC's approval has been obtained.

.3 Install geotextile/geomembrane liner as indicated on the Drawings and in accordance with Section 02498 – Geotextiles and 02499 – Geomembranes, of the Specifications.

.4 Place Type 4 granular fill over the liner system as indicated on the Drawings.

.5 The first lift of granular fill immediately over the liner system shall be 300 mm. Carry out granular fill placement using low ground pressure equipment as indicated in Clause 3.3.3.6 of this Section.

.6 Prevent damage to the liner during granular fill placement. The following are provided as guidelines for equipment traffic.

Backfill Thickness over Liner	Allowable Ground Pressures/Placement Equipment
No Backfill and no geotextile	Foot traffic or ATV only.
150 mm or less	Hand Placement (e.g, foot traffic or ATV only)
200 mm to 300 mm	28.7 kPa to 29.0 kPa (D3-D4 Cat Track Loaders – Low Ground Pressure)
Greater than 300 mm	29.0 kPa to 59.9 kPa (D4 to D6 Style Cat or Equivalent)
600 mm	72.8 kPa to 109 kPa (D7 to D9 Style CAT or Equivalent)
900 mm	Loaded Scrapers, Motor Graders
900 to 1200 mm	Loaded Tandem Axle Trucks

.7 Install thermistors at the locations indicated on the Drawings or as directed by INAC in accordance with Section 02510 – Instrumentation.

.8 Place Tier II contaminated soil in the landfill in lifts not exceeding 300 mm in loose thickness. Compact with a minimum of three passes of vibratory roller.

.9 Construct the final cover over the landfill to the specified thicknesses and grades including the installation of geomembrane lining systems as indicated on the Drawings and in accordance with Section 02498 – Geotextiles and Section 02499 – Geomembranes.

3.4 Placement of Type 1 Granular Fill (shot rock)

.1 Fine grade area to be covered with Type 1 Granular Fill to uniform, even surface. Fill depressions with suitable material and compact to provide firm bed.

.2 Place Type 1 on the Type 2 granular fill on designated areas to the designated thickness as shown on the Drawings.

.3 Compact with a minimum of three passes with a vibratory roller.

.4 Finish surface even, free of large openings and neat in appearance.

3.5 Construction of Test Embankments

.1 Place and compact Type 2 granular fill in accordance Clause 3.3 of this Section in the designated test embankment area to the lines and dimensions as indicated on the Drawings.

.2 Install thermistors at the locations within the test embankment in accordance with Section 02510 – Instrumentation.

.3 Place Type 1 granular fill in accordance with Clause 3.2 of this Section.

3.6 Maintenance

.1 Maintain finished surfaces in a condition in accordance with this Section until succeeding material is applied or until acceptance.

3.7 End of Construction Season

.1 Ensure all exposed liner is covered at the end of construction season with 300 mm minimum loose thickness of Type 4 granular fill.

.2 Remove all snow and ice at the start of the next construction season, taking care not to disturb liner system.

.3 Pump out standing water prior to compaction of Type 4 granular fill and any additional fill placement.

.4 Compact Type 4 granular fill to meet the requirements of this Section

END OF SECTION

1.0 GENERAL

1.1 Description

.1 This section specifies the requirements for the supply and installation of non-woven geotextiles in the Tier II landfill in conjunction with geomembrane liners, and in the test embankment.

1.2 Related Work

.1 Section 02209 - Grading.

.2 Section 02499 - Geomembranes.

1.3 References

.1 CAN/CGSB-4.2-M88, Textile Test Methods.

.2 CAN/CGSB-148.1-M85, Methods of Testing Geotextiles and Geomembranes.

.3 ASTM D4751-87, Test Method for Determining the Apparent Opening Size of a Geotextile.

.4 ASTM D4632 - Elongation at Failure.

.5 ASTM D3786 - Mullen Burst Strength.

.6 ASTM D4533 - Trapezoid Tear Strength.

.7 ASTM D3787 - Puncture Strength.

1.4 Manufacturer's Certification and Warranty

.1 Provide to INAC, prior to shipment of the material to site, a signed manufacturer's certification that the material to be shipped to the site has test values for each property listed in Table 02498-1 (at the end of this section) that meet or exceed the property values specified for that material.

.2 These certificates shall be signed by the Manufacturer's Product Manager or Quality Control Manager.

.3 Provide a written warranty from the geotextile manufacturer against defects or deficiencies in the quality of the geotextile material supplied.

2.0 PRODUCTS

2.1 Materials

.1 Non-Woven Geotextile: The geotextile shall be a non-woven fabric consisting only of continuous chain polymeric filaments or yarns of polyester, formed into a stable network by needlepunching. The fabric shall be inert to commonly encountered chemicals, hydrocarbons, mildew and rot resistant, resistant to ultraviolet light exposure, insect and rodent resistant, and conform to the properties in Table 02498-1 (at the end of this section). The minimum average roll value (weakest principal direction) for strength properties of any individual roll tested from the manufacturing lot or lots of a particular shipment shall be in excess of the minimum average roll value (weakest principal direction) stipulated herein.

.2 Seams: overlapped in accordance with manufacturer's recommendations.

.3 Type 4 Granular Fill as per Section 02209 – Grading.

2.2 Shipping, Handling and Storage

.1 Provide the geotextile in rolls wrapped with protective covering to protect the fabric from mud, dirt, dust, and debris. The fabric shall be free of defects or flaws which significantly affect its physical properties. Label each roll of fabric in the shipment with a number or symbol to identify that production run.

.2 During delivery and storage, protect geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris, rodents and water.

2.3 Conformance Testing

.1 Conformance testing of the geotextile is not required; verification of the manufacturing quality control documentation for the production run, as per Clause 1.4 of this Section, will be sufficient for determination of material conformance.

3.0 EXECUTION

3.1 Quality Assurance

.1 All materials, procedures, operations, and methods shall be in strict conformance with the Drawings and Specifications and shall be subjected to strict quality assurance monitoring as detailed herein. The installed systems shall conform to the Drawings and Specifications, except as otherwise authorized in writing by INAC.

3.2 Underlying Surface Preparation

.1 Ensure that the surface underlying the geotextile is graded smooth and is free from angular rocks, debris and protrusions. Remove all particles greater than 75 mm in diameter.

3.3 Deployment

.1 Do not begin installation of the geotextile until the base has been approved by INAC.

.2 Deploy the geotextile by unrolling onto the prepared surface in orientation, manner and locations indicated.

.3 Place geotextile material smooth and free of tension stress, folds, wrinkles and creases.

.4 Place geotextile material on sloping surfaces in one continuous length from toe of slope to upper extent of geotextile.

.5 Overlap each successive strip of geotextile a minimum of 600 mm over previously laid strip.

.6 Geotextile overlaps shall be heat tracked or glued to prevent lifting or separation of overlap.

.7 Protect installed geotextile material from displacement and damage until, during and after placement of additional material layers.

.8 Repair rips or tears with a patch to cover a minimum of 1 metre on each side of the rip or tear.

.9 Secure the geotextile by placing uniform lifts of granular material as shown on the Drawings, not exceeding 250 mm in loose thickness, and compact to 95 percent of Maximum Dry Density in accordance with ASTM D698. Compact backfill in such a manner as to not damage the geotextile/liner system.

3.4 Protection

.1 Do not permit passage of any vehicle directly on geotextile at any time.

TABLE 02498-1 TEST REQUIREMENTS: NON-WOVEN GEOTEXTILE	
Physical Properties	Minimum Average Roll Value (Weakest Principal Direction)
Thickness - Typical ASTM D5199 (mm)	3.0
Grab Tensile Strength ASTM D4632 (N)	1650
Elongation at Failure ASTM D4632 (%)	50
Trapezoid Tear Strength ASTM D4533 (N)	640
Apparent Opening Size ASTM D4751 (microns)	150
Puncture ASTM D4833 (N)	1060
Weight - Typical ASTM D5261 (g/m²)	540

END OF SECTION

1.0 GENERAL

1.1 Description

.1 This section specifies the requirements for the supply and installation of two sides textured and smooth Geomembrane Liner to be installed within the Tier II Landfill

1.2 Related Work

.1 Section 02209 - Grading.

.2 Section 02498 - Geotextiles.

1.3 References

.1 ASTM D4437-84 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.

.2 ASTM D2487, Classification of Soils for Engineering Purposes.

.3 CGSB 148.1, No. 112 (Draft), Air Pressure Test.

.4 National Sanitation Foundation Listing Services, Standard Number S4 - Flexible Membrane Liners (NSF-S4).

1.4 Definitions

.1 Embedment Material: Type 4 Material placed below (base layer) and above the geomembrane (cover layer), where indicated.

1.5 Manufacturer’s Certification and Warranty

.1 The geomembrane manufacturer shall have at least two years of continuous experience in the manufacture of Textured High Density Polyethylene (HDPE) geomembrane rolls and/or experience totalling 4,000,000 square metres of manufactured Textured HDPE geomembrane.

.2 Provide to INAC, prior to shipment of materials to the site, the following:

.1 Name of the manufacturer and information on the manufacturer’s factory size, equipment, personnel, number of shifts per day and capacity per shift.
.2 Manufacturer's quality control program and manual, or descriptive documentation.
.3 List of material properties and liner samples.

.4 A signed manufacturing certification that the materials to be shipped to the site have test values for each property listed in Table 02499-1 (at the end of this Section) that meet or exceed the property values specified for that material. These certificates shall be signed by the Product Manager or Quality Control Manager of the geomembrane manufacturer.

.5 Resume of the qualifications of the Installation Supervisor and Master Seamer to be assigned to the project.

.3 Provide a written 20 year warranty against defects or deficiencies in the quality of the liner material supplied.

1.6 Geomembrane Installer

.1 The geomembrane shall be installed by an approved Geomembrane Installer trained and licensed by the geomembrane manufacturer to install the manufacturer's geomembrane. Installation shall be performed under the constant direction of the Contractor's field Installation Supervisor who shall remain on site and be responsible, throughout the liner installation, for liner activities by the Installer. This Installation Supervisor shall have installed or supervised the installation and seaming of a minimum of 3,000,000 square metres of HDPE geomembrane. The Installation Supervisor shall remain on site until all Type 4 Cover Material has been placed over the entire geomembrane.

.2 Actual seaming shall be performed under the direction of a Master Seamer who has seamed a minimum of 3,000,000 square metres of HDPE geomembrane. The Master Seamer, who may also be the Installation Supervisor, shall be present whenever seaming is performed.

.3 Provide as part of the bid document the following information regarding the Geomembrane Installer:

.1 Brief historical background.
.2 Insurance coverage.
.3 Welding procedures.
.4 Information on equipment and personnel.

.4 Provide adequate proof of qualification of the Installation Supervisor, including a list of at least five completed facilities, totalling a minimum of 200,000 square metres for which the Supervisor has installed or supervised the installation of HDPE geomembrane. For each installation, the following information shall be provided:

.1 Name and purpose of facility, its location and date of installation.
.2 Name of Owner and Design Engineer.
.3 Thickness of geomembrane and surface area of the installed geomembrane.
.4 Type of seaming, patching and tacking equipment.

.5 Provide prior to liner installation:

.1 Proposed installation panel layout identifying seams and details. The drawings shall indicate roll number, sizes, and position of rolls and shall be subject to the approval of INAC.

.2 Any proposed variance or deviation from the specified guidelines. Submit changes in writing to INAC a minimum of seven working days prior to the scheduled start of geomembrane installation. Acceptance or rejection by INAC shall be provided prior to the start of installation activities.

1.7 Geomembrane Acceptance

.1 Retain ownership and responsibility for the geomembrane until acceptance by INAC.

.2 The geomembrane liner shall be accepted by INAC when all of the following conditions are met:

.1 Installation of the entire liner is finished.

.2 Verification of the adequacy of all field seams and repairs, including associated testing, is complete.

.3 Certification as described in this Section and including record drawings, is provided by the Contractor to INAC.

1.8 Workmanship Warranty

.1 The Contractor shall warranty the liner installation to be free of defects in materials and workmanship for a period of 2 years following the date of acceptance by INAC or INAC's representative.

.2 The Contractor shall agree to make, at his expense, any repairs or replacements made necessary by defects in materials or workmanship in the work that became evident within said warranty period.

.3 The Contractor shall make repairs and replacements promptly upon receipt of written order from INAC or its authorized representative. If the Contractor fails to make repairs and replacements promptly, INAC may do so and the Contractor shall be liable for the cost of such repairs and replacements.

2.0 PRODUCTS

2.1 Materials

2.1.1 Geomembrane Liner

.1 The physical properties of the HDPE geomembrane shall be in accordance with ASTM D1248 where applicable. Material properties specified in Table 02499-1 at the end of this Section shall govern.

.2 The HDPE geomembrane shall be formulated from resin incorporating a flexible modifier, and consisting of approximately 98% polyethylene, 2.0% carbon black, and trace amounts of antioxidants and heat stabilizers.

.3 The **base and side slope** geomembrane shall incorporate a co-extruded textured surface **on both sides** to increase the friction between the liner and the material on which it is placed.

.4 The geomembrane shall be designed for flexible geomembrane applications, resistant to UV radiation, and suitable for exposed conditions.

.5 The HDPE geomembrane shall be capable of being heat sealed or solvent welded for making field splices, seams and repairs.

2.1.2 Geotextiles

.1 Non-woven geotextiles as per Section 02498 - Geotextiles, Subsection 2.1.1.

2.2 Manufacturing Quality Control

.1 Provide certification from the geomembrane manufacturer prior to shipment to site that the geomembrane supplied for this project is in conformance with the Specification.

.2 Provide certification from the geomembrane manufacturer prior to shipment to site that sampling and testing of the material, in accordance with ASTM D1248 have been carried out. At minimum, the geomembrane manufacturer shall perform the applicable tests every 7,500 square metres to assure conformance with the values listed in Table 02499-1 at the end of this Section.

2.3 Shipping, Handling and Storage

.1 The shipping of geomembrane(s) shall conform to the requirements of the geomembrane manufacturer, but in any event shall be carried out in a manner which shall protect the material from damage in transit. Place a protective cover on each package to protect the material against damage during shipping, handling and storage.

.2 Move geomembrane(s) about the site in a manner that will not damage the material.

.3 Store geomembrane(s) on site in a secure location that will minimize the potential for damage due to the proximity of working equipment, bear incidences, etc. In some cases, geomembrane can be marshalled at various locations to minimize transit distances and delays during deployment.

3.0 EXECUTION

3.1 Quality Assurance

3.1.1 Contractor Construction Quality Control

.1 A visual inspection of the liner panels and joints shall be made as the installation progresses and again upon completion of the liner. Defective and questionable areas shall be clearly marked and repaired. All areas identified shall be repaired to the satisfaction of INAC.

.2 The Contractor shall further test all joints and repairs in the HDPE liner by vacuum testing or pressurized dual seams testing (for double hot wedge welds only). All testing shall be done in the presence of or with knowledge of INAC. All defective areas detected shall be repaired to the satisfaction of INAC.

.3 The Contractor shall perform a vacuum test on all extrusion welded seams and repairs, in the following manner:

.1 The area to be tested shall be cleaned of all dirt, debris, and other foreign matter and then a soap and water solution shall be applied.
.2 A gasket vacuum box (American Parts and Service Company, Alhambra, California, Series #A100 or approved equal) assembly consisting of a rigid housing, a clean transparent viewing window, and a vacuum gauge shall be immediately placed, in a manner to ensure a seal over the area of the liner to be tested.
.3 A vacuum of 3 to 6 psi shall be induced and held for a minimum of 5 seconds or long enough for the area to be thoroughly examined.
.4 Examine the geomembrane through the viewing window for the presence of soap bubbling; all areas where leaks are identified shall be marked and repaired.
.5 Any portion of an extrusion seam or repair that can not be vacuum tested must be pick tested.

.4 The Contractor shall perform pressurized testing of all double wedge weld seams, regardless of length, in the following manner:

.1 A needle with pressure gauge, or other approved pressure feed device equipped with a pressure gauge, shall then be inserted into the channel produced in the middle of the double wedge weld.
.2 The channel shall be pressurized to 45 psi to allow the seam to stretch and stabilize. The pressure shall then be dropped to 35 psi and sustained for five minutes.
.3 If the loss of pressure exceeds two (2) psi or does not stabilize, then the seam will either be repaired entirely or the faulty area will be located and marked for repair.
.4 If blockage is present, locate and test seam on both sides of blockage.
.5 Remove needle or other approved pressure feed device and seal all penetration holes by extrusion welding.

3.1.2 Destructive Testing

Qualification Welds:

.1 Conduct destructive tests in accordance with ASTM D4437-84 on qualification welds to verify that seaming conditions and equipment are satisfactory.

.2 Test seams at the beginning of each seaming period, if welding has ceased for a period of 2 hours or more for each seaming apparatus used that day when climatic conditions cause wide changes in geomembrane temperature (±5°C in 1 hour) or other conditions that could affect seam quality.

.3 Make all qualification welds at a location selected by INAC in the area of the seaming and in contact with the base material. The qualification welds shall be a minimum of 1 metre long with the seam centred lengthwise. Cut specimens from each opposite end of the test seam and test for shear and peel. If a test seam fails to meet field seam specifications, the seaming apparatus and/or seam shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive successful full test seams are achieved. A seam pass is achieved when the seam exhibits the following properties:

.1 Completed seams shall have a minimum strength in shear of at least 90% of the specified parent material tensile strength at yield when tested in accordance with ASTM D4437, or approved equal.

.2 Completed seams shall have a minimum strength in peal of at least 80% of the specified parent material tensile strength at yield, and break as a film tear bond or a minimum of 10% adhesion break when tested in accordance with ASTM D4437, or approved equal.

Field Seams:

.1 Destructive testing of field seams is not required. Verification of the integrity of field seams by destructive testing of test strips and the non-destructive testing of field seams will be sufficient for determination of conformance.

3.1.3 Recording of Results

.1 Provide daily documentation of all testing to INAC. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successively retested.

3.2 Defects and Repairs

.1 Inspect all seams and non-seam areas of the installed geomembrane for defects, holes, blisters, undispersed raw materials and any sign of contamination by foreign matter. Brush, blow, or wash the geomembrane surface, if required for inspection. INAC shall decide if cleaning of the geomembrane is needed to facilitate inspection. This inspection shall be done immediately after placement of the liner.

.2 Non-destructively test each suspect location in seam and non-seam areas, as appropriate, in the presence of INAC. Mark each location that fails the non-destructive testing, and repair accordingly.

.3 Make a vacuum box available on site in the event that non-destructive testing of non-seam areas is required.

.4 Adhere to the following procedures in completion of geomembrane repairs:

.1 Restart/reseam defective seams as described in these Specifications.
.2 Repair holes and/or tears 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.
.3 Repair blisters, large holes, undispersed raw materials, and contamination by foreign matter by patching.
.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. Patches shall be applied using approved methods only.
.5 Non-destructively test each repair, except when INAC 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 retested until passing test results are achieved.
.6 Carry out field patching operations at temperatures below +10°C by heat welding only.

3.3 Weather Conditions

.1 Do NOT proceed with seaming when ambient air temperature or adverse weather conditions jeopardize the integrity of the liner installation. The Installer shall demonstrate that acceptable seaming can be performed by completing trial welds acceptable to INAC. Geomembrane seaming shall not be done during any precipitation, in the presence of excessive moisture (e.g. fog, rain, dew) or in the presence of excessive winds.

3.4 Base Preparation

.1 Prepare 200 mm of Type 4 Granular Fill base layer by levelling and compacting the layer to 95% of Maximum Dry Density in accordance with ASTM D698. Do NOT begin installation of the geomembrane or geotextile until the base layer has been approved by INAC. Install geotextile in accordance with Section 02498 - Geotextiles.

3.5 Deployment

.1 Ensure that:

.1 No equipment or tools damage the geomembrane by handling, trafficking or other means.
.2 No personnel working on the geomembrane wear damaging shoes or engage in other activities that could damage the geomembrane.
.3 The method used to unroll the panels does not cause scratches or crimps in the geomembrane and does not damage the supporting soil or underlying geotextile.
.4 The method used to place the panels minimize wrinkles (especially differential wrinkles between adjacent panels).
.5 Slack for thermal contraction is well distributed, and in accordance with the manufacturer's recommendations.
.6 All defects are marked and documented for repairs. Defects are defined as any abnormalities that affect the physical properties of the geomembrane material. If greater than ten defects per 500 m^2 exist, then replace or repair damaged geomembrane areas at the discretion of INAC.
.7 Use sand bags or other appropriate measures to prevent movement of the geomembrane panels.

3.6 Field Seaming

.1 Perform field seaming only when weather conditions are favourable, or where seaming operations can be protected from unfavourable weather conditions.

.2 Make field seams between sheets of liner material using approved welding systems, equipment and techniques. Acceptable welding systems include extrusion fillet welding and hot wedge welding using a double wedge welder. All wedge welders shall be specifically designed for and be compatible with the liner material and recommended by the manufacturer. Only repairs and detail welds shall be extrusion welded.

.3 Clean the contact surfaces of the materials of dirt, dust, moisture, or other foreign materials.

.4 Lay the materials to be field seamed flat against one another. Align the materials with sufficient overlap, and bond in accordance with the manufacturer’s recommended procedures. Prior to seaming, match wrinkles to avoid fishmouths.

.5 Make seams so there are no loose edges.

.6 Where possible, orient seams on the slopes perpendicular to the toe of the slope; i.e. oriented down, not across the slope.

.7 Seams which parallel the toe of the slope shall have the top sheet overlap the bottom sheet.

.8 Cross and toe seams shall be staggered a minimum of one metre.

.9 An overlap line a minimum of 150 mm from the edge of the underlying sheet will be clearly identified on every fusion seam.

.10 The overlap shall be sufficient to leave a loose flap of geomembrane at least 25 mm wide adjacent to both sides of the seam.

3.7 Cover Material

.1 Install geotextile cover in accordance with Section 02498 - Geotextiles.

.2 A minimum of 200 mm of cover between low ground pressure equipment and the liner is required at all times. Refer to equipment restrictions in Clause 3.3.3.6, Section 02209.

.3 Avoid undue stress on the liner at all times. Push cover material up side slopes, not down.

.4 Remove all rocks, stones, roots, or other debris that could cause damage to the liner.

.5 Avoid sharp turns or quick stops with equipment that could pinch and tear the liner.

.6 Place material ahead of the leading edge of the fill in such a fashion as to prevent stressing the geomembrane. Do not slide cover material over the liner.

.7 Report any damage to INAC immediately and perform repairs without needless delay.

.8 Place and maintain cover in a uniform thickness, free of ruts and irregularities. Place Type 4 Cover in one single lift. Minimize traffic during placement.

.9 Do not work wet cover material that cannot support equipment.

TABLE 02499-1
HDPE GEOMEMBRANE MATERIAL TEST REQUIREMENTS

Physical Property	Test Method	Minimum Requirement 60 mil HDPE Textured Both Sides	Minimum Requirement 60 mil HDPE Smooth Both Sides
Thickness (Minimum)	ASTM D751/1593/5199	1.35 mm (54 mil)	1.35 mm (54 mil)
Tensile Strength - Stress at Break	ASTM D638 Modified Type IV Die	13 kN/m 75 ppi	40 kN/m 225 ppi
Tensile Strength - Stress at Yield	ASTM D638 Modified Type IV Die	22 kN/m 126 ppi	22 kN/m 126 ppi
Elongation at Break Tensile Strength - Strain at Break (50 mm gauge)	ASTM D638 Modified Type IV Die	100%	560%
Elongation at Yield Tensile Strength - Strength at Yield (33 mm gauge)	ASTM D638 Modified Type IV Die	12%	12%
Tear Resistance	ASTM D1004	187 N (42 lbs)	187 N (42 lbs)
Puncture Resistance	FTMS 101, Method 2065	356 N (80 lbs)	356 N (80 lbs)
Carbon Black Content	ASTM D1603	2%	2%
Notched Constant Load	ASTM D5897	200 hr.	200 hr.
Low Temperature	ASTM D746	<-60°C (<-76°F)	<-60°C (<-76°F)
Asperity Height (Average)	GRIGM 12	0.175 mm (7 mil)	
Coefficient of Friction (Peak and Residual) (Geomembrane and Non-Woven Geotextile)	ASTM 5321	18°	

END OF SECTION

1.0 GENERAL

1.1 Description

.1 This section specifies the requirements for the supply and installation of survey control points, monitoring wells, and permanent ground temperature cables with ground temperature measurement points including data loggers. These instruments are used to monitor groundwater in the area of the Tier II Landfill, and ground temperature within the Tier II landfill and test embankment. Ground temperature cables (thermistors) will be supplied by Queen's University.

.2 Complete the installation of the monitoring wells as indicated on the drawings prior to placement of Tier II contaminated soil within the landfill.

1.2 Related Work

.1 Section 02209 - Grading.

2.0 PRODUCTS

2.1 Drilling Equipment

.1 The drilling equipment shall be capable of accessing the required locations.

.2 The drilling equipment shall be capable of drilling 100 mm and 150 mm diameter holes.

.3 The drilling equipment shall be capable of penetrating frozen and unfrozen overburden soils including granular soils, ice rich soils, saturated soils and bedrock.

2.2 Monitoring Well Pipe

.1 38 mm (nominal diameter), Schedule 10 #304 stainless steel pipe with flush threads and 38 mm diameter watertight end cap (top and bottom).

.2 38 mm (nominal diameter), Schedule 10 #304 stainless steel screen, 1.0 metre maximum screen length per installation with flush threads both ends. Screen slot size to be 0.5 mm.

.3 All pipe and screen to remain in protective polyethylene wrapping until installation.

.4 Filter sock as cover over monitoring well screen.

2.3 Ground Temperature Cables Pipe

.1 50 mm (nominal diameter), Schedule 40 PVC, couplings and watertight end cap, as required to make the complete installation.

2.4 Survey Control Monuments

.1 25 mm (nominal diameter), steel pipe, threaded/welded as required to provide the lengths described in Clause 3.3 of this section.

.2 The steel pipe shall have a flange welded to the base. The flange size should be no less than the hole diameter less 50 mm.

.3 Grease to be an acceptable “food grade” product.

.4 As an alternative to the steel pipe, in areas where intact bedrock is exposed at surface, a “cross” chiselled into bedrock is acceptable.

2.5 Ground Temperature Cables

.1 Ground Temperature Thermistor Beads: YSI (44007) or approved equivalent, with a 0.2°C accuracy, and a nominal resistance of 5,000 ohms at 25°C.

.2 Cable: stranded copper conductors, 20 conductor and 24 gauge with a Kevlar jacket.

.3 Connectors: Cable to be supplied with an Amphenol connector comprising: a shell end (97-3057-1012-1); male insert (9720-29P); male shell (97-3106A-20); and a screw cap (9760-20P) with a chain attachment to the shell end. A set screw shall be drilled and tapped into the connector to prevent the connector from being unscrewed from the cable.

.4 Ground Temperature Cable Moulding: Heat injection polyurethane moulding, or an approved equivalent, to seal the ground temperature thermistor beads. The outside diameter of the moulding is to be compatible with installation in a 50 mm diameter PVC pipe as specified in Clause 2.3.1. The cable is to remain watertight under a water head of 100 m.

.5 Identification Tag: to be permanently installed, indicating the site name and the ground temperature cable serial number.

.6 Cable Fabrication: Cable length to be based on depth shown on Drawings. Additional cable fabrication details are as follows:

.1 Beads to be spaced on the cable within 10 mm of the indicated location.
.2 Wire the cables using the following wiring code (note that the number of beads varies as indicated on the Drawings). For cables with less than 16 beads, numbering shall begin with Bead 1 and Terminal A, common shall be on Terminal Letter M):

Ground Temperature Thermistor Bead Number	Terminal Letter on Connector
1 (top of cable)	A
2	B
3	C
4	D
5	E
6	F
7	G
8	H
9	J
10	K
11	L
12	N
13	P
14	R
15	S
16 (bottom of cable)	T
Common	M

.3 Mark the identification and serial number of each cable permanently onto the body of the connector.

.4 Provide all beads with a common lead. Solder the beads to the common lead and to the cable harness.

.5 Prepare the cable harness by removing a 25 to 35 mm length of cable jacket (jacket cutouts) at each bead location, and extracting the appropriate wire for the bead location and the common wire for the cable.

.6 Solder the beads to both wires with some slack incorporated into the wiring and placed on the outside of the cable bundle. During soldering, protect the beads to keep their temperature below the manufacturer's recommended limit.

.7 Cover the beads with a layer of heat reflective tape with the adhesive side of the tape not in contact with the bead. Place a second layer of heat reflective tape with the adhesive side down, on either side of the jacket cutout.

.8 Cover each bead with injection moulding extending a minimum of 40 mm above and below the bead location.

.7 Ground Temperature Cable Calibration:

.1 Provide copies of calibration data to INAC prior to delivery to site.

.2 Verify that each ground temperature cable is functioning properly, and calibrate the ground temperature thermistor beads.

.3 Immerse into an ice bath, each section of the cable with a ground temperature thermistor bead. Once thermal equilibrium is reached, record the resistance reading using a digital multimeter and the temperatures recorded on the cables associated data logger. Compare readings with temperature of the ice bath determined with a precision thermometer accurate to ± 0.01 °C.

.4 Repeat the process a minimum of three times, and determine the average 0°C connection for each bead.

2.6 Switch Box and Multimeter

.1 Switchbox: A metal or plastic box to house a rotary switch; a 17 pin Amphenol female connector to couple the switchbox to the installed ground temperature cable; and a 2 pin, 0.6 m long cable with a strain relief connector for connection to a digital multimeter. The rotary switch is to be a 75 mm diameter Omega rotary selector switch with 16 settings and a standard round grip, or approved equivalent.

.2 Multimeter: A Fluke digital multimeter, or approved equivalent, with two decimal place display at 30 kilo ohms, an accuracy of +0.5%, and a resolution of 0.01 kilo ohms.

2.7 Data Loggers

.1 Lakewood Systems Ltd. R-X-16 Data Storage Unit, or approved equivalent. Provide one data logger for each ground temperature cable installation.

.2 Data logger to include:

.1 16 channel terminal board and multiplexer.
.2 Resistor RMIOKSIP (2 per data logger required).
.3 Lithium Battery Model UL-16.
.4 19 mm diameter, 2.5 m long grounding rod; strap between rod and weatherproof housing.
.5 Nema 4 Aluminum Enclosure.
.6 UL-MX 64K Memory Expansion.

.3 Provide one Com Cable Model No. UCC-7 for the site.

.4 The data logger shall have a female Amphenol multi-pin connector compatible with the ground temperature thermistor cable described in Clause 2.4 of this Section.

.5 Program data loggers to read cables once every 12 hours. Provide Windows based Dateview Plus software on site to monitor, retrieve data and reset the data loggers.

.6 Provide to INAC, three copies of the Operations and Maintenance Manuals for the data loggers.

.7 Clearly label each data logger with an identification number.

.8 Install each data logger together with the corresponding calibrated thermistor cable.

.9 Provide “project files” for supplied hardware.

2.8 Ground Temperature Cable Protective Casing

.1 Provide a 1.8 m long, 200 mm diameter data housing unit coated with electrostatic paint and with a locking cap. Lakewood Model RDH, or approved equivalent.

2.9 Monitoring Well Protective Casing

.1 150 mm diameter galvanized, Schedule 40 steel pipe, threaded as required.

.2 Threaded, locking steel cap for monitoring wells only.

.3 Keyed padlock, with same key for all monitoring wells and ground temperature thermistors.

.4 Provide a minimum of six (6) keys to INAC upon completion of installation.

2.10 Filter Sand

.1 Inert and organic free #20 - #40 Silica Sand.

2.11 Bentonite Seal

.1 Bentonite product certified as polymer and organic free; granular form or approved equivalent.

2.12 Grout

.1 Sika Grout Arctic 100 or approved equivalent.

2.13 Paint

.1 Fluorescent orange.

3.0 EXECUTION

3.1 Installation of Monitoring Wells

.1 Advise INAC a minimum of 10 days in advance of drilling program to allow scheduling of inspection services by INAC. INAC or designated representative will be in attendance for the duration of the drilling program.

.2 Layout monitoring wells at locations as indicated on the drawings and confirm the location with INAC.

.3 Install monitoring wells at the locations and to the depths as indicated on the Drawings or as directed by INAC.

.4 Use a suitable drill rig to drill 150 mm diameter holes for the monitoring wells.

.5 Make available on site, temporary hole casing material. Install hole casing material in the drill hole as required to prevent sloughing of the hole.

.6 Grout the pipe in place at the depth indicated on the Drawings using Sika Grout Arctic 100 or an approved equivalent according to manufacturer's recommendations. Place grout in the hole so as not to contaminate the upper portion of the hole, or the slotted section of the pipe.

.7 Record the depth of the top of the grout.

.8 Backfill remainder of the hole with clean filter sand to a depth of 200 mm above the screened portion of the pipe. Gradually remove hole casing material during backfilling operations.

.9 Place granular bentonite around the pipe and between the pipe and the drill hole to fill the annulus from ground surface to a depth of 300 mm. Mound ground surface material to a height of approximately 150 mm around the perimeter of the well to promote hydration of the bentonite pellets.

.10 Measure stick up of pipe from ground surface.

.11 Place the protective casing and lockable cap over the pipe.

.12 Paint metal casing, cap and marker posts with fluorescent orange paint.

.13 Final locations of the monitoring wells to be determined in the field by INAC.

3.2 Installation of Vertical Ground Temperature Cables

.1 Install ground temperature cables at the locations and to the depths indicated on the Drawings or as directed by INAC.

.2 Take precautions not to damage liner materials when installing ground temperature cables.

.3 If excavation is used to install vertical ground temperature cables, use a suitable excavator and compact granular backfill material to 95% of Maximum Dry Density in accordance with ASTM D698. Use hand compaction equipment to ensure satisfactory compaction.

.4 If drilling is to be used to install ground temperature cables, make available on site, hole casing material. Install hole casing material in the drill hole as required to prevent sloughing of the hole.

.5 Grout the pipe in place according to grout manufacturer’s recommendations.

.6 Place the data housing and lockable cap over the pipe.

.7 Paint caps with fluorescent orange paint.

.8 Install the data logger in the data housing so that it can be easily removed and replaced.

.9 Install grounding rod 2.5 m below ground surface, and connect grounding rod to data logger and data housing. Install the grounding rod connector wire within the data housing.

.10 Final locations of the vertical ground temperature cables are to be determined in the field by INAC.

.11 The Engineer will complete the ground temperature cables installation report. Advise INAC of the installation at 96 hours prior to commencement.

.12 INAC will confirm data logger and ground temperature cable operation by downloading data after 100 hours of operation and by taking manual ground temperature thermistor readings using the switch box and multimeter. The Contractor will be responsible for all repairs if there is a malfunction.

.13 Provide ground temperature thermistor beads at 0.5 m maximum spacing including one at the bottom of the installation and one within 0.5 m from the ground surface.

3.3 Installation of Permanent Survey Control Monuments

.1 Install permanent survey control monuments at locations as indicated on the Drawings, or as directed by INAC, to a minimum of 5 metre depth.

.2 If intact bedrock is encountered, the minimum depth may be reduced, at the Engineer's discretion, to maintain a 2 m embedment.

.3 In areas where intact bedrock is encountered at surface, a “cross” chiselled into bedrock is an acceptable alternative.

.1 The cross shall have minimum dimensions of 200 mm x 200 mm x 20 mm depth.

.4 Use a suitable drill rig to drill holes for the pipe which serves as permanent survey control.

.5 Make available on-site, hole casing material. Install hole casing material in the drill hole, as required, to prevent sloughing.

.6 Apply grease to the 25 mm steel pipe, as indicated on the Drawings, before installation.

.7 Grout the control monument in the hole for the lower 2 metres ONLY. Use Sika Grout Arctic 100 or an approved equivalent according to manufacturer’s recommendations. Fill the remaining voids with sand.

.8 The control monument shall be flush with ground surface following completion. Ensure positive drainage away from the survey control monument.

.9 Following set-up of the grout, tie-in survey control monuments to the site survey coordinate system. Survey horizontal accuracy to be 1 part in 25,000 and vertical accuracy to be less than 10 mm. MARK WITH A DRILL HOLE OR PUNCH THE TOP OF THE 25 mm STEEL PIPE. Provide coordinates and elevation data at this mark to INAC for each monument installed.

.10 Construct clearly visible markers around the survey control monuments, to prevent damage and to facilitate identification.

.11 Final locations of the survey control monuments to be determined in the field by INAC.

3.4 Protection of Ground Temperature Cables and Monitoring Wells

.1 Construct clearly visible barricades to protect the installed ground temperature cables and monitoring wells. Immediately replace, at Contractor's cost, any existing and installed monitoring wells and ground temperature cables damaged by the Contractor.

.2 Provide access to any monitoring well and ground temperature cable, and cooperate with INAC when INAC is obtaining groundwater samples and recording ground temperature.

END OF SECTION