AGNICO-EAGLE MINES LTD
MEADOWBANK DIVISION

EXPANSION OF FUEL STORAGE FACILITIES

BAKER LAKE, NUNAVUT

TECHNICAL SPECS DOCUMENT

CONSULTANT REF.: VD2259-3

DATE: NOVEMBER 30, 2009

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Prepared and approved by :

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AEM Construction Department
Civil & Environment Projects

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PART 1 - GENERAL

1.1 ADMINISTRATIVE

.1 Submit to Engineer submittals listed for review. Submit promptly and in orderly sequence to not cause delay in Work. Failure to submit in ample time is not considered sufficient reason for extension of Contract Time and no claim for extension by reason of such default will be allowed.

.2 Do not proceed with Work affected by submittal until review is complete.

.3 Present shop drawings, product data, samples and mock-ups in SI Metric units.

.4 Where items or information is not produced in SI Metric units converted values are acceptable.

.5 Review submittals prior to submission to Engineer. This review represents that necessary requirements have been determined and verified, or will be, and that each submittal has been checked and coordinated with requirements of Work and Contract Documents. Submittals not stamped, signed, dated and identified as to specific project will be returned without being examined and considered rejected.

.6 Notify Engineer, in writing at time of submission, identifying deviations from requirements of Contract Documents stating reasons for deviations.

.7 Verify field measurements and affected adjacent Work are coordinated.

.8 Contractor's responsibility for errors and omissions in submission is not relieved by Engineer's review of submittals.

.9 Contractor's responsibility for deviations in submission from requirements of Contract Documents is not relieved Engineer review.

.10 Keep one reviewed copy of each submission on site.

1.2 SHOP DRAWINGS AND PRODUCT DATA

.1 Refer to CCDC 2 GC 3.

.2 The term "shop drawings" means drawings, diagrams, illustrations, schedules, performance charts, brochures and other data which are to be provided by Contractor to illustrate details of a portion of Work.

.3 Submit shop drawings bearing stamp and signature of qualified professional engineer licensed in Territory of Nunavut, Canada.

.4 Indicate materials, methods of construction and attachment or anchorage, erection diagrams, connections, explanatory notes and other information necessary for completion of Work. Where articles or equipment attach or connect to other articles or equipment, indicate that such items have been coordinated, regardless of Section under which adjacent items will be supplied and installed. Indicate cross references to design drawings and specifications.

.5 Allow 5 days for Engineer's review of each submission.

.6 Adjustments made on shop drawings by Engineer are not intended to change Contract Price. If adjustments affect value of Work, state such in writing to Engineer prior to proceeding with Work.

.7 Make changes in shop drawings as Engineer may require, consistent with Contract Documents. When resubmitting, notify Engineer in writing of revisions other than those requested.

.8 Accompany submissions with transmittal letter, containing:
- .1 Date.
- .2 Project title and number.
- .3 Contractor's name and address.
- .4 Identification and quantity of each shop drawing, product data and sample.
- .5 Other pertinent data.

.9 Submissions include:
- .1 Date and revision dates.
- .2 Project title and number.
- .3 Name and address of:
  - .1 Subcontractor.
  - .2 Supplier.
  - .3 Manufacturer.
- .4 Contractor's stamp, signed by Contractor's authorized representative certifying approval of submissions, verification of field measurements and compliance with Contract Documents.
- .5 Details of appropriate portions of Work as applicable:
  - .1 Fabrication.
  - .2 Layout, showing dimensions, including identified field dimensions, and clearances.
  - .3 Setting or erection details.
  - .4 Capacities.
  - .5 Performance characteristics.
  - .6 Standards.
  - .7 Operating weight.
  - .8 Wiring diagrams.
  - .9 Single line and schematic diagrams.
  - .10 Relationship to adjacent work.

.10 After Engineer's review, distribute copies.

.11 Submit electronic copy of shop drawings for each requirement requested in specification Sections and as Engineer may reasonably request.

.12 Submit electronic copies of product data sheets or brochures for requirements requested in specification Sections and as requested by Engineer where shop drawings will not be prepared due to standardized manufacture of product.

.13 Submit electronic copies of test reports for requirements requested in specification Sections and as requested by Engineer.

.1 Report signed by authorized official of testing laboratory that material, product or system identical to material, product or system to be provided has been tested in accord with specified requirements.

.2 Testing must have been within 3 years of date of contract award for project.

.14 Submit electronic copies of certificates for requirements requested in specification Sections and as requested by Engineer.

.1 Statements printed on manufacturer's letterhead and signed by responsible officials of manufacturer of product, system or material attesting that product, system or material meets specification requirements.

.2 Certificates must be dated after award of project contract complete with project name.

.15 Submit electronic copies of manufacturers instructions for requirements requested in specification Sections and as requested by Engineer.

.1 Pre-printed material describing installation of product, system or material, including special notices and Material Safety Data Sheets concerning impedances, hazards and safety precautions.

.16 Submit electronic copies of Manufacturer's Field Reports for requirements requested in specification Sections and as requested by Engineer.

.1 Documentation of the testing and verification actions taken by manufacturer's representative to confirm compliance with manufacturer's standards or instructions.

.17 Submit electronic copies of Operation and Maintenance Data for requirements requested in specification Sections and as requested by Engineer.

.18 Delete information not applicable to project.

.19 Supplement standard information to provide details applicable to project.

.20 If upon review by Engineer, no errors or omissions are discovered or if only minor corrections are made, copies will be returned and fabrication and installation of Work may proceed. If shop drawings are rejected, noted copy will be returned and resubmission of corrected shop drawings, through same procedure indicated above, must be performed before fabrication and installation of Work may proceed.

.21 The review of shop drawings by AGNICO-EAGLES MINES LTD (AEM) is for sole purpose of ascertaining conformance with general concept.

.1 This review shall not mean that AEM approves detail design inherent in shop drawings, responsibility for which shall remain with Contractor submitting same, and such review shall not relieve Contractor of responsibility for errors or omissions in shop drawings or of responsibility for meeting requirements of construction and Contract Documents.

.2 Without restricting generality of foregoing, Contractor is responsible for dimensions to be confirmed and correlated at job site, for information that pertains solely to fabrication processes or to techniques of construction and installation and for co-ordination of Work of sub-trades.

1.3 PROGRESS PHOTOGRAPHS

.1 Submit progress photographs in accordance with reasonable practices.

1.4 CERTIFICATES AND TRANSCRIPTS

.1 Immediately after award of Contract, submit Workers' Compensation Board status.

.2 Submit transcription of insurance immediately after award of Contract.

PART 2 – PRODUCTS

2.1 NOT USED

.1 Not Used.

PART 3 - EXECUTION

3.1 NOT USED

.1 Not Used.

PART 1 - GENERAL

1.1 DEFINITIONS

.1 Environmental Pollution and Damage: presence of chemical, physical, biological elements or agents which adversely affect human health and welfare; unfavourably alter ecological balances of importance to human life; affect other species of importance to humankind; or degrade environment aesthetically, culturally and/or historically.

.2 Environmental Protection: prevention/control of pollution and habitat or environment disruption during construction. Control of environmental pollution and damage requires consideration of land, water, and air; biological and cultural resources; and includes management of visual aesthetics; noise; solid, chemical, gaseous, and liquid waste; radiant energy and radioactive material as well as other pollutants.

1.2 SUBMITTALS

.1 Prior to commencing construction activities or delivery of materials to site, submit Environmental Protection Plan for review and approval by Engineer. The Environmental Protection Plan is to present comprehensive overview of known or potential environmental issues which must be addressed during construction.

.2 Address topics at level of detail commensurate with environmental issue and required construction tasks.

.3 Environmental protection plan: include:

- .1 Names of persons responsible for ensuring adherence to Environmental Protection Plan.
- .2 Names and qualifications of persons responsible for manifesting hazardous waste to be removed from site.
- .3 Names and qualifications of persons responsible for training site personnel.
- .4 Descriptions of environmental protection personnel training program.
- .5 Erosion and sediment control plan which identifies type and location of erosion and sediment controls to be provided including monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.
- .6 Drawings showing locations of proposed temporary excavations or embankments for haul roads, stream crossings, material storage areas, structures, sanitary facilities, and stockpiles of excess or spoil materials including methods to control runoff and to contain materials on site.

.7 Traffic control plans including measures to reduce erosion of temporary roadbeds by construction traffic, especially during wet weather. Plans include measures to minimize amount of mud transported onto paved public roads by vehicles or runoff.

.8 Work area plan showing proposed activity in each portion of area and identifying areas of limited use or non-use. Plan to include measures for marking limits of use areas including methods for protection of features to be preserved within authorized work areas.

.9 Spill Control Plan: including procedures, instructions, and reports to be used in event of unforeseen spill of regulated substance.

.10 Non-Hazardous solid waste disposal plan identifying methods and locations for solid waste disposal including clearing debris.

.11 Air pollution control plan detailing provisions to assure that dust, debris, materials, and trash, do not become air borne and travel off project site.

.12 Contaminant prevention plan that: identifies potentially hazardous substances to be used on job site; identifies intended actions to prevent introduction of such materials into air, water, or ground; and details provisions for compliance with Federal, Provincial, and Municipal laws and regulations for storage and handling of these materials.

.13 Waste water management plan that identifies methods and procedures for management and/or discharge of waste waters which are directly derived from construction activities, such as concrete curing water, clean-up water, dewatering of ground water, disinfection water, hydrostatic test water, and water used in flushing of lines.

.14 Historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands.

.15 Pesticide treatment plan: to be included and updated, as required.

1.3 FIRES

.1 Fires and burning of rubbish on site is not permitted.

1.4 DISPOSAL OF WASTES

.1 Do not bury rubbish and waste materials on the worksite.

.2 Do not dispose of waste or volatile materials, such as mineral spirits, oil or paint thinner into waterways, storm or sanitary sewers.

1.5 DRAINAGE

.1 Provide erosion and sediment control plan that identifies type and location of erosion and sediment controls to be provided. Plan: include monitoring and reporting requirements to assure that control measures are in compliance with erosion and sediment control plan, Federal, Provincial, and Municipal laws and regulations.

.2 Storm Water Pollution Prevention Plan (SWPPP) to be substituted for erosion and sedimentations control plan.

.3 Provide temporary drainage and pumping as necessary to keep excavations and site free from water.

.4 Do not pump water containing suspended materials into waterways, sewer or drainage systems.

.5 Control disposal or runoff of water containing suspended materials or other harmful substances in accordance with local authority requirements.

1.6 POLLUTION CONTROL

.1 Maintain temporary erosion and pollution control features installed under this contract.

.2 Control emissions from equipment and plant to local authorities' emission requirements.

.3 Prevent sandblasting and other extraneous materials from contaminating air and waterways beyond application area, by providing temporary enclosures.

.4 Cover or wet down dry materials and rubbish to prevent blowing dust and debris. Provide dust control for temporary roads.

1.7 HISTORICAL / ARCHAEOLOGICAL CONTROL

.1 Provide historical, archaeological, cultural resources biological resources and wetlands plan that defines procedures for identifying and protecting historical, archaeological, cultural resources, biological resources and wetlands known to be on project site: and/or identifies procedures to be followed if historical archaeological, cultural resources, biological resources and wetlands not previously known to be onsite or in area are discovered during construction.

.2 Plan: include methods to assure protection of known or discovered resources and identify lines of communication between Contractor personnel and Consultant.

1.8 NOTIFICATION

.1 Engineer will notify Contractor in writing of observed noncompliance with Federal, Provincial or Municipal environmental laws or regulations, permits, and other elements of Contractor's Environmental Protection plan.

.2 Contractor: after receipt of such notice, inform Engineer of proposed corrective action and take such action for approval by Consultant.

.3 Engineer will issue stop order of work until satisfactory corrective action has been taken.

.4 No time extensions granted or adjustments allowed to Contractor for such suspensions.

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 33 56 13 - Fuel storage tanks

.3 Section D 20 50 - Fuel-oil piping

1.2 REFERENCES

.1 Canadian Gas Association (CGA)
  .1 CGA Recommended Practice OCC-1-96, for the control of external corrosion on buried or submerged metallic piping systems.

.2 Canadian Standards Association (CSA)
  .1 CSA C22.3 No.4-1974 (R1999) Control of Electrochemical Corrosion of Underground Metallic Structures.

.3 National Association of Corrosion Engineers (NACE)

1.3 TIMEFRAME FOR IMPLEMENTATION OF CATHODIC PROTECTION

.1 Existing and future field-erected aboveground fuel tanks and pipelines may have sufficient corrosion protection due to the application of a coating, and site-specific conditions.

.2 The corrosion allowance that is factored in steel plate thickness for walls of fuel tanks, which was calculated according to API Standard 650, is itself part of the corrosion program.

.3 Owner will retain the services of a *corrosion expert* within three (3) years of the commissioning of this fuel storage system, for the purpose of determining the necessity and suitability of implementation of cathodic protection into the corrosion protection program.

1.4 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate location of anodes, test positions, connecting cables, wire splicing details, installation procedures, power supply, hardware and accessories.

1.5 WARRANTY

.1 Contractor hereby warrants that the cathodic protection will be effective in accordance with General Conditions, but for five years from the installation date.

PART 2 – PRODUCTS

2.1 EQUIPMENT

.1 Provide complete cathodic protection system as indicated by Owner, comprising galvanic or sacrificial anodes having a minimum design life, of 10 years: to CSA 22.3 No.4.

.2 Proceed to implementation of any recommendations made by the *corrosion expert* in the inspection report submitted to the Owner, and revise the technical requirements stipulated herein accordingly.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Install system including bonding of system to structure, in accordance with NACE standards.

.2 Locate test stations in weatherproof housings, as indicated by Owner.

.3 Make joints and connections by means of thermit welding. Bond pipelines to structure.

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 32 11 23 - Aggregate Base Courses.

1.2 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
  .1 ASTM D 698-00ae1, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort 600kN-m/m³.

.2 Canadian Standards Association (CSA International)
  .1 CSA-A23.1/A23.2-[04], Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
  .2 CAN/CSA-A3000-[03], Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
  .1 CSA-A3001-[03], Cementitious Materials for Use in Concrete.

.3 Department of Justice Canada
  .1 Explosives Act, R.S., c. E-15, s. 1 (updated September 27th, 2005).

.4 Ontario Provincial Standard Specifications (OPSS)/Ontario Ministry of Transportation
  .1 OPSS-[April 2003].

.5 U.S. Environmental Protection Agency (EPA)/Office of Water
  .1 EPA 832R92005, Storm Water Management for Construction Activities: Developing Pollution Prevention Plans and Best Management Practices.

1.3 SUBMITTALS

.1 Provide submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Following the confirmation of geotechnical data by drilling and surveying of the elevation profile of solid rock interface under the permafrost layer ; communicate any discrepancies concerning the elevation profile of solid rock to the Engineer.

1.4 DEFINITIONS

.1 Excavation classes: two classes of excavation will be recognized ; rock excavation and common excavation.
  .1 Rock : any solid material in excess of 0.5 m³ and which cannot be removed by means of heavy duty mechanical excavating equipment with 1.15 m³ bucket. For this project only, frozen material will be classified as rock for measurement and

payment purposes.

.2 Common excavation: excavation of materials of whatever nature, which are not included under definitions of rock excavation.

.2 Unclassified excavation: for deposits of whatever character encountered in Work.

.3 Waste : excavated material unsuitable for use in Work or surplus to requirements.

.4 Unsuitable materials:

.1 Weak, chemically unstable, and compressible materials.

.2 Frost susceptible materials:

.1 Fine grained soils, such as silt or till materials

.2 Table:

Sieve Designation	% Passing
2.00 mm	100
0.10 mm	45 - 100
0.02 mm	10 - 80
0.005 mm	0 - 45

.3 Coarse grained soils containing more than 20% passing 0.075 mm sieve.

.5 Unshrinkable fill: very weak mixture of cement, concrete aggregates and water that resists settlement when placed in utility trenches, and capable of being excavated.

1.5 QUALITY ASSURANCE/REGULATOR Y REQUIREMENTS

.1 Shore and brace excavations, protect slopes and banks and perform work in accordance with Territorial and Municipal regulations whichever is more stringent.

.2 Comply with Explosives Act of Canada.

.3 Perform blasting in accordance with Territorial and Municipal regulations: repair damage as directed by Engineer.

.4 Do not blast within 3 m of building and where damage would result.

.5 Health and Safety Requirements: do construction occupational health and safety in accordance with Territorial regulations.

1.6 EXISTING CONDITIONS

.1 Examine the theoretical rock profile shown on cross sections of drawings.

.2 Before commencing work, verify and establish location of buried and aboveground services, such as electric cables and fuel pipelines, on and adjacent to site.

.3 Proceed to the confirmation of geotechnical data by drilling and surveying of the elevation profile of solid rock interface under the permafrost layer.

.4 Communicate in a diligent manner any discrepancies concerning the elevation profile of solid rock to the Engineer, in order to allow the implementation of work change orders and any modification to the construction drawings, if required by the Engineer.

PART 2 – PRODUCTS

2.1 AGGREGATE MATERIALS

.1 Blasted rock, with maximum size of 600 mm

.2 Granular A to OPSS 1010 Standard.

.3 Granular B Type 1 to OPSS 1010 Standard.

.4 Screened Sand to OPSS 1004 Standard.

.5 Lean Concrete, only if required by Owner, to be proportioned and mixed to provide:
- .1 Maximum compressive strength of 0.4 MPa at 28 days.
- .2 Maximum Portland cement content of 25 kg/m³.
- .3 Minimum strength of 0.07 MPa at 24 h.
- .4 Concrete aggregates: to CAN/CSA-A23.1/A23.2.
- .5 Cement: to CAN/CSA-A3001, Type GU.
- .6 Slump: 160 to 200 mm.

PART 3 - EXECUTION

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction.

3.2 PREPARATION/PROTECTION

.1 Keep excavations clean, free of standing water, and loose soil.

.2 Where soil is subject to significant volume change due to change in moisture content, cover and protect to Engineer approval.

.3 Protect natural and man-made features required to remain undisturbed.

.4 Protect buried services that are required to remain undisturbed.

3.3 EXCAVATION

.1 Strip topsoil over areas to be covered by new construction, over areas where grade changes are required, and so that excavated material may be stockpiled without covering topsoil.
  .1 Stockpile topsoil on site for later use.

.2 Excavate as required to carry out work.
  .1 Do not disturb soil or rock below bearing surfaces.
  .2 Notify Engineer when excavations are complete.
  .3 If bearings are unsatisfactory, additional excavation and / or rock removal will be authorized in writing and paid for as additional work.
  .4 Excavation taken below depths shown without Engineer's written authorization to be filled with crushed rock fill at Contractor's expense.

.4 Excavate to subgrade levels.
  .1 In addition, remove all topsoil, organic matter, debris and other loose and harmful matter encountered at subgrade level.

3.5 BACKFILLING

.1 Inspection: do not commence backfilling until fill material and spaces to be filled have been inspected and approved by Engineer.

.2 Remove snow, ice, construction debris, organic soil and standing water from spaces to be filled.

.3 Lateral support: maintain even levels of backfill around structures as work progresses, to equalize earth pressures.

.4 Compaction of subgrade: compact existing subgrade slabs on grade, to same compaction as specified for fill.
- .1 Fill excavated areas with selected subgrade material compacted as specified.

.5 Placing:
- .1 Place backfill, fill and base course material in 300 mm lifts: add water as required to achieve specified density.
- .2 Place unshrinkable fill in areas as indicated by Owner: consolidate and level unshrinkable fill with internal vibrators.

.6 Compaction: compact each layer of material to following densities for material to ASTM D 698:
- .1 To underside of basecourses: 95%.
- .2 Basecourses: 98%.
- .3 Elsewhere: 90%.

.7 Blown rock material, not capable of fine grading, is not acceptable, imported material must be placed on this type of material

3.6 GRADING

.1 Grade so that water will drain away from structure, walls and driveable areas, to catch basins and other disposal areas approved by the Engineer.
- .1 Grade to be gradual between finished spot elevations shown on drawings.

3.7 FIELD QUALITY CONTROL

.1 Testing of materials and compaction of backfill and unshrinkable fill may be carried out by testing laboratory designated by Engineer, if required.

.2 Begin backfilling operations once material has been approved for use by Engineer.

.3 Not later than 24 hours before backfilling or filling with approved material, notify Engineer so that compaction tests can be carried out by designated testing agency.

3.8 SHORTAGE AND SURPLUS

.1 Supply necessary fill to meet backfilling and grading requirements and with minimum and maximum rough grade variance.

.2 Dispose of surplus material off site, in accordance with Municipal regulations.

3.9 CLEANING

.1 Proceed in accordance with Municipal regulations.

.2 On completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedure.

.2 Section 31 00 00.01 – Earthwork – Short Form.

1.2 ALLOWANCES

.1 Cost of blast survey and monitoring will be paid by Owner.

1.3 MEASUREMENT PROCEDURES

.1 Quantities will be taken from cross section showing original rock surface and actual grade line set by Engineer, except that minimum depth of rock required to be excavated to be considered as 300 mm.

1.4 REFERENCES

Refer to Sections 1.10 and 3.4 for specific information on distances from blasting site to structures.

1.5 DEFINITION

.1 Rock: any solid material in excess of 0.5 m^3 and which cannot be removed by means of heavy duty mechanical excavating equipment with 1.15 m^3 bucket. For this project only, frozen material will be classified as rock for measurement and payment purposes.

.2 PPV: peak particle velocity.

1.6 SUBMITTALS

.1 Blasting Operation
- .1 Submit to Engineer and local authorities having jurisdiction for approval, written proposal of operations for removal of rock by blasting, in accordance with Section 01 33 00 - Submittal Procedures.
- .2 Indicate proposed method of carrying out work, types and quantities of explosives to be used, loading charts and drill hole patterns, type of caps, blasting techniques, blast protection measures for items such as flying rock, vibration, dust and noise control. Include details on protective measures, blasting time and other details.
- .3 Submit records to Engineer at end of each shift. Maintain complete and accurate record of drilling and blasting operations.

1.7 QUALIFICATIONS

.1 Retain licensed explosives expert to program and supervise blasting work, to interpret recommendations of pre-blasting report, and to determine precautions, preparation and operations techniques.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse in accordance with local practices.

.2 Remove from site and dispose of all packaging materials as directed by Owner.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Ensure emptied containers are sealed and stored safely.

1.9 BLASTING SURVEY AND MONITORING

.1 Owner will visit property holders of adjacent buildings and structures to determine existing conditions and describe blasting and seismic recording operations.

.2 Seismographic monitoring will be conducted during entire progress of blasting operations.

1.10 BLASTING AND VIBRATION CONTROL

.1 Reduce ground vibrations to avoid damage to nearby aboveground fuel storage tanks.

.2 The vibration control requirements of this particular project are that vibration from blasting shall not exceed 12 mm/s at distance of 50 m, or 27 mm/s at 30 m from blast.

.3 In vicinity of structure, PPV not to exceed 12 mm/s at distance of 50 m, at structure.

.4 An indication of the weight of explosives per shot is 15 kg per 20 millisecond period.

.5 Complete blasting operations in full before any structural element including floor plates and roof rafter poles for fuel storage tanks are installed within 20 m from blast holes.

.6 Arrange the drill pattern and initial cut as for the free face of blast wall to be directed North, or away from the existing aboveground fuel storage tanks.

.7 Use of rubber mats or of a similar means of fly rock reduction is mandatory.

PART 2 – PRODUCTS

2.1 MATERIALS

Materials used will be determined more precisely in the written proposal of operations for removal of rock by blasting, to be submitted in accordance with Section 01 33 00 - Submittal Procedures.

PART 3 - EXECUTION

3.1 PROTECTION

.1 Prevent damage to surroundings and injuries in accordance with Territorial and Local regulations; post guards, sound warnings and display signs when blasting to take place.

3.2 ROCK REMOVAL

.1 Remove rock to alignments, profiles, and cross sections shown on the latest revision of construction drawings, unless otherwise directed by Engineer.

.2 Explosive blasting is [not] permitted [at locations indicated].
.1 Do blasting operations in accordance with Local and Territorial codes.

.3 Use rock removal procedures to produce uniform and stable excavation surfaces. Minimize overbreak, in order to avoid damage to adjacent structures.

.4 Excavate rock to horizontal surfaces, with slope not to exceed 4 %.

.5 Cut trenches to widths as indicated.

.6 Use pre-shearing, cushion blasting or other smooth wall drilling and blasting techniques unless specified otherwise or directed by Engineer.

.7 Remove boulders and fragments which may slide or roll into excavated areas.

.8 Correct excessive rock removal, in accordance with Section 31 00 00.01 – Earthwork.

3.3 ROCK DISPOSAL

.1 Do not dispose of removed rock. Material must be stockpiled to appropriate location as indicated by the Owner, for later use in the construction of containment dykes.

3.4 DETAILED CALCULATIONS ON EXPECTED PEAK PARTICLE VELOCITY AROUND EXISTING FUEL TANKS

Peak Particle Velocity Calculation Results

Job Number: VD2259-3 Expansion of fuel storage facilities at Baker Lake, Nunavut
Description: Determination of blasting procedures in area adjacent to existing bulk fuel storage tanks

Client: Agnico-Eagle Mines, Meadowbank Division
Date: 2009/11/25
By: Patrick Giard, P.Eng.

		US units	SI units
		VALUE	**VALUE**
expected Peak Particle Velocity	PPV	**0.47 in /sec**	**12 mm /sec**
	k	100	
	a	-1.6	
Scaled Distance	SD	28.5	
Distance from Shot to Structure	**d**	**164.0 ft**	**50 m**
Weight of Shot per delay	w	33.1 lbs per 20 millisecond period	15 kg per 20 millisecond period

The **Distance from Shot to Structure** is inherent to this project (fixed) between the worksite and existing fuel tanks 3 and 4.

The **recommended weight of explosives** per shot is **15 kg** per 20 millisecond period.

The **expected** Peak Particle Velocity is **12 mm per second.**

2009-11-25

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation of polymeric geotextiles, for use in the secondary containment area, located directly under and around the aboveground fuel storage tanks, and the purpose of which is to protect the HDPE liner from puncture.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 31 32 19 02- Geomembranes.

.3 Section 33 56 13 - Aboveground fuel storage tanks.

1.3 MEASUREMENT AND PAYMENT PROCEDURES

.1 Geomembranes will be measured in square metres of surface covered by material. Payment for the installation will be made on an hourly basis, as agreed with the Owner.

1.4 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)
- .1 ASTM D 4491-99a, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
- .2 ASTM D 4595-86(2001), Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
- .3 ASTM D 4716-01, Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
- .4 ASTM D 4751-99a, Standard Test Method for Determining Apparent Opening Size of a Geotextile.

.2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-4.2 No. 11.2-M89(April 1997), Textile Test Methods - Bursting Strength - Ball Burst Test (Extension of September 1989).
- .2 CAN/CGSB-148.1, Methods of Testing Geotextiles and Complete Geomembranes.
  - .1 No.2-M85, Methods of Testing Geosynthetics - Mass per Unit Area.
  - .2 No.3-M85, Methods of Testing Geosynthetics - Thickness of Geotextiles.
  - .3 No.6.1-93, Methods of Testing Geotextiles and Geomembranes - Bursting Strength of Geotextiles Under No Compressive Load.
  - .4 No.7.3-92, Methods of Testing Geotextiles and Geomembranes - Grab Tensile Test for Geotextiles.

.3 Ontario Provincial Standard Specifications (OPSS)
- .1 OPSS 1860-March 1998, Material Specification for Geotextiles.

1.5 SUBMITTALS

.1 Do not submit samples of geomembranes. Material will be supplied by the Owner.

1.6 CERTIFICATES

.1 Owner will obtain copies of manufacturer's mill test data prior to start of work.

1.7 DELIVERY, STORAGE AND HANDLING

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

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Separate waste materials for reuse in accordance with local practices.

.2 Remove from site and dispose of all packaging materials as directed by Owner.

.3 Fold up metal banding, flatten and place in designated area for later use.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 Geotextile: Needlepunched Nonwoven, Short staple Polypropylene fiber, supplied in rolls.
- .1 Width: 3.0 m minimum.
- .2 Length: no minimum length required, use of partial rolls is permitted.
- .3 Composed of: minimum 85% by mass of polypropylene with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure.

.2 Physical properties:
- .1 Thickness: to ASTM D4632
- .2 Mass per unit area: to CAN/CGSB-148.1, No.2
- .3 Tensile strength and elongation in any principal direction: to CAN/CGSB-148.1, No.7.3
  - .1 Tensile strength: minimum 650 N, wet condition.
  - .2 Seam strength: equal to or greater than tensile strength of fabric.
- .4 Grab tensile strength and elongation: to CAN/CGSB-148.1, No.7.3.

.3 Factory seams: sewn in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Place geotextile material by unrolling onto graded surface in orientation, manner and locations indicated and retain in position with sand bags.

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

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

.4 Overlap each successive strip of geotextile 400 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 4 h of placement.

.9 Replace damaged or deteriorated geotextile to approval of Engineer.

.10 Place and compact soil layers in accordance with Section 31 24 13 - Roadway Embankments.

3.2 CLEANING

.1 Remove construction debris from Project site and dispose of debris in an environmentally responsible and legal manner.

3.3 PROTECTION

.1 Vehicular traffic not permitted directly on geotextile.

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation of HDPE liner, a.k.a. geomembrane, for use in the secondary containment area, located directly under and around the aboveground fuel storage tanks.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 31 32 19 01- Geotextiles.

.3 Section 33 56 13 - Aboveground fuel storage tanks.

1.3 MEASUREMENT AND PAYMENT PROCEDURES

.1 Geomembranes will be measured in square metres of surface covered by material. Payment for the installation will be made on an hourly basis, as agreed with the Owner.

1.4 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM D 413-[98(2002)e1], Standard Test Methods for Rubber Property-Adhesion to Flexible Substrate.
- .2 ASTM D 638-[02a], Standard Test Method for Tensile Properties of Plastics.
- .3 ASTM D 746-[98e1], Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
- .4 ASTM D 792-[00], Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
- .5 ASTM D 1004-[94a(2003)], Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
- .6 ASTM D 1204-[02], Standard Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature.
- .7 ASTM D 1238-[01e1], Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
- .8 ASTM D 1593-[99], Standard Specification for Nonrigid Vinyl Chloride Plastic Film and Sheeting.
- .9 ASTM D 1603-[01], Standard Test Method for Carbon Black in Olefin Plastics.
- .10 ASTM D 1693-[01], Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics.
- .11 ASTM D 882-[02], Standard Test Methods for Tensile Properties of Thin Plastic Sheeting.
- .12 ASTM D 1203-[94(1999)e1], Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods.
- .13 ASTM D 1790-[02], Brittleness Temperature of Plastic Sheeting by Impact.

1.5 SUBMITTALS

.1 Do not submit samples of geomembranes. Material will be supplied by the Owner.

1.6 CERTIFICATES

.1 Owner will obtain copies of manufacturer's mill test data prior to start of work.

1.7 QUALITY ASSURANCE

.1 Test quality of resin and membrane to ensure consistency of raw material and geomembrane quality in accordance with manufacturer's recommendations.

.2 Test seams in strength and peel at beginning of each seaming period, and at least once every 4 h if welding operation is interrupted, for each seaming apparatus and seamer used that day. Also test at least two samples from each panel, with samples taken from extra material, such that panel is not damaged and blanket geometry is not altered.

.3 If seam test specimen fails in seam, repeat on new specimen. If new specimen fails in seam, material will not be used for seaming until deficiencies are corrected and two consecutive successful test seams are achieved.

.4 Test seams by non-destructive methods over their full length, using vacuum test unit or air pressure test.

.1 Vacuum chamber to contain glass viewport and seal for sealing chamber to seam area. With chamber sealed in place and after partly filling chamber with water, apply vacuum of 17.2 kPa. Seam failure is detected by presence of air bubbles through water.

.2 Use air lance to apply air at 343 kPa through nozzle directed at edge of overlap seam. Seam failure is indicated by inflation or lifting of any part of geomembrane.

.5 Provide test results to Engineer, for each shift's production, including documentation of non-destructive testing and repairs at the end of each shift.

1.8 DELIVERY, STORAGE AND HANDLING

.1 During delivery and storage, protect geo-membranes from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

1.9 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate disposal facilities.

.2 Separate for reuse and place into designated piles any unused steel in accordance with AEM Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Dispose of hazardous materials in accordance with Territorial and Municipal regulations.

.5 Clearly label location of salvaged material's storage areas.

.6 Ensure emptied containers are sealed and stored safely.

.7 Divert unused wood and steel materials from landfill to metal recycling facility as directed by AEM Environmental Dept.

.8 Divert unused concrete materials from landfill to local quarry as approved by local authorities.

.9 Fold up metal banding, flatten and place in designated area for later disposal.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 Geomembrane: extruded synthetic sheet.
- .1 Supplied in:
  - .1 Rolls of 7.0 m minimum width.
  - .2 Nominal thickness of 1.5 mm (60 MIL)
- .2 Composed of high density polyethylene resin with inhibitors added to base plastic to resist deterioration by ultra-violet and heat exposure.

.2 Physical properties:
- .1 Specific gravity of resin: to ASTM D 1505, minimum 0.940 g/cc.
- .2 Melt index of resin: to ASTM D 1238, minimum 0.05 g/min.
- .3 Thickness: to ASTM D 5199 :
  - .1 Minimum average thickness : 1500 microns
  - .2 Lowest individual thickness reading : 1350 microns
- .4 Tensile strength and elongation at yield: to ASTM D 6693 :
  - .1 Yield tensile strength: minimum 22 N/mm.
  - .2 Yield elongation: minimum 12 %.
- .5 Tensile strength and elongation at break: to ASTM D 6693 :
  - .1 Break tensile strength: minimum 40 N/mm.
  - .2 Break elongation: minimum 700 %.
- .6 Modulus of elasticity: to ASTM D 638, minimum 550 kPa.
- .7 Tear resistance: to ASTM D 1004, Die C, minimum 187 N.
- .8 Puncture resistance: to ASTM D 4883, minimum 480 N.
- .10 Dimensional stability, each direction: to ASTM D 1204, 100 degrees C, 1 hour, maximum 1%.
- .11 Environmental stress crack: to ASTM D 5397, minimum 300 h.
- .12 Low temperature brittleness: to ASTM D 746, Procedure B, minus 40 degrees C.
- .13 Brittleness temperature: to ASTM D 1790.
- .14 Carbon black content: to ASTM D 1603, minimum 2.5%, maximum 3.5% by mass.
- .15 Seam strength (at yield point): 280 N and film tear bond.
- .16 Seam peel adhesion: to ASTM D 6392.
  - .1 Shear Strength, 21 kN/m
  - .2 Peel Strength, 15.9 kN/m for Hot Wedge
  - .3 Peel Strength, 13.6 kN/m for Extrusion Fillet
- .17 Total content of additives, fillers or extenders: maximum 3.5% by weight.
- .18 Geomembrane: free of striations, roughness, pinholes, bubbles, blisters, un-dispersed raw materials and any sign of contamination by foreign matter.

.3 Seams: welded in accordance with manufacturer's recommendations. Physical properties for resin used for welding to be same as those for resin used in manufacture of membrane.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 GEOMEMBRANE INSTALLATION

.1 Materials Logistics

.1 Transportation and On-site Storage

The geomembrane rolls shall be shipped by flatbed trailer to the job site. The geomembrane shall be stored so as to be protected from puncture, dirt, grease, moisture and excessive heat. Damaged material shall be stored separately for repair or replacement. The rolls shall be stored on a prepared smooth surface (not wooden pallets) and should not be stacked more than two rolls high.

.2 Earthwork

.1 General

The owner or his representative (soil quality assurance inspector) shall inspect the subgrade preparation. Prior to liner installation the subgrade shall be compacted in accordance with the project specifications. Weak or compressible areas which cannot be satisfactorily compacted should be removed and replaced with properly compacted fill. All surfaces to be lined shall be smooth and free of all foreign and organic material, sharp objects, or debris of any kind. The subgrade shall provide a firm, unyielding foundation with no sharp changes or abrupt breaks in grade. Standing water or excessive moisture shall not beallowed. The installer, on a daily basis, shall approve the surface on which the geomembrane will be installed. After the supporting soil surface has been approved, it shall be the installer's responsibility to indicate to the inspector any changes to its condition that may require repair work.

.2 Anchor Trench

The anchor trench shall be excavated to the line, grade, and width shown on the project construction drawings, prior to liner system placement. Slightly rounded corners shall be provided in the trench to avoid sharp bends in the geomembrane.

.3 HDPE LINER specifications Method of Placement

The rolls shall be deployed using a spreader bar assembly attached to a loader bucket or by other methods approved by the project engineer. The installer shall be responsible for the following:

.1 Equipment or tools shall not damage the geomembrane during handling, transportation and deployment.

.2 Personnel working on the geomembrane shall not smoke or wear damaging shoes.

.3 The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

.4 Adequate loading (e.g., sand bags or similar items that will not damage the geomembrane) shall be placed to prevent uplift by wind (in case of high

winds, continuous loading is recommended along edges of panels to minimize risk of wind flow under the panels).

.4 Weather Conditions

Geomembrane deployment shall proceed at ambient temperatures that are suitable, according to manufacturer specifications. Placement can proceed below 0°C only after it has been verified by the inspector that the material can be seamed according to the specification. Geomembrane placement 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, as determined by the installation supervisor.

.5 Field Seaming

Approved seaming processes are fusion and extrusion welding. On side slopes, seams shall be oriented in the general direction of maximum slope, i.e., oriented down, not across the slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized. No base T-seam shall be closer than 5 feet from the toe of the slope. Seams shall be aligned with the least possible number of wrinkles and "fishmouths." If a fishmouth or wrinkle is found, it shall be relieved and cap-stripped.

.1 Seam Overlap

Geomembrane panels must have a finished minimum overlap of 4 inches for fusion welding and 6 inches for extrusion welding. Cleaning solvents may not be used unless the product is approved by the liner manufacturer.

.2 Test Seams

Field test seams shall be conducted on the liner to verify that seaming conditions are satisfactory. Test seams shall be conducted at the beginning of each seaming period and at least once every 4 hours, for each seaming apparatus and personnel used that day.

Poly-Flex LINER specifications 15 All test seams shall be made in contact with the subgrade. Welding rod used for extrusion welding shall have the same properties as the resin used to manufacture the geomembrane. The test seam samples shall be 10 feet long for fusion welding and 3 feet long for extrusion welding with the seam centered lengthwise. Three specimens shall be cut from each end of the test seams by the inspector. The inspector shall use a tensiometer to test 3 specimens for shear and 3 specimens for peel. Each specimen shall be one inch wide with a grip separation of 4 inches plus the width of the seam. The seam shall be centered between the clamps. The rate of grip separation shall be 2 inches per minute.

.3 Assessment of Seam Test Results

For both smooth and textured seams the strength of two out of three 1.0 inch (25 mm) wide strip specimens should meet or exceed values given in this specification. The third must meet or exceed 80% of the given values. The shear percent elongation should exceed 50%. The assumed gauge length is considered to be the unseamed sheet material on either side of the welded area. Elongation measurements should be omitted for field testing. In addition, the peel separation should not exceed 25% based on the proportion of area of separated bond to the area of the original bonding. Regarding the locus-of-break patterns of the different seaming methods in shear and peel, the following are unacceptable break codes per their description in the ASTM D 6392. In this regard, SIP is an acceptable break code.

Unacceptable Break Codes Hot Wedge: AD and AD-BRK > 25% Extrusion Fillet: AD1, AD2 and AD-Weld (unless strength is achieved)

.4 Non-Destructive Seam Testing

The Installer shall non-destructively test all field seams over their full length.

A. Vacuum Box Testing Equipment for testing extrusion seams shall be comprised of the following:

.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 Soapy solution in a plastic bucket with a mop.

The following procedures shall be followed by the installer:

.1 Excess sheet overlap shall be trimmed away.

.2 Wet a strip of geomembrane approximately 12 inches wide by the length of box with the soapy solution.

.3 Place the box over the wetted area and compress.

.4 Create a vacuum of 3 - 5 psig.

.5 Ensure that a leak-tight seal is created.

.6 For a period of approximately 10 seconds, examine the geomembrane through the viewingwindow for the presence of animated soap bubbles. 16

Poly-Flex LINER specifications

.7 If no animated bubbles appear after 10 seconds, close the vacuum valve and open thebleed valve, move the box over the next adjoining area with a minimum 3 inches overlapand repeat the process.

.8 All areas where animated soap bubbles appear shall be marked, repaired and then retested. The following procedures shall apply to locations where seams cannot be non-destructivelytested.

.1 If the seam is accessible to testing equipment prior to final installation, the seam shall benon-destructively tested prior to final installation.

.2 If the seam cannot be tested prior to final installation, the seams shall be spark testedaccording to the spark tester manufacturer's procedures.

B. Air Pressure Testing (For Double Fusion Seams Only)

Equipment for testing double seams shall be comprised of the following:

.1 An air pump equipped with pressure gauge capable of generating and sustaining a pressure between 25 and 30 psi.

.2 A pressure gauge equipped with a sharp hollow needle. The following procedures shall be followed by the installer:

.1 Seal one end of the seam to be tested.

.2 Insert needle or other approved pressure feed device through the sealed end of the channelcreated by the double wedge fusion weld.

.3 Energize the air pump to verify the unobstructed passage of air through the channel.

.4 Seal the other end of the channel.

.5 Energize the air pump to a pressure between 25 and 30 psi, close valve, allow 2 minutesfor the injected air to come to equilibrium in the channel, and sustain pressure for approximately 5 minutes.

.6 If loss of pressure exceeds 4 psi, or pressure does not stabilize, locate faulty area, repair and retest.

.7 If pressure does not drop below the acceptable value after five minutes, cut the air channelopen at the opposite end from the pressure gauge. The air channel should deflateimmediately indicating that the entire length of the seam has been tested.

.5 Destructive Seam Testing

Destructive seam testing should be minimized to preserve the integrity of the liner. The installer shall provide the inspector with one destructive test

sample per project specifications (usually once per 500 feet of seam length) from a location specified by the inspector.

A. Sampling Procedure In order to obtain test results prior to completion of liner installation, samples shall be cut by the installer as the seaming progresses. The installer shall also record the date, location, and pass or fail description. All holes in the geomembrane resulting from obtaining the seam samples shall be immediately patched and vacuum tested.

B. Size and Disposition of Samples The samples shall be 12 inches wide by 36 inches long with the seam centered lengthwise. The sample shall be cut into three equal-length pieces, one to be given to the inspector, one to be given to the owner and one to the installer.

C. Field Laboratory Testing The inspector shall test ten 1-inch wide specimens from his sample, five specimens for shear strength and five for peel strength.

D. Independent Laboratory Testing The owner, at his discretion and expense, may send seam samples to a laboratory for testing. The test method and procedures to be used by the independent laboratory shall be the same as used in field testing.

E. Procedures for Destructive Test Failure The following procedures shall apply whenever a sample fails the field destructive test:

.1 The installer shall cap strip the seam between the failed location and any passed test locations.

2. The installer can retrace the welding path to an intermediate location (usually 10 feet from the location of the failed test), and take a sample for an additional field test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, then the process is repeated.

.3 Over the length of seam failure, the installer shall either cut out the old seam, reposition the panel and reseam, or add a cap strip.

.6 Defects and Repairs

All seams and non-seam areas of the geomembrane shall be inspected by the inspector for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection.

A. Evaluation

Each suspect location in seam and non-seam areas shall be non-destructively tested as appropriate in the presence of the

inspector. Each location that fails the non-destructive testing shall be marked by the inspector, and repaired accordingly.

B. Repair Procedures

.1 Defective seams shall be cap stripped or replaced.

.2 Small holes shall be repaired by extrusion welding a bead of extrudate over the hole. If the hole is larger than 1/4 inch, it shall be patched.

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

.4 Blisters, large cuts and undispersed raw materials shall be repaired by patches.

.5 Patches shall be completed by extrusion welding. The weld area shall be ground no more than 10 minutes prior to welding. No more than 10% of the thickness shall be removed by grinding. 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. The welding shall restart by grinding the existing seam and rewelding a new seam. Patches shall be round or oval in shape, made of the same geomembrane, and extend a minimum of 6 inches beyond the edge of defects.

C. Verification of Repairs

Each repair shall be non-destructively tested. 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. The inspector shall keep daily documentation of all non-destructive and destructive testing. This documentation shall identify all seams that initially failed the test and include evidence that these seams were repaired and successfully retested.

.5 Cover Material and Backfilling of Anchor Trench

The geomembrane shall be covered as soon as possible. The covering operation shall not damage the geomembrane. The cover soil material shall be free of foreign and organic material, sharp objects, or debris of any kind, which could potentially damage the geomembrane. No construction equipment or machinery shall operate directly on the geomembrane. The use of lightweight machinery (i.e., generator, etc.) with low ground pressure is allowed. The anchor trench shall be backfilled by the earthwork contractor. Trench backfill material shall be placed and compacted in accordance with the project specifications. Care shall be taken when backfilling the trenches to prevent any damage to the geomembrane. If damage occurs, it shall be repaired prior to backfilling.

.6 Geomembrane Acceptance

The installer shall retain all ownership and responsibility for the geomembrane until accepted by the owner. Final acceptance is when all of the following conditions are met:

.1 Installation is finished.

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

3.2 CLEANING

.1 Remove construction debris from Project site and dispose of debris in an environmentally responsible and legal manner.

3.3 PROTECTION

.1 Do not permit vehicular traffic directly on membrane.

PART 1 - GENERAL

1.1 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

.1 Owner to supply all granular base materials at pit, or stockpile.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 31 32 19 01- Geotextiles.

.3 Section 31 32 19 02- Geomembranes.

.4 Section 33 56 13 - Aboveground fuel storage tanks.

1.3 MEASUREMENT AND PAYMENT PROCEDURES

.1 Measure granular base in truck box measurement of material incorporated into Work and accepted by Engineer. Submit volume estimates to Owner for cost control purposes.

.2 Measure excavation of base, sub-base and sub-grade materials to correct deficiencies in sub-grade in machinery engine hours.
.1 Measure backfill of sub-grade with common materials approved by Engineer.

.3 Measure hauling granular base material in cubic metre-kilometres computed by taking product of number of cubic metres of material placed multiplied by haul distance in kilometres. Measure haul distance from source of material to worksite, measured along shortest route determined by Engineer as being feasible and satisfactory.

.4 Measure water addition for compaction in machinery engine hours.

.5 Measure compaction of granular base in engine hours for each type of compaction unit employed including operator, fuel and maintenance.

1.4 REFERENCES

.1 American Society for Testing and Materials (ASTM)
.1 ASTM C 117-[95], Standard Test Methods for Material Finer Than 0.075 mm Sieve in Mineral Aggregates by Washing.
.2 ASTM C 131-[96], Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
.3 ASTM C 136-[96a], Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
.4 ASTM D 698-[00a], Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400ft-lbf/ft^3) (600kN-m/m^3).

.5 ASTM D 1557-[00], Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000ft-lbf/ft³) (2,700kN-m/m³).
.6 ASTM D 1883-[99], Standard Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
.7 ASTM D 4318-[00], Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

.2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-8.1-[88], Sieves, Testing, Woven Wire, Inch Series.
.2 CAN/CGSB-8.2-[M88], Sieves, Testing, Woven Wire, Metric.

1.5 DELIVERY, STORAGE AND HANDLING

.1 Deliver and stockpile aggregates as directed by Owner. Stockpile a minimum of 50% of total aggregate required prior to beginning construction of secondary containment dykes..

.2 if cement is used, store cement in weather tight bins or silos that provide protection from dampness and easy access for inspection and identification of each shipment.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate disposal facilities.

.2 Separate for reuse and place into designated piles any unused steel in accordance with AEM Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Dispose of hazardous materials in accordance with Territorial and Municipal regulations.

.5 Clearly label location of salvaged material's storage areas.

.6 Ensure emptied containers are sealed and stored safely.

.7 Divert unused wood and steel materials from landfill to metal recycling facility as directed by AEM Environmental Dept.

.8 Divert unused concrete materials from landfill to local quarry as approved by local authorities.

.9 Fold up metal banding, flatten and place in designated area for later disposal.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 Granular base: material in accordance with following requirements:
- .1 Blasted rock, with maximum size of 600 mm
- .2 Granular A to OPSS 1010 Standard.
- .3 Granular B Type 1 to OPSS 1010 Standard.
- .4 Screened Sand to OPSS 1004 Standard.
  - .1 Gradation Method for screened sand :

Sieve Size	Gradation (LS-602), Percent Passing
4.75 mm	90 - 100
2.36 mm	50 - 95
1.18 mm	20 - 90
600 µm	0 - 70
300 µm	0 - 35
150 µm	0 - 15
75 µm	0 - 5.0

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATION

.1 Start placement of granular base only after sub-base subgrade surface has been inspected and approved by Engineer.

.2 Placing
- .1 Construct granular base to depth and grade in areas indicated.
- .2 Ensure no frozen material is placed.
- .3 Place material only on clean unfrozen surface, free from snow and ice.
- .4 Begin spreading base material on crown line or on high side of one-way slope.
- .5 Place material using methods which do not lead to segregation of aggregate.
- .6 For spreading and shaping material, use spreader boxes having adjustable templates or screeds which will place material in uniform layers of required thickness.
- .7 Place material to full width in uniform layers not exceeding 200 mm compacted thickness. Engineer may authorize lifts (layers) of a maximum of 300 mm thickness if it is demonstrated that specified compaction levels can be achieved.
- .8 Shape each layer to smooth contour and compact to specified density before succeeding layer is placed.

.3 Compaction Equipment
- .1 Compaction equipment to be capable of obtaining required material densities.
- .2 Efficiency of equipment not specified to be proved at least as efficient as specified equipment at no extra cost and written approval must be received from Consultant before use.
- .3 Equipped with device that records hours of actual work, not motor running hours.

.4 Compacting
- .1 Compact to density not less than 95.0 % of corrected maximum dry density in accordance with ASTM D 1557, a.k.a. 95.0 % of Modified Proctor Test.
- .2 Shape and roll aggregate layers alternately to obtain a smooth, even and uniformly compacted base.
- .3 Apply water as necessary during compacting to obtain specified density.
- .4 Correct surface irregularities by loosening and adding or removing material until surface is within specified tolerance.

.5 Proof rolling
- .1 For proof rolling use standard roller of 45400 kg gross mass with four pneumatic tires each carrying 11350 kg and inflated to 620 kPa. Four tires arranged abreast with centre to centre spacing of 730 mm.
- .2 Make sufficient passes with proof roller to subject every point on surface to three separate passes of loaded tire.

.3 Where proof rolling reveals areas of defective subgrade:
  .1 Remove base, sub-base and subgrade material to depth and extent as directed by Consultant.
  .2 Backfill excavated subgrade with indicated material as directed by Engineer and compact to 95.0 % of Modified Proctor Test.
  .3 Replace sub-base material and compact accordingly.
  .4 Replace base material and compact in accordance with this Section.

.4 Where proof rolling reveals defective base or sub-base, remove defective materials to depth and extent as directed by Consultant and replace with new materials as directed by Engineer.

3.2 SITE TOLERANCES

.1 Finished base surface to be within plus or minus 10 mm of established grade and cross section but not uniformly high or low.

3.3 PROTECTION

.1 Maintain finished base in condition conforming to this Section until succeeding material is applied or until acceptance by Engineer.

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 31 00 00_01 – Earthwork

.3 Section 32 11 23 – Aggregate base courses

.4 Section 33 41 00 – Storm utility drainage piping

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

.1 Owner will supply all construction materials, unless otherwise noted.

1.3 MEASUREMENT AND PAYMENT PROCEDURES

.1 Measure excavation and backfill work in man hours and machinery engine hours, which will be used for payment. Submit expended hours to Owner for cost control purposes.

1.4 REFERENCES

.1 American Society for Testing and Materials International (ASTM)
- .1 ASTM A 48/A 48M-[00], Standard Specification for Gray Iron Castings.
- .2 ASTM C 117-[04], Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing.
- .3 ASTM C 136-[05], Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
- .4 ASTM C 139-[05], Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes.
- .5 ASTM C 478M-[06], Standard Specification for Precast Reinforced Concrete Manhole Sections [Metric].

.2 Canadian General Standards Board (CGSB)
- .1 CAN/CGSB-8.1-[88], Sieves, Testing, Woven Wire, Inch Series.
- .2 CAN/CGSB-8.2-[M88], Sieves, Testing, Woven Wire, Metric.

.3 Canadian Standards Association (CSA International)
- .1 CAN/CSA-A23.1-[04]/A23.2-[04], Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.
- .2 CAN/CSA-A3000-[03(R2005)], Cementitious Materials Compendium (Consists of A3001, A3002, A3003, A3004 and A3005).
  - .1 CSA-A3001-[03], Cementitious Materials for Use in Concrete.
  - .2 CSA-A3002-[03], Masonry and Mortar Cement.
- .3 CAN/CSA-A165 Series-[04], CSA Standards on Concrete Masonry Units (Consists of A165.1, A165.2 and A165.3).
- .4 CAN/CSA-G30.18-[M92(R2002)], Billet Steel Bars for Concrete Reinforcement.
- .5 CAN/CSA-G164-[M92(R2003)], Hot Dip Galvanizing of Irregularly Shaped Articles.

.4 Ontario Provincial Standard Specifications (OPSS)
- .1 OPSS 407-November 2004, Construction Specification For Maintenance Hole, Catch Basin, Ditch Inlet And Valve Chamber Installation.

1.5 SUBMITTALS

.1 No submittals are required for this division.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Packing, shipping, handling and unloading:
- .1 Deliver, store and handle materials as directed by Owner.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate disposal facilities.

.2 Separate for reuse and place into designated piles any unused steel in accordance with AEM Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Dispose of hazardous materials in accordance with Territorial and Municipal regulations.

.5 Clearly label location of salvaged material's storage areas.

.6 Ensure emptied containers are sealed and stored safely.

.7 Divert unused wood and steel materials from landfill to metal recycling facility as directed by AEM Environmental Dept.

.8 Divert unused concrete materials from landfill to local quarry as approved by local authorities.

.9 Fold up metal banding, flatten and place in designated area for later disposal.

PART 2 – PRODUCTS

2.2 MATERIALS

.1 Precast manhole units: to ASTM C 478M, circular or oval.
- .1 Top sections eccentric cone or flat slab top type with opening offset for vertical ladder installation.
- .2 Monolithic bases to be approved by Engineer and set on slabs cast in place.

.3 Precast catch basin sections: to ASTM C478M.

.4 Joints: made watertight using rubber rings or cement mortar.

.5 Mortar:
- .1 Masonry Cement: to CAN/CSA-A3002.

.6 Ladder rungs: to CAN/CSA-G30.18, No.25M billet steel deformed bars.
- .1 Rungs to be safety pattern (drop step type).

.7 Adjusting rings: to ASTM C 478M.

.8 Concrete Brick: to CAN3-A165 Series.

.9 Drop manhole pipe: same as sewer pipe.

.10 Galvanized iron sheet: approximately 2 mm thick.

.11 Steel gratings, I-beams and fasteners: as indicated.

.12 Frames, gratings, covers to dimensions as indicated and following requirements:
- .1 Metal gratings and covers to bear evenly on frames.
  - .1 Frame with grating or cover to constitute one unit.
  - .2 Assemble and mark unit components before shipment.
- .2 Gray iron castings: to ASTM A 48/A 48M, strength class 30B.
- .3 Castings: [coated with two applications of asphalt varnish] [sand blasted or cleaned and ground to eliminate surface imperfections].
- .4 Manhole frames and covers: cover cast without perforations [and complete with two 25 mm square lifting holes to OPSS 407.
- .5 Catch basin frames and covers: to OPSS 407.
- .6 Manhole frames and covers: light duty for landscape service.
- .7 Size: 762 mm clear diameter.
- .8 Granular bedding and backfill: in accordance with Section 32 11 23 - Aggregates.
- .9 Lean Concrete: in accordance with Section 31 00 00_01 – Earthwork.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage instructions, and datasheets.

3.2 EXCAVATION AND BACKFILL

.1 Excavate and backfill in accordance with Section 31 00 00_01 – Earthwork and as indicated.

.2 Obtain approval of Engineer before installing manholes or catch basins.

3.4 INSTALLATION

.1 Construct units in accordance with details shown on drawings issued for construction, plumb and true to alignment and grade.

.2 Dewater excavation to approval of Engineer and remove soft and foreign material before placing concrete base.

.3 Cast bottom slabs directly on undisturbed ground.

.4 Set precast concrete base on 150 mm minimum of granular bedding compacted to 95% corrected maximum dry density.

.5 Precast units:
- .1 Set bottom section of precast unit in bed of cement mortar and bond to concrete slab or base.
- .2 Make each successive joint watertight with approved rubber ring gaskets, cement mortar, epoxy resin cement, or combination of these materials.
- .3 Clean surplus mortar and joint compounds from interior surface of unit.
- .4 Plug lifting holes with concrete plugs set in cement mortar or mastic compound.

.6 Compact granular backfill to 95% corrected maximum dry density.

.7 Place frame and cover on top section to elevation as indicated, use ring if needed.

.8 Clean units of debris and foreign materials.
- .1 Remove fins and sharp projections.
- .2 Prevent debris from entering system.

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation procedures for storm sewer.

1.2 PRODUCTS INSTALLED BUT NOT SUPPLIED UNDER THIS SECTION

.1 Owner will supply all construction materials, unless otherwise noted.

1.3 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 31 00 00_01 – Earthwork

.3 Section 32 11 23 – Aggregate base courses

.4 Section 33 05 13 – Manholes and catch basin

1.4 MEASUREMENT AND PAYMENT PROCEDURES

.1 Measure installation of culverts in man hours and machinery engine hours, which will be used for payment. Submit expended hours to Owner for cost control purposes.

1.5 REFERENCES

.1 American Society for Testing and Materials International, (ASTM)
- .1 ASTM C 443M-02, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric).
- .2 ASTM D 698-00a, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
- .3 ASTM D 1056-00, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
- .4 ASTM D 2680-01, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
- .5 ASTM D 3034-00, Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
- .6 ASTM F 405-97, Standard Specification for Corrugated Polyethylene (PE) Tubing and Fittings.
- .7 ASTM F 667-97, Standard Specification for Large Diameter Corrugated Polyethylene Tubing and Fittings.
- .8 ASTM F 794-01, Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.

.2 Canadian General Standards Board (CGSB)
.1 CAN/CGSB-8.1-M89, Sieves, Testing, Woven Wire, Inch Series.
.2 CAN/CGSB-8.2-M88, Sieves, Testing, Woven Wire, Metric.

.3 Canadian Standards Association (CSA International)
.1 CAN/CSA-A3000-98(April 2001), Cementitious Materials Compendium (Consists of A5-98, A8-98, A23.5-98, A362-98, A363-98, A456.1-98, A456.2-98, A456.3-98).
.1 CAN/CSA-A5-98, Portland Cement.
.2 CAN/CSA-A257 Series-M92(R1998), Standards for Concrete Pipe.
.3 CSA B1800-02, Plastic Non-pressure Pipe Compendium - B1800 Series (Consists of B181.1, B181.2, B181.3, B181.5, B182.1, B182.2, B182.4, B182.6, B182.7, B182.8 and B182.11).
.1 CSA B182.2-02, PVC Sewer Pipe and Fittings (PSM Type).
.2 CSA B182.4-02, Profile PVC Sewer Pipe and Fittings.
.3 CSA B182.11-02, Recommended Practice for the Installation of Thermoplastic Drain, Storm, and Sewer Pipe and Fittings.
.4 CSA-G401-01, Corrugated Steel Pipe Products.

.4 Department of Justice Canada (Jus)
.1 Canadian Environmental Protection Act, 1999 (CEPA).

.5 Transport Canada (TC)
.1 Transportation of Dangerous Goods Act, 1992 (TDGA)

1.6 SUBMITTALS

.1 No submittals are required for this division.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate disposal facilities.

.2 Separate for reuse and place into designated piles any unused steel in accordance with AEM Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Dispose of hazardous materials in accordance with Territorial and Municipal regulations.

.5 Clearly label location of salvaged material's storage areas.

.6 Ensure emptied containers are sealed and stored safely.

.7 Divert unused wood and steel materials from landfill to metal recycling facility as directed by AEM Environmental Dept.

.8 Divert unused concrete materials from landfill to local quarry as approved by local authorities.

.9 Fold up metal banding, flatten and place in designated area for later disposal.

PART 2 - PRODUCTS

2.1 CORRUGATED STEEL PIPE

.1 Corrugated steel pipe and couplers: to CSA-G401.
.1 Gaskets: to ASTM D 1056.

2.2 PLASTIC PIPE

.1 Type PSM Poly Vinyl Chloride (PVC): to ASTM D 3034 CSA-B182.2.
.1 Standard Dimensional Ratio (SDR): 28 35 41.
.2 Locked-in Separate gasket and integral bell system.
.3 Nominal lengths: 4 6 m.

.2 Large diameter, ribbed PVC sewer pipe and fittings: to CSA B182.4 ASTM F 794.

.3 Corrugated polyethylene pipe: high density to ASTM F 667 ASTM F 405 BNQ-3624-115.

.4 Acrylonitrile - Butadiene - Styrene (ABS): to ASTM D 2680 CAN/CSA-B182.1.

.5 Acceptable material:.

2.3 PIPE BEDDING AND SURROUND MATERIAL

.1 Granular material in accordance with Section 31 05 16 - Aggregate Materials and following requirements:
.1 Crushed or screened stone, gravel or sand.
.2 Gradations to be within limits specified when tested to ASTM C 136 and ASTM C 117. Sieve sizes to CAN/CGSB-8.1 CAN/CGSB-8.2.

.2 Table

Sieve Designation (mm)	% Passing Stone/Gravel	Gravel/Sand
25	[100]	-
19	-	-
12.5	[65-90]	[100]
9.5	-	-
4.75	[35-55]	[50-100]
2.00		[30-90]
0.425	[10-25]	[10-50]
0.180	-	-

0.075	[0-8]	[0-10]

2.4 BACKFILL MATERIAL

.1 As indicated.

.2 Type 3 to Section 31 23 33.01 - Excavating Trenching and Backfilling.

.3 Unshrinkable fill: in accordance with Section 31 23 33.01 - Excavating, Trenching and Backfilling.

2.5 JOINT MORTAR

Not applicable for corrugated steel and plastic pipes.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Clean pipes and fittings of debris and water before installation, and remove defective materials from site to approval of Consultant.

3.2 TRENCHING

.1 Do trenching Work in accordance with Section 31 00 00.01 - Earthwork.

.2 Do not allow contents of sewer or sewer connection to flow into trench.

.3 Trench alignment and depth to approval of Engineer prior to placing bedding material and pipe.

.4 Water jetting of backfill under haunches of corrugated steel pipe may be permitted if recommended by manufacturer and approved by Engineer.

3.3 GRANULAR BEDDING

.1 Place bedding in unfrozen condition.

.2 Place granular bedding material in uniform layers not exceeding 150 mm compacted thickness to depth of mm to depth as indicated.

.3 Shape bed true to grade and to provide continuous, uniform bearing surface for pipe. Do not use blocks when bedding pipes.

.4 Shape transverse depressions as required to suit joints.

.5 Compact each layer full width of bed to at least 95 % corrected maximum dry density maximum density to ASTM D 698.

.6 Fill excavation below bottom of specified bedding adjacent to manholes or catch basins with lean mix concrete compacted bedding material compacted common backfill.

3.4 INSTALLATION

.1 Lay and join pipes to: ASTM C 12.

.2 Lay and join pipe in accordance with manufacturer's recommendations and to approval of Engineer.

.3 Handle pipe using methods approved by Engineer.
.1 Do not use chains or cables passed through rigid pipe bore so that weight of pipe bears upon pipe ends.

.4 Lay pipes on prepared bed, true to line and grade with pipe inverts smooth and free of sags or high points.
.1 Ensure barrel of each pipe is in contact with shaped bed throughout its full length.

.5 Begin laying at outlet and proceed in upstream direction with socket ends of pipe facing upgrade.

.6 Lay corrugated steel pipe:
.1 With outside circumferential laps facing upgrade and longitudinal laps or seams at side or quarter points.
.2 With longitudinal centre line of paved invert coinciding with flow line.

.7 Do not exceed maximum joint deflection recommended by pipe manufacturer.

.8 Do not allow water to flow through pipes during construction except as may be permitted by Engineer.

.9 Whenever Work is suspended, install removable watertight bulkhead at open end of last pipe laid to prevent entry of foreign materials.

.10 Install plastic pipe and fittings in accordance with CSA B182.11.

.11 Joints:
.1 Corrugated steel pipe:
.1 Install gaskets as indicated.
.2 Match corrugations or indentations of coupler band with pipe sections before tightening.
.3 Tap coupler firmly while tightening, to take up slack and ensure snug fit.
.4 Ensure bolts are inserted and tightened.

.12 When any stoppage of Work occurs, restrain pipes as directed by Engineer, to prevent "creep" during down time.

.13 Plug lifting holes with Engineer approved prefabricated plugs, set in shrinkage compensating grout.

.14 Cut pipes as required for special inserts, fittings or closure pieces, as recommended by pipe manufacturer, without damaging pipe or its coating and to leave smooth end at right angles to axis of pipe.

.15 Make watertight connections to manholes and catch basins.
.1 Use shrinkage compensating grout when suitable gaskets are not available.

.16 Use prefabricated saddles or approved field connections for connecting pipes to existing sewer pipes.
.1 Joint to be structurally sound and watertight.

.17 Temporarily plug open upstream ends of pipes with removable watertight concrete, steel or plastic bulkheads.

3.5 PIPE SURROUND

.1 Place surround material in unfrozen condition.

.2 Upon completion of pipe laying, and after Engineer has inspected pipe joints, surround and cover pipes as indicated.
.1 Leave joints and fittings exposed until field testing is completed.

.3 Hand place surround material in uniform layers not exceeding 150 mm compacted thickness as indicated.
.1 Do not dump material within m of pipe.

.4 Place layers uniformly and simultaneously on each side of pipe.

.5 Compact each layer from pipe invert to mid height of pipe to at least 95 % corrected maximum dry density maximum density to ASTM D 698.

.6 Compact each layer from mid height of pipe to underside of backfill to at least 90 % corrected maximum dry density maximum density to ASTM D 698.

.7 When field test results are acceptable to Engineer, place surround material at pipe joints.

3.6 BACKFILL

.1 Place backfill material in unfrozen condition.

.2 Place backfill material, above pipe surround, in uniform layers not exceeding 150 mm compacted thickness up to grades as indicated.

.3 Under paving and walks, compact backfill to at least 95 % corrected maximum dry density maximum density to ASTM D 698. In other areas, compact backfill to at least 90 % corrected maximum dry density maximum density to ASTM D 698.

.4 Place unshrinkable backfill in accordance with Section 31 00 00.01 – Earthwork but only if indicated by owner.

3.7 FIELD TESTING

.1 Repair or replace pipe, pipe joint or bedding found defective.

.2 When directed by Engineer, draw tapered wooden plug with diameter of 50 mm less than nominal pipe diameter through sewer to ensure that pipe is free of obstruction.

PART 1 - GENERAL

1.1 SECTION INCLUDES

.1 Materials and installation for *Aboveground Oil Storage Tanks*.

1.2 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 26 42 00 - Cathodic Protection.

.3 Section 31 32 19.01 - Geotextiles

.4 Section 31 32 19.02 - Geomembranes.

.5 Section D 20 50 – Fuel-Oil Piping.

1.3 REFERENCES

.1 American National Standards Institute (ANSI).
- .1 ANSI/NFPA-329-99, Handling Underground Releases of Flammable and Combustible Liquids.
- .2 ANSI/API 650-2000, Welded Steel Tanks for Oil Storage.

.2 American Petroleum Institute (API).
- .1 API RP 651-1997, Cathodic Protection of Aboveground Petroleum Storage Tanks.
- .2 API STD 653-R01, Tank Inspection, Repair, Alteration, and Reconstruction.

.3 Canadian Council of Ministers of the Environment (CCME).
- .1 CCME-PN1326-2004, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.

.4 Department of Justice Canada (Jus).
- .1 Canadian Environmental Protection Act, 1999 (CEPA).

.5 The Master Painters Institute (MPI).
- .1 Architectural Painting Specification Manual - September 2002.

.6 Underwriters' Laboratories of Canada (ULC).
- .1 ULC/ORD-C58.9-97, Secondary Containment Liners for Underground and Aboveground Tanks.
- .2 CAN/ULC S653-06, Standard for Aboveground Steel Contained Tank Assemblies for Flammable and Combustible Liquids.

.7 National Research Council/Institute for Research in Construction.

.1 NRCC 38727, National Fire Code of Canada (NFC)-1995.

.8 Transport Canada (TC).

.1 Transportation of Dangerous Goods Act, 1992 (TDGA).

1.4 SUBMITTALS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate all details of construction, appurtenances, and installation on the shop drawings.

.3 Shop drawings to detail and indicate following as applicable to project requirements. Submit manufacturers product data to supplement shop drawings.

.1 Size, materials and locations of ladders, ladder cages, catwalks and lifting lugs.
.2 Tanks capacity.
.3 Size and location of fittings.
.4 Environmental compliance package accessories.
.5 Decals, type size and location.
.6 Accessories: provide details and manufacturers product data.
.7 Size, material and location of manholes.
.8 Size, materials and locations of railings, stairs, ladders and walkways.
.9 Finishes.
.10 Electronic accessories: provide details and manufacturers product data.
.11 Piping, values and fittings: type, materials, sizes, piping connection details, valve shut-off type and location, cathodic protection system complete with stamp of corrosion expert indicating that design complies with standards, Federal and Provincial regulations.
.12 Spill containment: provide description of method[s] and show sizes, materials and locations for collecting spills at connection point between storage tank system and delivery truck, rail car, or vessel.
.13 Size and location of site pads.
.14 Level gauging: type and locations, include:
.1 Provide details and manufacturer's product data.
.15 Ancillary devices: provide details and manufacturer's product data.
.16 Grounding and bonding: provide details of design, type, materials and locations.
.17 Corrosion protection: provide details of design, type, materials and locations.
.18 Field-erected AST overfill-protection systems: provide details of design, type, materials and locations.
.19 Containment system for spills, overfills and storm runoff water: provide details, materials used, and locations.

1.5 WASTE MANAGEMENT AND DISPOSAL

.1 Remove from site and dispose of all packaging materials at appropriate disposal facilities.

.2 Separate for reuse and place into designated piles any unused steel in accordance with AEM Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Dispose of hazardous materials in accordance with Territorial and Municipal regulations.

.5 Clearly label location of salvaged material's storage areas.

.6 Ensure emptied containers are sealed and stored safely.

.7 Divert unused wood and steel materials from landfill to metal recycling facility as directed by AEM Environmental Dept.

.8 Divert unused concrete materials from landfill to local quarry as approved by local authorities.

.9 Dispose of unused paint or coating material at an official hazardous material collections site as approved by AEM Environmental Dept.

.10 Do not dispose unused paint and painting materials into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.11 Fold up metal banding, flatten and place in designated area for later disposal.

PART 2 – PRODUCTS

2.1 TANKS: CONVENTIONAL STEEL

This section is not applicable to the present project.

2.2 TANKS: STEEL DYKED

This section is not applicable to the present project.

2.3 TANKS: STEEL INSULATED AND LINED CONCRETE ENCLOSED

This section is not applicable to the present project.

2.4 TANKS WITH SECONDARY CONTAINMENT

.1 Single-wall, single-bottom storage tank placed entirely within dyked area, complete with impermeable barrier in floor of containment area and in dyke walls.

.2 Secondary containment impermeable barriers:
- .1 To ULC/ORD-C107.7, using High density polyethylene liner and installed so that:
  - .1 Fluids entering interstitial space flow by gravity to containment sump.
  - .2 High density polyethylene liner is installed under the tank floor.
- .2 Sustained permeability of HDPE liner is not influenced by differential pressure.
- .3 Nominal thickness of High density polyethylene liner will be 1.50 mm.
- .4 Placement of a suitable geotextile under and over the HDPE liner is indicated on the construction drawings, and will reduce the risk of puncturing the HDPE liner.
- .5 Placement of a layer of screened sand under and over the geotextile is indicated on the construction drawings, and will further reduce the puncture risks.
- .6 The anchoring method of the HDPE liner into a key located on top of the dykes is indicated on the construction drawings.
- .7 Detailed Specifications for the High density polyethylene liner are :
  - .1 Minimum average thickness, ASTM D 5199 : 1500 microns
  - .2 Lowest individual thickness reading, ASTM D 5199 : 1350 microns
  - .3 Roll Width : minimum of 7.0 m
  - .4 Density, ASTM D 1505/D : 0.940 g/cc
  - .5 Tensile Properties, ASTM D 6693 :
    1. Yield Strength, 22 kN/m
    2. Break Strength, 40 kN/m
    3. Yield Elongation, 12%
    4. Break Elongation, 700%
  - .6 Tear Resistance, N ASTM D : 187 N
  - .7 Puncture Resistance, N ASTM D 4833 : 480 N
  - .8 Stress Crack Resistance, ASTM D 5397 : 300 hours
  - .9 Carbon Black Content, ASTM D 1603 : 3.0%

.10 Seam Properties, ASTM D 6392 (@ 5 cm/min) :
1. Shear Strength, 21 kN/m
2. Peel Strength, 15.9 kN/m for Hot Wedge
3. Peel Strength, 13.6 kN/m for Extrusion Fillet

2.5 PIPING, VALVES AND FITTINGS

.1 In accordance with Section D 20 50 - Fuel Oil Piping.

.2 Flexible pipe and fittings used

.3 Mechanical joints on buried primary piping is not permitted.

.4 Piping located below product level shall be equipped with either a manual or automatic shut-off at the N2 outlet of each storage tank.

.5 Provide means for collecting fuel spills (e.g. a sump or suitable container) at connection point between storage tank system and delivery truck, barge, or vessel.

.6 If applicable, steel underground piping to have cathodic protection system designed by corrosion expert and in accordance with Section 26 42 00 - Cathodic Protection. Flexible pipe and fittings used for primary pipe in underground service shall be designed, constructed and certified to ULC/ORD-C107.4.

2.6 THERMOMETERS

.1 Manual thermometers will be used during tank dipping procedures for inventory reconciliation procedures.

2.7 LEVEL GAUGING

.1 Tank level gauging and indicator.
.1 Mechanical, float and tape direct reading device such as VAREC 2500 series ATG.
.2 Gauge and gauge openings: protected against liquid overflow.

.2 Access hatch will be installed on roof of field erected tanks and will be used during the precision tank dipping procedures for inventory reconciliation procedures.

2.8 GROUNDING AND BONDING

.1 Perform grounding of steel tanks as indicated by the AEM Electrical Dept.

2.9 CORROSION PROTECTION

.1 Underground Piping.
- .1 No unidergound piping is foreseen in the latest revision of project drawings.
- .2 Should an underground piping section be required, drawings would be revised accordingly and designed in accordance with CAN/ULC-S603.1.

.2 Steel storage tank systems.
- .1 Cathodic protection requirements will be ascertained by a corrosion expert.

2.10 DAMAGED/REPAIRED TANKS

.1 While not foreseen within this project, repairs would be done in conformance with API 653.

2.11 RELOCATED TANKS

This section is not applicable to the present project.

2.12 TANK INSULATION

This section is not applicable to the present project.

2.13 OVERFILL AND SPILL CONTAINMENT

.1 Field-erected AST overfill-protection systems.
- .1 Truck, rail ship or barge delivery.
  - .1 Visual and audible alarm system for detecting fluid level that will activate and alert personnel in enough time to terminate product flow to storage tank and prevent overfill.

2.14 PRODUCT TRANSFER

.1 ASTs with normal vent and separate emergency vent.
- .1 Liquid- and vapour-tight connection on fill pipes for flammable products.

2.15 LINER PENETRATION

.1 At high point or raised part of dyke floor.

.2 Sealed.

2.21 TANK BOTTOM WATER

.1 Segregated from rainwater.

.2 Disposed of in accordance with applicable Territorial regulations, guidelines and policies.

2.22 SPILLS, OVERFILLS AND STORM RUNOFF WATER

.1 Contained, treated and disposed of in accordance with applicable Territorial regulations, guidelines and policies.

.2 Oil/water separator to be used for treatment of storm water runoff from transfer area.
- .1 Oil/water separator is designed to produce discharge water with 15 mg/L, or less, of oil and grease at a treatment flow rate of 50 USGPM per unit.
- .2 Oil/water separator is designed for oil with specific gravity of 0.90.
- .3 Oil/water separator is designed with hydraulic retention time required to separate oil with particle droplet size of 60 microns from storm water.
- .4 Storm runoff water will not discharge directly into the oil/water separator, but rather accumulate in a containment sump within dykes for further treatment.
- .5 Storm runoff water will be pumped into the oil/water separator, when needed.
- .6 Oil/water separator inflow from sump pump will be restricted to 80% of unit treatment flow rate, as specified by the manufacturer (40 USGPM), through an orifice plate flow reduction device, thus eliminating formation of oil emulsion.
- .7 The excess flow from the orifice plate flow reduction device will return by gravity to the surface water runoff sump located within the dyked containment area.

PART 3 - EXECUTION

3.1 INSTALLATION

.1 Field erection of tanks will be made in accordance with API Standard 650, latest revision, National Fire Code of Canada, and recommendations from CCME PN 1326 (2003).

.2 Field erection of tanks will be made by certified welders and journeymen, and under the supervision of an Engineer.

.3 Upon completion of field work, provide certification of installation to the Owner.

3.2 FIELD QUALITY CONTROL

.1 Test tanks for leaks to requirements of API Standard 650 and in presence of Engineer.

3.3 TOUCH-UP

.1 Where coating is damaged, touch-up with original coating material.

3.4 LEVEL GAUGE SYSTEM

.1 Shield capillary and tubing connections in heavy duty 50 mm polyethylene pipe.

.2 Calibrate system.

PART 1 - GENERAL

1.1 SUMMARY

.1 Section Includes:
- .1 Fuel dispensing systems.

.2 Related Sections:
- .1 Section 01 33 00 - Submittal Procedures.
- .2 Section 01 35 43 - Environmental Procedures.
- .3 Section 33 56 13 - Aboveground Fuel Storage Tanks

1.2 REFERENCES

.1 American Petroleum Institute (API)
- .1 API STD 1104-e01, Welding of Pipelines and Related Facilities.
- .2 API SPEC 5L-04, Specification for Line Pipe.
- .3 API SPEC 6D-02, Specification for Pipeline Valves.
- .4 ANSI/API 650-2000, Welded Steel Tanks for Oil Storage.

.2 American Society of Mechanical Engineers (ASME)
- .1 ASME B16.11-01, Forged Fittings Socket Welding and Threaded.

.3 American Society for Testing and Materials International (ASTM)
- .1 ASTM A 48/A 48M-00, Standard Specification for Gray Iron Castings.
- .2 ASTM A 53/A 53M-04, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- .3 ASTM A 181/A 181M-01, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

.4 Canadian Standards Association (CSA International)
- .1 CSA-B139-04, Installation Code For Oil Burning Equipment.
- .2 CAN/CSA W48-01, Filler Metals and Allied Materials for Metal Arc Welding.
- .3 CSA-W178.1-02, Certification of Welding Inspection Organizations.

.5 Canadian Council of Ministers of the Environment (CCME)
- .1 CCME PN1326-2003, Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.

1.3 PERFORMANCE REQUIREMENTS

.1 Select equipment to operate at best efficiency points.

.2 Fuel Dispensing Systems:
.1 Safeguard natural streams, waterways and storm drainage systems from contamination in accordance with local codes and authorities having jurisdiction.
.2 Design piping system to work to maximum anticipated working pressures and temperatures encountered within system.
.3 Protect tanks and piping located outside of building from accidental damage.
.4 Berm above ground tanks.
.5 Protect below ground piping from frost damage.

1.4 SUBMITTALS

.1 Submittals in accordance with Section 01 33 00 - Submittal Procedures.

.2 Product Data:
.1 Submit manufacturer's printed product literature, specifications and data sheet.

.3 Shop Drawings:
.1 Submit Shop Drawings to indicate project layout, including:
.1 Information on operating mechanisms, finishes and location of manufacturer's nameplates.
.2 Vertical and horizontal piping locations and elevations and connections details.
.3 Catalogue details for types of pipe and accessories illustrating profiles, dimensions and methods of assembly.
.4 Schedule identifying units and their locations.

.4 Test Reports: submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.5 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.6 Instructions:
.1 Submit manufacturer's installation instructions.
.2 Submit manufacturer's instructions for commissioning activities for equipment provided in this section.

.7 Manufacturer's Field Services: submit reports within five days of receipt from manufacturer.

1.5 QUALITY ASSURANCE

.1 Provide products of this section from same manufacturer, to insure uniformity of supplies.

.3 Welding Inspectors: to CSA-W178.2.

.4 Storage Tanks: to CCME PN1326 and ANSI/API 650-2000.

.5 Verification: contractor's final verification and quality control procedures should be in accordance with local practices, consult with Owner for more details.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Store and manage hazardous materials in accordance with local practices, consult with Owner for more details.

.2 Waste Management and Disposal:

.1 Remove from site and dispose of all packaging materials at appropriate disposal facilities.

.2 Separate for reuse and place into designated piles any unused steel in accordance with AEM Waste Management Plan.

.3 Place materials defined as hazardous or toxic in designated containers.

.4 Dispose of hazardous materials in accordance with Territorial and Municipal regulations.

.5 Clearly label location of salvaged material's storage areas.

.6 Ensure emptied containers are sealed and stored safely.

.7 Divert unused wood and steel materials from landfill to metal recycling facility as directed by AEM Environmental Dept.

.8 Divert unused concrete materials from landfill to local quarry as approved by local authorities.

.9 Dispose of unused paint or coating material at an official hazardous material collections site as approved by AEM Environmental Dept.

.10 Do not dispose unused paint and painting materials into sewer system, into streams, lakes, onto ground or in other location where it will pose health or environmental hazard.

.11 Fold up metal banding, flatten and place in designated area for later disposal.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 Materials will be supplied by the Owner.

.2 Detailed specifications on materials that will be used are further defined in Appendix 3, which materials are to be identical to those used in construction of existing installations.

2.2 FUEL DISPENSING SYSTEMS

.1 Fuel Storage Tanks:
.1 Above ground, to ANSI/API 650-2000.

.2 Piping:
.1 Conform to Appendix 3 : Detailed pipe and valve specifications.

.3 Fittings:

.1 Conform to Appendix 3 : Detailed pipe and valve specifications.
.2 Strainer: ASTM A 48/A 48M.

.4 Pumps: no additional pumps are to be installed in present project ; there will be gravity flow from fuel tanks # 5 and fuel tank # 6 towards the existing fuel dispensing module.

.5 Fuel shut-off valve : Fuel piping located below the maximum fuel level of tanks should be provided with a means to prevent syphon flow coming from the tanks.

For this purpose, some automatic shut-off valves, of type ANSI Class 150 flanged plug valve, equipped with spring-return actuators would need to be installed on each N2 tank outlet, for all existing and future fuel tanks. This feature would prevent a major fuel spill in the eventuality of vehicle impact damage on the pipeline that supplies fuel to the dispensing module, at least during occurrences when the fuel dispensing pump is not operating.

PART 3 - EXECUTION

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written data, including technical bulletins, product catalog installation instructions, product carton installation instructions, and data sheets.

3.2 PREPARATION

.1 Obtain approval of authorities having jurisdiction prior to commencing work of this section.

3.3 INSTALLATION

.1 Fuel Dispensing:
- .1 Provide for thermal expansion of fuel in pipelines with a pressure release.
- .2 Do not cover buried piping or equipment prior to leak test approval.
- .3 Welding to API STD 1104, electrodes to CAN/CSA W48.1.

.2 Pressure test systems with compressed air, prior to filling the pipeline with fuel-oil, and submit results in writing to Engineer for approval and further pipeline commissioning.

3.4 FIELD QUALITY CONTROL

.1 Manufacturer's Services:
- .1 Have manufacturer of products, supplied under this Section, review Work involved in handling, installation/application, protection and cleaning, of their products.
- .2 Manufacturer's Field Services: provide manufacturer's field services consisting of product use recommendations.

.2 Verification:
- .1 Operate equipment and verify that performance criteria specified in this section has been achieved, prior to filling the pipeline with fuel-oil.

3.5 CLEANING

.1 Perform cleaning operations in accordance with manufacturer's recommendations.

PART 1 - GENERAL

1.1 RELATED SECTIONS

.1 Section 01 33 00 - Submittal Procedures.

.2 Section 32 11 23 - Aggregate Base Courses.

1.2 MEASUREMENT PROCEDURES

.1 Measure supply and installation of concrete roadside barrier in block units along its centreline.

1.3 SHOP DRAWINGS

.1 Submit shop drawings in accordance with Section 01 33 00 - Submittal Procedures.

.2 Indicate following items on shop drawings:
- .1 Concrete block dimensions.
- .2 Estimated weight per block
- .3 Location of cast lifting lugs, appropriate for block weight
- .4 Location of cast inserts for pipeline supports

1.4 SAMPLES

.1 No samples are to be submitted, once shop drawings have been approved.

.2 Inform Owner at least 2 days prior to beginning of pouring into forms, to allow inspection of forms and confirmation of the number of blocks to be installed.

PART 2 – PRODUCTS

2.1 MATERIALS

.1 External connectors:
  .1 Steel: as indicated by Owner.

.2 Reinforcement: in accordance with following requirements:
  .1 Grade 350 deformed bars, or as indicated by Owner.

.3 Concrete mixes and materials : as indicated by Owner.

.4 Granular base: in accordance with Section 32 11 23 - Aggregate Base Courses.

PART 3 - EXECUTION

3.1 PREPARATION

.1 Do grading in accordance with standard practices, and as indicated by Owner.

.2 Install granular base in accordance with Section 32 11 23 - Aggregate Base Courses.

.3 Install precast concrete blocks for pipeline support and permanent vehicle barriers according to quantities and installation layout, as indicated by Owner.

3.2 CONSTRUCTION

.1 Do forming and Install reinforcement as indicated by Owner.

.2 Precast units.

.1 Do concrete work in accordance with standard practices, and as indicated on approved shop drawings.
.2 Round edges including edges of joints, with 10 mm radius edging tool.
.3 Finish surfaces to within 3 mm in 1.2 m from line, level or grade as measured with straightedge placed on surface.
.4 Cast lifting lugs into concrete blocks.
.5 Cast metal inserts into blocks, on which pipeline supports may be welded to.
.6 Provide minimum 60 mm cover over reinforcement.
.7 Use only inverted steel forms.
.8 Concrete to be without surface defects to approval of Engineer.
.9 Place concrete barrier units and make connections as indicated. Alignment to be smooth with no visible deviations.

APPENDIX 1

OPSS 1010 (2003) MATERIAL SPECIFICATION FOR AGGREGATES – BASE, SUBBASE, SELECT SUBGRADE, AND BACKFILL MATERIAL

ONTARIO PROVINCIAL STANDARD SPECIFICATION

METRIC
OPSS 1010
November 2003

MATERIAL SPECIFICATION FOR AGGREGATES - BASE, SUBBASE, SELECT SUBGRADE, AND BACKFILL MATERIAL

TABLE OF CONTENTS

1010.01 SCOPE

This specification covers the material requirements for aggregates for use in base, subbase, select subgrade, granular surface, shouldering, and backfill material. Procedures for QC and QA and referee testing protocols are incorporated.

1010.01.01 Significance and Use of Appendices

Appendices are not a mandatory part of this specification unless invoked by the Owner.

Appendix 1010-A is a commentary appendix to provide designers with information on the use of the specification in a Contract.

Appendix 1010-B is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting fine aggregate test data, other than for LS-602 and LS-702.

Appendix 1010-C is an additional information option that is invoked only when referenced in the Contract Documents by the Owner. This appendix contains a form for reporting coarse aggregate test data, other than for LS-602.

1010.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specification, Material

OPSS 1001 Aggregates - General

Ministry of Transportation, Ontario, Publications

MTO Laboratory Testing Manual

LS-602	Sieve Analysis of Aggregates
LS-607	Percent Crushed Particles in Processed Coarse Aggregate
LS-609	Petrographic Analysis of Coarse Aggregate
LS-614	Freezing and Thawing of Coarse Aggregate
LS-616	Petrographic Analysis of Fine Aggregate
LS-617	Percent Particles with Two or More Crushed Faces and Uncrushed Particles in Processed Coarse Aggregate
LS-618	The Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-619	Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-621	Determination of Amount of Asphalt Coated Particles in Coarse Aggregate
LS-624	The Use of Control Charts for Construction Aggregates
LS-625	Sampling of Granular Materials
LS-702	Determination of Particle Size Analysis of Soils
LS-703/704	Liquid Limit, Plastic Limit and Plasticity Index of Soils
LS-709	Determination of Permeability of Granular Soils

1010.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Air-Cooled Blast-Furnace Slag means the material resulting from solidification of molten blast-furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface.

Bench means a ledge parallel to stratigraphic bedding that in quarries forms a single level of operation above which rock is excavated from a contiguous face.

Business Day means any Day except Saturdays, Sundays, and statutory holidays.

Control Chart means a graphical chart used to monitor the central tendency and variability of a material characteristic in order to control production.

Ceramic means porcelain, china, and whiteware, e.g., sinks, toilets, and bidets made from clay and silica fired at a high temperature, excluding clay brick and tile, free of organic materials, metal, and plastic.

Deleterious Material means materials from the recycling stream other than glass, ceramic, reclaimed asphalt pavement, and reclaimed concrete materials that includes but is not limited to the following: wood, clay brick, clay tile, plastic, gypsum, gypsum plaster, and wallboard.

Free of Clay means the amount of material with a particle diameter less than 2 m shall not be greater than 1% of the total sample when tested according to LS-702.

Glass means processed glass obtained from the recycling stream that is free of organic materials, metal, and plastic.

Granular A means a set of requirements for dense graded aggregates intended for use as granular base within the pavement structure, granular shouldering, and backfill.

Granular B means a set of requirements for well-graded aggregates intended for use as granular subbase within the pavement structure and granular backfill. Granular B may be either Type I or Type II.

Granular M means a set of requirements for dense graded aggregates intended for use on unpaved road surfaces and for the maintenance of unpaved shoulders.

Granular O means a set of requirements for open graded aggregates intended only for use as a free draining granular base within the pavement structure.

Granular S means a set of requirements for dense graded aggregates intended only for use as surface dressing of low volume unpaved roads with an AADT less than 200.

Nickel Slag means the non-metallic co-product resulting from the production of nickel.

Physical Property means an inherent attribute or feature of an aggregate or soil material. Tests are carried out to determine a materials resistance to weathering or degradation or both.

Pit-Run Material means material excavated directly from an existing bank in a pit and delivered to the job site without further processing, e.g., crushing, screening, washing, and classifying.

Production Characteristic means an attribute or feature of an aggregate or soil material, including gradation, that is introduced into the material through the manufacturing process, e.g., crushing, screening, and, blending.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received meet the specified requirements.

Quality Control (QC) means a system or a series of activities performed by the Contractor to ensure that materials supplied meet the specified requirements.

Random Numbers means numbers generated by chance and recorded in random number tables.

Reclaimed Asphalt Pavement (RAP) means processed hot mix asphalt material that is recovered by partial or full depth removal.

Reclaimed Concrete Material (RCM) means removed or processed old Portland cement concrete.

Referee Testing means testing by an independent laboratory selected by the Contract Administrator and acceptable to the Contractor, the results of which are used for resolving differences between QC and QA testing.

Select Subgrade Material (SSM) means a set of requirements for well-graded non-plastic aggregates used to replace poor subgrade materials and as swamp backfill.

Statistical Control means when all sources of assignable variation have been removed, that is when the variability of the process is confined to chance variation alone.

Steel Slag means the non-metallic co-product resulting from the production of steel in a basic oxygen or electric arc furnace.

1010.04 SUBMISSION and DESIGN REQUIREMENTS

1010.04.01 Submission of Test Data

The Contractor shall have test results available for the aggregates to be used in the work. At the request of the Contract Administrator, the Contractor shall make available or submit QC test results prior to the delivery of the material. Test results shall be submitted by either the stockpile/pit-run method or control chart method. All test data forms shall be legible.

Test data for each aggregate product shall be managed independently. Where more than one source is used for supplying materials, test data from each source and product shall be managed independently.

1010.05 MATERIALS

1010.05.01 General

The requirements of OPSS 1001 shall apply to this specification. Materials shall conform to this specification when tested according to the MTO Laboratory Testing Manual.

All aggregate source materials shall be clean hard durable particles free of earth, humus, and clay, e.g., coatings, lumps, and fragments. Where reclaimed materials are permitted, they shall be homogeneously blended. Where RCM is permitted, RCM shall not contain loose reinforcing materials.

Where air-cooled blast furnace slag, nickel slag, and RAP containing steel slag aggregates are used, site-specific notification shall be given by the Contractor to the Ontario Ministry of the Environment (MOE). Glass and ceramic material shall be processed to remove all deleterious organic materials.

One hundred percent of the processed glass and ceramic material shall pass the 13.2 mm sieve.

Steel slag shall not be used.

1010.05.02 Granular A, Granular M, and Granular S

Granular A, Granular M, and Granular S may be produced by crushing one or more of the following:

a) Quarried bedrock.

b) Naturally formed deposits of sand, gravel, and cobbles.

c) RAP up to 30% by mass.

d) RCM.

e) Air-cooled blast-furnace slag or nickel slag.

f) Glass or ceramic materials up to 15% by mass combined.

Granular A and Granular M may contain up to 100% RCM but shall not contain more than 30% by mass of asphalt coated particles and not more than a combined total of 15% by mass of glass and ceramic material. The combined amount of deleterious material shall not exceed a total of 1% by mass.

Granular A and Granular M containing RAP with steel slag aggregates shall be acceptable for unpaved gravel shoulders only.

1010.05.03 Granular B

1010.05.03.01 General

Granular B may be either Type I or Type II as described below.

1010.05.03.02 Granular B Type I

Granular B Type I may be produced from naturally formed deposits of sand, gravel, and cobbles or by crushing one or more of the following:

a) Quarried bedrock.

b) Air-cooled blast-furnace slag or nickel slag.

c) RCM.

d) RAP up to 30% by mass.

e) Glass or ceramic materials up to 15% by mass combined.

Granular B Type I may contain up to 100% RCM but shall not contain more than 30% by mass of asphalt coated particles. Granular B Type I may not contain more than a combined total of 15% by mass of glass and ceramic material. The combined amount of deleterious material shall not exceed 1% by mass.

RAP containing steel slag aggregates shall not be allowed.

1010.05.03.03 Granular B Type II

Granular B Type II shall only be obtained from crushing quarried bedrock, air-cooled blast furnace slag, or nickel slag. Steel slag and reclaimed materials shall not be used in the production of Granular B Type II.

1010.05.03.04 Granular O

Granular O shall only be produced by crushing quarried bedrock, or by crushing cobbles or boulders retained on the 50 mm sieve.

1010.05.03.05 Select Subgrade Material

Select subgrade material shall only be non-plastic granular or sandy type soil produced from naturally formed deposits.

1010.07 Production

1010.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates that have become mixed with foreign matter of any description, or aggregates that have become mixed with each other shall not be used and shall be removed from the stockpile immediately. When a change in the character of the materials occurs or when the performance of materials that meet the requirements of this specification is found to be unsatisfactory, the use of the materials shall be discontinued until the Contractor, with the approval of the Contract Administrator, proves the source to be satisfactory.

Once a stockpile has been produced, sampled, and tested for QC under the procedure for stockpile/pit-run method, no further materials shall be added to the stockpile. Stockpiles produced, sampled, and tested under the procedure for control chart method may continue to have materials added provided that sampling and testing show that materials in the stockpile conform to this specification and that the process remains in statistical control.

1010.07.02 Quality Control

1010.07.02.01 General

The Contractor shall be responsible for all QC sampling and testing required to show conformance of the aggregates with this specification. Either the stockpile/pit-run method or control chart method shall be used. These records shall be made available to the Contract Administrator upon request.

Where the stockpile/pit-run method has been selected, test data shall be obtained from samples taken from stockpiled or pit-run material to be used in the work.

Where the control chart method has been selected, control charts shall be prepared in accordance with LS-624 or similar method. Each control chart shall contain information regarding control limits, specification limits, target values, testing frequencies, sampling locations, and time period over which the testing has taken place. Each control chart shall include individual test data of the most recent sample indicated on the chart.

1010.07.02.02 Laboratory Requirements

The Contractor shall select all QC laboratories and shall be responsible for all costs associated with the testing for QC requirements.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current certificate from Canadian Council of Independent Laboratories (CCIL) as Type D for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specific tests, except LS-616 and LS-709.

An acceptable laboratory to conduct tests for gradation according to LS-602 and percent crushed particles according to LS-607 shall be one who holds a current certificate from CCIL as Type C.

Testing shall be conducted by qualified laboratory staff that hold a valid aggregate testing certificate from CCIL.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements provided they are acceptable to the Contract Administrator.

1010.07.03 Physical Properties

1010.07.03.01 Stockpile/Pit-Run Method

Testing demonstrating conformance of the aggregates with Table 1 shall be completed for each quantity of material produced according to the following schedule:

a) For the first 25,000 tonnes of aggregate produced.

b) For the next 50,000 tonnes of aggregate produced.

c) For each 100,000 tonnes of aggregate produced thereafter.

Further testing is required whenever material is produced from a new source or a new bench in a quarry or whenever a significant change in aggregate production or material occurs that may affect the quality of material.

1010.07.03.02 Control Chart Method

The Contractor shall use a Type 1 control chart as defined in LS-624 or similar method for each physical property requirement shown in Table 1. When the control chart has been established, the minimum frequency of sampling and further testing shall be as follows:

a) Annually, i.e., obtained within the past 12 months, where the mean value of the physical property is less than 75% of the limit given in Table 1 and the Type 1 control chart demonstrates the process to be in statistical control; or

b) Three times per year, spaced evenly throughout the aggregate production season, where the mean value of the physical property is greater than 75% of the limit given in Table 1 or the Type 1 control chart demonstrates the process to be out of statistical control.

1010.07.04 Production Characteristics

1010.07.04.01 Stockpile/Pit-Run Method

Testing demonstrating conformance of the aggregates with Table 2 shall be completed for each 1,000 tonnes of material produced.

1010.07.04.02 Control Chart Method

A Type 1 or Type 2 control chart according to LS-624 or similar method for each applicable requirement shown in Table 2 may be used.

Type 1 control charts shall cover production of at least 20,000 tonnes of material. Type 2 control charts shall cover production of at least 80,000 tonnes of material. New or revised control charts shall be required for each successive production and delivery quantity of material, as applicable.

a) Where a Type 1 chart is used, the minimum number of test results shall be twenty (n=20). When this control chart has been established, the frequency of sampling and further testing shall be as follows:

    i. When the mean value (n=20) of the test results is within the limit and the process is shown to be in statistical control, the frequency of sampling and testing may be decreased to meet the quantities shown in Table 3; otherwise,
    ii. The minimum frequency shall be every 1,000 tonnes of material produced.

b) Where a Type 2 chart is used, the minimum number of subgroups shall be twenty (k=20). When this control chart has been established, the frequency of sampling and further testing shall be as follows:

    i. When the process is shown to be in statistical control, frequency of sampling and testing may be decreased to meet the quantities shown in Table 3; otherwise,
    ii. The minimum frequency shall be every 1,000 tonnes of material produced.

1010.08 QUALITY ASSURANCE

1010.08.01 General

The Contract Administrator shall be allowed access to all sampling locations and reserves the right to take a QA sample at any time with notice to the Contractor. The Contract Administrator may elect to carry out testing at the QA laboratory to ensure that materials used in the work conform to the requirements of this specification.

Test data for each aggregate type shall be managed independently. Where more than one source is used for supplying materials, test data from each source, and product shall be managed independently.

1010.08.02 Sampling

Sampling shall be according to LS-625 taken at a time and location determined by the Contract Administrator.

Duplicate samples shall be obtained and sealed by the Contractor in the presence of the Contract Administrator. In the event that the Contractor is unavailable to take the sample, no further materials shall be placed in the work until the QA sample has been taken. Samples shall be of sufficient mass of the material to conduct the necessary gradation and physical property tests.

Each QA sample shall meet the requirements of Table 4 and shall be clearly identified both inside and outside of the container.

When materials contain blended or reclaimed aggregates or both, QA sampling shall be performed on the final blended product.

1010.08.03 QA Laboratory Requirements

The Owner will designate the QA laboratories and will be responsible for all costs associated with QA testing.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current certificate from CCIL as Type D for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specific tests, except for LS-616 and LS-709.

An acceptable laboratory to conduct tests for gradation according to LS-602 and percent crushed particles according to LS-607 shall be one that holds a current certificate from CCIL as Type C.

Testing shall be conducted by qualified laboratory staff that hold a valid aggregate testing certificate from CCIL.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements provided they are acceptable to the Contract Administrator.

1010.08.04 Acceptance

When QA testing has not been carried out, the material shall be deemed acceptable. Otherwise, QA test results or referee test results shall be used for acceptance purposes as indicated below.

When QA test results show that the materials meet the applicable requirements of Table 1 and Table 2, the material will be accepted.

When QA test results show that the material does not meet the applicable requirements of Table 1 and Table 2, the Contract Administrator shall notify the Contractor that materials represented by the test results shall not be accepted. This notification will take place in writing within 3 business days of receipt of the non-conforming data.

At the discretion of the Contract Administrator, irrespective of non-compliance with the requirements of Table 1 and Table 2, aggregates may be accepted on the basis of satisfactory field performance.

1010.08.05 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that fails to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option within 2 business days following notification of unacceptable material.

The Contract Administrator shall select a referee laboratory acceptable to the Contractor within 3 business days following the Contractor's notification to invoke referee testing. Referee samples shall be delivered to the referee laboratory from the QA laboratory by the Contract Administrator. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator. If referee materials are not available, the Contractor shall be responsible for obtaining and submitting new samples to the referee laboratory from a location to be decided by the Contract Administrator. The Contract Administrator shall be present to witness the sampling.

Referee testing shall be carried out in the presence of the Contract Administrator. Where applicable, the referee laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner. Comments on the nonconformity of the test methods must be made and corrected at the time of testing. If the testing cannot be corrected or if agreement on the procedure cannot be reached, the testing shall be postponed until the procedure is corrected or agreement between the parties is reached. Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the material represented by the test result, including materials in existing stockpiles or in the work shall not be accepted. The Contractor shall remove the material from the work at no cost to the Owner.

When a referee test result shows that the aggregates are in complete conformance with the requirements of this specification, the material represented by the sample shall be accepted.

The Owner will be responsible for the cost of referee testing provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the costs.

Table 1
Physical Property Requirements

Laboratory Test	MTO Test Number	Granular O	Granular A	Granular S	Granular B Type I and Type II	Granular M	Select Subgrade Material
Coarse Aggregate Petrographic Requirement	LS-609	(Note 2)	(Note 1) (Note 2)	(Note 2)	(Note 1) (Note 2)	(Note 1) (Note 2)	(Note 2)
Freeze-Thaw Loss, % maximum	LS-614	15	N/A	N/A	N/A	N/A	N/A
Fine Aggregate Petrographic Requirement	LS-616 LS-709		(Note 3)				
Micro-Deval Abrasion Coarse Aggregate loss, % maximum	LS-618	21	25	25	30 (Note 4)	25	30 (Note 4)
Micro-Deval Abrasion Fine Aggregate loss, % maximum	LS-619	25	30	30	35	30	N/A
Plasticity Index	LS-704	0	0	0	0	0	0
Percent crushed, minimum	LS-607	100	50	50	N/A	50	N/A
2 or more crushed faces, % minimum	LS-617	85	N/A	N/A	N/A	N/A	N/A
Asphalt Coated Particles, % maximum	LS-621	N/A	30	30	(Note 5)	30	N/A

Notes:

1. Granular A, B Type I, or M may contain up to 15% by mass of crushed glass and ceramic material combined.

2. Granular A, B Type I, M, and S shall not contain more than 1% by mass of deleterious material. Granular O, Granular B Type II, and SSM shall not contain more than 0.1% by mass of wood. Petrographic classification of rock type need not be reported. This requirement is only to be reported when such material is present.

3. Test required for materials north of the French and Mattawa Rivers only. For materials with greater than 5.0% passing the 75 μm sieve, the amount of mica passing the 150 μm sieve and retained on the 75 μm sieve, shall not exceed 10% of the material in that sieve fraction unless either testing according to LS-709 determines permeability values to be greater than 1.0×10^{-4} cm/s or field experience show satisfactory performance. Prior data demonstrating compliance with this requirement will be acceptable provided such testing has been done within the past five years and that field performance of these materials has been satisfactory.

4. The coarse aggregate Micro-Deval abrasion loss test requirements will be waived if the material has more than 80% passing the 4.75 mm sieve.

5. Granular B Type I may contain up to 30% asphalt coated particles. Granular B Type II shall not contain RAP or asphalt coated products.

Table 2
Gradation Requirements - Percent Passing

MTO Test Number	Sieve	Granular						Select Subgrade Material
		O	A	S	B (Note 1)		M	
					Type 1 (Note 2)	Type II		
LS-602	150 mm	N/A	N/A	N/A	100	N/A	N/A	100
	106 mm	N/A	N/A	N/A	N/A	100	N/A	N/A
	37.5 mm	100	N/A	N/A	N/A	N/A	N/A	N/A
	26.5 mm	95-100	100	100	50-100	50-100	N/A	50-100
	19.0 mm	80-95	85-100 (87-100*)	90-100	N/A	N/A	100	N/A
	13.2 mm	60-80	65-90 (75-95*)	75-100	N/A	N/A	75-95	N/A
	9.5 mm	50-70	50-73 (60-83*)	60-85	N/A	N/A	55-80	N/A
	4.75 mm	20-45	35-55 (40-60*)	40-60	20-100	20-55	35-55	20-100
	1.18 mm	0-15	15-40	20-40	10-100	10-40	15-40	10-100
	300 μm	N/A	5-22	11-25	2-65	5-22	5-22	5-95
	150 μm	N/A	N/A	N/A	N/A	N/A	N/A	2.0-65.0
	75 μm	0-5.0	2.0-8.0 (2.0-10.0**)	9.0-15.0 (9.0-17.0**)	0-8.0 (0-10.0**)	0-10.0	2.0-8.0 (2.0-10.0**)	0-25.0

Notes:

1. Where Granular B is used for granular backfill for pipe subdrains, 100% of the material shall pass the 37.5 mm sieve.

2. Where RAP is included in Granular B Type I, 100% of the RAP shall pass the 75 mm sieve. Conditions in Note 1 supersede this requirement.

* Where the aggregate is obtained from an air-cooled blast furnace slag source.

** Where the aggregate is obtained from a quarry or an air-cooled blast furnace slag or nickel slag source.

Table 3
Minimum Sampling and Testing Frequency for Control Chart Use

Material	Frequency for Type 1 Control Chart t	Frequency for Type 2 Control Chart t
Granular A, M, and S	2,500	5,000
Granular B and SSM	5,000	10,000
Granular O	2,000	4,000

Table 4
Sample Size

Material	Minimum Mass of Individual Field Samples kg
Granular A, S, M, and O	25
Granular B and SSM	50
Granular B and SSM 100% passing 26.5 mm sieve	25
Note: Each sample container shall hold no more than 25 kg of material.	

Appendix 1010-A, Commentary for OPSS 1010, November 2003

Note: This Appendix does not form part of the standard specification. It is intended to provide information to the designer on the use of this specification in a Contract.

Designer Action/Considerations

The designer should determine if the forms in Appendices 1010-B and 1010-C are to be used for submission purposes. If so, they need to be invoked by reference in the Contract Documents.

The use of steel slag aggregate is prohibited.

The designer should be aware that air-cooled blast furnace slag, nickel slag, and RAP containing steel slag aggregates may require specific placement guidelines based on local municipal and MOE requirements.

Prior to tendering, where Owner supplied or specified air-cooled blast furnace slag, nickel slag, or RAP containing steel slag aggregates are to be used, the designer should obtain site notification from MOE and ensure all environmental guidelines and requirements are met.

RAP content is determined by LS-623, percent Asphalt Coated Particles. However, this test is limited to identifying RAP content in the coarse aggregate portion only. Where RAP in fine aggregate is a concern a Petrographic Examination of the material passing the 4.75 mm sieve is recommended. (1010.05.02)

The Contract Documents should specify the QA testing to be performed in the Contract. If QA testing is not specified, the material will be deemed acceptable.

The designer may specify a higher percent crushed requirement to improve performance in higher traffic areas.

Related Ontario Provincial Standard Drawings

None.

Appendix 1010-B, Additional Information for OPSS 1010, November 2003

Note: This appendix is not a mandatory part of the standard specification. However, it is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1010 - FINE AGGREGATE TEST DATA
Granular A, B, M, O, S, and Select Subgrade Material (SSM)

Contract No:	Contractor:	Contract Location:
Name of Testing Laboratory:		
Telephone No:	Fax No:	Date Tested:

Material Type (check one)						
Granular						[ ] SSM
[ ] A	[ ] B Type I	[ ] B Type II	[ ] M	[ ] O	[ ] S	
Date Sampled (YY/MM/DD):		Sampled by (Print Name):			Material Source:	

Laboratory Test Number	Acceptance Requirements							Test Results	
	Granular						SSM		
	A	B Type I	B Type II	M	O	S		Reference Material	Sample
Petrographic Requirement, LS-616	For materials north of the French and Mattawa Rivers: maximum 10% mica (retained on the 75 μm sieve).							N/A	
Micro-Deval Abrasion Loss, % maximum, LS-619	30	35	35	30	25	30	N/A		
Plasticity Index, % maximum, LS-704	0	0	0	0	0	0	0	N/A	

Issued by Testing Laboratory Representative:

PRINT NAME SIGNATURE DATE

Received By Contract Administrator Representative:

PRINT NAME SIGNATURE DATE

Appendix 1010-C, Additional Information for OPSS 1010, November 2003

Note: This appendix is not a mandatory part of the standard specification. However, it is written in mandatory language to permit invoking it by reference in the Contract Documents.

OPSS 1010 - COARSE AGGREGATE TEST DATA
Granular A, B, M, O, S, and Select Subgrade Material (SSM)

Contract No:	**Contractor:**	**Contract Location:**
Name of Testing Laboratory:		
Telephone No:	**Fax No:**	**Date Tested:**

Material Type (check one)						
Granular						**[ ] SSM**
[ ] A	**[ ] B Type I**	**[ ] B Type II**	**[ ] M**	**[ ] O**	**[ ] S**	
Date Sampled (YY/MM/DD):		**Sampled By (Print Name):**			**Material Source:**	

Laboratory Test Number	**Acceptance Requirements**							**Test Results**	
	Granular						**SSM**		
	A	**B Type I**	**B Type II**	**M**	**O**	**S**		**Reference Material**	**Sample**
Crushed Particles, % minimum, LS-607	50	N/A	100	50	100	50	N/A	N/A	
Petrographic Requirement, LS-609	(Note 1)	N/A	(Note 1)	(Note 1)	N/A	(Note 1)	N/A	N/A	
Freeze-Thaw Loss, % maximum, LS-614	N/A	N/A	N/A	N/A	15	N/A	N/A		
2 Faces Crushed, % minimum, LS-617	N/A	N/A	N/A	N/A	85	N/A	N/A	N/A	
Micro-Deval Abrasion Loss, % maximum, LS-618	25	30 (Note 2)	30	25	21	25	30 (Note 2)		
Asphalt Coated Particles, % maximum, LS-621	30	30	N/A	30	N/A	30	N/A	N/A	

Notes:

1. Maximum of 15% by mass of crushed glass or ceramic material or both, and maximum of 1% by mass of deleterious materials (wood, clay brick, clay tile, gypsum, gypsum plaster, and wallboard).

2. The coarse aggregate Micro-Deval abrasion loss test requirement will be waived if the material has more than 80% passing the 4.75 mm sieve.

Issued by Testing Laboratory Representative:

PRINT NAME SIGNATURE DATE

Received By Contract Administrator Representative:

PRINT NAME SIGNATURE DATE

APPENDIX 2

OPSS 1004 (2005) MATERIAL SPECIFICATION
FOR AGGREGATES – MISCELLANEOUS

MATERIAL SPECIFICATION FOR AGGREGATES - MISCELLANEOUS

TABLE OF CONTENTS

1004.01 SCOPE

This specification covers material requirements for aggregates for use as granular sheeting, rip-rap, rock protection, gabion stone, clear stone, graded stone, truck arrester bed aggregate, mortar sand, winter sand, and granular fill applications. Quality control (QC) and quality assurance (QA) procedures and referee testing protocol are incorporated.

1004.01.01 Significance and Use of Appendices

Appendices are not a mandatory part of this specification unless invoked by the Owner.

Appendix 1004-A is a commentary appendix to provide designers with information on the use of the specification in a Contract.

1004.02 REFERENCES

This specification refers to the following standards, specifications, or publications:

Ontario Provincial Standard Specifications, Material

OPSS 1001 Aggregates - General

Ministry of Transportation, Ontario, Publications

MTO Laboratory Testing Manual:

LS-601	Materials Finer than 75 □m Sieve in Mineral Aggregates by Washing
LS-602	Sieve Analysis of Aggregates
LS-604	Relative Density and Absorption of Coarse Aggregate
LS-607	Percent Crushed Particles in Processed Coarse Aggregate
LS-608	Percent Flat and Elongated Particles in Coarse Aggregate
LS-610	Organic Impurities in Concrete Sands
LS-614	Freezing and Thawing of Coarse Aggregate
LS-616	Petrographic Analysis of Fine Aggregate
LS-618	Resistance of Coarse Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-619	Resistance of Fine Aggregate to Degradation by Abrasion in the Micro-Deval Apparatus
LS-624	Use of Control Charts for Construction Aggregates
LS-625	Sampling of Granular Materials
LS-703/704	Liquid Limit, Plastic Limit, and Plasticity Index of Soils
LS-709	Determination of Permeability of Granular Soils

ASTM International

C 87-03 Effect of Organic Impurities in Fine Aggregate on Strength of Mortar

1004.03 DEFINITIONS

For the purpose of this specification, the following definitions apply:

Business Day means any Day except Saturdays, Sundays, and statutory holidays.

Clear Stone means a graded aggregate intended for use in drainage, backfill, bedding, and other applications.

Gabion Stone means a graded fractured rock aggregate intended for use in gabion baskets and gabion mats.

Granular C and Granular D means an aggregate intended for use as granular fill.

Granular Sheeting means a graded granular aggregate material intended for use as a protective surface layer on erodible soil slopes.

Mortar Sand means a fine aggregate intended for application in Portland cement based mortars.

Nominal Maximum Size means the largest sieve in the applicable specification upon which material is permitted to be retained.

Physical Property means an inherent attribute or feature of an aggregate material. Tests are carried out to determine a material's resistance to weathering or degradation or both.

Pit-Run Material means material excavated directly from an existing bank in a pit and delivered to the job site without further processing, i.e., crushing, screening, washing, and classifying.

Quality Assurance (QA) means a system or series of activities carried out by the Owner to ensure that materials received from the Contractor meet the specified requirements.

Quality Control (QC) means a system or series of activities carried out by the Contractor to ensure that materials supplied to the Owner meet the specified requirements.

Referee Testing means testing by an independent laboratory selected by the Contract Administrator and acceptable to the Contractor, the results of which are used for resolving differences between QC and QA testing.

Rip-Rap means a well graded, fractured rock or crushed reclaimed concrete intended for use as slope protection in hydraulic channels.

Rock Protection means a well graded, fractured rock or crushed reclaimed concrete intended for use as general slope protection.

Spheroidal Particle means where the ratio of the greatest dimension in the longitudinal axis compared to the least dimension in a plane perpendicular to the longitudinal axis is less than 2:1.

Truck Arrester Bed Aggregate means a single-sized aggregate used in runaway truck lanes to slow and stop the progress of vehicles.

Winter Sand means a fine aggregate intended for application to roadways during winter conditions to improve frictional properties of the pavement surface.

1004.04 SUBMISSION AND DESIGN REQUIREMENTS

1004.04.01 Submission Requirements

1004.04.01.01 Test Data

At the request of the Contract Administrator, the Contractor shall make available or submit QC test results prior to the delivery of the material. Test results may be submitted by either the stockpile or control chart method. All test data forms shall be legible. Test data for each aggregate product shall be managed independently. When more than one source is used for supplying materials, test data from each source and product shall be managed independently.

1004.05 MATERIALS

1004.05.01 General

The requirements of OPSS 1001 shall apply to this specification. Material shall be according to this specification when tested according to the MTO Laboratory Testing Manual. Aggregates shall be according to this specification, when tested according to the methods given in this specification.

All aggregate source materials shall be clean, hard, durable particles free of earth, humus, clay coatings, and clay lumps. Aggregates may be sands, gravels, cobbles, boulders, or quarried rock. Reclaimed asphalt pavement, reclaimed Portland cement concrete, glass, other reclaimed materials, and slag materials shall not be used. When reclaimed materials are permitted by this specification or specified in the Contract Documents, they shall be homogeneously blended. When reclaimed Portland cement concrete is permitted, it shall not contain loose reinforcing material and shall be free of protruding metal.

Irrespective of compliance or non-compliance with the gradation and physical property requirements of this specification, aggregates may be accepted or rejected on the basis of field performance as determined by the Owner.

1004.05.02 Clear Stone

Clear stone may be 53.0 mm, 19.0 mm Type I, 19.0 mm Type II, 16.0 mm, 13.2 mm, or 9.5 mm and shall meet the physical property requirements shown in Table 1 and the gradation requirements shown in Table 2.

1004.05.03 Granular C and Granular D

Granular C and Granular D shall meet the physical property requirements shown in Table 3 and the gradation requirements shown in Table 4.

1004.05.04 Granular Sheeting

Granular sheeting shall meet the physical property requirements shown in Table 3 and the gradation requirements shown in Table 4.

1004.05.05 Rip-Rap, Rock Protection, and Gabion Stone

1004.05.05.01 General

Rip-rap, rock protection, and gabion stone shall be produced from crushed or fractured bedrock fragments with 100% fractured faces or crushed from cobbles or boulders greater than 300 mm diameter and shall not deteriorate when exposed to air and water and shall be resistant to deterioration by cycles of wetting, drying, freezing, and thawing.

Reclaimed Portland cement concrete may be used in non-watercourse applications.

1004.05.05.02 Rip-Rap and Gabion Stone

Rip-rap R-10 and R-50 classifications and gabion stone G-3 and G-10 classifications shall meet the gradation requirements shown in Table 5.

1004.05.05.03 Rock Protection

Rock protection shall be well graded with a maximum particle diameter of 500 mm with no more than 10% by mass of the material passing the 106 mm sieve. Rock protection shall have a maximum of 15% by mass of flat and elongated particles when tested according to LS-608.

1004.05.06 Truck Arrester Bed Aggregate

Truck arrester bed aggregate shall be pit-run material meeting the gradation requirements shown in Table 6 and the physical requirements shown in Table 7. In addition, truck arrester bed aggregate shall meet the following shape requirements:

a) Rounded particles shall be a minimum of 30% by mass. Rounded particles shall be determined by the procedure given in LS-607, reporting the percentage of rounded particles instead of crushed particles. The test specimen size shall be a minimum of 3,000 g passing the 26.5 mm sieve and retained on the 19 mm sieve.

b) Spheroidal particles shall be a minimum of 50% by mass. Spheroidal particles shall be determined by the procedure given in LS-608, using a figure-eight calliper in which the ratio of the opening at one end to that at the other end is 2:1 instead of 4:1. The test specimen size shall be a minimum of 3,000 g passing the 26.5 mm sieve and retained on the 19 mm sieve.

1004.05.07 Mortar Sand

1004.05.07.01 General

Mortar sand shall consist of natural sand, or subject to the approval of the Contract Administrator other inert materials with similar characteristics, or combinations thereof, having hard, strong, durable particles. The sand shall be free from a coating of any deleterious material and free from other deleterious substances.

1004.05.07.02 Gradation Requirements

Mortar sand shall meet the gradation requirements of Table 8.

1004.05.07.03 Test for Organic Impurities

The fine aggregate, when subjected to the sodium hydroxide colorimetric test according to LS-610, shall not produce a colour darker than the standard solution or organic plate number 3. A fine aggregate failing this test may be approved if it meets the requirements of the mortar strength test according to ASTM C 87.

1004.05.07.04 Test for Strength

When subjected to the mortar strength test according to ASTM C 87, mortar specimens containing the fine aggregate shall develop a compressive strength at the age of 7 Days when using Portland cement, of not less than 90% of the strength developed by a mortar prepared in the same manner with the same cement and graded Ottawa sand having a fineness modulus of 2.40 ± 0.10.

1004.05.08 Winter Sand

Winter sand shall meet the gradation requirements shown in Table 9. When obtained from sources from St. Joseph Island, Manitoulin Island, or areas of Ontario south and west of a boundary delineated by the Severn River, Provincial Highway 12 and Provincial Highway 7 east of Highway 12, winter sand shall have a maximum fine aggregate Micro-Deval abrasion loss of 25%, when tested according to LS-619.

1004.07 PRODUCTION

1004.07.01 Aggregate Processing, Handling, and Stockpiling

Aggregates separated during processing shall be placed in individual stockpiles. Processed aggregates secured from different sources and aggregates from the same source but of different gradations shall be placed in individual stockpiles. Materials shall be retained in stockpiles until all required QC testing has been completed.

Aggregates that have become mixed with foreign matter of any description or aggregates that have become mixed with each other shall not be used and shall be removed from the stockpile immediately. When a change in the character of the source material occurs or when the performance of material that meets the requirements of this specification is found to be unsatisfactory, use of the material shall be discontinued until a reappraisal by the Contractor and approved by the Contract Administrator, proves the source to be satisfactory.

Once a stockpile has been produced, sampled, and tested, no further material may be added to the stockpile. Stockpiles produced, sampled, and tested under the procedure for control chart method may continue to have material added, provided that sampling and testing show that the material in the stockpile is in accordance to this specification and that the process remains in statistical control.

1004.07.02 Quality Control

1004.07.02.01 General

The Contractor shall be responsible for all QC sampling and testing to show complete conformance of the aggregates with this specification. These records shall be made available to the Contract Administrator upon request.

When the stockpile method has been selected, test data shall be obtained from samples taken from stockpiled or pit-run material to be used in the Work.

When the control chart method has been selected, control charts shall be prepared in accordance with LS-624 or similar method. Each control chart shall contain information regarding control limits, specification limits, target values, testing frequencies, sampling locations, and time period over which the testing has taken place. Each control chart shall include individual test data of the most recent sample indicated on the chart.

1004.07.02.02 Quality Control Laboratory Requirements

The Contractor shall select all QC laboratories and shall be responsible for all costs associated with the testing for QC requirements.

An acceptable laboratory conducting tests for physical properties shall be one that holds a current Type D certificate from Canadian Council of Independent Laboratories (CCIL) for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specified tests, when applicable.

An acceptable laboratory conducting tests for materials finer than 75 μm by washing according to LS-601, gradation according to LS-602, and percent crushed particles according to LS-607 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff holding a valid aggregate testing certificate from CCIL.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided they are acceptable to the Contract Administrator.

1004.07.02.03 Gradation

For winter sand, a minimum of one gradation test result shall be conducted for each 1,000 tonnes of winter sand, or portion thereof, for quantities delivered to a single stockpile location. For all other materials, QC testing for gradation requirements shall be conducted at intervals chosen by the Contractor, but not less than the frequency specified in the Physical Properties clause.

When more than one source is used for supplying winter sand, each source shall be managed independently.

1004.07.02.04 Physical Properties

Except as noted below, test results demonstrating conformance of the aggregates with the physical property requirements of this specification shall be completed according to the following schedule on each material produced:

a) For the first 20,000 tonnes of aggregate produced.

b) For the next 20,000 tonnes of aggregate produced.

c) For each 40,000 tonnes of aggregate produced thereafter.

When required for winter sand, Micro-Deval abrasion test results obtained within the past 18 months shall be provided from each source to be used in the Work.

Further testing is required whenever material is produced from a new source or a new bench in a quarry or whenever a significant change in aggregate production or material occurs.

1004.07.02.05 Control Chart Method

When the control chart method has been selected, a Type 1 control chart, as defined in LS-624 or similar method shall be produced for each physical property requirement. When the control chart has been established, the minimum frequency of sampling and further testing shall be as follows:

a) Annually, i.e., obtained within the past 12 months, when the mean value of the physical property is less than 75% of the limit given in the appropriate table and the Type 1 control chart demonstrates the process to be in statistical control; or

b) Three times per year, spaced evenly throughout the aggregate production schedule, when the mean value of the physical property is greater than 75% of the limit given in the appropriate table or the Type 1 control chart demonstrates the process to be out of statistical control.

1004.08 QUALITY ASSURANCE

1004.08.01 General

The Contract Administrator shall be allowed access to all sampling locations and reserves the right to request a QA sample at any time from the Contractor. The Contract Administrator may elect to carry out testing of the QA sample to ensure that material used in the Work is according to the requirements of this specification. Testing shall be carried out at a laboratory designated by the Owner. The Owner shall be responsible for all costs associated with QA testing.

Test data for each aggregate type shall be managed independently. When more than one source is used for supplying material, test data from each source and product shall be managed independently.

1004.08.02 Sampling

Sampling shall be according to LS-625 and taken at the time and location determined by the Contract Administrator. Samples shall be of sufficient mass to conduct the necessary gradation and physical property tests of the material. In no case shall the sample weigh less than 10 kg. For winter sands, the sample shall have a mass of not less than 5 kg.

Duplicate samples shall be obtained and sealed by the Contractor in the presence of the Contract Administrator. In the event that the Contractor is unavailable to take the sample, no further materials shall be placed in the Work until the QA sample has been taken. Samples shall be delivered and stored as specified in the Contract Documents.

When material contains blended or reclaimed aggregates or both, QA sampling shall be performed on the final blended product.

1004.08.03 Quality Assurance Laboratory Requirements

An acceptable laboratory conducting QA tests for physical properties shall be one that holds a current Type D certificate from CCIL for the applicable test methods and also participates in the Annual MTO Proficiency Sample Testing Program for the specified tests, when applicable.

An acceptable laboratory conducting QA tests for materials finer than 75 μm by washing according to LS-601, gradation according to LS-602, and percent crushed particles according to LS-607 shall be one that holds a current Type C certificate from CCIL.

Testing shall be conducted by qualified laboratory staff holding a valid aggregate testing certificate from CCIL.

Equivalent alternate laboratory and technician certifications or laboratory proficiency testing programs may be used to demonstrate similar requirements, provided they are acceptable to the Contract Administrator.

1004.08.04 Testing and Retention of Samples

When the Contract Administrator has elected to carry out QA testing, one of the duplicate samples shall be randomly selected for testing by the QA laboratory. The QA laboratory shall retain the remaining sealed sample for possible referee testing.

1004.08.04.01 Winter Sand

Following delivery, winter sand shall be subject to a visual inspection of the stockpile to determine the presence of oversize material. Oversize particles may be confirmed with a 9.5 mm sieve.

1004.08.05 Acceptance

When the Contract Administrator has elected not to test the QA sample, the material shall be deemed acceptable. Otherwise, QA test results shall be used for acceptance purposes, except when referee testing of any aggregate or a visual examination of winter sand has been carried out.

When QA test results show that the material meets the applicable gradation and physical property requirements of this specification, the material shall be accepted.

When QA test results show that the material does not meet the applicable requirements of this specification, the Contract Administrator shall notify the Contractor that material represented by the test results shall not be accepted. This notification shall take place in writing within 3 Business Days of receipt of the non-conforming data.

1004.08.06 Referee Testing

When QA test results do not meet the requirements of this specification, the Contractor has the option of invoking referee testing of the test result that failed to meet the requirements. The Contractor shall notify the Contract Administrator of the selected option within 2 Business Days following notification of unacceptable material.

The Contract Administrator shall select a referee laboratory acceptable to the Contractor within 3 Business Days following the Contractor's notification to invoke referee testing. The Contract Administrator shall deliver referee samples to the referee laboratory. The sealed sample shall be opened in the presence of the Contractor and the Contract Administrator. If referee materials are not available, the Contractor shall be responsible for obtaining and submitting new samples to the referee laboratory from a location to be decided by the Contract Administrator. The Contract Administrator shall be present to witness the sampling.

Referee testing shall be carried out in the presence of the Contract Administrator. When applicable, the referee laboratory shall also test a control aggregate sample for each test method required. The Contractor may observe the testing at no cost to the Owner. Comments on the nonconformity of the test methods shall be made and corrected at the time of testing. If the testing cannot be corrected or if agreement on the procedure cannot be reached, the testing shall be postponed until the procedure is corrected or agreement between the parties is reached. Referee test results shall be binding on both the Owner and the Contractor.

When a referee test result shows that the aggregates do not meet the requirements of this specification, the material represented by the test result, including materials in existing stockpiles or in the Work, shall not be accepted. The Contractor shall remove the material from the Work at no cost to the Owner. Alternatively, the Owner may consider a Contractor's request for a reduced price in lieu of removal of aggregates that fail to meet the physical requirements of this specification. Irrespective of the negotiation of a reduced price payment, the warranty provisions of the Contract Documents shall apply.

When a referee test result shows that the aggregates are in accordance with the requirements of this specification, the material represented by the sample shall be accepted.

The Owner will be responsible for the cost of referee testing, provided that the referee test results show that the aggregates meet the applicable specifications. Otherwise, the Contractor shall be responsible for the costs.

Table 1
Physical Property Requirements for Clear Stone

Laboratory Test	MTO Test Number	Nominal Maximum Size		
		53 mm	19 mm Type 1	19 mm Type II, 16 mm, 13.2 mm, and 9.5 mm
Loss by Washing, Pass 75 μm Sieve, % maximum	LS-601	2.0	2.0	2.0
Crushed particles, % minimum	LS-607	-	50	60
Micro-Deval Abrasion Loss, coarse aggregate, % maximum	LS-618	25	25	25

Table 2
Gradation Requirements for Clear Stone

Sieve Size	Gradation (LS-602), Percent Passing					
	Nominal Maximum Size					
	53 mm	19 mm		16 mm	13.2 mm	9.5 mm
		Type I	Type II			
63 mm	100	-	-	-	-	-
53 mm	90 - 100	-	-	-	-	-
26.5 mm	-	100	100	-	-	-
19.0 mm	0 - 15	90 - 100	90 - 100	100	-	-
16.0 mm	-	-	65 - 90	96 - 100	100	-
13.2 mm	-	-	-	67 - 86	96 - 100	100
9.5 mm	-	0 - 55	20 - 55	29 - 52	50 - 73	95 - 100
6.7 mm	-	-	-	-	-	20 - 45
4.75 mm	-	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10
75 μm	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0	0 - 2.0

Table 3
Physical Property Requirements for Granular C, Granular D, and Granular Sheeting

Laboratory Test	MTO Test Number	Granular D	Granular C	Granular Sheeting
Petrographic Requirement, fine aggregate	LS-616 LS-709	(Note 1)		
Micro-Deval Abrasion Loss, coarse aggregate, % maximum (Note 2)	LS-618	30		
Micro-Deval Abrasion Loss, fine aggregate, % maximum	LS-619	35		
Plasticity Index (PI), maximum	LS-704	0		

Notes:

1. For materials north of the French/Mattawa Rivers only: for materials with > 5.0% passing the 75 μm sieve, the amount of mica retained on the 75 μm sieve, passing the 150 μm sieve, shall not exceed 10% of the material on that sieve, unless testing according to LS-709 determines permeability values > 1.0×10^{-4} cm/s or field experience show satisfactory performance. Prior data demonstrating compliance with this requirement shall be acceptable provided such testing has been done within the past five years and field performance has been satisfactory.

2. The requirement for the coarse aggregate Micro-Deval abrasion loss test shall be waived if the material has more than 80% passing the 4.75 mm sieve.

Table 4
Gradation Requirements for Granular C, Granular D, and Granular Sheeting

Sieve Size	Gradation (LS-602), Percent Passing		
	Granular C	Granular D	Granular Sheeting
150 mm	100	-	100
26.5 mm	50 - 100	-	50 - 100
13.2 mm	-	-	35 - 100
9.5 mm	-	100	-
4.75 mm	20 - 100	50 - 100	20 - 80
1.18 mm	10 - 100	20 - 55	10 - 50
300 μm	5 - 90	10 - 30	5 - 25
150 μm	4 - 30	-	0 - 15
75 μm	0 - 10.0	0 - 12.0	0 - 8.0

Table 5
Gradation Requirements for Gabion Stone and Rip-Rap

Mass kg	Approximate Dimension mm	Gradation, percent less than mass specified			
		Gabion Stone		Rip-Rap	
		G-3	G-10	R-10	R-50
75	305	-	-	-	100
50	265	-	-	-	70 - 90
25	210	-	-	-	40 - 55
15	180	-	100	100	-
10	155	-	90 - 100	70 - 90	-
5	125	100	-	40 - 55	-
3	105	90 - 100	-	-	-
2.5	100	-	0 - 5	-	0 - 15
0.5	60	0 - 5	-	0 - 15	-

Note:
A. Masses are based on approximate size of an equivalent cube with a specific gravity of 2.65 and are provided for estimating purposes only. Gradation is determined by weighing individual stone particles in the field or laboratory.

Table 6
Physical Property Requirements for Truck Arrester Bed Aggregate

Laboratory Test	MTO Test Number	Truck Arrestor Bed Aggregate
Loss by Washing, Pass 75 μm Sieve, % maximum	LS-601	1.0
Absorption, % maximum	LS-604	2.0
Freeze-Thaw Loss, % maximum	LS-614	6
Micro-Deval Abrasion Loss, coarse aggregate, % maximum	LS-618	21

Table 7
Gradation Requirements for Truck Arrester Bed Aggregate

Sieve Size	Gradation (LS-602), Percent Passing
37.5 mm	100
26.5 mm	90 - 100
19.0 mm	0 - 10

Table 8
Gradation Requirements for Mortar Sand

Sieve Size	Gradation (LS-602), Percent Passing
4.75 mm	100.0
2.36 mm	95 - 100
1.18 mm	60 - 100
600 μm	35 - 80
300 μm	15 - 50
150 μm	2 - 15
75 μm	0 - 5.0

Table 9
Gradation Requirements for Winter Sand

Sieve Size	Gradation (LS-602), Percent Passing
9.5 mm	100.0 (Note 1)
6.7 mm	97 - 100
4.75 mm	90 - 100
2.36 mm	50 - 95
1.18 mm	20 - 90
600 μm	0 - 70
300 μm	0 - 35
150 μm	0 - 15
75 μm	0 - 5.0

Notes:

1. In addition to LS-602, to be confirmed by visual inspection of the stockpile.

A. The minimum size of the test sample shall be 5 kg. Following oven drying, the sample shall be sieved on the 9.5 mm, 6.7 mm, and 4.75 mm sieves. Material passing the 4.75 mm sieve shall be split to an appropriate size according to LS-602 for subsequent washing and fine sieving. The final grading shall be calculated according to LS-602 as the percentage of material passing each sieve based on the total mass of the oven dried sample.

Appendix 1004-A, Commentary for OPSS 1004, November 2005

Note: This Appendix does not form part of the standard specification. It is intended to provide information to the designer on the use of this specification in a Contract.

Designer Action/Considerations

The designer should be aware that OPSS 1004 includes the introduction of new physical test methods, introduction of laboratory qualification requirements, minimum quality control (QC) requirements, and referee testing.

The designer should be aware that quality assurance (QA) testing for purposes of ensuring material used in the Work meets the requirements of OPSS 1004 is not mandatory, unless specifically included in the Contract Documents. The decision to conduct QA testing should be based on the size, complexity, and desired service life of the Work. The designer should specify the frequency of QA testing. In the event that the Contract Administrator elects not to carry out QA testing, QC test data may be used for acceptance purposes at the risk of the Owner. In this case, the minimum frequency of QC sampling and testing should be specified.

QC test data is typically obtained from samples taken from stockpiled material to be used in the Work. At the discretion of the Contract Administrator and when the quantities or dollar value of aggregate warrant, aggregate test data obtained within the past 18 months from the same location within the source which is to be used in the Work may be provided.

The designer should specify any additional referee testing laboratory requirements, including time lines, selection criteria or roster for referee laboratories, and the cost for referee testing.

The designer may consider the use of reclaimed materials as an alternate aggregate source material. If so, the designer should specify this requirement in the Contract Documents. (1004.05.01)

For the approval of rip-rap, rock protection, and gabion stone material, the designer should investigate the durability of available material for the intended use. (1004.05.05.01)

The designer should ensure that the need for stability of 53 mm clear stone is considered. When required, the minimum percent crushed requirement should be added. (Table 1)

The designer should specify the storage and delivery requirements for QA samples. (1004.08.02)

The designer should ensure that the Ontario Provincial Standards General Conditions of Contract and the 100 Series General Specifications are included in the Contract Documents.

Related Ontario Provincial Standard Drawings

None.

APPENDIX 3

SNC LAVALIN (2007) DETAILED PIPE AND VALVE SPECIFICATION – 2007-2008 PHASES

CLIENT: **AGNICO-EAGLE MINES LTD.**

PROJECT NAME: **MEADOWBANK GOLD PROJECT**

PROJECT NUMBER: **017202**

INSTRUCTION TO DOCUMENT CONTROL

☐ Entire specification revised. Reissue all pages.

☐ Reissue revised pages only.

STAMP THE SPECIFICATION AS FOLLOWS:

☐ Issued for comments.

☐ Issued for approval.

☐ Issued for quotation.

☐ Issued for purchase.

☒ Issued for construction.

SPECIFICATION REVISION INDEX

No.	Prepared By Date	Checked By Date	Project Manager Date	Client Approved Date	Pages Revised	Remarks
PA	R. Umeno 06Apr19	A. Wachmann 06Apr19				Issued for Fire Marshal's Initial Review
0	R. Umeno 07Aug15	A. Wachmann 07Aug15	A. Wachmann 07Aug15			Issued for Construction

MEADOWBANK GOLD PROJECT

PROJECT NUMBER 017202

PIPE & VALVE SPECIFICATION

017202-0000-46ES-1001

TABLE OF CONTENTS

1. GENERAL

This specification consisting of a series of Piping Material Classes as listed on the Piping Classes Index and a Valve Specification, defines the material requirements and limitations of piping systems for industrial/commercial, process and utility plants.

Each individual piping class is individually tailored to handle fluids or commodities within certain limitations.

2. CODES AND STANDARDS

Codes:

All components of piping systems shall comply with the following codes and standards, as applicable, the latest issues of which shall always be used.

ANSI - American National Standards Institute
API - American Petroleum Institute
ASTM - American Society for Testing and Materials
AWWA - American Water Works Association
ASME - American Society of Mechanical Engineers
CSA - Canadian Standards Association
NFPA - National Fire Protection Association

Provincial and/or local codes

3. PIPING AND VALVE CLASSIFICATION

Piping and components are classified primarily in accordance with their Material of Construction, pressure/temperature rating and end connection:

CB21
C - Carbon Steel
B - ANSI 150 lb Class
21 - Socket joint group

Piping Material Class Coding:

The first letter indicates the basic Material of Construction.

First Letter	Basic Material
A	Alloy
B	Iron
C	Carbon Steel
D	Mixed Materials - carbon steel/metals
F	Plastic - FRP (fiber reinforced plastic)
G	Galvanized
J	Plastics - (thermo fusion)
K	Mixed materials - plastics thermo fusion/metals
L	Lined Pipe
M	Miscellaneous (Glass, Vitreous Clay, Concrete, Rubber, etc.)
N	Non-Ferrous Metallic (Lead, Copper, Brass, etc.)
P	Plastics (Solvent Cement)
R	Mixed Materials - Plastics (Solvent Cement)/Metals
S	Stainless Steel
T	Titanium

The second letter designates the pressure-temperature rating or maximum service limits allowable in the piping class:

Second Letter	ASTM Rating	kPa Equivalent
A	Class 125 & lower	860 and lower
B	Class 150	1,035
C	Class 250	1,725
D	Class 300	2,070
E	Class 400	2,760
F	Class 600	4,140
G	Class 900	6,210
H	Class 1500	10,350
J	Class 2500	17,250 and higher

The numbers following the two letters represent the type of piping system and sequence of preparation generally in accordance with the following:

1 thru 20	Threaded joints
21 thru 40	Socket joints
41 thru 60	Butt Welded/Fusion joints
61 thru 80	Victaulic joints
81 thru 99	Other mechanical joints

Valve Class Coding:

Valves are classified and given a code (or tag no.) for ease of identification. See Valve Specification 016574-0000-46ES-1004.

4. SELECTION OF CLASSES

In individual piping classes, every component has been considered for the service it must perform. In selecting the suitable class, both safety and economy have been considered as well as past experiences.

Wall thickness for pressure piping shall not be less than “Standard Wall” as per ANSI code for Carbon Steel and not less that “Schedule 5S” for stainless steel.

Plastic pipe and fittings when designated SDR refers to the standard dimension ratio

$$SDR = \frac{\text{Pipe O.D. (inches)}}{\text{Minimum pipe wall thickness (inches)}}$$

Although corrosion allowances are not indicated for piping classes, most conditions require an allowance. These conditions have been considered in the selection of the appropriate wall thickness for each class.

5. ABBREVIATIONS COMMONLY USED

ANSI	American National Standards Institute
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
ASB	Asbestos
BE	Bevelled Ends
BEV	Bevelled
BLE	Bevelled Large End (Swage Nipples)
BOE	Bevelled One End
BB	Bolted Bonnet
BC	Bolted Cover
BLK	Black
BR	Brass or Bronze
BW	Butt-Weld
CS	Carbon Steel (Pipe and Fittings) Cast Steel (Valves)
CSA	Canadian Standards Association
CI	Cast Iron
C & W	Coated and Wrapped
CONC.	Concentric
CP	Cold Pressed (E.G. Hex Nuts used with Mach. Bolts)
c/w	Complete with
CWP	Cold Working Pressure
Dia.	Diameter
DI	Ductile Iron
ECC	Eccentric
EFW	Electric Fusion Welded
ERW	Electric Resistance Welded
FPT	Female Pipe Thread
FW	Field Weld
FLGD	Flanged
FF	Flat Face
FS	Forged Steel
GALV.	Galvanized
Gr.	Grade
GJ	Ground Joint
GE	Grooved End
HEX	Hexagonal
HP	High Pressure
ISRS	Inside Screw Rising Stem
ISNRS	Inside Screw Non Rising Stem
IBBM	Iron Body Brass Mounting
IPS	Iron Pipe Size
LJ	Lap Joint
LW	Lap Weld
LR	Long Radius
LP	Low Pressure
MPT	Male Pipe Thread

MI	Malleable Iron
MSS	Manufacturers' Standardization Society
MJ	Mechanical Joint
MP	Medium Pressure
NC	National Coarse Thread (Bolting)
Nom	Nominal
NPT	American National Standard Taper Pipe Thread
OS&Y	Outside Screw and Yoke
OQ	Oil Quenched (E.G. Hex Nuts)
OD	Outside Diameter
PBE	Plain Both Ends (Nipples)
PE	Plain Ends
POE	Plain One End
Rad	Radius
RF	Raised Face
RED	Reducer
RTJ	Ring Type Joint
Sch.	Schedule
SDR	Standard Dimension Ratio
sec.	Second
SMLS	Seamless
SR	Short Radius
SO	Slip On
SW	Socket Weld
SOL	Sockolet
SS	Stainless Steel
Std.	Standard
SWP	Steam Working Pressure
T & C	Threaded and Coupled
TBE	Thread Both End (Nipples)
THD	Threaded
TLE	Thread Large End (Nipples)
TOE	Thread One End (Nipples)
TP	Type
TSE	Thread Small End
TOL	Thredolet
UL	Underwriters Laboratories
WOG	Water, Oil and Gas (used in valve ratings)
WT	Weight
WN	Weld Neck
WOL	Weldolet
W/	With
XS	Extra Strong
XXS	Double Extra Strong

6. PIPING SPECIFICATION

PIPING CLASS: CB27 **SHEET 1 OF 2**

Item	Size Range	Material
Socket Weld Piping System		
Pipe	1/2" to 2"	X-heavy wall, ANSI B36.10, carbon steel ASTM A53, grade B, seamless, plain ends.
Fittings	1/2" to 2"	3000 lb ANSI B16.11, forged steel, ASTM A105, socket weld.
Union	1/2" to 2"	3000 lb ANSI B16.11, forged steel, ASTM A105, socket weld, steel to steel ground joint.
Flanges (Note 2)	1/2" to 2"	150 lb ANSI B16.5, RF, forged steel, ASTM A105, socket weld, X-heavy wall bore.
Gaskets	1/2" to 2"	150 lb ANSI, ring type, 1/16" thick, non-asbestos composition, GARLOCK "Blue-Guard" style 3000 or approved equal.
Bolts	1/2" to 2"	Stud bolts, carbon steel, ASTM A193, grade B7. Nuts ASTM A194, grade 2H.

Notes:

1. Wall thickness of x-heavy wall pipe (ANSI B36.10) is equal to those of schedule 80 pipe (ANSI B36.10) from 1/8" to 8" inclusive.
2. Use flat-faced flanges when mating to cast iron valves, strainers or equipment with flat face flanges.
3. Buried carbon steel pipe to be supplied with high-density 27 mil polyethylene "Shaw Yellow Jacket No. 1" protective coating or approved equal. Use Canusa Heat Shrink sleeves or approved equal at all welded joints.

PIPING CLASS: CB27 **SHEET 2 OF 2**

BRANCH SCHEDULE

SIZE		HEADER																	
		½	¾	1	1¼	1½	2												
B R A N C H	½	T	TR	TR	TR	TR	L												
	¾		T	TR	TR	TR	L												
	1			T	TR	TR	L												
	1¼				T	TR	TR												
	1½					T	TR												
	2						T												

LEGEND:

T - STRAIGHT TEE
TR - REDUCING TEE
L - THREDOLET, SOCKOLET & ELBOLET

PIPING CLASS: CB28 SHEET 1 OF 2

Item	Size Range	Material
Socket Weld Piping System		
Pipe	½" to 2"	Extra heavy wall (schedule 80), low temperature, ANSI B36.10, carbon steel ASTM A333, grade 6, seamless, plain ends
Fittings	½" to 2"	3000 lb. ANSI B16.11, forged steel, ASTM A350, grade LF2, socket weld
Unions	½" to 2"	3000 lb. ANSI B16.11, forged steel, ASTM A350, grade, LF2, socket weld, steel to steel ground joint
Flanges	½" to 2"	150 lb. ANSI B16.5, RF, forged steel, ASTM A350, grade LF2, socket weld, extra heavy wall bore
Gasket	½" to 2"	150 lb. ANSI, ring type, 1/8" thick, Graphoil laminate with flat 316SS insert, for low temperature service "GARLOCK FLEXIBLE GRAPHITE GRADE GH-R" or approval equal.
Bolts		Stud bolts, carbon steel, ASTM A320, grade L7. Nuts ASTM A194, grade 4.
Strainers	½" to 2"	Y pattern, 150 lb. ANSI class RF flanged, 316 stainless steel body, stainless steel screen, 20 mesh perforations, bolted cover, plugged drain. Hayward model 80 or approved equal.

Notes:

1. Wall thickness of extra heavy wall pipe (ANSI B36.10) is equal to those of schedule 80 pipe (ANSI B36.10) from 1/8" to 2", inclusive.
2. Buried carbon steel pipe to be supplied with high-density 27 mil polyethylene "Shaw Yellow Jacket No. 1" protective coating or approved equal. Use Canusa Heat Shrink sleeves or approval equal at all welded joints.

PIPING CLASS: CB28 **SHEET 2 OF 2**

BRANCH SCHEDULE

SIZE		HEADER																	
		½	¾	1	1	1	2												
BRANCH	½	T	T	T	T	T	L												
	¾		T	T	T	T	L												
	1			T	T	T	L												
	1				T	T	T												
	1					T	T												
	2						T												

LEGEND:

T - STRAIGHT TEE
TR - REDUCING TEE
L - THREDOLET, SOCKOLET & ELBOLET

PIPING CLASS: CB42 **SHEET 1 OF 2**

Item	Size Range	Material

Butt Welded Piping System

Pipe	2-1/2" to 36"	Standard wall, ANSI B36.10, carbon steel, ASTM A53, grade B. ERW, bevelled ends.
Fittings	2-1/2" to 36"	Standard wall, ANSI B16.9, carbon steel, ASTM A234, grade WPB, bevelled ends.
(Elbows)		Use long radius (1-1/2D elbows)
(Branches)		Refer to branch schedule, sheet 2
Flanges (Note 1)	2-1/2" to 24"	150 lb ANSI B16.5, RF, carbon steel, ASTM A105. Weld Neck, Std. Bore
	26" and above	150 lb ANSI B16.47 and conforming to MSS-SP44 Grade A, RF, carbon steel ASTM A105 Weld Neck, Std. Bore
Gasket	2-1/2" to 36"	150 lb ANSI, ring type, 1/16" thick, non-asbestos composition, GARLOCK "Blue-Guard" style 3000 or approved equal.
Bolts		Stud bolts, carbon steel, ASTM A193, grade B7. Nuts ASTM A194, grade 2H.
Strainers	3" to 10"	Y pattern, 150 lb ANSI RF, flanged, carbon steel body, stainless steel screen, 40 mesh perforation, bolted cover, plugged drain. Hayward model 80 or approved equal.

Notes:

1. Use flat faced flanges when mating to 125 lb FF, cast iron valves, strainers or equipment with flat faced flanges.
2. Use L outlet fittings to suit branch specification CB22 for 2" diameter and below.
3. L outlet fitting may be substituted for half coupling.
4. Reducing tee may be substituted for weldolet branch connection.

PIPING CLASS: CB42 **SHEET 2 OF2**

5. Plain and reinforced stub-in branch connections may be substituted provided preparation and welding is in accordance with ASME/ANSI B31.3.
6. Wall thickness of standard wall pipe (ANSI B36.10) is equal to those of schedule 40 pipe (ANSI B36.10) from 1/8" to 10" incl.
7. Buried carbon steel pipe to be supplied with high-density 27 mil polyethylene "Shaw Yellow Jacket No. 1" protective coating or approved equal. Use "Canusa" heat shrink sleeves or approved equal at all welded joints.

6. BRANCH SCHEDULE

SIZE		HEADER													
		2½	3	4	6	8	10	12	14	16	18	20	24	30	36
	½	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	¾	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	1	C	C	C	C	C	C	C	C	C	C	C	C	C	C
B	1¼	L	C	C	C	C	C	C	C	C	C	C	C	C	C
	1½	L	L	C	C	C	C	C	C	C	C	C	C	C	C
R	2	TR	L	L	C	C	C	C	C	C	C	C	C	C	C
	2½	T	TR	W	W	W	W	W	W	W	W	W	W	W	W
A	3		T	TR	W	W	W	W	W	W	W	W	W	W	W
	4			T	TR	W	W	W	W	W	W	W	W	W	W
N	6				T	TR	W	W	W	W	W	W	W	W	W
	8					T	TR	W	W	W	W		W	W	W
C	10						T	TR	W	W	W	W	W	W	W
	12							T	TR	W	W	W	W	W	W
H	14								T	TR	W	W	W	W	W
	16									T	TR	W	W	W	W
	18										T	TR	W	W	W
	20											T	TR	W	W
	24												T	TR	W
	30													T	TR
	36														W

LEGEND:

C - HALF COUPLING 3,000# (NOTE 3) L- THREDOLET, SOCKOLET & ELBOLET
T - STRAIGHT TEE W- WELDOLET (NOTES 4 AND 5)
TR - REDUCING TEE

PIPING CLASS: CB48 **SHEET 1 OF 2**

Item	Size Range	Material
Butt Welded Piping System		
Pipe	2½" to 24"	Standard wall, low temperature, ANSI B36.10, carbon steel, ASTM A333, grade 6, seamless, bevelled ends.
Fittings	2½" to 24"	Standard wall, ANSI B16.9, carbon steel, ASTM A420, grade WPL6, bevelled ends.
(Elbows)		Use long radius (1½D elbows).
(Branches)		Refer to branch schedule, sheet 2.
Flanges	2½" to 24"	150 lb ANSI B16.5, RF, carbon steel ASTM A350, grade LF2 weld neck, standard bore.
Gasket	2½" to 24"	150 lb ANSI ring type, χ" thick, Graphoil laminate with flat 316SS insert, for low temperature service. "GARLOCK FLEXIBLE GRAPHITE GRADE GH-R" or approved equal.
Bolts		Stud bolts, carbon steel, ASTM A320, grade L7, Nuts ASTM A194, grade 4.
Strainers	3" to 24"	Y pattern, 150 lb ANSI RF, flanged, 316 stainless steel body, stainless steel screen, 20 mesh perforation, bolted cover, plugged drain. Hayward model 80 or approved equal.

Notes:

1. Use L outlet fittings to suit branch specification CB28 for 2" diameter and below.
2. L outlet fitting may be substituted for half coupling.
3. Reducing tee may be substituted for weldolet branch connection.
4. Plain and reinforced stub-in branch connections may be substituted provided preparation and welding is in accordance with ASME/ANSI B31.3.

PIPING CLASS: CB48 **SHEET 2 OF 2**

5. Wall thickness of standard wall pipe (ANSI B36.10) is equal to those of schedule 40 pipe (ANSI B36.10) from χ" to 10" incl.
6. Buried carbon steel pipe to be supplied with high-density 27 mil polyethylene "Shaw Yellow Jacket No. 1" protective coating or approved equal. Use "Canusa" heat shrink sleeves or approved equal at all welded joints.

7. BRANCH SCHEDULE

SIZE		HEADER													
		2½	3	4	6	8	10	12	14	16	18	20	22	24	
	½	C	C	C	C	C	C	C	C	C	C	C	C	C	
	¾	C	C	C	C	C	C	C	C	C	C	C	C	C	
	1	C	C	C	C	C	C	C	C	C	C	C	C	C	
B	1	L	C	C	C	C	C	C	C	C	C	C	C	C	
	1	L	L	C	C	C	C	C	C	C	C	C	C	C	
R	2	TR	L	L	C	C	C	C	C	C	C	C	C	C	
	2	T	TR	W	W	W	W	W	W	W	W	W	W	W	
A	3		T	TR	W	W	W	W	W	W	W	W	W	W	
	4			T	TR	W	W	W	W	W	W	W	W	W	
N	6				T	TR	W	W	W	W	W	W	W	W	
	8					T	TR	W	W	W	W	W	W	W	
C	10						T	TR	W	W	W	W	W	W	
	12							T	TR	W	W	W	W	W	
H	14								T	TR	W	W	W	W	
	16									T	TR	W	W	W	
	18										T	TR	W	W	
	20											T	TR	W	
	22												T	TR	
	24													T	

LEGEND:

C - HALF COUPLING 3,000# (NOTE 2)
T - STRAIGHT TEE
TR - REDUCING TEE
L - THREDOLET, SOCKOLET & ELBOLET
W - WELDOLET (NOTES 3 AND 4)

PIPING CLASS: CB48 **SHEET 3 OF 3**

BRANCH SCHEDULE

SIZE		HEADER													
		2½	3	4	6	8	10	12	14	16	18	20	24	30	36
	½	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	¾	C	C	C	C	C	C	C	C	C	C	C	C	C	C
	1	C	C	C	C	C	C	C	C	C	C	C	C	C	C
B	1¼	L	C	C	C	C	C	C	C	C	C	C	C	C	C
	1½	L	L	C	C	C	C	C	C	C	C	C	C	C	C
R	2	TR	L	L	C	C	C	C	C	C	C	C	C	C	C
	2½	T	TR	W	W	W	W	W	W	W	W	W	W	W	W
A	3		T	TR	W	W	W	W	W	W	W	W	W	W	W
	4			T	TR	W	W	W	W	W	W	W	W	W	W
N	6				T	TR	W	W	W	W	W	W	W	W	W
	8					T	TR	W	W	W	W		W	W	W
C	10						T	TR	W	W	W	W	W	W	W
	12							T	TR	W	W	W	W	W	W
H	14								T	TR	W	W	W	W	W
	16									T	TR	W	W	W	W
	18										T	TR	W	W	W
	20											T	TR	W	W
	24												T	TR	W
	30													T	TR
	36														W

LEGEND:

C - HALF COUPLING 3,000# (NOTE 2)
T - STRAIGHT TEE
TR - REDUCING TEE
L - THREDOLET, SOCKOLET & ELBOLET
W - WELDOLET (NOTES 4 AND 5)

7. VALVE SPECIFICATION

VALVES

GAF1 Cast Steel Flanged Gate Valves (Outdoor)

Cast steel flanged gate valves shall be full bore, low temperature cast carbon steel, flexible gate, O.S.& Y, flanges ANSI Class 150, raised face, face to face dimensions to ANSI B16.10, flanges to ANSI B16.5, and as follows:

Body material:	Low temperature carbon steel to ASTM A352, Grade LCB
Trim material:	Wedge – Type 316 S.S. Seat – Stellite Stem – Type 316 S.S.
Standard of Acceptance:	Crane No. 47LU-F, A-352, Grade LCB Velan A-352, Grade LCB equivalent trim Kitz A-352, Grade LCB equivalent trim Newman-Hattersly A-352, Grade LCB equivalent trim

GAF2 Forged Steel Flanged Gate Valves (Indoor)

Forged steel flanged gate valves shall be conventional port opening, bolted bonnet, O.S.& Y., ANSI Class 150, raised face, face to face dimensions to ANSI B16.10, flanges to ANSI B16.5, and as follows:

Body material:	Carbon steel to ASTM A 105N
Trim material:	Wedge – stainless steel 316 stellited Seat – stainless steel 316 stellited Stem – stainless steel 316B
Standard of Acceptance:	Crane #B-3510 XU-F or equivalent Velan, Kitz or Newman-Hattersly

CKF1 Cast Steel Flanged Check Valves (Outdoor)

Cast steel flanged check valves shall be low temperature cast carbon steel, flanges ANSI Class 150, raised face, face to face dimensions to ANSI B16.10, flanges to ANSI B16.5, and as follows:

Body material:	Low temperature carbon steel to ASTM A-352, Grade LCB
Trim material:	Disc – Stainless steel, 13% Cr. Seat – stainless steel, 13% Cr.
Standard of Acceptance:	Crane No. 147 LU, A-352 Grade LCB or equivalent Velan, Kitz or Newman-Hattersly

CKF2 Forged Steel Flanged Check Valves (Indoor)

Forged steel flanged check valves shall be Class 150, regular port, flanges ANSI Class 150, raised face, face to face dimensions to ANSI B16.10, flanged to ANSI B16.5 and as follows:

Body material:	Forged steel to ASTM A105N
Trim material:	Disc – stainless steel 420 Seat – stainless steel ST6
Standard of Acceptance:	Crane #B-3665 LU-f or equivalent Velan, Kitz or Newman-Hattersly

BAF1 Cast Steel Flanged Ball Valves (Outdoor)

Cast steel flanged ball valves shall be full bore, low temperature cast carbon steel, flanges ANSI Class 150, raised face, face to face dimensions to ANSI B16.10, flanges to ANSI B16.5, and as follows:

Body material:	Low temperature carbon steel to ASTM A-352, Grade LCB
Standard of Acceptance:	Crane tork seal ball valve or equivalent Velan, Kitz or Newman-Hattersly

BAF2 Carbon Steel Threaded Ball Valves (Indoor & Outdoor)

Carbon steel threaded ball valves shall be one piece bar stock type, min. rating 6895 kPa, WOG at 38ºC, complete with handle incorporating padlocking feature. Valves to be fire safe to API 607 and as follows:

Body material:	Carbon steel ASTM A-105 or A-108
Trim material:	Ball – stainless steel 316 Seat – RTFE
Standard of Acceptance:	Crane #9401-LC or Velan HB-1000 memory stop or equivalent Kitz or Newman-Hattersly