

1.0 GENERAL

1.1 GENERAL

- .1 This section is a reference section specifying the quality of earthwork materials. Requirements for the inclusion of such materials in the Work are specified elsewhere in the Contract Documents. Due to project specific requirements, this section has been significantly revised from the Alberta Transportation Civil Works Master Specifications template.
- .2 Quality Control testing and its associated costs are to be the responsibility of the Contractor.
- .3 Quality Assurance testing and its associated costs are to be the responsibility of the Owner and Owner's selected testing agency.

1.2 DEFINITIONS

- .1 "Percent Passing by Mass" means the cumulative mass of particles that are finer than a specified size expressed as a percentage of the total mass of the sample.

1.3 REFERENCES

Provide earthwork materials in accordance with the following standards (latest revision) except where specified otherwise:

- .1 American Society for Testing and Materials (ASTM)
 - .1 ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)) (Standard Proctor)
 - .2 ASTM D2216 Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass (Lab Moisture Content)
 - .3 ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 - .4 ASTM D3080 Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
 - .5 ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils (Atterberg Limits)
 - .6 ASTM D4647 Standard Test Methods for Identification and Classification of Dispersive Clay Soils by the Pinhole Test

- .7 ASTM D5084 Standard Test Methods for Measurement of Hydraulic Conductivity (Permeability) of Saturated Porous Materials Using a Flexible Wall Permeameter
- .8 ASTM D6913 Standard Test Methods For Particle-Size Distribution (Gradation) Of Soils Using Sieve Analysis
- .9 ASTM D7928 Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
- .2 California Division of Highways
 - .1 CAL. 206 Method of Test for Specific Gravity and Absorption of Coarse Aggregate.
 - .2 CAL. 229 Method of Test for Durability Index.
- .3 Canadian General Standards Board (CGSB)
 - .1 CAN/CGSB-8.2-M Sieves, Testing, Woven Wire, Metric.

1.4 SUBMITTALS

Provide the following submittals:

- .1 A list of the proposed source(s) for each type of imported material, along with required quality control testing data, at least 7 days prior to delivery to the Site.
- .2 Name, contact information, and proof of certifications for an independent CSA certified and qualified earthworks materials testing laboratory proposed to complete Quality Control testing for the Work. This information is to be provided at least 7 days prior to engaging the laboratory.
- .3 Samples, of suitable quantities, of each type of imported material to be used at the Site when requested by the Owner or Engineer of Record for testing purposes prior to placement.
- .4 Results of all pre-qualification quality control tests and any additional quality control tests performed on the imported materials, taken at the source at least 7 days prior to delivery of such materials to the Site.
- .5 Copies of quality control test results for newly placed and reworked existing fill materials are to be provided within 48 hours of field testing or sampling.

1.5 QUALITY CONTROL

- .1 General
 - .1 Provide a quality control program to ensure that the specified requirements will be consistently attained throughout the Work. Provide the following quality control testing at the borrow source, and any additional testing or measures as required by the Contractor, Owner, and/or Engineer of Record. Quality control testing at the borrow source shall be completed in accordance with the prescribed minimum frequencies

outlined in the following table. The frequency of quality control testing may be increased as deemed necessary by the Engineer of Record until the Contractor consistently meets the specified requirements and/or based on variability of material from the source(s).

- .2 The Contractor is responsible for the procurement and supply of all required materials meeting the parameters outlined in clause 2.0 of this Section. The Contractor shall provide one (1) of each quality control test for each material to be considered for pre-qualification at least 7 days prior to the proposed delivery to Site. The Owner’s testing agency will also complete their own pre-qualification quality assurance testing on the proposed materials.

At Borrow Source – Quality Control Testing Frequencies		
Earthwork Material	Tests	Minimum Testing Frequency
Impervious Fill Zone 1A	Atterberg Limits	1 per source for pre-qualification and 1 per 4000 m3 exported or portion thereof
	Grain Size Analysis	1 per source for pre-qualification and 1 per 4000 m3 exported or portion thereof
	Dispersivity (Pinhole)	1 per source for pre-qualification and 1 per 15000 m3 exported or portion thereof
	Standard Proctor	1 per source for pre-qualification and 1 per 10000 m3 exported or portion thereof
	Lab Moisture Content	1 per source for pre-qualification and 1 per 4000 m3 exported or portion thereof
Retaining Wall Reinforced Fill Zone	Atterberg Limits	1 per source for pre-qualification and 1 per retaining wall location
	Grain Size Analysis	1 per source for pre-qualification and 1 per retaining wall location
	Dispersivity (Pinhole)	1 per source for pre-qualification and 1 per 10000 m3 exported or portion thereof
	Standard Proctor	1 per source for pre-qualification and 1 per 10000 m3 exported or portion thereof
	Lab Moisture Content	1 per source for pre-qualification and 1 per retaining wall location
Random Fill Zone 2A	N/A – Not Used	N/A – Not Used
Fine Filter Zone 3A	N/A – Not Used	N/A – Not Used
Coarse Filter Zone 3B	N/A – Not Used	N/A – Not Used
Drain Rock	Grain Size Analysis	1 per source for pre-qualification and as required by QA thereafter
Base Gravel Zone 4A	Grain Size Analysis Standard Proctor	1 per source for pre-qualification and as required by QA thereafter
Road Gravel Zone 4B	Grain Size Analysis Standard Proctor	1 per source for pre-qualification and as required by QA thereafter
Gravel Fill Zone 4C	N/A – Not Used	N/A – Not Used
Fine Riprap Bedding Zone 5A	N/A – Not Used	N/A – Not Used
Coarse Riprap Bedding Zone 5B	Grain Size Analysis	1 per source for pre-qualification and as required by QA thereafter
Gravel Armour Zone 5C	N/A – Not Used	N/A – Not Used

At Borrow Source – Quality Control Testing Frequencies		
Earthwork Material	Tests	Minimum Testing Frequency
Cobble Bedding Zone 5D	N/A – Not Used	N/A – Not Used
Riprap	Specific Gravity Absorption Durability Index	1 per source 1 per source 1 per source

Notes:

- .1 Perform specific gravity, absorption, and durability index testing of riprap materials within 180 days of the start of production. Perform Gravel Armour and Riprap Placement as specified in Section 02373 – Riprap and Riprap Bedding Placement.
 - .2 Although Impervious Fill Zone 1A and Retaining Wall Reinforced Fill Zone material have varying material design parameters, Retaining Wall Reinforced Fill Zone material can also be used in place of Zone 1A material outside of the reinforced zone on the retaining walls. If these two zones of material are from the same pre-qualified material source and meet both applicable minimum design parameters, the tests performed at each retaining wall location (with exception to Standard Proctors) can be utilized towards the Impervious Fill Zone 1A quality control testing frequencies for dike construction outside of the reinforced zone on the retaining walls.
 - .3 Conduct testing in accordance with the standards listed in clause 1.3 as determined by the Owner and Engineer of Record.
 - .4 Engage an independent CSA certified and qualified earthworks materials testing laboratory, with a permit to Practice in the Province of Alberta to sample and test earthwork materials, in accordance with the Contractor’s quality control program.
 - .5 Do not import any materials to the Site that may be contaminated with “Prohibited Noxious” or “Noxious” weeds under the Weed Control Act. If required, engage an independent agrologist to inspect the proposed sources of imported material and verify that they are not contaminated.
 - .6 Transport only suitable materials meeting the specifications to the Site. Transportation and/or placement of unsuitable materials to Site will not be compensated for. If material transported to site is deemed to be unsuitable, it shall be removed from Site and disposed of at the Contractor’s expense.
- .2 Sources of Sand, Gravel, and Rock Materials
- .1 During processing of sand, gravel, and rock materials, test materials from the discharge conveyor belt (or production stockpile for riprap) to verify that the material meets the specified gradation requirements. Notify the Engineer of Record at least 48 hours prior to starting production of materials intended for incorporation in the Work.

- .2 The pre-qualification quality control laboratory testing for processed aggregates is to have been completed within 30 days of applying for pre-qualification.
- .3 Promptly notify the Engineer of Record if any test fails to meet the specified requirements, and immediately take corrective measures as required to produce and use materials that are in accordance with the Contract Documents.
- .4 Dispose of or, where appropriate, reprocess any material which does not meet the requirements of the Contract Documents. The disposal or reprocessing of out of spec material will be performed at the expense of the Contractor.

1.6 QUALITY ASSURANCE

- .1 The Owner’s selected testing agency will perform testing to assure conformance to the specified requirements at the borrow source(s) and after the materials have been placed in its final specified location.
- .2 The Owner and Engineer of Record may reject earthwork materials at the source, in the transport vehicle, in the stockpile, or in place.
- .3 Samples of earthworks materials will be taken by the Owner’s selected testing agency for quality assurance testing. Testing will be conducted in accordance with the standards listed in clause 1.3 as determined by the Owner and Engineer of Record. One (1) of each quality assurance test will be completed for each source at the time of pre-qualification and as required thereafter by the Owner or Engineer of Record. Where a minimum frequency is provided, the frequency of quality assurance testing may be increased as deemed necessary by the Owner or Engineer of Record. The Contractor is to cooperate with the Owner’s testing agency and Engineer of Record during sampling and testing.

At Borrow Source – Quality Assurance Testing Frequencies		
Earthwork Material	Tests	Minimum Testing Frequency
Impervious Fill Zone 1A	Atterberg Limits	1 per source for pre-qualification and as required by the Engineer of Record
	Grain Size Analysis	1 per source for pre-qualification and as required by the Engineer of Record
	Dispersivity (Pinhole)	1 per source for pre-qualification and as required by the Engineer of Record
	Permeability	1 per source for pre-qualification and as required by the Engineer of Record
	Standard Proctor	1 per source for pre-qualification and as required by the Engineer of Record
	Direct Shear	1 per source for pre-qualification and as required following pre-qualification
	Lab Moisture Content	1 per source for pre-qualification and as required by the Engineer of Record
Retaining Wall Reinforced Fill Zone	Atterberg Limits	1 per source for pre-qualification and as required by the Engineer of Record
	Grain Size Analysis	1 per source for pre-qualification and as required by the Engineer of Record
	Dispersivity (Pinhole)	1 per source for pre-qualification and as required by the Engineer of Record
	Permeability	1 per source for pre-qualification and as required by the Engineer of Record

At Borrow Source – Quality Assurance Testing Frequencies		
Earthwork Material	Tests	Minimum Testing Frequency
	Standard Proctor	1 per source for pre-qualification and as required by the Engineer of Record
	Direct Shear	1 per source for pre-qualification and as required by the Engineer of Record
	Lab Moisture Content	1 per source for pre-qualification and as required by the Engineer of Record
Random Fill Zone 2A	N/A – Not Used	N/A – Not Used
Fine Filter Zone 3A	N/A – Not Used	N/A – Not Used
Coarse Filter Zone 3B	N/A – Not Used	N/A – Not Used
Drain Rock	Grain Size Analysis	1 per source for pre-qualification and 1 per 4000 m ³ exported or portion thereof
Base Gravel Zone 4A	Grain Size Analysis Standard Proctor	1 per source for pre-qualification and 1 per 2000 m ³ exported or portion thereof
Road Gravel Zone 4B	Grain Size Analysis Standard Proctor	1 per source for pre-qualification 1 per 2000 m ³ exported or portion thereof
Gravel Fill Zone 4C	N/A – Not Used	N/A – Not Used
Fine Riprap Bedding Zone 5A	N/A – Not Used	N/A – Not Used
Coarse Riprap Bedding Zone 5B	Grain Size Analysis	1 per source for pre-qualification and 1 per 4000 m ³ exported or portion thereof
Gravel Armour Zone 5C	N/A – Not Used	N/A – Not Used
Cobble Bedding Zone 5D	N/A – Not Used	N/A – Not Used
Riprap	Specific Gravity Absorption Durability Index	1 per source 1 per source 1 per source

Notes:

- .1 Although Impervious Fill Zone 1A and Retaining Wall Reinforced Fill Zone material have varying material design parameters, Retaining Wall Reinforced Fill Zone material can also be used in place of Zone 1A material outside of the reinforced zone on the retaining walls. If these two zones of material are from the same pre-qualified material source and meet both applicable minimum design parameters, the frequency of quality assurance testing will be determined by the Engineer of Record based on material parameters, material variability, and Contractor performance.
- .2 Only one pre-qualification test is required for each granular material source. The Owner and/or Engineer of Record may elect to forego additional pre-qualification quality assurance testing if suitable pre-qualification quality control testing has been provided by the Contractor.

2.0 PRODUCTS

2.1 MATERIALS

Provide materials in accordance with the following:

- .1 Gradations for earthworks materials except riprap: in accordance with ASTM D6913 and ASTM D7928. Specified sieve sizes are based on the nominal sieve opening sizes, in millimetres, under the Canadian Metric Sieve Series in accordance with CAN/CGSB-8.2-M.
- .2 Impervious Fill Zone 1A:
 - .1 Native soils obtained from Borrow Area Excavation, as supplied by the Contractor, that are free from organic materials, contamination, deleterious materials, and frozen materials.
 - .2 Inorganic, locally available clay/silt as classified by the Unified Soils Classification system with greater than a 45% fine content (≤ 0.075 mm), greater than 18% clay content (≤ 0.002 mm), a liquid limit greater than 25% and less than 60% ($25\% < LL < 60\%$), and a plastic limit greater than 15% ($15\% < PL$). Do not use highly dispersive materials, high plasticity clays with a liquid limit greater than 60%, or high plasticity clay shales with a liquid limit greater than 60% as Impervious Fill Zone 1A. Impervious Fill Zone 1A is to have a minimum friction angle of 25 degrees and a maximum hydraulic conductivity of $\leq 4 \times 10^{-6}$ m/s.
 - .3 Within 1,000 mm of structures and 600 mm of pipes, remove stones larger than 80 mm from the Impervious Fill Zone 1A.
- .3 Retaining Wall Reinforced Fill Zone:
 - .1 The fill material utilized within the retaining wall reinforced zone is to consist of a reworked clay till material supplied by the Contractor. The material is to be free from organic materials, contamination, deleterious materials, and frozen materials.
 - .2 The reworked clay till material within the reinforced zone of the retaining wall is to have a minimum friction angle of 28 degrees and a maximum hydraulic conductivity of 2×10^{-6} m/s. The reinforced zone fill material is to have greater than a 45% fines content (≤ 0.075 mm), greater than 18% clay content (≤ 0.002 mm), a liquid limit greater than 25% and less than 50% ($25\% < LL < 50\%$), and a plastic limit greater than 15% ($15\% < PL$). Do not use highly dispersive materials, high plasticity clays, or high plasticity clay shales with a liquid limit greater than 50% as Retaining Wall Reinforced Fill Zone material.
 - .3 With exception to the 0.5 m thick drain rock layer behind each retaining wall, no other granular materials shall be used within the reinforced zone of the retaining walls. Refer to clause 2.1.5.2 of this document for the specified drain rock gradation.
 - .4 Refer to the Engineer of Record's Issued for Tender (IFT) "Downtown Dike Redi Rock Retaining Walls Design" drawing package for further material specifications and technical requirements.

.4 Waste Fill:

- .1 Native soils from Site excavations that does not meet the requirements for Impervious Fill Zone 1A or Retaining Wall Reinforced Fill Zone material shall be considered as Waste Fill and disposed of accordingly, at the expense of the Contractor. Refer to Section 02332 – Waste Fill Placement.
- .2 Excess material from the Site, that meets the requirements for Impervious Fill Zone 1A or Retaining Wall Reinforced Fill Zone Material shall be stockpiled at a location provided by the Owner.
- .3 Topsoil shall not be considered Waste Fill. Subsoil can be considered a waste fill material or can be used for final grading above the Impervious Fill Zone 1A or outside of the dike footprint. Refer to Section 02234 – Topsoil and Subsoil Stripping for topsoil management specifications.

.5 Sand and Gravel Fill:

.1 General:

- .1 Sound, hard particles, free from silt and clay lumps, soft shale, contamination, deleterious materials, organic matter, and foreign substances.
- .2 Graded as specified with a smooth gradation curve with no excess or deficiency of any particular grain size within the required range.
- .3 Where blending is required, thoroughly mix the sand and gravel fill materials in a manner that produces a homogeneous fill of the specified gradation and avoids excessive segregation prior to placing the material at the Work or into dedicated stockpiles.
- .4 Crush, screen, wash, or otherwise process sand and gravel products as required to achieve specified gradations except where specified otherwise.

.2 Drain Rock

- .1 Drain rock shall be washed, graded, crushed, durable rock with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot.
- .2 20 mm Drain Rock

Sieve Size	Percent Passing by Mass
25 mm	100%
20 mm	0% – 100%
10 mm	0% – 5%
5 mm	0%

.3 40 mm Drain Rock

Sieve Size	Percent Passing by Mass
40 mm	100%
5 mm	0% – 10%
2.5 mm	0% – 5%
80µm	0% – 5%

.3 Base Gravel Zone 4A / Alberta Transportation Designation 2, Class 25mm:

- .1 Reasonably well graded crushed gravel and sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
25 mm	100%
20 mm	82% – 97%
16 mm	70% – 94%
10 mm	52% – 79%
5 mm	35% – 64%
1.25 mm	18% – 43%
630µm	12% – 34%
315µm	8% – 26%
160µm	5% – 18%
80µm	2% – 10%

- .2 At least 60% by mass of the particles retained on the 5 mm and larger sieves to have 2 or more fractured faces.

.4 Road Gravel Zone 4B / Alberta Transportation Designation 4, Class 20mm:

- .1 Reasonably well graded crushed gravel and sand with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points plotted on a standard semi-log soil grain size distribution plot:

Sieve Size	Percent Passing by Mass
20 mm	100%
10 mm	35% – 77%
5 mm	15% – 55%
1.25 mm	0% – 30%
80µm	0% – 12%

- .2 At least 40% by mass of the particles retained on the 5 mm and larger sieves to have 2 or more fractured faces.

.5 Coarse Riprap Bedding Zone 5B:

- .1 Well graded sand, gravel, and cobbles with a gradation that falls completely within the upper and lower bounds of the envelope defined by straight lines drawn directly between the following points:

Sieve Size	Percent Passing by Mass
80 mm	100
50 mm	70% - 100%
20mm	45% - 70%
5 mm	25% - 50%
1.25 mm	10% - 30%
160 µm	0% - 10%
80 µm	0% - 5%.

.6 Riprap:

.1 General

.1 Sound, hard, durable particles free from silt, clay, shale, sandstone, flaky particles, topsoil, organic matter, and other deleterious materials.

.2 Meet the following minimum requirements for soundness and durability.

Method of test	Requirements
California Division of Highways, CAL. 206	Minimum Specific Gravity: = 2.60 Maximum Absorption: = 2%
California Division of Highways, CAL 229	Minimum Durability Index: = 52 Durability Index may be less than 52 if DAR* > 23

$$\text{*Durability Absorption Ratio (DAR)} = \frac{\text{Durability Index}}{\text{Absorption \%} + 1\%}$$

.3 Ratio of maximum dimension to minimum dimension of individual pieces not to exceed 3.0.

.2 Riprap shall meet the following gradations per the Alberta Transportation Specifications for Bridge Construction – Section 10, Heavy Rock Riprap:

		CLASS			
		1M	1	2	3
Nominal Mass (kg)		7	40	200	700
Nominal Diameter (mm)		175	300	500	800
None greater than:	kg or mm	40 300	130 450	700 800	1800 1100
20% to 50%	kg or mm	10 200	70 350	300 600	1100 900
50% to 80%	kg or mm	7 175	40 300	200 500	700 800
100% greater than:	kg or mm	3 125	10 200	40 300	200 500

Percentages quoted are by mass.
Sizes quoted are equivalent spherical diameters, and are for guidance only.

3.0 EXECUTION

3.1 STOCKPILING OF SAND, GRAVEL, AND ROCK MATERIALS AT SITE

- .1 Drain Rock must be handled such that it remains clean, without incorporating dirt and fines, throughout stockpiling, transport, and installation.
- .2 Use equipment and methods that minimizes the amount of material handling, and that do not cause segregation or material breakdown.
- .3 Do not stockpile materials where contamination with the underlying soils can occur.
- .4 Stockpiles shall be constructed in a manner which minimizes segregation of material.
- .5 For gravel materials, construct temporary stockpiles by first distributing material over the entire base and then by building upwards in successive layers which do not exceed a thickness of 2 m per layer. Construct each layer working from the outer edges toward the centre of the stockpile. Complete each layer over the entire area before starting the subsequent layer. Keep traffic on the materials to a minimum during stockpiling. Do not push or dump gravel material over the edges or down the faces of the stockpile.
- .6 Keep stockpiles neat and regular in form.
- .7 Do not construct stockpiles that are more than 6 m in height.
- .8 Maintain a minimum clearance of 3 m between stockpiles of each material.
- .9 Replace stockpiled material that becomes contaminated, damaged, or lost.

3.2 PLACEMENT

- .1 Refer to Section 02331 – Fill Placement for subgrade preparation, placement of earthwork materials, and field testing of earthworks materials.

END OF SECTION