



# *City of Estevan*

## Construction Specifications

SECTION 1100  
TRENCH EXCAVATION AND BACKFILL

**1.0 GENERAL**

1.1 Scope:

This specification governs the requirements for trench excavation and backfill for the construction of underground utilities and structures.

1.2 Codes and Standards:

Excavation and backfill to conform to the following codes and standards:

- Saskatchewan Labour Standards Act, Occupational Health and Safety Regulations
- National Building Code
- City of Estevan Bylaws

1.3 Definitions:

- .1 Trench excavation: an excavation open from ground surface to the bottom of the pipe zone and may either have vertical side walls, maintained by bracing and sheeting, or sloped side walls from a maximum of 1.2 metres above the bottom of the trench excavation to the ground surface. Trench excavation shall be classified as common excavation or rock excavation.
- .2 Pipe zone: that portion of a trench excavation between the specified trench bottom and a level, 150 mm above the top of the pipe or as shown on the drawings.
- .3 Pipe foundation: over-excavation in the pipe zone filled with concrete or granular fill to provide a stable bedding.
- .4 Pipe bedding: shaped subgrade, granular fill or concrete within that portion of the pipe zone that supports the pipe and other appurtenances.
- .5 Pipe haunch: granular fill or concrete within that portion of the pipe zone between its bottom and springline of the pipe.
- .6 Initial backfill: granular fill within that portion of the pipe zone between the springline of the pipe to a level 150 mm above the top of the pipe.
- .7 Unstable trench bottom: an inadequate pipe bedding condition caused by organic material, sand under high seepage pressures (quick sand), ground water flows or subsurface moisture sufficient to render pipe bedding or subgrade material incapable of providing a stable support for pipe.

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- .8 Common excavation: is the removal of all surface and subsurface material other than topsoil or rock and shall include earth, clay, silt, sand, gravel, single boulders, hard pan (glacial till), frozen materials, soft or disintegrated rock or concrete, partially cemented materials, previously blasted stone in rock fills, pieces of fractured rock, boulders as well as such materials when found fallen into the excavation from adjacent areas, capable of removal by ripping or excavation by power operated excavators or shovels.
- .9 Rock excavation: boulders, pieces of concrete or masonry each monolithic piece exceeding 1.0 m<sup>3</sup> in volume, solid ledge rock, concrete or masonry which requires for its removal drilling and blasting, or breaking with a power operated hand tool for removal.
- .10 Trench backfill:
- (a) Select Common Excavation or Native Material: trench excavation from a source on the site or when authorized in writing by the Engineering Services Division, imported from a borrow within 1000 metres from the work area and from which all boulders larger than 150 mm in maximum dimension, large roots, stumps, topsoil, coal, excessively moist or highly plastic soil, soil unsuitable for backfill and other debris or deleterious material that would prevent or hamper mechanical compaction, or result in future settlement of the backfill, have been removed.
  - (b) Unshrinkable Fill: a low strength, high slump graded sand-cement mixture as described in the Canadian Portland Cement Association Information Bulletin #CP004.03P.
  - (c) Select Imported Backfill: approved soil as described in “native material” but imported to make up a deficiency of soil for trench backfill required to bring the trench surface to design grades, from a source located at a distance up to 1000 metres from the work area being with the free haul distance and eligible for overhaul if located in excess of 1000 metres from the work area.
  - (d) Granular material: well graded sand, well graded pit-run imported gravel and reclaimed well graded concrete or asphalt aggregate imported to the site.
  - (e) Foundation gravel: clean angular well graded pit-run or crusher run gravel used for the stabilization of trench bottom due to unstable trench bottom conditions, imported to the site.

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- .11 Unsuitable material: material such as organics, vegetation, roots, stumps, coal, highly plastic soils, boulders or stones larger than 150 mm in maximum dimension, debris, deleterious material, excessively moist soil which is deemed by the Engineering Services Division to be incapable of sufficient drying by aeration or blending with other suitable excavated soils on site to produce soil suitable for trench backfill, or other such material that would prevent or hamper mechanical compaction or result in future backfill settlement.
- .12 Topsoil: humus, peat or other soil containing organics.
- .13 Standard Proctor Density: Maximum Dry Density as determined by ASTM D698 and ASTM D2216 laboratory test methods field tested by either ASTM D2167 (rubber balloon method) or ASTM D1556 (sand cone method) or ASTM D2922/D3017 (nuclear methods).

**2.0 MATERIALS**

- 2.1 Topsoil: as described elsewhere in these specifications.
- 2.2 Trench excavation and backfill: as described in Articles 1.3 Definitions, 1.3.1 Trench Excavation, 1.3.10 Trench Backfill and further described as:
  - (a) Common excavation: as described in Article 1.3.8 Common excavation and the excavation of unsuitable materials described in Article 1.3.11 Unsuitable materials but excludes any topsoil removal or rock excavation.
  - (b) Rock excavation: as described in Article 1.3.9 but excludes any topsoil removal, common excavation or the excavation of unsuitable backfill material.
  - (c) Trench backfill: as described in Article 1.3.10 Trench Backfill 1.3.10 (a) Select Common Excavation or Native Material and shall include imported granular material described in Article 1.3.10 (d) and unshrinkable fill shown on the City of Estevan standard drawings and used for the foundation, haunch, bedding and initial backfill of pipe and appurtenances and any moist soils dried by aeration or blended with other suitable trench excavation but shall exclude imported backfill, foundation gravel, unshrinkable fill or imported granular material used above the pipe zone.
  - (d) Imported Backfill: as described in Article 1.3.10 (c).
- 2.3 Unshrinkable fill: concrete mixture containing a maximum of 25 kg/m<sup>3</sup> Portland Cement Type 10 (Type 30 for winter construction), sand conforming to Table 1 of CSA-A-23.10-M with maximum aggregate size of 6 mm and air entraining agents conforming to CAN3-A266.1-M. The materials shall be proportioned so as to produce a concrete mixture which will meet the following standards:

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Strength at 28 days	0.5 MPa $\pm$ 0.25 (measured as in CAN3-A23.2-9C)
Slump	175 $\pm$ 25 mm (measured as in CAN3-A23.2-5C)
Entrained air	4-6% (measured as in CAN-A23.2-4C)

- 2.4 Granular Materials: shall conform to the Section 1090 Granular Materials and Aggregates:

**3.0 INSTALLATION**

- 3.1 Testing:

- .1 No later than 48 hours before backfilling or filling excavations with approved materials, the Engineering Services Division shall be notified so that compaction testing by a designated laboratory can be arranged.
- .2 The Owner shall pay the costs of testing compaction.
- .3 The Contractor shall arrange, at its own cost and expense, to test gradation of granular materials, concrete, and unshrinkable fill and supply test results to the Engineering Services Division no later than one week before incorporating the material in the work.

- 3.2 Inspection and Protection of Existing Utilities and Surface Features:

The size, depth and location of existing utilities or structures as shown on the plans are for guidance only. Prior to commencing any excavation, notify applicable utilities, owners and authorities and establish the location and state of use of utilities and structures. Utilities shall be clearly marked and the locations of all buried utilities confirmed by careful test excavations.

Conduct with the Engineering Services Division and Owner a condition survey of existing buildings, trees and other plants, fencing, service poles, pavement and survey monuments or other structure which may be affected by the work.

Provide the Engineering Services Division with photographic documentation of areas or structures that may be affected by the work.

Protect all existing structures and surface features which may be affected by work from damage while work is in progress.

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3.3 Site Preparation:

- .1) Carry out topsoil stripping, clearing and grubbing the area within the limits of trench excavation and working space where required on the drawings, specified elsewhere in these specifications or as directed by the Engineering Services Division.
- .2) Cut pavement or sidewalk neatly along limits of proposed excavation in straight lines parallel to the trench centerline. Such cut width not to exceed that which is necessary for the trench soil conditions and not to exceed the specified maximum trench width at the ground surface shown on the drawings or specified in these specifications or marked on site by the Engineering Services Division.
- .3) Where in the opinion of the Engineering Services Division, existing pavement is in such poor condition that pre-cutting is not warranted, pavement may be cut by trenching equipment. Pavement removed to permit trenching shall be disposed of as waste material and shall not be placed in the trench backfill.

3.4 Trench Excavation:

- .1) Location of Excavation:

The Engineering Services Division will establish the trench alignment and depth by setting stakes at 15 to 20 metre intervals along a line offset from the centerline of the trench.

The Contractor will be provided with grade sheets indicating stake offsets, depth to pipe invert from existing ground and final grade elevations.

- .2) Open Trenches:

Excavate trenches only as far in advance as safety, traffic and weather conditions and ground water conditions in the trench permit.

Give due consideration to the protection of structures, piping and other man-made obstacles existing within the working area.

Do not extend excavation more than 120 m or such smaller length as may be recommended in the subsoil investigation report, noted on the drawing or as directed by the Engineering Services Division, beyond the pipe laying operation. No more than 10 m of trench shall remain open at the end of any one working day.

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.3) Depth:

Excavate trench to 100 mm below the bottom of the pipe or as required to provide sufficient space for pipe bedding or foundation gravel and to permit erection of forms, shoring, waterproofing and inspection of foundations. Excavate to clean lines to minimize the quantity of backfill required.

.4) Excavated Trench Material:

Stockpile excavated material along side the trench provided working space is adequate and without spilling onto private properties, disturbing fences, buildings, shrubs, lawns, crops or other items of value.

Stockpile excavated material to minimize blockage of traffic and drainage facilities.

Where excavated material cannot be piled along the trench, stockpile at locations approved by the Engineering Services Division and return for backfilling as required.

.5) Trench Width:

Excavate to produce clearance of not less than 150 mm between the outside of the pipe at its largest section and the trench sheeting or earth wall and not more than 300 mm clearance between the pipe and earth wall regardless of trench supports except that a minimum trench bottom width of 900 mm may be provided.

The above condition may prevail from the trench bottom to 300 mm above the top of the pipe.

Should a wider than permitted trench width be desired by the Contractor, the Engineering Services Division may consent to a written request by the Contractor proposing alternate bedding and/or pipe wall thickness provided that the cost of such alternates are borne by the Contractor.

Trench widths above a point 300 mm above the top of pipe shall be in accordance with the Occupational Health and Safety Regulations or as shown on the drawings or specifications.

Remove ledge rock, boulders and large stones to provide a minimum clearance of 100 mm below the pipe.

Where the maximum trench width is exceeded, provide special bedding or other precautions as directed by the Engineering Services Division at no extra cost to the City.

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.6) Undermining of Sidewalks, Curb and Gutters:

Excavate trench, where it is parallel to sidewalks, or curb and gutter, so that the walks or curbs will not be undermined.

Provide a minimum distance of 300 mm of undisturbed ground between the near edge of the walk or curb and the adjacent edge of the excavation.

If the near edge of the walk or curb and the adjacent edge of the excavation is less than that specified above use shoring or trench cage.

Backfill excavations intersecting proposed or existing concrete structures with unshrinkable fill material, a distance of 300 mm on either side of the concrete structure at the top of the trench and extending to the bottom of the trench.

.7) Bracing and Sheeting:

Shore the trench in a manner recommended by the Occupational Health and Safety Regulations, or as may be necessary to protect life, property and structures adjacent to the work, the work itself, or to maintain trench widths within specified limits.

Install shoring so that it does not extend below the springline of the pipe. Do not locate shoring closer than 150 mm to the widest section of the installed pipe. When it is necessary to place the shoring below the pipe springline, raise the shoring in 600 mm lifts and compact each lift to fill the void left by the raised sheeting when backfilling.

When shoring must be left in place, cut so that no shoring remains closer than a minimum of 900 mm to the ground surface.

Remove shoring in a manner which permits compaction of the backfill.

.8) Dewatering:

Control ground and surface water to the extent that excavation and pipe installation can proceed and the trench bottom is not disturbed to the detriment of the pipe installation.

All water encountered in the trench shall be pumped or bailed out. Only in the case of storm sewers may the pipe be used to drain such water.

Ensure that foundation problems with structures do not occur from selected method of dewatering.

Locate discharge and dispose of water from dewatering equipment such that loss, damage, nuisance or injury to the public does not occur.



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Discharge water from the trench into natural drainage channels, drains or storm sewers.

.9) Safety:

Excavate trench as required by the Occupational Health and Safety Regulations as may be necessary to protect life, property and work.

Sheet and brace open cut trenches as required by the Occupational Health and Safety Regulations, and as may be necessary to protect life, property and work. The granting of permission by the Engineering Services Division, however, shall not relieve the Contractor from his full responsibility under the contract and Occupational Health and Safety Regulations for the design and use of shoring and the conformance with OH&S Regulations in carrying out the work.

Blasting for excavation will not be permitted.

Night work, from sunset to sunrise, will only be allowed if written permission is given beforehand by the Engineering Services Division or to correct work that may present a hazard to the public or existing utilities. When any work is carried out at night, supply a sufficient number of electric or other approved and efficient lights to enable the work to be done in a satisfactory manner. No pipe shall be laid nor work done if in the opinion of the Engineering Services Division there is insufficient light to perform the work safely and satisfactorily.

.10) Trench Bottom Conditions:

Maintain trench width such that pipe can be installed without getting water, muck, silt, gravel or other foreign material into the pipe.

The trench bottom shall be firm and capable of supporting the pipe to be installed, otherwise stabilize bottom by means of over-excavation and the provision of a well graded foundation gravel designed to support the pipe.

Remove all deleterious material caused by machine excavation, trench water, workers operations or other reason from the trench bottom.

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.11) Unstable Foundation Conditions:

Excavate the trench so as to provide a uniform and continuous support for the pipe and fittings on solid undisturbed ground. Over-excavate unstable trench bottom to a level at which stable material is encountered or at which the addition of foundation gravel will provide a stable trench bottom.

Backfill over-excavation to the level of normal bedding with a well graded foundation gravel material.

Compact foundation gravel material with approved mechanical compactors in lifts having a maximum depth of 300 mm to provide a thoroughly consolidated pipe zone.

Excavate loose or deleterious material to the width, depth and length as required and backfill with well graded foundation gravel compacted in 300 mm layers to 95% Standard Proctor Density. The Contractor may at his own cost, use uniformly graded foundation gravel provided that such material is fully wrapped with non-woven geotextile as an alternate. Prior written approval of such materials shall be obtained for the Engineering Services Division before use.

Clearance between pipe and trench bottom or trench walls shall not be less than 150 mm for 600 mm O.D. pipe or less than 200 mm for pipe having an O.D. greater than 600 mm or more than 600mm for pipe having an O.D. more than 300mm.

Finish trench bottom with hand tools to provide a uniform and continuous support for the pipe.

.12) Coring: Conform to the requirements of Section 1600 – Augered, Tunneled and Bored Crossings

3.4 Trench Backfill:

.1) Backfill Within the Pipe Zone:

Backfill with granular bedding material (Class B bedding) placed in uniform layers and compacted by hand tampers or mechanical means for the full width of the trench. Backfill in layers not exceeding 150 mm in thickness and compacted to completely fill spaces under and adjacent to the pipe.

Place bedding material to lines and depths required. Provide holes for bell and spigot along the trench bottom so that the pipe barrel is evenly supported throughout the entire length.

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Compact the pipe bedding, haunching and initial backfill material to 95% Standard Proctor Density.

Where specified or directed by the Engineering Services Division, backfill with unshrinkable fill such that the material flows into the excavation and fills the entire space under the pipe. Place unshrinkable fill material to the springline of the pipe. Ensure that the pipe or pipe bedding are not disturbed during backfill placement and air is not trapped beneath horizontal projections or the other locations within the pipe zone excavation.

Where specified, place concrete (Class A) bedding material to lines and depths required. Provide holes for bell and spigot joints along the trench bottom to provide even support throughout the pipe length and ensure that the entire space between the trench bottom and springline of the pipe is completely filled especially the haunch.

.2) Backfill Above the Pipe Zone:

Native Material:

.1) Class II Backfill (where specified)

Backfill in uniform layers not exceeding the thickness required to obtain the specified density. The maximum allowable layer thickness shall be 300 mm unless otherwise approved by the Engineering Services Division. Compact backfill to a minimum 95% Standard Proctor Density.

Control the moisture content of the native backfill material to within  $\pm 3\%$  of the soil in the adjacent trench walls and within  $\pm 3\%$  of the optimum moisture content. Supply and add water or dry and aerate the backfill material as required or blend with dry native material to meet the moisture specification.

Areas to be backfilled shall be free from debris, snow, ice, water or frozen ground. Backfill material shall not be frozen or contain ice, snow or debris.

Where excavated trench material is not suitable for backfilling it shall be hauled and disposed of and imported backfill material shall be provided and placed.

Provide and place backfill material arising from a shortage of backfill material due to the construction operation or removal and disposal of rock, boulders or other material.

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Haul suitable material from elsewhere on the project site, or where this is not possible, provide material from other sources to make up such deficiencies in backfill material.

.2) Class III Backfill (where specified)

Conform to the provisions of Class II Backfill except compaction which may be carried out in lifts of 600 mm using crawler tractors or rubber-tired loaders.

.3) Class I Backfill (where specified)

Supply and deliver granular material with sufficient moisture to prevent dust generation during handling.

Backfill in uniform layers not to exceed the thickness required to obtain the specified density. The maximum allowable layer thickness shall be 150 mm for granular materials unless otherwise approved by the Engineering Services Division or recommended in the geotechnical report (if provided)

Compact backfill to 95% Standard Proctor Density.

Repair and pay for damage resulting from subsidence or heaving of the backfill within the duration of the maintenance period.

.4 Unshrinkable Fill

Place unshrinkable backfill such that the material flows into the excavations and fills the entire space. The initial lift shall be a maximum of one (1) metre in depth and reach final setting where the concrete is no longer fluid before additional low shrink material is placed on top of initial fill. Take care to ensure that the pipe or pipe bedding is not disturbed during backfill placement and air is not trapped beneath horizontal projections or the other locations within the excavation.

Cover unshrinkable backfill material for at least 24 hours with steel plates of sufficient strength to support traffic where required. Where road traffic is not to be accommodated cover and fence the excavation for 24 hours until the unshrinkable backfill is of sufficient strength to allow placement of pavement.

.3) Backfilling of Structures:

Structures include buildings, manholes, vaults and buried valves.

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Backfill structures with native material or granular material compacted to 95% Standard Proctor Density, in maximum lifts specified herein to within 1 metre of structure. Excavation to be free of ice, snow, debris and water at the time of backfilling.

Compact backfill adjacent to and/or under slabs and footings to 100% Standard Proctor Density or use unshrinkable fill. Use only hand operated tampers or equipment in this zone. Place backfill evenly around structures in order to maintain symmetrical loading.

.4) Disposal of Boulders:

Haul boulders to a site designated by the Owner.

.5) Disposal of Excess Common Excavation:

(a) Haul and place in stockpiles or shaped, spread and leveled in compacted layers as described for trench backfill above pipe zone, all excess common excavation materials at areas designated for such disposal in these specifications.

(b) Haul unsuitable and deleterious materials to designated disposal sites.

.6) Surface Maintenance During Construction:

Maintain all trench surfaces and working surfaces affected by construction until the project is accepted by the Owner.

Finish berms over trenches as specified prior to acceptance. Provide and place material to fill depressions resulting from the settlement of backfill.

Maintain graveled surfaces free of pot holes and washboard conditions. Grade surfaces to eliminate irregularities as often and as soon as they occur.

Mark locations which cannot be immediately reinstated to the specified standard by approved means to warn traffic of hazards until defects are rectified.

.7) Restoration:

Restore all areas adjacent to trench excavations disturbed during construction to a condition at least equivalent to that which existed prior to construction and submit a signed release to the Engineering Services Division prior to the Certificate of Completion.

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.8) Restoration of Paved Surfaces:

Compact trench backfill to a level 450 mm or as otherwise directed by the Engineering Services Division below finished grade and backfill the remainder with compacted granular base coarse to 100% of Standard Proctor Density.

Recut ragged cut pavement edges to form a straight line prior to placing base gravel.

Replace pavement adjacent to, but not within the limits of maximum trench width shown on the drawings, or marked on site by the Engineering Services Division and destroyed during construction at no cost to the Owner.

.9) Dust Control:

Use all means necessary to control dust on and near the work and on and near all off-site borrow areas if such dust is caused by the Contractor's operations during performance of the work or if resulting from the condition in which the Contractor leaves the site.

Maintain all surfaces as required to prevent dust being a nuisance to the public and concurrent performance of other work on-site.

.10) Trench Settlement During Warranty Period:

Replace materials and rectify all failures that occur as a result of settlement of trench backfill or collapse of trench walls during the warranty period. Refill settled trench areas with specified backfill material.

**4. MEASUREMENT AND PAYMENT**

4.1 The following work items in this section shall be deemed incidental to the supply and installation of watermains and appurtenances, sewer mains and appurtenances, water and sewer service connections:

- (i) site preparation;
- (ii) trench excavation and backfill.

4.2 The following work items in this section shall be paid in accordance with Contract unit prices, which shall be deemed full compensation for all labour, materials, equipment, supplies, superintendence, overhead and profit and for all work incidental to the supply, installation, completion and maintenance during warranty period of the respective items.

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- (i) **Imported native backfill above the pipe zone:** shall be paid on the basis of the volume of material measured in its position in cut at the site of borrow after reducing the volumes of topsoil removed and unsuitable material rejected, as agreed upon by the Engineering Services Division's site representative.
  - (ii) **Imported granular fill above the pipe zone:** shall be paid on the basis of the mass of material in Tonnes, certified by the Engineering Services Division as delivered to site, as a premeasured truck box count noted on delivery tickets, submitted to the Engineering Services Division within 6 hours of delivery, the final volume adjusted by a reduction factor of 15% to allow for compaction, variations in truck box fill, etc.
  - (iii) **Imported foundation gravel:** shall be paid on the basis of the mass of material in Tonnes, certified by the Engineering Services Division as delivered to site, and submitted within 6 hours of delivery.
  - (iv) **Unshrinkable fill above the pipe zone:** shall be paid on the basis of cubic metres delivered to site and noted on delivery tickets endorsed by the Engineering Services Division except where shown on the City of Estevan standard drawings for backfilling watermain valves, manholes, etc., which shall be deemed incidental to the installation of such appurtenances.
  - (v) **Rock excavation:** shall be paid on the basis of cubic metres of rock excavation measured in place and paid for at a rate of \$25.00 per cubic metre which price shall include excavation, blasting, loading, haul and disposal.
  - (vi) **Excess common excavation:** shall be paid on the basis of cubic metres of material measured in place at the designated disposal site. The Contract unit price shall include excavation, loading, haul and disposal by stockpiling or disposal by placement of compacted fill as specified.
- 4.3 All remaining work items described in this section shall be deemed incidental to the items in Article 4.1 and 4.2 of this section.