

SECTION 2: EARTHWORKS

SECTION 2: EARTHWORKS

SECTION 2: EARTHWORKS	I
SECTION 2.01 REMOVAL OF PAVEMENT	3
2.01.1 SCOPE	3
2.01.2 GENERAL	3
2.01.3 METHOD OF EXECUTION	3
2.01.3 MEASUREMENT	3
SECTION 2.02 REMOVAL OF OBSTRUCTIONS AND UTILITIES	4
2.02.1 SCOPE	4
2.02.2 GENERAL	4
2.02.3 CONSTRUCTION	4
2.02.4 MEASUREMENT	11
SECTION 2.07 SUBGRADE CONSTRUCTION	15
2.07.1 SCOPE	15
2.07.2 MATERIALS	15
2.07.3 CONSTRUCTION	15
2.07.4 MEASUREMENT	17
SECTION 2.09 STRUCTURAL EXCAVATION AND BACKFILL	18
2.09.1 SCOPE	18
2.09.2 EXCAVATION	18
2.09.3 BACKFILLING	21
2.09.4 MEASUREMENT	25
SECTION 2.10: EARTHWORK OF WET INFRASTRUCTURE SYSTEMS	27
2.10.1 SCOPE	27
2.10.2 GENERAL	27
2.10.3 STANDARDS AND CODES	27
2.10.4 EXCAVATION IN RESTRICTED AREA	29
2.10.5 METHODS OF DETECTION OF EXISTING UTILITIES	29
2.10.6 SHEETING AND BRACING	29
2.10.7 STOCKPILING OF EXCAVATED MATERIALS	30
2.10.8 EXCAVATION IN POOR SOIL	30
2.10.9 KEEPING EXCAVATIONS FREE FROM WATER	32
2.10.10 EXCAVATION IN ROCK	33
2.10.11 EXCAVATION FOR TRENCHES	34
2.10.12 EXCAVATION FOR FOUNDATIONS AND SUB-STRUCTURES	37
2.10.13 EXCAVATION NEAR EXISTING UTILITY LINES AND SERVICES	38
2.10.14 EXCAVATION	40
2.10.15 CARE AND RESTORATION OF ROAD PAVEMENTS AND STRUCTURES	40
2.10.16 PREPARATION AND INSPECTION OF EXCAVATIONS	41
2.10.17 FILLING AND BACKFILLING FOR PIPE TRENCHES AND MANHOLES	41
2.10.18 MEASUREMENT	44

SECTION 2.01 REMOVAL OF PAVEMENT

2.01.1 SCOPE

This item shall consist of removing existing pavement constructions, flexible and rigid, and all other pavement items, the disposal of such material and the cutting by mechanical saws of neat lines between areas to be removed and areas not to be removed, all as directed by the Engineer.

2.01.2 GENERAL

- A.. Areas designated for removal of existing pavement shall be determined by the Engineer.
- B. The method of removal shall be one which is acceptable to the Engineer. Every effort shall be made to remove only the pavement layers within the limits and depth designated.
- C. The manner and location of disposal for materials shall be subject to approval by the Engineer.

2.01.3 METHOD OF EXECUTION

C.1 Milling

Refer to Division 3, Section 3.06 where removal of pavement by milling is clearly specified. For depth exceeding 5 cm, a heavy duty milling machine, able to mill in one pass up to 10 cm depth, should be exclusively used by the Contractor.

C.2 Grubbing and Excavation

The Contractor may remove the pavement by any mean such excavating and grubbing if requirements related to pavement layers are not specific in this regard.
If aggregate layers are to be maintained, the Contractor should following the asphaltic pavement removal, properly reinstate these aggregate layers by providing, spreading and compacting aggregate base and sub base course for reinstatement and releveling, as specified in relevant Section.

2.01.3 MEASUREMENT

A. Pavement

Measurement and payment shall be made per linear meter for removal of asphaltic pavement. Thickness to be measured before the removal.

This rate shall be full compensation for furnishing all labour, equipment, tools, transport, depositing, and incidentals necessary to complete the item, including required reinstatement and rectification of existing aggregate layers at the Contractor's cost.

SECTION 2.02 REMOVAL OF OBSTRUCTIONS AND UTILITIES

2.02.1 SCOPE

The work covered in this Section consists of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, structures, abandoned pipelines, existing roadways, sidewalks, kerbs, signs, bollards, electricity columns, advertising signs and any other obstructions, which are not designated or permitted to remain. This Section also covers rerouting, relocating or diverting utilities, fencing, signs and other feature obstructing the Works, salvaging of designated materials and backfilling the resulting trenches, holes and pits.

2.02.2 GENERAL

A. The Contractor shall examine the Site and record all obstructions and utilities at the commencement of the Works. Examination shall include (but not be limited to) surveying, identification, collection of data from organisations, authorities and others, exploratory pits and trial trenching. The Engineer shall decide if obstructions and utilities not discovered at the commencement of the Works and that subsequently require removal, diversion or replacement shall be directly paid for or the costs considered covered under the Contract.

B. Any information or data, whether expressed or implied, obtained by the Contractor with respect to the existence or location of obstructions or utilities above or below ground shall neither be construed nor deemed to construe any passing of responsibility to the Employer or the Engineer for the correctness, accuracy, validity or use of any such information and data. The Contractor shall be solely responsible for his own assessment, interpretation and evaluation thereof and have made due allowance in his Tender for risks, contingencies and all other circumstances which may influence or affect the undertaking of the Works. This information shall be obtained without prejudice to the Contractor's obligation to inspect the Site prior to submitting his Tender, pursuant to sub-clause 11.1 of the Conditions of Contract.

C. The Engineer shall decide whether materials to be removed from the area are salvageable, perishable or non- perishable.

2.02.3 CONSTRUCTION

A General

A.1 The Contractor shall raze, remove and dispose of all buildings, foundations, structures, fences and other obstructions which are fully or partly on the ROW, except for utilities and other items for which alternative arrangements for removal have been made.

A.2 All salvageable material including steel bridges, lighting poles, electricity columns, ductile iron pipes, water supply lines, traffic signs, advertising signs, overhead signs and panels, bollards and any other material designated to be salvaged shall be removed, without causing unnecessary damage in sections or pieces and shall be transported and stored by the Contractor at locations instructed or approved by the Engineer or detailed on the Drawings, for later use or for collection by others as directed by the Engineer.

A.3 Unusable perishable material shall be destroyed. Non-perishable material may be disposed of off the Site, provided permission of the respective property owners has been obtained in writing to dispose of such materials on their land.

A.4 Salvaged pipe culverts and other re-usable structures shall be stored at accessible locations on Site, as approved by the Engineer, and shall become the property of the Employer.

B. Demolition of Existing Buildings and Structures

B.1 Demolition or partial demolition of existing buildings and structures adjacent to or within the works shall be carried out as indicated on the Drawings or as directed by the Engineer. Such demolition includes building foundations and supporting works to a uniform depth of 300 mm below the lowest foundation level.

B.2 Prior to carrying out the demolition or partial demolition of buildings or structures, the Contractor shall submit to the Engineer a method statement containing, but not limited to, the following:

- A schedule for disconnection, capping and/or continuation of utility services as required.
- A detailed sequence of demolition and removal work to ensure uninterrupted progress of other site operations.
- Proposals for the temporary diversion of traffic, pedestrian access and protection measures in accordance with the Safety, Health and Environmental regulations.
- Proposals for the partial demolition, making good and rehabilitation of buildings that are to be partly demolished by the Contractor as indicated on the Drawings.

B.3 Buildings and structures shall be vacated and decommissioned prior to start of demolition work.

B.4 Where buildings are to be partially demolished and/or reinstated by the property owner, the Contractor shall liaise with and coordinate his works as necessary to facilitate these demolition and reinstatement works.

B.5 Materials of salvable value to Contractor shall be removed from buildings and structures as work progresses. Salvaged items shall be transported from site as they are removed to storage as directed by the Engineer. Salvaged materials remain the property of the Employer, unless otherwise designated by the Engineer.

B.6 Demolition operations and removal of debris shall be carried out by methods that ensure minimum interference with roads, streets, footways and other adjacent occupied or used facilities

B.7 Roads, streets and footways shall only be closed with the Local Authority's consent. Alternative routes around closed or obstructed traffic ways shall be provided unless otherwise indicated on the Drawings or instructed by the Engineer

B.8 The Contractor shall take the following into account to ensure the safe passage of persons and to prevent damage to adjacent areas around demolition areas.

- The provision of temporary covered passageways.
- Interior and exterior shoring, bracing or support to prevent movement, settlement or collapse of structures to be demolished and adjacent properties or other facilities.

B.9 Accidental damage caused to adjacent buildings, structures and other features by demolition operations shall be promptly repaired at no cost to the Contractor and to the satisfaction of the Engineer.

B.10 Existing utilities shall be maintained in service and protected against damage during demolition operations.

B.11 Demolition work shall not commence until all utility disconnections have been completed and verified by the Engineer.

B.12 The Contractor shall take all necessary measures to control pollution arising from demolition works. Dust emissions shall be controlled by the use of water sprinkling, temporary enclosures and other suitable methods

B.13 Adjacent buildings, structures and other features shall be cleaned to remove dust, dirt and debris caused by demolition operations, as directed by Engineer, to return adjacent areas to their condition existing prior to the start of demolition work.

B.14 Foundations shall be removed to a depth of not less than 300 mm below the existing ground surface unless otherwise shown on the Drawings or instructed by the Engineer. All wood, metal and flooring shall be removed.

B.15 Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and, if within the construction area, shall be compacted to the type of compaction within the range for the adjacent roadway embankment as specified in Section 2.06 - Embankment Construction.

B.16 Prior to placement of fill material, all areas to be filled shall be free of standing water, frost, frozen material, trash and debris.

B.17 Fill materials shall be placed in horizontal uncompacted layers not exceeding 250 mm. Each layer shall be compacted at the optimum moisture content of the fill material to a density equal to original adjacent ground unless subsequent excavation for new work is required.

B.18 After fill placement and compaction is complete the Contractor shall grade the surface to meet adjacent contours and to provide flow to surface drainage.

C. Removal of Bridges, Culverts and Ditches

C.1 Bridges, culverts and other drainage structures in locations traversed by traffic shall not be removed until arrangements to the Engineer's approval have been made by the Contractor to maintain the flow of traffic.

C.2 Substructures of bridges, culverts and other drainage structures shall be removed down to the profile of the watercourse. Substructure away from the watercourse shall be removed to a depth of 300 mm below the adjacent natural ground surface. Where sections of existing structures lie wholly or partly within the limits for a new structure they shall be removed to the extent necessary to accommodate construction of the proposed structure.

C.3 Steel and timber bridges designated to be salvaged shall be dismantled without causing any damage. Steel members shall be match- marked and all salvaged material shall be inventorised, transported and delivered to designated areas or as directed by the Engineer. The Contractor shall submit a detailed method statement for the dismantling, removal and storage of the bridge structure for the Engineer's approval.

C.4 Blasting or other operations which are necessary for removal of existing structures or obstructions shall be completed prior to commencing any new construction in the vicinity.

C.5 Necessary safety measures shall be taken by the Contractor during all blasting operations to avoid injury to persons and damage to properties or to the finished work. A comprehensive Safety Method Statement shall be presented to the Engineer for approval prior to the start of blasting. Regardless of the Engineer's approval, blasting or other operations shall be performed at the entire risk and responsibility of the Contractor.

C.6 Where necessary or directed by the Engineer, the Contractor shall provide heavy mesh blasting mats for protection of persons, properties and the Works. If, in the opinion of the Engineer, blasting would be dangerous to persons or adjacent structures, or is being carried out in an unsafe or unacceptable manner, he shall prohibit subsequent blasting and instruct the Contractor to carry out the demolition works by alternative methods.

C.7 The Contractor shall make good the affected area following the removal of

bridges, culverts and ditches to the satisfaction of the Engineer.

D. Removal of Pipes

All pipes, unless otherwise directed by the Engineer, shall be removed and precautions taken to avoid breaking or damaging the pipes. The Contractor shall exercise the utmost care during the removal of pipes to avoid unnecessary damage.

E. Removal of Rocks and Boulders

Large rocks and boulders of individual sizes greater than 0.2 m³ or 500 kg lying within the limits of the Works shall be removed and disposed of as indicated on the Drawings or directed by the Engineer.

F. Removal of Fences, Walls and Gates

When fences, walls and gates enclosing properties and fields are to be removed, the Contractor shall notify the Engineer sufficiently in advance to give the property owner reasonable notice to make suitable arrangements, including temporary fencing and livestock relocation..

G. Removal of Wells

Existing wells, abandoned or active, which lie within the limits of the Works, shall be dismantled, backfilled, and compacted. All salvageable materials shall be removed and stored at locations on Site approved by the Engineer. All salvageable material shall become the property of the Employer. Wells shall be filled to the level of the surrounding ground and, if within the limits of construction, shall be compacted in accordance with the Drawings or as instructed by the Engineer.

H. Removal of Trees

Removal or transplanting of existing trees with a girth of less than one metre shall be carried out in accordance with the provisions of Section 2.01: Clearing and Grubbing. Trees with a girth of over one metre shall be felled by a suitably qualified tree surgeon approved by the Engineer and the stump and roots removed to a depth of 1.5 metres. The resulting timber and roots shall be disposed of in accordance with the Engineer's instructions.

I. Removal of Existing Utilities

I.1 The locations of existing utilities shall be investigated and established by the Contractor in consultation with the relevant Authority or Service Provider.

I.2 Any utility which has been damaged in the course of the work shall be replaced with equivalent materials, to the satisfaction of the Engineer and relevant Authority or Service Provider, by the Contractor at his own expense.

I.3 Any action taken by the Contractor with respect to power cables, telephone cables and water mains encountered during the course of the work, shall comply with the requirements of the responsible Authority and at his own expense

I.4 The Contractor shall coordinate with the Engineer and notify all Utility Owners and co-operate with them in respect of removal, rerouting, relocating and diverting utilities.

I.5 Enabling, relocating, rerouting and diverting utilities shall be carried out by the Contractor unless indicated otherwise in the Contract Documents or instructed by the Engineer. Works shall be executed in close coordination with the respective utility owner or service provider, including provision for inspection, salvaging of materials, connections and reconnections.

I.6 The Contractor shall coordinate with the Engineer and shall advise each affected Utility Owner in writing of his proposed construction schedule.

I.7 The Contractor shall be responsible for supporting and protecting realigned utilities and existing utilities that are to remain in place for the duration of the Contract and shall provide all necessary Temporary Works in this respect. Any damage caused to utilities and attributable to the Contractor shall be repaired at his expense, including any fees to be paid to Authorities relating to service interruptions.

I.8 The Works related to the relocation of water pipes, stormwater pipes and sewer pipes shall be carried out in accordance with Division 8 of the Specification: Drainage and Water Services and the utility owner and/or service provider's requirements.

I.9 The relocation of water pipes shall not be carried out until the Contractor obtains written approval from the Water Authority. The Contractor shall provide, at his own expense, all bonds and guarantees required by the Water Authority before relocation.

I.10 The Works related to the relocation of electric cables, posts, electric pylons, telephone cables and posts, etc. shall be carried out in accordance with Division 7 of the Specification: Street Lighting and Electrical Works and according to the Utility Owner and/or service provider's requirements. The Contractor shall contact the Utility Owners and/or service provider and prepare the necessary plans for the relocation of these utilities. Relocation works shall be carried under the supervision of the Utility Owner or service provider and completed works shall be subject to their acceptance.

J. Removal of Advertising Signs and Billboards

The removal of advertising signs and billboards located in the ROW shall be carried out by the Contractor in coordination with the concerned Authorities and respective Owners, unless the Owner indicates his intention to carry out such removal. The removed signs and billboards shall be transported and stored at the Owner's premises as directed by the Engineer.

K. Removal of Existing Roadside Furniture

Where necessary for the construction of the Works, or when instructed by the Engineer, the Contractor shall remove all roadside furniture including traffic signs, road studs, vehicular safety barriers, posts and foundations. The furniture shall be transported and stored for reuse or returned to the relevant owner as directed by the Engineer and all holes and voids resulting from the removal shall be infilled and compacted in accordance with these specifications.

L. Removal of Existing Bituminous and Cement Concrete Pavement

Unless otherwise detailed on the Drawings, the Contractor shall have the option to remove, pulverize, crush, blend and process existing bituminous and cement concrete pavement (including sidewalks, curbs, gutters and stairs) which are specified to be removed and use such materials in the new construction. All such salvaged pavement, proposed for use in new construction, shall be processed to conform to all specified gradation and quality requirements for the material to be placed in the new construction.

M. Removal of Existing Railway Tracks

M.1 The Contractor shall liaise with the Railway Authority in connection with removal of railway lines within the ROW. Dismantling of railway tracks and railway structures shall be carried in accordance with the Railway Authority's requirements. The Contractor shall comply with all regulations of the Railway Authority in executing work in or adjacent to their property.

M.2 The railway tracks shall be salvaged. All salvaged materials shall be inventoried, transported and delivered to the Railway Authority's stores as directed by the Engineer.

N. Cleaning of Existing Drainage Structures

Where shown on the Drawings or instructed by the Engineer, existing drainage structures (culverts pipes, ditches and the like) shall be cleared of all silt and debris to the satisfaction of the Engineer. All waste material shall be disposed of off site in accordance with Part 2.02.3 of this Section.

O. Raising or Lowering of Manhole and Road Gully Cover Levels

The Contractor shall raise or lower the levels of existing manhole and gully covers where necessary to suit the adjusted road profile. Care shall be taken in lifting the covers and

frames to avoid damage to the metalwork and chamber concrete. The covers and frames shall be reset to the finished road level in accordance with the requirements of Specification Section 8.05: Manholes, Chambers and Gullies. If, in the opinion of the Engineer, the Contractor damages frames or covers through neglect, the Contractor shall provide replacements, to the satisfaction of the Engineer, and at the Contractor's expense.

2.02.4 MEASUREMENT

A. Demolition and removal of existing buildings shall be measured by the square metre of the built surface area demolished including the ground floor slabs. The price shall include, but not be limited to, the following: -

- Demolition and disposal of all kinds of materials in the existing building including any foundations, walls or retaining structures.
- Disposal of materials other than those remaining the property of the Employer or those for reuse.
- Clearing, storing, protecting and transporting materials remaining the property of the Employer or those for reuse.
- Temporary support incidental to the demolition.
- Leaving parts of existing walls temporarily in position to act as buttresses.
- Temporarily redirecting, maintaining or sealing of existing services.
- Backfilling with suitable material and compacting up to ground level holes and voids arising from the demolition works
- Making good sections of buildings not to be demolished including all necessary finishing works.
- Other requirements as described by or in accordance with the Contract Documents and Drawings

B. Demolition and removal of existing structures, including bridges and culverts, shall be measured by the individual item. The price shall include the demolition and disposal of all kinds of materials in the existing structure including any foundations, walls, or retaining structures. The price shall include the following: -

- Demolition and disposal of all kinds of materials in the existing structure including any foundations, walls or retaining structures.
- Disposal of materials other than those remaining the property of the Employer or those for reuse.
- Clearing, storing, protecting and transporting materials remaining the property of the Employer or those for reuse.
- Temporary support incidental to the demolition.
- Leaving parts of existing walls temporarily in position to act as buttresses.
- Temporarily redirecting, maintaining or sealing of existing services.
- Backfilling with suitable material and compacting up to ground level holes and voids

arising from the demolition works

- Making good sections of buildings not to be demolished including all necessary finishing works.
- Other requirements as described by or in accordance with the Contract Documents and Drawings.

C. Unless specifically itemised in the Bill of Quantities or instructed by the Engineer, removal of existing pipes shall not be measured separately and the costs of excavation, removal, disposal, repair and backfilling shall be deemed to be included in the Contract prices for other pay items.

D. Removal and disposal of large rocks and boulders shall be measured by the cubic metre of unclassified highway excavation as prescribed in Section 2.03: Highway Excavation.

E. Removal and/or relocation of existing fences and walls shall be measured by the linear metre. The price shall include for, but not be limited to, dismantling of existing fencing, removal of post footings, transportation, storage and repair of existing fencing, backfilling and material compaction of existing post holes and re-erection on the existing fencing; all in accordance with these Specifications.

F. Removal of existing wells shall be measured by the number of wells dismantled, backfilled and compacted. The price shall include for, but not be limited to, removal, transportation and storage of salvageable materials, backfilling and compaction; all in accordance with these Specifications.

G. Removal of trees with a girth in excess of one metre shall be measured by the number of trees felled and stumped. The price shall include for, but not be limited to, felling, removal of stumps, transportation and disposal of timber and roots, backfilling and compaction to existing ground level; all in accordance with these Specifications.

H. Removal and Relocation of Utilities

H.1 Permanent realignment or replacement of Utilities shall be measured and paid in accordance with the rates set in the Bill of Quantities for the respective works. Where the Bills of Quantities contain a Provisional Sum for Realignment or Replacement of Utilities, payments shall be made against invoices and receipts for realignment, replacement or permanent diversion works approved by the Engineer and carried out by the Utility or Service Provider, a sub contractor nominated under the Contract or approved by the Engineer or against work directly carried out by the Contractor which has been negotiated and agreed with the Engineer prior to the execution of the work.. This Sum shall only be expended against works which are not accounted for as Pay Items elsewhere in the Specification or the Bill of Quantities.

H.2 The relocation or removal of electric and telephone overhead and underground cables shall be paid by the linear metre of the existing length of the cable. Rates shall include for, but not be limited to, preparation and submittal for the necessary plans for the relocation of these utilities, relocation of utilities, coordination with the Utility Owner and/or Service Provider, all fees required by these authorities for the supervision of the relocation or removal works, excavation, handling, transportation, replacement and repair of damaged cables, backfilling of all excavations, all other necessary installation works and commissioning; all in accordance with these Specifications.

H.3 The relocation or removal of electric, lighting and telephone poles, posts, pylons, shall be paid by the number relocated or removed. Rates shall include for, but not be limited to, preparation and submittal for the necessary plans for the relocation of these utilities, relocation of utilities, coordination with the Utility Owner and/or Service Provider, all fees required by these authorities for the supervision of the relocation works, excavation, dismantling, handling, transportation, replacement and repair, backfilling of all excavations, reassembly, re-erection all other necessary installation works and commissioning; all in accordance with these Specifications.

H.4 Rates for the relocation of potable water, storm water and sewer pipe lines shall be shall be paid by the linear metre of the existing length of the pipelines. The rate for potable water relocation works shall include for, but not be limited to, preparation and submittal for the necessary plans for the relocation of these utilities, relocation of utilities, all related incurred costs, including the costs of coordination with the water authority during the relocation to supervise any works including any fees related thereto, excavation, handling, transportation, replacement and repair of damaged pipes, backfilling of all excavations, all other necessary installation works and commissioning, all in accordance with these Specifications.

H.5 Temporary relocation and diversion of utilities required during construction, irrespective of the number of relocations and diversions required, supporting and protecting realigned and existing utilities that are to remain in place, including, but not limited to, all necessary temporary works shall not be measured for direct payment, but shall be considered as subsidiary works; the costs or which shall be deemed to be included in the Contract prices for Pay Items.

H.6 Survey works, investigation and mapping of existing utilities and obstructions, coordination costs, and fees requested by Utility Owners shall not be measured for direct payment, but shall be considered as subsidiary works the costs of which shall be deemed to be included in the Contract prices for Pay Items.

I. Removal of signs, billboards, poles and road studs shall be measured and paid by the item dismantled, stored, transported and rehabilitated, reused or disposed of off site. The price shall include for, but not be limited to, dismantling, removal and disposal of footings, transportation, storage and repair, backfilling and material compaction of holes and voids and re-erection, delivery to the owner's premises or disposal off site; all in accordance with these Specifications.

J. Demolition of existing barriers shall be paid by the linear metre of barrier to be demolished. The rates shall include for, but not be limited to, dismantling, removal and disposal of footings, transportation, storage and repair, backfilling and material compaction of holes and voids and re-erection, delivery to the owner's premises or disposal off site; all in accordance with these Specifications.

K. Removal of roadways and existing bituminous and concrete pavements shall be measured by the cubic metre of unclassified highway excavation as prescribed in Section 2.03 - Highway Excavation.

L. Removal of railway tracks shall be measured by the linear meter of track, measured along the centreline of the tracks, for the works specified. The price shall include for, but not be limited to, coordination with the Railway Authority, lifting of the track, loading and transportation to the Railway Authority depot.

M. Adjustment of manhole and gully cover levels shall be measured by the number of covers and frames adjusted as specified and accepted. The price shall include for, but not be limited to, removal and storage of the covers and frames for reuse, adjusting the level of the existing manhole neck and reinstallation of the covers and frames. The rate shall include saw cutting of the existing asphalt layer where applicable, excavation around the manhole (or the like), demolition and reconstruction of the access shaft, removing, cleaning, painting and reinstalling the existing manhole cover and frame (or the like) to the finished grade in either brickwork or concrete as appropriate.

N. Cleaning of existing box culverts, waterways, open concrete side drains and covered concrete side drains shall be measured by the linear metre of the section to be cleaned. The price shall include for, but not be limited to, cleaning and clearing, by mechanical means or by hand, transporting and disposing of silt and debris, above and below the waterline; all to the satisfaction and approval of the Engineer.

SECTION 2.07 SUBGRADE CONSTRUCTION

2.07.1 SCOPE

A. The work covered in this Section consists of furnishing materials, constructing the subgrade layer and preparing the subgrade surface ready to receive the pavement structure and shoulders, all as and where shown on the Drawings.

B. The subgrade layer is the selected material immediately below the subgrade surface.

2.07.2 MATERIALS

A. Subgrade material shall consist of selected material having a 4-day soaked CBR of not less than 20% when tested in accordance with AASHTO T 193 when compacted at 100% of modified proctor AASHTO (T-180-D) and having a maximum P.I. of 12%. Subgrade gradation shall be reasonably smooth without gap grading. All material shall pass the 75 mm sieve and not more than 18% shall pass the 0.075 mm (No. 200) sieve.

B. Minimum tests required on subgrade are listed in Section 2.06 - Embankment Construction

2.07.3 CONSTRUCTION

A. Subgrade in Cut

A.1 Where the subgrade is located in rock, the subgrade, unless shown otherwise on the Drawings, shall be undercut to a depth of 200 mm by drilling or blasting as directed. No rock shall project more than 50 mm above the undercut surface elevation. The subgrade layer shall then be constructed using approved subgrade material, as specified for subgrade in embankment.

A.2 Where the subgrade is on in-situ soil which is of a quality and CBR value at least equal to those specified for subgrade, the 200 mm depth of such material immediately below top of subgrade shall be scarified and all roots, topsoil, vegetable and other undesirable matter and rock particles larger than 75 mm in any dimension shall be removed. The material shall then be brought to a uniform moisture content within the specified range and compacted to 100% AASHTO T 180 (Method D) maximum density.

A.3 Where the subgrade is on in-situ soil which is unsuitable for retention as the subgrade layer, the material immediately below the top of subgrade layer shall be excavated, hauled away and disposed of unless approved for use as embankment fill. The subgrade layer shall then be constructed using approved subgrade material, as specified for subgrade in embankment. If the material below sub-grade does not satisfy the earthworks requirement to a depth of 60 cm, it shall be excavated for further 20 cm and replaced by suitable material.

A.4 The underlying material shall be scarified, levelled and rolled. The prepared surface shall be approved by the Engineer before placement of suitable material.

B. Subgrade in Embankment

The minimum layer thickness of subgrade shall be 20 cm unless otherwise shown on the Drawings or directed by the Engineer. The material in the layer underneath the subgrade shall consist of selected, approved subgrade material. The subgrade material shall be spread in one layer over the full width of the top of embankment, brought to a uniform moisture content within the specified range and compacted to 100% AASHTO T 180 (Method D) maximum density.

C. Surface Tolerances

C.1 All finished elevations, lines and grades shall be in accordance with the details shown on the Drawings. Each cross section shall be checked at maximum intervals of 25 metres, at each change in cross slope and elsewhere as directed by the Engineer.

C.2 The tolerances on elevations of finished subgrade, top of embankment under the subgrade layer and excavated surface in cuts shall be as follows:

Surface	Tolerances
<u>Finished Subgrade:</u>	
Soil	+10 or -30 mm
Rock (if approved)	+50 or -50 mm
<u>Top of Embankment or Excavated Cut Surface:</u>	
Soil	+10 or -30mm

C.3 When the finished subgrade surface is tested with a 4 m long straightedge placed parallel to, or at right angles to the centreline, the maximum depression of the surface from the testing by straight edge shall be 30 mm.

D. Maintenance of Finished Subgrade

The completed approved subgrade shall be continuously maintained in a smooth, well compacted and properly drained condition until the overlying sub-base (or base) course is constructed. The Engineer shall inspect and approve the condition of the subgrade immediately prior to the placement of the overlying layer.

2.07.4 MEASUREMENT

- A.** Subgrade layer preparation in embankment shall not be measured separately but shall be deemed to be included as part of embankment construction.
- B.** Subgrade preparation in cut including all excavation below top of subgrade, scarifying, removing undesirable matter and compacting shall be deemed payable as unclassified highway excavation.

SECTION 2.09 STRUCTURAL EXCAVATION AND BACKFILL

2.09.1 SCOPE

A. The work covered in this section consists of all excavation in any material for bridges, underpasses, overpasses, buildings, pump houses, box culverts, utility ducts, underdrains, drainage and utility structures, retaining walls of all types and for other major and minor structures; and including all necessary clearing and grubbing; bailing; drainage; pumping; sheeting; temporary shoring and cribbing, construction of temporary cofferdams or cribs, disposal of all excavated material and backfilling with suitable approved material, all as and where shown on the Drawings. This section does not include excavation and filling for drainage, sewage and water pipe trenches.

B. The work covered also includes the removal of sections of existing structures below ground which obstruct or interfere with the construction of new structures.

C. The Contractor shall have deemed to have satisfied himself, at the time of tendering, as to the type and nature of soils and rock that will be encountered in structural excavations.

2.09.2 EXCAVATION

A. General

A.1 The Contractor shall notify the Engineer in advance of the beginning of any excavation for structures so that the Engineer may, where necessary, survey and record the cross sectional elevations and measurements of the existing ground and existing structures affected by the proposed construction. Any materials removed or excavated before these measurements have been taken and approved by the Engineer shall not be paid for.

A.2 The Contractor shall be solely responsible for the safety at all times of all foundation and trench excavations whether supported or otherwise. Approval of the Contractor's support system or omission of a support system for any excavation shall not absolve the Contractor from his sole responsibility in this regard.

A.3 The Contractor shall take all necessary precautions, including shoring or otherwise, to protect employees in the excavation and on the ground above. The Engineer shall not enter excavated areas to approve the foundation and further work until he deems the areas to be safe.

A.4 In areas where the excavation is adjacent to public roads and walkways, the Contractor shall erect all necessary barricades, barriers, enclosed walkways, and warning signs necessary to restrict the exposure of the public to the excavation. All such safety measures shall conform to the requirements of Section 6.07 - Maintenance of Traffic and Detours and shall be subject to the approval of the Engineer.

A.5 The sides of all foundation pits and trenches shallower than 1.2 metres shall be vertical and adequately supported at all times to the satisfaction of the Engineer. Sides more than 1.5 m in depth shall be either sloped or supported. The Contractor shall demonstrate the stability of the slope gradient or the support system to the Engineer prior to and during excavation and entry.

A.6 Pits and trenches shall be kept free from water until footing concrete has been placed or drainage has been installed. The Contractor shall minimize, to the maximum extent practicable, the length of time excavated areas are left open. The Contractor shall be held responsible for damage due to weather, equipment and other causes during periods when the excavations are left open.

A.7 The Contractor shall schedule his work in order that no excavation is left in an exposed condition for a period greater than 30 days unless otherwise approved by the Engineer.

A.8 In areas where the excavation is adjacent to public highways and walkways, no excavation shall be left open for more than 7 days unless otherwise approved by the Engineer.

A.9 The Contractor shall schedule highway excavation and embankment and drainage works to complement each other. If the Contractor's earthwork progress exceeds the progress of the drainage construction to the point where the highway obstructs water flow, the Engineer shall instruct the Contractor to open adequate waterways through the highway at the locations where drainage structures are to be installed. Any damage to the highway caused by water passing through these openings shall be repaired at the Contractor's expense.

A.10 The Contractor shall notify the Engineer of any sign of failure or cracks within or around the excavation immediately when noticed.

A.11 Exploratory trench excavation 1m deep and 2m wide shall be carried out across structure footings and pile caps, either manually or using light equipment, under the close supervision of the Engineer to check the existence of archaeological remains, prior to commencement of full scale structure excavation.

B. Temporary Support System

B.1 Temporary support systems shall be used to protect the public and adjacent property during construction as necessary. The Contractor's design for such support system shall be submitted the Engineer for approval prior to commencing its construction.

B.2 All temporary support systems shall be designed with adequate factors of safety and with minimal maintenance requirements for the duration of their intended use and shall include adequate safety provisions to protect the public from construction activities.

B.3 Notwithstanding any approval of temporary support systems, the Contractor shall be solely responsible for the adequacy of their design and construction and for maintenance and all necessary safety precautions associated therewith.

C. Excavation for Bridges, Underpasses, Overpasses and other Major Structures

C.1 The foundations for bridges, underpasses, overpasses, buildings, pump houses and other major structures shall be excavated in accordance with the dimensions shown on the Drawings and shall be of sufficient size to permit the placing of the full widths and lengths of the footings.

C.2 The excavation shall be carried to the elevations shown on the Drawings or as established by the Engineer. Borehole records and results from soil tests undertaken during design and actual investigation of the completed foundation excavation shall be utilized by the Engineer to confirm the final depth. No concrete shall be placed in the excavation prior to the approval of the Engineer.

C.3 Unless shown otherwise on the Drawings, the base of all excavations shall be covered with a 100 mm minimum depth of lean (blinding) concrete Class 110/25 to serve as a working platform.

C.4 Foundation pits or trenches shall be of sufficient size and provide minimum sufficient working space to permit construction of structures or structure footings of the full width and length shown on the Drawings.

C.5 Where footings are to be constructed using formwork, the excavations shall not extend more than 500 mm beyond the maximum dimension on each side of the proposed footing unless additional working space is clearly required and approved by the Engineer. Any unauthorised overwidth of excavation beyond the lateral limits shown on the Drawings or approved by the Engineer shall be backfilled with selected fill or lean concrete as directed by the Engineer.

C.6 Where footings are to be located in or adjacent to firm original ground and where formwork is not required or ordered, any unauthorized overdepth excavation below the approved elevation of base of footing shall be backfilled with blinding concrete.

C.7 Where excavation to rock foundation is required, the excavation shall proceed to allow the solid rock to be exposed and prepared in horizontal beds or properly serrated for receiving the blinding concrete. All loose and disintegrated rock and thin strata shall be removed.

C.8 All blasting necessary for any pier or groups of piers or abutment shall be performed prior to placing any concrete. Blasting shall not be permitted in the vicinity of concrete which has not cured for at least 14 days. Blasting shall not affect concrete properties and integrity.

C.9 When, in the opinion of the Engineer, unsuitable material including garbage and domestic waste is encountered below foundation elevation, the Contractor shall excavate such material and replace it with suitable backfill material or concrete as shown on the Drawings or directed by the Engineer.

C.10 The Contractor shall be responsible for the design and execution of the temporary drainage works for all excavations. The Contractor's proposals shall be submitted to the Engineer for approval. Such approval does not relieve the Contractor for his sole responsibility in this regard.

D. Excavation for Box Culverts, Ducts and Miscellaneous Structures

D.1 Excavation shall be carried out to the limits required for construction and to the depth required for bedding material or for removal of unsuitable material. All trench excavation shall proceed upgrade, commencing at the downstream end.

D.2 Foundation material supporting the bedding or structure shall be AASHTO M 145 Class A-1-a, A-1-b or A-2-4 material compacted to 95% AASHTO T 80 maximum density. If natural material does not meet the classification requirements, it shall be subexcavated to a depth of at least 200 mm and replaced with material meeting the specified requirements. Any rock or hard material within 200 mm of the bottom of the pipes shall be similarly subexcavated and replaced with material meeting the specified requirements.

D.3 If special bedding material is not required, the foundations for precast and prefabricated culverts shall be formed to the shape of the culvert, including all protrusions. The shaping shall extend to 25% of the height of culvert.

D.4 The Engineer shall determine where rock encountered in the toe wall excavations for concrete box culverts, concrete headwalls or endwalls for pipe culverts is sufficiently competent to form part of the structure foundations.

D.5 When excavation is required for installation of ducts, the Contractor shall notify the Engineer upon completion of the excavation. No duct shall be laid until the depth and cross section of the excavation has been approved by the Engineer.

2.09.3 BACKFILLING

A. General

A.1 The Contractor shall obtain the Engineer's approval for his proposed method and rate of placing of backfill, before backfilling commences.

A.2 Backfill materials shall be uniformly graded granular material, capable of meeting the specified compaction requirements and having adequate permeability to permit free drainage through it. Backfill material shall conform to the following and to the values specified in subsequent sections:

- Minimum D10 value: 1 mm
- Maximum Plasticity Index: 10 per cent

A.3 Backfill under foundations shall not contain material with more than 10% fines passing the No. 200 sieve.

A.4 Backfill material shall not be placed against any structure until approval by the Engineer has been given. Unless otherwise shown on the Drawings, structures shall be backfilled to the same requirements as specified for the adjacent embankment.

A.5 Backfill shall be placed in level layers to the full width of the excavated area until the elevation of the original ground or surrounding embankment is reached. Backfill next to walls, between columns or in other confined areas, shall be compacted by hand methods or portable equipment as approved by the Engineer.

A.6 Each successive layer of backfill shall contain only sufficient material to ensure proper compaction and no layer shall be greater than 250 mm thick before compaction. The moisture content of the backfill material shall be uniform and within the designated range.

A.7 Jetting of fills or other hydraulic methods involving or likely to involve liquid or semi-liquid pressure shall not be permitted.

A.8 Water shall be drained from the areas to be backfilled wherever practicable. In cases where, in the opinion of the Engineer, it is not practicable to drain the areas to be backfilled, the initial backfill material shall consist of crushed, open graded material conforming to the following gradation:

ASTM Sieve Size	Percentage Passing
10mm (3/8")	100
No. 4	< 85
No. 30	< 45
No. 200	< 5

Such material shall be deposited without compaction only below the standing water level. Above the water level normal laying and compaction methods shall be employed.

A.9 Additional water added during placement of backfill material to achieve the required compaction shall be fresh water unless otherwise approved by the Engineer.

A.10 The minimum tests required for verification of fill material in each separate structural excavation are as follows: -

- One Proctor test
- One Gradation of Materials for each materials source or variation of material
- One Plasticity Index and field density for each compacted layer.

The Contractor shall carry out additional testing at no additional cost to the Contract if so instructed by the Engineer.

B. Backfilling for Bridges, Underpasses and Overpasses

B.1 Structures shall not be subject to the pressures of backfilling or to live loads until the 28-day strength of the concrete has been reached, unless a shorter period is approved in special circumstances where the load is sufficiently small as not to constitute a risk of any damage to the structure in the opinion of the Engineer. This period shall be extended if subnormal curing conditions exist.

B.2 Backfill placed around culverts, abutments and piers shall be deposited on all sides to approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the structure and slopes adjacent to the excavation shall be stepped, as necessary, to prevent such wedge action occurring.

B.3 All backfill intended to support falsework loads, including temporary fills and pier backfill, shall be designed for the minimum support required. As a minimum, such material shall be AASHTO M 145, Class A-1-a, A-1-b or A-2-4, compacted to 90% AASHTO T 180 maximum density.

B.4 Backfill material for bridge abutments and approach embankments within 20 metres of any part of the substructure shall be AASHTO M 145, Class A-1-a, A-1-b or A-2-4 compacted to 95% AASHTO T 180 maximum density up to the underside of the subgrade layer. The 200 mm minimum thickness of subgrade layer shall consist of approved subgrade material placed and compacted to 100% maximum density as specified under Section 2.07: Subgrade Construction. The backfill shall be completed to the level of the original ground or to the top elevation of any adjacent embankment.

B.5 Backfill around retaining walls shall be completed to the level of the original ground line and to such heights above original ground line or to the levels as shown on the Drawings. Care shall be exercised to prevent forward movement of the wall.

B.6 Unless shown otherwise on the Drawings, where special permeable backfill (sheathing) is to be placed against the back faces of abutments, retaining walls or wing walls, it shall consist of a continuous covering of proprietary filter cloth protected by a continuous wall of 200 mm minimum thickness precast porous (no-fines) concrete blocks laid in stretcher bond with dry joints. Prior to construction of the block wall, a Type 1 or Type 3 underdrain of at least 150 mm diameter shall be laid along the base of the wall under the sheathing in accordance with the relevant requirements of Section 6.04: Pipe Underdrains.

C. Backfilling for Box Culverts and Miscellaneous Structures

C.1 Backfill material for box culverts and miscellaneous structures within 300 mm of any part of the structure shall be Class A-1-a, A-1-b or A-2-4. Backfilling and construction of the subgrade layer shall be as specified for bridges, underpasses and overpasses.

C.2 Backfill around and over pipe culverts shall not commence until headwalls and wingwalls have been constructed and attained the specified 28-day strength.

C.3 Water used for compaction of backfill around metal pipes shall be from a source approved by the Engineer and shall not contain more than 0.5% combined chlorides and sulphates nor contain other potentially harmful minerals.

C.4 When pipes or other structures temporarily extend above the grade of the partially constructed embankment, the Contractor shall construct the fill over the structure of sufficient depth to protect the structure from any damage resulting from construction or other traffic.

C.5 Surplus material shall not be dumped in stream channels.

C.6 The Contractor shall complete the backfill around box culverts to the level of the original ground line and to the full width of excavation area. If the top of culvert extends above the original ground line the Contractor shall continue the backfill to the top of the culvert and for a width of 3 m on each side of the culvert for the full width of highway embankment. If the embankment is in place at the time of backfilling, the Contractor shall backfill around the culvert to the top of embankment.

C.7 Backfill around pipe culverts and storm drains shall be completed to the level of original ground line and to the full width of excavation area. If the top of the culvert extends above the original ground line the Contractor shall continue the backfill to the top of culvert for a width of 1.5 times the maximum external width of the culvert on each side of the culvert centreline to the full width of the highway embankment. If the embankment is in place at the time of backfilling, the Contractor shall backfill around the culvert to the top of culvert or as shown on the Drawings.

C.8 Any existing highway pavement cut through, damaged or removed during excavation for pipe culvert installation shall be reinstated after pipe installation and trench backfilling using base and surface course materials at least equivalent to those in the original pavement. Materials and construction shall conform to the relevant requirements of Section 4.08: Pavement Repairs and Trench Reinstatement Works.

C.9 Miscellaneous structures other than pipe culverts and storm drains shall be backfilled in accordance with the methods specified on the drawings or instructed by the Engineer. Compaction of backfill of structures outside the highway right-of-way or in approach roads, minor roads or similar areas shall be to 90% AASHTO T 180 maximum density.

D. Permeable Drainage Layer to Abutments, Retaining Walls and Bases of Structures

The drainage layer shall consist of clean single size no-fines gravel having a minimum size of 20 mm and minimum thickness of 300 mm.

2.09.4 MEASUREMENT

A. Structural backfilling, except permeable backing behind abutments and walls and for reinforced earthwalls, shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Structural Excavation.

B. All structural excavation of whatever type shall be measured as "unclassified" which shall be deemed to include all materials encountered of any nature, including silts, clays, sand, gravel and granular materials and fractured, jointed and solid rock.

C. Structural excavation for box culverts less than one square metre in external cross section and structural excavation for ducts, underdrains (subsoil drains), pits, slope protection works, fence posts, guardrail posts, lighting columns, sign posts, signal supports and all other minor structures, shall not be measured for direct payment, but shall be considered as subsidiary Works the costs of which will be deemed to be included in the Contract Prices for Pay Items.

D. Structural Excavation shall be measured by the cubic metre of material excavated hauled away and disposed of as directed, or stockpiled on or in the vicinity of the Works and the excavated areas backfilled, completed and accepted.

- E.** Measurement of structural excavation shall be of original ground elevations or ground elevations after removal of all unclassified highway excavation. Limits shall not be greater than vertical planes 500 mm from the maximum dimension, on each side of the footing or other controlling portion of the structure. Where structures are to be constructed against natural ground or rock, excavation limits shall be the dimensions of the structure as shown on the Drawings. Bottom limits shall be the ordered foundation elevations. Only material excavated from its original position shall be measured for payment. No measurements shall be made of structural excavation in embankments previously constructed by the Contractor.
- F.** Additional excavation in unstable material or other unsuitable material including garbage and domestic waste encountered below foundation level shall be measured as unclassified structural excavation.
- G.** Unauthorized overdepth and overwidth excavation in soil and rock and the backfill material including blinding concrete shall not be measured for direct payment, but shall be considered as subsidiary works the costs of which will be deemed to be included in the Concrete Prices for Pay Items.
- H.** Temporary cofferdams, temporary support system, bailing, drainage, pumping, sheeting, and all other temporary works shall not be measured for direct payment, but shall be considered as subsidiary works the costs of which will be deemed to be included in the Contract Prices for Pay Items.
- I.** Permeable drainage layer (permeable backing) shall be measured by the cubic metre, placed and accepted.
- J.** Fill behind reinforced soil and anchored earth walls shall be measured by the cubic metre, placed compacted and accepted.

SECTION 2.10: EARTHWORK OF WET INFRASTRUCTURE SYSTEMS

2.10.1 SCOPE

The work covered in this section consists of all excavation, filling and backfilling, stockpiling for wet infrastructure systems.

2.10.2 GENERAL

- A.** The Contractor shall carry out all the necessary excavations for trenches and structures such as manholes, inspection chambers, etc. for potable water, storm water, and sewerage (waste water) pipelines and network, to the required lines and grades and in any types of soil and ground of whatever nature may be. He shall backfill and compact such excavations in layers and to the extent specified and shall dispose of unsuitable and surplus material to approved dumping areas.
- B.** The Contractor shall furnish and place all sheeting, bracing and supports, execute all cofferdaming, pumping and draining and shall render the bottom of the excavations firm and dry until acceptable in all respects.
- C.** Excavations shall be carried out to the dimensions shown in the drawings and in such a manner to provide suitable room for building the structures or laying and joining the pipework.
- D.** All excavations, except as otherwise specified or permitted shall be made in the open and shall be carried out in such portions at one time as the Engineer may direct, in order to avoid inconvenience to the public and maintain safety of operations.
- E.** Excavation, dewatering, sheeting and bracing shall be carried out in such manner as to eliminate all possibility of undermining or disturbing existing services, foundations of existing structures or of work previously executed under this Contract.
- F.** The Contractor is to visit the Site, satisfy himself as to the nature of the ground and sub-soil to be excavated and make himself conversant with the local conditions to be encountered during the execution of the Contract. Any claims arising from want of knowledge in this respect shall not be entertained.

2.10.3 STANDARDS AND CODES

The following standards and codes in their latest edition shall be particularly applied to works covered by this section.

ASTM

- C 88 Soundness of Aggregate by Use of Sodium Sulphate or Magnesium Sulphate
- C 117 Test Method for Material Finer than 0.075mm (No. 200) Sieve in Mineral Aggregates by Washing
- C 131 Tests Method for Resistance to Degradation of Small-Size Coarse Aggregates by Abrasion and Impact in the Los Angeles Machine
- C 136 Method for Sieve Analysis of Fine and Coarse Aggregates

D 75	Practices for Sampling Aggregates
D 345	Sampling and Testing Calcium Chloride for Roads and Structural Applications
D 421	Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants
D 422	Particle Size Analysis of Soils
D 854	Specific Gravity of Soils
D 1556	Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
D 1883	Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils
D 2167	Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D 2419	Test Method for Sand Equivalent Value of Soils and Fine Aggregates
D 2937	Test Method for Density and Unit Weight of Soil in Place by the Drive-Cylinder Method
D 2974	Standard Method of Test for Moisture, Ash and Organic Matter of Peat and Other Organic Materials
D 2976	Standard Method of Test for pH of Peat Materials
D 2977	Standard Method of Test for Partical Size Range of Peat Materials for Horticultural Purposes
D 3282	Classification of Soils and Soil-Aggregate Mixtures for highway Construction Purposes
D 4318	Test Method for Liquid Limit, Plastic Limit and Plasticity Index of Soils
D 4944	Test Method for Field Determination of Water (Moisture) Content of Soil by the Calcium Carbide Gas Pressure Tester Method

AASHTO

M 145	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
T 2	Sampling Aggregates
T 11	Amount of Material Finer than 0.075mm Sieve in Aggregate
T 27	Sieve Analysis of Fine and Coarse Aggregates
T 86	Investigating and Sampling Soils and Rock for Engineering Purposes
T 87	Dry Preparation of Disturbed Soil and Soil Aggregate Samples for Test
T 88	Particle Size Analysis of Soils
T 89	Determining the Liquid Limit of Soils
T 90	Determining the Plastic Limit and Plasticity Index of Soils
T 93	Determining the Field Moisture Equivalent of Soils
T 96	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
T 100	Specific Gravity of Soils
T 104	Soundness of Aggregate by Use of Sodium or Magnesium Sulphate
T 143	Sampling and Testing Calcium Chloride for Roads and Structural Applications
T 176	Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test
T 180	Moisture-Density Relations of Soils using a 10 lb (4.54 kg) Hammer and an 18 in (457mm) Drop
T 191	Density of Soil In-Place by the Sand-Cone Method
T 193	The California Bearing Ratio
T 204	Density of Soil In-Place by the Drive Cylinder Method
T 205	Density of Soil In-Place by the Rubber-Balloon Method
T 217	Determination of Moisture in Soils by Means of a Calcium Carbide Gas Pressure Moisture Tester.

BS

BS 5930 Code of Practice for Site Investigations

2.10.4 EXCAVATION IN RESTRICTED AREA

In conformity with the Drawings, or as necessitated by Site conditions, or directed by the Engineer, the Contractor shall carry out excavations in restricted areas close to existing structures and utilities by hand in order to safeguard such structures and utilities from any damage whatsoever. The Contractor shall make good at his own cost any damage caused by him to these existing structures and utilities.

2.10.5 METHODS OF DETECTION OF EXISTING UTILITIES

A. Use of Metal Detector

Prior to the start of excavating any trial pit, the Contractor shall check using a METAL DETECTOR or other equipments the presence of existing utilities.

B. Trial Excavation

B.1 Prior to any excavation, the Contractor shall carry out trial trench and pit excavations to such extent as required in order to locate and expose existing buried services and utilities, or reveal ground conditions etc.,. The Contractor shall submit for approval a drawing showing the proposed location of all trial excavations to the Engineer. The prior approval of the Engineer shall be obtained for such excavations.

B.2 Unless otherwise approved, trial excavations shall be carried out by hand and in a manner to ensure that damage to existing utilities are avoided.

B.3 The Contractor shall submit to the Engineer for his approval a written report and drawings of the data obtained from trial excavations carried out at every location. No backfilling of such excavations shall be made prior to the approval of the Engineer. The Contractor shall reinstate and make good these trial pits.

2.10.6 SHEETING AND BRACING

A. The Contractor shall furnish, put in place and maintain such sheeting, bracing, shoring etc. as may be necessary to support the sides of the excavation and to prevent any movement of earth which could in any way diminish the width of the excavation to less than that necessary for proper construction, or could otherwise injure or delay the work, or endanger work people, adjacent services or structures. If the Engineer is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports to be put in at the expense of the Contractor.

B. In addition, wherever the excavations for trenches or structures are under water or are greater than three (3) meters below ground level, the Contractor shall present to the Engineer, for his approval, construction drawings indicating the proposed method of excavating, dewatering, supporting the sides of excavation such as trench

sheeting and shoring, sheet piling etc. and all other pertinent details relating to pipe laying and/or construction of structures.

- C. Wherever possible, sheeting shall be driven ahead of the excavation to avoid loss of material from behind the sheeting. If it is necessary to excavate below the sheeting, care shall be taken to avoid trimming behind the face along which the sheeting will be driven. Care shall be taken to prevent voids outside of the sheeting, but, if voids occur, they shall be filled immediately with sand and compacted.
- D. The Contractor shall leave in place to be embedded in the backfill, or concrete, all sheeting, bracing, etc., which is indicated in the Drawings to be so left in place or as may be ordered by the Engineer. He also shall leave in place any and all other sheeting, bracing, etc., which the Engineer may direct him in writing to leave in place, at any time during the progress of the work, for the purpose of preventing injury to structures or property.
- E. All sheeting and bracing not to be left in place shall be carefully removed in such manner as not to endanger the construction or other structures. All voids left or caused by the withdrawal of sheeting shall be backfilled immediately with approved material and compacted to the density specified herewith.

2.10.7 STOCKPILING OF EXCAVATED MATERIALS

- A. The stockpiling of excavated material on roadways or in any other areas that may cause nuisance to persons or property will not be permitted. If suitable storage areas to the approval of the Engineer are not available adjacent to work areas the Contractor must immediately load and transport all suitable excavated material to be used for select backfill to an approved off-site storage area to avoid any nuisance to persons or property. Surplus or unsuitable excavated material shall be immediately disposed off at an approved disposal location at any distance from the job site. The Contractor shall transport suitable material back to site for backfilling of trenches as soon as backfilling operations starts. The Contractor shall allow for this double handling in his unit rates. The Contractor is responsible for obtaining authorizations for the temporary use of off-site storage locations for excavated material.
- B. Excavated select material shall be stockpiled in approved storage areas to avoid obstructing entrances, sidewalks, driveways, hydrants, manholes and any other service and in a manner not to cause any obstruction to traffic. The Contractor shall ensure that stockpiled excavated material does not obstruct pedestrian or driver visibility at road crossings or junctions.
- C. Any damage resulting from Contractor's failure to comply shall be rectified at the Contractor's own expense, all as directed by the Engineer.

2.10.8 EXCAVATION IN POOR SOIL

- A. The Contractor shall report in writing to the Engineer any unsuitable or weak ground material which may be found below the indicated excavation levels before executing any trimming of the excavation, pipe laying, concreting, or other work.

- B.** Where the bottom of the trench or structure excavation at subgrade is found to be unstable or to include ashes, cinders, any type of refuse, vegetable or other organic material, stones, or large pieces and fragments of material that, in judgment of the Engineer, should be removed, the Contractor shall excavate and remove such unsuitable material to the width and depth ordered by the Engineer. The over excavation shall be made up by backfilling with suitable material, to the approval of the Engineer, in layers not exceeding 250 mm loose thickness. The layers shall be placed in accordance with AASHTO T 180 to 95 % compaction to provide a uniform and continuous bearing and support for the pipe. The trench bottom or structure subgrade shall be compacted prior to pipe laying or construction of foundations.
- C.** All groups of soil classified in accordance with ASTM (D 2487 / D 2488) types CL, OL, MH, CH, OH and PT shall be deemed unsuitable material.

Soil Classification To ASTM D 2487	
Soil Group Symbol	Soil Group Name
CL	Lean Clay
	Lean Clay with sand
	Lean Clay with gravel
	Sandy Lean Clay
	Sandy Lean Clay with gravel
	Gravelly Lean Clay
	Gravelly Lean Clay with sand
OL / OH	Organic soil
	Organic soil with sand
	Organic soil with gravel
	Sandy organic soil
	Sandy organic soil with gravel
	Gravelly organic soil
	Gravelly organic soil with sand
MH	Elastic silt
	Elastic silt with sand
	Elastic silt with gravel
	Sandy elastic silt
	Sandy elastic silt with gravel
	Gravelly elastic silt
	Gravelly elastic silt with sand
CH	Fat clay
	Fat clay with sand
	Fat clay with gravel
	Sandy fat clay
	Sandy fat clay with gravel
	Gravelly fat clay
	Gravelly fat clay with sand
PT	Peat (a soil composed primarily of vegetable tissue in various stages of decomposition, usually with an organic odor, a dark brown to black color, and a spongy consistency.

2.10.9 KEEPING EXCAVATIONS FREE FROM WATER

A. General

A.1 To ensure proper conditions at all times during construction, the Contractor shall provide and maintain ample means and devices (including spare units kept ready for immediate use in case of breakdowns) with which to intercept and/or remove promptly and dispose properly of all water entering trenches and other excavations. Such excavations shall be kept dry until the structures, pipes and appurtenances are built, backfilling completed, and Engineer's written approval to stop the dewatering of the considered section is granted.

A.2 All water pumped or drained from the work shall be disposed of in a suitable manner without undue interference with other work, damage to pavements, other surfaces, or property. Suitable temporary pipes, flumes, or channels shall be provided for water that may flow along or across the site of the work.

B. Temporary Subdrains

B.1 Temporary subdrains, if used, shall be laid in trenches, beneath the grade of the structure. Trenches shall be of suitable dimensions to provide room for the chosen size of subdrain and its surrounding gravel.

B.2 Subdrain pipe shall be acceptable vitrified-clay, PVC, or concrete pipe of standard thickness. Sewer pipe of the quality known as "seconds" will be acceptable.

B.3 Subdrains, if used, shall be laid at an approved distance below the bottom of the normal excavation and with open joints wrapped in cheesecloth and entirely surrounded by graded gravel, or crushed stone to prevent the admission of sand or other soil into the subdrains. The distance between the bottom of the pipe or structure and the top of the bell of the subdrain pipe shall be at least 8 cm unless otherwise permitted. The space between the subdrain and the pipe or structure shall be filled with screened gravel or crushed stone which shall be rammed if necessary and left with a surface suitable for laying the pipe or building the structures.

B.4 Unless otherwise directed by the Engineer all temporary drains and subdrains shall be finally sealed with concrete at intervals to the Engineer's satisfaction and all temporary ditches, sumps, wells, etc., shall be refilled, all surfaces reinstated and all damage made good as specified or directed.

C. Dewatering System

C.1 The Contractor shall provide, operate and maintain satisfactory an adequate system of pumps, well points, wells, sumps, pipework, drains, intercepting ditches, cut-off drains, subdrains, other dewatering equipment and all other things necessary to keep surface water out of the excavations and to remove from excavations surface water, sub-soil water or water from any other sources and to maintain the water table below bottoms of excavation in order that the construction can be carried out in the dry.

C.2 Prior to dewatering operations, the Contractor shall submit to the Engineer for review detailed procedures and means intended for such dewatering operations.

D. Flooding

The Contractor shall take all precautions, to any extent necessary, to avoid flooding of the excavations either as a result of failure of the dewatering system or of marine flooding, in order to ensure that excavation and backfilling, pipework, structures and appurtenances are constructed and completed to such extent, that such will not be damaged, floated, or subjected to uplift forces which may endanger or in any way affect their safety. Any damage arising from such flooding shall be made good at the Contractor's expense.

2.10.10 EXCAVATION IN ROCK

A. General

A.1 Rock excavation shall include but not be limited to, all volcanic, alluvial and residual boulders having a volume of 0.50 cubic meters or more, or any other unaltered and unweathered firm and rigid igneous, metamorphic and sedimentary rocks or cemented conglomerates which cannot be removed by normal excavator's tools and equipment and which require drilling, blasting, wedging, sledging, barring or breaking up with power operated tools or other special means for their removal. Isolated boulders or fractured rock that can be removed in pieces not larger than 0.5m³ shall not be classified as rock. Where a continuous layer of hard material occurs, it shall not be considered as rock where the thickness of the layers less than 150mm.

A.2 All encountered changes in the type of soil strata, during excavation works, shall be immediately logged and reported to the Engineer's representative for confirmation on site and approval. Unless stated otherwise, such logging shall be incorporated in the measurement of percentages and quantities of rock out of excavated soil as extra over other soil excavations.

A.3 In some circumstances and whenever the Engineer decides it is suitable, a Compressive Strength Tests shall be performed on a certain soil material at the contractor's expenses in order to determine whether excavated materials are to be considered as rock or not.

A.4 Under all circumstances, materials with a compressive strength of 60kg/cm² tested on a 24 hour soaked rock core to ASTM D2938 (or similar approved standard) shall not be counted as rock.

A.5 Rock, boulders, stones, etc., shall be removed to provide a clearance of at least 15 cm. below and to the sides of all pipes, valves, fittings, etc,

A.6 Where pipelines pass from rock to softer strata, the trench shall be excavated to an extra depth of 50 cm. where the rock ends and this extra depth shall be reduced successively in a straight line along a leveling stretch of about three (3) meters to the depth stated above and then backfilled with approved compacted material to the prescribed levels.

B. Rock Blasting

B.1 Rock blasting shall not be carried out without the prior approval of the Engineer. Should such approval be obtained the Contractor will be responsible for obtaining all necessary permits and approvals from the relevant authorities. The Contractor shall take all necessary precautions and measures for re-directing traffic as necessary during blasting operations and shall secure approval of his schedule for such interruptions and his proposed methods for safeguarding the public, property, vehicles and the like in the vicinity of the blasting operations. Where necessary or directed by the Engineer, the Contractor shall provide heavy mesh blasting mats for the protection of persons, properties and the works. If, in the opinion of the Authorities or the Engineer, blasting would be dangerous to persons or adjacent structures, or is being carried out in a dangerous or unacceptable manner, the Engineer may prohibit blasting and instruct the Contractor to excavate the rock by other means. The Contractor shall bear full responsibility for any damage and injury to persons, properties, utilities and the like as a result of blasting operations.

B.2 When blasting of rock is carried out, a reasonably uniform face shall be left, regardless of whether or not the excavation is carried out beyond the specified limits shown on the drawings. All breakages, slides and debris shall be removed by the Contractor and disposed off as directed.

B.3 All drilling and blasting shall be done in such a manner as will most nearly complete the excavation to the required grade lines and produce the least practicable disturbance of the material to be left in place. Blasting by means of drill holes, tunnels, or any other methods shall be entirely at the Contractor's risk.

B.4 Excessive blasting will not be permitted. Overbreakage and the backfilling thereof shall be at the Contractor's expense. Any material outside the approved cross section limits which may be shattered or loosened because of blasting shall be removed by the Contractor at his own expense. All rock slopes with loose material shall be scaled by workmen and all loose material removed.

B.5 Following blasting, clearing and scaling rock slopes, the face, benches and back of the slope shall be inspected for potential failure planes and the necessary remedial measures shall be taken, as approved by the Engineer.

2.10.11 EXCAVATION FOR TRENCHES

A. General

A.1 The Contractor shall erect all forms and bracing and make ready all excavations for trenches necessary to install all pipelines and any other conduits that may be required for this Contract, to the lines and grades shown in the Drawings and/or as directed by the Engineer.

A.2 Where pipe is to be embedded in sand, gravel or concrete, the trench may be excavated by machinery to, or to just below the designated grade, provided that the material remaining at the bottom of the trench is not disturbed.

A.3 Where pipe is to be laid directly on trench bottom, the excavation by machinery shall be stopped just above the designated grade and the bottom of trenches in earth shall be cut, trimmed and finished by means of hand tools to form a flat or shaped bottom, true to grade, so that the pipe will have a uniform continuous bearing on firm and undisturbed material between joints. If rock is encountered at the designated subgrade, the Contractor shall carry out excavations depending on the pipe diameter, fifteen (15) cm to twenty-five (25) cm below such subgrade and backfilled with approved sand fill or other specified material and compacted in accordance with these specifications.

A.4 During excavation, material suitable for backfilling shall be piled at sufficient distance from the sides of the trench to avoid overloading and prevent cave in or shall be transported to a temporary stockpile away from the site of the works subject to the approval of the Engineer. All excavated material not required, or unsuitable for backfilling, shall be removed and carted away to an approved dumping area.

A.5 Grading shall be done as necessary to prevent surface water or rainwater from flowing into trenches and any water which may accumulate therein shall be removed immediately. Trenches shall be kept dry during the whole period until backfilling is completed and approved.

B. Depth of Trench

B.1 Trenches shall be excavated to such depths as will permit the pipe to be laid at the elevations, slopes, or depths of cover indicated on the drawings and at uniform slopes between indicated elevations.

B.2 The depth of any trench shall be taken to mean the depth from the natural ground surface or reduced level following excavation for other work, whichever is the lowest, to the invert of the pipe, where correctly laid.

B.3 Where rock excavation is encountered, the trench shall be excavated to such extra depth as specified.

C. Width of Trench

C.1 Width of Trench for Sewerage and Stormwater Networks

Pipe trenches shall be made as narrow as practicable and shall not be widened by scraping or loosening materials from the sides. Every effort shall be made to keep the sides of the trenches firm and undisturbed until backfilling has been completed and consolidated.

Trenches shall be excavated with approximately vertical sides between the elevation of the center of the pipe and an elevation 30 cm above the top of the pipe. At this elevation the maximum width of trench for single pipes of the various diameters shall be as follows:

SINGLE PIPE TRENCHES FOR SEWERAGE AND STORMWATER NETWORKS

Pipe Diameter (mm)	Maximum Trench Width @ 30 cm from Top of Pipe, (mm)
150	650
200	700
250	750

Pipe Diameter (mm)	Maximum Trench Width @ 30 cm from Top of Pipe, (mm)
300	800
350	850
400	900
500	1000
600	1600
700	1700
800	1800
900	1900
1000	2200
1100	2300
1200	2400
1300	2500
1400	2600
1500	2700

C.2 Width of Trench for Potable Water Network

The width of excavation of pipe trenches for potable water networks shall be the minimum required width for efficient working after allowance has been made for any timbering and strutting.

Trenches shall be excavated with approximately vertical sides between the elevation of the center of the pipe and an elevation 30 cm above the top of the pipe. At this elevation the maximum width of trench for single pipes of the various diameters shall be, unless stated otherwise, as follows:

SINGLE PIPE TRENCHES FOR POTABLE WATER NETWORK

Pipe Diameter (mm)	Minimum Trench Width for Rigid Pipes (Ductile Iron, Galvanized Steel as applicable) (mm)	Minimum Trench Width for Flexible Pipes (PE) (mm)
Up to 50 mm	(Galvanized) 500	-----
60 to 100 mm	-----	D + 500
150 to 450 mm	(Ductile Iron) D + 500	-----
500 to 600 mm	(Ductile Iron) D + 1000	-----

C.3 General for Sewerage, Stormwater and Potable Water Networks

For each additional pipe in the same trench, the external diameter of the additional pipe shall be added together with 15 cm to form the minimum width of multiple pipe trench.

Trenches shall be of such extra widths, when required, as will permit the convenient placing of timber supports, sheeting and bracing and handling of specials.

If during excavation the width of the trench at 300 mm above the top of the pipe becomes greater than the above mentioned values, the Contractor may be instructed by the Engineer to change the pipe bedding details and any additional cost of implementing such instructions shall be borne by the Contractor.

The Contractor shall be responsible for the safety of all his trench excavations and all excavated pit sides, trench walls or slopes shall be stable and established with respect to all current international safety standards.

C.4 Trench Excavation In Fill

If pipe is to be laid in recently filled material, the material shall first be placed to the top of the fill or to a height of at least 30 cm above the top of the pipe, whichever is the lesser. Particular care shall be taken to ensure maximum consolidation of material under the pipe location. The pipe trench shall be excavated as though in undisturbed material.

C.5 Trench Bridging

The Contractor shall, at his own expense, provide suitable and safe bridges and other crossings where required for the accommodation of travel and to provide access to private property during construction and shall remove such said structures thereafter.

2.10.12 EXCAVATION FOR FOUNDATIONS AND SUB-STRUCTURES

- A.** Excavation for foundations and sub-structures shall be carried out to the lines and grades shown in the Drawings. The excavation shall be of sufficient dimensions to permit construction of forms and bracing for foundations and substructures and installation of waterproof materials or any other trade as called for.
- B.** The elevation of the bottom of foundations as shown in the Drawings shall be considered as approximate and indicative only.
- C.** The Engineer shall order in writing any change in dimensions or elevations of foundations as may be deemed necessary to secure a firm foundation of uniform density.
- D.** After each section of excavation is completed, the Contractor shall notify the Engineer to that effect and no concrete blinding course for foundations shall be poured until the Engineer has approved the excavation and the character of the foundation material.
- E.** Any method of excavation shall be approved provided it does not disturb the foundation layers or adjacent structures.
- F.** If during the progress of the work, loose or improperly compacted soil or such other material as the Engineer considers unsuitable is encountered below structure foundation level, or adjacent thereto, such material shall be removed within the limits as directed by the Engineer. The resulting void shall be backfilled with either plain concrete or with an approved material compacted to a density not less than 95% of the maximum dry density. The Engineer shall specify the system of backfilling to be employed at each location.

- G. Any such excavation encountered which would in the opinion of the Engineer be detrimental to load distribution of new foundations to the underlying soil, shall be excavated and backfilled with plain concrete, as directed by the Engineer.
- H. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface, either level, stepped, or serrated as directed by the Engineer. All seams or crevices shall be cleaned and grouted. All loose and disintegrated rock and thin strata shall be removed. When the footing is to rest on material other than rock, excavation to final grade shall not be made until just before the footing is to be placed.
- I. When the foundation material is soft or mucky or otherwise unsuitable as determined by the Engineer, the Contractor shall remove the unsuitable material and backfill with approved granular material or with plain concrete for high load carrying structures. The foundation fill shall be placed and compacted in 200 mm layers up to the foundation elevation. Compaction shall comply with these specifications.
- J. Any surplus excavated material or excavated material unsuitable for fill or backfill, shall be carted away and deposited in an approved dumping area.

2.10.13 EXCAVATION NEAR EXISTING UTILITY LINES AND SERVICES

- A. The Contractor's attention is brought to the fact that there exists along the projected sewerage line all kinds of existing utilities and services, mainly electrical and telephone cables, water lines, sanitary and storm water sewers, box and pipe culverts, manholes etc. Only a part of these services have been approximately located on the drawings and the Contractor shall be responsible for establishing the exact position of all utility lines and services liable to interfere with the new construction, prior to carrying out construction in the vicinity.
- B. The Employer accepts no responsibility for the reliability, completeness or otherwise, of the information available and the Contractor shall carry out as necessary, trial holes or trial trenches to locate such existing services and any other buried structures, where information can not be derived from records or surface indications. When such trial holes and trenches fall within the limits of the Contract excavation, the Contractor shall receive no additional compensation, the work being understood to be included as part of these excavations. If trial excavations are ordered beyond the limits of the Contract excavations, they shall be measured and paid for in accordance with the contract.
- C. As the excavation approaches pipes, conduits, or other underground structures, digging by machinery shall be discontinued and the excavation shall be done by means of hand tools, as directed. Such manual excavation, when incidental to excavation, shall be deemed to be included in the Contractor's rates and prices for excavation.

D. Notice of Intent

The Contractor shall file a Notice of Intent with the service authorities who have services at the site or works in progress at the site at least six weeks before he desires to carry out any work near, above, or under their services. He shall submit a detailed programme for each area in which the work shall be commenced and the anticipated date of commencement in addition to a report, signed by the Engineer, the service authority Engineer and the Contractor confirming the Notice of Intent.

E. Shop Drawings

Prior to commencing construction and subsequent to the contractor's determination of the location of the existing utility lines, the Contractor shall prepare and submit to the Engineer for his review shop drawings complete with the description of the procedure, materials and related data of the Contractor's proposed method of protection for said utility lines. Review and comments by the Engineer shall in no way relieve the Contractor of the full responsibility for all protection and precautions required during the Works.

F. Protection of Existing Structures and Utilities

F.1 The Contractor shall be responsible for the care and protection of all existing utilities or other facilities, buildings and structures which may be encountered in or near the area of work. Temporary support, adequate protection and maintenance of all underground and surface utilities encountered in the progress of the work shall be furnished by the Contractor at his expense and under the direction of the Engineer and the service authority. Any structures that have been disturbed shall be restored immediately.

F.2 The Contractor shall be responsible for bracing and support of structures, utilities and services to prevent settlement, displacement, or damage to same.

F.3 The Contractor shall remove and cap abandoned utilities in accordance with service authority direction and as directed by the Engineer. The method of capping the lines shall conform to the requirements of the utility or service authority.

G. Maintaining Utilities in Operation

The Contractor shall ensure that all existing utilities such as electric power, water, sanitary sewers, road lighting and telephone services shall not be interrupted during the course of this project. This may require the establishment of temporary service connections including sewer house connections until the Works are complete and all reinstatement of utilities is made.

H. Relocation and Replacement of Existing Services and Structures

H.1 Apart from clarifying and locating positions to prevent damage to existing services, the scrutiny is required to clarify those services which might conflict with the Permanent Works.

H.2 Where this conflict would arise, the Engineer will consider if an amendment to the design can be made, or if a diversion of the existing main service is needed. In order that any such diversion be made in advance of the construction, it is essential that the scrutiny of these services be made well in advance of any excavation works commencing and the Contractor shall be deemed to have allowed in his rates for complying with the above.

H.3 Where encountered services and utilities are in conflict with the Permanent Works, the relocation of such services and utilities must be approved in detail by the Engineer.

H.4 All work in connection with removal and relocation shall be carried out by the contractor under the supervision of the Engineer and/or the concerned utility authority. Alternatively, the concerned authority may carry out the work itself, in which case the contractor will afford all reasonable assistance and access during the undertaking of the work.

H.5 All relocation work shall be designed by the Contractor in conjunction with the utility authority and shall comply in all respects with their current regulations and specifications. The Contractor must allow for the preparation of all shop drawings and for obtaining approvals for the designs from concerned authorities.

H.6 For each case of main conflict of existing services with the Permanent Works, the Contractor shall inform the Engineer by writing and prepare, for his approval entirely at his own expense, suitable scale drawings of his proposed diversion or amendment to the design.

H.7 In addition to the scrutiny referred to above, the Contractor shall take all reasonable precautions to prevent damage to existing buried main services and connections to buildings. Any damage shall be repaired at the Contractor's expense.

H.8 In removing existing pipes or other structures, the Contractor shall use care to avoid damage to materials and the Engineer shall include for payment only those new materials which, in his judgment are necessary to replace those unavoidably damaged.

H.9 The structures to which the provisions of this Clause shall apply include utility lines and cables and other structures which in the opinion of the Engineer will impede progress to such an extent that satisfactory construction cannot proceed until they have been changed in location, removed (to be later restored), or replaced. When fences interfere with the Contractor's operations, he shall remove and (unless otherwise instructed by the Engineer) later restore them to at least as good a condition as that in which they were found immediately before the work was begun, all without additional compensation. The restoration of fences shall be done as promptly as possible and not left until the end of the construction period.

2.10.14 EXCAVATION

The Contractor shall remove only as much of any road pavement as is necessary for the execution of the work. All existing road pavement to be removed for excavation purposes shall be neatly saw cut with appropriate pneumatic tools to leave a neat square edge suitable for proper reinstatement on completion of the works. Any overbreakage or damage to the road surface caused by the Contractor's operations shall be neatly cut back to a sound surface, to the approval of the Engineer, prior to reinstatement of the road, all at the expense of the Contractor. Reinstatement shall be carried out in accordance with the relevant section of these specifications.

2.10.15 CARE AND RESTORATION OF ROAD PAVEMENTS AND STRUCTURES

- A.** On paved surfaces the Contractor shall not use or operate tractors, bulldozers, or other power-operated equipment the treads of wheels of which are so shaped as to cut or otherwise injure such surfaces.
- B.** All pavements which have been damaged by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun all to the approval of the Engineer.
- C.** The restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the end of the construction period and shall be at

the Contractor's expense. Restoration shall be carried out in accordance with the relevant section of these specifications.

2.10.16 PREPARATION AND INSPECTION OF EXCAVATIONS

Bottoms of excavations shall be leveled, well rammed and consolidated before laying of pipes, placing concrete foundations etc., all to the approval of the Engineer.

If excavations are carried out below the levels indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted, selected fill if the excavation is for a pipeline, or with Class B concrete if the excavation is for a masonry or concrete structure, all to the satisfaction of the Engineer.

2.10.17 FILLING AND BACKFILLING FOR PIPE TRENCHES AND MANHOLES

A. General

A.1 In general and unless other material is indicated on the Drawings or specified, material used for backfilling trenches and excavations around structures shall be suitable excavated material. Suitable material shall be cohesionless material free from organic matter, perishable material, chemically contaminated material and stones exceeding 50mm in size and shall have a plasticity index not exceeding 10 and a Liquid Limit not exceeding 40.

A.2 If there are insufficient quantities of suitable material obtained from excavations, then the Contractor shall obtain additional quantities of such suitable material from approved borrow pits. The Selected Fill and Suitable Fill materials quantities supplied by the Contractor from borrow areas shall be paid to the Contractor at the rates shown in the Bills of Quantities.

A.3 Wherever a percentage of compaction for backfill is indicated or specified, it shall be the percent of maximum density at optimum moisture content as determined by Method D of ASTM D1557 latest editions Standard Methods of Test for Moisture-Density Relations of Soils Using 10 lb. Rammer and 18 in. Drop. If the percentage of compaction is not indicated, it shall be understood to be 95 %.

A.4 Filling and backfilling shall start only after preparation and inspection of trench excavations and testing of the structures to be backfilled has been performed and approval by the Engineer has been secured.

B. Backfilling Around Manholes, Chambers and Other Related Structures

B.1 Excavated areas around manholes, chambers and other related structures shall be backfilled with suitable materials approved by the Engineer. Backfill materials shall be placed in horizontal layers not exceeding 200 mm in depth and compacted in accordance with these Specifications. Each layer shall be moistened or dried as required and thoroughly compacted as specified. The maximum size of particle allowed in the backfill within one metre of structures shall be 50 mm. Unless otherwise stated elsewhere or shown on drawings, material approved for filling and Backfilling shall conform to AASHTO M 145 groups A-1-a, A-1-b, A-3, or A-2-4.

B.2 Where indicated on the Drawings suitable backfill material behind structures shall be AASHTO M 145 group A-1-a, A-1-b or A-2-4.

B.3 Potable water shall be used in backfilling excavation. Backfill shall be placed to the original ground level or as indicated on the Drawings.

B.4 Backfill shall not be placed against or on any structure until such structure has attained the strength to safely support the loads to which it will be subjected. Unequal soil pressures shall be avoided by depositing the backfill evenly around the structure. For walls with fill on both sides, the difference in the level of backfill shall not be such as to endanger the safety of the walls.

B.5 Walls with fill on both sides shall have the fill constructed such that the difference in the top elevation of the fill on the two sides does not exceed 60 cm at any time.

C. Fill and Backfill Under Manholes, Chambers and Other Related Structures

C.1 Unless otherwise indicated or specified, all fill and backfill under manholes, chambers and other related structures shall be compacted well graded screened gravel having a maximum size of 5 cm. The gravel shall consist of clean, hard and durable particles or fragments, free from dirt, vegetable, or other objectionable matter and free from an excess of soft, thin, elongated, laminated or disintegrated pieces. Crushed rock of suitable size and grading may be used instead of screened gravel. The specification which follows shall apply whichever material is used.

C.2 The fill and backfill materials shall be spread in layers of uniform thickness not exceeding fifteen (15) cm and then shall be thoroughly compacted by means of a suitable vibrator or mechanical tamper to attain the specified percentage of compaction specified in this section

D. Backfilling Pipe Trenches

D.1 All backfilling within roadways and footpath limits, tiled areas and underneath, around and over concrete structures shall be compacted to a minimum of 95% of AASHTO T180 density. Backfilling all other areas shall be compacted to a minimum of 90 % of AASHTO T180 density. All compaction shall be done in layers not exceeding 150mm in thickness and fill shall be brought up simultaneously on all sides of the excavation.

D.2 Excavations shall be backfilled above pipe encasement with suitable excavated or imported material without unnecessary delay, but not until pipes and manholes and other construction details have been tested and accepted by the Engineer. Suitable material shall be cohesionless material free from organic matter, perishable material, chemically contaminated material and stones exceeding 50mm in size and shall have a plasticity index not exceeding 12.

Where required and/or directed by the Engineer, a timber grillage shall be used to break the fall of material dropped from a height of more than 1.50 meters.

D.3 Pieces of bituminous pavement shall be excluded from the backfill unless their use is expressly permitted, in which case they shall be broken up as directed.

D.4 As soon as practicable after the pipes have been laid and the joints have acquired a suitable degree of hardness, if applicable, or the structures have been built and are structurally adequate to support the loads, (including construction loads) to which they will be subjected, the backfilling shall be carried out. Under no circumstances shall water be permitted to rise in non-backfilled trenches after the pipe has been placed.

D.5 Trenches shall not be backfilled at pipe joints until after that section of the pipeline has successfully passed any specified tests required.

D.6 The zone around the pipe shall be backfilled with the materials and to the limits indicated on the Drawings.

D.7 Trenches for pipes shall be backfilled by selected fill to a depth of 300 mm above the top of the pipe by hand, using the specified materials for pipe bedding and surround and shall be thoroughly compacted by careful hand tamping in layers 15 cm in depth up each side. Above the 300 mm, approved mechanical means such as water-jetting, puddling or tamping shall be used for compaction. The Contractor shall use special care in placing this portion of the backfill so as to avoid damaging or moving the pipe.

D.8 Backfilling should not start before 24 hours after placing any concrete. Heavy compactors and any traffic loadings should not be allowed before 72 hours after placing any concrete.

D.9 Whatever method of compacting backfill is used, care shall be taken that stones and lumps are not nested and that all voids between stones are completely filled with fine material. The Contractor shall, as part of the work done under the items involving earth excavation and rock excavation as appropriate, furnish and place all other necessary backfill material.

D.10 All voids left by the removal of sheeting shall be completely backfilled with suitable materials and thoroughly compacted.

D.11 When required, excavated material which is acceptable to the Engineer for use in the pavement sub-base course shall be placed at the top of the backfill to such depths as may be specified elsewhere or as directed.

D.12 Necessary precautions shall be taken during backfilling to ensure that pipes, manholes and other structures are not damaged. Any spaces left by the withdrawal of timbering shall be properly filled and compacted immediately.

D.13 Follow manufacturer's recommendations for backfilling around GRP pipes and concrete pipes. Strict adherence to the manufacturer's instructions for laying and backfilling, under, around and above the pipe and as approved by the Engineer.

E. Selected Fill Material for Pipe Trenches (Granular Fill)

E.1 Selected fill material as bedding and surround to pipes shall consist of approved granular material (crushed rock aggregates), which shall exclude particles larger than 14 mm in size. The material shall be capable of being compacted to a solid mass and achieve a 95% compaction Proctor Test.

E.2 Selected fill material shall comply with group type GW, GP, in compliance with ASTM D 2487.

E.3 Selected fill material shall not contain ashes, cinder, refuse, rubbish, organic material, or the like. All selected material used for backfilling shall be placed in layers not exceeding 150 mm and compacted as detailed in this section of the Specifications.

E.4 Excavated local sand material may be used if satisfactory, subject to the approval of the Engineer.

F. Suitable Fill for Pipe Trenches (Backfill)

F.1 Suitable fill material to backfill pipe trenches shall consist of approved cohesionless material, sand or crushed rock aggregates (0-50mm) free from (organic matter, perishable material, chemically contaminated material and stones exceeding 50mm in size) and shall have a plasticity index not exceeding 10 and a Liquid Limit not exceeding 40.

F.2 If there are insufficient quantities of suitable material obtained from excavations, then the Contractor shall obtain additional quantities of such suitable material from approved borrow pits. The Selected Fill and Suitable Fill materials quantities supplied by the Contractor from borrow areas shall be paid to the contractor at the rates shown in the Bill of Quantities.

2.10.18 MEASUREMENT

- A.** Excavation is to be understood as unclassified for “Trench Excavation” and “Structural Excavation”.
- B.** Trench excavation for water, sanitary sewerage (waste water), storm water, culverts and channels shall be measured under “Trench Excavation for Pipes including backfill” in cubic meters.
- C.** All excavations including excavation to reduce levels shall start from the subgrade levels of all roadway excavations. Starting levels of excavations to be carried out in areas already excavated and measured shall be the bottom level of such excavation previously measured (Roadway works).
- D.** Length of trench shall be the same length of item to be laid in, deducting all excavation measured under other items, or voids where trench is not carried out.
- E.** The maximum width of trench for water, sewerage and storm water lines shall be as stated in this Specification. Trenches to be used for more than one item, shall be so described stating the number and size of each utility within the trench.
- F.** The average depth of trench shall be the difference between the average natural ground level and the average invert level between two stations plus the thickness of the pipe and bedding as specified. The average natural ground level is defined by using the levels at the two stations only and the average invert level is defined by using the invert levels of the starting and ending points of the two stations. The two stations mentioned above are any structure at the starting and ending points of each pipe section (normally between two manholes) with no structure whatsoever interrupting this pipe or cable section.

- G.** Additional trench excavation in rock areas to provide greater depth of sand bed to pipes shall be deemed to be included in the rates for excavation.
- H.** Excavation for culverts, manholes, structures, etc..., shall be measured under "Structural Excavation including backfill" in cubic meters (Refer to section 2.09). The volume measured shall be the volume which is to be either occupied by or vertically above any part of works to be excavated. Additional excavation necessary to provide working space or for shoring shall be measured up to 0.5 m from the reinforced concrete edges. The volume of such excavations shall be computed as the product of the resulting horizontal or plan area, and the average depth from the starting level to the underside of the base or blinding layer.
- I.** In addition to what is stated before in these preambles and in the description of the items, the rates of excavation items shall include but not be limited to:
 - a.* Excavating in any type of ground, including rock, or materials (concrete, pavement, etc...) structural fill, contaminated fill, clay or others.
 - b.* Excavating by hand or machine.
 - c.* Dewatering operations necessary for keeping excavation free from water whether groundwater, sea water or any other sources.
 - d.* Leveling or grading and compacting bottom of excavations.
 - e.* All necessary double handling of excavated materials.
 - f.* Trimming or planking and strutting sides, bracing, driving steel sheeting or piling (steel or reinforced concrete) and any other temporary or permanent supports to sides of excavation and to existing structures and utilities around the trench.
 - g.* Selecting excavated materials, backfilling and compacting.
 - h.* Removal of and carting away surplus materials and storage of selected backfill including all labour and transport cost involved in removing such material to an approved storage area away from the site and it's subsequent re-transport back to the site.
 - i.* Any additional excavation beyond 0.5m necessary to provide working space or shoring.
 - j.* Exposing by hand digging or special equipment, supporting, protecting and maintaining existing services and utilities.
 - k.* Making good all work disturbed.
 - l.* Temporary supports to roads or structure as required by the Engineer and trench bridging.
 - m.* Any backfilling, concrete fill or other works required to be carried out to excavations as a result of excavations beyond the specified line and level.

- n. Working above or under, alongside, across or near existing utilities and utility structures including pipes, cables, ducts, duct banks, manholes, septic tanks, chambers, services, valves, thrust blocks, drainage channels, gully inlets, and the like, and maintaining existing services in operation. Repair and reinstatement of all utilities affected by the excavation, payment of fines resulting from damage to any utility, temporary support of any utility if deemed necessary, maintaining existing services in operation and all necessary works in connection with the protection and safety of adjacent structures, utilities and services, and all other incidental works.
 - o. Reinstatement of all surfaces damaged by traffic due to the Works.
- J. All backfill work to make up levels shall not be measured separately.
- K. Providing and operating all pump and pump stations for overpumping and flow diversion of sewage as specified shall be measured and paid separately.
- L. No separate payment shall be made for fill work using surplus excavated materials, all costs in respect of selecting suitable material from excavations and transporting same to temporary stockpiles, re-excavating from stockpiles, loading, hauling, off loading, spreading, leveling, shaping, watering and compacting and performing all tests as required by the Specifications, all double handling of materials and all other works necessary in accordance with the Engineer's requirements and the Specifications shall be deemed to be included in the rates of excavations.
- M. The rates shall include for all costs in respect of payment of charges for materials obtained from borrow pits, excavation, loading, hauling, off loading, leveling, watering, compacting, double handling, shaping and performing all tests as required by the Specifications, all in accordance with the Specifications and to the approval of the Engineer.