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## 2 EARTHWORKS

### 2.1 GENERAL

#### 2.1.1 Scope

- 1 This Part includes earthworks for pipelines including, excavation, granular pipe bedding, concrete protection of pipe, backfill and compaction, and service protection ducts to protect existing utilities.
- 2 Related Sections are as follows:

This Section

Part 1, ..... General  
Part 3, ..... Pipeline Installation  
Part 9, ..... Trenchless Pipeline Construction  
Part 10, ..... Sewer Rehabilitation  
Part 12, ..... Vacuum Sewerage System

Section 1, General  
Section 3, Ground Investigation  
Section 5, Concrete  
Section 6, Roadworks  
Section 12, Earthworks Related to Buildings  
Section 28, Landscaping.

#### 2.1.2 References

- 1 The following standards and other documents are referred to in this Part
  - BS 410.....Test sieves
  - BS 1924 .....Stabilised materials for civil engineering purposes
  - ASTM D1140.....Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing
  - ASTM D1556/D1556M... Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
  - ASTM D1883.....Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
  - ASTM D4318..... Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
  - ASTM D6913/D6913M. Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
  - ASTM D6938..... Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
  - BS 6031 .....Code of practice for earthworks
  - EN 12620 .....Aggregates for concrete
  - ISO 10319 .....Geosynthetics
  - ISO 11058 .....Geotextiles and geotextile-related products
  - ISO 12236 .....Geosynthetics
  - ISO 12956 .....Geotextiles and geotextile-related products
  - Ministry of Municipality, Roads Department, Highway Maintenance Section, Code of Practice and Specification for Road Openings in the Highway

### **2.1.3 Definitions**

- 1 Trench excavation means excavation in all materials of whatever nature encountered for trenches into which pipes, ducts or cables are to be laid, or manholes, chambers and appurtenances constructed, and the term pipe shall mean pipe of all kinds and for whatever purposes.

### **2.1.4 Trial Holes**

- 1 Trial holes for determining the location of existing services shall be excavated well ahead of the trench excavation to such depths as necessary to determine and confirm the alignment for the trench and the soil condition. The Contractor shall arrange for the refilling and reinstatement of trial holes to be carried out immediately after the required information is obtained. The reinstatement of trial holes shall be carried out to the approval of the Engineer.

### **2.1.5 Services Co-ordination**

- 1 In addition to the requirements of the relevant Parts of Section 1 and Part 1 of this Section, the following paragraphs shall apply to services co-ordination for pipeline excavations.
- 2 Notwithstanding any relevant information furnished by the Engineer, the Contractor shall be responsible for ascertaining from his own inspection of the Site and the respective Utilities Service Departments and private landowners the position of all mains, pipes, cables, and other services and facilities whether underground or overhead within or near the Site.
- 3 Except as otherwise specified, the Contractor shall make arrangements necessary for carrying out the Works with the various Utilities Service Departments and private landowners. The Contractor shall be responsible for any damage caused as a result of his omission in this respect, and for any damage caused by his failure to notify the Engineer's representative and the agencies concerned immediately any service is encountered in the excavations.
- 4 Work on existing services is specified in Subparts 2.4, 2.5 and 2.7 of this Part.

## **2.2 EXCAVATIONS**

### **2.2.1 General**

- 1 The Contractor shall be deemed to have obtained additional site information in accordance with Clause 1.3.1 of this Section.

### **2.2.2 Surfaces**

- 1 Before the surface of the area to be excavated is disturbed the Contractor shall take and record levels of the area in the presence of the Engineer. At least two days notice shall be provided to the Engineer.
- 2 The demolition of existing works shall be in accordance with Section 2.
- 3 Except as otherwise designated in the Project Specification or directed by the Engineer, breaking out and restoration of existing surfaces and works shall be done in accordance with the Code of Practice and Specification for Road Openings in the Highway published by the Highway Maintenance Section, Civil Engineering Department, Ministry of Municipality.
- 4 Surface materials shall be carefully stripped or otherwise removed and set aside for reuse, restoration, or replacement as directed by the Engineer.
- 5 Where the trench excavation crosses surface barriers such as fences and walls the Contractor shall
  - (a) obtain the written approval of the Engineer before breaching the barrier

- (b) minimise the size of the opening, where possible using a short heading
- (c) carefully dismantle the barrier as necessary for reuse, replacement, or reinstatement
- (d) provide temporary fencing for any removed parts of such barriers as directed by the Engineer.

### 2.2.3 Materials

- 1 Selected excavated material shall be the most suitable portions of the excavated material free from matter harmful to other materials in the works and which is capable of being compacted to the specified density to form stable fill. The material shall also conform to the requirements mentioned in Clauses 3.3.2, 3.3.3 and 3.3.5 of Section 6.

It shall be the responsibility of the Contractor to locate suitable borrowed or imported fill material which may be necessary and to carry out such tests as the Engineer may require to demonstrate the suitability of the fill to be supplied.

Imported fill shall be from a source approved by the Engineer. Imported fill shall be in accordance with Table 2.1. Table 2.1 Specification for trench Backfill

Item No	Parameter	Test Method	Permissible Limits
1*	% passing 75mm sieve	ASTM D6913	100%
2	% passing 0.075mm sieve	ASTM D1140	Max 30%
3	Liquid limit	ASTM D4318 (A)	Max 10%
4	Plasticity index	ASTM D4318	Max 10%
5	CBR Swelling	ASTM D1883 (soaked)	Min 15% at 95% MPD Max 2%
6	In-situ density	ASTM D6938 / ASTM D1556	Min 95% MPD
7	Acid soluble chloride content	BS 1377-Part 3	Max 2%
8	Acid soluble sulphate content	BS 1377-Part 3	Max 3%
9	Organic matter	BS 1377-Part 3	Max 2%

\*Note: maximum stone size of 75 mm except as specified in Clause 2.3.4 of this Part

- 2 Excavated material unsuitable for use in the Works shall not be stockpiled on the Site.
- 3 Disposal of excavated material not used in the Works shall be the responsibility of the Contractor and shall be at a location approved by the relevant government agency.
- 4 Excavated material shall not be stockpiled on road reservations nor at other locations designated in the Project Specification. The Contractor shall confine his operations to the working areas available to him for the construction of the Works particularly where this is located in roads or in other places to which the public has free access.
- 5 Stockpiling materials on the Site or off the Site, as necessary, shall be the responsibility of the Contractor. The stockpiling of surplus excavated material or other debris on site is not permitted. All surplus excavated material shall be removed from site to approved disposal sites. All dump trucks transporting waste shall be fully covered to prevent discharge of the contents.

- 6 Any temporary storage alongside the trench excavation shall be to stable slopes and heights and deposited in such a manner that no damage and as little inconvenience as possible is caused. Backfilling materials shall be fenced off and continuously irrigated with water to avoid dust and pollution.
- 7 Where the nature of the excavated material is suitable, the Contractor's temporary storage as aforesaid shall include for separate storage as the Engineer may direct of the various grades of materials hereinafter specified for the refilling and surface reinstatement of trench or structure excavation, namely, soft material, coarse material, hard material and topsoil. The Contractor is to agree a screening location with the concerned municipality.
- 8 The screening of trench excavated material will not be permitted on site without the written approval of the Engineer.
- 9 The Contractor shall post signs indicating proposed use of material stockpiled. Post signs shall be readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
- 10 The Contractor shall not stockpile excavated materials near or over existing facilities, adjacent property, or completed work, if weight of stockpiled material could induce excessive settlement.
- 11 The Contractor shall obtain all necessary approvals for the sites of borrow pits and quarries. All borrow pits shall be left in a tidy and regular state. The Contractor shall ensure that pits are self-draining at all times and do not constitute a nuisance and danger to the public.

#### **2.2.4 Excavations to be Kept Dry**

- 1 The Contractor shall keep excavations free of water, sewage, and other liquids whether affected by tides, floods, storms, or otherwise so that the Works shall be constructed in dry conditions.
- 2 The Contractor shall keep the subsoil or accumulated water or sewage at a level lower than the bottom of the permanent work until trench backfilling is complete or for such other period directed by the Engineer.
- 3 Measures taken by the Contractor for the control of water shall conform with the specifications of this Part.

#### **2.2.5 Access**

- 1 A minimum clear carriageway width of 3 m shall be maintained for vehicular traffic unless otherwise approved by the Engineer.
- 2 Excavations in roads shall be organised to reduce to a minimum the interval between opening up and backfilling excavations.
- 3 The Contractor shall supply, post and display at all entrances to all properties a Notice of Excavation before any excavation is undertaken in front of or in the vicinity of the property. The notice shall be in the form of a self-adhesive glossy sticker which shall be easily removable. A typical sample is shown in Section E of the Contract Documents. The Contractor shall remove the label after all the excavation has been backfilled.
- 4 Should cess-pits of other artificial obstructions be encountered in the excavation either above or below ground level the Contractor shall forthwith advise the Engineer's Representative thereof and execute at his own cost such work as may be ordered.
- 5 The Contractor shall allow for laying pipes through any cess pits or septic tanks encountered along the route. Pipes shall be laid such that joints occur either side of the structure or in a manner approved by the Engineer's Representative.

## 2.2.6 Trench Excavations

- 1 The Contractor shall provide the necessary support of excavations. Details of excavation support systems shall be submitted to the Engineer for review and approval at least sixty (60) days before any excavation work commences.
- 2 Support of excavations shall be provided in accordance with BS 6031, except as otherwise specified in this Part.
- 3 The term "necessary support of excavations" covers all normal methods of temporary support including timber, concrete, steel sheet piling, steel trench sheeting or other materials as may be approved by the Engineer. Where excavation is carried out near or under an existing structure or any portion of the Work, the Contractor shall prevent damage due to subsidence with methods approved by the Engineer.
- 4 The maximum trench width shall be as given in Table 2.2 unless otherwise shown on the drawings. The width of the excavation shall be increased if necessary to provide space for the trench support system; undercutting of the trench sides will not be permitted.

Table 2.2 – Maximum pipe trench width at 300mm above pipe crown

Nominal Bore mm	Maximum Trench Width mm	Nominal Bore mm	Maximum Trench Width mm
100	550	600	1350
150	600	800	1550
200	800	1000	2000
300	900	1200	2300
400	1000	1400	2500
500	1250	1500	2700

If the Contractor exceeds these trench widths he shall provide plain or reinforced concrete cradles and /or reinforced concrete arches to the requirements shown on the drawings and to the approval of the Engineer at no additional cost. When directed by the Engineer, supply and install strong and sufficient shoring to support excavations at no additional cost.

- 5 No additional payment will be made to the Contractor for working in a confined space or if the position of the Works precludes the use of mechanical excavators or the storage of excavated materials next to the excavations.
- 6 The Contractor shall submit shop drawings of all temporary works and trench support systems or proprietary manufacturers' catalogues detailing his proposed methods of construction at least one month prior to starting excavations. The shop drawings shall be complete with all details, design calculations, and description of construction methods. The Engineer's approval of the Contractor's submittal shall not relieve the Contractor from obligations under the Contract.
- 7 Except as otherwise precluded by the Project Specification, the Contractor may propose to excavate with battered side slopes. If required by the Engineer, the Contractor shall provide three copies of a report which shall include relevant calculations and method statement demonstrating the adequacy of the proposals.
- 8 In the event of any trench being excavated with battered or stepped sides, that portion of the trench which extends from the formation to a point not less than 300 mm above the crown of the pipe when laid in its correct position shall be formed with vertical sides. Support shall be provided to the vertical trench sides to prevent ground movement. Where temporary trench supports are provided they shall be such that no ground movement occurs on removal.

- 9 Where battered sides are proposed, no excavation work shall begin until the Engineer's approval has been obtained. The Engineer's approval shall not relieve the Contractor from his obligations under the Contract.
- 10 The line and level of trenches shall be as shown on the Drawings and shall be maintained in accordance with the following procedure:
- before beginning trench excavations, the route of the pipeline shall be surveyed and set out accurately and the existing ground level shall be agreed with the Engineer
  - sight rails shall then be fixed and maintained at each change of gradient, and at as many intermediate points as may be necessary. The centreline and the level to which the excavation is to be carried out shall be marked on the site rails and the rails shall not be more than 20 m apart
  - alternate methods to maintain line and level of excavations shall be subject to the approval of the Engineer.
- 11 Trench excavation shall be carried out as follows:
- trench excavation shall be carried out by such methods and to such lines, dimensions and depths as shall allow for the proper construction of the Works
  - trench widths shall conform with the limits shown on the Drawings, or ,in the case of flexible pipes, to the widths stated in the Contractor's approved methods statement. Where trench widths do not conform to the limits shown on the Drawings, the Engineer will direct the Contractor as to the measures to be taken to remedy the situation. Such remedial works shall be carried out by the Contractor as an obligation under the Contract at no additional cost to the Employer
  - rock encountered in trench excavations shall be so excavated that the clearance between the pipe, when laid, and the rock sides and bottom of the trench is kept to the minimum limits necessary to provide for the specified thickness of bedding and where provided the concrete protection of the pipe.
  - bell holes and holes and depressions for couplings, valves and the like shall be excavated the same distance below these installations as specified for the pipe.
  - When the trench width measured 300mm above the crown of the pipe exceeds the maximum allowable shown on the drawings for granular surround the Contractor shall proceed as Clause 4.3.2 of this Section.
- 12 Limitations on the lengths of opened trenches shall be as follows:
- no length of trench excavation shall begin until the pipes and fittings to be laid in the length of excavation are available at the Site.
  - the Engineer reserves the right to direct the Contractor on the lengths of trench which shall be excavated at any one time
  - the Contractor shall not be permitted to excavate trenches in more than one location in any road at a given time without the Engineer's approval
  - in areas accessible by the public, the maximum length of open trench in any one section shall not exceed 100 m. In other areas the trench shall be dug only so far in advance of pipe laying as the Engineer shall permit.
- 13 The Contractor shall at his own expense remove from the Site all unsuitable and excess material resulting from excavations beyond that required for the foundation, lining or bedding and shall make good the same with concrete or suitable fill material as may be required by the Engineer.

- 14 The Engineer will inspect ground condition, or trench formation level and may direct the Contractor to remove additional material and to refill the excavation with concrete or other approved material. Should any acceptable native material at the foundation level subsequently become unsuitable the Contractor shall remove it and replace it with concrete or other suitable material as directed by the Engineer at no additional cost to the Employer.
- 15 If utility obstructions are encountered during excavation and cannot be diverted, the Contractor shall make the necessary changes to the design drawings and submit to the Engineer for approval. The Contractor shall not make any deviation from the specified lines or grade of the tunnel without written approval from the Engineer.
- 16 Excavation shall be carried out to the dimensions, depths or levels in such a manner as to avoid excavation of or disturbance of material below grade.
- 17 Pipes of greater strength or the use of superior pipe bedding may be used in lieu of maintaining the maximum trench widths shown in Table 2.1 or specified for various pipe diameters, subject to the Engineer's prior written approval.
- 18 The Contractor shall excavate trenches to the levels that will allow for the pipe wall thickness and bedding thickness.
- 19 The Contractor shall leave a clear space as approved by the Engineer, between the edge of the excavation and the inner toes of the spoil banks.
- 20 The Contractor shall grade the trench bottom with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown on the design drawings or as specified.
- 21 The Contractor shall remove soft sub-grade that may cause pipe settlement and replace with suitable backfill compacted in layers not exceeding 150 mm.
- 22 The bottom of excavations for permanent structural works shall be free from mud and water, trimmed clean, protected from the effects of the weather and consolidated to achieve the required bearing capacity prior to the placement of structural work or construction materials within the excavation.

#### **2.2.7 Appurtenant Structures for Pipelines**

- 1 The Contractor shall carry out the necessary excavations to accommodate appurtenant structures such as manholes, chambers and thrust blocks. The requirements for the completion of excavations and handling of excavated material shall be as specified above for trench excavations shall apply.

#### **2.2.8 Excavation in Roads**

- 1 In addition to the foregoing and the provisions of Section 1, pipeline excavation in roads and highway reserves including the provision of public safety facilities including barriers and enclosures shall be in accordance with the Code of Practice and Specification for Road Openings in the Highway published by the Highway Maintenance Section, Roads Department, Ministry of Municipality (MM).
- 2 Where trenches are excavated open cut in roads, the asphalt shall be saw cut along the edges of the trench, prior to excavation.
- 3 In the lanes of the road that remain open to traffic, road drains and channels shall be kept free from construction materials, debris and obstruction at all times.

- 4 Normally trench excavation along roads shall be located in the service reserves or verges adjacent to the road rather than in the carriageway itself. Trench excavation shall wherever practicable be carried out in such a way that every part of the excavation is at least 1 m clear of the existing edge of the carriageway. The Contractor shall obtain information regarding utilities reservations from the Planning Department of the Ministry of Municipality and refer to their publication entitled Road Hierarchy: General Guidance for Road Cross-Sections and Utilities Disposition.
- 5 The Contractor shall take special precautions, which includes the continuous support of the sides of the excavation, from the start of excavation until the refilling and compaction of the trench backfill material is completed.
- 6 The Engineer may direct the trench excavation to be realigned from that shown on the Drawings to facilitate the flow of traffic.
- 7 Where trench excavation or any other part of the Works obstructs any footpath or right-of-way, or property access, the Contractor shall provide, at his own cost, a temporary access around the obstruction to the satisfaction of the Engineer. Where applicable, this temporary access shall include stout wooden bridges with hand rails and kick boards or other approved construction across any open trench. Suitable steel road plates shall be provided and maintained where vehicle access is deemed necessary.
- 8 No excavated material shall be permitted to be deposited or stockpiled in grassed or planted areas. The Contractor shall immediately remove excavated material to a temporary storage area and import selected approved materials for the trench filling operations.
- 9 Where excavated material has temporarily been deposited on a verge, the verge shall on completion of backfill be restored to its original condition and left free from debris.

#### **2.2.9 Excavation in Areas Other Than Road Reserves**

- 1 Areas other than road reserves shall include but not be limited to cultivated areas, undeveloped areas, footpaths, verges, non-asphalt roads, lanes, alleys, and all private lands.
- 2 The Contractor shall take measures to prevent access of unauthorised persons, the general public and animals to areas in which there are open excavations, access routes and steep or loose slopes arising from the Contractor's operations.
- 3 The Contractor shall provide adequate temporary barriers and fencing. When necessary, barriers and fencing shall be illuminated.
- 4 Temporary barriers and fencing shall not be removed without the Engineer's written permission, which will not normally be given until the trench excavation has been refilled and reinstated.

#### **2.2.10 Support of Excavations**

- 1 The Engineer reserves the right to direct the Contractor to take measures to augment the Contractor's proposals for the support of excavated surfaces. If, in the opinion of the Engineer, the support proposed by the Contractor is insufficient, the Contractor shall modify his proposals and provide trench support as directed by the Engineer. The absence of the Engineer's direction, or action by the Contractor in accordance with the direction of the Engineer shall not relieve the Contractor of his obligations under the Contract.
- 2 Shoring shall be properly maintained until in the opinion of the Engineer the permanent work is sufficiently advanced to permit the shoring to be removed. The removal of shoring shall be carried out only under the personal supervision of a competent foreman. If the Contractor proposes not to remove the shoring on completion of the permanent work he shall obtain the Engineer's prior written approval.

- 3 All temporary works supporting the faces of excavations shall be removed during backfilling with the approval of the Engineer. Where removal is impracticable and with the approval of the Engineer, temporary works shall be left in place. Temporary works left in place shall be at no additional cost to the Employer.
- 4 When, in the opinion of the Engineer, temporary supports need to be left in excavations to support existing structures or the permanent Works, the Engineer may direct that temporary supports be left in place. Temporary supports left in place shall be at no additional cost to the Employer.
- 5 Underpinning, supports and other protective measures that are required for buildings, structures and apparatus in or adjoining excavations shall be provided by the Contractor. Such permanent or temporary works shall be of adequate design and construction. When directed by the Engineer, the Contractor shall submit his methods statement for such work for the approval of the Engineer. The Engineer's approval shall not relieve the Contractor from his obligations under the Contract.
- 6 Damage to the Works and any consequential damages caused by the removal of shoring are the responsibility of the Contractor. Permission or approval by the Engineer to remove shoring shall not relieve the Contractor from this responsibility.

#### **2.2.11 Slips and Falls and Excess Excavation**

- 1 Slips and falls in trenches shall be prevented as follows:
  - (a) the Contractor shall effectively support the sides of all trench excavation to prevent slips and falls of material in the excavation. Support may include the use of closed sheeting or steel sheet piles, where necessary, to prevent any fall or run from any portion of the ground outside the excavation into the trench and to prevent settlement of or damage to existing services and structures next to the excavation.
  - (b) any excavation carried out by the Contractor to prevent slips and fall, or should portions of trench walls slip or fall away, the Contractor shall at his own expense take all necessary remedial measures including the excavation removal and reinstatement of all the ground thereby disturbed.
  - (c) in all cases where the voids so formed when backfilled would provide support for the permanent Works or adjacent structures and services, such voids shall be filled with Grade 20 SRC concrete at the Contractor's expense. In all other cases the voids shall be filled with selected excavated material compacted as specified in this Part.

#### **2.2.12 Trimming and Levelling**

- 1 No excavation shall be filled in or covered with concrete until it has been inspected by the Engineer.
- 2 Where shown on the Drawings or instructed by the Engineer, a layer of blinding concrete shall be placed to the required thickness to protect the formation and provide a clean working surface.
- 3 The Contractor shall compact the formation before placing the blinding concrete, when in the opinion of the Engineer the formation density can be improved by compaction.
- 4 When excavating to specified levels for trench excavation for pipelines, or to specified limits for the face of any thrust block or other structure required to abut or to rest upon undisturbed ground, excavations shall be trimmed as follows:

- (a) the Contractor shall not excavate the last 150 mm until immediately before beginning construction work except where the Engineer permits otherwise. Should the Contractor have excavated to within 150 mm above these specified levels or to within 150 mm of these specified limits before he is ready or able to commence the construction work he shall where required by the Engineer excavate further so as to remove not less than 150 mm of material immediately before commencing the construction work and any such further excavation and additional foundation material ordered by the Engineer shall be at the cost of the Contractor. The last 150 mm shall be hand excavated
- (b) the bottom of excavations shall be carefully boned in and trimmed true to grade with the aid of a straight-edge.

#### **2.2.13 Excavations Not to be Left Open**

- 1 Trench excavation shall be carried out expeditiously in the following manner:
  - (a) the refilling and surface reinstatement of trench excavations shall begin and be completed as soon as reasonably practicable after the pipes have been laid and jointed
  - (b) the Contractor shall take precautions to prevent flotation of pipes in locations where open trench excavations become flooded, and these precautions shall include the partial refilling of the trench leaving pipe joints exposed for tests of the joints
  - (c) if the Engineer considers that the Contractor is not complying with the foregoing requirements, The Engineer will not permit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation.

#### **2.2.14 Dewatering of Excavations**

- 1 For construction dewatering refer to Section 1 Part 24 Construction Dewatering. Refer to PWA Manual of Construction Dewatering
- 2 The Contractor shall submit methods statements including drawings and data showing the intended plan for dewatering operations. Details of locations and capacities of dewatering wells, well points, pumps, sumps, collection and discharge lines, standby units, water disposal methods, monitoring and settlement shall be included. The methods statement shall be submitted to the Engineer for approval not less than 30 days before the start of dewatering operations. The Engineer reserves the right to reject the proposal if he is not satisfied with measures.
- 3 The Contractor shall satisfy himself on the scope of dewatering necessary for the construction of the Works and shall make the necessary investigations to obtain the required data and information.
- 4 Where necessary, the Contractor shall divert natural and artificial waterways encountered at the Site until the Works are completed.
- 5 The Contractor shall perform dewatering as necessary to ensure that
  - (a) the Works are installed on dry areas and excavations, including without limitation the construction of all structures and underground piping
  - (b) dewatering is carried out only to a depth sufficient for the required excavation
  - (c) during construction, no groundwater shall come into contact with any concrete surface or reinforcement

- (d) structures shall be capable of withstanding any hydrostatic pressure to which it may be subjected during construction and until completed.
- 6 The Contractor's dewatering operations shall be conducted so as not to endanger the foundations or stability of the Works or any adjacent structures. Damage caused by the Contractor's operations shall be made good by the Contractor at no additional cost to the Employer.
- 7 Discharge of groundwater from excavations to the sea, into surface storage ponds or deep well recharge shall require the approval of the Ministry of Municipality.
- 8 Water removed from excavations shall first pass through settlement tanks and on-site treatment prior to discharge.
- 9 Unless otherwise approved by the Engineer, wellpoint dewatering systems shall be provided on both sides of trenches.
- 10 The static water level shall be drawn down a minimum of 300 mm below the bottom of the excavation so as to maintain the undisturbed state of the foundation soils and allow the placement of any fill or backfill to the required density. The dewatering system shall be installed and operated so that the groundwater level outside the excavation is not reduced to the extent that would damage or endanger adjacent structures or property.
- 11 The Contractor shall, where extensive dewatering is required, be fully qualified to perform the dewatering operations or shall furnish the services of an experienced, qualified, and equipped dewatering subcontractor to design and operate the dewatering and groundwater recharging system required for the work, all subject to the Engineer's approval.
- 12 When directed by the Engineer, the Contractor shall establish a specified number of groundwater level monitoring stations at each site which shall be observed during the work. These shall be located as directed by the Engineer and consist of acceptable open tube piezometers. When directed by the Engineer, the Contractor shall provide settlement gauges to the approval of the Engineer and monitor settlement of new and existing facilities.
- 13 Dewatering shall not result in the flow of water along the pipe zone material. Full consideration should be given to the use of cut-off walls to reduce the potential for groundwater flow along pipe trenches. The Contractor shall submit for the Engineer's approval, details of his proposed method of working and temporary works installations to achieve this.
- 14 If the use of drainage conduits, channels or subdrains is approved by the Engineer and are to be left in place below the level and within the width limits of permanent Works they shall be structural capable of providing support. Ballast filled subdrains to be left in place under concrete shall be covered with a geotextile membrane. Subdrains left in place shall be filled with Grade 20 SRC concrete or an approved cementitious grout.
- 15 The release of groundwater to its natural static level shall be performed so as to maintain the undisturbed state of the natural foundation soils, prevent disturbance of compacted fill or backfill and prevent floatation or movement of structures, pipelines and sewers.
- 16 No dewatering system shall be removed until infiltration testing is completed nor without the approval of the Engineer. Monitoring and settlement measurement systems shall be maintained in operation until removal is approved by the Engineer. With the approval of the Engineer, wellpoints and like items may be abandoned in place.
- 17 Partially completed permanent works shall not be allowed to become flooded and the Contractor shall allow for additional standby pumps and equipment required to ensure this. A pump operator shall be on site 24 hours per day to supervise pumping equipment.

- 18 In the event of partially completed trenches becoming flooded, the Contractor shall re-excavate to formation level and re-lay the pipes.
- 19 The Contractor shall provide a silt-trap in any temporary drain which he may construct and prior to discharge into any permanent drain which he may wish to use for the removal of water during the construction period. The Contractor shall keep both temporary and permanent drains clear of silt to the satisfaction of the Engineer until the completion of the Contract. Any silting up of the watercourses arising from the Contractor's failure to comply with this Clause shall be remedied at his expense whether within the Site or not.

## 2.3 BACKFILL

### 2.3.1 Pipe Bedding

- 1 Pipe bedding shall be provided as shown on the Drawings or stated in the Contractor's approved methods statement.
- 2 Pipe bedding shall be well compacted to a minimum void ratio to provide a high load-bearing capacity and a stable base below the pipe and shall completely fill the whole width of the trench excavated. Compaction requirements equivalent to at least 90 percent of the Standard Proctor Maximum Dry Density shall be achieved. Additional bedding necessary to fill voids created by over excavation shall be provided entirely at the Contractor's expense.
- 3 Pipe bedding shall consist of granular material or as agreed by the Engineer and shall conform with the following requirements:
  - (a) shall consist of strong durable crushed rock or recycled aggregate in accordance with Section 6 Part 9 from a source approved by the Engineer. No reactive carbonate rock or sources with indication of local groundwater contamination shall be used.
  - (b) pipe bedding material for rigid pipes shall be according to the following grading limits giving in Table 2.3.

Table 2.3 – Gradation Requirements for Pipe Bedding, Rigid Pipes

Sieve Size			
	<300	300 - 800	>800
	% by Mass Passing	% by Mass Passing	% by Mass Passing
25mm	-	-	100
20mm	-	100	90 - 100
14mm	90 - 100	80 - 100	50 - 80
10mm	50 - 85	60 - 85	40 - 70
5mm	10 - 40	20 - 55	25 - 60
2.36mm	0 - 10	10 - 30	10 - 40
0.300	-	0 - 10	0 - 15

- (c) The minimum thickness of pipe bedding material below the barrel of the pipe is given in Table 2.4.

**Table 2.4 – Minimum thickness of bedding material below barrel of pipe**

Nominal Bore (mm)	Uniform Soil		
	Hand Finished Trench Bottom	Machine Dug Trench Bottom	Rock
100 & 150	100	150	200
200 - 500	150	200	250
600 - 800	175	225	275
1000 & above	200	250	300

- (d) Pipe bedding and backfill to French drains shall be in accordance with Section 6, Part 17, Clause 17.9.5.
  - (e) The total loss factor for the granular material used in French drains using the ten minute rotational test shall not exceed 10%.
  - (f) Chloride and sulphate levels for bedding materials shall conform to BS 1377-3.
- 4 Pipe bedding material for flexible pipes be according to the following grading limits given in Table 2.5.

**Table 2.5 – Gradation Requirements for Pipe Bedding, Flexible Pipes**

Sieve Size	Pipe Diameter (mm)	
	<300 % by Mass Passing	≥300 % by Mass Passing
14mm	-	90 - 100
10mm	50 - 85	50 - 85
5mm	10 - 40	0 - 10
2.36mm	0 - 10	0 - 10

- i. The minimum thickness of granular bedding material around the barrel of the pipes shall be 100mm. Should the Contractor exceed the trench widths given in Table 2.1 he shall precede as Clause 4.3.2 of this Section.
- 5 The design of GRP and PE pipes and bedding is specified in Parts 3 and 4 of this Section. Granular bedding materials for GRP pipe shall be 10mm nominal size according to the grading limits given in Table 2.5 and also meet the manufacturer's requirements.
- 6 After trimming and compaction of the formation, granular bedding material shall be spread in the trench bottom.
- 7 Cut-off walls shall be formed in granular bedding and surround to pipes to prevent the bedding acting as a subsoil drain. Cut-off walls shall be provided at a maximum spacing of 40 m with one at each manhole and structure and at least one cut-off wall between two adjacent manholes and structures.
- 8 Cut-off walls shall be made from an impervious fine grained clay mixture, prepared with addition of water where necessary, to suitable trench spoil if available, or imported. Concrete cut-off walls shall be Grade 20 SRC concrete. Cut-off walls shall be installed across the full cross-section of the granular bedding material and shall be at least 300 mm wide along the axis of the pipeline.
- 9 Concreting to the pipeline shall be either bed or bed and surround or encasement or backfill as shown on the Drawings or directed by the Engineer and shall be of Grade 20 SRC concrete placed as follows:
- (a) concrete shall not be placed until the joints at each end of the pipe have been completed

- (b) each pipe to be encased shall be supported on at least two purpose made precast concrete blocks, which shall be left in place
  - (c) concrete encasement shall be placed to the required depth in one operation and pipes shall be prevented from floating or otherwise moving during concreting
  - (d) continuity of concrete backfill or encasement to pipe with flexible joints shall be broken at each joint, unless otherwise approved by the Engineer
  - (e) flexible joints in concrete beds and surrounds to pipes shall be formed as shown on the Drawings with suitable compressible fibrous board or other similar approved material
  - (f) compaction shall be carried out with approved mechanical vibrators. The maximum period of time between mixing of the materials and final compaction of any given material shall be kept to a minimum.
- 10 Where unstable ground conditions are met which are likely to cause undue settlement in the pipeline, the Contractor shall submit a report including site data and the Contractor's proposal for remedial works including structural calculations for the approval of the Engineer. The Contractor shall carry out the following remedial works as directed by the Engineer.
- (a) improvement of mechanical properties of the soil
  - (b) replacement of soil by other soil or blinding concrete
  - (c) pile foundations
  - (d) reinforced concrete slab foundation.
- 2.3.2 Pipe Surround**
- 1 Pipe surround shall be provided as shown on the Drawings or stated in the Contractor's approved method statements.
  - 2 When concrete cradles are used, all concrete shall have attained adequate strength before backfilling of the excavation commences between the completed structure and sides of excavations.
  - 3 Material for pipe surround and to the first 300mm above the top of the pipe, shall be granular material as specified in Clause 2.3.1. The material shall be free from sharped edged stones or other material which may cause damage to the permanent Works.
  - 4 Material for pipe surround shall be placed in layers of not greater than 150mm compacted thickness and thoroughly rammed with suitably shaped rammers working alternatively on either side of the pipe until the fill has been carried up at least 300mm above the top of the pipe. Care shall be taken to avoid damage to the pipe, coating or sheathing.
  - 5 Compaction requirements equivalent to at least 90 per cent of the Standard Proctor Maximum Dry Density shall be achieved.

**2.3.3 Geotextile Filter Membrane**

- 1 Geotextile filter membrane for surround to granular material for ground water drainage shall conform with the requirements of Section 6 Part 18 Clause 18.1, Table 18.1, Clause 18.2 and shall be used in the zone extending downwards from 1.5m above the long term water table. The long term water table is to be determined on the basis of observations made on site of the initially encountered water table in the excavations. The placement of Geotextile is then to be directed by the Engineer. Geotextile membrane for structural support to pipe surround in soft ground shall be wrapped round the granular bedding as shown on the Contract drawings.
- 2 For both of the above applications the minimum geotextile properties shall be:
  - (a) mean peak strength ISO 10319 8kN/m

- (b) elongation at peak strength ISO 10319 28%
- (c) CBR puncture resistance ISO 12236 1500N
- (d) pore size (O90) ISO 12956 0.15mm
- (e) permeability (50cm head) ISO 11058 100l/m<sup>2</sup>.s
- 3 The fabric shall be woven or non-woven consisting of long chain polymeric filaments or yarns formed into a stable network such that the filaments or yarns retain their relative position to each other.
- 4 The fabric shall be inert to commonly encountered chemicals and chemical properties of the soil and water. Geotextile fabric shall surround the granular bedding as follows:
- (a) the surface to receive the fabric shall be formed to a relatively smooth condition free of obstruction, depressions, and debris. The geotextile fabric shall be laid loosely.
  - (b) if the proposed area for fabric requires more than one panel width of fabric, the panels shall be overlapped a minimum of 15 percent of the panel width
  - (c) to prevent slippage of the overlapping fabric, the areas of overlap shall be stabilised, as approved by the Engineer, with pins, anchor blocks, or piles of aggregate
  - (d) fabric damaged or displaced before or during installation or during placement of backfill material shall be repaired or replaced

#### 2.3.4 Backfilling Excavation

- 1 All concrete shall have attained adequate strength before backfilling of the excavation commences between the completed structure and sides of excavations.
- 2 Selected fill material for trench backfill in open areas, shall be suitable material selected from the excavated material as specified in Clause 2.2.3 of this Part. Stones larger than 75 mm in size may be allowed, provided in the opinion of the Engineer, the required densities can be achieved.
- 3 Selected fill material for trench backfill under paved areas, shall be suitable material selected from excavated materials meeting the following requirements of Clause 2.2.3 Table 2.1:
- 4 The trench backfill material shall be placed in layers of not greater depth than 200mm thickness and be thoroughly compacted to 95 percent of the Standard Proctor Maximum Dry Density by approved mechanical compaction equipment. In roads and footpaths, the coarse filling is to be carried up to the level at which surface reinstatement is to begin; elsewhere, to such level as with the surface reinstatement of the whole of the topsoil will leave the finished work sufficient to allow for future settlement to the original ground level.
- 5 The moisture content of the material before compaction shall not vary by more than ±2% of the optimum moisture content (BS 1377 Part 2:1990, Test 3.2). If in the opinion of the Engineer, the fill is too dry, it shall be watered at the expense of the Contractor in an approved manner during refilling as may be directed by the Engineer.
- 6 Any nuclear density measurement (NDM) tests undertaken shall be performed only by persons or companies holding a valid Authorised User Certificate issued by the Materials Central Laboratory. Each NDM device shall have a valid Calibration Certificate, also issued by the Central Materials Laboratory.
- 7 The Contractor shall provide the necessary testing apparatus for monitoring soil properties and shall maintain the apparatus in good working order. A daily log of tests carried out shall be provided to the Engineer. Testing of soil properties shall be carried out by an approval laboratory.

- 8 Tests to determine the optimum dry density of the fill material shall be carried out as directed on site, the frequency depending on consistency of material and test results.
- 9 Unless directed otherwise, testing for density and moisture content shall be at the rate of:
- (a) one test per backfill layer for each structure such as manholes, chambers, and thrust blocks
  - (b) one test per backfill layer for every 30 m of pipeline trench.
- 10 Should the backfilling material being placed become unacceptable to the Engineer due to
- (c) exposure to weather
  - (d) flooding
  - (e) having become puddled, soft, segregated
  - (f) otherwise unacceptable during the progress of work
- The Contractor shall at his own expense remove such damaged, softened or segregated material and replace it with fresh approved material.
- 11 To permit the proper consolidation of backfill into the voids behind trench sheeting and supports, trench sheeting shall be withdrawn gradually as backfill progresses in depth and along the trench.
- 12 On no account shall any excavated material be dozed back when filling trenches in roads and no filling shall be carried out unless in the opinion of the Engineer, sufficient mechanical compactors are in operation on that portion of the work.
- 13 Where in the opinion of the Engineer sufficient supplies of the suitable material for trench backfilling cannot reasonably be obtained from excavations the Engineer may order the Contractor to:
- (h) carry out such work as may be necessary to screen out stones
  - (i) borrow excavate material from suitable borrow areas on the Site or off the Site and transport it to the length of trench to be filled to the approval of the Engineer.
- All costs for borrow material shall be borne by the Contractor.
- 14 Trench backfilling shall be carried out expeditiously as soon as practicable after the pipeline has been laid, tested and approved.
- 15 Trench bottom shall be free of any foreign material or backfill contaminated with foreign material from the trench bottom.
- 16 The grade of the bedding material shall be checked and any irregularities corrected. The top 25-50 mm of compacted bedding material shall be loosened with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.
- 17 Backfill material shall be placed simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in the same trench.
- (j) Pipes up to and including 250 mm in diameter: First lift of backfill less than or equal to 1/2 pipe diameter.
  - (k) Pipe over 250 mm in diameter: Maximum 150 mm lifts.
- 18 Each lift, including the area under haunches, shall be thoroughly compacted with handheld tamping bars supplemented by "walking in" and slicing material under haunches with a shovel to ensure that voids are completely filled before placing each succeeding lift.

- 19 After the full depth of the pipe zone material has been placed as specified, the material shall be compacted by a minimum of three passes with a vibratory plate compactor only over the area between the sides of the pipe and the trench walls.
- 20 Power-driven impact compactors shall not be used to compact pipe zone material.
- 21 Backfill used above pipe zone shall be processed to meet specified gradation requirements. Moisture content shall be adjusted as necessary to obtain specified compaction.
- 22 Backfill shall not be allowed to free fall into the trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 600 mm of backfill has been provided over the top of the pipe.
- 23 Power driven impact type compactors shall not be used for compaction until at least 1.2 m of backfill is placed over top of pipe.

### 2.3.5 Backfilling Excavations with Cement-Bound Granular Material

- 1 Backfilling excavations with cement-bound granular material shall be used for filling excavations at manholes, access shafts, pipe line structures in roadways, underneath exposed existing pipelines or as approved by the Engineer.
- 2 Cement-bound granular material shall consist of crushed, hard, clean, durable rock or washed sand or a combination thereof. The material shall be sufficiently well-graded to ensure a well-closed surface finish and have a grading within the range shown in Table 2.6

ii. **Table 2.6– Grading for cement-bound granular material**

BS 410 sieve size	Percentage by Mass Passing
50 mm	100
37.5 mm	95 - 100
20 mm	45 - 100
10 mm	35 - 100
5 mm	25 - 100
600 µm	8 - 65
300 µm	5 - 40
75 µm	0 - 10

- 3 The granular material shall be mixed with sufficient cement to provide the crushing strength specified in Paragraph 12 of this Clause. The material shall be mixed in a paddle or pan type mixer which may be batch or continuous type. Where a batch mixer is used, the mixing times shall not be less than one minute unless the Engineer approves a shorter time subject to the results of preliminary trials. Where a continuous mixer is used, the paddles, baffles and rate of feed of materials shall be adjusted to provide a uniformly mixed material. Where a spray is used for distributing water into the mixer, it shall be adjusted to provide a uniform moisture content throughout the mix.
- 4 The moisture content of the mixed material shall not exceed 2 % above the optimum as determined in accordance with the Vibrating Hammer Test of BS 1924.
- 5 The Contractor shall carry out preliminary tests on trial mixes to attain the specified crushing strength.

- 6 Plant-mixed material shall be transported to the site by vehicles which shall have capacities suited to the output of the mixing plant and site conditions, and be capable of clean discharge. Mixed material shall be immediately transported to its required location and shall be suitably protected from the prevailing climatic conditions during transportation and the period before tipping.
- 7 All mixed material shall be placed and immediately spread evenly in one layer such that after compaction the thickness does not exceed 150 mm.
- 8 Compaction in trenches shall be carried out immediately after the material has been spread and completed within two hours of the addition of cement.
- 9 Compaction shall be carried out to achieve a density equivalent to 95 % of the average density of the set of five cubes required for testing in paragraph 12 of this Clause.
- 10 Any layer of cement-bound granular material not covered within two hours shall, immediately on completion, be cured for a minimum period of 7 day unless otherwise approved by the Engineer or the surface is covered by permanent works. Surface curing shall be achieved by covering with impermeable plastic sheeting until the next permanent layer is laid. The plastic sheeting shall be adequately secured to the surface and joints shall be have a minimum 300 mm overlap, set to prevent egress of moisture.
- 11 Samples of the mixed material shall be taken from the site immediately before compaction of the material. A batch of five random samples shall be taken from each layer or such other area as decided by the Engineer. From each sample a cube test specimen shall be prepared, cured and tested using the procedure in BS 1924. The specimens shall be compacted to be within 95 % of the cube density when compacted by vibratory hammer. The specimens shall then be cured at constant moisture content within the range of curing temperatures stated in BS 1924 for a period of 7 days. The specimen shall then be weighed, the dimensions checked and tested in unconfined compression. A representative portion of the crushed material from each specimen shall then be retained for a moisture content determination in accordance with BS 1924 and the dry density of each specimen determined using mass, dimensions and the moisture content of the material.
- 12 The average 7 days crushing strength for each batch of five test specimens made and tested in accordance with the method described herein shall be not less than 3.5 MPa for cubes. In addition to complying with the minimum strength requirements, the root mean square of the coefficient of variation of the crushing strength of five successive batches of five test specimens of the cement-bound granular material shall not exceed 25 %. If an area or layer of cement-bound granular material represented by these specimens fails these tests, the defective material shall be removed and replaced with new material at the Contractor's expense.
- 13 The cement-bound granular material shall in no case be less than 150 mm thick from the outside barrel of the pipe to the nearest point of the shoring, and the greatest care shall be exercised to ensure complete filling of all voids and thorough consolidation of the concrete. The Contractor shall allow in his prices for the additional concrete used in excess of the net requirement.
- 14 Cement – Bound Granular Material discharged from truck mounted drum type mixer into trench shall:
  - (a) Placed in lifts as necessary to prevent uplift (flootation) of new and existing facilities.
  - (b) In travelled areas, fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
  - (c) In other areas, fill the trench section as shown on the Contract Drawings.

### **2.3.6 Backfilling Excavation with Flowable Fill (Foamed Concrete)**

- 1 Backfilling excavations with flowable fill shall be used for filling excavations at manholes, trenches, access shafts, pipeline structures in roadways, underneath exposed existing pipelines or as approved by the Engineer.
- 2 Flowable fill may be placed by chutes, conveyors, buckets or pumps depending upon the application and accessibility.
- 3 For trench backfill, flowable fill shall be placed continuously. To contain the flowable fill along long open trenches or open ended structures in stages, the end points shall be adequately bulkheaded to prevent movement.
- 4 Flowable fill shall be placed in a manner to prevent flotation or displacement of the embedded item.
- 5 The 28-day compressive strength of the flowable fill shall be 5 MPa with a unit density of between 1600 – 2000 kg/m<sup>3</sup>. Accelerators may be used subject to the approval of the Engineer.

### **2.3.7 Backfilling Next to Pipeline Structures**

- 1 Fill materials adjacent to structures such as manholes and chambers shall be placed in accordance with Clause 2.3.4 above.
- 2 Fill material next to structures other than pipeline structures shall be carried out as Specified in Section 12.

### **2.3.8 No-Fines Concrete as Trench Backfill**

- 1 Except where otherwise noted in this Clause, the design, manufacture, use and testing of no-fines concrete shall comply with the requirements of Section 5 Part 6.
- 2 All material shall be placed and spread evenly. The full width of the excavated trench shall be filled; formwork other than that required for temporary constructions joints will not be permitted. The Contractor shall be responsible for the use of any extra material required to fill the trench beyond the maximum trench widths detailed on the drawings. The no-fines concrete shall generally be brought up to a height no higher than the level of undisturbed rock on either side of the trench.
- 3 Compaction shall be carried out with approved mechanical vibrators. The maximum period of time between mixing of the materials and final compaction of any given material shall be kept to a minimum.
- 4 Any layer not covered within 2 hours by another layer of no-fines concrete shall, immediately on completion of compaction, be cured for a period which shall not be less than 7 days unless the Engineer agrees otherwise. Curing shall be achieved by covering until the next layer is laid with impermeable plastic sheeting, adequately secured from being blown off the surface and with joints overlapped at least 300mm and set to prohibit egress of moisture.

## **2.4 REINSTATEMENT OF SURFACES**

### **2.4.1 Reinstatement within the Highway**

- 1 All reinstatement of roadworks to be carried out in the public highway shall be carried out in accordance with the latest "Code of Practice and Specification of Road Openings in the Highways".

### **2.4.2 Reinstatement of Surfaces Other Than in the Highway**

- 1 Unless provided in the Project Specification, surfaces shall be restored to a condition conforming to the requirements for the particular surface described in the relevant section of this Specification. Where no specification exists, restoration shall be to the satisfaction of the Engineer.
- 2 All surfaces, gardens or lawns shall be restored to a condition equal to the original surface to the satisfaction of all Authority requirements, the Engineer and the owners/occupiers.
- 3 Any reinstatement shall be fully maintained by the Contractor until such time that a Taking-Over Certificate has been issued for the Works or for the Part of the Works containing the reinstatement.

## 2.5 EXISTING SERVICES

- 1 The requirements of this Subpart are in addition to the general requirements specified in Clause 2.1.5 of this Part.
- 2 The Contractor shall be required to submit in advance to the various Utilities Services Departments and to the relevant Municipality where the Works affect the trees and plants and a weekly programme of the pipelines he intends to lay in order that the various departments can expose or advise on the location of their respective services.
- 3 Except as otherwise designated in the Project Specification, the Contractor shall be responsible for maintaining all services and utilities including but not limited to waterways, sewers, drains, gas and oil mains, water mains electricity and telecommunication cables and all other services, structures, trees, and plants encountered during the construction of the Works and for any remedial measures necessary to make good any damage caused thereto.
- 4 Where designated in the Project Specification, work on services shall be carried out by the relevant Utility Service Department. The Contractor shall co-ordinate his work with the work of the Utility Service Department, and carry out his work so as not to interfere with or damage their services.
- 5 Where work is carried out close to or across the line of existing services, the Contractor shall where necessary provide temporary supports or slings. Where service is interfered with or damaged, the Contractor shall immediately notify the relevant Utilities Service Department and shall not undertake repairs without their authorisation and approval. Unless otherwise authorised and approved, repairs shall be undertaken by the Utilities Service Department and the cost of such work shall be borne by the Contractor, and the Contractor shall reimburse the Utilities Service Department its account for performing such work.
- 6 Where specified on the Drawings or by the relevant Utility Service Departments split ducts, conforming with the requirements of Clause 2.7.1 of this Part shall be provided for the permanent support and protection of services.
- 7 The Utility Service Department and the Engineer shall determine whether or not a service requires to be permanently diverted, temporarily diverted or supported.
- 8 Where existing services have to be permanently or temporarily diverted as the unavoidable result of the construction of the Works, such diversions shall be carried out either by the Contractor or the Utilities Service Department as directed by Engineer.
- 9 Safety shall always be maintained in all work in the vicinity of existing services in accordance with particular requirements of Utilities Service Department and the requirements of Section 1 and Part 1 of this Section.

- 10 In addition to the provisions of the above paragraphs, when carrying out pipelaying operations in the vicinity of existing gas or oil pipelines, the following requirements shall apply:
- (a) the minimum clearance between the bottom of the oil or gas line and the top of the pipeline being constructed is to be 600 mm
  - (b) a hand excavated pilot hole shall be dug to determine the gas or oil line invert level and position prior to any trench excavation in gas or oil pipeline reservation
  - (c) the excavation for the pipeline under construction must be carried out by hand up to 2.0 m either side of the existing gas or oil pipeline
  - (d) manually operated jack hammers may be used within 5.0 m of the buried pipeline only after completion of item (c) above
  - (e) the use of mechanical or hydraulic rock-breakers shall not be allowed within 5.0 m of the buried pipeline
  - (f) before the exposure of live pipeline the Contractor is to erect a suitable substantial barrier to prevent damage to the exposed pipeline.
  - (g) on completion of the concrete surround to the pipelines under construction, the existing gas or oil pipeline shall be rebedded with a minimum of 150 mm of naturally occurring soft dune sand bed and surround. The remaining backfill and bund shall be made up of selected desert fill with a particle size not exceeding 150 mm which shall be free from organic matter. The Qatar Petroleum (QP) (onshore) Engineer shall be notified a minimum of 24 h in advance, to witness the backfilling operation
  - (h) damage to the external protective wrapping to the gas or oil pipeline shall be reported promptly to the QP who will arrange for the damage to be inspected and repaired in strict accordance with QP (onshore) procedures at the Contractor's cost
  - (i) the Contractor is to provide constant competent supervision whilst work is carried out next to the existing gas or oil pipelines
  - (j) when the works reach 15 m from the existing gas or oil pipeline, the Contractor shall contact the QP (onshore) Engineering Superintendent, who will arrange the necessary permit to work. QP (onshore) will require a minimum of 48 h notice before work begins
  - (l) a QP (onshore) permit to work does not in any way make QP (onshore) responsible for any of the Contractor's work, nor does it absolve the Contractor from his responsibilities for complying with the above, but only allows the Works to be carried out in accordance with the agreed working methods and practices. QP (onshore) reserve the right to visit the site regularly to observe that the agreed methods and practices are being adhered to and to stop the work and withdraw the permits to work should they consider there is adequate justification to do so
  - (m) the requirements of QP (onshore) may vary from and are not necessarily limited to the foregoing.

## 2.6 BLASTING

- 1 The Contractor shall not use any explosives in the construction of the works without the prior written approval of the Engineer and such approval shall be contingent upon the Contractor being authorised by the Civil Defence Department and the Police.

- 2 The Contractor shall inform the Engineer in advance about the types and quantities of explosives needed. Explosives shall be obtained and used in accordance with the regulations and procedures of the relevant Government Department. The Contractor shall be deemed to have copies of relevant documentation and to be knowledgeable of relevant practices. The Contractor shall provide copies of relevant documentation to the Engineer for the Engineer's inspection.
- 3 Notwithstanding the requirements of this Clause, the Contractor is responsible for the safe and correct transport, handling and use of explosives.
- 4 Except as otherwise provided in the relevant regulations and procedures the handling of explosives shall be carried out to conform with the requirements stated in the following paragraphs.
- 5 Except as otherwise permitted by the Government, all unused explosives, or explosive accessories shall be destroyed at the end of each day's work.
- 6 Explosives and detonators shall be carried in separate vehicles during transport. The vehicles must be clean and in a good state of repair and be of sufficient capacity to convey the explosives safely. The Police may refuse to issue explosives if vehicles do not meet those standards. A red flag must be clearly displayed by all vehicles when carrying explosives.
- 7 The Contractor must appoint in writing at least one shotfirer who is in possession of a Qatar Shotfirer's Certificate of Competence to carry out all work with explosives on behalf of the Contractor. The Contractor shall present and provide copies of such certification to the Engineer for inspection.
- 8 The Contractor must establish simple safety rules covering the handling and use of explosives. A copy of these rules will be given to the concerned shotfirer, who will sign a receipt book kept for this purpose by the Contractor.
- 9 The safety rules shall specify:
  - (a) the places where explosives are to be used
  - (b) times of blasting
  - (c) measures to be taken to contain the products of blasting
  - (d) method of initiation
  - (e) posting of warning notices, yellow blasting flags and sentries; and audible warning, if applicable
  - (f) actions to be taken in the event of any unusual occurrence or accident
  - (g) any other safety aspects relating to the use of explosives
  - (h) any special instructions concerning transport
  - (i) instructions relating to the limitation of blast vibrations, where appropriate.
- 10 The Contractor shall submit a copy of the safety rules to the Engineer.
- 11 Shotfirers shall be responsible to the Contractor for ensuring that all explosives and accessories are safely and carefully handled and used, in accordance with the regulations and procedures of the Government, and his own knowledge of correct shotfiring procedure.
- 12 Where so directed by the Engineer, the Contractor shall provide and operate suitable instruments to monitor and record the blast vibrations at no additional cost to the Employer.

- 13 Where blasting vibration could cause nuisance; e.g., in close proximity to buildings, pipelines or other structures, the Contractor shall ensure that careful attention is given to the vibration levels to minimise nuisance.

## **2.7 MISCELLANEOUS**

### **2.7.1 Service Ducts**

- 1 The Contractor shall furnish and install new protection ducts of split PVC-U pipes, concrete encased, to protect existing utility mains or cables where new pipelines are to cross such utility mains or cables.
- 2 After the split PVC-U pipe has been placed around the existing utility mains or cables, the pipe shall be wrapped twice with polyethylene film, 150 µm thick, to prevent fresh concrete from entering the duct. The protection ducts shall be supported on suitable non-corrosive spacers before placing the concrete encasement.
- 3 All concrete work shall be in accordance with the requirements of Section 5 and concrete encasement shall be with Grade 20 SRC concrete.

### **2.7.2 Formation of Bunds and Embankments**

- 1 The material used in the formation of embankments bunds and other areas of fill shall be obtained by the Contractor from sources approved by the Engineer. The material shall equate to selected excavated material or similar.
- 2 Bund and embankment material at the optimum moisture content shall be built up evenly over the full width and compacted in layers not exceeding 300 mm in compacted depth. The moisture content of material may require adjustment to that required to attain maximum density. Material which contains insufficient moisture to obtain the desired compaction will require the incorporation of additional water by the use of approved sprinklers and mixing.
- 3 Layers more than 300 mm below road formation levels shall be compacted to 90 % of the maximum dry density. Layers less than 300 mm below road formation level shall be compacted to 95 % of the maximum dry density. Maximum dry density shall be determined in accordance with CML 12-97
- 4 The Contractor shall ensure that material laid immediately next to a structure, concrete wall or thrust block is well compacted. Hand operated vibrating plate compactors vibro-tampers or power rammers shall be used. In other cases, compaction shall be carried out by vibrating compactors smooth wheel or pneumatic tire rollers of types approved by the Engineer.
- 5 In forming bunds and embankments, the Contractor shall make allowance for consolidation and shrinkage in attaining the dimensions of bunds and embankments shown on the Drawings.
- 6 The Contractor shall make due allowance for consolidation and settlement of embankments and bunds both in width and height. Any subsidence that may occur during the period of maintenance shall be corrected by the Contractor at no additional cost and to the satisfaction of the Engineer.
- 7 Round tops of cut slopes in soil to not less than a 1.8 m radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

**END OF PART**