

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

NATIONAL WATER SUPPLY AND DRAINAGE BOARD
MINISTRY OF URBAN DEVELOPMENT, CONSTRUCTION
AND PUBLIC UTILITIES
DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

THE DETAILED DESIGN STUDY
ON
THE PROJECT FOR REDUCTION
OF NON-REVENUE WATER
IN THE GREATER COLOMBO AREA
IN
THE DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

FINAL REPORT

(DRAFT) TENDER DOCUMENTS
FOR CIVIL WORKS
VOLUME 2

MARCH 2001

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SECTION 9 TECHNICAL SPECIFICATIONS

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**9.1 GENERAL SPECIFICATIONS
– CIVIL WORKS**

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9.1.1 EARTHWORKS AND TRENCHING

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9.1.1 EARTHWORKS AND TRENCHING

9.1.1.1 GENERAL SITE WORK

9.1.1.1.1 *General Excavation*

The entire area within the limits of earthwork as indicated shall be constructed to the lines, grades, elevations, slopes and cross sections indicated on the drawings with added allowance for the thickness of gravel base and paving where required. Slopes and drainage features shall present a neat uniform appearance upon completion of the work and shall be approved by the Engineer. Excavated materials meeting the requirement of fill materials may be conserved for subsequent use or placed as earth fill immediately after excavation upon approval of the Engineer. The suitability of all excavated materials for specific purposes shall be determined by the Engineer. The Contractor shall not waste or otherwise dispose of suitable excavated materials. All excavation shall be performed under the limitations and requirements set out in the sections of this specification pertaining to control of water.

9.1.1.1.2 *Earthwork*

The earthwork shall include all the work such as excavation of all materials of whatever nature encountered, handling, hauling and compaction of required fill materials, disposal of all excess excavated material, shoring and protection work, preparation of subgrade, dewatering as necessary, protection of adjacent property, backfill, surface reinstatement, and embankment to the lines and grades indicated on the drawings.

9.1.1.1.3 *Site Investigation*

(1) General

Foundation investigation data at the clear water well, water towers, reservoirs and pumping station sites are available for review at the office of the Engineer and may be used as a guide to surface and subsurface soil conditions at that site. The boring logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from those occurring at the boring locations. Also, the passage of time may result in a change of the subsurface conditions or water-levels at the boring locations. The Employer does not guarantee any statements, opinions, or conclusions contained in the report. The Contractor shall assume all responsibility for deductions and conclusions as to the nature of the materials to be excavated, the difficulties involved, dewatering, and maintaining the required excavations and of doing the work affected by the subsurface conditions at the site of the work. Neither the Employer nor any of its Officers, the Engineer or Consultant shall be liable for any loss sustained by the Contractor by or deduced from said borings, samples, tests, and/or reports, and the actual conditions encountered during the progress of the work.

9.1.1.1.4 *Levels to be Recorded*

Before the surface of any part of the Site is disturbed or the works thereon are begun, the Contractor shall take and record levels of any such part, in the manner specified or as agreed with the Engineer. Two working days notice is to be given the Engineer so that the recording of levels can be performed in the presence of the Engineer.

9.1.1.1.5 *Rock and Hard Materials*

For the purpose of this Contract rock is defined a natural materials that is so hard that, in the opinion of the Engineer, it cannot be removed by the ordinary methods of hand or machine excavation without undue difficulty, or without preliminary work to break or loosen the material by use of blasting impostors, or similar procedures.

Hard material is similarly defined as artificial material such as concrete that, in the opinion of the Engineer, is so hard that it cannot be removed by the ordinary methods of hand or machine excavation without undue difficulty or without preliminary work to break or loosen the material.

Use of such preliminary procedures will not in itself justify rock or hard material classification. The Contractor shall notify the Engineer as soon as he encounters rock or hard material for which he intends to claim payment to permit an assessment to be made as work proceeds.

9.1.1.1.6 *Explosives and Blasting*

The Engineer shall have power to regulate, restrict or prohibit blasting if in his opinion it is necessary to do so for the safety of persons or property or to safeguard the works. No blasting shall be carried out in any part of the Works without the permission in writing of the Engineer. Such permission shall not absolve the Contractor from any of his obligations or liabilities under the Contract and he shall take all necessary precautions including the use of blasting nets to avoid damage, loss or injury to persons and to public or private property.

(1) Responsibility

The Contractor shall be solely responsible for injury to persons, or property that may result from his use of explosives, and the exercise of, or failure to exercise control on the part of the Engineer shall in no way relieve him of responsibility for injury or damage resulting from their use.

(2) Supervision

All blasting shall be done under the supervision of a competent blasting expert, and subject to Sri Lanka regulations for blasting.

(3) Blasting Caps

If electric blasting caps are used, precautions should be taken to warn operators of radio equipment to stop transmitting in any area in which blasting operations are in progress.

(4) Location

Explosives shall not be used within any distance that the Engineer may direct from concrete placed in the Works, any existing structure, water main, electric cable, sewer, conduit, or other service.

(5) License

The Contractor shall obtain the necessary licenses for the storage, transport and handling of explosives and shall provide a store or stores suitable for explosives in accordance with local regulations.

9.1.1.1.7 *Bracing and Shoring*

Excavated surfaces too steep to be safe and stable if unsupported shall be supported as necessary to safeguard the work and workmen, to prevent sliding or settling of the adjacent ground, and to avoid damaging existing improvements. The width of the excavation shall be increased if necessary to provide space for sheeting, Bracing, shoring, and other supporting installations. The Contractor shall furnish, place and subsequently remove such supporting installations.

9.1.1.1.8 *Borrow Excavation*

When the quantities of suitable surplus materials obtained from specific excavations are insufficient to construct the specified fills, additional materials shall be obtained from approved borrow areas. Borrow pits shall be excavated and finally dressed in a manner to eliminate steep or unstable side slopes or other hazardous or unsightly conditions. The extent and depth of borrow pits and the limits of designated borrow areas shall be approved by the Engineer. The Contractor is responsible for the arrangement and payment for all borrow material and the material selected shall meet the approval of the Engineer.

9.1.1.1.9 *Disposal of Material*

All surplus excavated material and materials arising from site clearance shall be disposed by the Contractor to the tips provided by the Contractor and approved by the Engineer. All requirements herein for the disposal by the Contractor of materials arising from Site clearance or from excavations are subject to the applicable provisions of the Conditions of Contract.

9.1.1.1.10 *Excess Excavation to be Made Good*

The Contractor at his own expense shall remove from the Site all materials residing from excess excavation below that required for the foundation and bedding and shall make good the same with such kind of all material or in such class of concrete as may be reasonably required by the Engineer having regard to the circumstances.

9.1.1.1.11 *Control of Water*

The Contractor shall furnish, install and operate all necessary machinery, appliances, and equipment to keep excavations free from water during construction and shall dispose of water so as not to cause injury to private property, or to cause a nuisance or menace to the public. Berms shall be provided to prevent surface water from draining into structural excavations. Earth banks shall be suitably protected from damage by erosion during construction. Any damage occurring shall be repaired by the Contractor at his expense.

9.1.1.1.12 *Standard Earthwork Compaction Test Procedure*

All compacted earth fill dry density shall equal or exceed the specified percentage as determined by ASTM D1557, Method C. This method will be used to determine the maximum dry density of each type of soil used in compacted fill, backfill, and embankments and to measure the relative compaction at optimum moisture content of compacted fills, backfill, embankment and sub-grades.

During the course of the work, the Contractor, under supervision of the Engineer, will perform such tests as are required to identify materials, to determine compaction characteristics, to determine moisture content, and to determine density of fill in place. These tests performed by the Contractor will be used to verify that the backfill and fill conform to the requirements of the specifications.

9.1.1.1.13 *Testing*

Testing will be performed by the Contractor or an approved testing laboratory selected by the Contractor when, where, and as directed by the Engineer. The costs of all compaction testing and other as stated above will be borne by the Contractor. The Contractor shall adjust his operations so as to permit time to make tests, and shall excavate and fill such holes as may be required for sampling and testing.

9.1.1.2 ACCESS, SITE CLEARANCE AND EMBANKMENTS

9.1.1.2.1 *Access*

The Contractor shall construct and maintain necessary haul and access roads within the construction area as required to complete all work. Upon completion of construction, all haul or access roads, backfill, and disposal areas shall be dressed to provide drainage and left in a slightly condition. The Contractor shall maintain existing public thoroughfares and control dust, such that it not be offensive and that all public thoroughfares be effectively signed, with flagmen present, to ensure the safety of all inhabitants.

9.1.1.2.2 *Site Clearance*

The entire site area shall be cleared and grubbed of all vegetation, including soil in the root zone. All the existing structures, which need to be removed from the site, shall be demolished and debris disposed. Any underground existing items which are likely to interfere with the work, shall be unearthed and removed. All deleterious material, such as trees, brush, heavy vegetation, trash, broken concrete, large stones, etc. shall be removed from the site area. All soil, rock or other materials unsuitable for use in a compacted backfill, fill or as foundation materials, as determined by the Engineer, shall be excavated and exported from the site. Disposal of cleared material shall be approved by the Engineer. All stumps, roots, and root clusters having a diameter greater than 25 mm shall be removed to a depth of at least 500 mm for concrete structures and 300 mm for embankment sites and other areas. In any case, flora which exhibits a re-growth potential after grubbing to these depths shall be removed entirely. Such determinations shall be made by the Engineer.

The Contractor shall verify any existing underground services, and after obtaining the approval of the relevant authority, shall relocate such services elsewhere.

The Contractor shall also check the necessity of the relocation of any overhead electricity or telecommunication cables or posts which will interfere with the construction work. If such necessity arises, Contractor shall obtain the permission from the relevant authority and get the relocation done.

Any expenditure involved in such relocation shall be borne by the Contractor.

9.1.1.2.3 *Materials for the Construction of Earth Embankments and Site Grading*

(1) Engineered Fill Materials

Furnish from sources approved by Engineer impervious soils free from trash, roots, sod or other perishable materials. Rock particles larger than 150 mm in any dimension shall be removed prior to compaction of fill. Excavated site soils meeting the requirements of impervious embankment fill may be used for engineered fill as approved by the Engineer. Certain areas within a larger designated excavation area may not be suitable for embankment fill and such areas shall be rejected as embankment fill and be disposed of by the Contractor.

(2) Site Grading Material

Existing site soils free from trash, roots, sod, or other perishable materials or as specified for engineered fill material.

9.1.1.2.4 *Embankment Filling and Structure Back-filling*

All fills, embankments, and structure backfill shall be placed in dry areas and dry excavations.

(1) Equipment

Use equipment for construction of fills and backfill that produces the specified compaction, type and capacities as required and approved by the Engineer.

(2) Protection

Protect all working areas from damage by water or otherwise maintain site drainage at all times, and keep water from standing on top of constructed fills and backfill. Heavy equipment shall not be operated within 0.6 m of any structure and vibrating rollers within 1.5 m of any structure.

9.1.1.2.5 *Foundation Preparation*

Foundations for earth fill shall be stripped to remove all obstructions, vegetation, debris, or other unsuitable materials. Except as otherwise specified, foundation surfaces shall be graded to remove surface irregularities and shall be scarified and loosened to a minimum depth of 100 mm. The moisture content shall be controlled as specified for engineered fill and the surface materials of the foundation shall be compacted and bonded with the first layer of earth fill as specified for subsequent layers of earth fill.

(1) Rock Foundations

All rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed. Pervious rock foundations shall be excavated to 150 mm below finished grade shown on the drawings and a lining shall be placed as specified herein. Fill immediately adjacent to such rock foundations or not accessible with large compaction equipment shall be compacted to the specified density by means of hard tamping or manually directed power tampers or plate vibrators.

(2) Benching

Where slope of existing soils to receive fill exceeds 4:1, horizontal benches shall be cut to key the new fill material to the existing soils. At least 600 mm of existing soil normal to the original slope shall be removed and re-compacted as the new fill is brought up in layers.

9.1.1.2.6 Construction of Fills and Embankments

Engineered fills as at 9.1.1.2.3 (1) & (2) shall be conducted where indicated or specified, and wherever fills are required in areas to receive structures, using approved engineered fill material. Other fills shall be conducted in the same manner using site grading fill materials or engineered fill material. The material for the fill should have the same properties as those of the existing bund material and should not contain any undesirable materials including clays, silts, peat and other organic soils.

(1) Placement

Earth fill shall not be placed until the required excavation and foundation prepared have been -completed and the foundation has been inspected and approved by the Engineer. Fill shall be placed in approximately horizontal layers of thickness that can be uniformly compacted by the equipment used but of maximum 200 mm loose thickness. Hand compacted fill including fill compacted by manually directed power tampers, shall be placed in a manner which will prevent damage to the structures and will allow structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure. Pond embankments shall be placed in a manner such that they meet the following additional requirements.

(i) Distribution

The distribution of materials throughout each layer shall be essentially uniform and the fill shall be free from lenses, pockets, streaks, or layers of material differing substantially in texture of gradation from the surrounding material.

(ii) Hard Surfaces

If the surface of any layer becomes too hard and/or smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth not less than 750 mm before the next layer is placed.

(ii) Drainage

The top surface of all embankments shall be approximately level during construction except that a crown or cross slope (super elevation) of not less than 2 percent shall be maintained for effective drainage. Though not shown on the drawings, all finish grade embankment to surfaces shall be finished with 2 percent crown or cross-slope as applicable for the site drainage.

(2) Compaction

All engineered fills beneath structures shall be compacted to not less than 95% of maximum dry density including areas 1.5 m outside the structures area. All other engineered fill shall be compacted to not less than 90% of maximum dry density. All fill shall be moistened or aerated to

control the moisture content to within 2% of optimum and then compacted. Uniform moisture distribution shall be obtained by discing, blading, or other approved methods prior to the compaction of the layer. If the top surface of the preceding layer of compacted fill or foundation becomes too dry or wet to permit suitable bond it shall be scarified and moistened by sprinkling or aerated to an acceptable moisture content prior to the placement of the next layer.

(3) *Structural Backfilling*

Excavated or imported material that meets the requirements shall be used for engineered fill material. Backfill shall be compacted by use of tamping or sheepfoot roller or mechanical tamper or other approved methods. Backfill material shall be brought to within 2% of optimum moisture content and shall be compacted in layers of depths compatible with the equipment used. Flooding or jetting shall not be accepted unless approved by the Engineer. Backfill shall be compacted to not less than 90 percent of maximum dry density.

9.1.1.2.7 *Control of Water*

(1) *Drainage Provisions*

Drainage ditches, diversions, and temporary pipes shall be provided as required to maintain drainage off the work areas. Ditches and diversions shall be provided with cross-sectional area at least equal to that of the intercepted watercourses, as approved by the Engineer.

(2) *De-watering*

The Contractor shall perform de-watering as required so that all work of the Contract is installed on dry areas and excavations, including without limitation the construction of structures and underground piping.

(3) *Qualifications*

The Contractor shall be fully qualified to perform the de-watering operations or shall furnish the services of an experienced, qualified, and equipped, de-watering subcontractor to design and operate the de-watering and ground water recharging systems required for the work, all subject to the Engineers' approval.

(4) *Data Available for Examination*

Reports of subsurface investigations made for design purposes will be made available to the Contractor for examination. This data will be made available for information only.

(5) *Monitoring*

The Contractor shall establish at least one ground water level monitoring station at the site which will be observed by the Engineer during the work located as directed by the Engineer and consisting of acceptable shallow open tube piezometers. Also provide up to four settlement gauges at the site at times and locations designated by the Engineer to monitor settlement of new and existing facilities.

(6) Submittal

For record purposes only and not for review or approval, shop drawings and data shall be submitted to the Engineer showing the intended plan for de-watering and recharging operations. Locations and capacities of de-watering wells, well points, pumps, sumps, collection and discharge lines, standby units, water recharge system, water disposal methods, monitoring and settlement measuring equipment, and data collection and dissemination shall be included. These shall be submitted not less than 35 days prior to start of de-watering operations.

(7) Operation

De-watering systems shall be maintained in continuous operation until the involved work is completed, including the placing and compaction of backfill materials in the dry conditions.

(8) Maintenance of Existing Water Table Level

Perform all required operations and continuously maintain the level of the water table outside the de-watered areas, as approved. Maintain a water injection recharging system to replenish the ground water supply as required to maintain the water table, including pumps, piping, well points, standby units, other required equipment, and a source of water sufficient to meet the recharge requirements should supply of water from de-watering operations be interrupted or become inadequate.

(9) Protection of Existing Facilities

Maintain standby equipment of sufficient size and capacity to ensure continuous operation of the de-watering and recharging systems. Where any sloped excavation infringes on or potentially endangers any existing facilities or structures provide shoring, sheeting, and bracing according to plans and calculations signed and stamped by a Structural or Civil Engineer. File a copy of such plans and calculations with the Engineer for record purposes. At his expense, Contractor shall repair and make good all damage or resettlement to the foundation or other portion of any existing facilities or structures and for damage to existing works caused by permanent or temporary failure or operation of the de-watering or recharging systems or by failure to maintain the existing groundwater level outside the de-watered areas.

(10) Disposal of Water

Water shall be disposed properly into a natural water course to the approval of the Engineer. Contractor shall take necessary care not to inject it back to the ground or not to cause any damage to new or existing facilities, or to any adjoining property.

(11) Removal

Equipment brought for construction purposes shall be removed when no longer required. Monitoring and settlement measurement systems shall be maintained in operation until removal is approved by the Engineer. To the extent approved by the Engineer, well points and like items may be abandoned in place.

9.1.1.2.8 *Turfing*

The exterior slopes of all embankments and other locations as indicated on the plans or directed by the Engineer shall receive turfing cut from approved areas of well established grassland bearing non-creeping grass. Turf shall be cut not more than four days before it is required for re-laying and shall be free from weeds. Surfaces to receive turfing shall be levelled and covered evenly with 50 mm of approved soil rich in humus. Each turf shall be not exceeding 300 mm square, cut at least 50 mm thick with a good quantity of the original soil adhering to them. They shall be laid with close joints on the prepared surface secured with two cleft wooden pegs 300 mm long. The surface of the turfing should be smooth without ripples, swells or depressions and should be watered and tendered until well rooted. Joints between adjacent turfs shall be filled flush with humus soil. Any turf which fails to thrive shall be replaced, at the Contractors expense. They should not be laid when heavy rain is expected and should not be cut until two months after laying. The price of turfing shall also include cutting to within 50 mm of ground level at least once every six weeks until the end of the Maintenance Period.

9.1.1.2.9 *Trees and Shrubs*

This work shall consists of clearing, grubbing, removing and disposal of all types and sizes of trees within the designated site area. The Contractor shall establish the limits of clearing and grubbing and designate all trees, shrubs and plants that are to remain and obtain the Engineer's prior approval for the same. In carrying out the work care shall be exercised to ensure that the existing facilities, utilities and services, trees and plants, designated for preservation and also the adjoining property are protected from injury or damage which could result from the Contractor's operations.

All saleable timber as designated by the Engineer shall be neatly stored in an approved accessible place within or near the right of way as directed and shall be trimmed and stacked in accordance with the requirements of the appropriate Government Agency to which the timber belongs or as directed by the Engineer. Unsaleable timber as designated by the Engineer and all stumps, roots, logs and other refuse from the clearing and from the grubbing operations shall be disposed of by burning or other means approved by the Engineer.

All burning shall be done in conformity with the regulations and at such times and in such manner as to prevent the fire from spreading to adjoining area. Contractor shall be responsible for any damage to property, or injury to persons, resulting from such operations. At the end of such operations the working area and the adjoining areas shall be left with a neat and finished appearances free of accumulations of burnt or half burnt material.

9.1.1.2.10 *Finish Grading*

9.1.1.2.10.1 *Description*

Commence top soil spreading after rough grading is completed and accepted by the Engineer. Spreading shall be carried out in conformity with these specifications at locations shown in the drawings or as directed by the Engineer.

9.1.1.2.10.2 *Materials*

Top soil provided shall consist of loose friable natural surface soil free of admixtures of sub-soil, refuse, stumps, roots, rocks, weeds or other material which would be detrimental to proper development of vegetable growth.

9.1.1.2.10.3 *Examination*

- (i) Ensure rough grading has been inspected and accepted before finish grade commences.
- (ii) Report in writing, to the Engineer prior to commencing work, any condition or defects encountered on site, which may adversely affect the performance of the work.
- (iii) Do not commence work until such conditions or defects have been completed. The tolerance allowance does not include filling, cutting, excavation and surplus fill removal for planting areas.
- (iv) Where rough grading and sub-grade have been established under the work of other sections, verify such sub-grade and report to the Engineer in writing any discrepancies before commencement of the work. Include any cutting or filling or any importation or removal. A tolerance of plus or minus 75 mm is acceptable.
- (v) Scarify subgrade to a depth of 75 mm and remove stone 50 mm in a diameter and larger, remove rocks, wood and construction debris.

9.1.1.2.10.4 *Preparation*

- (i) Finish sub-grade eliminating uneven areas and filling low spots. Remove debris subsoil contaminated with oil, gasoline other hazardous materials.

9.1.1.2.10.5 *Spreading of Topsoil*

- (i) Spread topsoil in uniform layers not exceeding 150 mm, dry sub-grade free of standing water.
- (ii) Spread topsoil to finished grade to an accuracy of ± 25 mm.
- (iii) Place topsoil to a minimum 150 mm compacted depth.
- (iv) Place topsoil, eliminating rough and low areas, to ensure positive drainage. Blend finished grades smoothly and evenly with adjacent grades.
- (v) Verify that ditches have adequate slopes and are properly graded to drain and prevent ponding.
- (vi) Fine grade area to a smooth, even, loose - textured surface, free of weeds, roots, debris, and free of stones 50 mm in diameter or larger, and to the Engineer's acceptance.

- (vii) Where not otherwise indicated give uniform slopes between points for which finished grade elevations are shown, or between such points and existing established grade. Round and smooth grades at top and toe of slopes and banks.
- (viii) Maintain proper surface drainage without pockets for depressions. Notify the Engineer in writing if the grades on the Drawing or the grades provided by rough grading will not permit proper drainage.

9.1.1.2.10.6 *Protection*

- (i) Protect finished area and make good damage caused by construction activity.

9.1.1.3 TRENCH EXCAVATION

9.1.1.3.1 *Pipe Trench Excavation - General*

Trench excavation means excavation in all materials of whatever nature encountered for trenches into which pipes are to be laid or pipe appurtenances constructed and the pipe shall mean pipe of all kinds and for whatever purposes.

9.1.1.3.2 *Trench Alignment and Grade*

Before starting excavation in any road the Contractor shall have obtained the approval of the Engineer and the relevant Road Authority for his detailed work programme for the trench excavation in roads at least 21 days ahead of the particular work. This programme shall contain the names of the roads and chainages to be excavated, date of commencement and planned completion date of backfilling, planned dates of completion of temporary reinstatement, and the dates of handing over to the relevant Road Authority. No excavation shall be permitted unless the Contractor shall have obtained approval of the said programme as aforesaid and can demonstrate that all necessary pipes fittings materials and plant are available on site for the speedy completion of all the work.

(1) Construction Alignment and Grade

The line and level of trenches shall be as shown on the Drawings or as determined from the Drawings or as may be directed by the Engineer. Before commencing trench excavations, the route of the trench shall be pegged out accurately and the natural ground levels shall be agreed with the Engineer. Strong sight rails shall then be fixed and maintained at each change of gradient, and at as many intermediate points as may be necessary. On these rails shall be marked the centre line and the level to which the excavation is to be carried out, such rails being not more than 50 m. apart and at changes of direction and grade.

(2) Changes in Line and Grade

In the event obstructions not shown on the plans are encountered during the progress of the work which will require alternations to the plans, the Engineer shall have the authority to change the plans and order the necessary deviation from the line and/or grade. The Contractor shall not make any deviation from the specified line and/ or grade without approval by the Engineer. Should any deviations in line and/or grade be permitted by the Engineer in order to reduce the amount of rock excavation or for other similar convenience to the Contractor, any additional costs for thrust blocks, valves, air and vacuum assemblies, blow-off assemblies, extra pipe footage, manholes or other appurtenances shall be borne by the Contractor. The Contractor shall include in his unit rates in the

Tender provision to cover any deviation from the invert grade shown on the plans to facilitate extra depth required to eliminate possible conflicts between culverts and other utilities.

(3) Trench Widths

Trench excavation shall be carried to such lines, dimensions and depths as shown in the drawings. Trench width shall be as required for proper assembly and inspection of joints. Unless the Engineer permits, minimum trench width shall be 300 mm plus the outside diameter of the pipe, maximum trench width shall be not greater than 500 mm plus the outside diameter of the pipe.

Nominal trench width shall be as indicated in the drawings. Trenches shall have vertical sides or battered trench as specified herein unless otherwise authorised by the Engineer.

Notwithstanding the foregoing, any rock in trench excavation 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 concrete protection of the pipe. Similar clearance shall be allowed for depressions for pipe sockets, flanges, couplings, valves and the like below these installations.

(4) Excavation for structures such as thrust blocks, valve chambers etc. shall be allowed 800mm working space for purposes of establishing Contractor's liability for permanent reinstatement costs.

(5) Excavated Materials

Materials excavated from the trenches may be used as backfill provided it meets the requirements specified here in for backfill material. Surplus materials from excavations shall be removed and disposed of by the Contractor as required by the Engineer and as specified. The trench shall be dug only so far in advance of pipe laying as the Engineer shall permit.

9.1.1.3.3 Trial Holes

Trial holes shall be excavated well ahead of the trench excavation to such depths as necessary to determine and confirm the alignment for the trench. Trial holes may also be required by the Contractor to determine the position of underground services, sub-soil drains or for any other reason.

The Contractor shall obtain all necessary permissions from the Authorities for the excavation of trial holes.

The Contractor shall arrange the refilling and reinstatement of trial holes to be carried out immediately after the required information is obtained. The reinstatement of the surfaces of trial holes shall be carried out to the approval of the Engineer and the Roads Reinstatements Authorities.

9.1.1.3.4 Trench Excavation in Roads

When excavating trenches along the public roads, the Contractor shall comply with the requirements and conditions of the relevant road maintenance authority having jurisdiction over the particular road, viz. the Road Development Authority, the Provincial Road Development Authority and Municipal Councils, or the Pradeshiya Sabhas (i.e. Local Authorities - for minor roads).

All trench excavation and other work carried out within the limits of any public road shall be completed as rapidly as possible and the Contractor shall make every effort to ensure that no more than half of the width of the carriageway shall be obstructed at one time. Road drains and curbs shall be kept free from obstruction. The Engineer may direct that trench excavation in highways shall be located in footpaths or in verges rather than in the carriageway. If that is the case, 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. In any event the Contractor shall take special precautions, which shall include the continuous support of the sides of the excavation, from the time when excavation is begun until the refilling of the trench is completed, to ensure that there is no disturbance of the adjacent road or road foundation. Where excavated material has temporarily been deposited on an adjacent surface, the surface shall on completion of refilling be restored entirely to its original condition and left free of loose stones.

(1) Excavation in carriageway

The excavation of trenches in roads shall be in the shoulders as far as possible. However when excavations are needed within the carriageway, the Contractor shall take all the necessary care to minimise the area of damage to the road surface. Before starting excavation, the Contractor shall use asphalt cutting apparatus comprising a diamond disc or similar, to cut the surface of the carriageway along the intended line of excavation.

(2) Security requirements

The Contractor shall inform the relevant local police station regarding the excavation in a public road at least three (3) days prior to the commencement.

(3) Safety precautions

The Contractor shall erect and continuously maintain road signs and adequate lighting through out the night ahead of the either end of excavation of trenches, warning about the excavation, until the temporary reinstatement is completed. The road signs should be written in red luminous paint on white background so that they are visible at night to the vehicle drivers.

Adequate protection shall be provided along the trench excavation to the approval of the Engineer. The excavated material shall not be deposited so that it will obstruct the movement of vehicles or the pedestrians. If the Engineer or the Road Authority directs so, Contractor shall remove the excavated material and store it elsewhere, until it is used for backfilling, at his own cost.

The Contractor shall maintain warning lights and luminous barricades throughout the night at the road crossings until it is temporarily reinstated, or at the trench excavations if it has to be kept open overnight, or at any other road excavation as directed by the Engineer.

The Contractor shall supply any reasonable materials and/or manpower necessary to maintain a smooth traffic flow as required and as directed by the Engineer.

(4) Road Closure

The roads under the purview of the respective authorities will not allow to complete closure for the traffic. The Contractor shall make every effort to avoid complete closure of other roads for the traffic due to the construction activities.

In any event that road closure is unavoidable, the Contractor shall obtain the approval of the Engineer to that effect, furnishing all the details of the work. Contractor shall also obtain the

permission from the road maintenance authority, public transport authorities, the local police station and any other relevant authority, and shall abide by their requirements. The Contractor shall allow in his work programme for any delays which may arise in obtaining such permissions.

9.1.1.3.5 *Trench Excavation in Surfaces Other than Roads*

Trench excavation in surfaces other than roads shall include all surfaces except those asphalt surfaces which require road reinstatement. These surfaces include but are not limited to play grounds, paddy fields, pasture land and the like, footpaths, verges, non-asphalt roads, lanes, alleys, bund embankment and all public and private lands.

Trench excavation near public places shall, if the Engineer so requires, have temporary fencing erected around that length. Temporary fencing shall not normally be removed until the trench excavation has been refilled and reinstated. The Contractor is hereby notified that generally pipe alignments not in roads are covered with a vegetation growth which must be removed and disposed off the site of work. The Contractor shall have particular regard to the safety of livestock which may be in the area, and shall ensure that all livestock which may be in the area, and shall ensure that all open excavations, access routes and steep or loose slopes arising from the Contractor's operations are adequately fenced and protected. After the erection of temporary fencing where required, the Contractor shall remove top soil to such depth and over such area as may be necessary to provide sufficient material to ensure adequate surface reinstatement of the working areas occupied by the Contractor for construction of the pipeline.

9.1.1.3.6 *Temporary Buildings*

Temporary building sites (squatters) may also occupy pipeline rights-of-way. The Employer will remove the occupants and the Contractor may demolish the buildings as directed by the Engineer. The Employer, under the laws of Sri Lanka, is not required to obtain easements or be liable for loss of business for construction of water pipelines and appurtenances. However, the Contractor is required to limit the damage to any existing improvement and to make full compensation for any damage done as a result of the construction activities.

9.1.1.3.7 *Bedding Types and Special Protection*

The Contractor shall adopt the special bedding type as specified in the relevant type drawing where appropriate. When ground conditions requiring the use of special bedding types are encountered, the Contractor shall inform the Engineer, and with his approval, adopt the proper bedding type. The chainages indicated in the longitudinal sectional drawings for special bedding types, are only for guidance. Decision of the Engineer in this regard shall be final.

When the minimum specified cover to the pipe line from the surface cannot be maintained due to some special reason, the Contractor shall adopt the special protection type using concrete pre-cast slabs as specified in the relevant type drawing and as instructed by the Engineer.

9.1.1.3.8 *Supporting Trench Excavation*

The Contractor shall effectively support the sides of all trench excavations which shall include the use of 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 structures adjacent to the excavation. The Contractor shall be deemed to have made his own allowance for

shoring up the sides of trenches, any extra excavation necessary to provide space for such support and for any other working space. If for any reason any portion of trench excavation shall give away, the Contractor shall at his own expense take all necessary remedial measures including the excavation and removal of all the ground thereby disturbed.

9.1.1.3.9 *Trimming Trench Excavation*

When excavating to specified levels for trench excavation or to specified limits for the face of any structure therein required to abut undisturbed ground, the Contractor shall not excavate the last 150 mm until 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 constructional work he shall where required by the Engineer excavate further so as to remove not less than 150 mm and any such further excavation and additional foundation material ordered by the Engineer shall be at the cost of the Contractor. The bottom of trench excavations shall be carefully boned in and trimmed true to grade with the aid of a straight edge at least 6m long so as to ensure a continuous support for the pipes. Any stones or flints either likely to cause the pipe to bed unevenly or to damage the pipe and its coating of greater than 25 mm in size shall be picked out of the trench bottom and any holes so formed shall be filled in with soft material and trimmed to the correct level. All shattered and loose material shall be removed from the bottom of the trench excavations so that the bedding material rests on a solid and clean foundation.

9.1.1.3.10 *Inspection by Engineer*

When the specified levels of trench excavation are reached the Engineer will inspect the ground exposed and if he considers that any part of the ground is by its nature unsuitable, he may direct the Contractor to excavate further and to refill the further excavation with such materials as he may direct. Should the bottom of any trench excavation while acceptable to the Engineer at the time of the inspection subsequently become unacceptable due to exposure to weather conditions or due to flooding or have become puddle, soft or loose during the progress of the works, the Contractor shall remove such damaged, softened or loosened material and excavate further by hand. In this case the cost of the extra excavation and of the additional foundation materials required will be the Contractor's responsibility.

9.1.1.3.11 *Disposing Material from Trench Excavation*

Subject to any specific requirements of the Contract, the Contractor shall make his own arrangements for the temporary storage of any excavated material which is required for use in refilling trench excavations, including any necessary double handling. In this connection the Contractor shall have regard to the working areas available to him for the construction of the pipeline particularly where this is located in roads or in other places to which the public has free access. Any temporary tips alongside the trench excavations shall be to stable slopes and heights. Where the nature of the excavated materials is suitable, the Contractor's temporary storage as aforesaid shall include for separate storage as the Engineer may direct of any of the various grades of material hereinafter specified for the refilling and surface reinstatement of trench excavation, namely, soft material, coarse material, hard material and topsoil. Any excavated material not required for or not suitable for use as refilling as aforesaid or use elsewhere in the Works shall become the property of the Contractor and he shall be entirely responsible for its removal from the Site and for its ultimate disposal. Contractors are reminded that when working along the carriageways it is often not possible to stack or place excavated materials along the trench and they may be required to remove such materials required for backfill to temporary sites to be provided by the Contractor and to return these materials on completion of pipe laying.

9.1.1.3.12 *Trenches not to be Left Open*

Trench excavation shall be carried out expeditiously and, subject to any specific requirements of the Contract, the refilling and surface reinstatement of trench excavations shall be commenced and completed as soon as reasonably practicable after the pipes have been laid and jointed. Pipe laying shall follow closely upon the progress of trench excavation, and the Contractor shall not permit more than 20 m of trench excavation ahead of pipe laying to remain open. The Contractor shall take precautions to prevent floatation of pipes in locations where open trench excavations may become flooded, and these precautions may include the partial refilling of the trench. If the Engineer considers that the Contractor is not complying with any of the foregoing requirements he may prohibit further trench excavation until he is satisfied with the progress of laying and testing of pipes and refilling of trench excavation. The Contractor shall not excavate trenches in more than one location in any one road at a given time without the Engineer's permission.

9.1.1.3.13 *Control of Water*

All excavation and placement of backfill and fill shall be carried out in the dry. The Contractor shall furnish, install and operate all necessary machinery, appliances and equipment to keep excavations free from water during construction, and shall dewater and dispose of the water so as not to cause injury to public or private property, or to cause a nuisance or a menace to the public. He shall at all times have on hand sufficient pumping equipment and machinery in good working condition for all ordinary emergencies, including power outage, and shall have available at all times competent workmen for the operation of the pumping equipment. During excavation, construction of pits, etc., installation of pipelines and fittings, placing of structure and trench backfill and the placing and setting of concrete, excavations shall be kept free of water. The Contractor shall control surface runoff so as to prevent entry or collection of water in excavations. The static water level shall be drawn down a minimum of one foot below the bottom of the excavation so as to maintain the undisturbed state of the foundations soils and allow the placement of any fill or backfill. The dewatering system shall be installed and operated so that the ground water level outside the excavation is not reduced to the extent that would damage or endanger adjacent structure or property.

(1) Submittals

The method, installation and details of the dewatering systems the Contractor proposes to use shall be submitted for approval of the Engineer before dewatering starts.

(2) Release of Groundwater

The release of ground water to its 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 flotation or movement of structures, pipelines and sewers.

9.1.1.3.14 *Backfilling Trench Excavations*

Trench excavations shall normally be refilled using suitable materials selected from the excavation. Soft material free from stones greater than 25 mm size shall be deposited in 150 mm layers from top of bedding to a depth not less than 300 mm from the crown of the pipe, and thoroughly rammed with suitably shaped rammers working alternately on either side of the pipe (particular care being taken to avoid damage to the pipe and any sheathing and the alignment). The remainder of the refilling may consist of coarse material (including broken rock from excavation in rock) free from boulders and clods of earth larger than 150 mm in size provided that the compacted

backfill is, in the opinion of the Engineer, sufficiently dense to prevent material from the superimposed layers being washed into the voids in such backfill. This coarse material shall be spread in layers of not greater depth than 200 mm and be thoroughly rammed by an approved mechanical rammer. The coarse filling is to be carried up to the surface level existing before the commencement of the Works (in roads and footpaths) or (elsewhere) to such level as with the surface reinstatement of the whole of the topsoil will leave the finished work sufficiently "proud" to allow for future settlement to the original ground level. Hard material such as broken rock and original road metalling shall normally be used only for the temporary reinstatement of road surfaces, but where it is suitable and available in sufficient quantity, it may be used in place of or as well as the aforesaid coarse material.

(1) Compaction

Where necessary, the Contractor shall adjust the moisture content of the refill material either by drying out or by adding water to assist the compaction of the materials. During the compaction, the backfill shall have a uniform moisture content equal to or a little above the optimum moisture content recorded in the Compaction Test. Backfill shall be compacted to a dry density of not less than 95% of the Laboratory Modified Proctor Density when tested in accordance with these specifications. The Contractor shall carry out a minimum of one compaction test each working day that back filling is taking place. The Contractor is advised to use clean river sand or other clean granular material approved by the Engineer to obtain the required compaction in the presence of wet conditions, if the excavated materials or selected backfill materials cannot be compacted and the compaction work is held up.

The Contractor is advised to consider the cost of such materials in his rates. Sand backfilling shall only be laid on level areas and the sand water jetted to consolidate completely. When sand or clean granular materials are used, they shall be protected from washing away by capping with 150 mm of lateritic soil with proper moisture content compacted to 95 %.

(2) Softened or Segregated Material

Should the material being placed as backfill, while acceptable at the time when approved, become unacceptable to the Engineer due to exposure to weather conditions or due to flooding or have become puddled, soft or segregated during the progress of works, the Contractor shall at his own expense remove such softened or segregated material and replace it with fresh approved material. 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. On no account shall any excavated material be dozed back when refilling trenches in roads and no backfilling shall be carried out unless in the opinion of the Engineer, sufficient mechanical rammers are in operation on that portion of the work.

9.1.1.3.15 Borrow Material - Special Measures

Where in the opinion of the Engineer sufficient supplies of the aforesaid material for trench refilling cannot reasonably be obtained from excavations the Engineer may order the Contractor to excavate suitable material from borrow areas and transport it to the length of trench to be backfilled, and the Contractor shall do any or all of these things as directed. No extra payment will be made to the Contractor for this work. In special circumstances, the Engineer shall direct the Contractor to refill trenches with concrete.

9.1.1.3.16 Surface Reinstatement in Asphalt Roads & Tar Macadam Roads

(1) Temporary reinstatement

At all major road carriageways and road crossings, the Contractor will be instructed to provide special temporary reinstatement as directed by the Engineer to the following specifications :

In all road carriageways backfilling and compacting trenches excavated shall be as per clause 9.1.1.3.14 up to 150 mm from the surface. Thereafter the top 150 mm of the trench shall be reinstated with aggregate base course (ABC) to the under-mentioned specification and then compacted using rammer compactor or equivalent.

In road crossings, all material excavated shall be disposed of as directed by the Engineer and the trenches shall be backfilled with sand and consolidate with water up to 150 mm from the surface. The top 150 mm of the trench shall be reinstated as mentioned above.

The surface of the compacted material shall be sprayed with a primer coat of bitumen MC-30 at a rate of 1 litre/sq.metre and shall be dressed with 6 mm chipping in one layer.

B.S.Seive Size	Percentage passing by weight
40 mm	100
20 mm	60 - 80
10 mm	40 - 60
5 mm	25 - 40
2.36 mm (No.7)	15 - 30
600 micron (No.25)	8 - 22
75 micron (No.200)	5 - 12

Kerbs, channels, edgings and quadrants disturbed by the Works shall be re-laid with existing units, providing they are not damaged to the satisfaction of the Engineer.

The frames of all manholes and surface boxes shall be reinstated by bedding and haunching. Surface boxes are to seat in the recess of a appropriate precast concrete section. Frame tops shall be flush with the adjoining surface on all sides.

(2) Permanent Surface Reinstatement

Permanent Surface reinstatement of backfilled trench excavations in asphalt roads will be carried out by the relevant Permanent Road Reinstatement Authority for each category of roads.

A joint site inspection shall be held by representatives of the Contractor, the Reinstatement Authority, and the Engineer prior to the commencement of Trench excavation to agree and record the existing conditions, necessary traffic diversions etc.

The Contractor shall take care to minimise damage. Any additional over break or damage over and above the specified maximum width due to his plant or operations will be to his cost, calculated at the rates agreed by the Engineer with the Reinstatement agency and payable by the Contractor to the Reinstatement Authority.

9.1.1.3.17 *Reinstatement of other Surfaces*

This section covers reinstatement of all surfaces other than those included in Clause 9.1.1.3.17 (asphalt roads). All non-asphalt roads and all other surfaces shall be restored to their original condition by the Contractor. After he has refilled all trench excavations on the site in the manner and to the level specified the Contractor shall replace all topsoil or other original surface material previously removed and it shall be evenly distributed and levelled over the full extent of the stripped area.

9.1.1.3.18 *Appurtenant Structures in the Pipeline*

The Contractor shall carry out further excavation as may be necessary to accommodate cast in situ or pre-cast chambers and thrust blocks etc. Such excavation shall include for disposal of surplus material and, where appropriate, for backfilling around the structures.

9.1.1.3.19 *Backfill Adjacent to Structures*

Backfill materials adjacent to structures shall be placed in such a manner as will ensure that they can be satisfactorily compacted without damage to the structures. Compaction adjacent to all structures shall be carried out by hand or by suitable hand operated plant. No compaction is permitted adjacent to concrete for fourteen days following placing the concrete.

9.1.1.3.20 *Land Drains*

When land drains, culverts, or field drains are severed by trench excavation they shall be kept in effective temporary operation during construction of the pipeline. At the appropriate state of refilling the trench excavation the drains shall be permanently restored to the satisfaction of the Engineer.

9.1.1.3.21 *Existing Services*

Where trench excavation is carried out close to or across the line of sewers, pipes, cables and other services the Contractor shall where necessary provide temporary supports or slings and where such sewer, pipe, cable or other service is temporarily disturbed it shall be replaced, where in the opinion of the Engineer, construction of the pipeline cannot reasonably be carried out unless the sewer, pipe or other service is permanently severed or permanently diverted or permanently supported by concrete he shall order the Contractor to undertake such work. The Contractor's attention is drawn to Clause 36 of the General Conditions of Contract..

9.1.1.3.22 *Restoring Existing Improvements*

All roads, other public and private property subject to excavation or damage and any damage in adjoining property caused by construction operations, shall be restored or repaired by the Contractor to a condition equal to that which existed prior to commencement.

9.1.1.3.23 *Slope Protection*

This work shall consist of preparing slopes, and incorporate turfing, rip rap or other suitable and approved material on the areas designated by the Engineer and as specified herein.

(1) Fill Slopes

Fill slope shall be covered with Turfing as specified in Clause 9.1.1.2.8. of this specification.

(2) Other Areas

Other area as called out on the plans to be covered with turfing shall be broken up to a depth of 300 mm and then the top 150 mm further cultivated until all lumps are broken up., Rocks brought to the surface (larger than 70 mm in greatest dimension) shall be removed and disposed of by the Contractor.

(3) Trenches

Trenches which have slopes of 15 to 30 percent longitudinally, as shown on the plans or as determined by the Engineer, shall be cultivated the full trench width plus 600 mm to a depth of 150 mm. Cross-trench diversion walls or ditches shall be constructed by the Contractor on all trenches with slopes of ten percent or greater longitudinally, at a maximum distance of 30 m apart.

Trenches with slopes of greater than 15 percent longitudinally and all fills, as well as other areas designated on the plans or by the Engineer shall be covered uniformly with turfing as specified in Clause 9.1.1.2.8 in this specification. In addition for trenches with slopes greater than 35 percent, cut off walls as shown on the drawings are to be constructed.

9.1.1.3.24 Shoring System (Planking and Strutting)

9.1.1.3.24.1 Description

Excavation with vertical sides shall be kept supported by planking and strutting which shall be "Close" or "Open" depending on the nature of the soil and the depth of trench excavated. The support required shall generally conform to section 10 of BS CP 2003.

Support for trench excavation along a public road shall be of adequate design and to the satisfaction of the Roads Development Authority.

9.1.1.3.24.2 Close Planking and Structure

Close planking and strutting shall completely cover the sides of the trench, generally with short, upright members called "poling boards". These shall be 250 mm x 38 mm in section or as directed by the Engineer. The board shall generally be placed in position vertically in parts, one board on each side of the cutting.

These shall be kept apart by a horizontal walings of strong wood at a minimum spacing of 1200 mm cross struttled as approved by the Engineer. The length and girth of the struts shall depend on the width of the trench.

Where the soil is very soft and loose, the boards shall be placed horizontally against the sides of the excavation and supported by vertical "walings" which shall be struttled to similar timber pieces on the opposite face of the trench.

The lowest boards supporting the sides shall be taken into the ground for a minimum depth of 75 mm. No portion of the vertical side of the trench shall remain exposed.

The withdrawal of the timber members shall be done very carefully to prevent collapse of the trench. It shall be started at one end and proceeded systematically to the other end. Concrete or masonry shall not be damaged while removing the planks. No claim from the Contractor shall be entertained, for any timber which cannot be withdrawn, or is lost or buried, unless such timber has been left permanently in position at the request of the Engineer.

Open Planking and strutting

In case of open planking and strutting, the entire side surface of the trench is not required to be covered. The vertical boards of 250 mm x 38 mm shall be spaced sufficiently apart to leave unsupported strips of about 500 mm average width. The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the Engineer. In all other respects open planking and strutting shall comply with Sub –Clause 9.1.1.3.24.2 for close planking and strutting.

9.1.1.4 GEOTEXTILES

Geotextiles shall be used for bedding types for pipes where it is specified.

The geotextile shall be wholly and is tropic fibrous material. It shall have properties not inferior to those demonstrated by Terram 1000 Manufactured by ICI fibres, UK and as listed below.

<u>Property</u>	<u>Tested Method</u>	<u>Value*</u>	<u>Unit</u>
Tensile strength (wet and dry) Under uniform applied stress		7,500	N/m
Grab tensile strength	ASTM 1682 100 m	660	N
Trapezoidal tear strength	ASTM 117	300	N
CBR Puncture Resistance	DIN 54307E	1,600	N
Burst Strength	ASTM 3786	1,400	kPa
Pore Size	-	>0.03	mm
	-	<0.10	mm
Permeability to water Under 100 mm head	-	50	L/m ² /sec

* Value = Minimum average value with individual values not more than 10% below the minimum average

The material shall not be susceptible to bacteria attack and shall be resistant to alkalis and acids with pH greater than 3. The Contractor shall lay the geo-textile material with overlaps of 500 mm at joints, and where necessary it shall be pegged.

9.1.1.5 ROAD CONSTRUCTION

9.1.1.5.1 *Extent of Work*

The road construction to be executed under the Contract consists of access to the sites and the internal roads. The extent of the roads are detailed in the Drawings.

9.1.1.5.2 *Sub-surface construction to be Completed*

Before the commencement of construction, all pipelines, drains, sewers and services ducts, chambers, etc. below formation level under the roads and other paved areas, footpaths and walkways shall be completed and approved by the Engineer.

9.1.1.5.3 *Preparation of Formation*

The formation to roads and footpaths ways shall be well cleaned, free from mud and slurry and properly shaped and compacted with the use of an approved roller to an even and uniform surface as shown on the Drawings. If ordered by the Engineer the formation shall be covered by the sub-base immediately it is ready and approved. Any extra excavation for removal of soft spots ordered by the Engineer shall be deemed to be included in the Contractor's rates for road construction. Once the formation has been prepared, constructional traffic shall not be allowed to run thereon without the permission of the Engineer.

9.1.1.5.4 *Use of Surface by Constructional Plant*

Constructional traffic used on pavements under construction shall be suitable in relation to the thickness of the courses it traverses so that damage is not caused to the sub-grade or the material already constructed. The wheels or tracks of plant moving over the various pavement courses shall be kept free from deleterious materials.

9.1.1.5.5 *Pavement Thickness*

Before construction of the pavement, California Bearing Ratio tests shall be carried out on samples of sub-grade material and on the prepared sub-grade by the Contractor. The Engineer may order variations in the thickness of the road base shown in the Drawings, based on the results thus obtained.

9.1.1.5.6 *Surface Level of Pavement Courses*

The levels of pavement courses shall be determined from the true pavement surface, which shall be the surface of the wearing course, calculated from the carriageway vertical profile and crossfalls as shown on the Drawings.

9.1.1.5.7 Sub-Base

On the approved formation, a sub-base consisting of a sand blanket shall be spread over the full width of the area to be paved and compacted to a finished thickness of 100 mm (minimum). The compaction shall be by means of either an 8 ton power driven roller or a vibratory roller having a weight exceeding 3 tons, until a state of compaction of at least 90% dry density is achieved.

9.1.1.5.8 Base

A base of crusher run rock fill graded from 3mm x to 40mm shall be spread over the centre width of the area to be paved and compacted to a finished thickness of 225mm minimum. Rolling shall then be carried out with a 8 ton power driven roller and any depression or surface irregularities which may occur during rolling shall be corrected. The whole surface, after approval, shall then be blinded with approved material, watered if need be and rolling continued until movement of the surface ceases under the action of rolling. The finished thickness of the base shall be a minimum of 225mm and the surface parallel to the finished surface of the road.

9.1.1.5.9 Rolled Asphalt Surfacing

The surfacing shall be two course (regulatory and wearing) hot rolled asphalt with a stone content of 40% complying with the requirements of B.S. 594:1992. The mix shall be suitable for local climatic conditions and be approved by the Engineer. The surfacing shall be able to withstand the movement and turning of heavy vehicular traffic without damage or distortion.

9.1.1.5.10 Regulatory Course

Before the regulatory course can be laid the surface of the road base shall be thoroughly cleaned and dried and shall be kept free from any loose or otherwise surplus material. Adherent patches of foreign material shall be removed from the surface by the use of a scraper or other suitable method. All waste material shall be removed from the site. After the surface has been thoroughly cleaned and dried and immediately prior to the spreading of the asphalt regulatory course a prime coat of emulsified bitumen to MC 30 or CSS1 shall be applied at a rate of 5 litres per 11 sq.metres. The regulatory course shall then be laid and compacted with at least 4 passes of an 8 ton power driven roller to a finished thickness of 50 mm and a surface parallel to the final surface. Immediately after completing the base course the surface shall be spread with fine screenings and re-rolled to form a temporary surface during the construction period.

9.1.1.5.11 Wearing Course

The top coat of asphalt shall have a minimum compacted thickness of 30mm. It shall not be laid until approved by the Engineer. Before the top coat is laid all kerbs shall be laid to the required lines and levels and all gully and manhole covers shall be correctly levelled so as to be flush with the finished surface of the road. The surface of the base course shall be cleaned free of mud, dirt and loose stones and all damage and depressions made good. Immediately prior to the spreading of the wearing course a tack coat of emulsified bitumen to BS 434 (CRS 1) shall be applied to the base course at a rate of 5 litres per 11 sq.metres.

9.1.1.5.12 *Compaction and Surface Finish*

As soon as rolling can be effected without causing undue displacement of the mixed material, and while the mixed material has a temperature of at least 175° F it shall be uniformly compacted by at least 4 passes of an 8 -10 ton roller having width of roll not less than 600mm. The material shall be rolled in longitudinal direction from the sides to the centre of the carriageway, overlapping on successive passes by at least a half width of the rear roll. Rollers shall not stand on newly laid material while there is a risk that the material will be deformed thereby. Rolling shall proceed at a sufficiently slow speed so as to avoid pushing or showing of the asphalt carpet. Areas of asphalt surfacing around manhole and gully covers etc. shall be finished by 11.35 kg (min) newly compacted asphalt until approved by the Engineer. The surface after final rolling shall be tested with a 3 metre straight edge (placed parallel to the centre line of the carriageway) and shall show no depression greater than 6 mm The levels shall not deviate from those specified by more than ± 6 mm.

9.1.1.5.13 *Scarifying Existing Surface and Jointing*

Where a new pavement abuts on to an existing pavement and the Engineer so directs, the surface of the latter shall be scarified, adjusted and reshaped to conform with new cambers or crossfalls. Materials from the existing road shall be used or disposed of as directed by the Engineer. All joints, both longitudinal and transverse shall be cut back square immediately prior to laying or further asphalt in contact with such joints, in order to ensure proper bond. The joint surface shall be given one coat of bitumen emulsion.

9.1.1.5.14 *Sampling and Testing*

Samples of asphalt mixes shall be taken as, when and where considered necessary by the Engineer, and testing shall, as far as practicable, be in accordance with BS 598:1996. The Contractor is to allow in his rates for the cost of all such tests. Where the test results prove the mix to be unsatisfactory, the Engineer may condemn all the asphalt represented by the unsatisfactory samples and all the rejected asphalt will be removed and replaced by the Contractor at his own expense.

9.1.1.5.15 *Costs to be included in Rates*

The cost of the California bearing Ratio tests and sampling and testing on any other materials to be used in the road construction shall be deemed to be included in the Contractor's rates for the road works. Where the test results prove any materials to be unsatisfactory, all such materials shall be removed and replaced at the Contractor's own expense.

9.1.1.6 CLASSIFICATION OF ROCK EXCAVATION

The Engineer's decision on the classification of excavated material shall be final. Rock excavation shall be based on the following guidelines :

"Rock" shall include all material which, in the opinion of the Engineer, requires blasting or the use of metal wedge hammers or the use of compressed air drilling for its removal and cannot be extracted by ripping with a tractor of at least 180 hp and rear mounted heavy duty ripper. Individual boulders greater than 2 cubic metres in volume shall be included when their nature and size are such that they cannot be removed without recourse to one of these methods.

In case of any doubt, the Engineer shall base his decision on the following criteria:

ROCK	
Typical Material	: Basalts Phonolytes and trachytes (Black trap), and hard crystal welded tuffs - ignimbrite.
Unconfined Crushing Strength	: Greater than 4kN/ Sq.m. (4 N/sq.cm)
Hammer Blow	: Solid from ringing to dully.
Pliers Crushing	: Not possible or causes grain fractures only.
50 mm diameter Core in Hand	: Cannot break 500 mm long piece.
Soaked in Water for one hour	: No change.

The breaking of concrete or road surface or road base will not be considered or paid for as rock excavation.

Decomposed rock, altered rock, agglomerates, tuffs and hard consolidated bound murrum (hardpan) will not be considered as rock.

The Engineer's decisions to the necessity or otherwise of rock excavating methods or appliances shall be final.

Notwithstanding the above, laterite (local name Kabook) shall not be considered as rock and no extra payment will be allowed for its removal

9.1.1.7 RUBBLE PITCHING CONSTRUCTION

Rubble pitching construction for protection of bed of culverts, earth slopes of culverts, ramps of causeways from erosion, etc. shall consist of quarried rock bonded together with cement-sand mortar of specified mix proportion, constructed as a lining of specified minimum thickness shown on the Drawings or as directed by the Engineer.

The surfaces of the earthwork to be protected with rubble pitching shall be first finished to the prescribed slopes, any weathering, runnels etc. being backfilled with approved material similar to the in-place soils. The surfaces so prepared shall be moistened with water, if required, and tamped or rolled to the satisfaction of the Engineer.

The materials and mortar for rubble pitching shall conform to the requirements elsewhere in this specification. Stones for pitching shall be flat bottom and not less than 150 mm in any part and 225 mm wide. The average thickness of individual stones may vary between 150 mm 225 mm, the percentage of smallest stones shall not be more than 25 percent.

The stones shall be laid and hammered down on the prepared surfaces of the earthwork, approximately plane but not smooth. The stones shall be hand-packed in such a manner that joints between stones can be completely filled with cement-sand mortar. Stones with overhanging joints shall not be allowed. The sides and top and bottom edges shall be left as wedges. The 'Bushings' or protuberances of stones shall not project more than 15 mm from the slopes of the joints. The rubble pitching shall be finished to the prescribed slopes, the permissible tolerance being 25 mm in a length of 3 m. The finished surface of the pitching shall be planes without depressions or protuberances.

9.1.1.8 CHAIN LINK FENCES AND GATES

9.1.1.8.1 General

This section specifies requirements for providing and installing fences and gates.

9.1.1.8.2 Materials

- (i) Chain-link fence fabric: steel fabric vinyl coated, height of wire, 2400 mm, 50 mm mesh, 3.8 mm, knuckled bottom, twisted top selvage.
- (ii) Posts, rails and braces: vinyl coated galvanized steel, ASTM A53, diameter of posts and dimensions of rails & braces as per drawing.
- (iii) Bottom tension wire: single strand, vinyl coated, galvanized steel wire, 5 mm diameter.
- (iv) Tie wire fasteners: single strand, vinyl coated, galvanized steel wire conforming to requirements of fence fabric, 5 mm diameter.
- (v) Tension bar: 5 x 20 mm, vinyl coated galvanized steel.
- (vi) Tension bar bands: 3 x20 mm vinyl coated galvanized steel.
- (vii) Gate frames: ASTM A53, vinyl coated galvanized steel pipe, diameter of pipe for outside frame out and diameter of interior bracing as per drawings.
 - 1. Fabricate gates as indicated with electrically welded joints, and hot dip galvanized after welding.
 - 2. Fasten fence to gate with twisted selvage at top.
 - 3. Furnish gates with galvanized malleable iron hinges, latch and latch catch with provision for padlock which can be attached and operated from either side of installed gate. Hinges shall allow gates to open in both directions (i.e. inwards and outwards).
 - 4. Furnish double gates with chain hook to hold gates open and centre with drop bolt for closed position.
- (viii) Barbed wire: 2 mm diameter galvanized steel wire to ASTM A121, 4 point barbs 125 mm spacing.
- (ix) Fittings & locks: should be of good quality approved by the Engineer.

9.1.1.8.3 Erection

- (i) Install new gates after final grading has been completed along lines as indicated on drawings.

- (ii) Set all posts plumb in grade 20(20) concrete to a depth of 1200 mm with width 300 mm diameter for line posts and 450 mm diameter for corner posts and gate posts.
- (iii) Space line posts 3000 mm apart, measured parallel to ground surface.
- (iv) Install straining posts at sharp changes in grade and where directed by Engineer.
- (v) Install corner posts where change in alignment exceeds 20°.
- (vi) Install end posts at end of fence and buildings. Install gate posts on both sides of gate openings.
- (vii) Do not install fence fabric until concrete has cured a minimum of 5 days.
- (viii) Install brace between end and gate posts and nearest line post, placed in centre of panel and parallel to ground surface. Install braces on both sides of corner and straining posts in similar manner.
- (ix) Install top rail between posts and fasten securely to posts with waterproof caps and overhang tops.
- (x) Install bottom tension wire, stretch tightly and fasten securely to end, corner, gate and straining posts with turnbuckles and tension bar bands.
- (xi) Lay out fence fabric. Stretch tightly to tension recommended by manufacturer and fasten to end, corner, gate and straining posts with tension bar secured to post with tension bar bands spaced at 300 mm intervals. Knuckled selvedge on bottom. Twisted selvedge on top.
- (xii) Secure fabric to top rails, line posts and bottom tension wire with tie wires at 450 mm intervals. Give tie wires minimum two twists.
- (xiii) Install barbed wire strands and clip securely to lugs of each bracket.

9.1.1.8.4 Replacement or Touch Up

- (i) Replace all materials where the vinyl coating is damaged so that the metal surface is exposed.
- (ii) Repair damaged galvanized surfaces. Clean damaged surfaces with wire brush removing loose and cracked spelter coatings. Apply two coats of approved zinc rich paints to damaged areas.

9.1.1.8.5 Finishing

- (i) Apply primer to all exposed elements including but not limited to posts, braces, fittings and hardware. Apply finish with two coats of semi-gloss enamel to all primed surfaces. Apply finishes by electrostatic process in accordance with manufacturer's recommendations.

9.1.1.9 PIPE UNDERDRAINS

9.1.1.9.1 Description

This work shall consist of perforated pipe underdrains and plain pipe outlets constructed in accordance with the Specification and in accordance with the lines, levels, grades, sizes, dimensions and types shown on the drawings.

9.1.1.9.2 Materials

(i) Pipes

Pipe for underdrains shall be perforated concrete, porous concrete, perforated asbestos cement or corrugated plastic and polyethylene or other approved material as shown on the drawings and called for in the Bill of Quantities. Pipes supplied shall conform with the AASHTO Standard Specifications as follows:

Perforated concrete	M175
Porous concrete	M176
Perforated asbestos cement	M189
Corrugated plastic and polyethylene	M252

(ii) Backfill Material

Porous backfill material for bedding and backfilling pipe underdrains shall conform to the requirements of Section 9.1.1.3.14. Impervious backfill material shall be a fine compactable soil approved by the Engineer.

9.1.1.9.3 Construction Methods

(I) Trench and Bedding

Trenches shall be excavated to the width, line and grade as shown on the Drawings. Unless shown otherwise, the depth shall vary from 1m to 1.5 m below the finished surface at the top of the trench where the construction is under a gutter, ditch or road-bed and to depths required for proper drainage at other locations. A 100 mm bed of approved granular backfill material shall be spread in the bottom of the trench throughout its entire length and brought to a uniform grade.

(iii) Placing Pipes and Backfilling

Pipes of the kind and size required shall be embedded firmly in the bedding material.

Bell and spigot pipes shall be laid with the bell ends up grade and the spigot ends fully entered in the adjacent bell and spot mortared to provide for centering of the pipes, but not closed to the infiltration of water.

The joints of butt-jointed pipe shall be covered with two ply tar paper strips not less than 150 mm in width and of sufficient length to permit the ends being turned outward and laid flat on the bedding material on either side of the pipes for a distance of 80 mm. In lieu of tar paper, the joints may be wrapped twice around with a strip of burlap or other approved material.

Perforated pipes shall be laid with the perforated side of the pipe down, and separate sections shall be firmly jointed with approved material.

After the pipes have been laid and have been inspected, and approved by the Engineer, porous backfill material shall be placed to the depth indicated on the drawings. Care should be exercised not to displace the pipes or joint covering around and over the pipes. The upper portion of the trench shall then be filled with suitable porous Material as shown on the drawings. All filling material shall be thoroughly compacted.

All work shall be constructed to the dimensions and other requirements stated on the drawings.

9.1.1.9.4 Measurement

The quantity measured for payment shall be the length in meters of pipe underdrains of the several kinds and sizes and the number of cubic meters of porous backfill material for pipe underdrains measured in place, complete and accepted. Excavation shall be carried out as directed by the Engineer but no special measurement shall be made for this operation.

9.1.1.9.5 Payment

The quantities of pipe underdrains, measured as provided above, shall be for at the Contract unit price per unit of measurement. The price and the payment shall be full compensation for trench excavation, furnishing and placing all material including outlets, labour, equipment, tools and incidentals necessary to complete the work.

