OMAN WASTEWATER SERVICES COMPANY S.A.O.C

الشركة العمانية لخدمات الصرف الصحي ش.م.ع.م

OMAN WASTEWATER SERVICES COMPANY

TECHNICAL STANDARD SPECIFICATION

CIVIL WORKS

SECTION 02

EARTHWORKS AND EXCAVATION

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SECTION 02 EARTHWORKS AND EXCAVATION

1. Relevant Standard

BS 6031 Earthworks

BS 8000 Excavation and Filling

BS 1377 Method of Testing Soils for Civil Engineering Purposes

CERIA REPORT 113

2. Excavation

2.1 General

All materials, methods and workmanship shall comply with the relevant British Standards and Codes of Practice:

Notwithstanding any information contained within any report of a site investigation the Contractor shall judge for himself the nature of the ground and shall be fully responsible for ascertaining all necessary information concerning permanent water table, periods of rainfall, flooding of the Site and all matters affecting the excavations and foundation work. The methods of excavation, which the Contractor will adopt, shall be at the sole discretion of the Contractor. The use of explosives may be permitted with the Engineer's written consent. The contractor shall take all necessary precautions of ensure the complete safety of all site personnel, including any third party, together with all buildings on the Site, including buildings completed or party completed by any third party.

The Contractor shall obtain all necessary licenses and permission covering the purchase and use of explosives, and shall meticulously observe the requirements of the relevant Authorities. No explosives shall be stored at the Site at any time.

The Contractor shall notify the Engineer in sufficient time in advance of the beginning of excavation for structures which constitute a billing item in the Bills of Quantities so that

the Engineer may observe the cross-sectional elevations and measurements taken of the existing ground and structure.

The Contractor shall report to the Engineer when excavations are completed and are ready to receive blinding concrete or foundation concrete if blinding is not required, and shall obtain consent before depositing concrete.

The sides of excavation may be sloped as required by soil conditions to stabilize the sides for safe working conditions. Such excavation shall be limited to the amount considered necessary for safety.

In the event of excavations being made larger than the sizes shown on the drawings or as otherwise directed by the Engineer, the Contractor shall fill in the excavated void to the correct profile with selected fill or with mass concrete as described in Section 03. Concrete work hereinafter at his own expense.

The final 150 mm. Depth of all excavations shall be taken out by hand unless allowed by the Engineer otherwise and the bottom leveled and rammed immediately prior to placing concrete.

Should any loose material be encountered at the bottom of any excavation, it shall be removed and the extra depth filled with concrete as directed by the Engineer.

Where shown, the excavation shall be either blinded with concrete as specified in the Contract Documents which shall be placed as soon as possible after the formation is approved, but not later than 48 hours after the final trimming of the bottom of the excavation, after which time fresh approval shall be sought and obtained from the Engineer before proceeding with this work.

The Contractor shall take all necessary steps by means of shoring, timbering, or otherwise refer to avoid slips and falls of the sides of the excavation but if any should occur the Contractor shall remove at his own expense all such fallen or disturbed material from the excavation and shall replace with backfilling as described elsewhere.

The Engineer may direct the Contractor to protect his excavation with timbering where, in his opinion, such timbering is necessary to ensure the safety of the workmen, adjoining structures and work generally. Any action taken by the Engineer in this regard will in no way relieve the Contractor of any responsibility or liability under the Contract.

Where a firm bearing material is not encountered at the elevation established for bearing, due to soft, spongy or otherwise unstable soil, all such unsuitable material shall be removed to the extent directed.

The Contractor shall keep the trench excavation free from water at all times.
Ground levels shall be agreed at suitable intervals with the Engineer.
Trial excavations may be ordered by hand or other methods to investigate the location of an existing service. The Contractor shall submit a written report or sketch drawings of data so obtained and the excavations shall not be backfilled without the Engineer's approval

2.2 Notification prior to Excavation

a) Prior to any works are undertaken, The Contractor shall undertake a Public Relation exercise to ensure that members of the public are fully aware of the works in progress. The Contractor shall:-

1) Prepare letter, in both English and Arabic, for every household describing the works. In the letter the contractor shall fully describe the following:-

   i) Working days and hours.

   ii) The telephone number of the OWSC helpline.

   iii) Project time frame

   iv) Reason for the works.

2) Undertake a door to door introduction with an Omani Public Relation Officer, to discuss the project with the house owner.

b) At all times during the works, the contractor shall ensure that inconvenience to the general public is reduced to a minimum and that they are kept aware of the construction programme as much as possible.

c) Posters shall be located at various locations around the project area to describe the benefits of the project in full and outlining the possible inconvenience during construction.

d) Prior to any works inside the property boundary, the contractor shall inform the resident no later than two weeks to prior commencement of the works.

e) Prior to any works outside a property, the contractor shall inform the resident by way of a letter in English and Arabic, no later than one week prior to commencement of the works.

2.3 Excavation Permit

An excavation permit shall be obtained for any excavation work to be done outside the plot boundary line.

Excavation permit will be issued to legally registered contractors who are authorised to do the works.

Application format can be purchased from the concerned local Authorities.

A detailed drawing showing the scope of work should be submitted along with the application. The alignment of the electric underground cable/overhead line/GTO line/water line or scope of any other work should be clearly marked/highlighted on the drawing.

Excavation involving asphalt road cutting shall follow the same procedure as above but shall be accompanied by a letter from a recognised road contractor stating that road cutting and re-instatement will be carried by them on the contractor behalf.

A bank guarantee shall be paid by the contractor for any road cutting.

3. Setting Out

Before any structural excavation is commenced the Contractor shall define the centre line or other agreed reference line of the Works and erect the necessary profiles throughout their full length if so required by the Engineer.

The area shall be trimmed to a clean, properly compared uniform surface to the lines and levels shown on the drawings. Any soft areas considered unsatisfactory by the Engineer shall be taken out and the extra depth filled with approved compacted fill.

4. Top Soil and Surface Material

Before commencing excavations or filling to an area, topsoil and other surfacing materials shall be stripped and stored separately from the subsoil as specified in the Contract documents. Subsequent spreading of topsoil shall be as directed by the Engineer.

5. Land Drains

Where pipelines are to be laid in agricultural land the surface and subsoil drainage shall be maintained whether natural or artificial. Before commencing work the Contractor shall ascertain from the owner or occupier of the land the location of any existing land drains.

6. Supports to Excavation

The Contractor shall, to the satisfaction of the Engineer, shore the sides of excavations for structures, trenches and pits to prevent them from slipping or falling. Should any slips, falls or settlement nevertheless occur they shall be made good by the Contractor, at his own expense, with selected fill or with mass concrete as may be directed by the Engineer.

In removing shoring from the sides of excavations, care shall be taken to avoid bringing loads onto any concrete until it has hardened sufficiently to carry such loads.

Timber or other materials used for shoring the sides of excavations shall be removed as the work proceeds except when ordered to be left in by the Engineer.

The Contractor shall provide the necessary support for excavations and shall submit to the Engineer his proposals for the supporting of excavations by trench sheeting or other approved means at least seven days prior to the commencement of any excavation works.

His proposals shall take into account the nature of the ground to be excavated, the level of the water table at the site and the proximity of buildings and roads.

The receipt of such consent shall not relieve the Contractor of any of his duties and responsibilities under the Contract. The Contractor shall be responsible for the stability of all excavations, and for the maintenance and protection of any adjacent property, structures and roads.

If in the opinion of the Engineer the support proposed for the excavations by the Contractor is insufficient then the Engineer will order the provision of stronger support than that provided by the Contractor and in this event the Contractor shall adopt the methods so ordered by the Engineer and shall have no claim against the Employer for any costs incurred in adopting the additional measures.

Trench supports shall be so arranged to permit withdrawal during the placing of the pipe bedding and backfilling so as to prevent voids.

The Contractor shall not remove temporary works supporting the excavations until in the opinion of the Engineer the permanent work is sufficiently advanced to permit such removal which shall be executed under the personal supervision of a competent person.

All temporary works supporting the excavation shall be removed during backfilling unless previous approval has been obtained from the Engineer. Where temporary supports have been used in the excavation any such supports left in because it is impracticable to remove them shall be left in at the expense of the Contractor.

Timbering steel sheeting strutting and sheet piling for the support of excavations where provided shall be fixed in accordance with BS 6031.

Battered sides to trenches or other excavations will only be permitted if they can be constructed within the limits of the site, without damage or interference to existing services, properties or structures, without undue interference with pedestrians and traffic and to slopes which are sufficiently flat to ensure stability of the ground.

7. Foundation Capacity Checks

The Contractor shall carry out soil testing, using an approved laboratory, at the location of all buildings and facilities to be constructed under the Contract. These tests are for the purposes of confirming foundation design and shall be carried out in advance of construction, as directed by the Engineer. The precise type and number of tests shall be as directed by the Engineer and shall be carried out at the appropriate foundation levels.

The costs involved in the performance of these tests shall be included in the Contractors Tender prices.

8. Dealing with Water

8.1. General

Groundwater in the Muscat region is a very special commodity. Long term dewatering can affect drinking wells and aquifers in the region. The Contractor shall therefore familiarise himself with the requirements in the Contract Documents for dewatering issues. Should the specific contract allow or be open on dewatering policy, the following clause is applicable.

The Contractor shall allow for all necessary liaisons with the Environmental and Water Resources Sections of the concerned local Authority with regard the planning and permitting of dewatering activities.

The Contractor shall obtain all necessary permits and approvals from the concerned local Authority prior to the start of dewatering and shall ensure that all the consent conditions imposed by the concerned local Authority regarding the dewatering permits/approvals are strictly complied with.

The Contractor must do all necessary measures to ensure proper dry conditions are maintained at all times during construction. The Contractor shall provide and maintain ample means and devices (including spare units kept ready for immediate use in case of breakdowns) with which to intercept and/or remove promptly and dispose properly of all water entering trenches and other excavations. Such excavations shall be kept dry until the structures, pipes, and appurtenances to be built therein have been completed. In addition precautions shall be taken to prevent floatation of partially built structures, completed structures to be filled on commissioning of the Works and pipelines awaiting backfilling.

The Contractor shall ensure that the static water level will be drawn down to a depth sufficient to keep the bottom of the excavation dry (at least 300mm below formation level). No excavation shall be allowed in wet conditions and no pipelaying or concrete activities shall commence until the Contractor demonstrates that he can maintain the excavations in dry conditions, acceptable to the Engineer. The Contractor must maintain dewatering at all times during construction so that no groundwater comes into contact with the pipe, exposed reinforcement or unprotected concrete surfaces. Failure to comply with the above shall entitle the Engineer to condemn the section of work affected and demand complete removal and replacement at the Contractor's expense.

If the Contractor fails to maintain the excavations in dry conditions (acceptable to the Engineer), the Client reserves the right to employ a professional dewatering subcontractor on the Contractor's behalf and expense.

Contractor shall be deemed to have visited the Site prior to submitting his Tender in order to make all necessary inspections and investigations to allow for the following in his Tender:

a) Temporary discharge lines, structures, pumps or other equipment necessary to prevent local flooding or ponding.
b) Means of access and working space.
c) Nature of the ground and sub-soils.
d) Presence of existing foundations or other hidden obstructions.
e) Level of the water table.

f) Extent of rock and possible cavities.

g) Support to neighbouring properties and structures.

h) Any other factors affecting the Work.

i) All approval/permitting activities

Any information made available to the Contractor, either in these documents or by any other source, will not relieve the Contractor of his responsibility to decide for himself the nature and extent of the Work, nor will it guarantee that similar conditions will apply on other parts of the Site.

Contractor shall be deemed to have contacted the relevant Authorities to establish the existence of any existing, live or redundant services adjacent to or passing through the area of work and shall be deemed to have allowed in his Tender for their location, diversion, demolition or removal.

Boring logs and related information depict subsurface conditions only at the specific locations and at the particular time designated on the logs.

a. Soil conditions at other locations may differ from conditions occurring at the boring locations.
b. Passage of time may result in a change of the subsurface conditions or water levels at the boring locations.
c. Employer does not guarantee any statements, opinions, or conclusions contained in the geotechnical report.

Contractor shall assume all responsibility for:

a. Deductions and conclusions made by him regarding the nature of the soil to be dewatered.
b. Difficulties involved in both dewatering and discharge activities.
c. Maintaining the dewatering at required elevations at all times during construction.
d. Carrying out his own investigation to satisfy himself for the validity of any subsoil information.

Neither the Employer nor the Engineer shall be liable for any loss sustained, from dewatering activities.

The Contractor shall submit, for the Engineering's approval, a detailed method statement for dewatering systems, meeting the requirements of the project soil and water table conditions. The method statement shall be submitted not less than 30 days before the start of dewatering operations. No dewatering

perations shall commence until the Engineer has approved the Contractor's method statement and all appropriate permits obtained.

Capacity calculations, locations and details for the dewatering system composts such as , pumps, sumps, collection and discharge lines, standby of the project soil and water table conditon units, water recharge system, water disposal system, monitoring equipment, settlement measuring equipment, data collection and dissemination shall be included.

Dewatering methods proposed in the Contractor's method statements may include temporary drains, intercepting ditches, cut-off drains, sub-drains, sumps, wells, pumps, well-points or other Dewatering equipment and shall include all other equipment necessary to keep water out of the excavations or to lower groundwater and structures liable to floatation.

The Contractor must provide experienced, qualified personnel to perform dewatering operations. If approved by the Engineer, the Contractor may furnish the services of an experienced, qualified and properly equipped Dewatering Subcontractor to design and operate the dewatering and groundwater recharging systems required for the work.

All necessary precautions shall be taken to prevent any adjacent ground from being adversely affected by loss of fines through any dewatering systems. All water must be removed and discharged in a manner to prevent local flooding or ponding, damage to adjacent property and nuisance or menace to the public.

All water pumped or drained from the work shall be disposed of in a suitable manner without undue interference with other work, damage to pavements, other services, or property. Suitable temporary pipes, flumes, or channels shall be provided for water that may flow along or across the site of the work. No such water is to be disposed of into the existing sewer/drainage systems of the town or otherwise prior written approval of the the concerned local Authority. Before discharging water to the sea, wadis, etc the Contractor shall obtain the prior approval of the concerned local Authority in writing.

If permission is given to use existing pipes or culverts which are not part of the live sewage system, they shall be thoroughly cleaned of all silt and any resulting damage made good after use.

When the Contractor proposes to make use of existing Dewatering pipelines, ducts, etc, he shall satisfy himself as to their condition prior to the use of them. If any of these items found to be in an unsatisfactory condition then, before use, the contractor shall notify the Engineer who may give instructions for the item to be replaced or repaired. Time taken to carry out such work will not be considered as delay to the Contractor's operations.

During use the Contractor shall be responsible for the condition of the pipeline, duct, etc, and any defect or failure shall be made good at the contractor's expense. Any delay to the Contractor's works caused by such defect or failure shall be deemed as the Contractor's responsibility.

After use by the Contractor such pipeline, duct, etc, shall be handed back to the concerned local Authority in a condition not less than that at the commencement of use. Any repairs or replacement required shall be at the Contractors expense.

It cannot be guaranteed that permission will b given to use existing ducts and pipelines.

Unless otherwise directed all temporary drains and sub-drains shall be finally sealed with concrete at approved intervals and all temporary ditches, sumps, wells, etc, shall be refilled and reinstated as specified elsewhere.

In the exceptional event that lagoons for the storage of groundwater are permitted, they must be suitably protected with fencing and attended by day and night to prevent access by the general public and will not be sited adjacent to buildings. Approved means of preventing the formation of mosquito larvae on the surface of the lagoons will be employed.

All Necessary precautions shall be taken to prevent any underground water from entering mains to be used for the conveyance of portable water.

8.2 Temporary Under-drains

Temporary under-drains, if used, shall be laid in trenches, beneath the grade of the structure. Trenches shall be of suitable dimensions to provide room for the chosen size of under-drain and its surrounding gravel.

Under-drains, if used, shall be laid at an approved distance below the bottom of the normal excavation and with joints wrapped round in geo-textile, and entirely surrounded by graded gravel, or crushed stone to prevent the admission of sand or other soil into the under-drains. The space between the under-drain and the pipe or structure shall be filled with the screened gravel or crushed stone which shall be rammed if necessary and left with a surface suitable for laying the pipe or building the structure.

8.3. Well point Drainage system

Where the nature of the Works necessitates, the Contractor shall establish adequate dewatering system which will drain the soil and prevent saturated soil from flowing into the excavation.

The installation of the dewatering system components and other such requirements shall be done under the supervision of the competent representative of the manufacturer. The Contractor shall do all special work which is necessary for the dewatering system to operate for the successful Dewatering of the excavations.

The Contractor shall closely monitor all dewatering activities to the satisfaction of the Engineer. Where required to do so by the Engineer, the Contractor shall establish a specified number of groundwater level monitoring stations at each site which will be observed during the work. These shall be located as directed by the Engineer and consist of acceptable open tube piezometers. If required by the Engineer, settlement gauges shall be provided as designated by the Engineer, to monitor settlement of new and existing facilities

No dewatering system shall be removed without the approval of the Engineer. Release of groundwater back to its static level shall be performed in a manner to prevent disturbance of natural foundation soils, compacted fill or backfill, and to prevent flotation or movement of structures, pipelines and sewers. Equipment shall only be removed when no longer required. Monitoring and settlement measurement systems shall be maintained in operation as required by the Engineer.

Sump pumps may only be used with the Engineer's permission where rocky or very dense strata are encountered. If permitted the contractor shall submit his method with all technical details for the Engineers approvals

Dewatering systems 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.

If necessary, a water injection recharging system shall be maintained to replenish the groundwater 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 dewatering operations be interrupted or become inadequate.

The Contractor shall repair all damage or settlement to foundations, structures, existing facilities, or works which were caused by failure of excavation protection, operations of dewatering or recharging system or failure to maintain the existing ground water outside the dewatering area. Discharge pipes shall be checked at regular intervals to ensure that the pumping system is functioning properly.

Water not injected back into the ground shall be disposed of in a manner to prevent local flooding, ponding or damage to new and existing facilities or adjoining properties.

If necessary, the contractor shall install suitable discharge lines of sufficient size and number to transfer all water to an approved disposal area. The route for dewatering discharge lines shall be subject to the Engineer's approval. All costs for placing, maintaining and removing such discharge lines shall be borne by the Contractor.

No water shall be pumped in to the drainage system, unless approved by the Engineer. Water removed from the excavations shall be pumped only to an approved area. Where necessary the Contractor shall divert natural and artificial waterways encountered as the site until the works are completed. The discharge from site dewatering equipment shall not be pumped into a stream or watercourse, unless the MRMEWR and the Municipality has without the given consent, of the concerned Authority

9. Excavation near Roads

9.1 Safety

When excavating at or near roads, to protect persons from injury and to avoid interference with traffic, adequate barricades, construction signs, torches, guards, flashing lights, etc., as required by the Engineer shall be provided and maintained during the progress of the construction work . All materials, stockpiles and equipment shall be placed in such a way that no obstruction or interference to traffic is made and that these are enclosed by fences or barricades and protected by lights.

9.2 Description

The Contractor shall make excavations in such a manner and to such minimum widths as will give adequate room for building the structures or laying and jointing the piping; shall furnish and place all sheeting, bracing, and supports; shall carry out all coffer damming, pumping, and draining.

In no case, except with the approval of the Engineer, shall the earth be plowed, scraped, or dug by machinery so near to the finished sub grade as to result in the disturbance of material below said sub grade, the last of the material to be excavated shall be removed by hand immediately before the placing of the pipe, masonry, or other structure.

9.3 Separation of Surface Materials

The Contractor shall remove only as much of any existing pavement as is necessary for the work. The Engineer may require that the pavement be cut with pneumatic tools, milling machine or the like without extra compensation to the Contractor, when in the opinion of the Engineer it is necessary to prevent damage to the remaining road surface. Where pavement is removed in large pieces, it shall be disposed of before proceeding with the excavation.

From areas within which excavations are to be made, topsoil shall be carefully stripped and separately stored to be used again as directed, or if the Contractor prefers not to separate surface materials, he shall furnish, as directed, loam and topsoil at least equal in quantity and quality to that excavated at no cost to the Works.

9.4 Sheeting and Bracing

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

For any excavations in or adjacent to roads all trenches must be supported by an approved method to ensure no settlement of roads either during construction, when withdrawing supports or thereafter.

10. Excavation for Structures

Where concrete is to be placed on an excavated surface other than rock, special care shall be taken not to disturb the bottom of the excavation. When the nature or condition of the bearing material upon which concrete is to be placed is determined to be such that the use

of heavy excavating equipment will reduce the stability of the soil, the final half meter of excavation to grade shall be performed either by means of light equipment or by hand labor methods.

Should the Contractor excavate to a depth greater than that required for the construction of the foundations or pile caps, such excavation shall be filled with Mass concrete as specified in the contract document at his own expense. Should the material forming the bottom of any excavation, while acceptable at the time of excavation, become puddle soft or loose during the progress of the Works, the Contractor shall at his own expense, remove all such softened or loosened material and replace with Mass concrete as specified in the contract documents or as directed by the Engineer.

Where rock, in either ledge or boulder formation or other unyielding material, is encountered in one portion of structural excavation for a box culvert and yielding material is encountered in an adjacent area of the structural excavation for the same box culvert, such unyielding material shall be removed for a minimum depth of half meter on as directed by the Engineer below grade and replaced with special backfill as directed by the Engineer

Where such unyielding material is encountered in excavation other than for box culverts or where an entire excavation for a box culvert bears on such materials, the rock or other unyielding material shall be cleared of all loose fragments and cut to a firm surface as directed by the Engineer.

The placing of concrete shall follow as closely as practicable the structural excavation.

11. Trench Excavation

11.1 General

The line and level of trenches shall be as shown on 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 level 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 center line and the level to which the excavation is to be carried out, such rails being not more than 20 m apart. Alternative methods to maintain line and level of pipelines shall be to the approval of the Engineer.

11.2 Trench Excavation

Trench excavation shall be carried out by such methods and to such lines, dimension and depths as shall allow for the proper construction of the works, provided always that, unless the Engineer permits otherwise, no trench excavation shall be less than 600 mm in width. Excavation shall be carried out by hand methods where required to ensure the stability of utilities encountered during excavation work. 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. The bottom of the trenches shall be properly trimmed off and a compacted granular bed of thickness as shown on the drawings shall be placed and prepared to provide a firm and uniform bearing throughout the length of the pipe.

The bedding shall be lightly raked prior to placing the pipes on it. Bell holes and holes and depressions for couplings, valves and the like shall be excavated the same distance below these installations. The materials excavated shall be used in the backfill or 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. Trenches shall have vertical sides unless otherwise authorized by the Engineer. No length of trench excavation shall be started until the pipes and fittings to be laid in that length are available on the Site. No trench shall remain open for longer than 30 days.

If obstructions not shown on the drawings are encountered during the progress of the work and these will require alterations to the drawings, the Engineer shall be notified and instruction given to the Contractor on how to proceed. 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 for convenience to the Contractor, any additional costs for the thrust blocks, valves, air and vacuum assemblies, washout assemblies, extra pipe footage, valve chambers or other appurtenances shall be borne by the Contractor. A sufficient number of air release and vacuum installations and washout assemblies have been shown on the drawings at high and low points, respectively, in the pipelines. Should the pipeline be constructed in a manner that the points are not located at the stations shown on the plans or in a manner that additional high or low points are caused in the profile for the convenience of the Contractor, the Contractor shall relocate

or add additional installations and assemblies at his own expense and as directed by the Engineer.

Unless otherwise specified or instructed, the minimum trench width shall be 600mm and in no case less than the outside pipe diameter plus "x" mm where, unless stated otherwise, "x" is equal to 500 mm for pipes having nominal diameters greater than 1400 mm and equal to 300 mm in other cases, and the upper limit shall be such as to meet design requirements and to minimize disruption of traffic, disturbance of other services or installations and risk to adjacent buildings or structures. Where the trench width is not specified elsewhere or shown on drawings or where the Engineer gives instructions concerning trench widths, the following trench widths shall normally apply

11.3 Trial Holes

The Contractor shall, in co-ordination with the Engineer, hand excavate trial holes well ahead of the trench excavation to such depths as necessary to determine and confirm the alignment for the trench, soil conditions and services. 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. Shop drawings shall be issued for information to the Engineer.

11.4 Existing Services

Where trench excavation is carried out close to or across the line of sewers, pipes, cables and other services, the Contractor shall, comply with the requirements of clause 6 section01 General. Only hand excavation shall be used where existing cables, water mains, sewers, etc., cross the pipeline alignment or run adjacent to it. Where specified on the drawings or by the relevant Utility Authority split ducts shall be provided. 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.

Notwithstanding any relevant information furnished by the Employer or Engineer, the Contractor shall be responsible for ascertaining from his own inspection of the Site and the respective utility Authorities and other public bodies the position of all mains, pipes and cables whether underground or overhead, within or near the Site. Any relocation of services shall be done in accordance with the requirements of the responsible Authorities.

11.5 Trench Excavation in Roads

Road or utility crossings shall be carried out using non-disruptive construction techniques. Where open excavation is allowed all trench excavation and other work carried out within the limits of any existing road or highway shall be completed as rapidly as possible and, in the case of roads capable of carrying two or more lanes of traffic, not more than half of the width of the carriageway shall be obstructed at any one time. In single-lane roads, the Contractor shall program his work in such a manner that the minimum inconvenience is caused to those persons who have reasonable grounds for using the road and, in the case of private or restricted roads, who have Authority to use them.

If, in the opinion of the Engineer, the amount of traffic using a road which is completely or partly obstructed by the works is sufficiently great to make it necessary, the Contractor shall operate a system of traffic control to the approval of the Engineer. Any such system of control shall erect appropriate warning signs at the approaches to sections of road in which or adjacent to which work is being executed. These signs shall be removed immediately, once the dangers of which they provide a warning have been removed. If the Contractor wishes to obstruct completely any road for any significant period of time, he shall apply to the Engineer for permission to do so. Obstruction of the road shall not begin until the Contractor receives the Engineer's permission in writing. The Engineer's approval shall not relieve the Contractor from his responsibility in obtaining permits from all concerned Authorities. Such permission will not, in general, be granted for roads which have more than one traffic lane or for those sections of roads for which satisfactory alternative routes do not exist. The costs incurred by the Contractor in respect of all aspects of work in roads including maintaining access past the works, the provision of a traffic control system and warning signs and the like shall be included in the rates for excavation and pipe laying. The Employer will not be liable to pay any compensation to the Contractor should permission to close any road to traffic not be granted for any reason.

Road drains and channels shall be kept free from obstruction at all times.

Normally trench excavation along roads will be located in the service reserves or verges adjacent to the road rather than in the carriageway itself.

The Engineer may direct the trench excavation to be realigned from that shown on the drawings in order to avoid interference with existing utilities and structures or to facilitate smooth traffic flow.

Where trench excavation or any other part of the works obstructs any footpath or right-of-way, the Contractor shall provide, at his own cost, a temporary footpath around the obstruction to the satisfaction of the Engineer. Where applicable, this temporary footpath shall include bridges of wooden planks or other approved construction across any open trenches.

Where excavated material has temporarily been deposited on a grass margin or verge, the margin shall on completion of refill be restored entirely to its original condition and left free from loose stones.

11.6 Trench Excavation in Surfaces Other than Roads

Trench Excavations 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 cultivated areas, undeveloped areas, footpaths, verges, non-asphalted roads, lanes, alley, and all private lands. Trench excavation shall if the Engineer so requires have temporary fencing erected around that length.

Temporary fencing shall not be removed without the Engineer's permission, which will not normally be given until the trench excavation has been refilled and reinstated. The Contractor shall have particular regard to the safety of animals which may be introduced to the areas, and shall ensure that all open excavation, access routes and steep or loose slopes arising from the Contractor's operations are adequately fenced and protected.

11.7 Fences and Walls

Where the trench excavation crosses barriers such as fences and walls the Contractor, as a temporary measure during construction of the pipeline, shall provide temporary fencing for any parts of such barriers as have had to be removed. After trench excavation has been reinstated, the Contractor shall carry out such work as the Engineer may order for permanent restoration of such barriers.

11.8 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 unreasonably excessively lengths of trench excavation to remain open while awaiting testing of the pipeline but not more than 200 m ahead of the pipe laying operation. 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 leaving pipe joints exposed for tests of the joints. 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 will not be permitted to excavate trenches in more than one location in any one road at a given time without the Engineer's permission. Accesses to houses and buildings shall be maintained at all times.

12. Excavation for Cables/Ducts

The Contractor in carrying out excavation for cables/ducts shall, where required, erect and maintain an approved type of temporary yellow plastic safety fencing around any work and shall provide fenced access ways across the trenches.

The bottom of the trench shall be accurately graded. Care shall be taken not to excavate below the depths indicated. Where rock is encountered, the rock shall be excavated to the required depth. Uneven surfaces of the bottom of trench shall be excavated 150 mm deeper. Such depth in rock shall be backfilled in accordance with clause **18** of this specification

with suitable fill material complying with the requirement of clause **18** and compacted as specified and/or as directed by the Engineer.

Whenever unsuitable soil is encountered, which in the opinion of the Engineer is to be removed, it shall be removed to the depth required and the trench backfilled to the proper grade with approved fill material and compacted.

The width and depth of the trenches for electrical and telephone cables/ducts shall be as specified in the relative drawings or as ordered by the Engineer. Banks may be sloped or widened to facilitate placement of cables, but not to the extent that will cause interference with other utilities and structures. No battering of trenches shall be allowed under existing carriageways, unless otherwise agreed by the Engineer.

13. Excavated Material

All excavated material will remain the property of the Employer unless designated as surplus to the Contract requirements in which case it will be removed from site immediately. The Contractor shall dispose of such surplus material as per Clause **15**

All excavated material shall be deposited so that it will cause as little damage and inconvenience as possible.

Excavated material for use as backfill shall be as approved. Different classes of material shall be handled and deposited separately.

The excavated material, if found unsuitable as backfill, shall be removed from site and shall be replaced with suitable imported backfill to the approval of the Engineer.

14. Replacement of Unsuitable Material

Loose soil, bad ground or cavities met within any part of the excavations for foundations of structures shall be excavated to a solid formation in accordance with the geotechnical investigation report recommendation and filled to foundation level with mass concrete as specified in the contract document.

Where exceptionally poor ground conditions and unsuitable materials are encountered at the limits (formation level) shown for structural excavation, the Contractor shall, at the direction of the Engineer, excavate down to firm ground in accordance with the geotechnical investigation report recommendations. The extra excavation shall be backfilled with either Mass concrete or special backfill.

15. Disposal of material

The Contractor shall seek approval for all the proposed disposal sites from the concerned Authority before work commences and disposal at such sites shall be at no extra cost to the Employer.

No excavated material shall be wasted without" written permission from the Engineer, and when such material is to be wasted, it shall be hauled to the approved tip or as otherwise directed by the Engineer. Excavated materials wasted by the Contractor without written Permission of the Engineer shall be replaced by the Contractor at his own expense. The Contractor shall adhere rigidly to the requirements of the concerned Authority requirements on the temporary storage and disposal of excavation material.

All material shall be stockpiled at an approved location and surrounded with approved barricades. The Contractor shall also display his name and contractor telephone number. Certain separate areas will be designated for the disposal of hard debris such as building rubble, broken concrete, kerbing, road pavement and the like. The Contractor shall use only these designated areas and shall keep these disposal areas neat and tidy at all times.

16. Rock Excavation

Rock shall be defined for the purpose of excavation as in-situ material which in the opinion of the Engineer requires the use of pneumatic hammers to remove in hand excavation or the use of a ripper fitted to a bull dozer for mechanical excavation.

17. Backfilling

17.1 General

The Contractor shall backfill all excavations in an expeditious manner to minimize disruption to the general public. Backfilling of trenches other than in roads and paved/tiled areas shall normally be carried out using selected excavated materials similar to the in-situ materials in which the trench or structure is being constructed. Special backfill shall be used where designated or directed.
Where the excavation is near an existing structure liable to subsidence, where part of the Works may later be constructed over or near it or in emergencies the Contractor may be instructed to backfill with concrete.

17.2 Selected Backfill

Material for backfilling may be selected from any part of the site and methods of selection may include sieving to remove large particles or methods of hand or machine sorting together with soil classification and soil property testing.

Backfilling with selected material shall be carried out as defined below.

a- Cohesive Soils

Cohesive soils shall be placed in layers not greater than 200 mm thick (compacted thickness) and compacted such that throughout each-layer placed the in situ dry density is not less than 95% of the maximum dry density of the soil as determined by BS 1377:Part 4:Test 3.5, as required'.

Use of nuclear meter for determining field densities shall be in accordance the local Authority requirements concerned.

If site trials show that the specified compaction can be achieved with layers greater than 200 mm compacted thickness approval may be given to backfill in layers of greater thickness, but not exceeding 250 mm, providing the plant utilized is that used for the trials.

The moisture content of soil may be determined in the field by the calcium carbide gas pressure test method (Speedy) in accordance with ASTM D4944. All calibration and testing shall be carried out by suitably accredited laboratory by the concerned local Authority.

b-Granular Soils

Granular soils shall be placed in layers not greater than 200 mm thick (compacted thickness) and compacted such that throughout each layer placed the in situ dry density is not less than 95% of the maximum dry density as determined by BS 1377 Part 4:Test 3.5 or 3.6 on the same soil, as required.

If site trials show that the specified compaction can be achieved with layers greater than 200 mm compacted thickness approval may be given to backfill in layers of greater thickness, but not exceeding 250 mm, providing the plant utilized is that used for the trials.

Unless otherwise directed the moisture content shall be maintained and if necessary adjusted by approved means to fall within 2% of the optimum moisture content.

For free draining granular soils that have no clearly defined optimum moisture content, compaction shall be carried out to achieve a relative density of not less than 95% as required. During compaction the soil shall be made as wet as practicable.

17.3 Backfill for Replacement Land Drain

Where a land drain passes through an excavation the backfill shall first be taken up to form a bed for replacement pipes. The severed drains shall then be exposed at each side of the trench to allow for connection and laying of a new drain across the excavation. This new drain shall be of similar pipes of the same diameter as those in the existing drain. Before any further backfilling is done the Contractor shall notify the owner or occupier to enable him to inspect the reinstated land drain. The replacement drain shall be surrounded with

pipe bedding to a minimum thickness 150 mm before further backfilling.
Immediately after completion of in situ-density tests, summary sheets, in an approved format, are to be updated and original test results submitted.

17.4 Filter Material

When required, filter material shall be placed in backfilling structures in accordance with the details shown on the Drawings. Filter material shall conform to the specified requirements for Fine Aggregate.

17.5 Backfilling of Trenches

After the pipe/cables ducts have been laid, the trench backfilling shall commence with approved fill in compacted layers not exceeding 200 mm thick, each layer being well compacted by hand with iron rammers weighing not less than 5 kg, until the trench has been filled to a height of 300 mm above the top of the cable/duct.

The remainder of the trench shall then be refilled in compacted layers not exceeding 200 mm in thickness, each layer being well compacted with power rammers, vibrating plate compactors or other mechanical means of a type to be approved until the ground is thoroughly consolidated up to the required level for surface reinstatement. Each layer shall be compacted to 95% of its maximum dry density. Should the quantity of the excavated materials be not sufficient, due to unsuitability or otherwise, for the process of backfill and fill, the Contractor shall obtain the quantity required of such backfill and fill from approved borrow pits and transport same to the site of work at his own expense.

Trenches shall not be backfilled until all required tests are performed and until the Engineer has verified that the pipes cables, other service. Have been installed in accordance with the Specifications and Drawings.

Lumps and clods shall be broken up before use. Materials shall not be dropped from a height and where directed water shall be added to assist in adequate consolidation.
Where cover to pipes cables/ducts is less than 400 mm, or where ordered by the Engineer, protection in the form of concrete encasing shall be provided according to the approved drawing or as directed by the Engineer.

17.6 Compaction Test

a) Compaction of fill materials shall be assessed by an approved Laboratory in accordance with BS 1377. One test shall be performed per 100m^2 of each layer of fill. The percentage compaction achieved, defined as follow% compaction = field dry density/ max lab dry density x 100

b) Compliance shall be assessed on the average of any four consecutive tests being within the required range of compaction. Individual results shall not deviate from that range by more than the following limits:Beneath roads and structures: -1%, +2% Backfill to structures and pipelines: ±2%

Other areas: 3%,

c) In the event of non-compliance, the Contractor may make a further attempt to compact the material prior to re-testing. Any material failing on re-test shall be removed and replaced at the Contractor's expense. The Engineer may withdraw approval for any material which the Contractor is regularly unable to compact to the required percentages or may require further laboratory tests at any time when it is considered that the material varies from that submitted for approval. On the contractor own expense.

d) The Contractor shall be responsible for managing discrete stockpiles of fill material from the same source. The precise characteristics of the material from each stockpile must be known at all times and available for utilization in the compaction testing procedures described above. Stockpile material shall be retested to ensure that the properties used in the regular compaction testing programme are up-to-date at the direction of the Engineer or at a maximum of 3 month intervals.

Unless directed otherwise on site Compaction test of in-situ soils shall be at the minimum rate of:

a) One test per backfill layer for each 100 m^2.
b) One test per backfill layer for every 30 linear meters of pipeline trench Backfill laid in one operation.

18. Trees

The Contractor shall not fell any tree unless expressly identified in the Contract or Particular Specification.

If required, the Contractor shall obtain all necessary Local Authority approvals except where otherwise provided for in the Contract.

19. Soft Landscape and Landscape Irrigation

19.1. The work shall consist of furnishing and planting palms, trees, vines, shrubs, water plants, ground covers, grass and other plants. It shall also include preparing and finishing planting pits and beds. The work shall also include maintenance and other incidental planting procedure work, all as necessary to complete the planting operations in a workmanlike manner, according to the provisions of this specification and in conformity with the lines shown on the drawings or established by the Engineer.

19.2. The drawings issued along with the tender are only indicative and the tenderer shall allow in his rates, all the necessary requirement to carry out the scope of works detailed in the bill of quantities and specifications anywhere within the site as directed by the Engineer.

19.3. The following standards are applicable:

BS 3936 – Part 1	Nursery Stock, Trees and Shrubs
BS 4428	General Landscape Operations
BS 5436	Cultivation and Planting of Trees

19.4. All rubbish and litter as it accumulates within the landscape boundary, shall be cleared and carted away daily. The areas shall be kept in a clean and tidy condition with all drive ways, paths, edges, kerbs gutters and gullies swept and kept clear of debris at all times. All rubbish and debris shall be carted away to a dump as directed by the Engineer.

19.5. Only chemicals approved and listed under the "Agricultural Chemicals Approval Scheme" issued by the Ministry of Agriculture, Fisheries and Food, London will be used. All chemicals shall be non-toxic to human beings, birds and animals and subject to the approval of the Engineer.

19.6. All work shall be carried out during the appropriate season and in weather conditions suitable for the operation. In particular, planting shall not be carried out

before October or after March without the specific approval of the engineer. An exception will be the planting of large palms which shall be planted during the period of optimum root growth i.e., mid April to the end of September.

19.7. All materials to be used in the landscape contract and stored at the Contractor's yard shall be kept covered and protected. In particular any plants held for planting shall be kept in a special compound, sheltered from the direct sun and drying winds and watered regularly.

19.8. The contractor shall determine the location of all underground services prior to commencing excavation works. Any work around the existing services shall be carried out by hand and the contractor shall allow all such excavation rates.

19.9. Prior to the commencement of the work at site the contractor shall submit for the Engineers approval a chart showing the Contract Management Organisation. Details including CV's etc of the contract supervisory staff shall also be submitted. The Contract Management Team shall include but not limited to:

A qualified Landscape Architect with minimum 10 years experience in the design and supervision of major jobs of this magnitude in the Gulf countries

A qualified Horticulturist with minimum 10 years experience.

All other necessary Engineers and Supervisors.

A written approval of the Engineer shall be obtained for any temporary or permanent replacement of the site staff.

19.10. The soil to be used for planting shall be free draining, non toxic and capable of sustaining healthy plant growth and shall be obtained from well drained arable land approved by the Engineer. The soil shall not contain calcium carbonate, subsoil, refuse, roots, heavy clay, noxious weeds, hypoxic materials, course sand, rocks, sticks, litter or any other deleterious material. The soil shall have the pH factor 6.0 8.5, soluble salts a maximum 1500 PPM, electrical conductivity not more than 7mm nos/cm at 25^0 Celsius and SAR value not more than 12. The soil shall be brought to the site or spread only in dry and not in muddy conditions. The physical characteristic of the soil shall be sandy loan made up of 50% sand of 0.05 – 2.00 mm, 25-30% silt of 0.002-0.05mm and 10-15% of clay less than 0.002mm.

19.11. The soil shall be stored in heaps less than 1.50m high and the heaps shall be protected from ondue compaction. A sample load of minimum 5 m^3 shall be obtained for the Engineers approval and this sample shall be retained at site through out the contract for comparison, if approved by the Engineer.

19.12. Peat moss shall be confirming to BS 4156, free of mineral matter such as Sulphur and Iron and free of woody materials. It shall have a pH value of 4.0 – 5.0 and shall be air dry. Peat moss shall be provided at the rate of 150 ltrs per palm, 80 ltrs per tree, 40 ltrs per shrub/vine/grass/succulents, 60 ltrs per square meter shrub bed 40 lters per linear meter of hedge and 20 ltrs per square meter of ground cover and lawn.

19.13. Organic manure shall be well rotted, unleashed animal dung with not more than 5% vegetable matter, pest and weed free or shall be with a minimum organic content of 45% weight, and free from any deleterious matter.

19.14. A sample bag of manure shall be provided to the approval of Engineer with sufficient test results prior to the use at site.

19.15. Manure shall be provided at the rate of 2 bags per palm pit, 1 bag per tree pit, ½ bag per shrub/vine/grass/succulents pit, 1 bag per m^2 of shrub bed, ½ bag per/m of hedge and ½ bag per m^2 of ground cover and grass.

19.16. General fertilizer shall be sulphur coated slow release compound fertilizer, 16:18:5 + Fe for palms, trees, shrubs and 16:18:5 + Fe+tTrace element for grass areas and ground covers. Slow release fertilizer tablets shall be 20:10:5 + chelated trace element Iron, Zinc and Manganese. The fertilizer shall be in the form of tablets, 21gm each and shall be sierra tabs.

19.17. Fertilizers shall be provided at the rate of 175gms for palm pit, 100gms for tree pit, 50 gms for shrub/vine grass/succulent pit, 100gms per m^2 for shrub bed and 50 gms per meter of hedge and 100gms per m^2 for ground covers and lawn areas.

19.18. Slow release fertiliser tablets shall be provided to trees and shrubs, 1 per every plant.

19.19. Castor meal shall be obtained from an approved manufacturer and shall be supplied in sealed 50 kg containers. Castor meal shall be applied at the rate of 1 kg per m3 of planting soil for all areas.

19.20. Gypsum shall be supplied in 25 kg sealed containers and shall be applied at a rate of 1 kg per m3 of planting soil for all areas.

24.21. Planting medium shall consist of a homogeneous mixture of soil, peatmoss, compost, fertilizers and other soil inputs as specified.

24.22. All plants shall be of the size specified in the plant schedule at the time of delivery to the site and shall be obtained from an approved source. Plants that meet the measurements specified but do not posses the normal balance between height and

spread will not be acceptable. Trees shall have a minimum calliper (measured at 500mm above ground level) of 15 mm. Shrubs and ground covers shall be twin or multi-stemmed.

24.23. All planting stock shall be well-balanced, well formed, sound, vigorous, healthy, free from disease, sunscald abrasion, harmful insects or insect eggs and with a healthy, un broken root system. Only nursery grown plants are acceptable unless specified otherwise.

24.24. Nomenclature of trees and plants shall conform to the scientific names given in: Royal Horticultural Society, " Directory of Gardening ".

Hostus 3.

Exotica.

Alternative names can be checked in these books. All plants must agree with the botanical description in these books. Hortus 3 and Exotica are the only Authorities for plants that are not listed in the RHS Directory

19.25. Palms shall be balled and burlapped unless container grown palms are available. Off shoots will not be acceptable. They shall have a vigorous root system, crown of new leaves, proper colour of leaves of an adult palm and sufficient hardiness.

19.26. Prior to transporting for transplanting, all suckers flowering and fruiting parts and approximately 30% of fronds shall be removed. The remaining fronds shall be sprayed with an anti-desiccant 24 hours prior to lifting. The fronds are to be lifted to enclose and protect the growing tip, wrapped in hessain and securely tied in position. The roots shall be balled and the hesasin tied.

The root ball is to be held secure using wire mesh and hessain materials to contain the soil and retain maximum soil moisture.

19.27. The contractor shall take whatever steps he deems necessary and to the approval of the Engineer to ensure the verticality of all palms. Verticality shall be maintained within a tolerance of 1:25.

19.28. Trees shall be systematically developed, the structure and habit of growth typical of their species with straight stems and an intact central leader. Trees shall be of the size specified in the plant schedule.

19.29. The shrubs shall be of twin or multi-stemmed, of good form, well grown and bushy. Deciduous shrubs may be supplied bare booted, earth balled and hessain covered or container grown. Each shrub shall posses a structure and habit of growth typical of their species. The size of the species shall be as per the plant schedule.

19.30. Climbing plants, succulents, ornamental grasses, ground covers etc shall be well rooted and of not less than 1 year full growth. Container grown plants shall be fully acclimatised to out side conditions prior to the delivery to the site.

19.31. Seasonal plants to be replanted in April and September and prior to planting the seasonals, the contractor shall take the approval of the plants he intends to plant at site.

19.32. Water plants shall be having a spread of about 750mm and the rhizomes shall be firm with new growth sprouts at the crown. Before planting trim away excess roots and any damaged foliage.

19.33. The grass used for the project shall be Paspallum vaginatum dethatched from an approved location agreed by the Engineer. No other species shall be allowed to plant at site and the contractors shall have his own local grown grass source for dethatchment. The source shall have an area equivalent to the double size of the grass area to be established as part of this contract.

19.34. All plant material shall be delivered to the site nursery by the contractor in accordance with the approved planting schedule. All plants shall be treated with anti desiccant prior to their delivery to site nursery. All plants shall be maintained at the nursery for appropriate length of time till they are hardened enough to be planted at site.

19.35. The sub-contractor shall construct a suitable nursery at a location approved by the Engineer, within the site. The nursery shall be established within 2 months from the award of sub-contract and shall be maintained through out the construction and maintenance period to the approval of the Engineer. The nursery shall be handed over to the client after the successful completion of the maintenance in good condition. The size of the nursery shall be 24.00 m x 18.00 m and shall be constructed to the Engineer's approval. The nursery shall have water storage facility and temporary irrigation network system.

19.36. All plants used for the project shall be grown in the contractors own nursery or obtained from a reputed local nursery subject to the approval of Engineer. Upon award of the contract the contractor shall submit a schedule indicating all plant species, source etc for the Engineer's inspection and approval.

19.37 All trees shall be double staked using straight timber, free of projections and pointed at one end. The stakes shall be hardwood, pressure impregnated and treated with non-injurious wood preservative applied at least two weeks prior to use. The stakes shall be 50 x 50 mm in section and 3000 mm in length.

10 Nos. sample stakes shall be provided and installed at site upon award of the contract for the Engineer's observation and approval. Stakes shall be green in colour.

19.38. The tree ties shall be 2 Nos. rubber ties per stake and shall be capable enough for site adjustments during maintenance.

19.39. Anti desiccant shall be an emulsion type, film forming agent designed to permit transpiration, but retard excessive loss of water from plants.

19.40. Bark mulch shall be coarse textured bark chippings spread to a depth of 75 mm to Engineer's approval. Gravel mulch shall be 20mm dia local water washed rounded gravel, spread to a thickness of 75mm to the Engineer's approval.

19.41. Pruning paint shall be water proof, antiseptic, adhesive, elastic and free of kersosine, coal, tar, creosote and other substances harmful to plants.

19.42. The soil separator membrane shall be used in all palm and tree pits below and above the gravel layer and on the sides of the pits. Sufficient overlapping shall be provided to ensure that there are no gaps in the installation. The membrane shall be geotextile non woven 100% polypropylene, weighing 140 gms/m^2. It shall have a thickness of 0.45 mm and good permeability to water. It shall be capable of resisting all naturally occurring soil additives and shall be resistant to tearing and stress.

19.43. Subsoil shall be excavated to achieve tolerances specified for finished level of soil and when reasonably dry and workable, graded to smooth, flowing contours with all minor hallows and ridges removed. Non-cohesive, light subsoils shall be loosened with a three-tine ripper, three hundred (300) mm deep at one (1.0) m centres. All perennial weeds shall be treated with herbicides and the period of time recommended by the manufacturer shall be allowed to elapse before grading.

19.44. Edges: unless otherwise stated, finished levels of sweet soil after settlement, shall be:

50 mm below adjoining paving or kerbs for shrubs and groundcovers.
25 mm below adjoining paving or kerbs for grass.
not less than 150 mm below the adjoining buildings.
married with adjoining soil areas.

19.45. Where finished levels are not given, the levels shall be such that the finished surface will be a smooth even fall (or gently flowing curve if shown) between the finished levels and the boundaries of the areas.

19.46. Grass areas shall be excavated to a depth of three hundred (300) mm below finished levels. Grass areas shall be brought up to finished levels by spreading three hundred (300) mm of agricultural soil. When reasonably dry and workable the agricultural soil shall be graded to smooth, flowing contours with all minor hollows and ridges removed

19.47. Group shrubs areas shall be cultivated to a depth of six hundred (600) mm. Planting medium shall be spread evenly over planting areas to a depth of six hundred (600) mm prior to planting.

19.48. Groundcover and annual areas shall be excavated to three hundred (300) mm depth. Planting medium shall be spread evenly over planting areas and cultivated to a depth of three hundred (300) mm prior to planting.

19.49. All weeds, rocks and other debris shall be removed and disposed of.

19.50. The Contractor shall ensure that all planting positions are well drained.

19.51. Planting sequence shall be:-

a) Grading grade soil as specified.

b) Setting out: Stake out the outline of planting areas approval by the Engineer.

c) Excavation and drainage: Excavate planting pits to specified sizes for trees, palms, shrubs, vines. Check drainage for all tree pits using pecolation test. Fill each pit with water and using a fixed marker bar check the level of water falls at least 10 mm in any one hour. If this amount of drainage is not achieved the pit has failed the test and the pit must be augered until satisfactory drainage is achieved. Plants shall be planted in pits. The pit area shall be moistened before excavation and the sand completely removed.

In the event that obstructions are encountered in any plant pit, the obstruction shall be removed to a depth not less than 1 m below grade and no less than 15 cm below bottom of ball or roots when plant is properly set at the required grade.

Recultivate planting areas to 300 mm depth if left for any length of time. Remove all weeds and rubbish.

Large excavations for ground cover beds and grass areas shall be backfilled with planting medium to a depth of 2 cm below final grade.

Additives and fertilizers shall be evenly spread across the surface of the beds and incorporates by two passes of a powdered rotovator.

d) Backfilling: Backfill pit/beds after having been tested for drainage with approved planting medium in layers not exceeding 300 mm and water compact. Allow for compaction/subsidence by overfilling by 100 mm. Once placed the growing medium shall be covered with plastic sheeting and until planting commences clearly marked to prevent disturbance.

19.52. The grass areas shall be backfilled with sweet soil to a depth of 2 cm below final grade. Additives and fertilizers shall be evenly spread across the surface of the beds and shall be incorporated into the soil by two passes of a powered rotovator.

19.53. Mix the specified soil additives with sweet soil at the rates specified. The soil shall be mixed mechanically by an approved method to create a homogeneous mixture . Application rates for the ameleorants shall be checked and approved by the engineer prior to mixing each batch.

19.54. Planting operation shall be carried out by experienced workmen familiar with planting procedures under the supervision within the limits of work shall be relocated on the site as directed by the engineer.

19.55. The feature trees selected should be matured with at least 3.00 m- 5.00m spread and 3 to 4 m clear trunk depending on the species and as indicated on the plant schedule. The trees should be well formed with uniform canopy and branches on all sides.

19.56. Tree pits shall be excavated one (1) m square by one point two (1.20) m deep from finished grade and the pit bottoms shall be broken up to a further depth of two hundred (200) mm. Excavated material shall be disposed off at the Contractor's expense.

19.57. Before planting, any broken or damaged roots shall be cut back to sound growth; any cut ends over twenty five (25) mm diameter shall be treated with tree wound dressing.

19.58. For bare-rooted trees, backfilling shall be placed in one hundred and fifty (150) mm to two hundred and fifty (250) mm layers to ensure close contact with roots and to eliminate air pockets. Firming shall take place as backfilling proceeds, so as not to damage roots; the soil shall be heeled in firmly around the root collar.

19.59. For root-balled trees, backfilling shall be firmed around the root-ball in one hundred and fifty (150) mm layers, so as not to disturb the roots.

19.60. All trees shall be placed in the centre of the pits and at the original soil depth and watered thoroughly after backfilling. all trees shall be surrounded by a water-holding depression, one hundred (100) mm deep.

19.61. Pits shall be excavated to the size of 2.0m x 2.0m x 2.0m for matured trees and the pit bottoms shall be broken up to a further depth of 200 mm. The pit shall not be deeper than the root ball. Place the tree in the centre of the pit and backfill with sweet soil mix. Firming shall be done while backfilling without damaging roots. Care should be taken to eliminate air pockets and ensure sweet soil to be in close contact with the roots. Form a basin around the tree and water judiciously.

19.62. The Contractor shall stake all trees as follows:

Standard trees:

After planting, two stakes shall be inserted into the tree pit with a minimum of one third below ground level and two thirds above ground level.

For root-balled trees and those in containers a crowbar or similar tool should be used to probe through the root system to make a pilot hole into which the stake can be driven with minimum root disturbance.

The tree shall be secured firmly, but not rigidly, to the stake with at least two (2) ties, to prevent abrasion between the stake and the tree. The top tie shall be positioned twenty five (25) mm from the top of the stake and the lower tie approximately halfway down.

The preparation for removal of matured trees should commence about 4 months prior to uprooting. Trenches of 1.0 m radius from the centre should be made around the tree. The depth of the trench should be 1.50 to 2.0 m and shall be backfilled with peat moss. Copious watering schedule to be followed until removal.

Root pruning should be minimal to get a root ball of about 1.5 m diameter. Prune 30% of the branches uniformly one week prior to uprooting without affecting the shape of the trees. Spray anti-desiccant prior to removal of the trees from the site.

Care should be taken to avoid damages to the roots while removing and the root ball may be burlaped.

The uprooted trees should not be exposed to direct sunlight or heat. While transporting, the uprooted trees should be protected with shade nets.

All matured trees shall be planted at site in adequate size pits filled with soilmix irrespective of the tree pit sizes mentioned for ordinary trees.

Extra Heavy Standard Trees:

After planting, three stakes shall be inserted into the tree pit equidistantly around the tree trunk with a minimum of one third of each stake below ground and two thirds above ground level. For root-balled trees and for those in weld mesh containers, the stakes shall be driven clear to the root-ball to avoid damage to the root system. The tree shall be secured firmly, but not rigidly, with approved proprietary ties.

19.63. Removal of Palm Trees

Palm trees selected for removal should be matured with 4.0 m clear trunk. The trunk of all the trees should be clean, straight and uniform.

Make trenches of 2.0 m depth about 1m away from the centre around the tree about 4 months before uprooting. Backfill the trenches with peat moss and follow copious water schedule thereafter. Root pruning to be minimal to get the required rootball of about 1 to 1.5m diameter.

Prune 30% of the fronds about a week prior to uprooting and water judiciously. Spray anti desiccants before removal from the site. Burlap the fronds with hessian cloth. Remove the trees without damaging the roots.

The uprooted trees should not be exposed to direct sunlight or heat. The trees are to be protected with shade nets while transporting.

19.64. Planting Palms:

Palms shall be planted in prepared pits, sizes as specified, transplanting, backfilled firmed in and watered, all as specified and to the approval of the Engineer.

Excavate pits of size 2m x 2m x 2m and backfill sweet soil mix in layers of 150mm up to about 500mm depth. Place the palm tree in the centre of the pit and continue backfilling. While backfilling water and firm up the soil to eliminate air pockets. Care should be taken to avoid damages to the roots when firming up in the soil. Form a basin around the tree and water judiciously.

Trunk burlap, frond wrapping and dead fronds shall be removed after new growth indicates that turgor has been restored or after the second growing season.

19.65. Planting Plants:

Planting holes for shrubs, climbers, succulents and ornamental grasses shall be excavated to a depth of six hundred (600) mm below finished grade and to 600 mm x 600 mm square. Beds shall be excavated to a depth of 600mm.

Whenever the root-ball, container or root system is of such a dimension as to prevent backfilling to be carried out adequately, the diameter of the hole shall be increased to a dimension five hundred (500) mm greater than that of the root-ball, etc. The bottom of the hole shall be broken up to a further depth of one hundred (100) mm.

Groundcover and annual beds shall be excavated to a depth of three hundred (300) mm below finished level.

Plants shall be set plumb and such a level that after settlement they will bear the same relationship to the level of the surrounding ground as they did in the nursery.

Earth-balled hessian covered plants shall have all cloth, ropes, etc., removed from the tops of the earth-balls but no cloth shall be removed from under the earth-balls.

Bare-rooted plants will not be accepted.

Disturbance of the root system or the balls of earth shall be avoided when removing plants from containers. Can cutters shall be used on metal containers

Plants with broken root-balls or root-balls that fall apart while being planted will be rejected by the Engineer.

Prepared planting medium shall be carefully packed around the root-ball in one hundred and fifty (150) mm layers and well heeled in to position the plant and eliminate all air pockets.

The plants shall be thoroughly watered when the plant area is backfilled to the base of the root-ball with planting medium. When the water has drained away completely, backfilling will be completed and the plant watered again.

Climbing plants shall have their leading shoots trained around the supporting wire mesh.

19.66. Pruning:

Immediately after planting, all plants are to be pruned as expressly required by the

Engineer and in accordance with accepted horticultural practices.

Pruning shall consist of carefully cutting back any damage, dead or diseased branches; the removal of any weak or malformed growth, with the aim of forming each type of stock to the standard shape for its species.

All pruning cuts greater than nineteen (19) mm shall be treated with an approved tree wound dressing.

19.67. Protection:

Newly planted trees and plants shall be protected where necessary until plants are established.

Any damage to planting shall be made good and the ground reinstated if disturbed, at the Contractor's expense.

19.68. Grass Stoons:

The grass stolons used for the project shall be paspallum vaginatum and no substitutions will be allowed. The contractor shall submit the proposed source of stolons to be used for the project along with his tender.

Preparation:

a) Prior to beginning planting operations the irrigation system must be completely commissioned and operational.

b) Bring the water content of the area to be planted to field capacity and allow water to percolate until standing water disappears.

c) Cultivate to a depth of 100 mm.

d) Keep dry dormant stolons refrigerated 0-3 degree C, until the area to be planted is prepared. Do not exceed two weeks of refrigeration. Soak stolons in water after removing from cold storage and prior to planting.

e) Do not exceed two days of storage on job site. Stolons are to be kept moist, shaded and ventilated during such storage.

f) Plant during the time of year when day time temperature do not exceed 38 degrees C and night time temperatures are not below 15 degrees C. Mean temperature should exceed 26 degrees C. Water within 15 minutes of planting at 38 degrees C, 30 minutes at 28 degrees C, 60 minutes at 21 degrees C and 120 minutes at 16 degrees C.

g) Plant utilizing a disc to cut in stolons and followed by a cultipacker roller, or other technique approved by the Engineer.

h) Water as necessary to keep the stolon bed moist until germination. Once grass is up begin lengthening intervals between irrigation cycles.

19.69. Water Plants:

Planting Medium: Heavy clay loam soil shall be used. The medium shall not be mixed with vermiculite, perlite, peat moss or any other similar material that will float. Do not use potting soil.

Planting: Water lilies should be planted in fabric pond pots or no hole plastic pots of about 30cm diameter and 25 cm deep. Planting should be done during the period of the year when the mean temperature is above 26 degrees C. Fill half of the pot with the planting medium and add 2 to 4 slow release fertilizer tablets (10:20:10 with Magnesium and other micro-nutrients). Ensure that the fertilizer tablets are not touching the rhizome. Then fill the planting medium up to about 5 cm from the top of the pot. Immediately on receipt of the plants rehydrate the rhizomes. Plant the rhizome at one edge of the container so that the non-growing end touches the side of the pot. Place the rhizome at about 45 degree angle in such a way that the crown is just above the soil line and the base of the rhizome is completely under the soil. Tamp the soil around the rhizome firmly to ensure it does not float when submerging the pot. Do not cover the growing point of water lilies with gravel or soil. Submerge the pot very slowly to a depth of approximately 15cm over the crown of the water lily. As the plants grow, it can be lowered further.

Other water plants shall be planted the same way as water lilies in pots of about 20cm diameter and 25cm deep while planting add 1 to 2 slow release fertilizer tablet submerge the containers slowly to a depth of about 10 to 15 cm.

All consumable, fertilizers, agro-chemicals, stakes, tree ties and tertiary irrigation fittings and consumables required during the 12 month maintenance period shall be provided in accordance with the Contract Specification.

Schedules are to be made with quantities of fertilizers, consumables, agro-chemicals, stakes, tree ties, tertiary irrigation fittings and all other consumables required during the 12 month maintenance period.

All maintenance work is to be undertaken by skilled gardeners under experienced supervision to good horticultural standards, all machinery required for these purposes shall be maintained in good working order and shall include a roller type lawn mower, strimmer, edging machine, sprayer, hedge trimmers, branch shears and other garden tools.

19.70. Operations & Maintenance Manual:

The Contractor shall compile a comprehensive Operations and Maintenance Manual which will include the following:

a. Pesticide/fungicide applications - including safety application rates and procedure, schedules of pesticides/fungicides/herbicides.

b. Irrigation Land Drainage and Storm water Drainage-including water application rates and maintenance procedures.

c. Fertilization - including fertilizer descriptions, application rates and programmes.

d. Salinity Control - including leaching methods and leaching programme monitoring.

e) Turf Grass Management - including mowing procedure, replacement of turf grass by stolons and sods and routine management procedures, aerification, top dressing, vertical mowing thatch removal, rolling and overseeding.

f) Propagation and seasonal replacement of all flowers in the flower garden.

g) General Maintenance - including pruning, stakes and ties, beam work, replacement and clean-up, protective fencing, etc.

h) Equipment Inventory, maintenance procedures and full manufacturers maintenance manual.

i) Personnel.

j) A schedule of plants used for the Project with quantities.

k) As-built drawings on 1:250 scale.

l) Original catalogue copies of all fertilizer, other chemicals, manure, etc.

m) This manual shall be submitted for approval to the Engineer by the contractor at least one (1) month before practical completion and should be approved prior to the commencement of the maintenance operations.