



United Nation Development Program



**Emergency Water Supply and Rehabilitation Programme
PAL 10-00052737**

"Construction Of Tal El-Sultan Water Networks in Rafah "

General and Particular (Technical) Specifications

**Center for Engineering and Planning (CEP)
&
Engineering & Management and Planning (EMCC)**

A) Special Specifications

1. INSTALLATION CONDITIONS

The pipes, fittings and appurtenances, subject of the enclosed particular technical specification, are to be installed in the Gaza strip.

- Place of installation: Tal Sultan /Rafah
- Country: PALESTINE
- Altitude: Sea Level
- Outside temperature ranging between: 5 and 40 °C
- Temperature inside the buildings ranging between: 10 and 40 °C
- Relative humidity ranging between: 60 and 100 %
- Climatic conditions:
Mediterranean, dry summer, sub-tropical climate with mild winter
- Soil: generally sand, clay

2. TEMPORARY WORKS AND REINSTATEMENT

The Contractor shall provide and maintain all temporary roads and tracks necessary for movement of plant and materials and remove them on completion and make good all Works damaged or disturbed.

The Contractor shall submit Drawings and full particulars of any Temporary Works to the Engineer before commencing.

The Engineer may require modifications to be made if he considers them to be insufficient and the Contractor shall give effect to such modifications but shall not be relieved of his responsibilities for their sufficiency.

The Contractor shall provide and maintain weatherproof sheds for storage of materials pertinent to the Works both for his own use and for the use of the Operator and remove on completion of the Works.

The Contractor shall construct the valve chambers and lay the pipes and fittings to avoid all public utilities encountered during the progress of the Works, except those utilities specifically detailed on the Drawings as being required to be diverted.

The Contractor shall make good, at his own expense, all damage to properties, land surface, roads and any public or private utilities.

3. EXISTING FACILITIES

The existing facilities must be kept in continuous operation throughout the construction period. No interruption will be permitted which adversely affects the degree of service provided. Provided permission is obtained from Operator via the Engineer in advance, portions of the existing facilities may be taken out of service for short periods corresponding with periods of minimum service demands.

4. LINES AND GRADES

The Contractor shall keep the Engineer informed, a reasonable time in advance, on the times and places at which he intends to do work, in order that lines may be established and necessary measurements for record and payment made with a minimum of inconveniences to the Engineer or delay to the Contract.

The Engineer will furnish the Contractor with such basic lines as he, the Engineer, deems necessary, but this shall not be construed to mean all lines, elevations and measurements. It shall be the Contractor's responsibility before commencing any section of the Work to locate any permanent benchmarks to be used. The Contractor shall refer all temporary benchmarks used.

The Contractor shall be responsible for the stakeout surveys for construction purposes and the replacement of monuments and property, markers disturbed by the work. The survey shall proceed in advance of the construction at a rate satisfactory to the Engineer. The Contractor shall be responsible for the accuracy of his work and shall maintain all reference points, stakes, etc., throughout the life of the Contract. Damaged, destroyed or inaccessible reference points, bench marks or stakes shall be (replaced by the Contractor). All computations, survey notes and other records necessary to accomplish the Work shall be neatly prepared by the contractor and made available to the Engineer upon request or furnished upon Contract completion.

The Contractor shall provide all instruments, equipment, stakes and other material necessary to perform the Work.

Any existing stakes or markers defining property lines and survey monuments which may be disturbed during construction shall be properly tied in to fixed reference points before being disturbed and accurately rest in their proper position upon completion of the Work.

5. SUBSURFACE STRUCTURES AND ALL UTILITIES

Before beginning excavation operations, the Contractor shall contact the specified departments of the Municipality and utilities and notify them of his intention to begin excavation operations.

The Drawings may not show any utility services, any of which may exist in the area. There may be certain other facilities in the work areas not listed or not shown on the Drawings, including all service connections that must remain in service.

It shall be the responsibility of the Contractor to determine the exact location of such pipeline, subsurface, structures and/or utilities ahead of his Work by exploratory excavation or other means and to take suitable precautions to prevent damage to them and to prevent interruption of the services which such facilities provide. Where pipelines, cess pits, subsurface structures and/or utilities encountered in the Work coincide with the location of the Operators chambers and/or water pipes and the Engineer deems it advisable, the location of the valve chambers and/or water pipes may be changed to avoid the facilities. Where the Engineer does not deem it advisable to relocate the Operator's chambers and/or water pipes and where the pipeline, subsurface structures and/or utilities require relocation before the work can proceed, the Contractor shall notify the Engineer and the owner of the facilities of the location and circumstances and shall cease Work, if necessary, until the Engineer can establish satisfactory procedures to properly divert the facilities in conflict with the Operator's chambers and/or water pipes.

6. SAFETY OF ADJOINING EXISTING BUILDINGS

The Contractor shall take all necessary precautions during the excavation for the Works particularly those excavations which are adjoining existing buildings and shall protect these buildings from damage or collapse by means of temporary or permanent shoring, strutting, sheet piling or underpinning or excavation in short length and/or other methods as he deems fit. Also, he shall properly support all foundations, trenches, walls, floors, etc., affecting the safety of the adjoining existing buildings.

The Contractor shall keep the Engineer informed as to the manner in which he intends to proceed with the execution of the excavations and obtain his approval; such approval if given shall not absolve the Contractor of his responsibility under this clause.

The Contractor shall save harmless and indemnify the Operator in respect of all claims, demands, proceedings, damages, costs, charges and expense whatsoever arising out of or in relation to any such matters in so far as the Contractor is responsible under this clause.

7. WATCHING

The Contractor shall allow for all necessary watching for the security of the Works and the protection of the public, including shelter and fuel for any watchman as required.

8. WATER FOR THE WORKS

The Contractor shall obtain all necessary permission from the PWA and Municipalities to provide water for the Works, with all temporary plumbing and storage, pay all charges, and alter, adapt and maintain temporary work as necessary and remove and make good on completion.

9. ELECTRICAL POWER AND LIGHTING FOR THE WORKS

The Contractor shall provide all necessary artificial lighting and power for the execution and security of the Works and for protection, with all meters, temporary wiring and fittings, etc., pay all charges, and alter, adapt and maintain the temporary work as necessary and remove and make good at completion.

10. MEDICAL FACILITIES

The Contractor shall arrange for medical attention to be available when necessary and shall provide dressing stations complete with all adequate first aid equipment within easy access of each Works area on the site.

The Contractor shall display in suitable places and names of his employees who are available from time to time to render first aid. The Contractor shall provide for the transport of serious cases to the nearest hospital.

11. CUSTOMS AND LOCAL DUES

All state dues, tolls rates, duties, fees and charges in connection with the Works shall be paid under a provisional sum item.

12. MATERIALS, GOODS AND WORKMANSHIP

Pipes, valves and fittings to be supplied by the Operator and/or the Contractor are specified in Particular Specifications.

Materials to be supplied by the Contractor and his workmanship shall be of a quality fit for purpose and comply with the International and/or Local Standards and approved by the Engineer.

13. IMPORTED MATERIALS

The Contractor is required to produce documentary evidence that all imported materials or items (if any) have been ordered within one week from the date the site is handed over for the commencement of the Works. This means materials or items which have to be ordered from abroad. As soon as orders have been placed, copies of such orders shall be submitted to the Engineer.

14. PERIODIC REPORTS

The Contractor must present to the Engineer's Representative detailed reports and schedules as stipulated in the Conditions of Contract, and shall prove to the Engineer the correctness of the above mentioned reports without having the right to claim for any extra payment or compensation whatsoever in regard or in relation to such reports.

15. PHOTOGRAPHS

The Contractor shall furnish the engineer's representative with a camera suitable for producing colour record photographs. The contractor will pay for all developing of the photographs taken by the Engineer's Representative. These costs shall be included in the unit prices of the works as listed in the Bill of Quantities.

16. SITE PROGRESS MEETINGS

Site Progress meetings shall be held at regular intervals at least once every week in the presence of the Engineer for the purpose of monitoring the Contractor's progress and to ensure that full compliance with the specifications and programme is being achieved, copies will be distributed to all persons concerned and full effect shall be given to all instructions contained therein.

Prior to such meetings the Contractor shall give to the Engineer's Representative details in writing of that portion of the Works he proposes to construct during the coming two weeks with details of the plant and methods he proposes to employ. These proposals shall be discussed at the meeting and no work based on such proposal shall proceed without the approval of the Engineer's Representative.

17. CANCELLATION DUE TO SLOW PROGRESS

If the Engineer shall be of the opinion that the Contractor will be unable to complete any section of the Works by the time specified or by such extension thereof as he may be entitled to, under the Contract and the Contractor has failed to carry out steps and to expedite the work in accordance with the Conditions of Contract or, if the Engineer is of the opinion that such steps are inadequate, the Engineer may, by written order, omit the whole or any part of the uncompleted work included in that section and the Operator shall be at liberty to execute such omitted work by

his own workmen or by other contractors. If the cost of such omitted or incomplete work shall exceed the sum which would have been payable to the Contractor on due completion of the said work, then the Contractor shall, upon demand, pay the Operator the amount of such excess and it shall be deemed a debt due by the Contractor to the Operator and shall be recoverable accordingly.

18. CARE OF THE WORKS

The Contractor shall keep all persons (including those employed by sub-contractors) under control and within the boundaries of the Site. He will be held responsible for the care of the existing premises and of the Works generally until their completion, including all work executed and materials, goods and plant (including those of sub-contractors and Suppliers) deposited on the Site; together with all risks arising from the weather, carelessness of work people, damage or loss by theft or any other cause; and he shall make good at his own expense, all such damage and loss.

19. PROTECTION FROM WEATHER AND FLOODS

The Contractor shall keep the Works well drained until the Engineer certifies that the whole of the Works is substantially complete and shall ensure that so far as is practical, all work is carried out in the dry weather. Excavated areas shall be kept well drained and free from standing water.

The Contractor shall construct, operate and maintain all temporary dams, watercourses and other Works of all kinds including pumping and well point de-watering plant that may be necessary to exclude water from the Works while construction is in progress. Such temporary Works and plant shall not be removed without the approval of the Engineer's Representative.

The Contractor shall be responsible for keeping the Works safe at all times particularly during any floods and or making good at his own expense any damage to the Works including any that may be attributable to flood. Any loss of production of additional costs of any kind that may result from floods shall be at the Contractor's own risk.

20. CLEARING AWAY

The Contractor shall take down and clear away all plant and temporary Works, including sheds, mess rooms, sanitary conveniences, offices, latrines, sign-boards, and other temporary Works, unless otherwise described, and made good.

The Contractor shall remove all existing rubbish and debris and surplus materials from the site as they accumulate and at completion; and clean all surfaces.

21. SITE ALONG PIPELINES IN ROADS

Wherever practicable the Site along pipelines in roads shall be maintained for vehicular traffic and pedestrians.

The Contractor shall provide access to all properties including garages fronting on such roads at all times.

The Contractor shall assume and have full responsibility for the adequacy of safety provisions on all streets, roads, private ways and walks affected by his work.

22. TRAFFIC SAFETY, CONTROL AND CLOSING OF ROADS

The Contractor shall not close any road until the Authority having charge of the road surfaces shall have previously given the appropriate notice or made the appropriate order and without the Contractor having first obtained the written consent of the Municipality to close the road. In the event of such consent being refused, the Contractor shall have no claim for any additional payment.

1. The Contractor shall provide, erect and maintain such traffic signs, lamps, barriers and traffic control signals as may be necessitated by the construction of the Works in accordance with the Municipality and Police requirements. The Contractor shall submit proposals for dealing with such situations to the Engineer and Police for consent. Compliance with this Clause shall not relieve the Contractor of any of his other obligations and liabilities under the Contract.
2. The Contractor shall, after consultation with any statutory or other authority concerned, submit to the Engineer for his approval a program based on such consultation showing the scheme of traffic management he proposes for carrying out the Works before commencing any work which affects the use of the public highway rights of way or parking areas and thereafter furnish such further details and information as necessitated by the Works or as the Engineer may require.
3. The Contractor shall not commence any work which affects the public highway until all traffic safety measures necessitated by the work are fully operational.
4. The traffic diversions and signs, lamps, barriers and traffic control signals shall be in accordance with the requirements of relevant Authority.
5. Traffic signs shall comply with the requirements of the Municipality.
6. The Contractor shall keep clean and legible at all times all traffic signs, lamps, barriers and traffic control signals and he shall position, re-position, cover or remove them as necessitated by the progress of the Works.

23. ROADS TO BE KEPT CLEAN

The Contractor shall take great care and all reasonable precautions to ensure that the roads and thorough fares used by him either for the construction of the Works or for the transport of plant, labour and materials, are kept clean at all times.

24. PROGRAMMING

In preparing his programme of Works, the Contractor shall pay due regard to the priority required by certain Works, all periods required for statutory notices, other construction projects in the area and traffic management requirements of the Municipalities.

25. INSPECTION

The Contractor shall employ works foremen to supervise and inspect the work of the construction or pipe-laying gangs.

The Contractor shall submit and agree site records to the Engineer's Representative on a weekly basis, including but not limited to the following:

1. Daily records of plant, materials and operators employed on the site.

2. Test certificates of all materials, concrete cube tests and hydraulic tests undertaken.
3. Daily records of works installed and tested including, house connections,
4. Records of the trench conditions encountered.
5. Full records of all works undertaken to adequately support the measurement to be agreed.
6. Records of all delays to the programme.
7. Stock control and materials schedules cross - referencing.
8. Records and registers of all correspondence, technical queries, site instructions, variation orders, daily work record sheets, day work sheets, drawing issues, drawing revisions and any claims.
9. Marked up prints of specifications, construction drawings and standard details to fully reflect the as - built conditions.

26. PROTECTION OF FINISHES

The Contractor shall take every care to prevent damage to the Works from whatever cause and shall ensure that adequate protection is given to all Works from the activities of following trades and nominated sub-contractors. Vulnerable parts of the work particularly liable to damage shall be protected as may be reasonably required by the Engineer's Representative.

27. CO-OPERATION WITH OTHER CONTRACTORS

The Contractor shall note that other Works may be constructed in the Site of Works. He shall liaise, co-operate and co-ordinate his operations with the contractors of other Works and organise their respective contracts so as to minimise interference to each other and to the public.

28. SUPPRESSION OF NOISE AND POLLUTION

The Contractor shall make every reasonable endeavour both by means of reasonable hours of work, temporary Works and by the use of particular plant or silencing devices to ensure that the level of noise or pollution resulting from the execution of the Works does not cause nuisance to the Public.

The Contractor shall take all such precautions as may be necessary in the conduct of the work to avoid water pollution, air pollution, noise pollution harmful to health, spreading of plant diseases and pests or damage to natural resources or the environment, all as is consistent with good practice and as required by applicable laws, ordinances and regulations or lawful orders or authority having jurisdiction.

29. PROTECTIVE EQUIPMENT AND CLOTHING

The Contractor shall provide and maintain all necessary protective and safety equipment and clothing for the operatives and Site staff and ensure that they are used.

30. DELAYS AND NON-PRODUCTIVE TIME

The Contractor shall be deemed to have allowed for all delay caused by difficulty in obtaining labour and materials or by suspension of part of the Works due to adverse and inclement weather conditions.

The Contractor shall allow for all costs incurred by non-productive time.

31. CLEANING UP

During its progress the work and adjacent areas affected thereby shall be kept clean and all rubbish, surplus materials and unattended equipment shall be removed and all damage repaired in a timely manner so that the public and property owners will be inconvenienced as little as possible.

Where material or debris has washed or flowed into or been placed in existing watercourse, ditches, gutters, drains, pipes, structures, work done under this Contract, or elsewhere during the course of the Contractor's operations, such materials or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipes, structures and work, etc., shall, upon completion of the work, be left in a clean and neat condition.

The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment, to a condition at least equal to that existing immediately prior to the beginning of operations.

The Contractor shall thoroughly clean all materials and equipment installed by him and his sub-contractors and on completion of the work shall deliver it undamaged and in new condition.

32. PERMITS, LICENSES AND FEES

The Contractor shall obtain and pay for all construction permits and licenses. The Operator shall assist Contractor, when necessary, in obtaining such permits and licenses. The Contractor shall pay all governmental charges and inspection fees necessary to carry out the work. The Contractor shall also pay all charges of utility service companies for connections to the work. These costs shall be reimbursed through a provisional sum.

33. ASSISTANCE TO THE ENGINEER'S REPRESENTATIVE

The Contractor shall give such assistance and supply such labour as may be required by the Engineer's Representative in connection with the Contract when required.

Such labour shall be retained in the employment of the Contractor, but shall operate and perform their duties under the direction of the Engineer's Representative.

34. VEHICLES FOR THE ENGINEER'S STAFF

NA

35. OFFICES FOR THE ENGINEER'S REPRESENTATIVE

The Contractor shall provide suitable site offices for the use of the Engineer's Representative and his assistants, throughout the period of construction. The site offices shall be constructed in a location approved by the Engineer's Representative during the mobilisation period. The offices shall be of fixed type and shall have walls, ceiling and partitions lined with Mansonite hardboard or similar material. All rooms shall have glazed windows complete with fly screens. Adequate fitted hardware, electrical switches, sockets, lighting, and plumbing fittings, sanitary ware and fittings and fixtures etc., shall be provided as necessary for the different areas.

The site offices shall be equipped, serviced and maintained in a clean, weatherproof and sanitary condition. Each operational site shall be provided with one office.

The electrical installation shall provide for simultaneous use of all electrical appliances.

The Contractor shall arrange for a temporary power supply to the offices and provide and maintain adequate diesel generator sets. All electricity bills shall be paid by the Contractor.

The Contractor may either arrange for a temporary main water supply or alternatively provide tankered water supply.

Throughout the duration of the Contract, the Contractor shall ensure an uninterrupted supply of water and electricity to the offices.

The offices shall be completed and all the equipment provided by the Commencement of the Permanent Works.

The Contractor shall provide all items listed in the attached Schedules.

Specific Requirements

1. The Contractor shall be responsible for making all arrangements and payments in respects of any land required for the site of the office building.
2. The Contractor shall be responsible for the security of the building and its contents at all times, cover all the operation and maintenance costs for the building and equipment provided and shall employ watchmen for this purpose.
3. The building shall become the property of the Contractor after the completion of the Works.
4. All offices furniture shall remain the property of the Contractor and will be returned to the contractor after the completion of the works.

SCHEDULE OF OFFICES

The requirements of the site offices on this contract are as follows:

<u>Room No.</u>	<u>Description</u>	<u>Size Requirement</u>
1	Supervision	4m x 3m
2	Toilet	1.5m x 2m
3	Kitchen	2m x 1.5m

SCHEDULE OF Furniture

The Furniture required under this contract for the site offices indicated in the schedule of offices shall be to the Engineer’s approval and are as follows:

<u>Item</u>	<u>Description</u>	<u>Quantity</u>
a	Desk with two locking drawers and chair	1
b	Chair plastic covered, padded steel frame	4
c	Samples cupboard	1
d	Four drawers steel filing cabinet	1
e	In/out tray	1
f	Waste paper basket	1
g	2 ring gas burner	
h	Fan	1

The costs for these items shall be included in the contractor’s unit prices.

36. SIGNBOARDS AND BOARDS

The contractor shall erect signboards and boards in prominent positions adjacent to the work to the satisfaction of the engineer as per the attached sketch.

The materials of construction shall consist of the following:

Posts and Struts	Timber or Galvanised steel tubes coated in extruded grey PVC
Foundations	Concrete
Backboards	Timber or ply, painted white wood
Signboards	Plastic or other approved
Fixings	By the Contractor

The Contractor shall be responsible for the structural design of all posts, struts, fixings and foundations.

All the text and logo shall be dark blue on a white background

The number of main signboards to **be supplied is 1.**

The Contractor shall allow for all associated costs in providing, erecting and relocation of this number of signboards when entering an amount in the unit prices provided in the Bill of

Quantities.

In addition to the main signboards mentioned above, the contractor shall supply and install portable two signboards 100x70 cm size and shall indicate names of (project, client, consultant, contractor and Municipality). The price of these signboards shall be included in the contractor's unit prices.

37. COMPUTER

The Contractor shall provide one computer and one laser printer as described below for the use of the Engineer's Representative and his assistants, throughout the period of construction. Computer should meet the following specifications (will be the property of the contractor once the project finishes):

- HP Compaq dc 7600 small form factor
- Microsoft®, Window ®, XP Professional –SP2
- Intel ® Pentium ® 4650 (3.4/800/2M)
- 1GB PC2-4200(DDR2-533)
- 1.44MB, Floppy Drive SFF
- 80GB SATA 3.0 Gb/s HARD Drive
- 16X DVD+/- RW Drive (LS/DL/DF)
- ATI RNX300SE, 128 MB PCIE DVI
- Integrated Broadcom Gigabit NIC
- HP standard keyboard PS/2
- HP USB optical mouse (cbt/slvr)
- 3/3/3(parts/labor/on-site)
- 17" Flat panel screen.
- HP USB 2-Button optional scroll mouse (Carbonated/ silver)
- HP USB 04 Standard Keyboard.

38. Minimum Contractor Staff and Salaries

Beside labours and technicians, the minimum contractor's staff should be as follows

- Project Manager 1
- Site Engineer 1
- Surveyor 1
- Office boy 1

The minimum salaries of the contractor's staff should be as follows

- Project Manager 25 US\$
- Site Engineer 20 US\$
- Surveyor 15 US\$
- Office boy 12 US\$
- Technician 15 US\$
- Labour 12 US\$

B) Particular (Technical) Specifications

EXCAVATION, TRENCHING AND BACKFILLING

1. SCOPE OF WORK

This section covers trenching and backfilling work and shall include the necessary clearing, grubbing and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring and protection work; preparation of sub-grades; pumping and dewatering as necessary or required; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other related work.

No classification of excavated materials will be made. Trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition or condition thereof.

2. SITE INVESTIGATION

The Contractor shall be deemed to have visited the site of Works and satisfied himself as to the nature of the ground and made himself conversant with the local conditions to be encountered during the execution of the Contract.

3. MATERIALS

Construction materials supplied by the Contractor shall include but not be limited to the following:

Backfill

Backfill and fill shall be structurally sound material such as sand or native soil free of rocks, lumps, vegetable and other organic materials, obtained from suitable excavated material and/or from approved borrow pits. The backfill shall be appropriate for the existing road or paving construction to be reinstated as required.

Water shall be clean potable water free from injurious amounts of oil, acid or any other deleterious mineral and/or organic matter.

Concrete for thrust blocks, chambers, cover slabs or used as fill for making up to correct level and areas of over-excavation, shall have a characteristic strength of 25 N/mm².

Pipe bedding and surrounds shall be sand.

The sand shall be clean coarse sand free from dirt or organic materials.

4. SITE PREPARATION

Prior to commencing any excavation work, the Contractor shall establish a horizontal and vertical

survey network, record existing ground elevations and stake the location of trenches to be excavated. The Contractor shall prepare the site for construction by clearing, removing and disposing of all items not indicated on the Drawings to remain or so defined by the Engineer. The Contractor shall obtain relevant excavation and road cutting permits as required before commencing work.

Existing Utilities

The Contractor shall ascertain the whereabouts of all existing utilities on the site both, above and below ground.

The Contractor shall be held responsible for all damages entailed on any of the utilities adjacent to the site resulting from the Works.

All proposed or existing utilities, including buried pipes, sewers, ducts, culverts, cesspits, chambers and the like, in the vicinity of the work site, are to be determined by the Contractor and the location of them is to be shown on the as-built drawings.

Prior to commencement of excavation, the Contractor shall establish the number and location of underground utilities and chambers in the immediate proximity of the work.

Where necessary, the Contractor shall use hand tools to excavate test pits prior to excavation to determine the exact locations of existing utilities. It shall be the responsibility of the Contractor to make such explorations sufficiently in advance of construction to enable the engineer to approve modifications, if any, to be made to the pipeline, structure or conflicting utility. The Contractor shall obtain the permission of the Engineer before commencing any test pits and shall fence, mark and protect them, as required by the Engineer. Test pits shall be refilled by hand as soon as practicable after the necessary information has been obtained.

Cutting of existing asphalt must be carried out by cutting saw.

As the excavation approach sewers conduits, cables or other underground facilities, the excavation shall be continued with care by means of hand tools. Where necessary, the Contractor shall provide temporary support for the existing utilities to prevent damage during his operations. Notwithstanding these provisions, if damage to existing utilities results from the Contractor's operations, such damage shall be repaired without delay by the Contractor to the Utility owner's satisfaction.

If damage to existing utilities causes disruption to Contractor's schedule of work by delaying work in the area of such damage, the Contractor shall re-adjust his programme, methods of working and resources so that critical dates in the schedule for the completion of the Contract are not affected. This shall not be deemed to be an instructed acceleration.

Removal of Existing Structures and Other Obstructions

This work shall include, but not be limited to, the removal of existing structures and other obstructions interfering with the Works. The salvaging of any of these materials for the use for the Operator shall be as directed by the Engineer and unwanted materials shall be disposed off the Site in a satisfactory manner as directed by the Engineer.

Cleaning and Grubbing

The Contractor shall perform the clearing and grubbing (if any), of top soil consisting mainly of loose soil, vegetable and organic matters, drift sand, unsuitable soil and rubbish by scarifying the

areas to be excavated and sidewalks to a minimum depth of 300mm from the natural ground level. All materials resulting from the above operations shall be removed from the site, loaded and transported and off loaded, spread and leveled to approved dumps.

5. SETTING-OUT

The Contractor shall stake-out the work as shown on the Drawings and secure the Engineer's approval of his stake-out before proceeding with construction. If, in the opinion of the Engineer, modification of the line or grade is advisable before or after stake-out, the Engineer will issue detailed instructions in writing to the Contractor for such modification and the Contractor shall revise the stake-out for further approval in accordance with the relevant Clause of the Conditions of Contract.

6. EXCAVATION

The Contractor shall perform all excavation true to line, width and depths shown on the Drawings or to such further lines, depths or dimensions or to reach suitable bearing strata as may be directed by the Engineer.

Keeping Excavations Free from Water

All excavations shall be kept clear of water by pumping or bailing or by well-point de-watering, but the latter system shall not be employed if any danger exists of withdrawing water from the foundations of the adjoining buildings and such water shall be discharged clear of the Works and the method adopted shall in no way contravene with regulations of the Municipalities.

The system or systems to be employed shall be approved by the Engineer. Such approval if given, shall not waive the Contractor's responsibilities and liabilities under the Contract.

Particular attention shall be paid to the installation of sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel and public.

Storing of Suitable Excavated Material

During excavation, materials suitable for backfill shall be stockpiled on the site at adequate distance from the sides of the excavation to avoid over-loading and prevent collapse of the trench walls.

Disposal of Unsuitable and Surplus Excavated Material

Upon the order of the Engineer, all unsuitable and surplus materials shall be immediately removed, loaded and transported off the site area by the Contractor to approved dumps and he shall abide by the relevant local regulations.

7. CUTTING PAVEMENT AND SURFACE MATERIALS

The Contractor shall remove only as much of any existing pavement as is necessary for the installation of the works. The Engineer's Representative may require that the pavement shall be cut with pneumatic tools or cutting saw. Where pavements are removed in large sections, they shall be disposed of before proceeding with the excavation.

From areas within which excavations are to be made, loam and topsoil shall be carefully removed

and separately stored to be used again as directed by the Engineer.

8. SHEETING, SHORING AND BRACING

Except where banks are cut back on a stable slope, excavation shall be sheeted, braced and shored as necessary to prevent collapse of the excavations. 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 which could in any way diminish the width of the excavation to less than that necessary for proper construction, or could otherwise injure or delay the work, or endanger adjacent structures. If the Engineer's Representative is of the opinion that at any point sufficient proper supports have not been provided, he may order additional supports.

The Engineer may direct that sheeting and bracing be cut off at any specified elevation.

All sheeting and bracing not to be left in place shall be carefully removed in such manner as not to endanger the construction or other structures. All voids left or caused by the withdrawal of sheeting shall be backfilled immediately with approved material and compacted by ramming with tools especially adapted to that purpose, by watering or by other means as may be directed.

9. TRENCH EXCAVATION

General Requirements

Trench excavation work shall be performed in a safe and proper manner with appropriate precautions being taken to safeguard workmen and existing structures and utilities against all hazards.

All trench excavation shall be open cut from the surface unless authorised by the Engineer and shall be excavated so that pipes can be laid straight at uniform grade without dips or humps between terminal elevations indicated on the Drawings.

No more trench shall be opened in advance of pipe laying than is necessary to expedite the work. The maximum length of open trench on any line under construction shall be 50m.

The pipe is to be laid in sand bedding, as indicated on the Drawings or directed by the Engineer. The trench is to be excavated by labour to, or to just below, the designated sub-grade, provided that the material remaining at the bottom of the trench is not disturbed. The pipe is not to be laid directly on the trench bottom.

Whenever unstable soil which in the opinion of the Engineer is incapable of properly supporting the pipe is encountered in the bottom of the trench, such soil shall be removed to the depth instructed and the trench backfilled to the proper grade with sand approved by the Engineer.

Hand excavation is the preferred method of excavation and is to be used wherever practicable.

Mechanical Excavation

The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, tree roots, buildings, culverts or other existing property, utilities or structures above or below ground. In all such locations hand excavation shall be used.

Mechanical equipment if used for trench excavation shall be of type approved by the Engineer.

Equipment shall be so operated that the rough trench excavation bottom can be controlled; that uniform trench widths and vertical sidewalks are obtained at least from an elevation 20cm above the top of the installed pipe when accurately laid to specified alignment will be centred in the trench with adequate clearance between the pipe and sidewalks of the trench.

Alignment and Minimum Cover

The alignment of each pipeline shall be fixed and determined from offset stakes. Horizontal alignment of pipes and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe.

Pipe grades or elevations are not definitely fixed by the Contract Drawings; trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the **pipe of 110cm for main lines with surface traffic, 80cm for main lines with no traffic including pavements.** Greater pipe cover depths may be necessary at certain locations, the locations and depths will be determined by the Engineer. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finish ground or pavement surface elevation except where future surface elevations are indicated on the Drawings. Where there is no adequate minimum cover, concrete encasement shall be used as detailed on the Drawings or as directed by the Engineer.

10. DEPTH OF TRENCH

The depth of trench shall be the sum of the **specified cover to pipe plus pipe O.D plus 15cm minimum.**

The trench bottom shall be straight and even so as to provide a good support for the pipe along its entire length and shall be free of roots, stones, lumps and other hard objects that may injure the pipe or its protective coating as applicable.

The sand bedding under the pipe shall be not less than 15cm.

11. WIDTH OF TRENCH

No wide unsupported trenches shall be permitted, in general, within the area of the works and therefore all trenches should conform to the minimum trench widths stated and shall be supported with the use of approved trench sheeting or sheet piles.

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

Trenches shall be excavated with vertical sides between the formation level and an elevation 30cm above the top of the pipe. In the vertical section, the maximum and minimum trench widths shall be the pipe outside diameter plus 30 and 20 cm respectively from both sides of the pipe.

The payment for reinstatement of asphalt shall be in meter run.

The trench width at the ground surface shall be excavated as narrow as practicable but may vary with, and depend upon its depth and the nature of the ground encountered.

12. EXCAVATION FOR VALVE CHAMBERS

Excavation for the valve chambers shall be carried out to the dimensions, lines and grades shown on the Drawings or required by the Engineer.

Should it appear that the bottom of the excavation does not provide a solid base for the chamber, the Contractor shall be required to consolidate the bottom using hand tampers and increasing the moisture content, if required, all as directed by the Engineer.

Any over-excavation at the bottom of the structure shall be restored to the proper grade by filling the over-excavation with suitable material or shall be filled with concrete. In the case of over-excavation in the walls, whether caused by careless work or by the necessity to prevent slides by excavating to a slope or for any other reason, the Contractor shall remove all loose material from the excavation, construct the walls of the structure to the dimensions shown on the Drawings and fill the spaces between the structures and the sides of the excavation with compacted backfill in layers of 15cm thickness. The material of the backfill shall be moistened if necessary and compacted to the level of the adjacent natural soil.

13. UNAUTHORIZED EXCAVATION

If the bottom of any excavation is taken out beyond the limits indicated or prescribed, the resulting void shall be backfilled at the Contractor's expense with thoroughly compacted, selected screened gravel or sand fill as directed by the engineer if the excavation was for a pipeline or with concrete if the excavation was for a structure or a manhole.

14. ELIMINATION OF UNSUITABLE MATERIAL

Suitable material shall comprise all material that is acceptable in accordance with the Contract for use in the Works. Suitable material for earthworks shall be approved soil with a plasticity index not exceeding 6% obtained from excavations within the Works or from borrow pits approved by the Engineer. It shall not contain an excess of fines.

Unsuitable material shall be deemed to be:

- Rock particles exceeding 50mm in size.
- Organic material, stumps and other perishable material.
- Material susceptible to spontaneous combustion.
- Soils of liquid limit exceeding 40% and/or plasticity index exceeding 6%.
- Any other material which the Engineer may deem to be unsuitable for earthwork.

If material unsuitable for foundation (in the opinion of the Engineer's Representative) is found at or below the grade to which excavation would normally be carried in accordance with the Drawings and/or structure, the Contractor shall remove such material to the required width and depth and replace it with compacted, selected screened gravel, sand fill or concrete as directed by the Engineer's Representative.

15. DISPOSAL OF SURPLUS EXCAVATION MATERIALS

All surplus excavated materials shall be disposed of by the Contractor, except as otherwise directed or approved by the Engineer.

16. ACCESS ACROSS TRENCHES

The Contractor shall provide temporary, safe access across trenches at crossings where required for the accommodation of travel and to provide access to private property during construction and shall only remove them when the permanent access is reinstated.

17. BACKFILLING

In general, and unless other material is indicated on the Drawings or specified, material used for backfilling trenches and excavations around structures shall be suitable material.

18. FILL AND BACKFILL UNDER STRUCTURES

Unless otherwise indicated or specified, all fill and backfill under structures shall be compacted.

The percentage of compacting for backfill shall be 98% maximum density at optimum moisture content.

19. BACKFILLING AROUND STRUCTURES

The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage as practicable after the structures are structurally adequate and other necessary work has been done, special leakage tests, if required, shall be made. Promptly after the completion of such tests, the backfilling shall be started and then shall proceed until its completion. Suitable material shall be used in backfilling. Unequal soil pressure shall be avoided by depositing the material evenly around the structure.

The material shall be placed and compacted as specified below, insofar as applicable. Compacting shall be accomplished by water-jetting or puddling, if the nature of the material permits, otherwise by tamping.

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

20. BACKFILLING PIPE TRENCHES

As soon as practicable after the pipes have been laid and tested, the backfilling shall be started and thereafter it shall proceed until its completion. Under no circumstances shall water be permitted to rise in unbackfilled trenches after the pipe has been placed.

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

Bedding and Pipe Surround

The pipes shall be bedded on 15cm sand with full 15cm-sand surround. Sand filling around pipe shall be thoroughly compacted by careful hand tamping in layers of 15cm in depth each side and over the crown of the pipe.

Remainder of Trench

The remainder of the trench above the zone around the pipe, shall be filled with suitable material and compacted by tamping or otherwise approved, in accordance with the nature of the material and the existing pavement or road construction.

Tamping

Suitable material shall be deposited and spread in uniform, parallel layers not exceeding 20cm thick before compacting. Before the next layer is placed, each layer shall be tamped as required so as to obtain a thoroughly compacted mass. The Contractor shall furnish and use an adequate number of power-driven tampers, each weighing at least 10kg for this purpose. Care shall be taken that the material close to the bank, as well as in all other portions of the trench, is thoroughly compacted.

To ensure proper compacting by tamping, the material shall first be wet by sprinkling. However no compacting by tamping shall be done when the material is too wet either from rain or too great an application of water to be compacted properly; at such times the work shall be suspended until the previously placed and new materials have dried out sufficiently to permit proper compacting or such other precautions shall be taken as may be necessary to obtain proper compacting.

No superficial load shall be placed on the exposed surface of the trench unless the backfill, if of non-cohesive sand is vibrated or tamped in layers not exceeding 20cm in depth until the Engineer's Representative is satisfied that sufficient settlement has occurred to alleviate live or impact loads.

Miscellaneous Requirements

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

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

When required, excavated material which is acceptable to the Engineer for surfacing or pavement sub-base shall be placed at the top of the backfill to such depths as may be specified elsewhere or as directed. The surface shall be brought to the required grade and stones raked out and removed.

21. PREPARATION OF SUBGRADE

The Contractor shall remove loam topsoil, loose vegetable matter, stumps, large roots, etc..., from areas upon which material will be placed for grading. The subgrade shall be shaped as directed by the Engineer and shall be so prepared for forking, furrowing or plowing that the first layer of the new material placed therein will be well bonded to it.

UPVC AND HDPE PIPES, FITTINGS AND HOUSE CONNECTIONS

The contractor shall install and test the pipes, fittings and appurtenances, as indicated on the drawings and as herein specified.

1. PIPE LAYING

Handling of Pipes

The contractor shall protect all pipes from damage while being handled. Procedures and equipment for handling the pipe units and fittings into position in the trenches shall be presented by the contractor to the engineer's representative for approval by the latter prior to their being

implemented and used in the works. If slings are used in the handling of the pipes they shall be provided with rubber linings to avoid injury to the pipe.

Installation of Pipe

Preparation of the trench bottom shall be such that when the pipe is placed it shall be true to line and grade as specified on the drawings or as directed by the engineer's representative. Trenches shall be dry when the trench bottom is prepared.

Bedding material shall be placed in the trench bottom to a depth of at least 15-cm below the bottom of the pipe. A continuous trough shall be formed to receive the bottom quadrant of the pipe barrel. Bell or coupling holes shall be formed so that, upon being placed, initially only the pipe barrel is in contact with the trench bottom.

Pipe units and fittings shall be inspected for damage and defects before and after placement in the trench. Any damaged or unsound item shall not be used and, if already placed in the trench, shall be removed and replaced with a sound unit at the cost and responsibility of the contractor.

Pipes shall be protected during handling against impact shocks and free fall. Pipes shall be kept clean at all times.

All pipes and fittings shall be cleared of all debris, dirt, etc., before being installed and shall be kept clean until accepted in the completed work. The Contractor shall pull a plywood-proving disc or mandrel through each installed pipe to ensure no debris is left in the pipe bore as laying proceeds.

All pipes shall be laid and maintained to the required lines and grades. Fittings shall be at the required locations with joints centered and spigots pushed home to the manufacturers specified insertion depth. No deviation shall be made from the required line or grade except with the written consent of the engineer's representative.

Deflection in horizontal or vertical alignment shall not be performed without the approval of the engineer's representative as to the extent of the deflection. In no case shall such deflection be done at the pipe joint. Pipe joint deflections must not be greater than one degree. If any bending is required it should be done at the central portion of the pipe and not exceeding the limits specified by the manufacturer. Whenever the required deflection exceeds the permissible limits the contractor shall install proper bends in the line and anchor these as required. Care should be exercised to lay the pipe in such manner as to minimize the number of these high and low points.

After each pipe has been properly bedded, a minimum 15-cm. Sand fill shall be placed between the pipe and the sides of the trench, and thoroughly compacted to hold the pipe in correct alignment.

Where the grade or alignment of the pipe is obstructed by existing utility services, the obstruction shall be avoided by modifying the alignment or grade (or such obstruction shall be relocated if instructed), all in accordance with the instructions of the engineer's representative.

Jointing of Pipes

All joint surfaces shall be cleaned. Before forming the joint, the previously installed unit shall be checked to ascertain that a close joint exists with the previously installed unit and that the inverts conform to the required grade. The pipe shall not be forced to the required grade by mishandling.

Immediately before jointing the pipe, the pipe end shall be lubricated in accordance with the manufacturer's specification. Each pipe unit shall then be carefully pushed into place without damage to pipe or gasket. Approved devices shall be used to ease the pipe units together to the specified insertion depth. Spigot ends of uPVC pipes shall be pushed into the socket end strictly following the manufacturer's instructions until it reaches the insertion depth. The pipe should never be over-inserted.

Except in the case of flanged fittings and when jointing to existing pipelines of different materials, all joints will be:

Electro-fusion for polyethylene pipes (50mm)
Flexible joints with spigot and sockets sealed with rubber rings or gaskets.

Basic requirements for all types of joints are:

1. Cleanliness of all parts.
2. Correct location of components.
3. Centralization of spigot within sockets.
4. Strict compliance with the Manufacturer's specification.

Long radius curves in the pipeline shall conform to the Manufacturers specification.

The deflection at joint of pipes used in the work shall not exceed one degree.

The Contractor shall take care that all pipes and couplings are clean and free of foreign matter before subsequent sections are jointed.

During jointing with electro-fusion care should be taken that joints are not moved before the cooling process has been completed.

The Contractor shall make himself and his employees acquainted with and comply with the instructions issued by the manufacturers of the various types of proprietary joints and couplings for incorporation in the work. The Contractor shall be responsible for obtaining copies of these instructions.

Connection of UPVC or HDPE pipes to flanged fittings shall be by means of flanged adapters or couplings (dressers). Connection of new plastic pipes to existing pipes of mainly asbestos and steel will be done by special flange adaptors, if required. Saddle connections to UPVC and Steel Mains shall be in accordance with the suppliers specifications. Connections may be made in the dry or under pressure.

All joints shall be capable of withstanding the various tests as specified in the applicable standards.

The pipes shall be laid and bedded in 15 cm. full sand surround except where concrete protection may be specified. The granular fill shall be placed over the full width of the bottom of the trench. The side fill shall be placed in thin layers and well compacted.

Depth of back fill above the sand surround and surface material shall conform with the requirements for the appropriate road or pavement construction. The back fill material may be the excavated soil, provided it is suitable for compaction.

Adequate precautions shall be taken by the way of backfilling or other means to anchor each pipe securely to prevent floatation of the pipeline in the event of the trench being flooded or during

possible concreting.

2. SERVICE CONNECTIONS

The existing service connections are to be replaced. New service connections shall be made between the saddle tees and the existing service connection pipe with new HDPE pipe below ground level (as per the Standard Detail). The Contractor shall provide the connector /adaptor fitting connecting the HDPE pipe and the existing service pipe. These fittings shall cater for the full range of existing service pipe types and diameters ranging from 15 ,20 ,25 ,32mm or other diameter, in either plastic or galvanized steel..

The Contractor shall make an assessment of the various types of existing service connections and their prevalence based on survey of a representative sample, and order sufficient quantities of the different types and sizes of connectors/adaptors required, to ensure any combination of existing service pipes can be connected. These fittings shall be either P.E, brass or, if necessary, galvanized steel and must be suitable for use with potable water.

Where the existing Service connection above ground level is in poor condition, as assessed by the Engineers Representatives, it shall be replaced with new galvanised vertical pipe up to the water meter stop valve connection. The Contractor shall supply the necessary connector fittings between the new galvanised pipe and the water meter stop valve as well as the HDPE pipe. This galvanised pipe and the associated connections shall be paid under separate item.

The Contractor shall make an assessment of the various types and sizes of water meter stop valve arrangements, based on a survey of a representative sample, and order sufficient quantities of the different water meter stop valve connectors required to ensure any combination of existing stop valve meters and galvanised pipes can be connected. These fittings shall be brass or, if necessary, galvanized steel and must be suitable for use with potable water. All the connector fittings shall be approved by the Engineer prior to installation.

Where it deemed necessary, the contractor shall supply and fix steel or brass plugs for the service pipes whether the pipe is new or to be abandoned later on until the system is functioning completely.

3. THRUST BLOCKS, ANCHORS AND CONCRETE SURROUNDING

If not otherwise instructed the Contractor shall provide thrust blocks at all bends, tees, branches and tapers and at blank ends as specified by the pipe Manufactures and the Engineer. Enlargements shall be excavated in sides and bottom of the trench to accommodate anchorage and thrust blocks. The back of supports and blocks shall abut on to undisturbed solid ground. All loose material shall be removed before concreting.

The thrust blocks shall be designed by the Contractor in accordance with the BS.8110 - the structural use of concrete. The Contractor shall show that soil resistance is greater than or equal to 1.2 times the force exerted by the pipe when subjected to the test pressure. The soil resistance shall be calculated as the frictional resistance of the soil against the thrust block. The passive resistance of the soil shall not be considered in thrust block calculations.

Concrete shall extend to undisturbed ground on thrust faces of thrust blocks and on both faces of anchor blocks.

Where details are not shown on the drawings, the Contractor shall prepare proposals for thrust and anchor blocks and submit them to the Engineer's Representative for approval. Such approval shall not relieve the Contractor of his responsibility for the adequacy of his proposals. Special details shall be shown on the drawings or instructed at site where environmental or ground conditions dictate.

Plywood plates, suitably moulded to the pipes barrel, shall be used to prevent direct contact between the concrete and uPVC pipes.

4. LOCATION OF VALVES

The exact locations of valves shall be specified according to Drawings and the Engineer's instructions.

5. PIPES PROTRUDING FROM STRUCTURES, CONCRETE SURROUNDS AND ANCHOR BLOCKS

Unless otherwise detailed a pipeline at or below ground level protruding from a structure shall have two flexible joints adjacent to the structure located as follows:

Pipe Diameter (mm)	Maximum distance to first joint (mm)	Distance between first and second joint (mm)	
		Min.	Max.
Up to 400	150	450	2.5 * dia., but not less than 450 mm.

6. PROTECTION OF PIPELINES AND PIPELINE COMPONENTS:

Pipelines

Class A concrete protection slabs as detailed on the drawing shall be provided over the uPVC pipelines under roads when cover to the pipe is equal or less than 1.0 m for pressure line.

7. INDICATOR POSTS TO PRESSURE MAINS

Where pressure mains pass through open ground, not adjacent to roads, or where the danger of accidental breakage by excavation is evident, the Engineer may instruct the erection of indicator posts of an approved design. Details of the indicator post construction and spacing shall be shown on the drawings or be directed by the Engineer.

CLEANING, TESTING AND DISINFECTION

1. CLEANING AND INSPECTION OF PIPELINES

During and until commissioning the Contractor shall provide and maintain wooden plugs in all open ends of pipes, to prevent the ingress of silt and deleterious matter into the pipelines.

After backfilling pipe trenches and completing valve chambers, hatch boxes etc. and before the trench surfaces are reinstated, the interior of pipelines shall be cleaned of silt and debris by approved methods for inspection by the Engineer's Representative as follows:

All newly constructed pipelines of 500mm (nom.) internal diameter and smaller shall have a loose plug passed through them to show that they are clear of obstruction and free from deflection. The loose plug shall be dimensioned to suit the permissible minimum deflected diameter of the pipe.

2. HYDROSTATIC PRESSURE TESTING

General

After pipe laying, casting of concrete structures on the distribution network and partial backfill have been completed, the lines shall be tested over their entire length or, in the case of long lines, in sections. The pressure test shall only be performed in the presence of the Engineer's Representative.

The test pressure shall be determined by the Engineer in each case. The required pressure shall be obtained by means of a special pressure pump or by connecting the line to a suitable source of pressure.

Preparation for Pressure Test

The Contractor shall provide written notice to the Engineer of any tests two days before the test is to be carried out. All tests must be witnessed by the consultant's Engineer. The Contractor shall maintain written records of the tests and provide copies of the records to the Engineer prior to the completion of the project.

The Contractor shall provide all water, fittings, pipe stoppers, test pump pressure gauges and the necessary equipment and tools for pipe work. Hydraulic pumps, gauges and apparatus shall be equipped with locking devices to prevent tampering during the test period.

Filling of the distribution work with water shall not begin until 7 days after the last concrete structures have been cast. Prior to filling the lines, all joints and structures shall be inspected and be in good condition and proper functioning of all valves shall be ascertained. When testing a section not ending in a valve, the open end shall be a bulkhead and securely anchored. The testing installation and the working of the pump shall also be examined.

Prior to hydraulically testing the pipelines the Contractor shall provide adequate temporary thrust blocks at the ends of uncompleted sections, pipes shall be partially backfilled to about 500 mm above the crown of the pipe, in order to anchor the pipes during testing. Joints and fittings, however, shall remain uncovered until the pipeline has been tested satisfactorily. All house connection pipes that are connected to the pipe under testing shall be temporarily plugged with approved fittings.

The length of the section of pipeline to be tested may be determined by the contractor but shall not exceed 500 meters. Levels of the length of pipe under test shall be such that the minimum test pressure specified is achieved at all points whilst the maximum test pressure specified is nowhere exceeded.

Filling the Distribution Network with Water

The lines shall not be filled until the Engineer's written approval has been given. The lines shall be filled gradually and slowly in order to prevent water hammer or chattering in the pipes and to permit the escape of all air from the pipelines. The rate at which the lines are to be filled shall be determined by the availability of water. Consideration shall be given to filling mains at night, but always with the approval of the Municipality Engineer.

Before testing the line should be filled slowly and evenly with water through any convenient top or valve from the lowest end point. At every high point an automatic air release valve must be installed. After expelling all the entrapped air out of the test portion, all air release valves should be closed. If it is not possible to fill the line from the lowest point, an additional outlet should be added at the inlet point to release air at that point and this line/section should be kept filled for 24 hours before the pressure test.

At the commencement of filling, all blow out valves shall be open and each valve shall be closed after the water has flushed all dirt that may have accumulated in the pipes.

After the filling has been completed, but before the pressure is raised, all valves shall be inspected for water-tightness and all leaks in gaskets and stuffing boxes shall be stopped. Should this inspection show any leaks at the joints or defects in the valves that cannot be repaired while the lines are full of water, the lines shall be drained and the necessary repairs done. This inspection shall be repeated until all leaks are stopped.

Valves shall not be used to isolate sections forming the pipeline during testing operations.

Pressure Test

The pressure test shall be 1.5 times the nominal pressure (15bar) for the main pipelines and 10 bar for house connections. The pressure shall be raised slowly to the specified test pressure and maintained at that pressure for a period long enough for the Engineer to examine the whole section under test. The pipeline shall be maintained under this pressure for a period of 24 hours, during which period the pressure shall not be allowed to fall below 100% of the test pressure but shall be restored to the full test pressure by such pumping as may be necessary.

Should any inspection be unsatisfactory or any test fail, the Contractor shall replace defective pipes, leaking joints or otherwise re-execute defective work as instructed following which cleaning and testing will be repeated until the Engineer's Representative certifies the pipeline to be satisfactory.

The pressure test shall also serve as a strength test for the concrete anchor and thrust blocks, thus these structures shall be designed by the Contractor accordingly. Any structures failing the test shall be replaced by the Contractor at his own expense.

3. DISINFECTION AND FLUSHING OF PIPES

Pipelines, manholes, chambers/structures will be inspected again before commissioning or taking over (whichever is sooner) and shall be cleaned again in whole, flushing with clean water and a swab to be pushed through the length of the pipeline by hydrostatic pressure. The swab shall be first soaked in sterilizing solution.

Flushing of the new pipeline may be carried out by temporary connections to the existing water system if present in the working area. PWA will charge for giving the water to the Contractor as

per for flushing including all other necessary requirements such as water tankers in the absence of mains water.

Upon completion of hydraulic tests the Contractor shall flush out the pipework with chlorinated fresh water and a cleaning swab will be passed through the pipework. This process will be continued until the flushing water runs clear.

The Contractor shall prepare a solution of chlorinated dosing solution using calcium hydrochloride at a rate of 77g/cu.m of system water volume, or with chlorinated water containing between 30 and 50 mg per liter of free chlorine. The solution shall be slowly pumped into the pipeline and a chloride level of 50 p.p.m. shall be maintained for a period of 8 hours.

The pipe work shall be flushed out until the chloride level drops below 0.2 ppm when tested with standard DPD (Diethyl-P Phenylendiamine) method and shall be clear of any detergent content when tested in accordance with BS 2690 - Part 11.

The Contractor shall provide the swab and water and shall be responsible for the disposal of water.

4. CONNECTIONS TO EXISTING PIPELINES

All final connections of new pipelines to existing pipelines will be carried out by the Contractor in the presence of the Engineers Representative and under the direction of the Municipality Engineers.

MANHOLES AND CHAMBERS

1. GENERAL

All concrete chambers and manholes are to be supplied by the Contractor.

2. CLEANING

All manholes and valve chambers specified under this section shall be cleaned of any accumulation of silt, mortar, debris or any other foreign matter of any kind and shall be free of any such accumulations at the time of final inspection.

3. CONSTRUCTION OF MANHOLES AND VALVE CHAMBERS

All manholes and chambers shall have reinforced-concrete bases. The Contractor shall construct all manholes, chambers, and special structures including transition chambers and outfall structures as indicated on the Drawings and herein specified.

Manholes, chambers, and special structures shall conform in shape, size, dimensions, materials, and other respects to the details indicated on the Drawings or as ordered by the Engineer.

Manhole and chamber cover slabs shall be either precast or cast in place reinforced-concrete as marked on the Drawings. The cast iron frames and covers for manholes and chambers shall be brought to grade by the number of courses of concrete blocks shown on the Drawings and a reinforced concrete frame into which the cast iron frame is embedded. Class A concrete shall be cast to a minimum thickness of 150mm around the concrete blocks for rigidity.

Manhole walls (rings) and cover slabs shall be either precast or cast in place reinforced-concrete. In precast construction rubber o-rings are to be placed in all joints except for the joint between the cast in place roof slab and the top wall ring. In below the manhole cover slab shall have removable plus or minus 30cm high concrete ring.

4. FORMWORK OF VALVE CHAMBERS

The Contractor shall be responsible for the design and stability of the formwork. The Contractor shall submit a full program of work indicating the various phases for the erection and removal of forms and the manner in which he intends to execute.

5. PRECAST ELEMENTS

Precast elements shall be either of concrete or mortar as shown on the Drawings and as specified hereinafter.

Materials

Precast Concrete Elements

Precast concrete elements shall be of plain or reinforced concrete dimensions, thickness and reinforcement rods and bars shown on the Drawings and stated in the Bill of Quantities.

Precast Mortar Elements

Moist tamped mortar precast elements shall be of a mixture of ordinary or tinted cement and sand (fine aggregate) approximately in the proportions of one part cement to two and one-half parts of sand. The sand shall be specially selected for colour and grading. The sand shall be screened through 1/8" inch square meshes and all oversize particles shall be discarded. Only sufficient water shall be used in mixing to permit the immediate removal of the member from the mould. The pattern, dimensions and thickness shall be as shown on the Drawings and/or as directed in writing by the Engineer.

Mortar

Mortar for joining the precast elements shall be composed of one part of Portland cement and three parts of clean sand unless otherwise specified. The cement and sand shall conform to the requirements of ordinary Portland cement and aggregate for mortar specified herebefore.

Fabrication

Precast concrete or mortar elements shall be cast in mortar-tight metal lined timber moulds and shall be mechanically vibrated when cast. The Precast elements shall be removed from the moulds as soon as practicable and shall be kept damp for a period of at least 10 days. Any elements that shows checking or soft corners or surfaces shall be rejected. The method of storage and handling shall be such as to preserve true and even edges and corners, any precast element which becomes chipped, marred or cracked before or during the process of placing shall be rejected, sampling of precast elements shall be submitted to the Engineer for approval, prior to fabrication, at the Contractor's own expense.

Workmanship

All precast concrete or mortar elements shall be well cleaned and thoroughly wetted with clean

water before placing in their positions shown on the Drawings. The precast elements shall be bedded and jointed in cement and sand mortar (1:3) mix and the joints raked out on both faces to receive plaster or pointing as indicated on the Drawings and/or stated in the Bill of Quantities to the satisfaction of the Engineer.

CONCRETE WORKS

1. GENERAL

Concrete work shall consist of furnishing all materials and constructing structures of the forms, shapes and dimensions shown on the Drawings or as directed, using Portland Cement Concrete, in accordance with the details shown on the Drawings and these Specifications.

Portland cement concrete shall consist of a mixture of Portland Cement, fine aggregate, coarse aggregate, water and additives when required. The mixture shall be proportioned, mixed, placed and cured in accordance with the requirements of B.S. 8110 Part 1:1985 Sections 6 and 7 specification. Where an additional clause conflicts or is inconsistent with the requirements of B.S. 8110, the additional clause shall always prevail. The concrete mixes shall be designed mixes for special or ordinary concrete as defined in B.S. 8110 Clause 6.3, the design requirements of which are laid down in this Specification.

2. MATERIALS

General Requirements

The classes of concrete and their respective minimum cement content, consistencies and the minimum required compressive strengths shall be as shown:

Class	Comp.Strength (N/mm)		Slump (mm)	Min.Cement Content (kg/m)	MaxFree w/c Ratio
	7 days	28 days			
A (30/20/SRC)	20	30	25 - 75	350	0.55
B (25/20/SRC)	17	25	25 - 75	300	0.6
C (15/20/SRC)	10	15	25 - 100	200	0.7

3. FINE AGGREGATE FOR CONCRETE AND MORTAR

Fine aggregate for concrete shall consist of natural screened and washed sand or crushed sand having hard and durable particles, or of other inert materials with similar characteristics. It shall not contain harmful material such as clay lumps, tree roots, shale, iron pyrites, coal, mica, organic matter or any deleterious matter which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary the aggregate shall be washed and sieved to remove the deleterious substances.

The fine aggregate shall comply in all respects with the requirements of B.S. 882.

Fine aggregate of fine grading (BS 882) shall not be used. In addition to the above, fine concrete aggregate shall meet the following requirements:

Fineness Modulus,	- Max. +/- 0.2 variance from test sample
Sodium Sulphate Soundness,	- Max. 10 %
Clay and Friable Particles,	- Max. 1% by weight

Test for Organic Impurities	- Lighter than standard
Material Passing 0.075 mm sieve	- Max. 3%
Chlorides (Cl), BS 812, part 117 aggregate	- Max. 0.06% by weight of fine (acid soluble)
Sulphate (SO ₃), BS 812, part 118 (acid soluble)	- Max. 0.3% by weight of fine aggregate
Sand Equivalent,	- Min. 75

Fine concrete aggregate shall conform to one of the following gradings (reproduced from BS882):

BS 410 Test Sieve (mm)	Percentage by Weight Passing BS Sieve	
	Coarse	Medium
10	100	100
5	100	100
2.36	60 - 100	65 - 100
1.18	30 - 90	45 - 100
0.6	15 - 54	25 - 80
0.3	5 - 40	5 - 48
0.15	0 - 15	0 - 15

4. COARSE AGGREGATE FOR CONCRETE

Coarse aggregate for concrete shall consist of natural gravel, crushed gravel, or crushed stone, free from coating of clay or other deleterious substances. It shall not contain harmful materials such as pyrites, coal, mica, laminated materials, tree roots, shale, or any materials which may attack the reinforcement, in such a form or in sufficient quantity to affect adversely the strength and durability of the concrete. If necessary, coarse aggregate shall be washed to remove deleterious substances.

The aggregate shall comply in all respects with the requirements of B.S. 882. The aggregate shall also fulfill the following requirements:

Flakiness Index (37.5 mm)	B.S. 812	0 - 40%
Flakiness Index (20 mm)	B.S. 812	0 - 20%
Elongation Index (20 mm)	B.S. 812	0 - 35%

In addition to the above, coarse concrete aggregate shall meet the following requirements:

Sodium Sulphate Soundness	- Max. 10% loss
Abrasion,	- Max. 40% loss
Clay lumps and Friable Particles	- Max. 0.25 % by weight
Soft Fragments and Shale	- Max. 3% by weight
BS. 812	
Passing 0.075 mm,	- Max. 1%
Chlorides (Cl) BS 812, Part 117 (acid soluble)	- Max. 0.02% by weight of Coarse Aggregate

Sulphates (SO ₃) BS 812, Part 118 (acid soluble)	- Max. 0.3% by weight of Coarse Aggregate
Water Absorption	- Max. 2%

The coarse aggregate shall conform to the following gradings in accordance with the nominal size of aggregate specified (reproduced from BS 882).

BS 410 Sieve mm	40mm	Nominal Size of Single-Size Aggregate Percentage by weight passing BS Sieve		
		20mm	14mm	10mm
50	100	-	-	-
37.5	85-100	100	-	-
20.0	0-25	85-100	100	-
14.0	-	-	85-100` 100	-
10.0	0-5	0-25	0-50	85-100
5.0	-	0-5	0-10	0-25
-	-	-	-	0-5

Combined Aggregate - Approved coarse aggregate and fine concrete aggregate in each batch of concrete shall be combined in proportions as specified in BS.882 and as approved by the Engineer. However, in no case shall materials passing the 0.075 mm sieve exceed three (3) percent by weight of the combined aggregate.

For the overall concrete mix the following controls of salts contents of aggregates shall be adopted:

Chlorides (Cl)	Max. 0.3% by weight of cement
Sulphates (SO ₃)	Max. 4% by weight of cement

The combined concrete aggregate gradation used in the work shall be as specified, except when otherwise approved or directed by the Engineer. Changes from one gradation to another shall not be made during the progress of the work unless approved by the Engineer.

Naturally occurring sand/gravel mixtures (all in aggregates) shall not be used unless otherwise directed by the Engineer.

5. WATER

Water for washing aggregate and for mixing of concrete shall be fresh, clean and substantially free from oil, acids, alkali, sewage, deleterious mineral or organic matter. It shall not contain chlorides such as sodium chloride in excess of 600 ppm nor sulphites such as sodium sulphate in excess of 500 ppm. It shall comply in all respects with B.S. 3148.

Water for curing concrete shall not have a pH lower than 5 or more than 7.5 nor contain impurities in sufficient amounts to cause discoloration of the concrete. Sources of water shall be maintained at such depth and the water shall be withdrawn in such a manner as to exclude silt, mud, grass and other foreign matter.

Approval of Source - All sources of water for use with cement shall be approved by the Engineer.

If at any time during construction the water from an approved source becomes unsatisfactory, the Contractor will be required to provide satisfactory water from some other source.

6. CEMENT

General

The cement shall be of approved manufacture and shall be delivered in bags with seals unbroken, or delivered in bulk, it shall be delivered in approved containers. Test certificates from the manufacturers or suppliers shall be submitted for each consignment and shall indicate the results of the tests for compressive strength, setting time, soundness and fineness carried out in accordance with the requirements of the relevant ASTM or British Standards. Further tests may be required by the Engineer after the cement is delivered and stored on the Site. The failure of any sample to satisfy the B.S. or ASTM requirements shall entitle the Engineer to reject the entire consignment from which it was taken. Cement should be stored on the site such a way to keep it away from water at all times. Sulphate Resisting Cement shall be used unless otherwise directed.

Portland cement

Normal and rapid hardening cement shall comply with B.S.12.

Sulphate Resisting Cement

Sulphate resisting cement shall comply with B.S. 4027.

Admixtures

Air entraining agents, plasticisers, water proofing agents, retarders, and other similar admixtures shall comply with British Standard Specifications (5075, 8110, 1014, 3587, 3892) and shall be used in accordance with the manufacturer's recommendations and B.S. Samples of proposed admixtures shall, if required, be submitted to an approved testing authority by the Contractor in order to ascertain its suitability for use in the Works. Use of any admixtures must be approved before hand by the Engineer.

The cost of such admixtures shall be included in the cost of concrete and no extra payment shall be made if they are used. The proportions of cement, fine aggregate and water shall be determined by the Contractor before concreting commences and submitted together with such test results as may be required to the Engineer for approval and the Contractor shall not commence concreting before such approval is given nor shall he alter or vary in any way the proportion of mix unless he submits fresh test results and mix proportions to the Engineer for approval.

The approval by the Engineer of such mix designs does not in any way absolve the Contractor of any of the requirements of the Specifications.

7. MIXING AND TESTING

Samples of Aggregates

Samples of both fine and coarse aggregates are to be submitted to the Engineer for testing at least one week before commencing deliveries. No deliveries in bulk are to be commenced until such samples are approved by the Engineer as complying with this Specification.

Trial Mixes

Following the engineer's approval of the materials for each class of concrete, the Contractor shall prepare a trial mix of each grade of concrete in the presence of the Engineer' Representative. Each trial mix shall comprise not less than 1/3 of a cubic meter of concrete and shall be mixed in an approved type of concrete mixer similar to that which the Contractor propose to employ on the Works. The quantities of all ingredients of trial mix including water shall be carefully determined

by weight according to the approved mix design. Each trial mix shall show no tendency to segregate when handled and compacted by the methods by which the Contractor proposes to handle and compact the grade of concrete in the Works and it shall be capable of adequate compaction by such methods.

Water/Cement Ratio

The quantity of water to be added to the cement and aggregates during mixing shall be just sufficient to produce a workable mix to enable it to be well compacted and worked into corners of formwork and around reinforcement. All mixes shall be designed in respect of the proportioning of water so that the Slump Test as carried out according to B.S.1881 shall be in accordance with the slump specification. Measurement of water on the site shall take into account the moisture present in the aggregates, and Slump Tests shall be taken sufficiently frequently to ensure that variations in the moisture content of the aggregate are fully taken into account in determining the amount of water to be added.

Measurement of Ingredients

The aggregates for the concrete shall be measured by weight but measurement by volume may be allowed in special circumstances with approval of the Engineer.

When the aggregates are to be measured by weight the weight batching machines shall be of a type approved by the Engineer's Representative. They shall be kept clean and in good condition and adjustment. At intervals as the Engineer's Representative may require, the Contractor shall check the accuracy of each weight-batching machine.

When the aggregates are to be measured by volume, the proportions of fine and coarse aggregates shall be measured in well constructed gauge boxes, of dimensions approved by the Engineer's Representative to guarantee that whole multiples of such gauge boxes will ensure the use of one or more whole bags or containers of cement and the capacity of the concrete mixer shall be such as to ensure that no splitting of cement bags or containers is required. Gauge boxes shall be properly filled and struck off level, addition of fine aggregates to allow for bulking due to moisture content being made as required.

An efficient water measuring device shall be fitted to each concrete mixer.

Any cement container shall be such as to contain an accurately weighed amount of cement.

Mixing Concrete

The concrete shall be mixed in a power driven machine of the batch type, no hand mixing shall be permitted. Mixing shall continue until the mass of concrete batch is uniform in consistency and colour. The method of discharge shall be such as to cause no segregation of the concrete materials.

Concrete which has commenced to set before placement shall not be re-mixed and shall be rejected and in no case used in the works.

Concrete Testing - Compressive Crushing Strength

One set of three test cubes (15cm x 15cm x 15 cm) shall be taken from each 6 cubic metre batch or one set of three test cubes for each individual concrete member (anchor block) if the concrete is batched individually. The cubes shall be cured in water at ambient air temperature. One cube shall be tested at 7 days and the other two at 28 days. The compressive strength shall be deemed to be the average strength value obtained from the two cubes crushed at 28 days. The result of the 7-day cube compressive strength shall act as an early warning indicator that the 28 day strength may not be achieved. Where the specified 28-day strength is not achieved the Contractor shall replace the defective concrete member at his own cost.

Concrete Testing - Workability

The contractor shall carry out slump tests on each separate concrete batch or delivery and additional slump tests every one hour on the same batch or delivery if the time for placing concrete exceeds one hour. The cost of slump tests is deemed to be included in the cost for providing and placing concrete.

Concrete Testing - Materials

The Contractor shall also obtain and furnish the Engineer with current Material Test Certificates from the concrete supplier or otherwise for the following parameters;

Grading, fine and coarse aggregate
Flakiness and Elongation Index
Compacting Factor Test
Co-efficient of expansion for the aggregates
Absorption Index
Mix Design

8. TRANSPORTING CONCRETE

Concrete shall be taken from the place of mixing to the place of deposition by methods which shall prevent the segregation or loss of the ingredients and which are sufficiently rapid to ensure that the concrete does not commence to set before it is compacted in position. The concrete shall be deposited as near as possible to its final position in the works and shall not be allowed to flow laterally into position. Deposition of the concrete through shutes shall not be permitted nor dropped freely from a height exceeding 1.50m.

9. PLACING CONCRETE - GENERAL

Concrete shall not be placed without the Engineers approval. The approval shall be given on satisfactory completion of checking by the Contractor and the Engineers Representative, which shall include the following;

- Extent of the foundation and preparation,
- Character of the bearing surface preparation,
- Correct alignment, placing and cover to reinforcement,
- Overall cleanliness.

The concrete shall be placed in its final position as soon as possible after it has been mixed, and in any case before the initial set has taken place. The Contractor shall ensure that concrete, which has already been placed in position and has commenced to set is not disturbed by the placing and compaction of further concrete nearby. All concrete shall be carefully worked around and between reinforcement and all other embedded fittings without such reinforcement or fittings being disturbed. Concrete is to be worked well up against whatever surface it joins.

Suitable measures shall be taken by the Contractor to ensure that concrete placed in hot weather conditions shall not impair the quality or strength of the final installed concrete. Due regard shall be paid to ambient and mix temperatures. Surfaces and forms prepared to receive the concrete shall be shaded wherever practicable and moistened with water to prevent drying out of the concrete coming into contact with hot surfaces or reinforcement.

10. COMPACTING CONCRETE

Tamping

All concrete shall be thoroughly compacted to the maximum with approved tampers without any segregation in its final position before it commences to set. Care shall be taken to avoid the use of spade type tampers, which may cause segregation. Initial compaction shall be with tampers and compaction with screed boards shall be limited to final shape and finish. During the placing and compaction of reinforced concrete, a competent steel fixer shall be in attendance to adjust and correct if necessary the position of the reinforcement.

Vibrating

Concrete shall be compacted by vibrating with an approved vibrator. The vibrators shall not be attached to any reinforcement or embedded fittings and where immersion type vibrators are used, care shall be taken to ensure that they do not come into contact with the reinforcement or embedded fittings. Freshly placed concrete shall not be vibrated in a manner likely to cause damage to concrete, which has already begun its initial set. Concrete shall not be vibrated excessively where segregation would result. Shutter type vibrators shall not be used. Nor shall immersion type vibrators come into contact with the formwork.

11. CURING OF CONCRETE

All concrete shall be protected from the harmful effects of sunshine, drying winds, rain, flowing water, or other adverse effects. For at least 7 days after placing, the concrete shall be prevented from drying out by being sprayed with water and covered with hessian, clean sand or other approved material, which shall be kept wet.

Membrane curing of concrete with an approved liquid may be used as an alternative to curing with water except that membrane curing liquid shall not be applied to surfaces of concrete from which the shuttering has been struck, until the concrete surface and finish has been inspected and approved by the Engineer.

Concrete curing compound shall be readily distinguishable upon the concrete surface for at least four hours after the application. The colour, if any, shall be inconspicuous on exposed surfaces within seven days after application.

The contractor shall ensure that the concrete is adequately protected against inclement weather until properly set and shall if necessary provide additional protection to that specified above.

12. INSPECTION OF CONCRETE

The condition of formed surfaces shall be inspected immediately on striking the shuttering by the Contractor and Engineers Representative, for the presence of defects. Any remedial action approved by the Engineers Representative, such as application of cement slurry or mortar to superficial defects, shall be carried out immediately while the concrete surface is still moist and before any curing membrane is applied.

13. DEFECTIVE CONCRETE

The Contractor shall on the written instruction of the Engineer's Representative remove and reconstruct any portion of the work which in the opinion of the Engineer's Representative is

unsatisfactory as regards the quality of concrete, incorrect dimension or position of the cast concrete, badly placed or insufficient reinforcement, honeycombing or other such cause as to render the construction defective or non compliant with the specification or which may prejudicially affect the strength or durability of the construction.

14. REPAIRS TO CONCRETE

The method of repairing and replacing defective concrete, which the contractor proposes to adopt, shall be submitted to the Engineer's Representative for prior approval and the repair shall be carried out in such manner as he may direct or approve.

15. SUPERVISION OF CONCRETE WORK

Throughout the progress of the concrete work the Contractor shall employ and provide such supervision as is necessary to ensure the following:

- The day to day control of the quality of the concrete;
- The mixing, transporting, placing, compacting, curing and protection of the concrete;
- The testing of concrete and material constituents specified;
- Investigation of defects as required by the Engineer; and
- Preparation of all concreting records and reports as required by the Engineer.

16. FINISHING OF CONCRETE

All concrete surfaces not formed by shuttering shall be trowled to a smooth dense surface with the minimum of cement and fine particles being brought to the surface and shall be free from irregularities.

Shuttered surfaces of concrete may be formed by casting against sawn timber. All other exposed concrete including precast concrete shall be cast against steel, plywood or planed timber formwork and shall be carefully rubbed down with carborundum to remove all imperfections and irregularities.

17. DESIGN AND CONSTRUCTION OF FORMWORK

Formwork shall in every respect be adapted to the structure and the required surface finish of the concrete. It shall include all temporary moulds for forming the concrete to the required shape and finish for the support of such moulds. It shall be fixed in true alignment and securely wedged and braced so as to be able to withstand, without displacement, deflection or movement of any kind, the weight of the construction and the movement of persons, materials and plant. Joints shall be close enough to prevent the leakage of liquid and fine materials from the concrete.

The Engineer's Representative may require at the prior submission for approval of the Contractor's proposals for the design and construction of formwork including supports. The formwork shall be constructed so as to permit its removal without damage to the concrete.

18. SPACING BLOCKS AND TEMPORARY TIES

Internal spacing blocks and construction ties shall be avoided as far as possible and practicable. Where it is intended that these shall be removed whether before or after the concrete has set, the making good of the concrete shall be subject to the Engineer's Representatives approval. The removal of the blocks or internal ties must not jeopardise the stability of the construction. If, with

the approval of the Engineer's Representative, these are allowed to remain in the concrete then they shall be of a material and quality that they do not prejudice the strength of the work. Concrete spacing blocks shall be made of concrete at least equal in quality to the main concrete. Metal ties shall be positioned such that they do not come into contact with any of the reinforcement or fittings and no part of the tie shall be permanently embedded in the concrete nearer than 5 cm to the exterior surface of the concrete.

All holes resulting on the concrete surface from their removal shall be infilled with 1:2 cement mortar.

19. PREPARATION FOR CONCRETING

Immediately before the concrete is deposited, the formwork, shall be thoroughly cleaned out and freed from sawdust, shavings, wire cuttings, dust, sand, soil and all other deleterious and extraneous materials. Temporary openings shall be provided in the formwork to facilitate this work. The internal surfaces of the formwork shall, immediately prior to final erection, be coated with mould oil. The mould oil shall be of approved type and shall be applied uniformly and the quantities used shall be the minimum consistent with its purposes. The contractor shall ensure that all steel reinforcement and adjoining concrete surfaces are kept free of mould oil.

20. APPROVAL BEFORE CONCRETING

The Contractor shall in all cases request the approval of the formwork by the Engineer's Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor's request for approval and his intention to commence concreting shall be not less than 24 hours.

Such approval shall not absolve the Contractor of his responsibilities under the Contract.

21. REMOVAL OF FORMWORK

All formwork shall be struck without jarring the concrete or subjecting the concrete to sudden shock. Before striking any formwork the Contractor shall demonstrate to the Engineer's Representative that the concrete has attained adequate strength.

22. BLINDING CONCRETE

Prior to placing any structural concrete on natural surfaces, a blinding layer of class C concrete shall be laid to a minimum of 75mm thickness. This blinding layer shall be suitably cured prior to subsequent concrete placement. The blinding shall be clean and free from any dust and impurities prior to subsequent concrete placement.

23. CONCRETE BELOW GROUND

All concrete placed below ground level shall be painted with two coats of bituminous paint membrane.

24. REINFORCED CONCRETE DESIGN

All reinforced concrete shall be designed to BS 8110 or similar approved by the Engineer.

25. CEMENT MORTAR AND GROUT

Mortars and grout shall be composed of Portland cement and sand in the following proportions;

Quality	Portland Cement	Sand
G1	1	1
G2	1	2
G3	1	3

The amount of water added shall be sufficient to make the mortar or grout workable, consistent with its purpose.

26. READY MIXED CONCRETE

The use of concrete delivered to the site in a plastic condition ready for placing in its final position shall be permitted provided that the constituent materials and the concrete mix shall comply with the requirements of this specification and subject to the following conditions:

- Water shall only be added to the mix under the control of the central batching plant,
- No further addition of water shall be permitted,
- Dry batching with water added on site shall not be permitted,
- The Contractor shall submit details of his proposed supplier to the Engineer for approval including copies of all specified current materials test certificates plus copies of batching plant and dosing meter calibration certificates,

The Concrete shall be placed in its final position within 1-hour maximum of the time of adding cement to the wetted aggregates.

The contractor shall provide one copy of the delivery ticket number together with a record of the slump test on site, times of placing, completion time of placing, position of placing plus the works test cube reference number. If necessary the site test cubes results should be capable of being compared with the central batching plant cube results.

27. REINFORCEMENT STEEL

The Contractor shall be responsible for the provision of reinforcement steel in sufficient quantity and of the specified steel grade, diameter, length and shape as shown on the drawings.

All reinforcing steel shall be high yield deformed reinforcing steel bars with a yield strength of 400 N/mm².

Mild steel where otherwise specified shall be either deformed or plain bars to BS 4449.

Tying wire shall be No. 16 gauge soft annealed iron wire.

28. REINFORCEMENT STEEL FIXING

Prior to concreting the Contractor shall ensure that all reinforcement bars are entirely free from loose mill scale, loose rust, oil, grease, paint, mould oil, and all other deleterious and extraneous material. All hooks, bends and shape codes for bar bending schedules shall be to BS 1478, or equivalent to be approved by the Engineer. Bars shall be bent to the correct radius around proprietary mandrels of the requisite diameter.

All bars to be fixed shall be so positioned to provide the specified cover of concrete. The steel reinforcement bars shall be fixed with tying wire to form a rigid cage.

Reinforcement projecting from the framework for continuation shall be adequately supported throughout concreting and shall not be sent out of position.

The Contractor shall in all cases request the approval of the steel fixing by the Engineer's Representative in sufficient time to allow an inspection to be made and shall not commence concreting until such approval is obtained. The period between the Contractor's request for approval and his intention to commence concreting shall be not less than 24 hours.

Such approval shall not absolve the contractor of his responsibilities under the Contract.

29. CONCRETE SPACING BLOCKS SHALL BE USED TO ENSURE CORRECT PLACING AND COVER OF THE BARS

1. Concrete spacing blocks shall be used to ensure correct placing and cover of the bars.
2. The cover to reinforcement between the outside of the bars and the concrete face shall be 40mm -0 +5mm. With straw rope covered by hessian cloth and secured in place by binding wire which shall be carried under the flange of the gland
3. All plain ends shall be adequately protected by straw rope secured in place by binding wire or strap. None of the packing will be returnable. The cost of packing shall be included for in the schedule rates.
4. The materials supplied shall be of the appropriate grade and quality and shall be adequately protected against the climatic conditions in the middle East
5. All plastic materials shall be protected from direct sunlight and appropriate coverings supplied for use at the delivery and storage areas.

Abandonment

Water mains to be abandoned shall be isolated from the network supply by physically cutting the pipe to provide a clear distance of one metre from the existing supply pipe to be retained in service. In addition the cut ends shall be plugged with grout, type G2, to a distance of one metre from the cut end. The Contractor shall provide a sacrificial form within the pipe end to prevent loss of grout down the length of the abandoned main during placement of the grout plug.

Where existing mains to be abandoned have been laid on the surface or at a very shallow depth where it would not be appropriate to leave the abandoned pipe in position, then the Engineers Representative shall instruct its removal and disposal off site as required. In such cases the former trench of the abandoned pipe shall be levelled off and the ground level dressed off locally.

REINSTATEMENT OF ROADS AND PAVINGS

Unless otherwise instructed, all the roads and paving shall be fully reinstated to the existing roads and paving condition and this shall include the base course, asphalt layers and inter lock tiles.

1. BASE

Description

This work shall consist of, watering mixing, spreading and compacting crushed stone base course in accordance with these Specifications and in conformity with the lines, grades, thickness, and typical cross sections as directed by the Engineer.

Materials

The base course material shall consist of hard, durable particles or fragments of stone or gravel crushed to the required size by mechanical crusher, and a filler of sand or other finely divided mineral matter. The material shall be free from vegetable matter, clay lumps, and the deleterious substances.

General Requirements

The gradation of the crushed stone shall conform to the following grading requirements:

Grading requirements

SIEVE SIZE		PERCENT PASSING BY WEIGHT GRADING	
INCHES	MM	A	B
1.5	38.100	100	-
1	25.400	75-100	100
0.75	19.100	60-90	70-100
0.5	12.700	45-80	-
0.375	9.520	40-70	50-80
No. 4	9.760	30-65	35-65
No. 10	2.000	20-40	25-50
No. 40	0.420	8-20	15-30
No. 200	0.074	5-10	5-15

All base-course aggregates shall confirm to the following physical requirements:

- Loss of Sodium Sulphate soundness Test (AASHTO T 104) 12%
Maximum
- Loss of Magnesium Sulphate Soundness Test (AASHTO T 104) 18%
Maximum
- Loss by Abrasion Test (AASHTO T 96) 40%
Maximum
- Thin and Elongated Pieces by Weight (larger than 1-inch thickness
less than 1/5 length) 5%
- Friable Particles (AASHTO T 112) 0.25%
maximum

- | | |
|--------------------------------------|-------------|
| ▪ Liquid Limit (AASHTO -T- 89) | 25 maximum |
| ▪ Shrinkage Limits (AASHTO -1- 89) | 4% maximum |
| ▪ Plasticity Index (AASHTO -T- 90) | (3-6) % |
| ▪ Sand Equivalent (AASHTO T 176) | 40 minimum |
| ▪ Maximum Dry Density (AASHTO T 180) | 2.10 gr/cc |
| ▪ CBR (BS 1377) after 4 days soaking | 90% minimum |

The portion of the material retained on a No. 4 sieve shall be known as coarse aggregate, and that portion passing a No. 4 sieve shall be known as fine aggregate.

Coarse aggregate shall have a percentage of wear of not more than 40% at 500 revolutions as determined by the AASHTO 96 Test method.

The material must pass the ASTM soundness test so that the decrease after 5 cycles will be not more than 12 percent when sodium sulfate is used or not more than 18 percent when magnesium sulfate is used. CBR must not be less than 90 percent at maximum dry density and expansion when a compacted sample is soaked not to exceed 1 percent.

Spreading

Crushed stone for base course shall be delivered to the roadbeds as uniform mixtures and each layer shall be spread in one operation. Segregation shall be avoided and the base shall be free from pockets of coarse or fine material.

The base course material shall be deposited on the prepared sub-base by approved mechanical method at a uniform quantity which will provide the required compacted thickness within the specified tolerances without resorting to spotting, picking-up or shifting the base material.

The base course material shall be spread and compacted in layers each 20 cm thick after compaction.

Compacting

The base course material shall be watered and compacted to not less than 98 percent of maximum dry density (Modified AASHTO) as determined in the laboratory.

The surface of the finished base course at any point shall not vary more than 1.5 cm above or below the grade established by the Engineer's Representative.

If the above requirements are not complied with the base shall be reshaped reworked watered and thoroughly recompact to conform to the specified requirements.

2. BITUMINOUS PRIME COAT

Description

This work shall consist of furnishing and applying a bituminous prime coat to the finished base course surface in accordance with these Specifications and as shown on the Drawings.

Materials

The grade of asphalt used for priming shall be medium-curing cutback asphalt; MC-30, MC-70, MC-250 as per ASTM D2027 Specification. The rate of application, which is 1.0 kg per square meter at the specified temperature.

Preparation of the Surface

Holes and depressions shall be repaired by removing all loose and defective material and replacing it with approved granular material as directed by the Engineer. All bumps, ridges, depressions, corrugations and waves shall be corrected by lightly grading the road surface with an autopatrol grader. If necessary and if ordered by the Engineer the surface may be reshaped and recompacted. All loose material shall be swept from the surface prior to priming by means of a power broom. The surface of the road may be dampened slightly with water prior to priming if so ordered by the Engineer.

3. BITUMINOUS TACK COAT

Description

This work shall consist of furnishing and applying a bituminous tack coat RC2 grade between the binder and wearing asphalt concrete courses using a power broom, or a power blower, or both, and an approved pressure distributor.

Application

The selected asphalt binder shall be sprayed on the pavement or surface at the rate as directed by the Engineer's Representative of approximately 1/4 to 3/4 kilograms per square meter. Prior to spraying the surface shall be swept clean. The application of the liquid asphalt shall be uniform and shall be sprayed at a temperature as set by the Engineer's representative and only when the surface is dry and the air temperature is greater than 20°C and the pavement temperature is higher than 25°C. The pressure distributor shall be such as to satisfy the requirements for spraying. It shall be equipped with an approved heating device, tachometers, and gauges to measure the speed of the truck in meters per minute and the amount of sprayed asphalt in liters per minute. All gauges and dials shall be clearly visible to the pressure distributor operators. The spray bars shall be of sufficient length to spray the required width for the application. A hand spray shall be used to cover any areas not accessible to the pressure distributor.

The surface shall be allowed to dry until it is in a proper condition of tackiness to receive the surface course. Tack coat shall be applied only so far in advance of surface course placement as is necessary to obtain this proper condition of tackiness. Until the surface course is placed, the Contractor shall protect the tack coat from damage.

4. ASPHALTIC CONCRETE

Description

This work shall consist of furnishing and mixing aggregate and asphalt binder, and spreading and compacting the mixture, all as specified in these Specifications and in conformity with the lines, grades, thickness and typical cross section shown on the Drawings.

Materials

1. **Mineral Aggregate**

Mineral aggregate for asphaltic concrete shall consist of coarse aggregate, fine aggregate and filler if such is required to obtain the grading for the combined aggregate.

a. Coarse aggregate shall consist of clean crushed rock or crushed gravel. The aggregate shall be uniformly graded within the limits specified. The coarse aggregate shall pass the following:

Soundness Sodium Sulphate (5 cycles) ASTM C88	10% Max.
Magnesium Sulphate	12% Max.
Loss by Abrasion after 100 revolutions ASTM or latest revision thereof	40% Max.
Thin and elongated pieces, by weight pieces larger than 1" less than 1/5 of the length.	25% Max.
Soft fragments ASTM C235-57T or latest revision thereof	25% Max.

The coarse aggregate shall have at least one mechanically fractured face on 80 percent of the particles retained on the No. 4 sieve. And when coated with asphalt shall pass the stripping test not less than 95% coated bituminous.

b. The fine aggregate shall consist of natural sands free from lumps of clay or silt or other deleterious material. The sizes of the particles shall be such as to provide the required specified graded aggregate when blended with the coarse aggregate. The fine aggregate may be produced with the coarse aggregate if the source of the paving aggregate is such that the processing requirements of the specifications.

c. Mineral filler shall be Portland Cement, rock dust, or natural filler from approved deposits. Such filler need only to be added to the aggregate to secure the specified grading of the combined aggregate. The mineral filler shall meet the following gradation requirements.

U.S. STANDARD SIEVE	PERCENT PASSING BY DRY WEIGHT
#30	100
#100	95
#200	65

d. The intent of these Specifications is to have the Contractor supply a combined aggregate to the pugmill of the asphalt plant that meets the grading requirements as herein specified. The Contractor may supply to his asphalt plant a combined aggregate or he may choose to supply the various components of the final aggregate and deliver these to a set of cold feeders. In any case irrespective of the way the Contractor may select to deliver the aggregate to the plant, it shall be heated and following the heating and drying it shall be delivered to a set of screens to be separated into sizes as specified prior to delivery to the pugmill where it is mixed with the specified liquid asphalt. The addition of mineral filler may or may not be necessary but the

grading requirements of the total aggregate must be met irrespective of the manner that the Contractor chooses to produce the specified aggregate.

The combined mineral aggregate shall meet the following physical requirements:

Sand Equivalent	50 Minimum
Plasticity index	6 maximum

2. **Asphalt Cement**

Unless otherwise specified the asphalt cement shall be the product produced by the latest specification for asphalt cement for use in road pavement construction and shall have a penetration at (25°C) 77°F of 60 to 70, when tested by means of the latest ASTM test method for measuring penetration.

Grading Requirements and Asphalt percent

The asphalt mixture shall conform to the requirements of this specification. The mineral aggregate, (that is the combination of the coarse aggregate, the fine aggregate and the filler) for the binder and wearing courses shall be within the following limits:

ASTM SIEVE SIZE	MIX FORMULA		
	A	B (wearing course)	C (Binder course)
		V.T.M.=3-5 %	V.T.M.=3-7%
		V.M.A.=14.5 % min	V.M.A.=13.5% min.
1.5 inch	-	-	100%
1.0 inch	-	100%	95-100%
0.75 inch	100%	95-100%	76-95%
0.5 inch	95-100%	80-95%	64-82%
0.95 inch	70-95%	70-87%	55-74%
No. 4	50-70%	50-65%	38-54%
No. 10	32-52%	35-50%	25-41%
No. 40	16-30%	16-30%	12-23%
No. 80	10-20%	10-20%	7-16%
No. 200	4-9%	4-9%	4-8%

The grading of the above aggregate shall be uniform within the limits specified above. Any addition or rejection of any size or sizes necessary to produce a uniform aggregate shall be the full and complete responsibility of the Contractor. Fines or mineral filler will only be added when the natural crushed material is short of such sizes and the addition is required to bring the combined aggregate within the limits specified above.

Preparation of the Asphalt Cement

The penetration of the asphalt cement shall be tested by the Engineer's Representative from time to time to ensure that it is maintained at a uniform consistency. The Engineer's Representative may test other physical properties of the asphalt to check on the quality of the material delivered and to ensure that it meets the required specification. For asphaltic concrete as herein specified the asphalt shall be 60/70 penetration paving grade asphalt, unless otherwise specified in the special provisions of the Contract. The 60/70 asphalt shall be heated in an approved storage tank to a temperature of 325°F (163°C) prior to being mixed with the heated aggregates. The

permissible range for heating and mixing is 149°C to 163°C when this grade of asphalt is used. The aggregates will be fed to the mixer at a uniform rate and at a temperature range identical to that of the asphalt cement.

Laying the Asphaltic Concrete

The paving shall be accomplished by means of a self-propelled paver of standard make and design, equipped with a vibratory screed, capable of laying the pavement true to line and grade.

The freshly laid mix shall be rolled by means of approved rollers. The breakdown roller shall be 3-5 tons and the back roller shall be 8 to 10 tons. In addition, there shall be one rubber-tired roller. Rolling shall be done by commencing at the edge and progressing to the center with an overlap of half the width of the roller on each pass. The rollers shall be operated at a very slow speed as directed by the Engineer's Representative and shall not stop and reverse at the same point at each pass. Rolling shall be carried out as close behind the paver as possible. The rubber-tired roller shall have smooth tires and shall be operated either in front or behind the back roller as may be required to obtain the required result.

Hand raking and handwork shall be kept to a minimum and the indiscriminate throwing of hot mix across the fresh pavement to correct surface deficiencies shall not be permitted. Where hand raking or hand finishing is necessary, the large stones in the mix at the surface shall be raked out and thrown clear of the fresh pavement.

All joints in the pavement shall be vertical. Joints at the start of a day's run shall be cut vertical and the surplus of hardened material removed. The end joint shall be hand raked in such a manner to provide a finished surface free from any bump or depression and the rolling of the end joint shall be crosswise to the roadway with at least half of the roller on the previously laid mat. Likewise, the center joint shall be rolled in such a manner as to provide a smooth joint and the initial pass of the roller shall be such that at least half of the roller is on the hardened pavement adjoining the mat being paved. Where two or more layers of asphaltic mix are being laid, the center joint and the construction joints shall not be placed in the same vertical plane.

Density Requirements

The density of the finished pavement shall be not less than 98 percent of the Marshall density obtained in the laboratory.

Pavement Uniformity

The finished pavement shall be of uniform thickness and texture and the thickness shall not vary more than 6mm from that specified.

The surface tolerance of any paving course shall be such so as not to exceed 6mm when tested by means of a 4 meter straight edge longitudinally and 3mm when tested transversely.

Any layer with deviations exceeding the foregoing limits shall be corrected or removed and replaced by the Contractor at his own expense, to the satisfaction of the Engineer's Representative.

MISCELLANEOUS WELDING

1. CUTTING AND PREPARING PIPES FOR WELDING

Square cuts shall be in a plane perpendicular to the pipe axis. Oblique cuts shall be done accurately to the required angle in such a manner that the cut edge is in one plane. Pipe ends for butt welding shall be bevelled to an angle of 30° with the plane of the edge, with a permissible variation of +3° or - 0°.

All cutting shall be done with a mechanical tool, or by acetylene flame cutting by means of a special cutting device or Arc-air (carbon electrode with air jet). Flame cut surfaces shall be filed smooth.

Cutting of mortar-lined pipes shall always be done with Arc-air cutting equipment. After the metal has been cut through to the mortar lining, the latter shall be carefully broken along the cut and pipe edge prepared for welding as required above in subsection 30518(a).

2. WELDING OF FLANGES

The welding of flanges to pipes shall be of the same quality as that specified for pipe welds. Slip-on flanges shall receive an interior weld inside the flange opening, in addition to the external weld. Weld-neck flanges shall be attached to pipe ends as specified above for the welding together of pipes, care being taken to ensure a perfect concentric alignment between pipe and flange. When welding on flanges, care shall be taken that the face of the flanges is perpendicular to the pipe axis. Flanges faces shall be kept free from weld material of other defects such as splutter, dirt, etc. All defects in the flange faces that may interfere with the proper sealing of flanges shall be repaired.

3. WELDED ELBOWS

These shall consist of suitable obliquely cut pieces of pipe (“miters”) welded together. These mitres shall be cut to the exact dimensions shown on the drawings and accurately fitted together so that after welding the completed elbow will have the exact shape and dimensions shown on the drawings. The ends of the mitres shall be bevelled for welding as specified above.

In all elbows having diameter of more than 10” the seams between mitres shall also receive an internal weld pass, which shall be made after the weld root has been thoroughly cleaned.

4. FABRICATION ON BRANCH OUTLETS

Fabricated T and Y branch connections shall be produced by cutting the branch pipe to the correct intersection shape to fit the curvature of the main pipe, cutting the required opening in the main pipe and welding the branch pipe to the main pipe.

The quality of welds shall be specified for pipe connections. The inside of the pipe intersection shall be cleaned and smoothed to ensure unobstructed flow in the pipe.

Where shown on the drawings or instructed by the Engineer, the Contractor shall installed weld reinforcement saddles to fabricated T and Y branches specified above. The saddle shall cut and bent to the required shape and slipped over the branch, its outside edges shall be welded to the main pipe, while the edge of its opening shall be welded to the branch pipe Quality of welds shall

be as specified above the edge of its opening shall be welded to the branch pipe. Quality of welds shall be as specified above for welding of pipes.

5. FABRICATION ON PIPE REDUCERS

The Contractor shall fabricate the reducers from steel plate properly cut, rolled and welded or by cutting out wedge-shaped pieces from a length of pipe the diameter of which shall be equal to the larger diameter of the required reduces, squeezing the pipe together to the shape of the reducer and welding along the cut edges, which shall be straight and bevelled for welding, the gap between them being of uniform width over the whole length. On pipes having a diameter of more than 10" an internal pass shall be added to each weld, which shall not protrude more than 1.5mm into the inside of the pipe. The ends of the pipe reducer shall have edges in parallel placed perpendicular to the pipe axis and shall be bevelled for butt welding.

6. PREFABRICATED FITTINGS

Prefabricated elbows, tees and reducers shall be jointed to pipes by square butt welds or by lap welds as specified above for pipe-welding, care being taken that the true alignment and correct position of the fitting are ensured.

7. INSTALLATION OF VALVES AND FITTINGS

General

Before being installed, the valves and fittings, and especially valve seats, shall be cleaned of any dirt that may have entered them.

When installing the valves, their correct position shall be ensured by means of a spirit level.

Fitting the valves to pipes shall be done accurately, but without using force. Fitting of valves by tightening bolts forcibly or by any other method that will cause internal stresses in the valve or flanges will not be permitted.

8. WELD INSPECTION AND TESTS OF VARIOUS WELDS

General

The Engineer's representative himself or by his authorized agent will exercise a continuous control of the welding work and will inspect the quality of the welds. In addition to routine supervision and visual inspection of the completed welds, the Engineer's Representative will have the right to request samples to be cut from the welds for destructive tests. If so required by the Engineer's Representative, welds shall also be tested by radiography.

Destructive Tests

General: Destructive tests will include all or part of the following, at the discretion of the Engineer's Representative:

Break Test.

Bend Test.

Tensile Test (in special cases).

Both the Contractor and the Engineer will endeavour to ensure the proper execution of the welds, so as to avoid altogether or minimize the number of destructive tests.

Frequency of Tests

Should one of the samples taken for the destructive tests not meet the standards of acceptability set out below, the Contractor will be required to cut additional samples from the same weld or from other welds made by the same welder. If one of the new samples does not meet the requirements, the Contractor will be required to cut more samples until a clear picture of the extent of defective welds is obtained. Should such additional tests show that the quality of the welds is unacceptable, as determined by the Engineer, the Engineer may require the Contractor to remove and re-weld all welds made by the welder concerned. In the event of the test sample meeting the requirements of the Specification, the cost of cutting the sample and preparing and testing the specimens, and that of patching the pipe where the sample fail to meet the above requirements, all such cost, as well as the cost of all additional tests that may be required, to determine the extent of the defective welds as aforesaid, shall be borne by the contractor.

Taking Samples for Bend Test, Break Test, and Tensile Test

Bend Test, Break Test and Tensile Test shall be cut from the pipe in the forms of strips 5cm wide, perpendicular to the weld seam and extending 10cm on either side of the weld, so that the weld will be located in the center of the sample.

The opening resulting from cutting the sample shall be closed by welding on a patch of steel plate having a thickness not less than that of the pipe wall.

The cost of patching up opening as herein described shall be included in the cost of taking samples as specified above.

Bend Test: The bend test samples shall be bent in suitable jig in the field or in the shop. The bend shall be located exactly over the weld with the weld face on the convex side. The sample shall be considered as meeting the requirements if it will not break and no cracks larger than 3mm in any direction will appear on the convex side of the bend.

Break Test: The break test sample shall be hacksaw-notched on both edges across the center of the weld to ensure breaking of the sample in the weld. The sample shall be supported on both sides of the weld and broken by a strong hammer blow. The required result is the broken surface shall show full penetration of the weld and no burns or excessive slag inclusions. The break surface shall not show more than one gas pocket per square centimetre, provided that no gas pocket has a diameter of more than 1.5mm.

Tensile Test: Samples for tensile strength and elongation tests shall be send for testing to an authorised laboratory. These tests will serve as a control of the welding procedure and of the quality of the electrodes but not to test the welder's ability. In this test the samples shall show a tensile strength not less than that required of the steel of which the pipes are made.

TECHNICAL SPECIFICATION FOR MATERIAL SUPPLY

• **TECHNICAL SPECIFICATION FOR MATERIAL SUPPLY**

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Appendix A - Standards

1. PRELIMINARIES

1.1 General

This specification relates to the supply of pipes and fittings by the Operator to the Contractor.

This specification has been based on current practice and the pipes and fittings comply with the relevant International Standards, (ISO's) or British Standards, (BS's) listed in Appendix A as well as the Israeli requirements enacted by the Israeli Institute for Standards for part of the Goods.

The water network system existing in the Gaza strip comprises mainly Imperial dimensioned pipes and fittings therefore provision of Imperial dimensioned pipes and fittings are detailed for the rehabilitation work. HDPE pipes are available in metric dimensions only. All pipes and fittings to be supplied shall be pressure rated to PN 10.

1.2 Supply

The materials have been pre-ordered and are being delivered to the Operators Storeyard at PWA stores.

uPVC Pipes and Fittings, Gate Valves, Air Valves, Couplings, HDPE Pipes, Tapping Saddles and Associated Fittings have been delivered to PWA stores.

1.3 Protection

All materials shall be securely packed in crates or boxes for protection against damage during transit.

Flanges of valves shall be protected by wooden discs temporarily bolted on or secured by steel strapping. Spindle caps of valves shall be removed and secured to the inner side of one of the wooden discs by means of a steel strip. Otherwise they shall be packed in a case. The projecting end of the spindle shall be well wrapped with straw rope covered by hessian cloth and secured in place by binding wire which shall be carried under the flange of the gland.

All plain ends shall be adequately protected by straw rope secured in place by binding wire or strap. None of the packing will be returnable. The cost of packing shall be included for in the schedule rates.

The materials supplied shall be of the appropriate grade and quality and shall be adequately protected against the climatic conditions in the Middle East.

All plastic materials shall be protected from direct sunlight and appropriate coverings supplied for use at the delivery and storage areas.

1.4 Identification

1. The supplier shall be responsible to ensure that each separate item, crate, or package has permanently attached to it, in a conspicuous position, an identification plate of weather - resistant material on which are engraved or stamped;

- The manufacturers name;
- Contents description and quantity;
- Serial number or reference numbers identifiable on the delivery note and cross-referenced to the purchase order item references; and
- Weight.

2. In addition the container shall be marked with the following information;

- Total gross weight;

- Total net weight; and
- Packing list reference number.

1.5 Handling

Care shall be taken during loading, transporting, and unloading to prevent damage to the pipes, fittings, or coatings. Under no circumstances shall pipes or fittings be dropped or rolled against one another. All pipes and fittings shall be examined. Any damage to the coatings shall be repaired as directed by the Operator.

All pipes shall be bundled or packaged in such a manner as to provide adequate support and protection for the ends during transportation from the manufacturer to the Purchaser. All special provisions for ocean shipment shall be provided.

2. PIPES

2.1 General

All pipes supplied shall be suitable for potable water supply.

Pipes shall not be exposed to sunlight for any extended period

Any pipes (or fittings) with an indentation greater than 10% of the wall thickness shall be rejected. Any pipes (or fittings) distorted out of round by more than 5% shall be rejected.

All pipes shall be pressure rated to PN 10.

Pipes shall bear clear and permanent markings showing the nominal diameter, pressure rating, type, year of manufacture and the manufacturers name or trade mark. Markings on pipe lengths shall always be at the same end. Painting of data shall be acceptable for all pipe material.

All ISO, or alternative, recommended tests including witnessed tests shall be carried out and certified in writing to the Operator, on delivery of the batches.

2.2 Unplasticised Polyvinyl Chloride (uPVC) Pipes

uPVC pipes shall have spigot and socket joints with rubber O-ring gaskets.

All joints shall have the same characteristic strength as the connecting pipe.

2.3 High Density Polyethylene (HDPE) Pipes

The raw material from which the pipes are made shall be composed substantially of high density polyethylene to which may be added only those additives that are required for manufacture of the pipes. The raw material shall contain carbon black of not less than 2% by weight.

Dimensions and tolerances shall comply with ISO Standards.

2.4 Polyethylene External Coated Steel Pipes And Fittings

Description Of Pipes

Except as otherwise specified, steel pipes shall meet the requirements of S.I. 530 for the grade and wall thickness shown on the Drawings. Pipes shall be either with plain ends for butt-welding or with a bell on one end for fillet welded lap joints. Pipes shall normally be supplied with a cement- mortar lining on the inside. Pipes for installation below ground shall be supplied with an external polyethylene coating.

Dimensions and Tolerances

Dimensions

The pipes shall be supplied with minimum wall thickness of 3/16" for diameters of 14", 12" AND 10", and with minimum wall thickness of 5/32" for diameters of 8", 6" and 4" pipes.

The pipes shall be supplied in 12 meters lengths. Each supply may include a percentage of short pieces. However, pipes shorter than 6 meters shall not be accepted and the percentage of short pieces shall not exceed 5% of the total lengths of each supply.

Tolerances

The tolerance on the specified wall thickness is +12% and -5% (except on weld areas where maximum height of weld reinforcement shall be 3mm) with a minimum of +0.5 mm.

The tolerance on the outside diameter is +-0.75 or +-10mm.

Cement Lining

The cement lining shall consist of a mixture of sand with a gradation varying between 0.16 mm and 5mm and with a 96% purity index, potable water and portland or blast furnace cement with low water solubility.

The cement lining shall be carried out in the mill by means of centrifugation and shall have a smooth surface coat consisting of fine grains of sand and cement.

The specific gravity of the mortar used shall be not less than 2.2 after centrifugation.

The thickness of cement lining shall be as per AWWA C205 -85 stipulations.

Inspection and Repair

Surface of lining shall be checked on 100 percent of production; the Contractor shall submit to the Engineer manufacturer's certificates to this effect. All over-sanded areas, blisters, cracks as a result of impacts and unsatisfactory thin spots shall be cut to the minimum permitted length.

Temperature and shrinkage cracks less than 1 mm width need not be repaired. Wider cracks have to be repaired if they do not heal under continuous soaking in water. When cement lining is damaged locally, protection of the bare zone shall be ensured by either applying a bituminous primer Endolac or similar followed by a coat of mastic bitumen or another product recommended by the pipe manufacturer, or by cutting out and replacing by hand to the full required thickness of the cement lining. Which method of repair to be used will be decided by the Engineer.

3. PIPE FITTINGS

3.1 General

Pipe fittings shall comprise any of the following items; flanged spigot, and socket fittings, couplers, flanged couplings, tees, elbows, bends, reducers, extension pieces, or any other special fitting identified in the schedule of pipes and fittings. Valves and Accessories are specified separately in Sections 4 and 5.

Pipe fittings shall be suitable for potable water supply.

Pipe fittings shall conform to ISO Standards.

All Pipe fittings shall be pressure rated PN 10.

All ISO, or alternative, recommended tests and witnessed tests shall be carried out and certified in writing to the Operator, on delivery of the batches.

Pipe fittings shall bear clear and permanent markings showing the nominal diameter, pressure rating, type, year of manufacture and the manufacturers name or trade mark. Markings on pipe fittings shall always be at the same end. Painting of data shall be acceptable for all pipe fitting materials.

Pipe fittings shall be compatible with the associated pipes and have equal or higher pressure ratings as the associated pipes.

The supplier shall provide sufficient quantities of inert, waterproof filler paste, flange wrapping tape and paste, to protect all bolted connections of flanges, couplers and fittings.

All pipe fittings specified to be coated with 'epoxy paint' shall be defined to mean that they are coated with epoxy resin powder electro-statically applied to a thickness of 250 microns. The supplier shall submit full details and technical specification of any alternative protective coating system proposed at the time of tender, for approval by the Operator.

3.2 Materials

Pipe fittings may be fabricated from either UPVC, HDPE, mild steel, stainless steel, ductile iron or copper alloy.

UPVC fittings shall be formed in injection moulds or machined from extruded stock. Fittings fabricated by solvent cement techniques shall not be accepted.

Materials, properties and strengths of the fittings made of UPVC shall equal or exceed those of the pipe.

HDPE fittings shall be supplied by the same manufacturer and shall be made from the same raw material and with the equivalent or superior quality requirements as those of the HDPE pipe.

Materials shall comply with ISO Standards.

3.3 Couplings and Flange Couplings

All couplings fabricated from mild steel or ductile iron shall be descaled and coated with epoxy paint or similar approved by the Operator.

Straight couplings, flanged couplings, tees and elbows of 50mm or less shall be manufactured in gunmetal or HDPE.

Couplings shall be supplied with a central register or locating plugs. The central collar shall be 1.5 times thicker than the equivalent standard pipe thickness.

Every coupling, and flange coupling shall be capable of withstanding without leakage the pressure rating of the section of pipeline it is supplied with.

The pressure rating shall be clearly stamped on all couplings and flange couplings. Flange couplings for jointing plain ended pipes to specials shall be capable of maintaining a watertight joint over a range of axial movement of at least 25mm and an angular deflection of not less than 2 degrees.

3.4 Flanged Fittings

All flanged fittings, fabricated from mild steel or ductile iron, shall be descaled and coated with epoxy paint or similar approved by the Operator.

Flanges shall comply with ISO Standards and bolt holes shall straddle the vertical axis of the flange.

All steel flanges shall be welded to the pipe by the electric arc process or other approved method. The flanges shall be of the raised face type and shall be truly faced over their whole width. Bolt holes shall be drilled on centre lines, truly in line end to end with the longitudinal axis. All flanges shall be rated as PN 10. All flanges shall be adequate to withstand test pressures for the specials to which they are attached.

Flanged joints shall be furnished complete with gaskets, bolts, nuts and washers.

The supplier shall provide additional gaskets, bolts, nuts and washer sets, equivalent to 5% of the scheduled quantity, to allow for wastage or losses during the rehabilitation installation works.

All gaskets shall be full faced and suitable for potable water supply in the Middle East climate. The supplier shall demonstrate the suitability of the gasket at the time of tender.

Bolts and nuts shall be in carbon steel and shall be hot-dipped galvanised spun (to a standard sufficient for a saline environment). The bolts shall be hexagonal head type, and their dimensions shall conform to ISO Metric Black Hexagon Bolts, Screws and Nuts. "Normal Thickness Nut Type, or similar approved by the Operator.

4. VALVES

4.1 General

Valves shall be suitable for potable water supply.

All protective coatings shall be non-toxic and shall not foster micro biological growth nor impart any odour, taste, cloudiness or discoloration to the water. All ferrous surfaces in contact with water shall be coated with epoxy paint or similar approved by the Operator.

Valve bodies shall give the following information

Year of manufacture

Manufacturer's name.

Working pressure;

Size of valve;

all to be cast in raised letters, upon an appropriate part of the body. Where appropriate the marking shall have a minimum size of 25mm (1 inch), raised 3mm (1/8 inch).

After completion of assembly, each valve shall be shop operated three times from the fully open position to the fully closed position and returned to fully open under no flow condition to demonstrate that the assembly is working.

All valves shall be hydraulically tested at the place of manufacture to the pressures specified and shall satisfactorily pass the specified tests before they are packed for delivery.

The operating gear of valves shall be such that one man can open and close the valve against an unbalanced head 15% in excess of the maximum to be encountered in service.

Packed glands shall be arranged for easy replacement of the packing, which shall be accessible without removal of the valve from the pipe and while the valve is still in service. Precautions shall be taken to prevent corrosion of the valve spindles in contact with the gland packing.

Flanges of valves shall be to PN10.

4.2 Gate Valves

Gate valves shall conform to ISO Standards.

All Gate valves shall be fabricated in ductile iron.

The minimum working pressure of all gate valves shall be PN10.

Gate valves shall be of the resilient face type .

The operating stem shall have 'o' -ring seals.

The direction of opening for all gate valves shall be anti-clockwise as viewed from the top.

Valve ends shall be flanged type.

All external body and flange surfaces shall be coated with epoxy paint, or similar approved by the Operator.

All interior surfaces except the finished and seating surfaces, shall be coated with , epoxy paint, or similar approved by the Operator.

For resilient faced gate valves, a hydrostatic test pressure equal to twice the rated working pressure of the valve shall be applied to the body with the gate in the open position. The test shall show no leakage through the metal, flanged joint, or stem seals. Subsequently, a test shall be made from each direction at the rated working pressure to prove the sealing ability of each valve from both directions of flow. The test shall show no leakage through the metal, pressure - containing joints, or past the seat.

4.3 Air Valves

Air valves shall be fabricated to ISO standards.

All air valves shall have flanged ends.

All air valves shall be fabricated in ductile iron and pressure rated to PN 10.

Air valves shall be of single and double orifice type.

All air valves shall have a means of isolation. Each air valve may be supplied with a horizontally positioned isolating valve of the same size, with bevel gearing arrangement for vertical operation and a set of flange jointing materials including nuts, bolts, washers and joint gaskets for insertion between the air valve and isolating valve. The bevel gear pinion shall be of corrosion proof steel. The supplier may propose an alternative, for approval by the Operator.

All surfaces, except the finished or seating surface shall be coated with epoxy paint, or similar approved by the Operator.

Double orifice air valves shall be of 'aerokinetic' type incorporating hydrodynamic principles suitable for air exhausting during charging or venting when emptying of the main. The ball-sealed orifice shall always remain open while air is discharged and shall be immediately closed when the water rises in the valve to lift the ball and seal the orifice. The escaping turbulent air or a mixture of air and water spray (even at the critical velocity of 300 m/sec) shall not cause the ball to be thrown into the discharging air stream and be blown shut prematurely during the filling of the water main at high rate. Under no circumstances shall the large orifice ball blow shut prematurely.

The ball of the large orifice shall bear a calculated mathematical relation with the inlet diameter of the valve i.e. the average cross - sectional area of escaping air stream, so that the ball will be blown shut by a stream of water but held down by a stream of air. The weights of each ball of the same size and type shall not differ by more than 2%.

Single orifice air valves shall be relief in action and shall operate such that the ball cannot be held against the orifice by air pressure alone.

The design of the valve shall be such as to allow maximum free air discharge and inflow at pressure differentials of plus 0.5 bar and minus 0.2 bar respectively. The supplier shall submit with his Tender, curves for free air discharge and inflow against various air pressures at valve

inlet.

The orifice shall be either copper alloy or stainless steel, not less than 3 mm and tapering to 10 mm suitable to release accumulated air within the pipe. The profile of the orifice shall be such as to avoid damage to the ball surface. The orifice shall be protected by a suitable plug of stainless steel. All air valves shall be made insect proof by providing stainless steel screens at the vents leading into the atmosphere.

The low-pressure cover shall be designed to withstand the full operating thrust in the working condition. A neoprene seat ring shall be held securely in place under the low pressure cover by a joint support ring to prevent it from sagging when the ball is not sealing the orifice.

After completion of machining but before assembly the valve body shall be hydraulically tested to twice the working pressure for a period of 5 minutes and thereafter compressed air at a slightly higher pressure shall be released through the valve inlet to check the function of the ball.

Subsequently the hydraulic pressure shall be reduced to 0.5 bar and there shall be no leakage through any of the orifices.

4.4 Fire Hydrants

Fire hydrants shall be 'Street Fire Hydrant' type, for above ground operation.

Fire hydrant nominal flange size shall be 80mm diameter.

All fire hydrants shall be pressure rated to PN 10.

Hydrant thread to be 2.5 inch Round Thread Outlet.

Direction of opening to be anti-clockwise as viewed from the top.

Nozzle size to be 2.5 inch

Operating nut shall be key-bar operated

The body and cap of the hydrant shall be fabricated from, ductile iron.

The fire hose connection shall be fabricated from cast bronze having the following properties;

Chemical Composition;

Copper: 82.0-87.0%

Lead 4.0-6.0%

Tin 4.0-6.0%

Zinc 4.0-7.0%

Mechanical Properties;

Tensile Strength 210 MPa minimum

Yield Strength 95 MPa minimum

Elongation 15%

'O' rings and gaskets shall be suitable for potable water supplies.

All foundry and machine work shall be in accordance with standard good practice.

When assembled hydrants shall be well fitted and smooth operating.

All joints shall be faced true and watertight under operating and test pressures.

All iron parts receiving bronze mountings shall be made true and smooth, and the bronze mounting shall be finished to fit.

All castings shall be clean and sound without defects that would impair their service. No plugging, welding, or repairing of such defects shall be permitted.

All like parts of the same model and size produced by the same manufacturer shall be interchangeable.

Each hose connection shall have caps attached to the barrel by chains.

All internal and external surfaces, except seating surfaces shall be coated in epoxy paint.

4.5 Check Valves (Non Return Valves)

Check valves shall be of the swing type with an extended hinge pin extended from both sides. Check valves shall be used to prevent automatically reversing of flow. Check valves shall comply with BS 4090 with cast iron body, door and cover, gunmetal seats and stainless steel hinge pin. All materials shall be to appropriate British Standards.

4.6 Butterfly Valve

Butterfly valves shall comply with B.S.5155 or B.S.3952. The valve body and disc shall be of cast iron to B.S. 1452 with stub shafts of stainless steel to B.S.970. The seal shall be of nitrile rubber sealing against phosphor bronze seats. The valve body shall be attached to the pipeline with flanges. Butterfly valves in the smaller sizes may be of the water type where the valve is bolted in between pipe flanges. The seal shall be of nitrile rubber covering and lapped over the internal surface of the valve. Valves of this type shall be only for sizes up to and including 300 mm. All valves above this size shall have integral flanges.

For both wedge gate valves and butterfly valves manual mechanisms for operation shall be provided. The gearing shall be such that seven to eight complete revolutions of the hand wheel is required for complete closure. All valves shall be operated by handwheel unless otherwise specified. No valve shall be lever operated. Tee keys and bars may be specified on washout valves.

Handwheels shall be turned in a clockwise direction to close the valve and shall be clearly marked with the word "CLOSE" in English and an arrow in the appropriate direction. Handwheels shall be of cast iron or plastic encased steel.

5. ACCESSORIES

5.1 Surface Boxes and Chambers

All surface boxes shall be fabricated from ductile iron.

Surface boxes shall be heavy duty and resistant to damage or displacement by heavy traffic.

Surface boxes shall be either square opening or round with chains attached to the covers and frame.

Covers shall have the letter 'W' on the top surface.

All chamber boxes shall be fabricated in uPVC, have the equivalent clear opening dimensions of the respective surface box and shall be 300mm deep.

5.2 Tapping Saddles

Tapping saddles shall be of the type fitted to the top of the pipe and shall be capable of allowing insertion of the ferrule cock under working pressure.

Tapping saddles may be fabricated from ductile iron or copper alloy.

The supplier shall ensure full compatibility of the saddle with the under-pressure equipment and ferrule cocks, and shall provide full details of the system at the time of tender.

5.3 Ferrule Cocks

Ferrule cocks shall be fitted to the top of the pipe and shall be capable of being fitted under working pressure.

Ferrule cocks are to be fabricated in copper alloy.

5.4 Repair Collars

Repair collars shall be of the split or wrap around type.
Repair collars shall be fabricated from ductile iron, or stainless steel.

5.5 Stop Taps

Stop taps shall be manufactured for underground operation and operated from the surface by a stop tap key.

Stop taps shall be manufactured from copper alloy or other material to be approved by the Operator. Full details including alternative standards shall be provided by the supplier at the time of tender.

5.6 Combined Tracer and Marker Tape

The combined tracer and marker tape shall be manufactured in metallic mesh, 100mm wide, of maximum opening size of 25mm and shall be detectable by an electronic main locator at a depth of 1m.

The metallic strip is to be protected from corrosion by PVC coating coloured blue.
Other material may be considered subject to the supplier submitting alternative details at the time of tender.

6. MANUALS AND TECHNICAL SPECIFICATIONS

The supplier shall supply full technical specifications for the items to be supplied at the time of tender. In addition he shall provide full instruction manuals which describe the correct methods and procedures necessary to construct the pipeline system in accordance with best practice.

The supplier shall provide, at the time of tender, details of the of the equipment necessary to correctly install the pipeline system including under-pressure tapping machines, pipe cutters, chamfering (beveling) tools, joint making equipment, lubrication materials and loose tools.

Twelve sets of all instructions and operating manuals for each type of valve and appurtenance shall be provided; six English and six in Arabic, with delivery of the first batch of materials.