



In partnership with



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**CONSTRUCTION OF CHEBANG'ANG WATER SUPPLY PROJECT IN BOMET COUNTY**

**TENDER NAME: PIPE LAYING AND INSTALLATION OF FITTINGS FOR  
CONVEYANCE PIPELINE FOR CHEBANGANG WATER SUPPLY  
PROJECT PHASE II IN BOMET COUNTY**

**TENDER NO. KRCS/PRF7925/2021**

**CLOSSING DATE: 5<sup>TH</sup> MAY 2021**

**TENDER DOCUMENTS**

**VOLUME 2: SPECIFICATIONS**

**APRIL 2021**

## SECTION IV: TECHNICAL SPECIFICATIONS

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## **GENERAL**

### **DESCRIPTION OF THE WORKS**

The works are as described in part 2, section VII of the Bidding documents under, Works requirements.

### **LOCATION OF THE WORKS**

The locations of the works are shown on drawing described in Part 2, Section VII of the bidding document and in any other drawings issued with the bidding documents.

### **ACCESS**

The Contractor shall be responsible for obtaining the owners' and occupiers' permission for any temporary access. The Contractor shall be responsible for the maintenance of temporarily occupied land, and shall exhibit written confirmation that he has restored at his own expense, the ground fences etc., disturbed for temporary access to the owners and occupier's satisfaction.

### **SITE ALONG PIPELINES IN PRIVATE LANDS**

The Client will serve the necessary notices to permit pipelines to be laid in private lands in accordance with the program of work which the Contractor will submit. The Contractor shall not enter on the lands until given permission in writing by the Engineer. If required the Contractor temporarily fence the site where the works are to be, or are being constructed to the satisfaction of the Engineer and the Contractor shall confine all the works, plant, labour, materials, and transport within the site so fenced. The working width allowed to the Contractor will generally be 10m unless otherwise instructed by the Engineer.

All liability arising from any departure from these limits without the written consent of the Engineer will be borne by the Contractor. Arrangements with each occupier will be made for the protection of stock. Unless otherwise stated, the cost of all fencing will be deemed to be included in the price for the item watching, lighting and fencing

### **SITE INVESTIGATIONS**

The Contractor will conduct his own site investigations. He shall make and be responsible for his own interpretations of any results of site investigations. Such results, particularly in regard to the level of rock etcetera, and may he wishes, subject to the approval of the Engineer, which will not be unreasonably with health, make further explorations at his own expense.

The Engineer may direct the constructor to execute further investigations at the Employer's expenses, but the Contractor shall be responsible for immediate executions for such works and the effects of any delays caused by the Contractor in not executing such instructions promptly will be at his own expense.

### **EXECUTION OF THE WORKS**

The Contractor shall execute the works in the manner, and according to the program submitted with his tender and as amended and approved from time to time by the Engineer.

Where necessary, due to the requirement of completing certain portions of work the Contractor shall execute such works at such times as may be instructed by the Engineer.

The Contractor shall, where instructed by the Engineer, which instructions shall not unreasonable, supply and use special plant for the execution of particular parts of the work as are specified in such instruction.

Should the Employer so require, the Engineer shall instruct that those parts of the works which have been completed and are required by the Employer, shall be put into service. Such actions shall not however relieve the Contractor of any of his obligations with regard to maintenance.

The effects of such instructions which may be given in accordance to the Contract shall be incorporated into the Contractor's program. Any delays and extra costs incurred by the Contractor shall be at his own expense.

The Contractor shall at his own expense make all and any arrangements for the supply of any temporary services that he may require. In particular, the supply of water shall not be standard approved by the Engineer.

Suppression of Noise: The Contractor shall make every reasonable endeavor both by means of temporary works and by use of particular plant or silencing devices to ensure that the noise level resulting from the works does not constitute a nuisance

#### **CONTRACT DRAWINGS**

The Contract drawings shall be issued to the Contractor at the start of the Contract. The Engineer may from time to time issue such further drawings as are necessary to the Contractor. Any drawings that may be prepared and submitted by the Contractor to further describe the permanent works and which are approved by the Engineer shall become Contract Drawings upon the issue of such approval.

#### **LEVELS DATUMS**

The Engineer shall provide the Contractor with the levels and co-ordinate positions of the datum's he shall use. The Contractor shall establish at each site steel datum pegs which shall be securely concreted inland shall agree with the Engineer the level and co-ordinates of each and every peg.

The levels and positions shown on the drawings are believed but not guaranteed to be correct. In the event of any discrepancies the Contractor shall notify the Engineer in writing immediately who will issue such correct dimensions, levels or positions within two days.

The Contractor may establish additional temporary bench marks for his own convenience but each temporary bench mark shall be of a design and in a location approved by the Engineer and shall be accurate in relation to the bench marks established by the Engineer.

The Contractor shall protect the reference points and level bench marks and in the event of any damage he shall re-survey and re-establish the points and bench marks.



## **SETTING OUT.**

The Contractor shall appoint and employ the necessary qualified and experienced staff to set out the Works accurately. The Contractor shall establish and locate all lines and levels and be responsible for the correct location of all Works.

Where directed by the Engineer, the Contractor shall take such levels and dimensions as may be required for the purposes of measurements prior to disturbance of the ground. These shall be agreed between the Contractor and the Engineer in writing before any of the surface is disturbed or covered up.

The Contractor shall be responsible for all setting out of the work in accordance with the drawings the Engineer's Instructions. On completion of any setting out of the work he shall inform the Engineer who shall, if he considers it necessary, check all such setting out, but such approval shall not relieve the Contractor of any of his responsibilities or obligations under Contract.

## **BOUNDARIES OF THE WORKS**

The boundaries of the works are shown on the on the Contract drawings. The Contractor shall be given possession of such parts of the site as he requires. Where possible he shall be given the whole of the site, but not part of the site which is in the possession of another Contractor, until such other Contractor agrees, or has completed his works.

The Contractor shall fully protect and maintain the site to the Engineers satisfaction under Clause 19 of the Conditions of Contract.

The Contractor shall provide temporary fencing, or immediately install permanent fencing where such is required. Where the permanent works do not include fencing (drains and pipelines etc.) the Contractor shall submit his proposals to the Engineer as to how he intends to fulfill his obligations under the Contractor which shall be to the approval of the Engineer.

## **RESTRICTIONS ON ROADS**

The Contractor shall not run tracked vehicle or other vehicle with excessive wheel loads on any road, being, completed, which forms parts of the permanent works, nor on any public or private road without the approval of the authority, owner, or other controlling body, and subject to such conditions as each may require.

The Contractor shall respect all weights limits and all notices of closure which apply to roads during wet weather.

The Engineer shall have the power to restrict the Contractor's use of any roads, either in direction of traffic, speed of traffic or numbers of vehicles in order to preserve such roads or to make such roads safe for use by the general public.

Where other Contractors require the use of the same roads or trucks, the Engineer may prescribe times of usage, or any other form of control, which shall be executed by the Contractor at his own expense, including the supply of traffic lights, flagmen, or any other thing.

## **COMMUNICATIONS**

The Contractor shall supply as directed by the Engineer communication equipment to be installed at and communicate between the site office or offices provided for the Engineers Representative and the Engineers office, and addition mobile units as required the of the Engineers representative staff, ownership on which revert to the employer on completion of the Contract.

The Contractor shall make available at his major site office or offices a representative who shall be immediately available at all times during normal working hours. To such representatives shall be delegated full authority to confer with the Engineer's Representative or his Deputy and to take all steps and to issue all those instructions which may be required in an emergency to ensure the safety of all personnel of the works and of all the Employer's and other property on the site and the immediate vicinity thereof. The Engineer's Representative may from time to time at his discretion after taking into consideration all the prevailing conditions allow some relaxation of this clause but t such relaxation shall be made only with the written permission and subject to any special conditions which he may then require.

## **PROVISIONS FOR THE ENGINEERS REPRESENTATIVE**

The Contractor shall provide for the use of the Engineer's Representative and his staff the offices. These offices (ownership of which will revert to the Contractor to the conclusion of the Contract.) shall be erected in the places as instructed by the Engineer's Representative.

The Contractor shall be responsible for providing all temporary services including gas, electricity and water as may be required all at his own expense. The Contractor shall ensure that the offices are cleaned every day and guarded at night.

The Contractor shall provide for the sole use of the Engineer's Representative and his staff the surveying equipment and other equipment ownership of which will revert to the Contractor at the conclusion of the Contractor. No survey work shall be approved by the Engineer until survey equipment has been provided.

The Contractor shall make available such labour and materials as the Engineer's Representative may require for survey work in connection with the works.

The Contractor shall purchase on behalf of the Employer as directed by the Engineer vehicles shall be for the sole use of the Engineer and the staff and which will revert to the Employer on completion of the Contract, or at such earlier time as may be required.

The Contractor shall pay for all the expenses incurred in the operation of such vehicles which shall include any taxation, car tracking devices and attendant costs, licenses, fuels, oils, service, spares including tyres, insurance including alternative transport should the vehicle or vehicles be in any way out of use, and at the end of the Contract of any overhaul before the vehicle or vehicles returned to the employer.

The Contractor shall make available such drivers as are required by the Engineer's Representative or his for the satisfactory operation of such vehicle, and where directed by the Engineer's Representative shall provide such as security arrangement as he deems necessary.

The Contractor shall provide all necessary tackle, test equipment, access, labour, staff and another thing the Engineer's Representatives may reasonably require in order that he may conveniently quickly carry out such inspections as he deems necessary at any time during the Contract.

During the period of Maintenance, the Contractor shall make available, on due notice from the Engineer, such staff etcetera as are required for inspections and a responsible senior representative to take note of, and executive all those matters which the Engineer may direct be attended to by the Contractor to fulfill his obligations under the Contract.

## **MATERIALS**

The Employer shall provide those materials listed in Appendix B, which will be made available at the times stated and are for inclusion in the work specified. The Engineer may from time to time advise the Contractor of any changes.

The materials will be stored at one of the Employers storage areas shown in Appendix E all such other place as may be notified to the Contractor from time to time. The Contractor shall make all the necessary arrangement to take delivery of such materials in accordance with clause 90 of the Condition of Contract within 3 days of the date of the Engineers instruction to take delivery of the same.

In the event that the Contractor requires such materials before they are available, due to delays or other circumstances beyond his control, he shall give the Engineer two weeks' notice in writing. Any delays arising out of the non-availability of materials to be supplied to the Contractor that have not been advised to the Engineer in writing shall be at the expense of the Contractor.

All other materials which are of similar nature that are additionally required to be supplied by the Contractor under clause 8 of the Conditions of Contract shall be purchased from an approved manufacturer, and shall to the same specification as those materials supplied by the Employer all to such alternatives specification as may be issued by the Engineer.

Further to clause 36 of the conditions of Contract, the Contractor shall take all responsibility for ensuring that samples are provided, and any necessary tests executed, and all assistance provide to the Engineer in order to expedite his approval.

Any delays which are caused late submission of samples, execution of tests, ordering and delivery of materials shall be at the expense of the Contractor

## **EXISTING SERVICES**

The Contractor shall take every precaution to ensure that all existing services pipes culverts cables drainage and irrigation ditches and the like are located supported and safeguarded from damage even though they may not be in the line of excavation but near to it. Any damage caused to any such services pipes curvets cable drainage and irrigation ditches and the like attributable to the Contractor's operations or to his negligence shall be made good by or for the Contractor at his expense to that satisfaction of the Engineer and that of the owner or responsible Authority. In the event of the owner or responsible Authority electing to repair such damage

themselves the Contractor shall pay the cost of his or their so doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable period of their account represented to the Employer reserves the right to settle the Account and deduct the sum paid to him from moneys due or which may be become due to the Contractor.

If it should become necessary for the proper of execution of the work temporarily to remove or divert an existing pipe sewer filed – drain cable drainage or irrigation ditch or other service, the Contractor shall obtain permission from the responsible Authority or owner and shall carry out the work at his own expense in a manner and at times to be approved by such Authority or owner and shall be subsequently reinstate the work to the satisfaction of such Authority or owner. In the event of the owner or responsible Authority electing to repair such damage the Contractor shall pay for the cost of his or so their doing them work. Should the Contractor fail to pay the cost of the said work within a reasonable period of their account being represented the Employer reserves the right to settle the account and deduct the sum paid by him from moneys due or which may become due to the Contractor.

The Contractor's attention is particularly drawn to the requirements to maintain drainage and irrigation ditches in order to avoid in interaction of flow of water there in to the satisfaction of the Engineer owner or responsible Authority and the Contractor shall be deemed temporarily works so required.

If in the opinion of the Engineer or the responsible Authority or owner should become necessary permanently to remove or re-align any existing pipe sewer field-drain cable ditch or other services, the Contractors shall obtain permission where necessary from the responsible Authority or owner and shall carry out and complete the work to the satisfaction of the Engineer and such Authority or owner. Payment for such additional work will be made in accordance with clause 52 of the condition of Contract provided always that the necessity for such permanent diversion has not arisen due to the fault of the Contractor.

In the event of the Owner or responsible Authority electing to arrange for the permanent diversion of an existing service the permanent diversion of which has become necessary due to the fault of the Contractor the Contractor shall pay the cost of his or their doing the work. Should the Contractor fail to pay the cost of the said work within a reasonable of the account being presented the Employer reserves the right to settle the account and deduct the sum paid by him from moneys due or which may come due to then Contractor.

If in the opinion of the Engineer or the responsible Authority or owner it should come necessary to provide permanent support for any existing pipe sewer cable structure or other thing disturbed exposed or injured during or after the exaction of the works the Contractor shall carry out promptly such addition works as the Engineer may require to provide such permanent support. Payment for such payment work will be made in accordance with clause 52 of the conditions of Contract, provided always the necessity for such permanent support has not arisen due to the fault of the Contractor.

Any of the work involving repair replacement or re-alignment of existing pipes sewers or other services may be carried out by the responsible Authority or owner if

they so desire. In such case the Contractor shall allow them the facilities and assistance they may require and shall bear the full expense for such work except in the case of permanent removal or re-alignment which will be paid for by the Employer.

### **CONTRACTORS OFFICES ETCETERA**

The Contractor shall advise the Engineer at which of his offices any notices may be served under clause 68 of the conditions of Contract.

The Contractor shall provide and maintain an office for his Representative. If the Contractor so desires he may also erect his yard, stores, etcetera on the site in such positions as may be approved by the Engineer, which approval will be subject to the yards, stores etcetera not interfering in any way with the permanent works, nor with any of the other Contractor, infringing any law any regulations of the country of local Authority.

The Contractor shall provide and maintain at or near the site suitable and sufficient shelters, mess rooms, wash rooms, latrines etcetera, as are necessary and customary, to the satisfaction of the Engineer and in accordance to the laws and regulations of the local Authority.

The Contractor shall provide and maintain in an easily accessible place at the site of the works adequate first aid outfits for the old duration of the Contract, to the satisfaction of the Engineer's Representative.

Where necessary the Contractor shall provide protective or any other special clothing or equipment for his any other special clothing or equipment for his employees that may be necessary and shall make the same or similar available to the Engineer's Representative and his staff when they so require for the purposes of inspection or any other purpose in conjunction with the execution of their duties.

Where the Contractor wishes to construct a camp to accommodate his labour, the following requirements shall be adhered to, and shall also be subject to the requirements of the labour ordinances of Kenya and any other requirements made by the district or provincial Administration or any local Authority.

Adequate arrangements shall be made for: -

- (i) the proper disposal of all refuse;
- (ii) a supply of portable and domestic water not less than 90 litres per head par day for labour resident in the camp with an adequate number of storage tanks maintained in a hygienic condition;
- (iii) The storage of food in hygienic conditions in buildings with raised floors.
- (iv) Maintaining the camps at all times in a clean at all times in a clean condition to the satisfaction of the Medical Officer of Health (hereinafter referred to as the Medical Officer of Health);
- (v) The control of and extermination of all rats and vitamin. Such control and extermination to be excised in conjunction and co-operation with the medical officer of health;

- (vi) the disposal without nuisance of all storm and surface water and waste water from latrines, kitchens and storage tanks;
- (vii) The maintenance of all tentage buildings and works in a proper and state of repair;
- (viii) The inspection by the responsible supervisor at least one daily of all labour camps.

All camps sites which the Contractor may erect shall conform to the following requirements: -

- (i) The space between any two tents or buildings shall not be less than 3 metres and in general there shall be 6 meters between rows of tents or buildings and the camp boundary;
- (ii) All walls and roofs shall be waterproof and thatch or similar materials shall not be used;
- (iii) The floor shall be firm and even at least 10cm above the level of the adjoining ground; floors should generally slope towards the door;
- (iv) Adequate means of permanent ventilation shall be provided;
- (v) Fires shall be prohibited in sleeping quarters.

Latrines shall be provided at the rate of one seat or aperture for every 15 persons. Such latrines shall be of the deep pit type and shall be constructed at corrugated iron or other approved material and each compartment shall not be less than 1 sq. meter in area and in addition they shall: -

- (i) Be conveniently sited and not nearer than 15 meters from the nearest camp buildings
- (ii) Have the aperture sited over a hole not less than 6 metres deep
- (iii) Be adequately fly- proofed. Or as otherwise approved by the Engineer's Representative

A room or building shall be provided for the drying of cloths. Such room or building shall be of sufficient size and shall be equipped with heating and ventilating arrangements and facilities adequate for hanging up and drying clothes for all laborer employed on the site. The users of the drying room or building shall be controlled in an orderly manner and every precaution shall be taken against theft and disturbances.

The Contractor shall at all times exercise a proper and adequate control of all labour camps and shall provide and install such lighting as may be necessary to exercise such control by night. He shall be responsible for the protection of all persons properly living therein and shall at all-time take immediate and effective steps for the camps or in the immediate vicinity thereof. He shall provide watchmen or Askaris to ensure at all times that no person fouls the camp and the vicinity thereof and to enforce the use of the latrines for the relief of nature.

The brewing of alcoholic liquor shall be prohibited within the confines of camps and on all lands belonging or leased to or in forest excised in favour of the Employer. The sales and consumption of alcoholic liquor shall be permitted only at the discretion of the Engineer's Representative and under such conditions as he in conjunction with the labour officer may prescribe.

The following conditions regarding animals shall be enforced: -

- (i) no animals of any description shall be allowed in any labour camp without the permission of the Medical Officer of Health;

Should such permission be granted animals and livestock shall be kept under such conditions as the Medical officer of health shall impose and no circumstances shall such livestock be permitted in any buildings not specially provided for the same and no building nor livestock shall be near than 6 meters to a building for human use or storage of food.

The Contractor shall provide adequate audible means of giving the alarm in the event of an outbreak of fire and shall make all arrangements which may be necessary for the sounding of such an alarm. The Contractor shall take all precautions against fires and comply with any requirements concerning fires as the fire officer of the City Council of Nairobi may direct and he shall provide labour pangas beaters axes etcetera as may be necessary for the isolation and extinguishing of fires with the utmost expedition whether such fires be in his camp on the site or on adjacent land.

#### **PRECAUTIONS AGAINST CONTAMINATION OF THE WORKS**

The Contractor shall satisfy the Engineer that all his personnel working on the site are medically suitable to be in contact with a public water supply and his personnel shall undergo any necessary medical test, at the Contractor's expense, to show that they are free from any infectious diseases and are not carriers of any such diseases.

The Contractor shall at all times take every possible precaution against contamination of the work and existing Waterworks. The Contractor shall give strict instructions to all persons employed by him to use the sanity accommodation provided.

Throughout the Contract the site and all permanent and temporary works shall be kept in clean, tidy and sanitary conditions.

The Contractor shall at all-time take measures to avoid contamination of existing water courses and drains by petrol oil or other harmful materials.

The Contractor shall be responsible for making all arrangements for the disposal of waste water including the disposal of water from the water testing of mains and water retaining structures.

## **EARTHWORKS**

### **CONDITIONS OF SITE**

Before carrying out any work on any site the site shall be inspected in conjunction with the Engineer's representative to establish its general condition which shall be agreed and recorded in writing.

Details recorded shall include the location of all boundary and survey beacons the condition of building surface terracing (if any) ditches water courses roads tracks fences and other information relating to the site and elsewhere which may be affected by the Contractor's operations.

In the event of any boundary or survey beacon established for the purpose of land title being disturbed or displaced as a result of the Contractor's operations the Contractor shall forthwith at his own expense replace the beacon and shall employ the services of an approved licensed surveyor for his purpose.

### **SITE CLEARANCE**

The Contractor shall strip all topsoil and vegetation over the areas indicated on the drawings, to a depth of 250mm or such greater depth as is required to establish a surface completely free of roots and other vegetable matter.

The Contractor shall dismantle and buildings or other permanent structure where possible and stack the recoverable materials on the adjoining land of the owner of such structure, and demolish and clear away any other structures.

Underground structures and chambers shall be demolished to the levels shown on the drawings, cleared out and filled with suitable material approved by the Engineer.

Subject to the requirements of sub clause 2.3, and the Conditions of Contract. All other materials arising out of site clearance will be deemed to become the property of the Contractor, and shall be disposed by him off the site, or on the site in a manner and place approved by the Engineer

### **CLEARANCE OF TREES AND SHRUBS**

Where shown on the drawings or directed by the Engineer trees shall be uprooted or cut down as near to ground level as possible and all timber shall be deemed to become the property of the Employer. The Contractor shall cut and stack such timber as is salvable as directed by the Engineer.

Stumps and tree roots shall, unless otherwise directed by the Engineer, be grubbed out, blasted or burnt a deposited off the site in dumps to be provided by the Contractor. All holes left by the stumps or roots shall be backfilled with suitable material in a manner approved by the Engineer.

Bushes, undergrowth, or small trees, the trunks of which are less than 3 00mm girth at 1 meter above ground level, excepting coffee bushes or tea plants, shall be uprooted, and burnt or otherwise disposed of.

### **EROSION**

The Contractor shall take particular care at all times to prevent erosion on every site elsewhere on land which may be affected by his operations and the Engineer may



impose such reasonable limitations and restrictions upon the method of clearance and upon the timing and season of the year when clearance is carried out as the circumstances seem to him to warrant.

### **GROUND LEVELS**

Following the completion of site clearance and before the commencement of any earthworks the sites shall be surveyed in conjunction with the Engineer's Representative to establish existing ground levels and these agreed ground levels shall form the basis for the circulation of quantities of any subsequent excavation and filling.

### **TRIAL HOLES**

The Contractor shall excavate refill and restore in advance of his program all such trial holes as he may require for the location of water and other mains cables rock etc. the cost of these trial holes shall be included in his excavation rates, unless certain trial holes required by the Engineer are scheduled on the Bill of Quantities and payment will only be made for these.

### **EXCAVATION GENERALLY**

Excavation shall be made by open cutting unless tunneling or heading is specified or approved by the Engineer and shall be taken out as nearly as possible to exact dimensions and levels so that the minimum of infilling will afterwards be necessary.

It shall be the Contractor's responsibility at all time to ensure the stability and safety of excavations and the Contractor shall take all measures necessary to ensure that no collapse or subsidence occurs.

The sides of all excavations shall be kept true and shall where necessary be adequately supported by means of timber steel or other type struts wailings poling boards sheeting bracing and the like. All supports shall be of sound design and construction and shall take all measures and construction and shall be sufficiently watertight to permit excavation concreting and other work to be completed satisfactorily.

Excavations shall be kept free from water and it shall be the Contractor's responsibility to construct and maintain temporary diversion and drainage works and to carry out pumping and to take all measures necessary to comply with this requirement.

In the event of soft or otherwise unsuitable ground being encountered at formation level in any excavation the Contractor shall forthwith inform the Engineer's Representative and shall excavate to such extra depth and refill, with compacted granular or other approved fill or class 15 concrete as the Engineer may require. Payment for such additional excavation and additional refilling will be made at the tendered rates provided refilling that the formation has not become soft or otherwise unsuitable due to the fault of the contractor. The requirements of this paragraph shall apply also to the face of any excavation with which concrete or other work will be in contact except that in the case of a side face the Engineer may alternatively require that the net dimensions of the concrete or work shall be increased.

The Contractor shall provide all necessary support of excavations. If in the opinion of the Engineer's representative the support proposed is insufficient, then the provision of stronger support will be ordered. The Contractor's prices for excavation shall include for all support necessary.

No temporary works supporting the excavations shall be removed until in the opinion of the Engineer's Representative the work is sufficiently advanced to permit such removal. The removal shall be carried out under the supervision of a competent foreman.

Any approval of the excavation support, or of the removal thereof, shall not relieve the Contractor from his responsibilities under the Contract

### **EXCAVATION IN EXCESS**

If any part of any excavation is in error excavated deeper and/or wider than is required, the extra depth and or width shall be filled with class 15 concrete or compacted granular or other approved fill to the Contractor's expense as the Engineer may require

### **MECHANICAL EXCAVATION**

A mechanical excavator shall be employed by the Contractor only if the subsoil is suitable and will allow the timbering of the trenches or other excavations to be kept sufficiently close up to ensure that no slips falls or disturbance of the ground take place or there are no pipes cables mains or other services or property which may be disturbed or damaged by its use.

When mechanical excavators are used a sufficient depth of materials shall be left over the bottom of the excavations to ensure that the ground at formation level is not damaged or disturbed in any way. The excavation shall then be completed to formation level by hand

### **EXCAVATION FOR FOUNDATIONS THRUST AND ANCHOR BLOCKS**

Excavation for foundations and for thrust and anchor blocks shall be to such depths as the Engineer may direct and no concrete or other material shall be placed until the formation has been examined and approved. Due notice shall be given to the Engineer's Representative to enable him to examine the formation well in advance.

The Engineer may direct that a layer of excavation of not less than 75mm thickness shall be left undisturbed and subsequently taken out by hand immediately before concrete or other material is placed. Similarly, where concrete or other material is placed in contact with the side face of an excavation the Engineer may direct that the final 75mm thickness of the excavation to that face shall be left undisturbed and subsequently taken out neatly to profile by hand.

Areas of excavations which are to receive a layer of site concrete as a screeding under the structural concrete shall be covered with the screeding immediately the excavation has been completed.

If in the opinion of the Engineer due to the fault of the Contractor the ground becomes weathered prior to the placing of concrete or other material the Contractor shall excavate the weathered soil and replace it with Class 15 concrete to the original formation level at his own expense

## **EXCAVATION IN ROCK**

Rock shall be defined as material which cannot be ripped to an average depth of greater than 300mm by a track type crawler tractor complying with the following:

- a) in good order complete with all equipment and accessories as supplied;
- b) rated 300 BHP flywheel power or over;
- c) with an operating weight of not less than 37.2 tonnes;
- d) equipped with a hydraulically operated single tine ripper compatible with the tractor used; and
- e) operated by a qualified operator in accordance with the manufacturer's recommendations and to the satisfaction of the Engineer.

In all cases rock will require the use of heavy pneumatic tools or breakers, or require blasting to form the excavation

Where it is impractical to prove hard material by the above method then the quantity of hard material, if any, shall be determined by the Engineer.

Where excavation contains individual boulders of hard material greater than 0.3m<sup>3</sup> each in volume then such boulders shall be classified as rock

The Engineer's decision on whether the excavation is in rock will be final

Soft material: Soft material shall be all material other than rock

## **EXCAVATION IN TRENCH**

A maximum of 100m only of trench excavation may be opened at any one time, unless the Contractor is directed otherwise by the Engineer. Before further excavation will be allowed, the Contractor will require to have completed backfilling the trench, with the exception of the 'joint-holes'

As specified elsewhere, pipe testing shall be done in maximum lengths of 600mm and no length of partially backfilled trench with "open-holes" longer than 600mm will be allowed, unless directed otherwise by the Engineer.

Where levels for the pipe are indicated on drawings or are issued by the Engineer's Representative, the Contractor will be required to lay the pipes to these levels using profiles, bedding or boning rods, at no extra cost.

Where the Contractor is not otherwise directed on levels, pipes shall be laid with steady rises, falls and curves to a nominal cover of 800mm in fields and verges and 1.0m in roads. The Engineer's Representative shall finalize levels as work proceeds.

Trench excavation in the first instance shall not be carried down to a depth nearer than 75mm to formation level. The bottoming up to formation shall be done by hand immediately before pipe laying.

Except for joint-holes, the trench shall be bottomed carefully so that each pipe shall rest on firm bed along its length-the bottom being free from undulations and of uniform grade.

An over-excavation of the trench either on the sides or on the bottom shall be filled at the Contractor's expense with grade 7/20 concrete, unless otherwise directed

### **KEEPING ROCK FACES DRY**

The Contractor shall keep free of running water and pools the surface of rock upon or against which concrete is to be deposited and no concrete shall be placed until surfaces of the rock are properly drained. Special precautions are to be taken to prevent running water from washing out cement or concrete while it is setting or in any other way from injuring the works. Drains and pipes shall be provided in or behind concrete as may be necessary for the temporary conveyance of water and shall afterwards be grouted up and such laying and grouting shall be at the Contractor's cost

### **CLEANING ROCK SURFACES**

The faces and surfaces of all rock against which concrete is to be placed shall after being excavated to the required limits be properly cleaned and left free from all dust loose pieces or rock mud dirty and other loose material and they shall be perfectly clean when the concrete is deposited

### **EXPLOSIVES**

Should the Contractor wish to transport or use explosives on or in connection with the Works he shall comply with the Explosives Laws in Kenya. The Contractor shall provide a special proper store for explosives in accordance with local regulations and shall provide experienced men for handling explosives to the satisfaction of the Engineer and the Authority concerned.

Blasting shall only be carried out on those sections of the works for which permission is in writing shall have been given by the Engineer's Representative and shall be restricted to such hours and conditions as he may prescribe. Such permission shall not be withheld nor such hours and conditions imposed unreasonably.

The greatest care shall be taken in the use of explosives. The charges being so placed and of such amount as in no way to weaken existing structures or the foundations or ground adjacent to the existing and proposed works. The Contractor shall take all necessary precautions to prevent loss injury or accidents to persons or property and shall be entirely liable for any accident or damage that may result from the use of explosives.

### **EXCAVATED MATERIALS SUITABLE FOR RE-USE**

In so far as they may be suitable and comply with the specification materials arising from excavations may be used in the works.

The Contractor in excavating shall ensure that all materials suitable for re-use are kept separate and set aside and protected as necessary to prevent loss or deterioration.

The materials forming the surface and foundations of roads tracks and footways shall when excavated and if required for further use be carefully separated all hard materials being kept free from soil or other excavated materials.

Paving slabs bricks and similar surfaces shall be carefully removed and stacked. Prior to the commencement of excavation, the number of badly broken and unusable paving slabs bricks etc. on the line of the excavation shall be agreed with the

Engineer's Representative and only the cost of replacing these shall be paid as an extra to the Contractor.

In verges and other grass surfaces the grass and top soil shall be stripped and separately stacked.

In particular, the Contractor in excavation shall ensure that all lump free or other approved material suitable for filling around and over pipes shall be kept separate and re-used for this purpose and the Contractor shall not be entitled to payment for screening or transport as provided for in clause 2.17 of this specification if this requirement is not complied with.

#### **DISPOSAL OF SURPLUS EXCAVATED MATERIAL**

Where instructed by the Engineer's Representative surplus soil material from excavations shall be disposed of to a tip or tips to be provided by the Employer. All other surplus excavated material shall be disposed of by the Contractor to tips provided by the contractor and approved by the Engineer. Free haul distance shall not exceed 5 km

#### **REFILLING OF EXCAVATIONS**

All refilling excavations and trenches shall be thoroughly compacted in layers not exceeding 150mm compacted thickness and by means which will not damage the works

#### **MAKING GOOD SUBSIDENCES AFTER REFILLING**

All refilling whether or foundations or in pipe trenches shall be thoroughly compacted by ramming and any subsidence due to consolidation shall be made up by the Contractor at his own expense with extra compacted material. Should subsidence occur after any temporary or permanent surface reinstatement has been completed the surface reinstatement shall first be removed, the hollows made up and then the surface reinstatement re-laid

#### **REMOVAL OF TIMBER FROM EXCAVATIONS**

Timbering shall be removed from excavations before or during the process of refilling except in so far as this removal of timber would be likely to cause damage to adjacent property structures or structural in which event the Contractor shall leave in the excavations such timbers as he considers necessary to prevent damage the proper repair of which the Contractor shall be solely responsible for in the event any such damage occurring.

Except as provided for below no extra payment will be made for timbers left in excavations and the Contractor will be deemed to have allowed for this contingency in pricing his Tender. The Engineer will however certify for payment in respect for such timber as is ordered to be left in excavation but only in so far as he is satisfied that the need for the timber does not arise from any negligence of the Contractor.

#### **REINSTATEMENT OF SURFACES**

All surfaces whether public or private who are affected by the works shall be reinstated temporarily by the Contractor in the first instance and in due course when the ground has consolidated fully he shall reinstate the surfaces permanently.

The temporary reinstatement and maintenance and permanent reinstatement and maintenance of all surfaces of roads streets paths fields' verges gardens and any other surfaces which have been affected by the operations of the Contractor shall be his sole liability and shall be carried out to the satisfaction of the Engineer and of the responsible authority.

Permanent reinstatement shall not be carried out until the ground has consolidated completely and the Contractor shall apply to the Engineer for the permission to carry out this work. In the event of further settlement occurring after the completion of the permanent reinstatement and during the currency of the Contract the Contractor shall forthwith make good the reinstatement to the approved al of the Engineer or responsible authority.

For the purpose of temporary and permanent reinstatement in roads trucks and footpaths the surface width of trenches shall be increased by 150mm on each side of the trench for a depth of 75mm to provide a solid abutment for the surfacing material.

The Contractor will have careful regard to adjacent kerb foundations and kerbs. He will be held responsible for, and will be required to make good, any damage to kerbs and foundations due to his operations.

The Contractor shall at his own expense maintain in a stock proof condition all fences, walls and hedges disturbed by his operations during the course of the contract.

All hedges, walls, fences, retaining walls, etc., which the Contractor may disturb in the course of his operations, shall be thoroughly restored to the satisfaction of the Engineer. The cost of this restoration shall be deemed to be included in the tendered rates.

All public or private services or drains interfered with during the course of the work shall be restored and maintained by the Contractor to the satisfaction of the Engineer. Where a drain is encountered, the Contractor shall immediately survey it and record the details in a special book. The location, direction and condition of the drain must be noted. The Contractor must take steps to allow the drainage system to function normally during his operations. The restoration work using the existing or new pipes, as the Engineer directs, shall be done and maintained to the satisfaction of the owners and tenants. The cost of this restoration and maintenance shall be deemed to be included in the excavation rates.

Materials forming the surface or foundations of roads tracks and footpaths may if they are approved by the Engineer to be used by the Contractor in the temporary reinstatement of surface. The Contractor shall provide all additional materials necessary for the reinstatement.

In verges and other grass surfaces and after the refilling has been thoroughly consolidated the topsoil shall be re-laid rolled planted with grass as may be necessary watered and attended until the grass well established. Should the grass fail it shall be replanted as required until the satisfactory growth is obtained.

Contractor shall take all necessary precautions to ensure that no toxic materials which may cause damage to vegetation or livestock or pollute streams or

watercourses are used in any temporary or permanent reinstatement and shall indemnify the employer against any claims arising out of the use of such materials.

If the work of reinstatement as carried out by the Contractor is not to the satisfaction of the Engineer and/or the responsible Authority and should the Contractor not remedy the defect forthwith any remedial work considered necessary may be undertaken by the Employer and/or the responsible Authority at the Contractor's expense

### **FORMING BANKS AND FILLED AREAS**

Banks and filled areas shall be made and built up to the levels dimensions and shapes as shown on the Drawings or may be subsequently directed by the Engineer.

Before the filling is started the ground on which embankments are to be sited shall be stripped of all grass and topsoil and all roots vegetable matter and other unsuitable substances removed.

The filling to be used on the embankments and filled areas shall be materials selected by the Engineer's Representative from that arising surplus from excavation, the material being placed according to its nature as shall be directed that is, coarse hard material may be placed at the bottom with the fine material and/or soil placed at the top or at the surface.

The filling shall be placed in layers not exceeding 150mm thick each layer being thoroughly compacted by an approved vibratory roller to the satisfaction of the Engineer

### **TOP SOILING**

Surfaces required to be grassed shall be planted with approved local grass at a spacing of 200mmx200mm. The grassed areas shall be replanted if the first or subsequent operation is unfruitful or if for any reason the grass is destroyed. Grassed areas shall be watered and attended until the grass has become well established.

The soiling and planting of the grass in slopes shall be carried out immediately the slope is formed and the grass shall be kept weeded and cut until the work is accepted at the time of the certificate of Completion.

The Contractor shall supply attendance during the period of maintenance to ensure that all planted grass is kept weeded and cut, and if necessary watered

### **RESTORATION OF BORROW AREAS SPOILT TIPS AND QUARRIES**

Any quarries or other borrow areas developed by the Contractor for the sole purpose of the works shall be finished to safe and fair slopes to the approval of the Engineer. Where directed by the Engineer, areas shall be resolved with at least 100mm of topsoil and grassed. The cost of such work be included in the Contractor's prices

### **HARDCORE**

Hardcore for use in foundations to footways and paved areas shall consist of sound hard stone or broken rock or concrete derived from excavations or demolition of structures and shall be 75mm in size. Sufficient but not excessive blinding material of smaller sizes may be permitted at the discretion of the Engineer's Representative

## **ROCK PITCHING**

Rock pitching shall consist of a free draining mixture of broken hard stone obtained from quarries approved by the Engineer which shall have a maximum size of 300mm and which shall not contain more than 5% by weight of material which will pass a 10mm B.S. sieve. Between these limits the material shall be reasonably well graded so as to form a free drainage blanket without large voids.

### **FREE DRAINING MATERIAL**

Free draining fill for use as backing to walls shall consist of sound hard stone or broken rock or concrete derived from demolition of structures. The particles shall be roughly uniform and shall be between 74mm and 25mm in size. All smaller particles dust rubbish and organic matter shall be excluded

### **GABION PROTECTION**

Gabions shall be of the wire cage rock fill type and shall be laid on a fibre mat which shall be placed on the slope to be protected immediately after preparation of the slope. The Gabions shall be placed as soon as possible on the mat.

Fibre mat under layer to the gabions shall be a heavy grade non-woven fabric from manmade fibres, which will allow the passage of water through it, and shall be equivalent to or better than "Teram 2000" as manufactured by I.C.I. fibres, of Hook stones Road, Horwogate, Yorkshire HG2 8QN, England. Alternative materials shall be subject to the Engineer's approval.

The fibre mat shall be laid from the bottom of the slope upwards, and shall be covered by gabions such that there is now more than 30 meters in length exposed in any direction. Vehicles or other traffic shall not be allowed to run directly in the fibre mat.

Gabions shall be of the hexagon wire mesh type, with mesh dimensions of 80mmx100mm. The minimum dimensions shall not exceed 83mm. wire shall be galvanized prior to weaving the mesh to resist corrosion from river water. The size of the wires shall be as follows: -

Mesh wires	3.0mm dia.
Binding & Connecting wire	2.4mm dia.
Selvedge wire	3.9mm dia.

The gabions shall be of the following standard sizes

- 2m x 1m x 1.5m
- 2m x 1m x 1m
- 6m x 2m x 0.3m

The gabions shall be provided with diaphragms to divide the boxes in compartments with a maximum dimension in any direction of 1m. Joints shall be flexible and shall consist of not less than one and half full turns of wire, at each mesh point of the joint line.



Gabions shall be generally equivalent to or better than those manufactured by Maccaferri Gabions of America, 1 Lefrack city polaza, flushing, New York 11368 U.S.A. Alternative materials shall be subject to the Engineer's Approval.

Rock fill for Gabions shall conform to the requirements of clause 225, but in addition the maximum size shall be 220mm, and the minimum size shall be 120mm. however up to 10% of some smaller blinding material to fill the internal voids between the bigger rocks will be allowed.

The gabions shall be placed in their final positions prior to filling with rock, and shall then be tied together and filled with rock. After filling with rocks the tops shall be closed and securely tied. The larger rocks shall be placed on the upper face of the gabion in order to present a reasonably closed surface. All assembly, erection, stretching, filling with rock, final wing shall be in accordance with the instructions as issued by Maccaferri Gabions of America, or other approved manufactures instructions, as well as cutting, folding of the mesh to form nonstandard shapes, joints, angles etc.

### **PAYMENT FOR EXCAVATIONS**

The rates shall include for excavation in any material other than rock. The Contractor must include for surface clearance, laying aside surface material, for pumping or otherwise freeing from water, for all support; for uplifting and compacting; and for disposal of all surface material. Where applicable, separate items are allowed in the Schedule for replacing unsuitable material with concrete or imported granular bedding and backfill; for concrete backfill in road crossings; for cutting through concrete and tarmac roads and footpaths; for temporary and permanent reinstatement; for trial holes and for removal of trees

Trenches will be measured by the lineal meters and the depth will be taken as the depth from the natural ground surface to the invert of the pipe. Depth measurement shall be taken daily and agreed on site. Where the natural ground surface has already been lowered by excavation, the depth of the trench or other excavation shall be measured from the ground surface as lowered.

Where the natural ground surface is to be covered with embankment or other filling, the depth of excavation shall be measured from the natural ground surface before being so covered.

For measurement of items involving the trench width, the width shall be taken as the minimum width as described in special specifications

In the measurement of thrust blocks and chambers the excavation will be taken as enlargement extending from the trench outwards the width of the trench being taken as indicated above.

Excavation shall be measured net to the lines shown on the drawings or as instructed, and no allowance shall be made for over break, working space or timbering.

## **CONCRETE**

### **3.1 GENERAL**

The standard of material and of workmanship shall not be inferior to the recommendations of the current Kenya standard or British Standard code of practice, BS 8110: The Structural Use of reinforced Concrete in Buildings or British Standard code of Practice, BS 8007: The design and construction of Reinforced concrete structures for the storage of Liquids (Whichever is applicable to the particular structure) or Appropriate British standards

The requirements outlined in the above documents must be read with those of this section of the specification and where any conflict exists between the recommendations of the above and of this specification, the requirements of this specification shall prevail.

As and when required by the Engineer the Contractor shall prepare and submit, before commencing the work, a time-chart (additional to the general program) detailing the various operations for concrete work.

No material shall be used in the works until prior approval for its use has been given by the Engineer; neither shall any change in the nature, quality, kind, and type, source of supply or manufacture be made without the Engineer's permission. The names of manufactures and test certificates shall be supplied as soon as possible to the Engineer. The cost of providing samples and the cost of carrying out tests required together with the cost of supplying equipment for sampling and site testing indicated in column 3 and 4 of table 7 of this section 3 of the specification shall be borne by the Contractor.

During the process of the works, consignment notes shall be supplied to the Engineer giving details of each consignment.

### **3.2 CONCRETE**

#### **1.1.1 REQUIREMENTS**

The mix proportions shall be selected to ensure that the workability of the fresh concrete is suitable for the conditions of handling and placing, having regard to structural element being constructed, the disposition of reinforcement, the climatic conditions prevailing and the limitations set by the Table 1 for the particular class of concrete specified. Notwithstanding the strength requirements of this specification, in order to ensure adequate durability of the finished concrete, while at the same time limiting its shrinkage characteristics, the following limits shall not be exceeded:

TABLE 1 : Water and Cement Relationships

Class of Concrete	W/C (by weight)	Total Water per 50 kg. of Cement liters	Limit of combined Weight of Dry Aggregate to 50 kg cement Max. (Kg.)
30 or 30 (s)*	0.45	21.2	320
25 or 25 (s)	0.50	22.6	360
20 or 20 (s)	0.55	24.7	400
15 or 15 (s)	0.60	26.7	450
10 or 10 (s)	0.65	28.8	

\*(s) refers to concrete made with sulphate-resisting cement

In all cases of mix proportioning, the added water shall be included with due allowance for the moisture contained in the aggregate and shall be the minimum consistent with the workability requirements. Where difficulty is experienced in maintaining the correct workability for the water-cement ratio outlined in table 1 the use of water reducing additive may be permitted subject to Clause 3.2.9.

Where aggregate do not conform to the moisture requirements of clause 202 (i) of C.P. 8007 (or subsequent prevailing B.S code) but are permitted for use, in the case of water retaining structures the water content indicated in Table 1 shall be reduced by 2.5 liters per 50 kg of cement.

Where the concrete is to be used in structures protected from the elements, and are not water retaining, the water content indicated in Table 1 may be increased by 2.5 liters per 50kg of cement.

### 1.1.2 STRENGTH

The basis for assessing the strength of concrete shall be related to the characteristic strength, defined as the strength of the concrete at 28 days, as determined by the standard method of testing) below which not more than 5% of the test results shall fail.

The relationship between the class of the concrete and the characteristic strength shall accord with Table 2.

TABLE 2 Concrete Strength Requirements

Class of Concrete	Characteristic strength N/mm <sup>2</sup>	
	28 - day	7 - day
30 or 30 (s)	30	0.67 times the Corresponding 28 – day Characteristic Strength
25 or 25 (s)	25	
20 or 20 (s)	20	
15 or 15 (s)	15	
10 or 10 (s)	10	

### 1.1.3 MIXES

Structural concrete proportions may be determined by an approved Mix Design method or by using the nominal mixes set out in Table 3. For small sections of work, the Engineer may give permission for Nominal Mix proportioning to be used. Non-structural concrete shall conform to the requirements set out in Table 3.

To satisfy the requirements of this specification the mix proportions for all concrete, other than on-structural concrete, shall be designed.

#### *Design Mixes*

Proportions shall be determined in accordance with the British Department of the Environment of publication entitled “design of concrete Mixes” or other approved methods, for the requirements set out in Clause 302.1 and 302.2.

For the purpose of determining the design mean strength of the concrete a margin shall be added to the characteristic strength (indicated in Table 2) for the particular class of concrete. This design margin shall be assessed on the degree of control reasonably to be expected in the manufacture of the concrete and shall not be less than 7.5N/mm<sup>2</sup> or less than 1.64 times the standard deviation. Until such time as the standard deviation has assessed the margin shall be or less than 15 N/mm<sup>2</sup>.

Details of the designed mixes shall be forwarded immediately to the Engineer for his approval. Concrete produced from the designed mixes shall conform to the Engineer for his approval. Concrete produced from the designed mixes shall conform to the workability requirements given in Table 4.

#### *Nominal Mixes*

Nominal mix proportioning is applicable only to non-structure concrete and in exceptional cases when permitted by the Engineer for structural concrete. Proportional shall conform to the requirements of Table 3.

TABLE 3 : Nominal Mix Proportions

class of concrete/strength N/mm <sup>2</sup> )	Nominal Mix
30 or 30 (s)	1:1:2
25 or 25 (s)	1:1 1/2:3
20 or 20 (s)	1:2:4
15 or 15 (s)	1:3:5
10 or 10 (s)	1:4:8

TABLE 4 Workability Requirements

Use of concrete	Max. Size of AGG. (mm)	Slump (mm)	Compacting Factor	Degree of Workability
Use of concrete	10	0-6	.80 - .86	"Low"
Roads Vibrated by hand machines	12	6 – 20	.81 - .87	
	20	12 – 25	.82 - .88	
Mass concrete	40	25 – 50	.82 - .88	
Concrete benching				
Normal reinforced concrete	10	6 – 25	.86 - .92	"medium"
	12	20 – 40	.87 - .93	
	20	25 – 50	.88 - .94	
	40	50 - 100	.88 - 94	
Sections with congested reinforcement (not suitable for Vibration)	10	25 – 50	.92 – 97	"High"
	12	40 – 100	.93 – 97	
	20	50 – 130	.94 - .97	
	40	100 - 180	.94 - .97	

#### **1.1.4 QUALITY CONTROL**

The principal basis of control shall be by comparison of the results of the compression cube tests at 28 days, except for small quantities of concrete whose strength can be otherwise derived and which is permitted for use by the Engineer. 40 sample cubes shall be made initially in eight samples each day for five days of concreting and thereafter one sample in 25 mixes or not less than one for each day's concreting.

Where materials are of an unfamiliar grading or type, compression tests shall be carried out at 7 days and adjustments made in advance of the main control methods outlined above.

Cube test results will be examined individually in 10 consecutive sets of four and the standard deviation and mean strength of each set calculated. The concrete mix proportions will only be acceptable if all of the following requirements are compiled with: -

- Not more than two results in 40 are less than the characteristics crushing strength
- No value of the average for any set of four results is less than the characteristic strength plus one-half of the design margin (Clause 3.2.3).

When 40 results have been obtained and the mean strength and standard deviation are calculated, the mean strength minus 1.64 times the standard deviation shall be greater than the characteristic strength.

Where the results do not, conform to the above requirements the following action shall be taken: -

- Adjustment to the mix shall be made to obtain the strength required.
- In the case where any result is less than 80% of the characteristic strength – in accordance with Clause 3.5.15.

#### **1.1.5 PRODUCTION**

Aggregates and cement shall be proportional by weigh- batching, and water shall be proportional by volume. Subject to the prior approval of the Engineer volume-batching of aggregates may be used for small sections of work, but volume-batching of cement will in no case be accepted. The Contractor may, however, so proportion the mix that each batch shall use a whole bag or bags of cement, the weight of which is known precisely. Where permission has been given for volume-batching of aggregates, has been given for volume-batching of aggregates, all gauge boxes shall be accurate and strongly constructed and due allowance shall be made for bulking of the aggregates in assessing the correct volume to be used. (Clause 602 of CP 114 or an equivalent current BS code). The aggregate and the cement shall be thoroughly mixed in a clean mechanical mixer for a period of time agreed with the Engineer and the water added on the approved design.

The amount of water added shall conform to the requirements of these specifications

Batch mixing machines shall comply with the requirements of B.S. 1305. They shall be provided in such numbers and of such capacity as to ensure a continuous supply of freshly mixed concrete at all times during construction.

Continuous mixing machines shall be used only with the written permission of the Engineer.

Hand mixing of small quantities of concrete may be allowed at the discretion of the Engineer. If his permission is given mixing shall be done on close-jointed wooden flour, the material being carefully turned over twice in a dry state, and three times after the additional of water sprinkled through a rose.

#### **1.1.6 CEMENT**

Except where otherwise specified, or where specifically ordered, Ordinary and rapid-hardening Portland to B.S 12 shall be used

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

High Alum, super sulphated, pozzolanic, low heat, blast furnace or other cement shall only be used as directed by the Engineer. They shall not be considered within the scope of this specification but shall be subject to the requirements of a supplementary specification when required to be used.

No extra payment will be made to the Contractor if on his own initiative he uses Rapid-hardening Portland cement.

Cement shall be fresh when delivered to site and the consignments shall be used in the order of their delivery. The Contractor shall mark one date of delivery on each consignment and each consignment shall be stored separately and in such a manner as to be easily accessible and identifiable.

No cement in bags or other containers shall be used unless these and the manufacturer's seals are intact at the mixing.

If the cement is delivered in bags it shall be stored in a waterproof shed or building at a temperature of not less than 8°C and the bags shall be placed on dry boards above the floor to prevent deterioration or contamination from any cause.

Bulk cement may be used providing it is stored in an approved container.

The Contractor shall not use cement which has hardened into lumps, but subject to removal of the lumps by screening, the Engineer may allow such cement to be used in non-structural concrete mixes. Cement of different types shall be kept separate in storage and shall not be mixed together in the production of concrete.

Different consignments of cement shall be stored in such order so that the first consignment is used first and the rest in order of arrival.

#### **1.1.7 AGGREGATES**

Fine and coarse aggregates shall be as defined by and be of the quality and nature required by BS.882 and BS1201 whichever is applicable. In addition, they shall be chemically inert to alkali reaction.

Aggregates shall conform to the moisture absorption requirements of clause 202 (i) of B.S.2007 (or an equivalent current code); otherwise the contractor shall prove the

durability of the finished concrete by approved tests (clause 306.1) when used for making concrete required for liquid- retaining structures. Aggregates of rounded shape or otherwise capable of producing a concrete of good workability with the minimum addition of water shall be preferred. The Contractor shall ensure that the nature and grading of aggregates remain reasonably consistence, and shall, if necessary, stockpile and include different grading to ensure that the overall grading remains constant for each section of the work.

Dust or flour resulting from crushing the aggregate shall not be allowed to contaminate the stockpiles. When, in the opinion of the Engineer such contamination has taken place it shall be removed by an approved means or otherwise the aggregate shall be rejected.

For mass concrete, in order to improve the consistency of the mix, dust or flour resulting from crushing the aggregate, may be subject to test, be included in controlled quantities to supplement the fine aggregate. The aggregates of various sizes shall be kept separately and away from all possible contamination and shall be stored on a hard standing area or in bins, provided with proper drainage at the base of the stockpiles.

Except where aggregates have been otherwise specified on the Drawings the grading of the grading shall be as follows:

*Coarse aggregates*

- 10mm max.size, graded, for all fine concrete
- 20mm max. size, graded, for all reinforced concrete in beams and for walls and slabs not greater than 40cm.thick.
- 40mm max. size, graded, for all reinforced concrete walls and slabs in excess of 40cm.thick.

*Fine aggregate:*

Where aggregates conforming to zones 2 or 3 of B.S 882 are available they shall be used.

For nominal mixes, where permitted to be used, zone 2 aggregate only shall be used, except for non-structural concrete class 10 where all-in aggregates may be used.

### **1.1.8 WATER**

The Contractor shall supply all water, make all arrangements and pay all charges in respect of such supply. Where water be obtained from a public water supply it shall be used. Where water cannot be obtained from public supply it shall tested in accordance with B.S. 3148 and if necessary shall be treated to assure compliance therewith.

Water for washing and curing shall be such that it will impair neither the strength nor its appearance.



## **REINFORCEMENT**

### **1.1.9 STEEL**

Reinforcement shall be; -

- Plain round mild steel or high Yield steel bars conforming to B.S.4449.
- Cold worked steel bars conforming to B.S 4461, or
- Fabric reinforcement conforming to B.S.4483
- Tying wire shall be 1.6mm diameter (No. 16 gauge) soft annealed iron wire. Alternatively clips of an approved type may be used.

The Contractor shall obtain from his suppliers certificates of the mechanical and physical properties of the reinforcement and shall submit them to the Engineer for approval.

Where galvanized reinforcement is specified, galvanizing shall comply with the requirement of B.S.729, part 1.

### **1.1.10 STORAGE**

Reinforcement shall be stored on site under cover and supported clear of the ground and such manner as to make identification easy. Supports shall be such that distorting of the steel is avoided and contamination and corrosion prevented.

### **1.1.11 BENDING AND FIXING**

The contractor shall provide onsite facilities for cutting and bending reinforcement whether he is ordering his reinforcement bent or not and shall ensure that a token amount of straight bar is available on site by the Engineer.

Reinforcement shall be wire brushed and cleaned at the Contractor's expense, before and/or after it is placed in position, if required by the Engineer.

The bars shall be cold bent in strict accordance with the bending schedules and the Contractor shall be responsible for the accuracy of the bending. Bending dimensions shall be worked to the tolerance indicated in B.S.4466. Bars in which any errors in bending are beyond the limits of the foregoing tolerances shall be placed at the Contractor's cost by correcting bent new bars, or, may be straightened and rebent cold subject to the Engineer's prior approval. Any discrepancy or inaccuracy found in the bar schedule shall be notified to the Engineer immediately.

After bending, reinforcement shall be surely bundled and labeled with weather-proof tags or shall be marked with other approved signs by which it can readily be identified.

Before assembling or fixing the reinforcement the dimensions to which it has been bent shall be checked by the Contractor against the bar schedules.

The reinforcement shall be fixed in strict accordance with the Drawings as regards cover, spacing and position, and suitable precautions shall be taken by the Contractor to prevent the displacement of reinforcement during the placing and compaction of concrete.

Where required to support and retain the reinforcement in its correct position the Contractor shall provide templates stools or other supports at his own cost He shall allow for cutting to correct length all corner lacer bars included in the bar schedules as standard lengths.

Precast concrete support blocks for reinforcement shall be manufactured from class 30 fine concrete to ensure the correct cover thickness. They shall be well cured before use and carefully stored on site to avoid contamination. Plastic and metal supports, chairs, etc. may be used subject to the Engineer's prior approval.

A lap of not less than 40 diameters of the smaller bar shall be provided at the junction of two bars for which the lap is not specifically detailed on the drawings.

All intersections of bars in walls and slabs and all connections between binders or links and main bars in columns or beams shall be tied with soft iron wire or with fixing clips which shall not be allowed to make contact with the shuttering or the project material into the specified cover.

Unless permitted by the Engineer, welding of bar reinforcement at intersections or for the joining of bars is prohibited. Where permission is granted, welding shall be carried out in accordance with the recommendations of the institute of welding for the welding of reinforcing bars for reinforced concrete construction.

When fixed reinforcement is left exposed for a delayed period of time, it shall be thoroughly cleaned and painted with neat cement grout.

Where galvanized reinforced is used any damage suffered by galvanizing shall be made good by the application of an approved galvanizing formulation, before concrete placing is commenced.

#### **1.1.12 CEMENT GROUT**

Unless otherwise directed, cement grout shall consist of Ordinary Port Land Cement and water mixed in the proportion of one part by volume of water. The grout shall be used within one hour of mixing.

#### **1.1.13 MORTAR**

Cement -mortar for chamber block work, pipe joints or plaster shall consist one-part cement three parts sand, or as directed by the Engineer. The mortar shall be used immediately it is mixed and on no account shall it be used after it has developed its initial set. Any mortar which has commenced to test before being used shall be rejected. The material shall be turned over dry at least three times before the water is added

#### **SHUTTERING**

#### **1.1.14 REQUIREMENTS**

The term "shuttering" shall be taken to include centering, formwork, strutting, bracing and the like. Shuttering shall be of such accuracy, strength and rigidity as to carry the weight and pressure from the concrete to be placed on or against it, together with all constructional, wind or other loads likely to be imparted to it, without producing deformation of the finished concrete in excess of the tolerances outlined in clause

304.5 and Table 5 and their design and construction shall in all respects be subject to the Approval of the Engineer.

All shuttering shall be sufficiently tight, without purging, to prevent loss of grout during the vibration of the concrete. Faces of shuttering shall be clean, free from projecting nails, adhering grout and other imperfections or defects which would prevent the specified surface finish from being attained. They shall be treated with approved mould oil before positioning. Great care shall be exercised to prevent reinforcement or steel work from being contaminating the oil during erection of the shuttering. Shuttering, which as a result of prolonged use or general deterioration does not, in the opinion of the Engineer, conform to the particular requirement set out in this clause, shall not be used.

Through bolts or ties will not be permitted in liquid-retaining structures. The Contractor shall use only those bolts or ties as are capable of being removed in whole or in part so that no part remains embedded in the concrete than the specified thickness of cover to the reinforcement. Beam soffits shall be erected with an upward camber of 5mm for each 3m of span. Top shuttering shall be counterweighted or otherwise anchored by the flotation. Boxes for forming holes shall be constructed so as to be easily removable without damaging the concrete during removal.

Openings for inspection of the inside of beam, wall, column and similar shuttering and for cleaning-out purposes shall be formed so that they can conveniently be closed before the placing of the concrete.

All props shall be supported on adequate sole plates and shall not bear directly on or against concrete. They shall be capable of being released gently and without shock from the supported shuttering. No appliance for supporting the shuttering shall be built into the permanent structure without the Engineer's prior approval. Props for upper level support shall be placed directly over those at lower levels, and the lowermost props shall bear upon work sufficiently mature to carry the load. Shuttering shall be such as to allow of its removal without damaging the concrete, and in the case of suspended floors, for the removals of the beam sides and slab soffits without disturbing the beam-bottom boards and their props.

Before concreting, the areas which are intended to receive the concrete shall be cleaned by jetting with compressed air and all water extraneous material removed.

Where timber is used for shuttering it shall be properly curved free from warp, straight, clean and free from loose knots.

Where metal forms are used for shuttering they shall be of the type strengthened by intermediate ribs or cross bracing.

Moving shuttering may be used where in the opinion of the Engineer it is appropriate.

#### **1.1.15 SAWN SHUTTERING**

Sawn shuttering shall produce an ordinary standard of finish consistent with normal good practice for use where the size of the finish concrete will not be exposed. The face in contact with the concrete shall consist of sawn timber boards, sheet metal or other approved material.

### 1.1.16 WROUGHT SHUTTERING

Wrought shuttering for use where the face of the finished concrete is to be exposed shall produce a high standard of finished consistency with the best practice. The face in contact with the concrete shall consist of wrought and thickened boards tongued and grooved of not less than 3cm. finished thickness, framed plywood of metal panels or other approved material. Joints between boards and/ or panels shall be arranged in uniform pattern.

#### *Special wrought Shuttering (for fair faced finish)*

Special wrought shuttering shall provide the highest standard of finish where the face of the finished concrete is to form a particular feature. The face in contact with the concrete shall consist of large smooth sheets, unless otherwise specified, arranged in an approved uniform pattern, with joints coinciding with possible architectural features, sills, window heads, or changes in direction or surface. Accurate alignment of the joints shall be maintained. Wrought boarding and standard steel panels shall not be used unless special faced.

#### *Tolerances*

Unless otherwise indicated on the Drawings, the tolerances of the finished concrete with respect to the dimensions shown the Drawings shall not exceed the limits set out in Table 5.

TABLE 5 Tolerances of Dimensions for Finished Concrete

Item	Tolerance (mm)
Overall dimension and Levels	± 5
Column sizes	± 5
Beam Sizes Wall sizes	-0
vertical lines out of plumb	5mm + 5mm in every 15m.

Except in the case of Sawn Shuttering the dimension of the finished concrete shall be not less than those shown on the Drawings.

### 1.1.17 STRIKING OF SHUTTERING

The recommendations set out in Table 6 are given as a minimum requirement for the striking shuttering: -

TABLE 6 Striking of Shuttering

Item	Ordinary Portland cement Normal weather 16 <sup>0</sup> c(days)	Rapid-Hardening Cement Normal Weather 16 <sup>0</sup> c(days)
Beam sides, Walls Columns	1	1
Slabs (props left under)	4	3

Beam soffits (props left under)	7	5
Removal of props to slabs	8	5
Removal of props to beams	16	8

The above striking times are for normal conditions and before deciding on the actual time for each case, the Contractor shall consider and extend the period as tabled if.-

- The span of the structural member under consideration exceeds 6m for beams and 3m for slabs. An additional span shall then be allowed;
- The dead load of the structural member under consideration forms a large proportion of the total design load;
- Constructional loads coming on to the structural member under consideration are being placed soon after the concreting operations and these loads form a large proportion of the total design load;
- The setting of the concrete has been restarted for any reason;
- The temperature falls below 80c.an additional period of 12 hours shall be added for each day on which the temperature falls below 80c.for temperature falling below 30c the additional period to be added shall be 24 hours for each day on which the temperature falls below 3<sup>0</sup>c;

Any combination of all of the above points and other considerations which could call for such a precaution to be taken. Information regarding para 3.4.6.2 (b) above will be supplied by the Engineer; any other design information relevant to the above shall be obtained by the Contractor from the Engineer.

## **CONCRETING**

### **1.1.18 REQUIREMENTS**

The finished concrete shall be dense, durable, and impervious to the ingress of water, free from cracks and honeycombing, resistant to wear and mild chemical attack. Special concrete is referred to under particular sections of Clause 307.

### **1.1.19 TRANSPORTING OF CONCRETE**

Concrete shall be transported to the place of final deposit by approved means.

Barrows spades and other equipment shall in the process of transporting concrete shall be thoroughly cleaned before each day's work or after a long interruption and they shall be free from hardened concrete. Concrete shall be transported as soon as possible after mixing, by methods which will prevent the segregation, loss of contamination of the ingredients. Proper bridging arrangements for traffic over reinforcement shall be provided so that the reinforcement is not distorted, damaged or displaced.

Where approval is obtained for concrete to be conveyed by chutes, these shall have a slope (not exceeding 1 vertical to 2 horizontal) such as to ensure a continuous flow of concrete. Additional water shall not be introduced to assist the flow. If deposition is to be intermittent the chutes shall be arranged to discharge into storage hopper. In no case will a clear fall of more than 1m, be permitted at the discharge end of the chute.

Where approval is obtained for pumping the concrete pump manufacturer's recommendations shall be followed. The pumps used shall be of adequate capacity and power to ensure delivery of continuous supply. The Contractor shall provide adequate alternative arrangements for transporting the concrete in case of a breakdown of the pumping equipment.

Whenever the transport of concrete is interrupted for any length of time (periods of over 1 hour shall be treated as such) the chutes, pumps, pipes and any other means of distribution shall be thoroughly flushed out and cleaned. These shall also be flushed out immediately prior to resumption of concreting and shall be kept free from hardened concrete. All wash water used shall be discharged outside the shuttering and clear of any freshly placed concrete.

### **1.1.20 PLACING AND COMPACTION**

No concrete shall be placed until the Contractor has obtained approval to do so from the Engineer's Representative. When the Contractor intends to place concrete he shall inform the Engineer's Representative in sufficient time to enable his to inspect the reinforcement, shuttering and surface on which the concrete is to be placed and the Contractor shall provide all facilities for such inspection.

Concrete shall be placed within 30 minutes of mixing, to uniform level, in layers not exceeding 50cm, deep in such manner as to avoid segregation, and each layer shall be compacted by means of approved vibrators to form a dense material free from honeycombing and other blemishes. Compaction by hand may be used only with the prior approval of the Engineer.

Vibration time, the effective radius and other vibration characteristics shall be in accordance with the vibrator manufacturer's recommendations. If internal vibrators are used, they shall be withdrawn immediately when water or a thin film of mortar begins to appear on the surface of the concrete. Withdrawal shall be carried out slowly to avoid cavitation.

Where two distinct batches of concrete, placed at different periods of time and forming part of the same concreting operation are required to be formed monolithically with each other, the more mature concrete shall be penetrated by the vibrator to a sufficient depth to affect plastic movement between the two batches. Where the concrete does not respond to the action of the vibrator, it shall be deemed to have set, and no further disturbance will be permitted. Unless otherwise instructed by the Engineer the condition shall be treated as for a "stoppage of work" and the marrying up of the two concretes shall be effected only when both concretes have properly set.

If shuttering vibrators are used, the shuttering shall be strong enough to withstand the forces of vibration.

Temporary or permanent stoppages of work shall be made only against stop ends

Unless otherwise specified, before placing new concrete against concrete which has already hardened, the face of the older concrete shall be prepared by the removal of any laitance and loose aggregate, and shall be cleaned by a jet of compressed air.

When displacers are permitted to be used they shall be so placed that no displacer is within 30cm, of any finished face or within 50cm, of any other displacer. On completion of any lift, displacers shall be so arranged that they project for half their height above the surface.

### ***Cold Weather Concreting (Using cement to B.S. 12)***

No concrete shall be placed while the air temperature is below 5<sup>0</sup>C, without the permission of the Engineer.

In the event of the Engineer giving permission for concreting to be carried out when the air temperature is below 5<sup>0</sup>c, the following conditions shall apply: -

- a) Concreting shall be at the sole risk of the Contractor and shall be carried out during the day only;
- b) Frost-bound aggregates shall not be used, and the ice shall be removed from shuttering and steelwork;
- c) No structural concrete shall be placed on frozen ground;

Concrete shall have a temperature of between 16<sup>0</sup>c and 24<sup>0</sup>c. On leaving the mixer and it shall be placed in position and compacted before its temperature has dropped to 5<sup>0</sup>c. To affect this, pre-heating of the mixer, heating of mixing water to a temperature not exceeding 6<sup>0</sup>c and heating of aggregates to not exceeding 50<sup>0</sup>c. Is permitted, but on no account shall cement be heated or admitted to the mixer until the aggregates and the water have been thoroughly mixed;

If the Engineer gives approval for the use of calcium chloride to accelerate the hardening, not more than 2% by weight of flake calcium chloride (calcium chloride to cement) shall be added. Where proprietary macerators are used their proportions shall be adjusted to satisfy this requirement. In all case the calcium chloride shall be dissolved in the mixing water before adding to the mix. Calcium chloride and proprietary accelerators shall not be used with other than Ordinary or Rapid Hardening Portland cement;

The placed concrete shall not be allowed to fall below the temperature of 3<sup>0</sup>c until it has thoroughly hardened. The provision of heaters, adequate covering and insulation shall be made as may be required to ensure this. Care shall be taken to prevent over-heating or carbonation of the concrete;

The period over which the precautions set out above shall apply (referred to as the pre-hardening period) shall not be less than 3 days unless otherwise permitted by the Engineer. Concrete temperatures shall be taken three times each day, morning, noon and evening, each at two separate positions expected to give the least favorable results;

Concrete once placed shall not be subjected to curing techniques involving the application of water to the surface;

The use of steel shuttering, unless insulated, will not be permitted.

### **Hot Weather Concreting (for temperature above 20<sup>0</sup>c)**

Concreting shall not be permitted if its temperature at placing is in excess of 38<sup>0</sup>c. In order to maintain the temperature of the concrete below this value the following precautions shall be taken wholly or in part as instructed by the Engineer: -

- All aggregate stockpiles, water lines and tanks the mixer shall be protected from the direct rays of the sun.
- Corse aggregate shall be cooled by constant watering where possible;
- Mixing water shall be cooled by the addition of ice to the storage tanks where necessary;

Rapid-hardening cement shall not be used;

Where the above precautions are inadequate concreting shall be carried out during the cooler parts of the day or during the night as may be directed by the Engineer.

When the air temperature is above 20<sup>0</sup>c, loss of mixing water by evaporation shall be considered in arriving at the amount of water to be added to the mix. In order to maintain the water/ cement ratio within permissible limits an approved water-reducing agent shall be included in the mix. The maximum water/cement ratios may be increased with the Engineer's permission by 0.05 (or 21/2 liters/50kg. of cement) during mixing, but on no account shall water be added to concrete directly or indirectly once it has left the mixer.

In order to reduce premature drying of the concrete during transporting and placing, all chutes, shuttering and reinforcement shall be cooled by watering when possible, or shall otherwise be protected from the direct rays of the sun. Any water so used shall be removed by jetting with compressed air before placing the concrete in close contact.

As soon as possible after concreting, the shuttering shall be struck (Clause 3.4.6) and the surface of the concrete shall be kept moist for a period of 4 days my mist spraying or, when permitted by the Engineer, by covering with wetted hessian or sand or by treatment with an approved curing membrane.

Where drying winds are encountered, wind shields shall be positioned as directed by the Engineer to protect exposed surface of the curing concrete.

#### **1.1.21 WET WEATHER CONCRETING**

Concreting during periods of constant rain shall not be permitted unless aggregate stockpiles, mixers and transporting equipment, and the areas to be concreted are adequately covered.

During showery weather, the Contractor shall ensure the work can be concluded at short notice by the provision of stop ends. On no account shall work be terminated before each section, between one stop end and another, is completed. Adequate covering shall be provided to protect newly placed concrete from the rain.

#### **1.1.22 HOLES CAVITIES AND FIXINGS**

The Contractor shall be responsible for the co-ordination of all requirements of his sub-Contractor s as regards provision of holes, chases, cavities and fixings and shall, if required by the Engineer, prepare drawings giving details of his sub-Contractor 's



requirements and shall send copies of such drawings to the Engineer prior to construction.

Holes, etc. shall be accurately marked and boxed-out before concreting operations commence and, without the Engineer's prior approval, no such holes, etc., shall be formed after the concrete has set.

Where bars, if placed to specified spacing would foal holes of size less than 25cm. x 25cm. the full length of the bar shall be moved to one side and in the case of holes exceeding 25cm. x 25cm. the bars shall be cut on site and lapped with additional equivalent bars, or as otherwise indicated on the Drawings.

However possible, the Contractor shall build in all pipework, ironwork, etc., which passes through walls and floors, and the pipework, ironwork, etc., shall first be thoroughly cleaned and freed from any deleterious matter, and every care shall be taken to ensure that it is thoroughly encased in concrete.

Bolts, hooks and other fixing shall be embedded in concrete, or holes shall be drilled and fitted with threaded expanding anchors to receive the bolts. The Contractor shall ensure that bolts, hooks, etc. are accurately positioned. Holding down bolts for machinery shall be sent to template.

Where brick or stonework is to form a facing to the concrete or where the need of a brick or stone wall butts against concrete face, galvanized metal ties of approved manufacture shall be incorporated. The distance between ties shall be gauged with due regard for the bonding of the walls, and at intervals required by the Engineer.

#### **1.1.23 PROTECTION AND CURING**

Newly placed concrete shall be protected by approved means from rain, drying winds, sun and contact with substances which can adversely affect it.

No traffic or constructional loads shall be permitted o newly placed concrete until it has hardened sufficiently to take such traffic or load without surface damage or deformation.

Exposed faces of concrete shall be kept moist after placing for not less than 3 days if Ordinary Portland and 2 days if Rapid-hardening cement is used. Membrane curing by approved materials ma is used when permitted by the Engineer.

Any concrete surfaces, arises and treads of stairways which might be damaged during the construction of the works shall be adequately protected.

#### **1.1.24 CONSTRUCTION JOINTS**

The position of construction joints, when not shown on the Drawings or otherwise required by this Specification, shall be decided on site having regard to the plant and labour made available by the Contractor for the manufacture, placing and compaction of the concrete as well as its curing, the climatic conditions prevailing at the time of concreting, the nature and size of the shuttering, and the conditions of operation of the work. The Contractor shall submit his proposals to the Engineer for his approval before commencing the work.

Construction joint surfaces shall be treated by the “wash-off” method (Para 3.5.9.5) except where it cannot be practically effected, in which case it shall be treated as for the placing of new concrete to hardened concrete.

When expanded metal lathing is used for the formation of construction joints rebate will not be required to be formed. The expanded metal lathing shall be left in the work and shall not be extend closer to the finished surface of the concrete than 25mm. It shall be securely fixed to the reinforcement.

The following particular requirement shall also be observed: -

- **Slabs supported on the ground**

In order to ensure control in the placing of concrete the Contractor shall provide control boards or form panels not larger than 15m<sup>2</sup> in area. These shall be lifted as the concreting proceeds except where they are of expanded metal in which case they may be left in position as part of the permanent works, provided that they shall not extend closer to the finished surface of the concrete than 25mm. In the event of a breakdown in the supply of concrete the Contractor shall ensure that an alternative supply of concrete is made available (to finish the work against the control boards acting as stop ends). The joint so formed then be treated as a construction joint. Where Ready-mixed concrete is permitted (Clause 3.7.4) the control boards shall be positioned so as to enclose a volume of concrete equal to that delivered by each truck.

Construction joints and control joints shall be formed normal to the surface of the retained concrete.

- **Suspended Beams and Slabs**

The reference to control boards in Para (a) shall apply, but generally, unless otherwise shown on the Drawings or permitted by the Engineer, construction joints shall be positioned at approximately mid span in both beams and slabs.

T-beams shall be formed to their full depth integrally with the adjacent slab and without horizontal joints.

- **Walls**

Horizontal construction joints in walls shall be formed along straight lines coinciding with the full height of the shuttering. The height of the shuttering thus controlling the height of the pour shall be determined with reference to the availability of concrete, the size and type of shuttering used, the thickness of the wall, the size and amount of reinforcement and the means of compaction available.

Unless otherwise indicated on the Drawing or otherwise permitted by the Engineer for the construction of circular tanks, concreting shall be carried out continuously for the full circumference without vertical joints. Where permission is granted for the use of vertical joints the Engineer may order, at no extra cost to the Employer, the inclusion of an approved type of water stop.

In the case of rectangular tanks, vertical joints shall not be positioned closer to any corner than 1m. They shall be formed with properly rebated stop ends or,

where conditions permit, by the use of expanded metal lathing; unreinforced manhole shall be constructed without vertical joints.

- **The “wash-off Method” of Preparing Construction Joints**

As soon as possible after concreting, and while the surface is still green, the surface of the concrete forming the joint shall be freed of loose aggregate and sprayed with a fine spray of water to prevent the formation of laitance. Subsequently all excess water shall be removed by a jet of compressed air and the surface left clean to receive further concrete.

### **1.1.25 MOVEMENT JOINTS**

These shall include contraction and expansion joints and shall be as indicated on the drawings.

Contraction Joints will be either contraction joints or partial contraction joints. Where partial contraction joints are specified a period of at least five days shall elapse between the concreting of the section on each side of the joint.

#### **Contraction Gap Construction**

Where the drawings indicate a contraction gap to be formed in any panel, concreting on either side of the gap shall be carried out so as to form partial contraction joints at each side of the gap. Prior to the concreting of the gap section, the joint surfaces shall be cleaned but otherwise left untreated. The concreting of the gap section shall or be carried out until a period of the adjacent sections.

#### **Alternate and Jointing Materials**

Alternate panel construction (other than contraction gap construction outlined above) will be permitted only with the approval of the Engineer, or in those cases where either the reinforcement is not continuing through the joint or where the panels are separated by expansion or contraction joints.

### **1.1.26 WATER STOP JOINTING MATERIALS**

Water stop and jointing materials shall be obtained from an approved manufacturer.

All water stop and jointing materials which are not required for immediate use shall be stored at all times in a cool damp place.

Water stop shall be manufactured of rubber or P.V.C. (polyvinylchloride) as stated in the Bills of quantities and shall be of the type and size shown on the Drawings. Site joints shall be made strictly in accordance with the manufacturer's instructions and all intersections and junctions shall be obtained prefabricated from the approved manufacturer.

Joint filler shall be manufactured of natural bonded cork or other approved material. Joint filler shall be cut and trimmed accurately to suit the joint profile and shall be maintained accurately in position by means of an approved adhesive.

Joint sealing compounds shall be approved rubber/bituminous compounds suitable for sealing joints in horizontal and vertical/sloping concrete surfaces as appropriate. Sealing compounds shall be applied strictly in accordance with the manufacturer's instructions and shall completely fill the joint recess.

Water stop shall be located and maintained accurately in position and details of the proposed method or fixing shall be submitted to the Engineer for approval. On no account shall water stop be secured by nails or by any other means involving puncture of or damage to the water stop material.

### **1.1.27 FINISHES**

All exposed faces of concrete unless otherwise specified shall be hard, smooth and free from honeycombing, air and water holes and other blemishes.

All projecting imperfections shall be rubbed down with carborundum stone or by other approved means and the grit and dust there from shall be thoroughly washed off with clean water.

The normal finish to slabs, unless otherwise billed, shall be formed by smooth floating the accurately leveled and screeded surface. Care shall be taken to ensure that the concrete is worked no more than is necessary to produce a uniform surface free from screed marks.

#### **Special finishes**

##### **Granolithic finishes**

Granolithic finishes shall conform to the recommendations laid down in "special for granolithic floor toppings laid on in-situ concrete", as published by the cement and concrete Association, with special reference to monolithic construction.

##### **Smooth-trowelled finishes**

Smooth-trowelled finishes shall be formed while the concrete is still wet by means of a steel trowel applied to an accurately leveled and screened surface (see also Clause 3.7.3).

##### **Screed Finishes**

Screed finishes shall be formed by leveling and screeding the concrete to produce a uniform, plain or ridged surface as specified, surplus concrete being struck off by a straight-edge immediately after compaction.

##### **Rush-hammered or pattern-worked Finishes**

When exposed aggregate is to be the surface texture, the Contractor shall ensure that a uniform distribution of the coarse aggregate takes place at the face. The shuttering shall be removed as soon as possible for the face to be treated; the surface shall be thoroughly wetted and wire-brushed, and brush-hammered or pattern worked as and when instructed. Surface retarders shall be used only when permitted by the Engineer.

Brush-hammering or pattern-working shall not be relied upon to obscure any defect in the concrete face which arise from shuttering imperfections.

**Table 7 SAMPLING, TESTING AND ACCEPTANCE STANDARDS**

MATERIALS	TEST	Site Sampling	Testing		Accepted Standards	Remarks
			On site	In Laboratory		
1	2	3	4	5	6	7
Cement	Ordinary Portland Rapid Hardening Sulphate Resisting			B.S. 4550	B.S.12 B.S.12 B.S.S4027	Manufacturers Test Certificate
Aggregates	Description and Classification		B.S.812 Section 2	-	B.S.882 OR 1201	Whichever is Applicable
	Particle Size		B.S.812 Sec.3	-	B.S.882 or 1201	
	Particle Shape		Visual	B.S.812 Sec 3		mix design
	Sp. Gravity		-	B.S.812 Sec 3		requirements
	Density		-	B.S.812 Sec 3		
	Voids		-	B.S.812 Sec 4		
	Absorption		-	B.S.812 Sec 4	B.S. 8007	See Freeze-thaw Test this table
	Organic Impurities		-	B.S.812 Sec. 5		
	Bulking of Fine Aggregate		B.S. 8110 CI.602			Nominal Mix Proportioning

	Moisture content			B.S 812 Sec.5		For adjustment of added water for concrete making
	Mechanical properties			B.S 812 Sec.5	B.S. 812 or 1201	Ten per cent fines value
MATERIALS	TEST	Site Sampling	Testing		Accepted Standards	Remarks
			On site	In Laboratory		
1	2	3	4	5	6	7
Water	Suitability	B.S. 3148	-	B.S. 3148	B.S.3148	Not required for potable water
Concrete	Compacting Factor Slump	B.S.1881 Pt.1	B.S.1881 Pt.2	B.S. 1881 Pt.2	This Spec.Table Cl. 302 Table 4	Workability tests
	Crushing		-	B.S. 1881 Pt.4	Table 2 This spec.	Cube test
	Flexural )		-	B.S 1881 Pt.4	C.P.114 cl.208c	As required
	Water Absorption)	C.P.114		B.S 1881Pt...5	B.S.340 para.19(b)	Precast concrete cl.308
	Freeze-thaw)	Cl.601 B.S.1881 Pt.3				Durability test for aggregates not complying with moisture absorption requirements of B.S 8007 Cl.202(I)

	Electrolytic) Efflorescence					As required for salt containing aggregate or saline water
	Cores	B.S 1881 Pt.4		B.S 1881 Pt.4	B.S 1881 para.114 with ref. to concrete strengths this specification	See clause 306.2
ADMIXTURES	Compatibility with cement	A required by laboratory				Tests carried out by Independent Laboratory as required.

### **1.1.28 MAKING GOOD**

Honey-combing or damaged surfaces of concrete, which in the opinion of the Engineer, are not such as to warrant the occurring out and replacement of the concrete, shall be made good as soon as possible after removal of the shuttering as follows: -

A 1:1.5 Portland cement and sand mixture shall be worked into the pores over the whole surface with a fine carborundum float in such a manner that no material is left on the concrete face than is necessary completely to fill the pores so that a uniformly smooth and dense surface of uniform colour is finally presented.

### **1.1.29 UNSATISFACTORY CONCRETE**

The Contractor shall on the Engineer's instructions to do so cut out and replace any concrete in any part of the structure if the Engineer's opinion: -

- a) The concrete does not conform to the specification, or
- b) Deleterious materials or materials which are likely to produce harmful effects have been included in the concrete, or
- c) The honey-combed or damaged surfaces are too extensive or
- d) The finished concrete sizes are not in accordance with the Drawings within permissible tolerances, or
- e) The settings-out is incorrect, or
- f) The steel cover has not been mentioned, or
- g) The protection, including curing, of the concrete during the construction was inadequate, resulting in damage, or
- h) The work of making good or other remedial measures the Engineer may indicate are not carried out to his satisfaction, or
- i) Undue deformation of or damage to the works has taken place due to inadequate shuttering, or to premature traffic and loading, or
- j) Any combination of the above points has taken place in unsatisfying work.

### **TESTING**

#### **1.1.30 SAMPLING AND TESTING (SEE ALSO CLAUSE 3.1 AND 3.2.4)**

The Contractor shall provide on the site equipment, staff and labour for carrying the sampling and testing outlined in columns 3 and 4 of table 7, and he shall carry out any or of those tests at such frequency as may requested by the Engineer.

All equipment shall be calibrated and checked from time to time as the Engineer may require.

The Contractor shall provide all samples required by the Engineer. Those samples to be tested in a laboratory as required by column 5 of Table 7 shall be carefully forwarded by the Contractor to an approved laboratory. Results of laboratory on site and copies of all test reports shall be forwarded in duplicate to the Engineer's Representative.



Frequency of tests and the number of samples required will be governed by the results of previous tests, the quality of the materials revealed during the tests, and the uniformity of that quality (see also Clause 3.2.4). Should it become evident that the quality of the concrete is deteriorating the Engineer may require additional samples to be taken and test cubes made and tested to determine the cause.

### **1.1.31 LOAD TESTING**

The Engineer may direct that a loading test made on the works or any part thereof if he deems such test to be necessary for one or more of the following reasons: -

Failure of "site cubes" to attain the strength requirements of clause 302.4

Premature removal of shuttering;

Overloading of structure during construction;

Improper compaction and/or curing of concrete;

Any other circumstances attributable to alleged negligence on the part of the Contractor, which, in the opinion of the Engineer, may result in a structure being of less than required strength.

If the loading test be ordered to be made solely or in part for reasons (a) to (d) the test shall be made at the Contractor's own cost.

If the loading test to be ordered to be made for reason (e), the Contractor shall be reimbursed for the cost of the test if the result is satisfactory.

Loading tests shall be carried out in accordance with B.S 8110, Clause 605 or as required by the Engineer.

If the results of the test are not satisfactory, the Engineer will direct that the part of the work concerned be taken down or removed and reconstructed to comply with the specification, or that such other remedial measures as he may think fit be taken to make the work acceptable and the Contractor shall carry out such work at his own cost.

The Engineer may also instruct the Contractor before a loading test takes place to take out cylindrical core specimens from the structures concerned and have them tested. The cutting equipment and the method of doing the work shall be to the Engineer's approval. The specimens shall be dealt with in accordance with B.S.1881. Prior to testing, the specimens shall be made available for examination by the Engineer. If the cores are ordered to be taken solely or in part for reasons (a) and (d) above, the work involved and the testing shall be made at the Contractor's own cost. If the cores are to be taken for reasons (b), (c) and (e) above, the Contractor will be reimbursed the cost if the loading test described in the previous paragraphs proves satisfactory.

### **SPECIAL CONCRETES**

#### **1.1.32 NO. FINES CONCRETE**

No-fines concrete for use in subsoil drainage shall consist of 1:8cement/aggregate mix by volume. Aggregate shall be 20mm, to 10mm, graded with no more than 5% passing the 10mm, sieve. Only sufficient water shall be added to ensure complete

coating of the aggregate. One half of these water shall be placed into the mixture first, after which the aggregate and cement shall be admitted. After partial mixing the balance of the water shall be added until a consistency of mix is achieved.

Preliminary test shall be carried out on the site to prove the suitability of the finished concrete, and adjustments made with the proportions and /or grading as may be required by the Engineer.

#### **1.1.33 AIR-ENTRAINED CONCRETE**

Concrete for roads and those structures where specified, shall include an approved air-entraining agent capable of producing a 5% air-entrainment with a tolerance of 0.5% (clause 3.2.9).

The mix shall be purposely designed, having regard for the nature of grading of the aggregates and air-entraining agent being used.

Preference shall be given to the use of air-entraining agents which can be administered in fixed calibrated amounts through a dependable mechanical dispenser or cachet, and which are added to the mixing water.

Frequent air meter tests shall be carried out and the consistency of the air-entrainment maintained to the above tolerances by adjustments in the mix, as may be necessary.

#### **1.1.34 BENCHING CONCRETE**

Concrete for benching in manholes, pumping stations and works structures shall consist of class 20 concrete unless otherwise specified. It shall be placed with low workability to the approximate shape required and, while still green, shall be finished with not less than 50mm, of class 25 "fine concrete" to a steel troweled finish and to the contours indicated on the Drawings.

#### **1.1.35 READY MIXED CONCRETE**

Unless otherwise stated the relevant clauses of B.S. 1926 shall apply.

Ready mixed concrete shall be used with the prior approval of the Engineer. The Contractor shall not be relieved of his obligation to provide concrete to the standard laid down in this specification by virtue of any approval given for the use of concrete supplied by others, and the Engineer reserves the right to withdraw his approval at any time consequent on any deterioration in the quality of the concrete, or unsatisfactory delivery on any other reason he considers detrimental to the work.

Ready mixed concrete manufactured off the site shall be transported in a revolving drum and shall be continuously agitated until it is used in the work unless otherwise approved. The time interval between adding water to the drum and placing shall not exceed 90 minutes. The time interval between completion of mixing and placing shall comply with clause 3.5.3

#### **PRECAST CONCRETE UNITS**

##### **1.1.36 REQUIREMENTS**

Precast concrete units, unless otherwise stated, shall be obtained from an approved manufacturer and shall be true to dimension and shape, with true rises and with

perfectly smooth exposed faces free from surface blemishes, air holes crazing and other defects, whether developed before or after building –in. They shall comply with the appropriate B.S in addition, the following requirements particular to the various units shall be compiled with: -clause 3.8.2 to 3.8.8 inclusive.)

The Contractor shall submit to the Engineer for his approval of all precast concrete items he proposes to use.

#### **1.1.37 WEIR BLOCKS AND SILLS**

Aggregates for making of weir block and sills shall conform to B.S.1201, except that the use of soft or weathered limestone coarse aggregate will not be permitted. Fine aggregate shall consist of sand resulting from the natural disintegration of sand resulting from the natural disintegration of rock. Blocks and sills shall be tested for water absorption in accordance with B.S.340 and shall display neither greater absorption than 2.5% after 20 minutes nor 6.5% after 24 hours immersion, the percentage being based on the dry weight of the test pieces. In addition, they shall exhibit no visible signs of distress when subjected to an approved freeze-thaw tests based on thirty cycles of exposure. After such a test the compressive strength the test piece shall not be less than 80% of the strength of a similar piece which has not been subjected to the test.

Weir blocks shall be ground to a polished surface on the upper and discharge faces

#### **1.1.38 COPING BLOCKS AND WEIR BLADE HOLDERS**

These units shall conform to the requirements for weir blocks stated above but without polishing shall be brought to a smooth surface on the exposed faces. Coping blocks of thickness 60mm or less shall be formed by pressing, employing pressures no less than 6.5N/mm<sup>2</sup> over the entire surface receiving the pressure, before being brought to the required finish.

#### **1.1.39 KERBS**

Precast concrete kerb shall conform to B.S.340, except that coarse aggregate shall conform to B.S.121. Fine aggregate shall consist of sand resulting from natural disintegration of rock. Approved air –entraining agents may be permitted to be used providing that approved adjustments are made to the mix with regard to water and fine aggregates proportions. In such case the moisture absorption limits set out in B.S.340 may be neglected subject to the concrete satisfying the freeze-thaw test laid down under the heading “Weir Blocks and Sills”.

#### **1.1.40 PAVING SLABS**

Paving slabs shall conform to B.S 368 and shall be 50mm thick.

#### **1.1.41 OTHER BLOCKS**

Blocks for building work shall conform to B.S2028.

#### **1.1.42 WALL UNITS**

L- Shaped wall units shall conform to the requirement of C.P.116 (or an equivalent current code). Where it's not intended to use coping blocks for the protection of upper exposed surface of the unit, the upper most 150mm for the full width of the unit, shall

be formed with concrete composed of aggregate complying with B.S .1201. Such concretes shall be formed integrally with the main body of the concrete.

### **CONCRETE IN DEEP LIFTS**

#### **1.1.43 LIMITATIONS**

Any height exceeding 2.5 meter from which concrete is poured into shuttering o form sections of walls will be considered within the terms of this Clause.

Deep lift construction will not be permitted where the reinforcing bars are to be placed closer than 10cm. To one another in any direction or, where the clear width at the point of admitting the concrete between one layer of reinforcement and another (or in the case of singly reinforced walls between reinforcement and shutter) is less than 20cm.

The method shall only be used where trial sections reveal that in the Engineer's opinion it can be satisfactorily employed in which case the requirements of this specification shall apply except where they are in conflicts with the requirements of this particular clause when the latter shall prevail.

#### **1.1.44 CONCRETE**

In order to prevent segregation of aggregates concrete mixes shall be designed for increased cohesion or, Where suitable, on a gap-graded bases. The use of approved admixtures may be made to achieve this end

At the same time, the mix shall be such as to limit the amount of bleeding in concrete, and where in the opinion of the Engineer, the quantity of free water rising to the surface is excessive, the mix shall be collected before further concreting ids undertaken.

In order to offset any increase in the water-cement ratio at the upper levels, the Engineer may require the concrete mix to be modified for the upper deposition.

A slump of 7.5cm shall not be exceeded.

#### **1.1.45 REINFORCEMENT**

In order that reinforcement is not distorted or displaced during construction as a result of it being used for gaining access in or out of the shuttering, all inter-section of vertical and horizontal steel shall be properly fastened.

All obstructions caused by spacer chairs shall be eliminated so as to permit an unobstructed passage for the concrete to the bottom of the shuttering. The Contractor may use sliding timber spacers instead of fixed concrete or plastic spacer block to position the reinforcement.

#### **1.1.46 SHUTTERING**

In view of the high pressures to be expected from this form of construction extra attention shall be paid to the strength and stability of the shuttering, to prevention of loss of grout, and to the prevention of displacement of adjacent panels.

The use of through-bolts and other accessories which might interfere with the free passage of concrete between and round the reinforcement shall be reduced to a minimum by the use of properly designed shuttering.

#### **1.1.47 CONCRETING**

Particular attention shall be paid to the concreting of the initial sections at the bottom of the shuttering to prevent segregation caused by rebound from the hard surface of the kicker, base and lower sections. The initial deposition shall therefore be made by using trucking methods, or by placing the concrete through openings formed in the sides of the shuttering. Such openings shall not be higher from the hard surface than 2.5m.

In order to reduce settlement, and consequently, cracking between two sections of concrete placed at the different intervals of concreting time, between one section and other shall be carried out on a gap-construction basis. The gap shall subsequently be concreted in distinct lifts not exceeding 2.5m in height. For the same reason, four concentrating two adjacent sections placed at the same time but of different heights (e.g. where boxing out is included), the difference in height shall not exceed 15% of the height of the deeper section.

Concreting from the upper level of the shuttering shall be carried out in such a manner as to ensure that the concrete is admitted centrally, between the faces of the shuttering. For this purpose, the Contractor shall make use of the trunking or shall use funnel-shaped hoppers extending for a distance of not less than 0.74m into the shuttering. A sufficient number of such hoppers shall be provided, and/or they shall be capable of movement along the length of the shuttering, to enable the concrete to be placed in contiguous heaps at the base of the pour. Such heaps shall not exceed 50cm in height.

Where excessive bleeding is evidence, the excess water shall be removed before placing further concrete.

#### **1.1.48 COMPACTION**

Compaction shall be carried out where possible by manual operation of poker vibrators within the shuttering. Where this is not possible vibrator shall be suspended in sufficient number to ensure uniform compaction along the wall receiving the concrete, without the need of their withdrawal and re-insertion. The means of suspension shall be such that vibrators may be progressively and systematically lifted and the concreting proceeds to ensure that every section of placed concrete is married into adjacent and underlying sections.

The use of vibrators to reposition deposited concrete is prohibited.

Surface vibrators attached to the shuttering may be used only to supplement the main means of compaction.

#### **SITE BOOKS AND STANDARDS**

#### **1.1.49 INSTRUCTIONS TO BE RECORDED**

The Contractor shall provide and keep permanently on the site a numbered triplicate book where in the Contractor shall record all instructions relating to concrete work issued by the Engineer or the Engineer's Representative. One copy of every entry therein shall be sent to the Engineer on the same day as the entry is made.

### **1.1.50 SITE DIARY**

The Contractor shall provide and keep permanently on the site a continuous entry diary wherein the Contractor shall record details of shuttering construction placing of reinforcement concreting and curing operations striking of shuttering making good and daily temperature and weather conditions. This diary shall always be available for inspection by the Engineer or Engineer's representative.

### **1.1.51 COPIES OF STANDARDS AND CODES**

The Contractor shall provide and keep permanently on the site copies of the following British standards codes of practice and road Notes (or equivalent current codes of practice): -

- B.S. 812
- B.S. 882
- B.S. 1478
- B.S. 881
- C.P 114
- B.S. 2007
- Road Note 4

The Contractor shall in addition provide and keep permanently on the site copies of such other standards code Notes and specifications as may be approved by the Engineer

In the event of any differences between the "special clauses" and the previous specifications under section 3 then the provision of this "special clauses" shall have precedence?

### **WATER RETAINING STRUCTURES-SPECIAL CLAUSES**

#### **1.1.52 MAKING GOOD**

The cement mortar used in filling recesses in the concrete formed by bobbins in connection with shuttering shall contain an approved expanding admixture.

#### **Construction Joints in Water Retaining Structures**

In water retaining structures P.V.C. water stops not less than 130mm. Wide manufactured by an approved manufacturer shall be built into all construction joints in wall which are exposed externally and construction joints in roofs of portable water retaining structures. Construction joints shall be formed at positions agreed by the Engineer.

The cost of forming construction joints shall be included for by the Contractor in his general concrete rates.

#### **Water Tightness of Structures**

The Contractor shall be solely responsible for the water tightness of structures and any remedial measures necessary.

## **TESTING OF WATER- RETAINING STRUCTURES**

All water-retaining structures shall be tested for water-tightness on completion in the following manner. The structures shall be filled with clean water in stages and held at each water level for such timer as the Engineer may require. Should any dampness or leakage occur at any stage, the water shall be drawn off and the defects remedied to the satisfaction of the Engineer. The procedure shall be continued and finally the structure shall be allowed to remain full for seven days. Should any dampness or leakage or others defects occur they shall be made good to the satisfaction of the Engineer and the structure re-tested until the water tightness is approved by the Engineer. A certificate of substantial completion will not be issued until after such tests have satisfactorily completed.

The Contractor shall provide a gauge to measure vibrations in water levels during the tests.

The testing shall be carried out before the excavations or backfilled and embankments placed.

In the case of water reservoirs where the roof is horizontal it shall be treated for water tightness by flooding (in small areas at a time if necessary) to a minimum depth of 25mm. The water shall be left standing for less than 24hours and the underside of the roof examined for dampness or leakage. Any defect shall be made good by the Contractor and the tests continued until the water tightness of the roof is approved by the Engineer.

The Contractor shall be solely for water tightness of structures and any remedial measures necessary.

The water used for testing shall be provided by and at the expense of the Contractor and shall be free from impurities and of such qualities which will not pollute or impure the water-retaining structure and be to the satisfaction of the Engineer's Representative.

The Contractor shall give the Engineer's representative at least 14 days' notice of the source of water intended for use for testing purpose.

The Contractor shall be solely responsible for making all arrangements necessary for obtaining water and provision of all equipment and labour and other things necessary for testing water-retaining structures.

In the case of reservoirs divided into two compartments by a central division wall, each compartment shall be tested separately, with the other compartment empty.

On satisfactory completion of water testing the reservoir s hall be kept full of water until supply water is available for cleansing and sterilizing.

## **CLEANSING AND STERLIZING WATER-RETAINING STRUCTURES**

The side of all potable water-retaining structures and all interior paperwork and fittings shall be thoroughly cleaned and washed after the water tightness test has been approved by the Engineer to remove all contamination and the water from these operations shall be removed by squeegees and drained away.

The structure shall then be filled to overflow level with potable water containing 20 parts per millions of chlorine and left for a period of at least 24 hours. The chlorinated water shall then be drained away and the structure refilled with normal supply water from which the samples shall be taken for analysis to the instruction of the Engineer. If any of the results of the analyses are satisfactory when compared with those of the control sample of the normal supply water the sterilizing process shall be repeated until the results of the test are satisfactory.

The cost of the initial sampling analyses and preparing reports on the bacteriological quality of the water shall be borne by the Employer but should any subsequent sampling analyses and preparing reports shall be borne by the Contractor.

All water required by the Contractor for cleansing and sterilizing water-retaining structures will be provided by the Employer and the cost of such water will be charged to the Contractor.

The contractor shall be solely responsible for making all arrangements necessary for obtaining water and the provision of all labour materials chemicals and other things necessary for cleansing and sterilizing water-retaining structures.



## **PIPELINES**

### **GENERAL**

The requirements of this section shall also apply to all pipework within reservoirs, and to drainage works as necessary, as well as to major pipeline works.

### **SETTING OUT**

The Way leaves, Easements or other Rights of way for pipelines will be defined by the Employer across any private land and by the Engineer across any land belonging to the Employer or to the Government.

The Engineer will hand over to the Contractor all such marks as define and said way leaves, easements or other rights of way, or such other information as is necessary for the Contractor to establish the boundaries thereof himself.

The Contractor shall set out the boundaries and shall provide, erect and maintain the position until final completion of the works using substantial timber stakes or other approved members, not less than 1.5m high indicating the said boundaries. Such stakes shall be provided at each and any change of direction of the boundary and at intervals not exceeding 100m, and at such intermediate points as are deemed necessary by the Engineer.

The Contractor shall submit to the Engineer at a scale of 1 in 500 horizontally and 1 in 50 vertically a profile of the ground levels after the initial clearing of the way leave, easement or other right of the way showing the proposed invert levels of the pipeline, and precise positions of all air valves and washouts, for the Engineer's approval.

### **BENCHING**

Where shown on the drawings the Contractor may excavate and fill on side slopes to form an access bench for the purposes of construction.

In the event that the Contractor wishes to make a bench either in places not considered necessary by the Engineer, or to make a larger bench than that allowed on the drawings the Contractor shall submit his proposals in the form of a plan at a scale of 1 in 500 at least five weeks in advance of the time he proposes to execute such work for the Engineer's Approval.

In the event that such approval is granted all expenses incurred due to such extra benching will be at the Contractor's expense. This includes but is not limited to the Employer's expenses incurred in negotiating with landowners, the compensation payable to such landowners, the costs of any erosion protection measures that may be specified at the time, or subsequently by the Engineer, or the cost if executed, of restoring the ground to its original profile and state of compaction.

In the event that the Contractor creates such benches as described above in excess of that allowed on the drawings or otherwise in writing by the Engineer, the Engineer will decide on the necessary remedial measures to be undertaken by the Contractor at the Contractor's expense.

### **SITE CLEARANCE**

Site clearance, including benching, shall be carried out subject to the requirements of section 2 (Earth-works) and subject to the following clauses. The Contractor should

note that the pipeline drawings do not require any areas to be cleared in accordance with clause 2.2.

### **HANDLING OF PIPES AND FITTINGS**

Before any pipes are delivered to site, the Contractor shall submit details to the Engineer of his proposals for handling pipes and fittings during transport, in store and during laying.

The requirements of lifting hooks will be that the Contractor removes the end plugs and make other arrangements to keep the inside of the pipes clean, and that the lifting hooks are of such a design so as not to damage either the lining or coating. The requirements for external lifting clamps will be that they are of such a design as not to damage the coating. It is envisaged that this requirement will be met by use of rubber covered, curved metal plates of the correct radius and of a sufficient size.

At no time except with the Engineer's approval shall the end caps of pipes and fittings be removed except for inspection at a storage area, when they shall be replaced and immediately prior to laying.

When pipes are loaded for transport they shall be at all times laid on suitably shaped padded cradles to prevent damage to the coating. When more than one tier of pipes is transported intermediate cradles as above described shall be used. Pillows shall be provided between lashing (ropes, wires, or chains etc.) and the pipes. All grades and lashing shall be of such widths as to prevent damage to the coating of the pipe, or distortion of the pipes.

Pipes which have spigot and socket fittings at the end, or flanges shall be stacked so that they are not resting on, or rested on by, other pipes or fittings.

All valves shall be handled with care and shall always be transported on timber packings, and where possible in the manufacturer's original packing if this is suitable.

Workmen must be prohibited from storing materials, tools, clothing, etc., or any other items, in the pipe. To prevent stones falling in to the pipe, and to prevent vermin, etc. entering, a close fitting wooden plug, must be secured on the end of the last pipe whenever work ceases. The plug must be so fixed that it requires a determined attempt to remove it. The Engineer reserves the right to stop all works on any section where the above practice is not carried out.

### **STORAGE OF PIPES**

The contractor shall only store pipes, fittings and other materials at places approved by the Engineer, and shall at all times provide adequate supervision and when no activity is in progress at such areas as to prevent theft or damage by persons other than the Contractor. Any damage incurred due to lack of such supervisions or protection will be Contractor's responsibility

Pipes shall not be stacked in storage areas, more than three tiers (or four when nested) high, except with the approval of the Engineer. The area on which the pipes are to be stacked shall be free draining. The grass or other vegetation shall be kept cut, and suitable timbers or cradles shall be provided on which the pipes shall be laid, end stops to the stacks shall also be provided.

Fittings and valves shall be more than one tier high, and they shall be supported off the ground by suitable timbers.

The Contractor shall take any necessary precaution to prevent fire in the storage areas, and shall provide and maintain firebreaks and other precautions

Care shall be taken to keep the gunmetal faces and seats of all valves clean and free from dirt or grit. No valve shall be closed without first wiping the faces with a clean cloth dipped in oil.

Rubber or similar gaskets shall be packed in wooden crates suitable for external storage, or stored inside the Contractor's stores building.

Fittings and valves shall be more than one tier high, and they shall be supported off the ground by suitable timbers.

The Contractor shall take any necessary precaution to prevent fire in the storage areas, and shall provide and maintain firebreaks and other precautions

Every precaution shall be taken to prevent damage to linings or coatings. No material shall be unloaded by dropping. Pipes, particularly PVC, shall not be dragged. Materials shall not be unloaded in such locations that will cause disruption of traffic or create a nuisance.

The Contractor is responsible for protection of pipes and fittings from prolonged exposure to direct sunlight. All damages and breakages of material shall be made good at the Contractor's cost.

### **STRINGING OF PIPES**

Pipes shall be handled and transported in accordance with the preceding clause. Where pipes, fittings or any other materials are laid out on the site adequate personnel shall be provided as required

Pipes shall be laid on suitable pillows or other supports approved by the Engineer. End caps shall not be removed until such time as the pipes is to be inspected and laid.

At places where the pipeline route crosses roads, tracks or any other access, and where directed by the Engineer, the Contractor shall so deposit the pipes so that the access to the public is not in any way prohibited. Where the pipeline crosses any field or other place or other place frequented by people or livestock similar provisions shall be made.

The Contractor may be prohibited from using certain roads and other tracks for the purpose of stringing on account of adverse weather conditions and no extra cost he may incur on this account or for any other road restriction, delay, or any other thing which increases the cost of the haulage will be allowed. The Contractor should not that such restrictions may be imposed due to dust in dry weather, as well as road damage due to wet weather.

### **UPVC PIPES**

Where uPVC pipes are being transported, strung, stored or handled they shall be supported along their whole length. They shall also be protected from the exposure to the sun by storage in sheds or under canvas etc. care shall be taken to ensure that

they are not dropped, hit, abrasion suffer any other treatment which might cause sum all imperfections.

### **SMALL PARTS AND RUBBER PARTS**

Air valves rubber joint rings gaskets bolts and similar fittings and materials shall be kept in approved locked premises and such fittings and materials shall not be distributed to the trench side until immediately prior to lying fixing joints as assembly thereof. All rubber joints ring and gaskets must be stored in a cool damp location and all fittings and materials shall at all times be stored in the shade under cover and protected from the weather to the satisfaction of the Engineer's Representative.

### **EXAMINATION OF PIPE ETC PRIOR TO LAYING**

Shortly before laying or fixing any valve pipe or fitting the Contractor shall in the presence of the Engineer's representative carefully examine each valve pipe and fitting as detailed in the these specifications to ascertain damage or defect occasioned to the valves pipes and fittings during loading unloading handling and transportation subsequent to the valve pipes and fittings having been delivered to and accepted by the Contractor as being in sound condition in accordance with clause 89 of the Conditions of Contract. All damage and all defects revealed by this examination shall be repaired and remedied to the satisfaction of the Engineer's representative.

The Contractor shall give the Engineer's Representative not less than 48 hours' notice of his intention to examine any pipes etc. And the Contractor shall not proceed to lay such pipes until they have been approved as free from damage and defects by the Engineer's Representative.

The external sheathing pipes and fittings and the external coating of coated pipes and fittings shall be examined by means of an approved "holiday" detector' operated in accordance with the supplier's instructions at a voltage not less than 12,000v and not greater than 14,000v. All "holidays" and damages/ defects in the external coating of pipes fittings valves etc. shall be repaired and made good in accordance with the manufacturer's instructions for repaired or damaged for external sheathing and internal lining "

The ends of steel pipes and fittings shall be examined for circularity. And distorted ends shall be corrected by an approved method to within the tolerances required by the mechanical couplings or other joints by which the pipes or fitting are to be jointed.

All ductile iron pipes and fittings which are severally dented or similarly damaged shall be discarded unless in the opinion of the Engineer's Representative a portion of such pipe or fitting may usefully be salvaged in which cases the Contractor may cut off and discard the damaged portion only.

After examination and any necessary repairs and attention all pipes fittings etc., shall be cleaned internally particular care taken to ensure that no stones etc., are bedded in bitumen or coal tar linings.

### **LAYING PIPES ETC**

Immediately before any pipe is lowered into the trench it shall be re-examined for soundness, and carefully brushed through to remove any stains, soil, or other matter.

The pipes shall be gently lowered singly into the trench, carefully set to the correct line and inclination, pressed home, held home and firmly bedded. Before the pipe is lowered, the trench bottom shall be thoroughly examined to ensure that no projection or other feature likely to cause damage is present. Where straight pipes are used for turning bends, the angle between two adjacent pipes shall not exceed the Manufacturer's recommendations, and in any case shall not be more than 2 degrees. Temporary supports to pipes shall only be used with the approval of the Inspector. Trenches must not be refilled until the Inspector has examined the joints. Any further alignment of the jointed pipeline shall be done under the direction of the Inspector.

Workmen must be prohibited from storing materials, tools, clothing, etc., or any other item, in the pipe. To prevent stones falling in to the pipe, and to prevent vermin, etc. entering, a close fitting wooden plug, must be secured on the end of the last pipe whenever work ceases. The plug must be so fixed that it requires a determined attempt to remove it. The Engineer reserves the right to stop all working on any section where the above practice is not carried out.

To ensure that no obstacle is left in the pipes after they are laid, a strong 'badger' of timber or other approved construction, with a chain or cord attached, shall be made to follow the pipe-jointing at a distance of 2 pipe lengths from the last-made joint. The badger shall be of diameter 10mm less than the internal diameter of the pipes, and shall not be removed from the line except in the presence of the Inspector. The badger shall be cushioned so as not to cause abrasions on the internal surface of the pipes.

In all jointing, the Contractor must adhere strictly to the manufacturer's recommendations and no person shall be engaged on jointing who is not skilled in this work. The Contractor should include for every expense in making the joint.

Before jointing, all joints must be checked to ensure that they are clean and undamaged.

Immediately before any new pipe is lowered into the trench the plug shall be removed from the end of the last pipe laid and the new pipe shall be carefully lowered into the trench with a crane or gantry operating within its designed working load or by the approved means.

Each pipe and fittings shall be laid true to alignment curve and gradient in accordance with the Drawings or as directed by the Engineer's Representative. The minimum cover and the minimum gradient shall not be less than 0.19 and 1 in 500 respectively.

Where gradients are slack or where invert levels are shown on the drawings or where on the drawings or where required by the Engineer's Representative the pipe shall be boned to even gradients and sight rails be provided for this purpose at intervals not exceeding 60m., and at all changes in grade.

Pipes laid in trenches shall be laid and final bedded on an even and uniform bed and if considered necessary by the Engineer's Representative the fines screened material shall be placed and consolidated in the trench bottom to provide such bed. Pipe shall not be dragged along the trench bottom. Joint holes shall be excavated

below the trench bottom and shall be as small as possible and shall be filled in compactly after pressure testing and before the refilling of the trench is completed.

The Contractor shall take all steps necessary to ensure that no dirty water or other extraneous matter is allowed to enter the pipes during or after laying. In the event of dirty water or extraneous matter entering the pipes the Contractor shall immediately carry out the necessary cleaning as may be directed by the Engineer Representative. No extra payment will be made or allowed for such work.

Except when necessary for jointing, the end of the last pipe laid shall be plugged to the satisfaction of the Engineer's Representative and the Contractor shall provide the sufficient number of and use proper plugs for this purpose.

Any damage to the external coating or to the internal lining of pipes fittings etc., sustained during laying shall be repaired and made good to the satisfaction to the Engineer's Representative who shall be afforded facilities of examining and testing any damaged areas of sheathing and lining may be tested with the "Holiday detector"

Pipe trenches shall not be refilled until permission to do so has been obtained from the Engineer's Representative. Subject to such permission being obtained trenches shall be refilled without delay to at least the minimum extent required by clause 429.3 hereof in readiness for pressure testing.

### **CUTTING OF PIPES**

Steel pipes supplied by the contractor, which are suitable for cutting, are distinguished by a red tint in the lime wash to coated pipes.

Such pipe shall not be ordinary laid and shall be kept for the purpose of makeup's and tie ins and other places where they are required to be cut upon the Engineer's approval.

Pipe shall be cut using mechanical equipment approved by the Engineer. Hand frame cutting equipment will not be permitted except for steel pipes. The ends of the pipes shall be prepared, and the coating and lining made good to be suitable for the type of joint to be employed. Before any cutting the external coating shall be removed for 150mm each side of the cut.

The Contractor shall cut all pipes where necessary with a proper cutting machine, suitable for the particular type of pipe being cut, at his own expense. Pipes shall be cut to produce a clean square cut of the pipe and lining if any, without shattering or separation. Any damage caused to the concrete lining of a pipe shall be rectified using an approved epoxy mortar at the Contractor's cost. Cut ends shall be prepared in accordance with the manufacturer's recommendations.

The cost of all cutting, trimming, chamfering, threading, etc., shall be included in the rates for laying and jointing the pipes.

### **PROPRIETARY JOINTS AND COUPLINGS**

Proprietary joints and coupling supplied by the Employer shall be assembled in accordance with the manufactures' instructions. The Contractor shall be responsible for obtaining such copies of the manufactures' instructions as he required, at his own expenses.

The Contractor shall be responsible for obtaining all the necessary special tools and appliances necessary for making the joints.

Flange joints shall be made with a clean flat gasket made of first quality soft insertion rubber at least 3mm thick incorporating 2 layers of cotton fabric. Faces shall be brought properly together and made fair and parallel before the bolts are tightened. Diametrically opposite bolts shall be tightened in sequence and final tightening shall be carefully and uniformly effected. Gaskets must be suitable for use at pressure up to 16 bars.

All necessary bolts, nuts washers and rubber insertion or jointing must be supplied by the Contractor, and he must ensure that adequate quantities are available on the site. Bolts and nuts of all body flanges of sluice valves and other apparatus must be tightened before testing. Only standard length spanners shall be used to tighten bolts, and the Contractor will require rectifying at his own cost damage due to cover tightening.

Immediately upon successful testing of the line, each joint shall be painted with 2 coats of approved bituminous paint, a sample; of which must be submitted to the Engineer for approval.

### **PVC Pipes**

The Contractor shall comply fully and strictly with the instructions issued by the manufacturers. He shall obtain and supply each of his foremen pipe layers a copy of these instructions.

- a) The Contractor shall ensure that the spigot and socket are free from dirt or grit and that the socket is free from grease and is dry.
- b) Only lubricants supplied by the manufacturer shall be used to lubricate the chamfer at the spigot and the joint ring.
- c) The Contractor shall check in the case of 'loose' rubber rings that the ring is inserted the correct way round.
- d) If the manufacturer has not fixed a mark to indicate joint penetration, the Contractor must fix such a mark.
- e) Cut pipes must be suitably chamfered. Pipes must be gently lowered in to the trench, and no dropping will be permitted.

The Pipe shall be pushed firmly into the socket until the penetration mark is just visible. Any system involving impact, either direct or indirect, on the pipe will not be permitted

The Contractor must join the pipes by one of the following methods: -

- a) End leverage 011 the pipe with a pinch bar using timber protectors.
- b) A direct push using manual labour or, under the strict supervision of the foreman, using the bucket of a hydraulic excavator operated by a skilled operator. The Engineer reserves the right to withdraw approval of this method if in his opinion the pipe is liable to be damaged.

- c) A 'pull-on' winch system using clamps and winch supplied by the manufacturer, or using other approved winch/ratchet arrangements
- d) A jacking system using a hydraulic or mechanical jack.

Lubricant, and cleaner will be supplied in accordance with the manufacturer's recommendations and should extra be required the Contractor will have to provide it at his own expense.

### **BOLTED GLAND COUPLINGS AND FLANGE ADAPTORS**

Further to the requirements of clause 415, the inside of the coupling sleeve shall be painted with a bituminous mastic paint approved by the Engineer.

After completion of the joint and after testing has been completed, the coupling shall be thoroughly cleaned and dried and appointed with a bituminous mastic paint, and then a coating material supplied by the Employer shall be molded around the whole joint, using molding boxes also supplied by the Employer, in accordance with the "Instructions for completion of external protection" as attached (Annex 2 to part 4).

### **Mechanical Coupling**

Mechanical couplings (Viking Johnson and similar) shall be thoroughly clean and dry when being assembled. The Manufacturer's instructions on assembly shall be rigidly adhered to. Before fitting, the pipes shall be marked in order that the centering of the coupling may readily be checked.

After testing, these couplings shall be painted 2 coats approved bituminous paint, or cast bitumen externally using moulds supplied under the Engineer's direction. The Contractor will be guided by the Bill item on the appropriate system.

### **Threaded Pipes (Galvanized Steel Tube)**

The threads shall be cleaned and any burrs removed from the ends. An approved jointing compound shall be used in accordance with the manufacturer's instructions. Compounds containing red lead shall not be used\* Pipes and fittings shall be correctly aligned and the joints screwed tight. The joints shall not be caulked, but made watertight by screwing only. Any excess jointing compound and yarn shall be removed and any exposed threads painted liberally with approved bituminous paint.

### **Ductile and Spun Iron Pipes**

All jointing of bolted gland type, rubber- ring flexible type joints, etc., shall comply fully and strictly with the instructions issued by the manufacturer.

### **FLANGED JOINTS**

Flanged joints shall be made with the gaskets and nuts, washers and bolts provided. Two washers shall be used per bolt one under the bolt head and the other the nut. The tightening the bolts shall be carried out evenly all round by tightening at any one time diametrically opposite pairs. In no case shall excess tightening be exerted in any nut or bolt. Spanner shall be of suitable length but not exceeding 300mm from the axis of the bolt to the extremity of the handle. Spanners shall not be lengthened in any manner in any manner in order to increase the purchase. After the satisfactory conclusion of the water tightness test all buried flange joints shall be protected by a



suitable approved wrapping in accordance with the manufacturer's instructions. All exposed joints shall be cleaned and be given two coats of approved bitumastic paint.

### **BENDS AND BENDING**

The Contractor shall be responsible for supplying, or having manufactured at his own expense all bends required by him in excess of those which are supplied by the employer for the positions shown on the drawings. Such bends may be fabricated from pipes supplied by the Employer. Such bends shall not be the same standard as those supplied by the employer.

Small deflections may be accommodated at flexible couplings but shall not exceed the degrees of bend given below.

Diameter	1300,	1200,	1000,	700,	600,	500,	400,	300
Deflection	1°	1½°	2°	2½°	2½°	3°	3°	4°

Cold bending of pipes will not normally be allowed as the pipes are lined and coated. However, the Engineer may allow the Contractor to carry out tests and if in the opinion of the Engineer the result of such tests are satisfactory may grant his approval.

An approved cold bending machine shall be used which has a full circle bending shoe which is capable of producing smooth symmetrical bend. There shall be no fluttering, wrinkling or distortion at the pipe at any bend, nor any stretching or thinning of the pipe wall. The coating and lining shall be repaired to the standard of an unbent pipe. The radius of the bend shall not be less than fifty diameters, of such other greater radius as may be allowed by the Engineer subject to the result of the field tests.

The Contractor shall submit his proposal for field bending sufficiently in advance to ensure that in the event of his proposals being unacceptable delays will not occur. If any delays occur the Contractor shall be reliable for all cost incurred. The pipes for the test shall be supplied by the Employer at the expenses of the Contractor, and should they be unusable after the tests and should any delays be caused due to late replacement of the Employer this shall be at the Contractor's risk.

Stress bents will not normally be allowed; however, the Engineer may allow the Contractor to carry out the tests and if in the opinion the Engineer the results of such tests are satisfactory may grant his approval. The radius of such bends shall not be less than one thousand diameters in any case. The test will be subject to the requirement of the provisions of these specifications for testing

### **GROUTING IN IRONWORK AND PIPES**

All brackets rag bolts and other run work for which holes have been boxed out or left in the concrete of a structure shall be carefully grouted into their correct position in all particulars. The grout in shall be carried out with cement and sand grout in such a manner that there shall be no apparent difference in the texture or colour throughout the face seepage of water either between the iron work and the set grout or between the set grout and the surrounding structure.

The above instructions shall apply also to the building in of pipes except that concrete of the class used for that part of that structure shall be used in lieu of cement grout.

### **THRUST AND ANCHOR BLOCKS**

Concrete thrust and anchor blocks shall be formed at bends tees and valves in accordance with the typical section shown the drawings or otherwise as directed by the Engineer. The additional excavation shall be made at the bends etc. have been jointed and shall then be placed with all possible speed. The back of supports and blocks shall be on to solid ground all loose material being removed before concreting.

The concrete used for thrust and anchor blocks shall be class 15 and after placing shall be kept in view for not less than six hours. No pressure shall be applied in any section of main until the concrete has had at least three day's curing.

Thrust blocks shall be measured per cubic metre of concrete and the rate shall include for all rough shuttering and screening of surfaces.

The Contractor shall construct temporary anchors for testing but before doing so shall submit his proposals to the Engineer for approval. The cost of these anchors shall be included in the rate for testing.

### **SLIP ANCHORS**

Anchors to prevent side slip shall be constructed where shown the drawings or where directed by the Engineer.

Anchors to prevent longitudinal slip shall be constructed where the slope of the pipe is greater than 1 in 3 or as otherwise directed by Engineer.

Slip anchors shall be constructed in class 15 concrete in accordance with typical details shown on the drawings and shall be located at such intervals as the Engineer will direct.

### **CONCRETE SURROUND TO PIPE**

Where pipelines pass under streams and rivers or under loads the section of pipeline under the stream river or load and for minimum distance of 1.0m, clear on either side of the bank or edge thereof such greater distance as the Engineer's Representative may require shall be surrounded with class 15 concrete in accordance with the typical detail shown on the drawings so as to provide a minimum of 150mm thickness protective surround to the pipe.

### **RIVER CROSSINGS**

River crossings shall include construction of under crossings and overcrossings of natural rivers streams gullies (where the circumstances seem to warrant) watercourses and the pipeline in accordance with the drawings. Only such referenced crossings as are shown in on the drawings will be considered as river crossings within the meaning of the Contractor and the Contractor shall be entitled to additional payment as provided for in these specifications hereof for crossings of minor or other obstructions of similar description not shown on the drawings or not so specifically referenced.

Payments for referenced river crossings will be made in accordance with the attendant rates for the respective works included in the relevant bill of quantities. The Contractor shall be entitled to payment in the form of a single fixed lump sum for each of the referenced crossings which sum shall be deemed to be inclusive of all additional costs and expenses incurred arising on accounted river diversion works difficult of access the handling and laying pipes etc. On piers the provision of scaffolding and all other matters or things which affect or influence the cost of completing each crossing and no variation in any of the fixed sums will be permitted on account of adverse whether condition increased flow of water in rivers and streams or any other thing resulting in the work being of greater difficulty or of longer duration than provided for the Contractor.

### **FLOATATION OF PIPELINE**

The Contractor shall be solely responsible for ensuring that floatation of the pipeline does not occur during construction. The extent of the backfill placed over each pipe after laying and before testing shall be such will prevent floatation of pipeline shall not be construed as limiting in any way the extent of the backfill so placed or which may be so required.

Should any section of the pipeline float out of line or level the section of pipeline so affected shall be removed and re-laid in accordance with the specification to the satisfaction of the Engineer's Representative, and any damaged sections shall be discarded. The cost of any pipe damaged or discarded through causes of floatation shall be chargeable to the Contractor.

### **PRESSURE TESTING**

All pipes shall be hydrostatically tested in the presence of the Engineer's Representative after laying. The Contractor shall give the Engineer's Representative not less than 48 hours' notice of his intention to carry out a pressure test.

Before any pressure is applied to any pipeline each pipe shall be securely anchored and when in trench shall be covered for at least two-thirds of its length with not less than 600mm of backfill material leaving the joints exposed no joints shall be backfilled or moulded or covered in any way until after the satisfactory completion of the pressure test.

Pressure testing shall be carried out as the work proceeds in such eighth of pipeline as are convenient and meet their approval of the Engineer's Representative. The end of the length of pipeline under test shall be closed by means of caps or blank flanges and this shall be securely braced and strutted to withstand the forces of the pressure test. Pipeline sluice valves shall not be used for closing pipe ends. All washout valves shall be fitted with blank flanges and the valves opened before the commencement of any pressure test. The Contractor shall be solely responsible for the provision of all caps and blank flanges necessary for testing of the pipeline and all bracing and strutting, and other materials necessary for carrying out the pressure test.

The test pressure in the section of the pipeline to be tested shall be as directed by the Engineer. The pressure in the pipeline shall be slowly raised to the test pressure, the test pump disconnected and the pipeline left charged under pressure with all air valves open for a period of not less than 24 hours to allow air in the pipeline to be

expelled and pipe linings and pipe walls of this period of time the test pump shall be reconnected and the pressure in the pipeline raised again to the test pressure and this pressure maintained for a period of 24 hours.

Throughout this period the pressure in the pipeline shall not be allowed to fall or rise more than 6m. Head of water below or above the tests pressure and this shall be accomplished by pumping water from the pipeline as required. The volume of water from the pipeline pumped into or released from the pipeline shall be carefully measured. At the end of the test period of 24 hours the pressure in the pipeline shall be adjusted to the tests pressure by pumping water into or releasing water from the pipeline as required.

The leakage from the pipeline shall be ascertained from the net volume of water that has been pumped into the pipeline during the test period. Leakage rates shall not be exceeding the amounts calculated in accordance with the following formula: -

$$\text{Leakage} = \frac{K \times D \times L \times P}{10,000,000} \quad \text{liters per twenty-four hours}$$

- Where K = 0.75 for steel pipes substantially welded  
= 3.50 for pipes with bolted Gland couplings  
= 22.00 for spigot and socket rubber sealed joints.  
= 44.00 for spigot and socket caulked joints

D = the nominal diameter in millimeters

L = the length in meters

P = the maximum tests pressure on the section of pipeline under test in kgf/cm<sup>2</sup>

During the period of the pressure test all joints shall be inspected from water tightness. All signs of leakage or faults shall be remedied whether total leakage from the pipeline under tests is less than the allowable leakage or not. Should any length of pipeline fail to pass the pressure test the Contractor shall at his own expense carry out all work necessary to locate and remedy the faults, and to retest the pipeline until it satisfactorily passes the test.

After the completion of pipe laying and installation of all fittings valves etc., the complete pipeline shall be subjected to a hydrostatic test under the tests pressure specified in clause above. While under this pressure the complete pipeline shall be inspected in the presence of the Engineer's Representative and all faults revealed shall be remedied to his satisfaction.

The water used for pressure testing shall be provided by the Contractor and shall be free from impurities and of such a quality which will not pollute or injure pipelines and to the satisfaction of the Engineer's Representative.

The Engineer's decisions shall be final in all matters relating to pressure testing.

All pipes shall be hydrostatically tested in the presence of the Engineer's Representative. Air testing of water mains will not be allowed under any circumstances without specific approval from the Engineer in writing.

Pipelines shall be tested in such lengths as directed by the Engineer, but normally 600 metres will be maximum length allowed in any one test. The Contractor shall give the Engineer's Representative not less than 48 hours' notice of his intention to carry out a pressure test. The test pressure which shall be applied to the lowest part of the main shall be: -

Class B - 90m

Class C - 135m

Class D - 180m.

For steel lines, the test pressure will be directed by the Engineer. Before any pressure is applied to any pipeline, each pipe shall be securely anchored, and in trench shall be covered for at least two-thirds of its length with not less than 600mm of backfill material, leaving the joints exposed.

The Contractor shall keep a record of all tests in a book, which shall be available for inspection and handed over to the Engineer on request. The Contractor is referred to Clause 1.14 regarding the availability of water for testing. In the event of a mains supply being unavailable, the water provided by the Contractor for testing shall be of such a quality which will not pollute pipelines.

The ends of the pipeline under test shall be closed by means of caps or blank flanges and these shall be securely braced and shrutted to withstand the force of the pressure test. All washout valves shall be fitted with blank flanges and the valves opened before the commencement of any test. Testing against sluice valves will not be permitted. The Contractor shall be solely responsible for all bracing and shrutting and for the provision of other materials necessary for carrying out the pressure test. The Council will, however, permit the Contractor to borrow blank flanges if these are available.

The Contractor shall provide a test pump, including an accurate pressure gauge of a scale acceptable to the Engineer, and the cost of this should be included in the rate for testing. The connecting pipework arrangement for fitting and pressurizing the main shall be as directed by the Engineer's Representative.

The main shall be slowly filled, preferably from the lowest point, and precautions shall be taken to ensure the release of all entrapped air. Air cocks may require to be fitted as necessary to achieve this. The pressure in the main shall then be slowly raised to a moderate pressure (circa 25 metres), at which point the test pump shall be disconnected and the line left charged with all air valves open for a period of 24 hours. This period is to allow air to be expelled and pipe walls of absorbent materials to become saturated. At the end of this period, the test pump shall be re-connected and the pressure in the pipeline raised to test pressure. The requirement of the test shall be that the test pressure will be recorded over a period of 4 hours. At the end of this test period the pressure in the pipeline shall be adjusted to the test pressure by pumping water into the pipeline. This quantity of water shall be carefully measured and shall be considered as the quantity of leakage. The leakage so ascertained shall

not exceed the volume calculated by the formulas: -10 litres per 50mm diameter per km per 50m head per 24 hours.

Should any length of pipeline fail to pass the pressure tests-

(a) **in the new mains;**

The Contractor shall, at his own expense carry out all work necessary to locate and remedy the faults and to re-test the pipeline until it passes the test. The cost of all repair material shall be charged to the Contractor if in the Engineer's opinion the repair was necessary due to faulty workmanship or negligence on the part of the Contractor.

(b) **in the mains already laid**

The Contractor shall carry out all work necessary to locate and remedy the faults and re-test the pipeline until it passes the test. All labour provided by the Contractor and not covered in Bill No. 3 of the Bill of Quantities shall be paid for as day works. The cost of all repair material shall be borne by the City Council\*

All signs of leakage or faults observed during the test, both in (a) and (b), shall be remedied whether total leakage from the pipeline under test is less than the allowable leakage or not. The Engineer's decision shall be final in all matters relating to testing.

**PROVING PIPELINE FREE FROM OBSTRUCTION**

Proving shall be carried out as pipe laying proceeds by passing through the pipeline a 'badger', which must be kept in the pipes at all times during construction of the pipelines. 'The Badger' shall be pulled forward and any obstructions or dirt removed the next one is placed in position, so that the barrel of the pipe is left perfectly clean.

The 'Badger' shall consist of polythene foam with dimensions approved by the Engineer, with suitable attachments to allow for pulling through the pipes.

Where the Contractor does not wish to use a badger, he may as an alternative swab the pipelines using a pig of polythene foam with dimensions approved by water pressure.

The Contractor shall supply all the necessary equipment including launching equipment, tracking equipment, control equipment and receiving equipment except where there are provided by the Employer as specified in appendix B. The Contractor shall supply and make all arrangements for disposal of all the water required at his own expense. pigs shall be passed through pipelines at a speed of between 0.2 and 0.4 meters per second to obtain the best cleaning results with the minimum number of passes. Should it be apparent from the debris a collected by the swab that damage to the lining has occurred, the Contractor shall be wholly responsible for repairing the lining to the satisfaction of the Engineer's Representative.

The swabbing operation shall be controlled by experienced Engineers to ensure that no undue surges in the pipeline, heavy docking of the pig or over pressuring of the pipeline occur causing damage to any of the permanent works. Any damage caused shall be made good by the Contractor to the satisfaction of the Engineer's Representative.

## **CLEANING & STERILIZING PIPELINES**

After the pipelines have been provided free from obstruction and satisfactorily pressure tested the Contractor shall flush out and cleanse the pipelines to the satisfaction of the Engineer's Representative. The water used for flushing and cleansing will be provided by the Employer, but the cost will be charged to the Contractor.

When the pipelines have been cleansed to the satisfaction of the Engineer's representative the Contractor shall introduce at a slow rate of water flow by a portable chlorinator or other approved means a solution of sterilizing agent in such quantity and of such strength as will result in a concentration of chlorine throughout the length of the pipes of not less than 30 parts per million. This sterilizing charge shall be allowed to remain in the pipeline for 24hrs after which time the pipelines shall be thoroughly flushed using the supply water to remove chlorine in excess of that in the supply water.

When this flushing has been satisfactorily completed samples of water shall be taken by the Engineer's representative for bacteriological analysis by the Employer. If any of the results of the analysis are unsatisfactory when compared with those of the control sample of the supply water the sterilizing process shall be repeated until satisfactory results are obtained. On completion of sterilizing and flushing the pipelines shall be left full of supply water.

The Contractor shall be solely responsible for the provision of all labour materials and chemicals necessary for carrying out the foregoing operations.

All water used for cleansing, sterilizing and flushing pipelines in accordance with this clause of the specification will be provided by the Employer in accordance with the conditions of contract. The cost of such water shall be charged to the Contractor and the Contractor shall be responsible for all temporary works and other arrangements in connection with cleansing, sterilizing and cleansing of the pipelines.

The cost of the initial sampling analyses and preparing reports on bacteriological quality of the water shall be borne by the Employer but costs of any subsequent sampling analyses and preparing reports should be initial reports be unsatisfactory shall be borne by the Contractor.

**After** the pipeline has been tested the Contractor shall thoroughly flush out and clean the pipeline to the Engineer's satisfaction.

After approval the Contractor shall fill the pipelines with water to which a sterilizing agent has been added by using a portable chlorinator or other approved method to give a concentration of chlorine throughout the length of the pipeline of not less than 30mg per litre. The solution shall remain in the pipeline for 4 hours after which the Contractor shall thoroughly flush the pipeline until the chlorine residual is reduced to that of the supply water.

The water shall remain in the pipeline for a further 24 hours after which samples will be taken, by the Employer for bacteriological analysis. Should the sample fail to meet the required standard, the complete sterilization process shall be repeated until satisfactory results are obtained after which the pipeline shall be left full of water.

The Contractor shall include in his rates all costs of labour, material, plant and chemicals required to complete the flushing and sterilizing to the Engineer's satisfaction.

The cost of the initial sampling and analysis shall be borne by the Employer and any subsequent sampling required due to unsatisfactory initial results shall be borne by the Contractor.

Bleaching powder if used by the Contractor, shall contain 70% chlorine and must be approved by the Engineer before use. Refer to Appendix.

The Contractor shall dispose of waste chlorine, solution in such a manner as to avoid the pollution of any water courses or reservoirs.

**CHLORINATION OF MAINS AT 50 PPM (mg/l)**

**USING 70% BLEACHING POWDER**

DIA OF PIPE		CONTENTS 2/100m	BLEACHING POWDER (kg)
75	(3 <sup>1/2</sup> )	440	0.020
100		785	0.04
150	(6 <sup>1/2</sup> )	1770	0.10
200	(8«)	3140	0.15
250	(10-0	4910	0.21
300	(12 <sup>1</sup> )	7070	0.30
375	(15")	11045	0.50
450	(18-);	15900 ;	0.70
525	(21 «)	21650   1	1.00
600	(24-')	28280	1.30

**NOTE;**

*For 1000 gallons @ 30ppm add Jib Bleaching Powder*

On completion of the whole of the pipe- laying works, and after proving that all pipes are free from obstructions, the pipes shall be sterilized in the manner described below:

- a) All hydrant sluice valves shall be closed. All other valves shall be in a fully open position.
- b) The pipes shall be charged with water at a slow rate of flow and by a portable chlorinator or other approved means a solution of sterilizing agent in such



quantity and of such strength as will result in a concentration of chlorine throughout the length of the pipes of not less than 30 parts per million.

- c) As soon as water starts to issue from open ended valves or stopcocks, these valves will be shut tight immediately.
- d) This sterilizing charge shall be allowed to remain in the pipelines for 24 hours after which time all waives and washouts shall be opened, and the pipes thoroughly flushed with water to remove all chlorine in excess of that in the supply water,
- e) The Contractor shall be totally responsible for seeing that water flushed from the pipes is channeled away to a ditch or make such arrangements to ensure that no damage to other works is caused by the flushing operation.
- f) When the flushing is satisfactorily completed, samples of water will be taken by the Engineer for bacteriological analysis by the M.O.H.
- g) If any of the results of these analyses are unsatisfactory, the sterilizing process shall be repeated until a satisfactory analysis of samples is achieved,
- h) The Contractor shall be solely responsible for the provision of all labour, materials, equipment and chemical necessary for carrying out the foregoing operations, and any repetition of these operations as may be necessary.
- i) The water used for sterilizing and flushing pipelines in accordance with this clause will be provided by the Council free of charge from the City's distribution system, except that if any of the operations have to be repeated under the provisions of this clause, or to the satisfaction of the Engineer, the Contractor will be charged for the amount of water used in carrying out these operations,
- j) The costs of initial sampling analyses shall be paid by the Council, but the costs of any subsequent sampling analysis should the initial reports be unsatisfactory shall be borne by the Contractor.

### **PAINTING**

Pipelines and fittings exposed to view at river over-crossings and in manholes and chambers shall be painted in accordance with clause 511 hereof.

### **MARKER POSTS**

Where appropriate, the Bill allows for the provision of marker posts. These shall be in accordance with the Contract Drawings. The Contractor shall allow in his price for painting the post as indicated on the Drawings or as directed

## **MATERIALS**

### **GENERAL**

Supply of pipes and fittings shall all be to the standard. No mixture or supplies to differing standards will be accepted. Nor shall the standards method of manufacture or specification be changed at any time from that agreed between the contractor and Engineer except on the Engineer's written agreement.

Fabrication drawings of all fittings, flanges and couplings shall be submitted to the Engineer within thirty days of the award of contract and will be returned either approved or with comments within a further fifteen days from receipt by the Engineer. Any delays caused by the submission of unacceptable or incorrect drawings will be at the contractor's expense.

The manufacturer shall not commence manufacture of fabrication of any plant to be supplied until receipt by him from the Engineer of the necessary approved drawing or other approval, except at his own risk.

All flanges of fittings shall be faced and drilled to conform to the dimensions specified in BS 4504 for the pressures specified, and shall be of the raised face type, finished as suggested in BS 4504. Drawings of the flange proposed shall be submitted with the Tender.

All plain ends on fittings shall be suitable for coupling to plain ended pipe with Bolted Gland type couplings.

All flange assemblies shall consist of the required number of studs or bolts, nuts, washers and gaskets. The tenderer shall submit with his tender details of the materials and threads to be used for bolts and nuts but supplies shall not be inferior to BS 4504 clause 5, to the approval of the Engineer.

Gaskets shall be of the 'inside bolt circle' type manufactured from Class A natural rubber in accordance with BS 2494, or other specification to the approval of the Engineer, which must be submitted with the Tender.

Bolted Gland type mechanical couplings for jointing plain-ended pipes shall be of the dresser Viking Johnson or similar type approved by the Engineer and shall be designed to accommodate the deflections given in Table 1.

The thickness of the steel in both the middle ring (sleeve) and the follower rings (flanges) shall be not less than 1.6mm thicker than the thickness of the walls of the adjoining pipes. The middle ring (sleeve) and the follower rings (flanges) shall be of such materials and dimensions that they are not stressed beyond half the yield stress of the material when the pipes connected by them are subjected to a hydrostatic test pressure of 22 kgf/cm<sup>2</sup>

Except where otherwise stated the middle ring (sleeve) of the coupling shall be provided with a suitable pipe stop (centre register).

The joint rings used shall be of Class 'A' natural rubber in accordance with the requirements of British standard specification BS 2494 or other specification approved by the Engineer.

Flange adaptors for jointing flanged fittings to plain ended pipes shall conform to the fore-going contents of this clause.

All mechanical coupling and flange adaptors shall be supplied with a shop coat of fast drying primer approved by the Engineer which is compatible with the material to be subsequently used for moulding or painting.

All the mechanical coupling will be protected externally, after assembling, with a bituminous or coal tar composition poured into moulds. The contractor shall allow in his rates for the mechanical couplings for the supply of all the necessary bituminous coal tar composition for this work, allowing for an amount 5% over the computed volume of composition necessary.

The contractor shall supply moulding boxes for the external protection of the couplings. The moulding boxes shall be cast aluminium alloy or other material approved by the Engineer. They shall be of economical design sized so that the minimum clearance over any part of the joint shall be 6mm and also make a close fit over the external surface of the pipe coating. The contractor shall supply two sets of all the necessary tool required for the mechanical couplings and moulding boxes.

Moulding boxes shall be of the cast aluminium alloy and to the approval of the Engineer. They shall be of economical design sized so that the minimum clearance over any part of the joint shall be 6mm and also make a close fit over the external surface of the pipe coating.

All plant shall be marked in accordance with clause 5 of BS 4772 except moulding boxes which standard of manufacture.

During manufacture and before dispatch from the place of manufacture the contractor shall allow for inspection by an inspector appointed by the Engineer. The inspection will include attendance at all pressure and material tests, execution of dimensional checks, inspection of the workmanship and standard of manufacture and scrutiny of evidence of the materials used in the construction. The manufacturer shall supply all necessary test rings, equipment, labour and any other facility required for the inspection.

The contractor shall provide the Engineer with a certificate in respect of each item stating that it complies in all respects with the agreed specifications, and has been submitted to and passed all the tests specified.

Plant will only be finally accepted within the storage area when the following conditions have been observed.

All coating and other repairs have been made good.

All pipes are stacked not more than three tiers high, laid on suitable timbers on level ground and properly chocked.

All fittings and boxes are laid out without stacking or piling.

The Engineer, or his representative, has carried out a final inspection,

The Engineer will reject any pipes or fittings which have been damaged due to handling procedure, and methods of transport and shipping which do not concur with the following: -

- Pipes should not be stacked more than three tiers high unless special precautions to avoid distortions to the pipe and damage to the coating are taken.
- Pipes and fittings shall not be dropped, or allowed to land on sharp or other objects which will cause bends, dents or damage to the coating.
- When lifting pipes and fittings special lifting hooks with curved saddles to fit the curvatures of the pipe or fitting shall be used. Alternative types of lifting hooks, clamps, or slings, may be used subject to the Engineer's approval. All such clamps or slings must be not less than 300mm wide and be such that no damage to the coating is caused.
- Suitable pillows shall be used to protect pipes and fittings under securing chains or other lashings when loads are being transported.
- Lined and sheathed pipes and fittings shall not be handled or hauled when the temperature is lower than 5°C without the prior approval of the Engineer, which will be subject to the suitability of the coating provided.

## **STEEL PIPE AND FITTINGS**

Steel pipes and fittings shall be in accordance with the American Petroleum Institute specification for High Test line Pipe, A.P.I. –standard 5 LX together with the additional clauses or amendments set out in this specification to be thickness and diameters given in Table 2.

### **Grade of steel used in pipe & fittings**

The grade of steel in the pipes and fittings shall be Grade x42 for welded pipe in accordance with Table 3.1 of A.P.I. standards 5LX, or 5LS.

### **Welding**

Pipes may be manufactured by either an electric resistance welding process or by a submerged arc welding process

Fittings shall be manufactured by an electric resistance welding process unless an alternative method is approved by the Engineer.

### **Manufacturing process**

The Tender shall at the time of tendering submit full details of the manufacturing processes he intends to use, which shall include but not be limited to: -

#### **Type or brand of steel**

Welding process, or extrusion process. The welding process shall include: -

Type and size of electrodes number of beads and rate of deposition of weld metal, and standard to which welding rods will be supplied if not the American National Standards Institute specification ANSI W3. 1-1973.

Electrical characteristics.

Weld position and direction of welding

Time lapse between passes.

Cleaning process and preparation of surface of steel before application of coating.

Specifications of all lining and sheathing materials their thickness and application procedures.

### **Fittings**

Fittings shall be fabricated from pipe conforming with the requirements of this specification. In addition, 10% of all welds shall be radiographed and the exposed film made available for inspection by the Engineer. Where considered necessary the Engineer may require additional radiography and hydraulic tests on fittings on which doubtful weld inspection on results are revealed.

### **Pipes ends**

Unless stated otherwise in the Bill of Quantities the pipes shall be supplied with unbeveled plain ends in accordance with section 6 clause 6.8 of A.P.I standard 5LX, suitable for slip-on type coupling.

### **Pipe Lengths**

Pipes shall be supplied in single Random Lengths, the distribution of lengths shall apply to each consignment shipped, in accordance with A.P.I standard 5LX 6.5, In addition 1% of all the pipes shall be to be tolerances specified in Table 2 over their whole length. Each pipe shall be supplied with one slip-on type coupling. Straight pipes of specified lengths shall be constructed as fittings.

### **Inspection & Testing**

Inspection and Testing shall be carried out as specified in APL standard 5LX.

Preparation of surfaces before

### **Sheathing or Lining**

Immediately prior to the application of priming material the surface of the steel shall be completely dry and free from contamination by oil, grease, dirt or other deleterious matter.

The method used by the contractor to prepare the surface of the steel and the degree of cleanliness and roughness of the surface shall be subject to the approval of the Engineer.

Details of the method proposed shall be submitted with the tender.

If necessary, the pipes shall be cleaned of oil, grease or wax by means of immersion in a bath of 10% by weight solution of sodium hydroxide at a temperature of at least 50° or other method approved by the Engineer.

Steel surface shall preferably be blast cleaned generally in accordance with the provision of British standard specification BS. S 4232: 1967. The surfaces shall not be less than 'first quality' as defined in British standard specification B.S 4232: 1967.

### **Lining and sheathing**

All pipes shall be protected internally by lining and externally by sheathing in accordance with this specification.

Tenders may propose bitumen (asphalt) or coal tar enamel for lining and sheathing and shall state in the Bill of Quantities the type of sheathing and lining proposed. The same enamel shall be used for both lining and sheathing.

#### **Coal Tar Enamel and Premier**

Coal Tar enamels for lining and sheathing, and primers for use with bitumen asphalt enamels, shall be in accordance with the "Normal Enamel" specified in AWWA standard 0203-73. The Tender shall provide full technical details of the materials to be used with his Tender.

#### **Bitumen Asphalt Enamel and Primer**

Bitumen asphalt for lining and sheathing, and primers for use with bitumen asphalt enamels, shall be in accordance with the materials specification contained in BS 4147: 1973. The Tender shall provide full technical details of the materials to be used with his Tender.

#### **Priming**

Immediately following the preparation of the steel surfaces primers shall be applied to the pipes and fittings in accordance with the procedures specified in AWWA standard C203-73.

All primers shall have good spraying and brushing properties and a minimum tendency to produce bubbles during application. The primer shall dry hard to the touch when applied as recommended. Full details of the proposed primer shall be submitted with the tender.

Primers shall produce an effective bond between the metal and subsequent coating of enamel. They shall contain no benzoil or other toxic or highly volatile solvents and no added pigments or inert fillers, or other substances and shall show no tendency to settle out in the container.

The primer shall be thoroughly agitated in the drums before use and care shall be taken to ensure that loss of the volatile portions of the primer has not caused thickening and that the primer is not contaminated by water, dirt or any other substances. Any primer so deteriorated or contaminated shall be destroyed.

Other methods of obtaining an effective bond between the metal and coating or enamel without the use of a primer including pre-heating the pipe shall be subject to the approval of the Engineer.

#### **Primers and Enamels for Testing**

If required by the Engineer the contractor shall submitted samples (not less than 20 kgs of enamel and 2.5 litres of primer) for testing and approval before use.

If required by the Engineer the contractor shall arrange to carry out common tests to determine the properties of the materials he proposes to use, to the satisfaction of the Engineer.

#### **Internal lining**

The contractor shall ensure that the internal surfaces of the pipe are clean, dry and free of dust before the application of the lining.

The application of the enamel to the inside surfaces of all pipes other than fittings shall be by centrifugal casting by either the Trough method or the Retracting weir or Feed Line method.

The temperature of the enamel on application shall be as recommended by the supplier of the enamel and the contractor shall provide the Engineer with a copy of the supplier's instructions and recommendations for the application of the enamel. Care shall be taken to ensure that it is at no time heated above the maximum temperature recommended. In the event of the enamel being subjected to a temperature above that recommended it shall not be used but shall be discarded.

During application of enamel the pipe shall be revolved at the speed best suited to produce a smooth glossy lining of uniform thickness. Finished enamel lining shall be free from wrinkles, sags, blisters or blow holes.

The thickness of the lining shall be 2.4mm and allowable variation in thickness shall not be outside the range 2 to 4mm except within 25mm of the longitudinal weld where the allowable maximum thickness will be 5mm.

All pieces of lined pipe in which excessive rough areas appear or other irregularities exist which the Engineer considers unsatisfactory shall be stripped of the entire lining and relined.

The lining shall be carried up to the end of the pipe where a cut off of approximately 45° shall be cleanly made while the enamel is plastic. The angle, for stopping the internal lining 150mm short of pipe ends.

All kettles shall be equipped with an efficient thermometer and adequate screens to prevent particles of foreign matter or other deleterious materials from appearing on the finished lining.

All materials rejected by the Engineer, or his appointed inspector by screens to prevent particles of foreign matter or other deleterious materials from appearing on the finished lining.

All materials rejected by the Engineer, or his appointed inspector by reason of prolonged heating, overheating, charring, contamination, etc., shall be dumped and on no circumstances reheated for re-use.

At all times during cold weather when the pipe temperature is below 8°C or during rainy or foggy weather when moisture tends to collect on cold pipe enameling shall be preceded by warming the pipe. Warming shall be done by any method which will heat the pipe uniformly to the recommended temperature without injury to the primer. Steel temperature of the pipe shall not exceed 70°C.

### **External sheathing**

The contractor shall ensure that the pipe is clean dry and free of dust before the application of the first flood coat of bitumen asphalt enamel or coal tar enamel. This shall be applied as soon as possible after the priming has dried. In the event of primer having gone 'dead' the contractor shall strip the dead primer and then re-prime the pipe. The contractor shall apply the first flood coat of enamel and while the enamel is still hot the pipe shall be wrapped with fibre glass inner wrap. This shall be wound on with enough tension to ensure that it is fully saturated but care shall be

taken to avoid pulling it through the enamel to the metal. The overlap of the inner wrap shall not less than 25mm and the thickness of the first coat shall be 2.4mm with an allowable tolerance of + 0.8mm.

The pipe shall then receive a second flood coat of enamel and whilst this is still hot shall be wound with outer wrap. Alternatively, the second coat of enamel may be applied simultaneously with the outer wrap. The overlaps of the outer wrap shall be 25mm and the thickness of the second coat shall be not less than 0.8mm.

The total thickness of the sheathing shall in no place be less than 2.4mm.

After sheathing the outer surface shall be given a coat of water resistant white wash as specified in Clause 3.18.

The inner wrap shall be a grass fibre tissue or alternatively a woven glass fibre mat to the approval of the Engineer. The composition of the fibre monofilaments and physical and chemical characteristics of the woven mat shall be similar to those specified for the Grass Fibre tissue and be in accordance with Sc.A.2.2 of AWWA std. c203-73.

The outer wrap shall consist of a glass fibre tissue or mat as specified in Clause 3.16.6 saturated with plasticized coal tar or bitumen (asphalt) enamel. The resultant outer wrap shall be uniformly flexible and with random pin holes to facilitate the release of the grass.

Faces of flanges shall be left bare, but the periphery and backs of the flanges shall be coated with primer only.

### **Lining and sheathing of fittings**

Fittings shall be cleaned primed and coated to give results which are equivalent to similar work on straight pipe sections. If the shape precludes spinning internal surfaces shall be doubled coated by application of enamel with hand daubers. The brush strokes of enamel shall be made in the direction of flow. All air brush strokes shall overlap to form a continuous coating.

### **White wash**

A white wash finish shall be applied to the sheathing and shall be of the following composition: -

Water	200 litres
Boiled linsed oil	4 litres
Processed quicklime	72 kg.
Salt (sodium chloride)	4.8 kg.

Lime and oil shall be slowly added simultaneously to the water and mixed thoroughly. The mixture shall be allowed to stand for not less than 3 days before it is used. A red dye shall be added to the whitewash and applied to the pipes defined in Clause 5.02

### **Holiday Testing**

All external sheathing will be tested by a holiday detector at the expense of the Contractor.



Repairs to the satisfactory of the Engineer will be allowed on those coatings having between one and five faults.

Where up to four faults occur within a single area of 400 sq.mm, these four faults are to be taken as a single fault.

The contractor shall provide facilities for the Engineer to carry out an adhesion test on the coating of up to 5% of the pipes. The adhesion test on the pipe shall follow the procedure for carrying out a peel test on test plates as described under section 2.4.4. (5) In AWWA std. C203-73. The adhesion of the enamel coating shall be such that no peeling of the coating results from such test. The coating shall be made good to the satisfaction of the Engineer, after completion of adhesion tests. The adhesion test shall be carried out over a temperature range consistent with the temperature of service conditions.

The Tenderer shall submit full details of the Holiday Detector he proposes to use, which shall be subject to the Engineer's approval, and the price for such instruments.

TABLE 1. Deflection Angles to be accommodated by Bolted Gland Couplings and flexible joints.

Pipe Diameter (mm)	700 to 550	500 to 350	300 and Below
Deflection Angle	3°	4°	5°

TABLE 2: Minimum wall Thickness for steel Pipes & Fittings

Pipe Diameter (mm)	950 to 650	600 to 450	400 to 350	300 to 200	150 and below
Thickness (mm)	7.9	7.1	5.5	4.7	3.1

TABLE 3: Tolerance on diameter for pipes refer Clause 5.02

Pipe Diameter (mm)	400 and above	350 to 200	150 and below
+ TOL (mm)	1.6	1.6	1.2
- TOL (mm)	1.6	1.2	0.8

### UPVC PIPES

Unplasticised polyvinyl chloride (upvc) pipes shall be manufactured to the latest revision of British Standard 3505: 1968 unplasticised pipe for cold water service. In the event of there being any inconsistency between the above standard and this specification, this specification, shall take precedence.

All pipes shall be supplied suitable for water works purposes for the transmission and storage of potable water (treated water) in the tropical conditions prevailing in Kenya in the Nairobi Area.

## **Joints**

The joint shall be spigot and socket of unplasticised UPVC sleeve or integral socket type and shall comply with the latest revision of B.S.4346 part 2: 1970 mechanical joint and fittings principally of UPVC. Spigot and socket joint which require a solvent cement to form them will not be accepted. Pipes spigot ends for use with rubber ring socket joints shall be cut square to the axis of the pipe, with the leading edge of the spigot chamfered to an angle of 15°.

The contractor shall include for the /and supply all lubricants necessary for making the joints.

## **Working Pressure**

Pipes shall be supplied to B.S.3505 class D or the latest edition of the Kenya standards Governing, i.e. maximum sustained working pressure of 12.0 bar (120m head of water).

## **Pipe Lengths**

The pipes shall be supplied in, straight Nominal 6m lengths.

## **Fire Hydrant Tees**

Each fire hydrant tee shall be supplied along with two mechanical couplings, complete with bolts, nuts and rubber gaskets for the flange. The flanged branch shall be 80mm N.D. and shall be faced and drilled to conform to the dimensions specified in B.S.4504: 1969 Table 16/11.

## **HDPE PIPES**

ISO 4427-1:2007 specifies the general aspects of polyethylene (PE) piping systems (mains and service pipes) intended for the conveyance of water for human consumption, including raw water prior to treatment and water for general purposes. It also specifies the test parameters for the test methods to which it refers.

In conjunction with the other parts of ISO 4427, it is applicable to PE pipes, fittings, their joints and to mechanical joints with components of other materials, intended to be used under the following conditions: a maximum operating pressure (MOP) up to and including 25 bar; an operating temperature of 20 °C as the reference temperature.

The pipes shall be manufactured from polyethylene containing only those antioxidants, UV stabilizers and pigments necessary for the manufacture of pipes conforming to this specification and for its end use, including weldability when it is possible. The pipes for drinking water shall be either black or blue or black with blue stripes.

## **Pipe Lengths**

The pipes from the diameter range of 16-110 mm are flexible and they can be wound in coils of different lengths, hence the need for fittings and time for installation can be minimized.

The pipes from the diameter range of 125-800 mm are produced in straight form pipes of 6 and 12 m length.

### **Handling and Storage**

All materials should be carefully examined during transportation and all flawed products should be identified and rejected before acceptance. If the same product is supplied by different suppliers, the products should be kept separately.

Pipes and fittings should be used through the First In – First Out (FIFO) principle, for better control of stocking rotations.

Only pipes from a known producer and with a known production date should be purchased and the pipes must be used according to the First In – First Out rule.

The blue polyethylene pipes should be kept under a cover and should not be exposed to direct sunlight until they are used. If it is necessary to keep the pipes in the open air, pipes should be covered with a sun-proof (non-transparent) covers.

In order to store the pipes properly, a levelled surface should be provided which is capable of carrying the full load, necessary handling should be used and stacking heights should be kept at a minimum and an optimum. A safe area is needed for the manoeuvre of carriages. For a proper and safe transportation, the height of the stored pipe piles should not exceed 3 meters.

If the pipes are stored in a pyramid shape, the pipes at the bottom may be subject to deformation at moist air. Therefore, the height of the pyramid stacks should not exceed 1.2 meters.

Polyethylene fittings should be kept on shelves and under a cover. The protective package and the cardboard boxes used by the manufacturer should be kept until the use of the products.

Polyethylene pipes and fittings should always be stored away from heat sources and vehicle exhausts. Polyethylene pipes and fittings should not be stored in the same place with machines that work with oil, hydraulic oils, gases, solvents and other flammable chemicals.

All the special tools and equipment used for connecting the polyethylene pipes and fittings should be kept separately and safely until used. The heating parts of the welding machines should be avoided since they can cause scratching during storage.

If it is necessary to store the pipes and fittings in the open air for a long time, they should be covered with canvas or black polyethylene in order to provide protection from sunlight (UV).

### **Installation**

For pipe installation, it is recommended that the pipes are placed into trenches at minimal depth of 45-60 cm, depending on the freezing zone. The installation of the pipes may be performed at air temperature of -5°C.

The polyethylene can be connected in different ways. The most frequent are:

- Butt welding
- Electro fusion welding
- Mechanical connecting

### **FIRE HYDRANT EXTENSION PIECES**

Fire hydrant extension pieces shall be double flanged. The flange shall conform to B.S.4504: 1969 Table 16.

### **STEEL TEES FOR PVC/STEEL**

Steel tees shall be plain-ended in accordance with specification B.S.534:1966 fig.10 dimensions shall be as shown in Table 5. Each Tee shall be supplied with couplings for the main line and for the branch.

### **FLANGED SPIGOTS**

Flanged spigots shall be faces and drilled to conform to the dimensions specified in B.S. 4504: 1969 Table 16.

### **STEEL FITTINGS**

- (a) All fittings shall conform to B.S 534:1966 either welded or seamless.
- (b) All fittings where specified shall be plain ended and suitable for use with flexible mechanical couplings.
- (c) The grade of steel used shall comply with the requirements of BS 3601.
- (d) The fittings shall be protected internally and externally as follows: -
  - Surface preparation in accordance with Clause 5.2 BS 534:1966
  - External protection in accordance with clause 5.4.1. of B.S 435:1966 followed by a coat of Non-stick white wash.
  - Internal protection in accordance with Clause 5.5.2 of BS 534:1966.
- (e) The fittings shall be supplied with unbeveled plain ends suitable for slip on type couplings. The fittings shall be free from indentation, projections or roll marks for a minimum of 150mm from all plain ends to permit a tight joint with the rubber gasket type couplings.

### **JUNIOR COUPLINGS**

All junior couplings shall be Pvc and shall be manufactured to comply with B.S 4346: part 2: 1970

### **MECHANICAL COUPLING**

The couplings are required for joining plain ended pipes of various sizes and shall be Viking Johnson or similar as approved by the General Manager and shall conform to

BS 534. The middle ring (sleeve) and follower rings (flanges) shall be of such material and dimensions that they are not stressed beyond half yield stress of the material when the pipes connected by them are subjected to hydrostatic test pressure of 22kg/cm<sup>2</sup>.

Except where stated otherwise the middle ring (sleeve) of the coupling shall be provided with a suitable pipe stop (center register).

The joint rings shall be of first grade rubber material and the physical properties of the mix shall meet the requirements of BS 2494 or similar specification approved by the General Manager.

The bolts used shall be of mild steel suitably protected against corrosion or aluminum bronze, stainless steel, or other material approved by the General Manager. All couplings shall be supplied with a sharp coat of quick drying primer which is compatible with a finishing protective coat of black bitumastic paint

### **FLANGE ADAPTORS**

Flange adaptors shall be drilled to conform to the dimensions specified in BS 4504:1969 Tables for nominal pressure of 16 bars (1 bar = 100 N/M<sup>2</sup>). These flange adaptors should be suitable for use with sluice valves manufactured to comply with BS 1218 or BS 5163.

Flange adaptors shall be drilled to conform to the dimensions specified in BS 4504: 1969 table 16/11 and shall be compatible with fire hydrants manufactured to BS. 750: 1964 type 2.

### **G.I FITTINGS**

All specials and fittings with the exception of barrel nipples shall conform to BSS 1740. they shall be galvanized in accordance with clause 2.7 of BS 1387: 1967.

### **BARREL NIPPLES**

Barrel Nipples shall conform to B.S.S. 1387: 1967.

### **STOP COCKS**

Screw down stopcocks shall conform to BSS 1010/1959. They shall be supported with ground faces and srutch head with the ends screwed BSP Female. They shall be of a heavy pattern.

### **G.I PIPES**

All Galvanized Iron Pipes shall conform to British Standard Specification No. 1387: 1967 medium grade.

The pipes shall be supplied in random length between 4 meters and 7 meters long with an average length of approximately 6 meters.

Each pipe length shall be provided with two sockets one at each end. The threads of all pipes and sockets shall be effectively covered with a good quality, long lasting grease or other suitable compound.

The Contractor shall allow for inspection by an Inspector appointed by the General Manager to attend to all tests to be carried on the material supplied in accordance with appropriate BS. The Contractor shall furnish the general manager with the

original copy of the manufacturer's certificate confirming that all the pipes comply in all respects with the requirements of the B.S.

### **FERRULES**

The ferrules are required to provide a connection between a Talbot or similar pipe saddle, strapped on to the water main and a small bore service pipe, the flow through the ferrule shall be controlled by an inner plug operated by a "T" head spanner. The ferrule shall be manufactured from brass to B.S 218 and designed such that there shall be no leakage of water at any joints or any other part. The normal working pressure is not greater than 90m head of water. The ferrule inlets are to be screwed male BSP thread and the outlet screwed female BSP thread.

### **SLUICE VALVES**

Sluice valves shall be suitable for water works purposes in tropical conditions, and shall be manufactured to comply with BS 1218 or BS5163 for the required size.

Sluice valves shall be suitable for a working pressure of 9.15 kfg/cm<sup>2</sup> (class 1 of BS 1218).

All sluice valves shall be double flanged, with flanged faces and drilled to conform to the dimensions specified in BS 4504/1969 tables for NP 16.

Spindles shall be of the non-rising type and screwed so as to close the valves when rotated in the clockwise direction. The direction of closing shall be clearly cast on the valve cap.

Valve shall be opened and tested in accordance with the procedures set out in appendix '19' of BS 1218

All sluice valves shall be manual operating type.

All sluice valves to have stamped or inscribed lettering giving the following information:

Manufacturer's trade mark or name.

The working pressure in meters head of water for which the valve is suitable.

The normal size of the valve in metric units.

All valves to be provided with cast iron spindle caps conforming to the dimension indicated in fig.6, table 6 and 7 and secured by bronze set screw fig; 4; all of BS1218. The direction of closing the caps to be indicated on the top.

### **AIR VALVES**

Air valve to be 'small' or single type orifice valves for the discharge of air during operation of the pipeline. All air valves shall set automatically.

All valves shall be tested to be drop tight at the required maximum working pressure. The supplier shall either test the valve operation by bleeding air into the test apparatus or produce other evidence of satisfactory operation to the Engineer.

Each single orifice air valve shall be complete with isolating cock.

Each air valve shall be marked with the cast-on or stamped lettering, giving the following: -

- Manufacture's name or trade mark.
- Working pressure in meter head of water.
- Size of the air valve in millimeter

Each air valve shall be suitable for a working pressure of not less than 100m head of water (i.e., 9.15 kgf /cm<sup>2</sup>).

### **FIRE HYDRANTS**

Fire hydrants shall be suitable for a maximum working pressure of 9.15kgf /cm<sup>2</sup>. Tested in accordance with the British Standard.

Fire hydrants to be according to British Standard (BS750, 1964 type2) screwed down with loose internal valve.

Inlet flanges to fire hydrants shall be 80mm DN and be faced and drilled to conform to the dimensions specified in BS4504, 1969 table 16/11. The outlet piece shall be screwed 2 1/2 "diameter BS 750 round threads. The outlet will also be provided with a cast iron cap.

The fire hydrants shall be capable of passing a minimum flow of 34l/sec.at a constant running pressure of 1.7 kgf/cm<sup>2</sup>.

### **GRAZED VITRIFIED CLAY PIPES.**

G.V.C pipes shall comply with B.S 65 and 540.

The following classes of strength will be required.

100 and 150mm dia		225 and 300mm dia
Class 1	18.36 KN/M	18.36 KN/M
CLASS 11	19.72 KN/M	24.48 KN/M

These figures are to be achieved when tested in accordance with the crushing proof test of B.S. 556.

### **COPPER TUBE**

Copper tube shall comply with BS 659 Table 1

### **POLYTHENE PIPE AND COMPRESSION JOINTS**

Polythene pipes shall comply with BS1972: 1967. Compression joints shall comply with BS864 and shall be gunmetal to BS1400 (L.G.2) or other material no subject to dezincification as approved by the Engineer.

### **NUTS, BOLTS AND WASHERS**

All nuts and bolts for use with pipelines shall be manufactured to B.S 4190 'ISO metric black hexagonal bolts, screws and nuts'. They shall be threaded in accordance with the B.S.3643 'ISO metric series'

Part 2 'limits and tolerances for coarse pitch series threads'.

Each bolt shall be provided with a nut and two thick Washers.

All rag bolts and fixing bolts, nuts and washers shall be sherardised or galvanized.

### **STEP IRONS**

Step irons shall be galvanized malleable cast iron and shall comply with B.S 1247 and be of the general purposes of precast concrete manholes pattern as applicable. The tail length on general purposes type shall be 230mm.

### **MAN HOLES COVERS**

Unless otherwise detailed manhole covers shall comply with B.S. 497 and be to the shape and sizes indicated on the drawings or specified by the Engineer.

### **WROUGHT IRON**

All wrought iron shall be of the 'Best Yorkshire' grade to Bs. 858 and where specified or shown on the drawing, wrought iron fabrications shall be heavily galvanized, mild steel will not be accepted where wrought iron has been specified.

### **BUILDING STONE**

All building stone shall be capable of withstanding when wet a crushing stress of 1.4kg/sq. mm. The source of stone shall be approved by the Engineer and stone supplied there from shall be free from Magadi, over-burden, mudstone, cracks, sandshoes, veins, laminations or other imperfections. The stone shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surface, to the size specified. For exposed stonework the maximum permission variation of any of the specified dimensions shall be 6mm provided to cut stone, supplied as 'rock face, stone may be hammer dressed on one face only, or on one face and once end, if in other respects it conforms with this specification. Stones shorter than 375mm will not be accepted.

Unless the engineer allows otherwise the contractor shall at his own expense provide and dress four 100m cubes of stone for testing.

The stone shall be sound when tested in accordance with B.S. 1438: Media for Biological Percolating Filters, Appendix B, (sodium sulphate soundness test) accept that:

The treatment shall be repeated for 10 cycles only; and

The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

### **BLOCK WORK**

Present hollow concrete blocks shall be of modular dimensions and of the thickness stated respect the blocks shall conform to B.S. 2028 Type "A".

All blocks shall be handled and stacked with care. The blocks shall be staked protected from rain by a cover and in such a way that air circulates around them. No broken block or blocks of improper quality shall be used.

All block work shall be bonded pointed and uniformly bedded in true horizontal courses in cement mortar and built true to line and profile. Block work shall be carried up evenly and in regular stages and no part shall be raised more than 1m above any other part of block work.



## **FENCING**

### **ERECTION**

As soon as the contractor is placed in possession of any part of the site he shall immediately erect fencing on the boundaries of the land where shown on the Drawings. In places where permanent fencing cannot be erected immediately, or where no one is required, the contractor shall, as directed by the Engineer, erect, and when and where required, re-erect and maintain temporarily fencing as is necessary for the proper protection of the works.

### **ACCESS**

Provision shall be made in temporary fencing for access, where directed by the Engineer, for the use of owners, tenants and other occupiers of the adjacent lands. Temporary fencing shall remain in position until it's replaced by permanent fencing or completion of the whole of the works unless the Engineer permits its earlier removal.

### **MAINTENANCE**

All fences shall be regularly inspected and maintained and defects being made good immediately they are noticed by or brought to the attention of the contractor. The contractor shall be responsible for all wear and tear for fencing how so ever arising until the construction of all other works has been completed, when the permanent fencing shall be handed over in sound condition, and the temporary fencing shall be removed.

### **TEMPORARY FENCING**

Unless specified otherwise on drawings or directed otherwise by the Engineer temporary fencing shall be post and wire fencing to B.S 1722 part 3 type SW48 using plain wire and round wooden posts, or an alternative approved by the Engineer which shall not be inferior. Where temporary fencing has to be removed temporary for the execution of any part of the works it shall be reinstated as soon as possible and in the meantime the gap in the fencing shall be patrolled to ensure that no unauthorized closing of the fence line occurs, and that no animal stock escapes from adjoining lands.

### **CHAIN LINK FENCING ON CONCRETE POSTS**

#### **1.1.53 Standard**

In general, all fencing is to be in accordance with B.S. 1722, prt 1: 1963.

#### **1.1.54 Reinforced Precast Concrete Posts.**

##### *Straining Posts*

These can be 130mm square in section and 3.280 m along overall wit 600mm top length cranked at an angle of 45 degrees to the vertical, slightly rounded at external and internal cranked angles and also at the top end. The post is to be reinforced with 4 N0. 8mm diameter milt steel bars bound by no. 12 S.W.G. Wire stirrups placed at 130 mm intervals, and suitably hold for stretcher bolts or stirrup wires. The post will be notched twice to receive ends of raking strips. Two faces of the post will have two

sets of galvanized mild steel angle iron cleats held by galvanized 25mm by 4mm G.M.S. flat iron stretcher bar and G.M.S. bolts and nuts.

The stretcher posts shall be provided shall be provided at all ends and corners, at changes in direction or acute variation in levels and at intervals not exceeding 69metres in straight length of face. The post shall be set in the ground to a depth of 0.75m in a 450mm<sup>2</sup> hole which is to be backfilled with class 15 concrete.

#### *Special Corner Posts*

These shall be provided at all corners. The posts shall be 130mm square, generally as straining posts, but the top cranked length and angle shall be altered to suit the corner angle to allow the barbed wire to run straight and level. The posts shall be set in the ground to a depth of 0.75m in a 500mm square hole which is to be backfilled with class 15 concrete.

#### *Struts or Stays*

The raking shall be 100mm square in section and 3000mm long overall with one end splayed to suite the notch in the strainer post. The strut is to be reinforced with 4 NO. 8mm dia. mild steel bars held by NO. 12 S.W.G. wire stirrups placed at 130mm intervals. The strut will be suitably hold for fixing by G.M.S, bolts through the strainer post. The strut will be set in the ground in a hole 300mm. wide by 850mm. long by 70mm deep which will be backfilled up to a depth of 400mm. With class 15 concrete and the rest with good earth.

### **CHAIN LINK FENCE**

#### **1.1.55 Line and Level**

The line shall be so erected that no completion it is truly on the boundary line of the plot. The top of the fence shall follow a general profile of the ground as agreed by the Engineer. The fence shall be embedded up to a depth of 80mm underground which will be graded to a general profile prior to the erection of the fencing. chain link fencing shall comply with B.S.1722, part 1, Clause 4 in general, and shall be galvanized for 50mm mesh, not less than no. 101/2 S.W.G. and shall be of type L.C. 72.B.

- Fittings for securing the fencing to the P.C.C. posts shall be in accordance with B.S.1722 part 1, Clause 14 and shall be heavily galvanized.
- Line wire shall be No.91/2 S.W.G. galvanized wire.
- Stirrup wire shall be No. 121/2 S.W.G galvanized wire.
- Tying wire for securing the chain-link fencing to the line wire shall be galvanized No. 141/2 S.W.G.

In general, all chain link in general all chain link fencing shall be fixed according to B.S.1722, part 1 clause 22.

### **BARBED WIRE FENCING ON WOODEN POSTS**

- *Timber*; All timber used for fencing shall be well seasoned, straight grained red cedar.

- *Straining posts* shall be 2.60m long and 0.15m in diameter. This shall be firmly embedded in ground and shall be provided at all ends, corners and acute changes in direction or level, and shall be erected at intervals not exceeding 100m in straight lengths of fences.
- *struts* shall be 0.10m in dia, and 3.0 m long secured to the straining post at an angle of 45° with a bird's mouth rebated joint spiked through with at least 2 NO. 45mm galvanized iron nails in previously drilled holes. The foot of the strut shall be sunk into the ground to a depth of 0.75m and the roots shall bear against the undisturbed ground. There shall be one strut to each lining of wires leaving the post.
- *Intermediate posts* shall be 2.40m long and of 100mm dia, and either pointed at one end and driven into the ground to a depth of 0.60m or sunk into the ground excavating a hole and backfilling. These shall be provided at intervals not exceeding 5m between strainer posts, except where intermediate posts occur.

### **FENCING WIRE**

The fence shall consist of six strands of wire spaced at 0.286m intervals, the bottom strand being 0.30m and the top 1.75m, from the ground level or such other spacing as directed.

The top wire shall be No.12 S.W.G. two ply galvanized steel wire with four point barbs 150mm apart. The lower 5 strands shall be either the same as the top wire, or plain 8 B.S.W.G. galvanized wire as set out in the bill of quantities. Binding wire, where used shall be number, 12 B.S.W.G galvanized and the staples shall be 38mm No. 8 S.W.G galvanized. The wire shall comply with B.S.1052 and the galvanizing to B.S.443, the minimum breaking strength for plain No. 8 S.W.G. steel wire shall be 1100 1B. and for two ply 12 S.W.G. barbed wire 950 1BS.

Each wire shall be strained tight by a means of at least one ratched winder or other approved strainer and the end made fast by two complete turn round the strainer post and by two staples driven tight. Each wire shall then be attached to the Intermediate post and dropper by a single staple or binding wire.

fencing shall be measured per meter run and the rate shall include for all material cutting to waste, labour, tools and transport, excavation and backfill and maintenance.

## **DRAINAGE**

### **8.1 GENERAL**

All drainage works shall comply with the Building code of the Republic of Kenya, and any local byelaws.

8The contractor shall bring to the Engineer's attention in writing any part of the works which he considers does not conform to such code or byelaws. If the Engineer considers that such part of the works does not conform he will issue an instruction.

### **8.2 CAST IRON PIPES AND FITTINGS**

Cast Iron pipes sewerage and drainage shall comply generally with BS 416 medium grade, and fitting with BS 1130.

### **8.3 EXCAVATION, ETCETERA**

The contractor shall adhere to the requirements of section 4 (pipelines) and to section 2 (Earthworks) as applicable.

### **8.4 CONCRETE PIPES AND FITTINGS**

Concrete pipes and fittings shall comply generally with BS 556 and shall be obtained from an approved manufacturer. The pipes and fittings shall have a smooth internal surface and the internal dimensions shall be true and regular and shall permit an even invert to be laid.

### **8.5 LAYING AND JOINING CONCRETE PIPES**

Before any length of pipes is laid all pipes shall be stood or slug vertically along the sides of the trench and be "ring" with a wooden mallet. Any damaged or cracked pipe shall be rejected.

Immediately before each pipe having a spigot and socket joint is laid a gasket of 12mm spun hempen tarred yarn shall be looped around the spigot end which shall then be firmly pushed home into the socket of the preceding pipe. The yarn shall be cut to such a length as to form a butt joint at the top of the pipe. The yarn shall be caulked into the joint with a caulking tool particular care being taken to ensure that the spigot end is held truly central in the socket. A jointing mixture of cement mortar as specified shall then be well forced into the joint with fingers. The compound shall be finished square with the end of the socket with trowel. No joint shall be cemented until the gaskets of the next three joints in advance have been completed.

In the case of concrete pipes with ogee joints the joints shall be buttered with cement mortar before pressing the pipes together and then flush point internally and externally.

Any jointing material which gets inside the pipes when a joint is being made shall be removed by "badger" which must be kept in the pipes during the time they are being laid. The badger shall be pulled forward and the surplus jointing each pipe and before immediately after the laying of each pipe and before the next one is placed in position so that the barrel of the pipe is left perfectly smooth and clean.

Joints shall be cured by covering with sacking which shall be kept moist until the joints have completely set.

Pipes shall be laid true to line by means of a line stretched along the side of the pipes and true to level by means of a straight edge 4m in length kept inside the pipes and pulled forward to pegs boned in at suitable intervals between sight rails set to the proper levels.

#### **8.6 PIPES ON GRAVEL BEDDING**

All concrete and asbestos cement pipes for drainage sewerage and ducts unless otherwise ordered shall be laid on a 10cm thick granular bedding brought up to at least the horizontal diameter of the pipe. The bedding materials shall consist of broken stone or gravel passing coarse sand in the proportions of 2 parts stone or gravel to 1-part sand.

Course grade gravel all-ballast or screened selected excavated material may be used for the granular bedding if it is of similar grading to that specified above and to the approval of the Engineer.

Where directed by the Engineer UPVC pipes shall be laid on a 10cm thick lump free bedding materials, which shall consist of particles passing a 5mm sieve but retained on a 1mm sieve.

The contractor shall include in his prices for the extra excavation and for the bedding material.

#### **8.7 CONSTRUCTION OF CHAMBERS AND MANHOLES**

Chambers shall be constructed as shown on the detailed Drawings in the positions shown on the drawings or as directed by the Engineer.

Step irons shall be built into the walls as the work proceeds and shall be spaced 30cm. Apart vertically and 30cm, horizontally, center to center.

The invert channels shall be laid in precast concrete channel to the fall of the pipeline and joint in cement mortar. All branch drains shall be connected to the main drain channel with half-channel bends of a proper angle and radius to lead with the run of the main drain channel the bends being as "slow" as possible. The invert of the branch drain shall where possible be at least 8cm, above the invert of the main satisfactory lead with a precast concrete channel the Engineer's representative may direct the invert channel to be formed in concrete and rendered.

Benching shall be finished and so formed that the top grades down at a one in six slope to the crown level of the outgoing pipe and the sides of the invert channel are vertical from this level down to that of center line of the pipe. Special care shall be taken to produce a perfectly smooth finish all over and to ensure the uniformity of slope of the benching top and that proper clearance is given round valves penstock and other fittings.

Manholes and chambers for sewers and drains shall be absolutely watertight. Particular attention shall be paid to the joint between incoming and outgoing pipes and the in-situ concrete portion of the manhole walls.

#### **8.8 STEP IRONS**

Step irons shall be of galvanized malleable iron and comply in all particulars to BS 1247.

## **8.9 FIXING OF INSPECTION COVERS AND MANHOLE COVERS**

All manhole and inspection covers shall be set in cement mortar or built into concrete slabs as shown or directed to the correct levels camber or falls.

## **8.10 TESTING DRAINS, MANHOLE, ETC**

All drains and manholes shall be watertight and clean throughout and shall be tested by the contractor under a minimum head of 10m in the presence of the Engineer's representative during the progress of the work at the completion of same and if so instructed immediately prior to the payment of the retention money or at any time as the Engineer may direct.

The contractor shall provide all labour water stoppers bends and other appliance necessary for conducting tests and no pipelines or other work shall be covered up until they have been seen and approved by the Engineer's Representative.

Should the pressure fall during a test the contractor shall locate the leaks and make them good after which the pressure shall be re-applied and the process repeated until the drains are satisfactory. All re-testing shall be at the contractor's sole expense.

In every case the water used for testing the pipes shall be left in the pipes until they are covered with earth or other filling to the top of the trench or a depth of at least 20cm over the top of the pipes and until permission is given by the Engineer's Representative for the water to be released. If after the Engineer's representative has approved the pipes and has given permission for the trenches to be refilled the pipes become damaged and lose water from any cause and/ or admit subsoil water the pipe shall be uncovered and the defect made good and the pipes retested as before to the satisfaction of the Engineer's Representative.

## **8.11 RAINWATER PIPES AND GUTTERS**

PVC rainwater down pipes, fittings and gutters shall comply with BS 4576.

Cast iron rainwater down pipes shall be of medium grade and comply with BS 460.

## **8.12 GRADED GRAVEL FOR DRAINS**

Graded gravel surround to drains shall be clean washed stone or crushed hard rock graded between 5mm and 20mm, and shall be approved by the Engineer. The contractor shall not vary the source or quality of the gravel without the Engineers approval.

## **STRUCTURAL STEELWORK**

### **MATERIALS**

All structural steel shall conform to the requirements of BS 4360, and shall be grade 43A for mild steel, and Grade 50B for high Yield steel.

Except where specified by the Engineer, all bolts and nuts shall comply with BS 3692 except for high strength Friction Grip bolts which shall comply with BS 4395.

Mild steel electrodes shall comply with the requirements of Bs 639, and High Yield steel with BS 2540.

### **SHOP WORK**

Where requested by the Engineer's Representative tow copies of all detailed fabrication drawings, erection drawings etcetera of structural steelwork shall be submitted for approval by the Engineer's Representative. Three copies of 'as fabricated" drawings shall be submitted for issue to the erecting site, together with three copies of all bolt schedules and erection instructions.

All structural steel fabrication shall confirm to the requirements of BS 153, except for fabrication for building which shall conform to BS 449. The use of High strength Friction Grip Bolts shall be in accordance with BS 3294.

All structural steelwork shall be fabricated using welded joints where possible for shop joints, and bolted joints for field assembly. Cleats for alignment and for connections shall be fitted to all stanchions at joints with beams.

All steel work shall be marked for identification of both the members and the joints. All members joined at one joint shall bear the same joint reference at the joint, as well as a separate member reference.

Marking shall be applied legibly and shall be such that it will be capable of withstanding all the effects of transportation, storage, and erection. Furthermore, it shall be non-injurious to the painting or other surface protection system provided.

Bolts, Nuts, washers, and other small parts shall be packed in sacks or crates for dispatch to the site. All packed separately, such that no sack or crate weighs more than 50kgs, and contains less than 100bolts or other parts.

### **PROTECTION OF STEELWORK**

All steelwork shall be protected in the following manner: -

Surface preparation: unless otherwise specified all surface preparation shall be by blast cleaning using compressed air, high pressure water or airless methods. Cleaning shall normally be to second quality finish comparable with Swedish as 2 ½ standard. Abrasives shall be such as to produce a surface roughness in the steel cleaned surface shall be undertaken within 4 hours of completing the cleaning process.

As an alternative to blast-cleaning, where appropriate, an approved pickling process (similar to the Footer process) may be used. In this case a pre-fabrication primer shall be applied to the surface while it is still warm and after it has completely dried.

Where approved or otherwise specified, mechanical or flame-cleaning methods may be employed for surface which are not appreciably rusted. Cleaning shall be comparable to Swedish B.ST. 3 standards.

Metal coatings: Shall comprise either hot dip galvanizing conforming to the requirements of B.S 729 pt. 1 or sprayed aluminum or zinc coatings conforming to the requirements of B.S 2569 pt 1 as may specified. In the case of dip galvanizing the metal shall be applied at the rate of 2 oz/sq. Ft. (610 g/m<sup>2</sup>) of surface area in a uniform covering 4 mills (100 microns) thick. In the case of sprayed metal coating the metal shall be applied to the previously blast-cleaned surface to give a covering of 4 mills (100 microns) nominal thickness.

For small items, such as bolts and threaded parts where metal coatings are specified, sherardising shall be carried out to give a covering of 1.2 oz/ft<sup>2</sup> (330 g/m<sup>2</sup>) of surface area.

Shop painting: Painting shall not be undertaken when the temperature is less than 30oc or when the Relative Humidity is greater than 85%

Contact surfaces to be connected by high strength friction grip bolts shall not be painted. Where surfaces are subsequently to be welded, galvanizing, metal spraying, or shop painting shall be terminated' within 75mm of the areas to be welded. Machined surfaces shall be not painted, but shall be protected against corrosion by means of a rust-inhibiting coating which can be easily removed on site or is not detrimental to the jointing condition if left in position. Other steel surfaces which, prior to dispatch are to be brought together in permanent contact with each other, shall after cleaning be primed and the work bolted up while the paint is still wet. Finishing paint shall be applied to the connected joint.

This does not apply to pre-fabrication primers.

Unless otherwise specified all painting set out in sub-clause (d), with the exception of the final finishing coat, shall be carried out in the shops.

Protective paint systems: The following sub-clause establishes the requirements for normal work. Where a particular specification relating to any particular work is in conflict with this sub-clause the requirements of the particular specification shall prevail.

Immediately after cleaning, those surfaces which have been prepared by blast-cleaning or picking shall be treated with an approved pre-fabrication primer. After fabrication, a zinc-rich primer (the metallic content of which shall not be less than 85%) shall be applied in one coat. Finishing coats (one of which shall be applied on site) shall consist of the following: - For normal conditions- a high build system – consisting of two coats of chlorinated rubber or epoxide-resin paint shall be applied in equal thickness of 5 mills (125 microns) each. For submerged or partially submerged conditions- a high-build paint system shall likewise be used, but shall consist of two coats of epoxy-pitch paint of similar thickness.

Those surface which have been metal coated, and are required to be painted in addition shall first be treated primer shall be such that its phosphoric acid content has been adjusted for etch-priming purposes. This shall be followed by one coat of Zinc-chrome primer. Unless otherwise specified the finish shall consist of two coats of



lamellar-pigmented paint, either micaceous iron oxide or aluminum as directed, except where aggressive, submerged or partially submerged conditions prevail, when the finish shall consist of two coats of epoxy-pitch paint applied in equal thickness of 5 mils (125microns) each.

Those surfaces which have been mechanically or flame-cleaned shall be brush-primed with one coat of red lead or calcium plumbate paint and finished with two coats of micaceous iron oxide or aluminum paint as directed.

## **SITE WORK**

The contractor shall be responsible for storage on site of all materials, and any necessary sorting, and for setting out the works, provision and casting in of all holding down bolts, bedding of base plates, erection, and field painting and any other work reasonably to be inferred from the contract documents.

Handling, stacking and storing: Handling, stacking and storing shall be such that damage and undue stress will not be incurred by the steel work. In this respect all steel beams, stanchions and joints shall be supported on the major axis of the section. Transportation and handling of sections on their side is therefore prohibited. Steel work shall be stored clear on the ground soil to prevent contamination. All small items, including bolts, nuts and washers shall be stored in a lockable container or room.

All quantities of materials shall be checked against the schedules as soon as possible and any deficiency made up without any delay.

*Setting out:* positioning and leveling of all steel work, plumbing of stanchions and the placing of every part of the structure with accuracy shall be in accordance with the approved drawings and to the satisfaction of the Engineer.

*Security during erection:* During erection the work shall be properly bolted or otherwise fastened and braced as may be necessary to ensure that all loads occurring or likely to occur during the erection period whether from equipment, plant or wind are adequately provided for and, this provision shall continue until such time as the floors, structural walls or other permanent bracing or fixings are in position.

*Base-plate supports:* prior to steel erection, all concrete foundations and supports for stanchion base-plates shall be checked for line and level, and holding-down bolts shall be properly located.

*Cleaning of steel work:* base plates and all steel-work shall be properly cleaned prior to erection. Surfaces to be brought in contact by HSFG bolts shall be clean and free of rust, paint or grease or any other substance likely to impair the efficiency of the connection.

*Erection:* permanent connections shall not be completed until as much of the structure as will be stiffened thereby has been properly aligned.

Bedding of stanchion bases shall not be carried until a sufficient number of bottom lengths of stanchions have been properly lined, leveled and plumbed and a sufficient number of floor beams are in position to establish the accuracy of the work. Temporary steel wedges shall be used to support the stanchion bases one inch clear of the concrete support, and grout of sufficient fluidity consisting of neat Portland

cement shall be poured under a suitable head to fill completely the previously cleaned and prepared interspace. Measures shall be taken by proper air venting to facilitate the grouting operation.

Bolts shall be tightened as the work proceeds.

Where HSFG bolts are used, each bolt and nut shall be assembled with one washer under the head of the bolt and with another washer under the nut. Tapered washer shall be correctly fitted and all nuts tightened against a surface normal to the axis of the bolt. Driving of bolts is not permitted. Nuts and bolts shall be tightened on a staggered pattern and where there are more than four in any one point, they shall be tightened from the center of the joint outwards. If, after final tightening, an HSFG nut or bolt is slacked off for any reason the bolt, nut and washer shall be discarded and not used again. HSFG bolts may be used temporarily to facilitate assembly during erection provided they are not fully tightened to the specified torque condition.

The use of drifts shall be restricted to work required to match fair holes, and shall not be permitted to distort or enlarge them or damage the surfaces. Where holes are clearly out of alignment, the matter shall be reported to the Engineer for his decision as to what remedial action to adopt. Where instructions are given to enlarge the holes this shall be carried out by reaming.

Cutting of members shall not be permitted except where instructed by the Engineer.

*Site welding.* Site welding where indicated on the drawings shall be carried out by the metal-arc process. It shall be undertaken by skilled welders and shall conform to the requirements of the recognized good practice. The Engineer's Representative may require welders to be tested in accordance with a suitable recognized standard, in which case only approved welders shall be allowed. Where applicable the welding of open-web steel joints to beams shall be carried out only to ensure a sufficient means of locating the joints in position to prevent the subsequent movement. Welding and bridging rods shall be sufficient to prevent lateral displacement and buckling during the concreting operations.

*Site painting:* All surfaces to be painted shall be dried and cleaned free of all oil, grease, dirt or other extraneous matter by the use of white spirit, water or other appropriate cleaning material. Where surfaces have been damaged in transit they shall be made good to the same standard to which they were originally protected. Where as a result of such damage the metal has been bared, the paint immediately adjacent to the affected area shall be trimmed down, the affected area cleaned by wire brushing and the protective paint system restored, to provide a coat by coat lapping at the junction of the new and old paint systems. Where welding has been carried out on site, the welds shall be deslagged and wire brushed, and a protective paint system applied similar to that of the surrounding steel faces.

Where surfaces have been left unpainted and are to be connected by High strength friction grip bolts they shall be cleaned as specified and the contact surfaces brought together without further treatment. After bolting up, those surfaces which, being exposed are not protected, shall be wire brushed, primed and painted to the requirement of clause 903.4 to give a coat by coat lapping with adjoining painted surfaces.

Where surfaces have been left unpainted and are to be completely embedded in concrete they shall be cleaned of all oil, grease and millscale or other extraneous matter immediately prior to concreting but shall otherwise be left untreated. Where steel work is to be partially embedded in concrete the paint system shall be continued into the concrete for a distance equal to the least internal dimension of the concrete forming the surround.

Unless otherwise specified the final coat of finishing paint shall be applied to the immediate area off all steel work connection after completion of erection. The main body of the steel work however may be painted on site before erection, in which case any damage sustained during the course of erection shall be made good to the satisfaction of the engineer. Painting will not be permitted when the temperature is below 30c or when relative Humidity is in excess of 85% or during wet weather.

### **LADDERS**

The sides of the ladders shall be 50 x 10mm. Mild steel flats set 450mm apart and the ends of the sides shall be bent and cracked at suitable angles for taking off from the walls and floorings. The sides shall be drilled to receive the rungs spaced at 225mm. Intervals. The rungs shall be 20mm.dia.mild steel bars and shall be fixed to the sides by offering them into the holes and fixing with a 4mm.fillet weld which be taken all round the perimeters of the bars.

The stays for the ladders shall be 25 x 10mm. Mild steel flats built at least 100mm, into the concrete of the supporting structure. The Built in ends of the stays shall be split and bent to give a good hold in the concrete. The ladders shall be fixed to stays with 10mm bolts.

The ladders and the stays shall be thickly galvanized after manufacture. After erection ladders shall be painted with 2 coats approved bituminous aluminum paint.

### **HAND RAILING**

Hand railing shall comprise the following items as shown on the drawings: -

- Stanchions to hold handrails, at a maximum of 2m. Intervals.
- Handrails at 0.5m and 1.0m above floor level.
- Face plates for building in to concrete.

Stanchions shall be fabricated from steel hollow box sections, or from black iron water pipe, or otherwise as shown on the drawings. The ends of the stanchions shall be sealed against the ingress of moisture by steel plates welded on. Hollow box sections or black iron water pipe shall be used for hand railing or as shown otherwise on the drawings. The minimum wall thickness of the sections used for stanchions and rails shall be 3mm.

### **ACCESS COVERS AND FLOORING**

Access covers and frames shall be fabricated from standard steel sections and chequer plate or open mesh flooring as shown on the Drawings, to the dimensions shown on the Drawings. The minimum thickness of all materials shall be 3mm.

## **MISCELLANEOUS SITE WORKS**

### **WROUGHT IRON**

All wrought iron shall be of the "Best Yorkshire" grade to 3.S. 858 and where specified or shown on the drawings wrought iron fabrications shall be heavily galvanised. Mild steel will not be accepted where wrought iron has been specified.

### **STRUCTURAL STEEL**

Structural steel components shall comply with B.S. 4360: Part 2 and B.S. 4 Part 1 or as stated in the Bills of Quantities.

### **SAFETY CHAINS AND FITTINGS**

Detachable safety chains are to be of the best galvanised iron crane chain quality of 10mm diameter, each end fitted with a stout galvanised 75mm diameter iron. The hooks shall be made from 12mm diameter wrought iron, 50mm diameter, with flattened and ragged tail 225mm long for building into walls.

The whole fitting shall be hot dipped galvanised after fabrication and shall have a zinc coating of 610gms/m and comply with B.S. 729 Part 1 with respect to the weight and uniformity of coating. Safety chains are required across downstream pipes 450mm dia. and over at manholes.

### **HANDRAILS**

Handrails shall be constructed of heavy quality galvanised steel tube to B.S. 1387: Steel Tubes and Tubular suitable for screwing to B.S. 21 Pipe Threads.

They shall be 25mm nominal bore fixed at 1m centres or as detailed on the drawings. All tubes and fittings shall be heavily galvanised and shall have a zinc coating of 2 610gms/m.

### **PERMANENT TRAFFIC SIGNS**

Permanent Traffic signs shall be either externally or internally illuminated, reflectorised or non-reflecting and shall conform in quality to British Standard 873: The Construction of Road Traffic Sign and Internally- illuminated Bollards. They shall have the dimensions, and legends, and be of material and finish, including and illumination or electorisation, shown on the drawings of stated in the Bill of Quantities.

Where illumination is to be provided this shall be tungsten filament or fluorescent tube, as shown in the drawings or stated in the Bill of Quantities and complying with the British Standard.

Traffic signs shall be erected with suitable fittings on posts made from tubular steel, reinforced or pre-stressed concrete or timber, all as shown on the drawings or stated in the Bill of Quantities, and complying with the British Standard.

## **MASONRY**

### **GENERAL**

All masonry work shall be constructed from building stone as specified in clause 5.7.

For culvert headwalls and other small works, the stone shall, unless otherwise specified, be rough dressed. For walls, facing and other exposed works the stone shall unless otherwise specified, be medium chisel-dressed.

#### **WORKMANSHIP**

The Contractor shall provide and use proper setting out rods for all work.

Stones shall be well soaked before use and the tops of walls shall be kept wet as the work proceeds. The stones shall be properly bonded so that no vertical joint in a course is within 115mm of a joint in the previous course. Alternate courses of walling at angles and intersections shall be carried through the full thickness of the adjoining walls. All perpendics reveal and other angles of the walling shall be built strictly true and square.

The stones shall be bedded, jointed and pointed in mortar in accordance with clause 4.3., with beds and joints 9mm' thick flushed up and grouted solid as the work proceeds.

All masonry work shall be cured in accordance with the relevant requirements of clause 4.10.

#### **BUILDING STONE**

All building stone shall be capable of withstanding when wet a crushing stress of 1.4 kg. /sq.mm. The source of stone shall be approved by the Engineer and stone supplied therefrom shall be free from Magadi, overburden, mudstone, cracks, sandholes, veins, laminations or other imperfections. The stone shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces, to the size specified. For exposed stonework the maximum permissible variation of any of the specified dimensions shall be 6mm provided that cut stone, supplied as 'rock face' stone may be hammer dressed on one face only, or on one face and one end, if in other respects it conforms with this specification. Stones shorter than 373mm will not be accepted.

Unless the Engineer allows otherwise the Contractor shall at his own expense provide and dress four 100mm cubes of stone for testing.

The stone shall be sound when tested in accordance with B.S. 1438: Media of Biological Percolating Filters, Appendix B, (Sodium Sulphate soundness test) accept that:

The treatment shall be repeated for 10 cycles only; and

The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

#### **CAST STONWORK**

Cast stone shall generally comply with the requirements of clause 5.7. Facing stones shall be brought up in courses to a height not exceeding 1 metre at a time, the concrete backing being then brought up and well incorporate rated into and round the backs of the stones and the projecting metal ties to ensure a complete bond. The stones shall be bedded and jointed as shown on the drawings.

All materials, moulds, mixing, casting and surface treatment, setting, jointing and pointing, and all centering, scaffolding and labour required to complete the cast stonework specified or as shown on the drawings, shall be included in the rates for such work.

### **MURRAM FOOTWAYS**

Murram footways shall consist of a 100mm of compacted murram as specified in clause 2.9(g) laid to the levels and falls shown on the drawings on a well compacted sub-grade.

### **PRECAST CONCRETE FLAGS**

Unless otherwise described in the contract precast concrete flags shall be hydraulically pressed and shall comply with the requirements of BS. 368. The flags shall be 50mm thick and, except where cutting is necessary, of a uniform width of 600mm a minimum length of 450mm and a maximum length of 900mm.

They shall be laid on a 50mm thickness of concrete grade 15 over a 75mm bed of murram as specified in clause 2.9(g). The slabs shall be laid to a regular 150mm or 300mm bond as directed, with joints at right angles to the line of the kerb. The prices for laying paving shall include all cutting whether straight or circular, bedding in with fine sand and grouting with mortar 3 to 1.

### **PRECAST CONCRETE KERBS, EDGINGS AND CHANNELS**

Precast concrete kerbs, edgings and channels shall be hydraulically pressed and shall comply with the requirements of B.S. 340. They shall be of a type specified in the Bills of Quantities and/or the supplementary specification.

They shall be laid and bedded on 12mm thickness of cement mortar which is laid over a foundation or haunch of concrete grade 20 constructed as shown on the drawings or as directed by the Engineer.

All kerbs edgings, channels, and quadrants shall be jointed with cement mortar as specified in clause 4.3. No joint shall exceed 12mm in width.

Especially cast circular kerbs and quadrants shall be used on curves where the radius is 20 metres or less. Expansion joints where shown on the drawings or directed by the Engineer shall be constructed.

All kerbs edgings, and quadrants shall be laid true to line and level and unit found to be more than 3mm out of line or level at either end shall be lifted and re-laid.

The price inserted in the Bill of Quantities shall include for any necessary excavation and refilling required in connection with the setting of the kerbs and edging and the disposal of surplus material.

### **TIMBER GENERALLY**

Timber for the works shall be the best quality sound straight and well-seasoned, free from rot, worm, beetle, decay, knots, or other defects and shall conform to British Standard 1860: Structural Timber Part 1.

Workmanship

The timber shall be sawn die square to the dimensioned scantlings of the finished work as shown on the drawings, and the Contractor shall make any necessary allowance for saw cuts and workings. Workmanship shall be neatly executed, tenons, mortices, scarves, checks and joints being accurately cut and fitted with screws,

All bolts screwed up against timber shall be provided with suitable washers.

### **CREOSOTING**

Timber to be creosoted shall be treated in conformity with the requirements of British Standard 913: Pressure Creosoting of Timber.

### **PERMANENT FENCING**

As soon as the Contractor is placed in possession of any part of the site he shall immediately erect fencing as specified.

Such fencing shall where practicable be the permanent fencing and the Contractor shall be responsible for all wear and tear howsoever arising until the completion of the construction of the other works when it shall be handed over complete in sound condition without defect. Such fences shall be patrolled regularly and maintained in a sound condition at all times and the cost of such patrolling and maintenance will be deemed to be covered by the prices inserted in the Bill of Quantities for fencing.

Permanent fencing shall be erected as shown on the drawings and in accordance with British Standard 1722: fencing.

All new fencing shall be neatly and efficiently jointed up to existing fences, walls, etc., and the cost of so doing shall be covered by the prices inserted in the Bill of Quantities for the various types of fencing.

### **CONCRETE FOOTINGS FOR FENCE POSTS**

Straining, end, and corner posts and struts of new fences shall be set in footings of concrete of grade 20 and all such footings shall be constructed to the dimensions shown on the drawings or as directed by the Engineer; any intermediate posts or standards erected in solid rock shall be set in concrete of the same grade.

### **TIMBER GATES**

Timber gates and posts shall be of approved timber as specified in clause 5.12 and shall be constructed, and provided with iron work for hanging and fastening, all as shown on the drawings. The butts of gate posts shall be left rough. Gate posts shall be embedded in concrete grade 20 as shown on the drawings and shall be erected and securely fastened to the terminal points for fencing and all gates shall be fixed to the satisfaction of the Engineer. The price inserted in the Bill of Quantities shall include for excavation erection, backfilling and disposal of surplus material.

### **IRON OR STEEL GATES AND POSTS**

Iron or steel gates and posts shall be as shown on the drawings or of an alternative type approved by the Engineer, provided with all necessary fittings for hanging and fastening. The price entered in the Bill of Quantities shall include for excavation, erection, backfilling and disposal of surplus material. Gate posts shall be embedded in concrete or grade 20 as shown on the drawings.

## **TEMPORARY FENCING**

As soon as the Contractor is placed in possession of any part of the site he shall in places where permanent fencing cannot be erected immediately, or where none is required, erect and when and where required re-erect, and maintain temporary fencing of a minimum standard, as shown on drawings, stated in the Bill of Quantities or directed by the Engineer.

Although the fencing is only for temporary use, a high standard of workmanship and care is required throughout.

Provision shall be made for access where directed by the Engineer for the use of owners, tenants and occupiers of the adjacent lands. Fences shall be thoroughly strutted at breaks and angles and properly joined to any existing fences. All posts shall be placed as firmly as possible and wires correctly strained at all times. If temporary fencing is removed temporarily for the execution of any part of the works it shall be replaced as soon as possible and in the meantime the gap in the fencing shall be patrolled so that no unauthorized entry on to or from adjoining land takes place. All fences shall be patrolled regularly and maintained in a sound condition, any defects being made good immediately they are noticed or brought to the notice of the Contractor.

The cost of all patrolling and maintenance will be deemed to be covered by the prices inserted in the Bill of quantities for fencing.

When an access is provided for owners, tenants and occupiers of adjoining lands, it shall be maintained in a reasonable condition so that use of the access is at no time impaired by the operations of the Contractor.

Temporary fencing shall not be removed until it is replaced immediately by permanent fencing. If no permanent fencing is required, the temporary fencing shall remain in position until completion of the whole of the works unless the Engineer agrees to its removal at an earlier date; when reinstated and left in a safe condition.

## **REMOVING AND RE-ERECTING EXISTING FENCES AND GATES**

Where required existing fences, gates and posts shall be carefully taken down, laid aside for re-use and re-erected in the positions shown on the drawings or directed by the Engineer. Only approved material shall be reused and the price for re-erecting shall include making good defects, whether resulting from the Contractor's operations or not and providing footings for posts and stays similar to existing footings. The price for re-erecting fences and gates shall also include for scraping and burning off existing paint and painting with three coats of best oil paint finished in an approved colour or where appropriate for re-creosoting with two coats of creosote complying with British Standard 144: Coal tar Creosote for the Preservation of Timber, unless otherwise approved by the Engineer.

## **PRETREATMENT AND PAINTING OF TIMBER**

Painting shall be carried out in accordance with the methods set out in B.S.C.P. 231.



Surfaces shall be clean and dry before primed with lead based primer to B.S. 2521. Primed surfaces shall be painted with two coats of oil based undercoating to B.S. 2525. One coat of finishing coat (Exterior Quality) shall be applied at B.S.2525/32.

The Engineer shall specify the colour of the finishing coat and the undercoats and finishing coat shall be of different colours as a check on the application of all coats of paint.

### **PRETREATMENT AND PAINTING OF SUNDRY METALWORK**

Sundry metalwork shall be any iron, steel or aluminium fabrication which is not machinery, supports to machinery, structural load bearing, or handrails

Surfaces of iron and steel shall be rendered clean, dry, and free from grease, rust or mill scale. The metal surface shall then be given one coat of zinc chromate primer containing not less than 21% zinc chromate according to B.S. 4652, or with micaceous iron oxide primer containing not less than 30% iron oxide as B.S. 3981. Galvanised surfaces which have been exposed to atmospheric weathering for not less than 6 months shall be cleaned down and primed with one coat of zinc chromate primer.

If the galvanised surface has not been weathered for 6 months it shall first be treated with either a proprietary etch primer or etching compound of the following composition:

Industrial methylated spirit	:	60%
Toulon	:	30%
Carbon tetrachloride	:	5%
Commercial hydrochloric acid	:	5%

After etching and before priming as described above, the galvanised surface shall be thoroughly rinsed with clean water to remove chemical residues, and then allowed to dry.

Aluminium surfaces shall be cleaned and thoroughly de- greased with industrial methylated spirit prior to the application of a thin coat of etch primer. After thoroughly rinsing with clean water to remove chemical residues and allowing to dry the etched surface shall be given one coat of zinc chromate primer containing not less than 20% by weight of zinc chromate and free from graphite and from oxide or hydroxide of lead.

Surfaces which have been primed shall then be painted as specified in clause 5.22.

### **PRETREATMENT AND PAINTING OF MACHINERY, SUPPORTS TO MACHINERY, STRUCTURAL LOAD BEARING MEMBERS AND HANDRAILS**

The term machinery shall mean the casing of machinery and not the mechanical or electrical apparatus so enclosed. External moving parts which are supposed to be bright metal finish shall be given 2 coats of a mixture of oil and tallow or other approved anti-rusting compound.

Steelwork and/or cast iron shall be shot blast cleaned to first quality finish to B.S. 4232 with a maximum profile of 75 microns. As soon as possible and within not more

than 4 hours a zinc coat of pure metal applied by hot spray, not less than 100 microns thick shall be applied.

As an alternative to the above, the work to be protected may be not dip galvanised to obtain a coating of not less than 750g/m on each face. Tubular-or enclosed members shall always be hot dip galvanised. As soon as possible after deposition of zinc coatings, and within not more than 4 hours, an etch primer coat shall be applied which shall seal all zinc coated faces.

Primed surfaces shall be painted with either:

- a) One undercoat and one gloss finishing coat of an alkyd vinyl enamel.
- b) Three coats of bituminous paint.

Alternative b) shall be used for parts to be submerged or partially submerged.

The Engineer shall specify the colour of the finishing coat of the alkyd vinyl enamel, and the shade of the undercoat shall be chosen to be a near match but be sufficiently different to prevent mistaking the one for the other.

Welded joints shall be treated with an approved neutralization agent after cleaning (weld line or similar) to be painted over the joint in 100mm wide bands.

Fabricated parts which have to be assembled before final painting shall be given one coat of undercoat or bituminous paint over the area of the join, and the parts shall be brought together and the joint made whilst the paint is still wet.

Hot dip galvanised shall comply with B.S. 729: Part 1. Hot spray zinc coatings shall comply with B.S. 2569: Part 1. Alkyd vinyl enamels shall be of a type giving a minimum of two years satisfactory performance under tropical conditions of high temperature and humidity, and ultra violet radiation. The hard gloss finish shall be capable of withstanding a temperature of 105 C without colour change, and be resistant to oils, acids, and alkalis.

### **NEOPRENE BEARING PADS**

Bearing pads shall comprise composite "sandwich" fabrications of alternate layers of neoprene and steel firmly bonded together.

The steel plates shall be mild steel and shall be free from sharp edges or burrs. The thickness of the outer steel plates shall not be less than 3mm and of the inner plates not less than 1.5mm.

The whole fabrication shall be enclosed in neoprene at least 5mm thick. The pads shall be such that they can accept the vertical or horizontal loads or rotation or sliding movements shown in the contract. They shall be supplied by an approved manufacturer.

### **GRASS**

The Contractor shall reinstate all grassed areas with grass seed of a quality equal to that surrounding the works. The Contractor shall fertilize and water the seed and be responsible for making the first cutting. At least 75% coverage of healthy sward shall be obtained before the end of the Maintenance Period.

## **TANKING**

External waterproof tanking to blockwork chambers or elsewhere shall be Colas East Africa Basement Tanking (External) or equal as described on Colas Specification N7-04. Preparation and application shall comply rigidly with the manufacturer's instructions in all respects.

## **GALVANIZING**

All articles to be galvanised shall be galvanised 'hot dip' to the requirements of BS 729 Part I. The metal shall be applied at the rate of 610 gm/m<sup>2</sup>, of surface area in a uniform covering 100 microns thick.

## **SHERARDISING**

Small items such as bolts, rag bolts and threaded parts shall, be sherardized to give a covering of 330 g/m of surface area.