REPUBLIC OF KENYA

MINISTRY OF WATER AND IRRIGATION

ATHI WATER WORKS DEVELOPMENT AGENCY

AFRICAN DEVELOPMENT BANK

P R O C U R E M E N T D O C U M E N T S

Volume 2: Requirements: Scope of Works and Specifications For

Procurement of

KENYA TOWNS SUSTAINABLE WATER SUPPLY AND SANITATION PROGRAM

Construction Works for Mwala Cluster Water Supply Project

Issued on: 25th April, 2023

ICB No: AWWDA/AfDB/KTSWSSP/W/08/2023

Athi Water Works Development Agency
Kenya

KENYA TOWNS SUSTAINABLE WATER SUPPLY AND SANITATION PROGRAM

CONSTRUCTION WORKS FOR MWALA CLUSTER WATER SUPPLY PROJECT

ICB No. AWWDA/AfDB/KTSWSSP/W/08/2023

SPECIFICATIONS

TABLE OF CONTENTS

SECTION 1: TECHNICAL SPECIFICATIONS

1. GENERAL

All materials, equipment and testing apparatus etc. to be furnished and Works to be executed by the Contractor in this Contract shall conform to the requirements of the latest Kenya Standards, International Standards Organization (ISO), European Norm (EN), Deutsches Institut fÜr Normung (DIN), British Standards (BS) or other approved applicable Standards in Kenya.

Equipment to be purchased shall be from well recognized manufacturers whose products are standardized and controlled by any recognized Standards Organization.

All dimensions and measurement units shall be in S.I. units.

The equipment to be employed by the Contractor shall have sufficient performance capacity and durability as to secure the completion of the Works within the construction period stipulated under the Contract. All materials and equipment shall be subject to inspections or tests by the Engineer at any time and in any state of completion both off-site and on-site as he deems necessary. **The Contractor shall furnish promptly, without additional charge, all facilities, labour and materials reasonably needed for performing such inspections and tests as may be required by the Engineer.**

The Contractor shall make diligent efforts to procure the specified materials, but when the materials specified are unavailable, for reasons beyond the control of the Contractor, substitutes may be used with prior written approval of the Engineer.

101. OFFICE FOR THE RESIDENT ENGINEER

For Supervision of the Works, 1Nr. Rented Office will be established within the Project Area. The Contractor to provide the rented office from the date of Commencement of Work. The Office including location shall be to the Resident Engineer's approval.

The Office shall be of a design and construction approved by the Resident Engineer and shall be constructed of strong, durable and weatherproof materials with walls, ceilings and floors adequately insulated against heat and cold.

The Office shall have a floor area of at least 120 square metres and shall be provided with equipment and furniture detailed under the following clauses. The Office shall have burglar proofing to all windows and external doors.

In addition to the above, provision will be made for shaded parking (carports) for at least four vehicles.

The Contractor shall arrange for the provision of telephones (and if necessary extensions) with suitable privacy for conversation for the exclusive use of the Resident Engineer and his Staff by means of a separate connection to the Telephone Exchange. Provision shall also be made by the Contractor for all necessary gas, electricity, kerosene, water, light, attendance and stationery required in connection with execution of the Contract.

Security Guards hired from a reputable Security Firm approved by the Resident Engineer shall be provided for day and night security at these Offices. The Office, furniture and equipment shall be insured against fire, theft and natural calamity.

101.(a) PROVISIONS AND CONSUMABLES FOR THE RESIDENT ENGINEER'S OFFICE

Stationery required **per month** as follows (Stationery to be approved every month by the Resident Engineer before ordering):

Stationery	Quantity for Office
Photocopy paper A4	4 Reams
A3 paper	2 Ream
Biro pens blue/black	½ Doz.
Clutch Pencils	½ Doz.
Box files	6 Nr
Spring Files	6 Nr
Spirals (various sizes of Reports)	2 Doz.
Embossed (hardback cover)	2 Doz.
Perspex covers	2 Doz.
Cellotape (medium)	1 Nr
Masking tape (medium)	1 Nr
Staples	2 Pac.
Paper clips (various sizes)	2 Pac.
Pencil leads (0.5/0.7)	2 Sets
C-DR (Pack of 12)	1 Pac.
CD-RW (Pack of 12)	1 Pac.
Highlighters (set of all colours)	2 Sets
A6 hardcover notebooks	2 Nr
Soft Pencil Erasers (Staedtler or equivalent)	3 Nr
Envelopes (all sizes)	3 Doz.
Batteries for flashlights	3 Sets
Black ink cartridge/ toner for the A4/A3 printer	1 Set
Colour cartridges/toner for the A4/A3 printer	1 Set

In addition, for each office, the Contractor to supply clean towels every day, soap, lavatory paper, disinfectant and cleaning materials, coffee/tea, milk, sugar, drinking water, refreshments, etc. These items are to be provided and maintained throughout the Contract Period, adequate for 6 Supervision Staff and 12 additional guests. The List of Provisions and Consumables to be given by the Resident Engineer every month.

The Contractor will also be responsible for the following services for the Office:

i) Payment for all services including water, electricity, sewerage, Telephone & Internet
ii) Guarding of the premises (24 hour security services);
iii) Maintaining insurance against theft of equipment and other materials from the offices;
iv) Service, maintain / repair office equipment and appliances;

The cost of all the above services shall be included by the Contractor under the relevant item in Bill No. 1 – Preliminaries and General for supply of Provisions and Consumables for the Resident Engineer's Office. Apart from the consumables, the rest of equipment will revert to the Employer at the end of the Contract.

101.(b) STAFF FOR THE RESIDENT ENGINEER'S OFFICE

The Contractor shall provide a Secretary for the exclusive use of the Resident Engineer for the duration of the Contract. The secretary shall be English speaking, with a minimum 5 years experience in secretarial / office administration work. The secretary shall be conversant with standard office computer hardware and software (MS-Word, Excel, PowerPoint, etc.). The Secretary shall be interviewed and tested by the Resident Engineer prior to deployment on the Works.

An Office Assistant (messenger / tea boy / office cleaner) shall also be provided by the Contractor exclusively for the Resident Engineer's Office.

AutoCAD Technician with Civil Engineering Diploma from a recognized College and minimum 3years experience in a Design Office will also be provided exclusively for the Resident Engineer's Office.

An Environment / Social Assistant a Degree in Environmental Science, Sociology or reputed field will also be provided exclusively for the Resident Engineer's Office.

The Contractor shall provide the services of Surveyors (with minimum Diploma in Surveying from a recognized Institution) and Chainmen for the sole use of the Resident Engineer for the whole period of the Contract.

101.(c) PROJECT VEHICLES

The Contractor shall service and maintain the vehicles to be used for supervision of the Contract by the Resident Engineer and his staff.

The Contractor shall ensure that all vehicles are licensed, comprehensively insured at all times, serviced and maintained in good condition to the satisfaction of the Resident Engineer or his authorized representative, so that the Resident Engineer shall at all times have the vehicles available for use in good serviceable condition. In the event of the vehicles being unserviceable for whatsoever reason, the Contractor shall provide alternative vehicles at his own cost of the same model in compliance with the provisions of this clause. The cost for such replacement vehicle to be covered by his rates.

Payments for maintenance shall include for provision of fuels, lubricants and tyres, all regular maintenance, minor and major repairs, including those occasioned by accidental damage from whatever cause arising, and everything else necessary to satisfy fully the requirements of this Clause.

The makes, models and colours of the vehicles shall be approved by the Resident Engineer prior to ordering.

The Contractor shall, at completion deliver the vehicles to the appropriate dealers for inspection. The dealers shall recommend to the Engineer's Authorized Representative what repairs in addition to the ordinary service are required to be carried out on the vehicles. The Contractor shall then ensure the necessary service/repairs are done. A certificate of road worthiness and satisfactory mechanical condition to be obtained from the Dealer.

The following will be carried out:

- Inspection by the Government Inspection Unit, if applicable
- Inspection and Valuation by the Automobile Association (AA) of Kenya

The Contractor shall hand over the respective Inspection / Valuation Reports to the Employer together with the vehicles. A Prime Cost item has been included in the Preliminary and General Items bill to cover running and maintenance costs of the Project Vehicles. The vehicles will revert back to the Employer at the end of the Contract.

101.(d) DRIVERS

The Contractor shall provide licensed drivers for the exclusive use of the Resident Engineer or his authorized representative. The drivers shall be available at all times during normal working hours and when specifically required by the Resident Engineer or his authorized representative, outside these hours.

The drivers shall have a minimum 10 years of clean driving record and a Certificate of Good Conduct from the Kenya Police. The drivers are to be employed and paid by the Contractor (including all overtime, NSSF, NHIF, etc.) but will report directly to the Resident Engineer for day to day instructions. The Resident Engineer will interview, test and approve the drivers prior to their deployment on the Works.

Each driver shall be provided with uniform as follows, as a minimum, to be replenished/replaced as and when necessary as directed by the Resident Engineer. The cost of uniform is deemed to be covered by the Contractor's monthly rate for the drivers.

- 2 Nr good quality Trousers - Navy Blue
- 3 Nr Shirts - Sky Blue
- 2 Nr woollen Sweaters - Navy Blue
- 1 Nr pair Hard Toe Shoes - Black
- 3 Nr Pairs of Socks - Black

101.(e) SURVEY EQUIPMENT

Listed below are the principal items of survey equipment to be made available for use during the whole duration of Project Implementation. All equipment shall be as new and with all necessary carrying containers, manuals, insurances, etc. The Equipment to revert to Contractor at completion of all Works.

Equipment	Quantity
Total Station including tripods, complete with reflectors, poles, brackets and carrying case (Wild or similar)	1 Nr
Real Time Kinematic (RTK) GPS Machine with Base Station and 2Nr. Rovers (CHC or equivalent)	1 Nr
Automatic Level (Wild or Similar) with legs and metric staff, complete with carrying case	2 Nr
Metric extending levelling staffs with vertical bubble	4 Nr
30m (enamelled or otherwise protected) steel bands	2 Nr
3 metre ranging rods	15 Nr
Survey umbrellas with stand	4 Nr
Work boots	8 sets
Rain Gear (trousers and jacket type, complete with rain hat)	8 sets

Equipment	Quantity
Hard hats	12 sets
5 metre retractable pocket steel tapes	8 Nr
30 metre metal tapes	4Nr
100 metre metal tapes	3Nr
Builders spirit levels 1000mm long	4 Nr
Hammers 3 kg each	4 Nr

The Contractor shall also supply pegs, crayons, spray paint, nails and all other items required for setting out and measuring the work.

The Contractor shall be responsible for maintaining the survey and field equipment throughout the Contract Period, including replacement of items damaged during the normal course of the Works.

The Contractor shall provide all such labour and assistance as may be required by the Engineer for checking the Contractor's setting out and/or survey.

The Contractor shall make available such labour, materials, equipment and consumables as the Engineer may require from time to time, for inspections and tests in connection with the Works.

101.(f) ACCOMMODATION

The Contractor to make provision for accommodation for the Resident Engineer (RE) and Works Supervision Staff. The furnished rented houses shall be to the approval of the Resident Engineer and shall comply with all his requirements. All costs in connection with the rental of house, supply, consumption and maintenance of water supply, electrical power, house help, etc., shall be borne by the Contractor. Provisions of full time security guards shall be made for the houses for day and night security. The provision for this is made under the relevant item in Bill No. 1 – Preliminaries & General.

102. OFFICE FOR CONTRACTOR

The Contractor shall have an office on the Sites to be approved by the Engineer and which shall be open and attended to at all hours during which work is in progress.

103. CLIMATE CONDITIONS

The Bidder to verify on his own, the climate conditions in the Project Area with the Kenya Meteorological Department including rainfall, temperature, etc. and make his Work Plan accordingly.

104. LEVEL DATUM

Before the commencement of Construction Work the Contractor shall establish, in a position to the approval of the Engineer, a bench mark comprising of steel datum pegs which shall be securely concreted in. The level of these pegs shall be established and agreed with the Engineer and all levels used in the construction of the Works shall be referred to these established datum points. The correctness of this datum shall be checked at regular intervals during the construction period as agreed with the Engineer.

Where possible construction drawings and all levels used for construction shall be referred to the national height datum as defined by the Survey of Kenya. The Contractor shall be responsible for obtaining the location and values of the permanent bench marks. In cases where such bench marks do not exist, the site datum shall be agreed with the Engineer.

105. SETTING OUT OF THE WORKS

The Site Layout Drawings show indicative Site Layouts. Prior to commencing construction, the Engineer will agree with the Contractor the basic information supplementary to that shown on the Drawings such as the position of manholes, chambers, centre-lines and base-lines sufficient for the Contractor to locate the Works.

The Contactor shall prepare detailed Setting Out Drawings and Data Sheets as necessary and submit them to the Engineer in triplicate for approval. Any modifications to the Setting Out Drawings or Data Sheets required by the Engineer shall be made by the Contractor and resubmitted for final approval. Should it be necessary during setting out or during construction for the approved setting out details to be amended, the Contractor shall amend the Drawings or Data Sheets or make new ones for approval as required by the Engineer.

For water pipelines, sewers, etc. the Contractor shall in the presence of the Engineer set-out the pipeline alignments in accordance with the indicative alignments shown on the drawings taking into account physical features on the ground, any existing services, any requirements of relevant Authorities and any changes deemed necessary by the Engineer, confirming the locations of all valves, air valves, washouts, hydrants, bends, manholes, etc.

The Contractor shall prepare and submit to the Engineer, at an approved scale, Plans of the Water / Sewerline Pipeline Routes and profiles of ground levels after any initial clearing of the wayleave or easement showing the proposed pipe invert levels and precise chainages for all valves, fittings, manholes, etc. for approval. Following approval, the Contractor shall submit to the Engineer two copies of the agreed alignment and profiles.

The Contractor shall also be required to carry out Site / Engineering Survey of demarcated land where permanent structures / appurtenances will be constructed as directed by the Engineer after initial clearance of sites. The Contractor shall prepare an updated layout plan with contours at 1.0m interval. The contours shall be generated from a 10x10m grid topo survey.

106. CONTROL OF TRAFFIC

In the event of single way traffic becoming necessary on any particular section of the Works, or on the approaches to the Works, the Contractor shall, in maintaining through traffic routes, provide a width of at least 3 metres for single way traffic. He shall also provide approved electrically operated signals for traffic control on each of the affected sections and any additional traffic signs as may be directed in accordance with Clause 108. Signal lights are to be operated by competent operators provided by the Contractor, if and when required by the Engineer. Manually operated “Stop-Go” signs will only be permitted if approved by the Engineer, and shall be of the size, colour and type authorized. The Contractor shall be responsible for liaison with Police.

107. TEMPORARY DIVERSION OF TRAFFIC

Temporary diversion ways, including those listed in any schedule to the Bill of Quantities shall be constructed whenever the site is intersected by existing public and private roads, footpaths, cycle tracks, farm accesses, temporary and accommodation roads.

Any diversion way shall be of such a standard of construction that it is suitable in all respects for the class or classes of traffic requiring to use it. It shall be constructed in advance of the taking up of the existing way and regularly maintained for so long as required in a satisfactory condition all to the approval of the Engineer.

108. TEMPORARY TRAFFIC SIGNS

The Contractor shall erect and maintain on the Works and at prescribed points on the approaches to the Works, all traffic signs necessary for the warning, direction and control of traffic and the size of all such signs and the lettering and wording thereon shall be reflectorised or adequately illuminated at night by approved means.

109. PROTECTION OF WORKS

The Contractor shall carefully protect from injury by weather all work and materials which may be affected thereby.

110. SURVEY BEACONS

During the progress of the Works, the Contractor shall not remove, damage, alter or destroy in any way whatsoever, any plot or survey beacons. He shall notify the Engineer of the need to interfere with any beacon. The Engineer shall authorize any removal and reinstatement that he considers necessary. Should any beacon be found to be above or below the level of the finished work, the Contractor shall immediately report the same to the Engineer.

Should any beacon be damaged or destroyed, the Contractor shall forthwith report the damage to the Engineer and to the Director of Surveys and shall be held liable for the cost of reinstatement thereof.

111. DAMAGE TO LAND

The Employer shall provide the Site upon which the Permanent Works are to be constructed. Where a drain or pipeline is to be within an existing road or track reserve or is otherwise located in land designated Public Domain, the Site width will be restricted to the limit of the public land. The existing boundary fences and walls shall not be disturbed without prior approval of the Engineer and, unless road diversions and closure notices are approved and posted, carriageways shall be left available for the safe passage of traffic.

Except where specified for the proper execution of the Works, the Contractor shall not interfere with any fence, hedge, tree, land or crops within, upon or forming the boundary of the site or elsewhere. In the event of such interference, the Contractor shall make good to the satisfaction of the owner and the Engineer and shall pay to the owner such damages as the Engineer may determine.

The Contractor shall not enter upon or occupy with men, tools, equipment or materials any land other than the site without the written consent of the owner of such land.

On occupation of the Site or other land the Contractor shall provide such fencing, as required.

112. RIVERS AND DRAINS

The Contractor shall at all times maintain the free flow of rivers and drains and prevent excavated material from the Works from being deposited in them.

113. REINSTATEMENT OF ROADS AND FOOTWAYS FOR WATER MAINS AND SEWER CROSSINGS

The Contractor shall allow in his rates for liaison with the relevant Roads Authority and obtain a Road Opening Permit. Statutory fee for road crossings will be paid under relevant Item in the Bills of Quantity.

The road crossings shall be constructed in the following specifications and any other requirement stipulated by the Road Authority:

- Excavated width of the trench shall not be less than 1m to ensure compaction to required standard
- Protective concrete raft slab shall be constructed for sewer pipes as per details given in the drawings.
- Backfilling shall be carried out with suitable selected excavated material upto the top
- 300mm, in layer thickness not exceeding 150mm at optimum moisture content
- The top 300mm layer shall be backfilled in two layers of 150mm each comprising of well graded stabilized gravel with 3% cement content at optimum moisture content
- Tarmac roads shall be reinstated to the original condition using approved asphalt from a recommended supplier.

The Contractor shall be responsible for all liaison with the Police for traffic control during execution of the works.

114. TEMPORARY WORKS

The Contractor shall provide, maintain and remove on completion of the Works all temporary Works including roadways, sleeper tracks and stagings etc., over roads, footpaths, suitable in every respect to carry all plant required for the work or for providing access or for any other purpose.

Details of Temporary Works shall be submitted in advance to the Engineer for his approval and the approval shall not relieve the Contractor of complete responsibility for their safety and satisfactory operation.

115. LIGHTING AND GUARDING OF OBSTRUCTIONS

The details of the method of signing and guarding an obstruction to traffic caused in the course of the execution of the Works shall be submitted to the Engineer for approval before that portion of the Works is commenced.

No greater area of the road than the Engineer considers necessary shall be closed at any one time.

Temporary traffic signs shall comply with Clause 108. Generally the following precautions will be required:-

Signing

An advance warning sign at least 1.22m x 0.92m in size and 70 metres in advance of the obstruction will be required, and where an appreciable change of direction is necessary at the obstruction, a sign (of the arrow or chevron type) at the obstruction itself. At particular danger points more comprehensive signing may be required.

Guarding

The obstruction shall be marked by posts carrying red flags or reflective red markers and by red lamps. The latter shall be spaced at 6 metres intervals in the direction of traffic flow and at 0.9 metres intervals across this direction. At least 3 lamps shall be placed across this direction of traffic flow. The flags and lamps on the traffic side of the obstruction shall be at least 5 metres from it.

Footpaths

Where a footpath is affected by an obstruction in any way it shall be separated from both obstruction and traffic by effective banners and red lamps spaced at 0.9 metres intervals.

116. EXISTING SERVICES

Before commencing Works which include excavation or ground levelling by manual or mechanical excavation the Contractor shall at his own expenses ascertain in writing from Telkom Kenya, Kenya Power & Lighting Co. Ltd., Data Cables Companies, the Water Services Provider and all other Public Bodies, Companies and persons who may be affected, the position and depth of their respective ducts, cables, mains, pipes, or other appurtenances. He shall thereupon search for and locate such services.

The Contractor shall at his own expense arrange to have effectually propped, protected, underpinned, altered, diverted, restored and made as may be necessary, all water courses, pipes, cables or ducts, poles or wires or their appurtenances disturbed or damaged during the progress of the Works, or in consequence thereof.

Except that such services as require to be removed or altered by virtue of the layout of the permanent work and not the manner in which the work is carried out, shall be so removed or altered at the direction and at the expense of the Employer.

The Contractor shall be liable for the cost of repairs to any services damaged as a result of carrying out the Works and execution of these Works.

117. CONNECTIONS TO EXISTING PIPES AND EQUIPMENT

The Contractor shall be responsible for joining up and making connections between water pipes, sewer pipes, etc. equipment installed by him and existing facilities. The Contractor shall submit to the Engineer a drawing showing the details of the connection, and shall state the date on which the particular connection is required, and the work shall not proceed until the Engineer’s approval has been given.

The Contractor shall be responsible for ensuring the compatibility of new pipes with existing pipework, cables, tubing, equipment, etc.

118. PRIVATELY OWNED OR PUBLIC SERVICES

If any privately owned or public services passing through the site will be affected by the Works, the Contractor shall provide at his own expense a satisfactory alternative service in full working order to the satisfaction of the owner of the services and the Engineer, before the cutting of the existing service. Any damage to private or public services shall be made good by the Contractor at his cost.

In case the remedial work is not executed promptly by the Contractor, the Engineer may make alternative arrangements for the execution of the work and debit the costs to the Contractor.

119. WATER SUPPLY

The Contractor shall provide for all purposes of the work, an adequate supply of water from a suitable source or sources approved by the Engineer. He must pay the water charges, if any, and make arrangements for supply, transport and distribution.

120. ADDITIONAL LAND

The Contractor shall select and arrange at his own expenses for any temporary occupation of land outside the site which he requires for the efficient execution of the Works. The Contractor must comply fully with all By-laws and Regulations currently in force in the area.

121. USE OF HEAVY PLANT

In the event of the Contractor desiring to use heavy machinery or plant, he shall first satisfy the Engineer that they will be of such size and used in such a manner as not to cause any disturbance or damage in particular to water, electricity, Post Office or other mains, cables and connections or to sewers, culverts etc. or interfere with the line or position of any overhead wires and cables of any sort, telegraph poles, power poles etc.

The Contractor will be held liable for any such damage or disturbance and shall pay the full costs of any reinstatement, relaying, repairing or refixing as may be required, as agreed between the Engineer and the owner affected.

122. PROVISION OF INSTRUMENTS AND LABOUR

The Contractor shall provide at his own expenses all instruments, materials, tools and other things which the Engineer considers necessary for his proper supervision of the Works and shall maintain the same in good order. He shall also provide materials, an experienced Surveyor and labour for attendance on the Engineer and his representatives in carrying out operations connected with the supervision of the Works. All charges arising out of such services shall be deemed to be included in his rates in the Bill of Quantities.

123. ACCESS TO SITES

The Contractor shall construct and maintain all temporary accesses required for the execution of the Works. Access roads shall be constructed and maintained up to the Site

Offices if required. The cost of all these Works shall be deemed to be covered by rates and prices quoted by the Contractor.

124. POLLUTION

The Contractor shall ensure that during the course of his operations no pollution of the atmosphere, rivers, reservoir catchment areas or groundwater is allowed to take place.

125. TREE PROTECTION

Trees within the permanent and temporary easement are the property of owners. Specific trees will be identified by the Engineer, prior to construction, and the Contractor shall neither remove nor cut their roots unless otherwise directed by the Engineer. If the roots of such trees appear within the trench areas, the Contractor shall handle the roots with maximum care so that no portion of the roots will be damaged. During the excavation of the trench, the exposed roots may be removed to a position that will not damage the roots and will not interfere with the pipelaying. During the construction, the roots shall be thoroughly protected by appropriate cover and wetted as directed. After the pipes are laid, the moved roots shall be placed back to the original locations and backfilled carefully by selected soft soil which can support vegetation.

126. GEOLOGICAL DATA

Any geological data that is made available to the Contractor and is relevant to the Works, will be for his guidance only, and no guarantee is given that other ground conditions will not be encountered. No claims based on the geological data provided shall be entertained by the Engineer. The Contractor shall be deemed to have made any additional investigations required before submission of his Bid.

127. WATCHING, FENCING AND LIGHTING

The Contractor shall arrange to employ watchmen to guard the Works both during the day and night from the commencement of the Works until the substantial completion of the Works.

Any excavation or other obstruction likely to cause injury or damage to any person or domestic animals must be fenced off as directed by the Engineer.

128. TIPS

The Contractor shall be responsible for provision of all tips, at his own expense, for disposal of all spoil or other rubbish collected during the construction of the Works. Any surplus excavated material not required shall also be carted away to these tips. The Contractor to liaise with the local Authorities for approval of location of tips.

129. TROPICALISATION

In choosing materials and their finishes, due regard shall be given to the tropical conditions of the site to which they will be subjected. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the Works which may be affected by the tropical conditions.

130. MONTHLY SITE MEETINGS

Throughout the project period, site meetings will be held at the Resident Engineer's

Office once every calendar month to discuss the progress of the work, schedule for the ensuing month, methods of construction, procurement, transportation, labours, etc. These meetings can be called at any other time intervals at the request of the Contractor or as directed by the Engineer. The meetings will be attended by Representatives of the Client, Supervision Team and the Contractor. Costs of holding the meetings shall be deemed to be covered under the Contractor's rates.

131. INSPECTION BY ENGINEER DURING DEFECTS LIABILITY PERIOD

The Engineer will give the Contractor due notice of his intention to carry out inspection during the Defects Liability Period and the Contractor shall upon receipt of such notice arrange for a responsible representative to be present at the times and dates named by the Engineer. This representative shall render all necessary assistance and take notice of all matters and things to which his attention is directed by the Engineer.

132. SUBMISSION OF SAMPLES

Before incorporating in the finished work any materials or articles which he supplies under the terms of the Contract, the Contractor shall submit to the Resident Engineer for approval a sample of each respective material or article, and such samples shall be delivered to and kept at his office for reference. All the respective kinds of materials and articles used in and upon the Works shall be at least equal in quality to the approved samples. Each and every sample shall be a fair average of the bulk material or of the article which it represents. The Resident Engineer may decide the method by which each sample to be taken from the bulk material shall be obtained. Any costs related to adhere to above will be deemed to be covered in Bidder's Rates.

133. RESPONSIBILITY FOR ORDERING MATERIALS AND MANUFACTURED ARTICLES AND SAMPLES FOR TESTING

The responsibility for so ordering and delivering materials and manufactured articles and samples that they may be tested sufficiently far in advance of the work as not to delay it, shall rest upon the Contractor, and he shall not be entitled to any time credit for delay occasioned by his neglect to order sufficiently well in advance or to effect payment of any costs he may incur as a result thereof.

With regard to any item in the Bill of Quantities which is the subject of a P.C. Sum, the Contractor shall notify the Engineer of his requirements as early as possible leaving ample time for the Engineer to make any necessary arrangements so that no delay occurs in the progress of the work.

134. TESTS OF MATERIALS AND MANUFACTURED ARTICLES BEFORE USE

Any or all of the materials and manufactured articles supplied by the Contractor for use on any of the Works throughout this Contract shall be subject in advance to tests as may be specified in the relevant Standard Specification as may from time to time be deemed necessary by the Engineer. Samples of all such materials and manufactured articles, together with all the necessary labour, materials, plant and apparatus for sampling and for carrying out of tests on the site on all such materials and manufactured articles shall be supplied by the Contractor at his own expenses. For all goods to be supplied including pipes, fittings valves, meters etc., factory and site Acceptance Inspection and Tests will be carried out. In addition, 3rd party independent inspection and testing will be carried out as directed by the Engineer. The cost of this has been allowed for in the

Preliminary and General Bill.

135. REJECTED MATERIALS

Should any material or manufactured articles be brought on to the site of the Works which are in the judgement of the Engineer unsound or of inferior quality or in any way unsuited for the work in which it is proposed to employ them, such materials or manufactured articles shall not be used upon the Works but shall be branded if, in the opinion of the Engineer, this is necessary and shall forthwith be removed from the site of the Works, all at the Contractor's expense and in each case as the Engineer shall direct.

136. QUALITY OF MATERIALS AND WORKMANSHIP

The materials and workmanship shall be of the best of their respective kinds and shall be to the approval of the Engineer. In the reading of this Specification the words "to the approval of the Engineer" shall be deemed to be included in the description of all materials incorporated in the Works, whether manufactured or natural and in the description of all operations for the due execution of the Works.

137. TEST RUNNING OF THE WORKS

Upon substantial completion of the scheme and official inspection which agrees to this, the Contractor shall operate the Works or completed and taken over sections for the test period indicated in the Bill of Quantities.

The Contractor shall supply all necessary personnel, equipment and consumables for the test running and together with the Engineer's Representative shall compile a list of detailed operating instructions that shall be incorporated into the Operation and Maintenance Manual. The Contractor shall further bring to the attention of the Engineer's Representative and of the Employer's operational staff any problem or defects he encounters during this period of test running so that solutions may be found and any necessary alterations made.

138. PERSONAL PROTECTIVE EQUIPMENT (PPE) FOR THE RESIDENT ENGINEER

The Contractor shall provide for the Resident Engineer, his Representative and assistants protective clothing and safety equipment necessary for the proper discharge of their duties on the Site.

The Contractor shall provide any necessary protective clothing and safety equipment for the use of authorized visitors to the site including the Employer and his staff and representatives and those of any relevant Authority who have reason to visit the Site.

139. OPERATION AND MAINTENANCE MANUALS

Draft Operation and Maintenance Manuals will be compiled prior to substantial completion and Handing Over of the Works.

The Manuals have to be revised and brought to a final draft state prior to the test running of the Schemes. The Contractor's rates should include for provision in triplicate, and in English, details of all the different manufactured plant and components incorporated in the Works including but not limited to all pertinent Manufacturers' Brochures, 'As-Built' Drawings prepared by the Contractor, Digital Progress Report Photographs, etc.

Substantial completion of the Works will not be considered until such detailed information as is required in triplicate has been submitted by the Contractor to and accepted by the Engineer.

140. CONSTRUCTION PROGRAMME

The Contractor shall submit to the Engineer for approval, a revision of the Construction Programme attached in four (4) copies and after approval to the Employer in two (2) copies in the following manner:

i) Within thirty (30) days after receiving the Letter of Acceptance, the Contractor shall submit to the Engineer for approval, a detailed Programme based on the key date stated hereinafter or other dates which are given in the Letter of Acceptance in the form of a Critical Path Method (hereinafter referred to as CPM Network) showing the order of procedure in which he proposes to carry out the Works including design, manufacture, delivery to the site, transport, storage, survey, construction, commissioning and maintenance. This Programme shall indicate clearly all activities and its duration along with the earliest and the latest event, times and the first and last dates of the submission of the Drawings and each date of shop inspection by the Engineer for the section or portion of the Works.

The Programme so prepared shall be rearranged in the form of a Time Bar-chart Schedule of which size shall be 841mm x 594mm (A-1 size). This Time Bar-chart Schedule shall be submitted to the Engineer together with the CPM Network.

ii) The CPM Network shall be in accordance with commonly accepted practices and shall show graphically the chain of activities / sub-activities and their sequential relationship with each other from the start of construction to the completion of the Contract. The Time Bar-chart Schedule shown in weeks shall list all main activities and its applicable sub-activities.

iii) In preparing the CPM Network and the Time Bar-chart Schedule the Contractor shall make due allowances for possible delays. Under no circumstances shall the CPM Network or the Time Bar-chart Schedule show a completion in excess of the "Time for Completion" stated in the Form of Bid.

iv) The Programme once approved by the Engineer shall thereafter be referred to as the Contractual Programme. The Engineer's approval of such programme shall not relieve the Contractor of any of his duties or responsibilities under the Contract.

The Contractual Programme approved shall supersede all other Programmes and shall be deemed to be the Programme on which the Contractor has based his Contract Sum and in accordance with which he will undertake the execution of the Works. This Programme shall become part of the Contract.

The Contractor shall ensure that all the Works including Works which may be carried out by any Sub-Contractors, are well coordinated with the overall Works under the Contract for the efficient execution of the Works, and shall clearly indicate them on the construction Programme.

The Contractor shall also describe the conditions of working shifts, if necessary, to execute the Works and whether work needs to be carried out at night and/or on Sundays and holidays. The Contractor should also indicate which particular Works are subject to these timings in his construction Programme.

Whenever the Contractor proposes to change the Contractual Programme, approval of the revision shall be obtained in writing from the Engineer.

If the Contractor has fallen behind the approved Contractual Programme or can foresee delay(s) therein, he shall, immediately after such default or event occurred or foreseen or at the request of the Engineer submit a revision of the Contractual Programme showing the reasons of such a delay and the proposed measures to recover such delay or to complete the Works on time, for the approval of the Engineer.

141. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Within 42 days of Commencement, the Contractor shall submit a Project Specific Environmental and Social Management Plan (ESMP) for approval of the Engineer. The Contractor must carry out all works in accordance with Kenyan Environmental Laws and Regulations, and the requirements of this document.

It is also a contractual obligation for the Contractor to take full cognizance of the environmental and social concerns and requirements as stipulated in the Employer's Environmental and Social Management Plan (ESMP) prepared for this Project and which is given in Chapter 12. The full Environmental and Social Impact Assessment (ESIA) Report will also be issued to the Contractor on Award.

Accordingly, the Contractor shall be required to prepare a site-specific Environmental and Social Management Plan (ESMP) for the project. This site-specific ESMP shall be based on the Contractor's evaluation of the requirements of these Specifications and the Employer's ESMP. The site-specific ESMP shall be submitted to the Engineer for approval within 42 days of Commencement.

The site-specific ESMP shall generally comply with the guidelines set out below.

The site-specific ESMP is the Contractor's operative document on how to enforce, mitigate, inspect and monitor potential Project impacts during mobilization, construction and demobilization. In this sense, it is an eminently practical and concrete instrument.

Based on the above, the structure and content of the site-specific ESMP shall emphasize the following aspects:

i) Executive Summary
ii) Introduction
iii) Project Description
- Focus on impact-generating activities (e.g. demand of water and permanent materials, earth movement, etc.);
- Environmental liabilities: identify and include a photographic registry of pre-existing environmental liabilities (e.g. gully erosion areas, abandoned borrow

pits, unauthorized dumping sites, etc.) that are not attribute to the implementation of the Project.

iv) Potential Impacts during Mobilisation, Construction and Demobilisation
- Apply simple rating of significance;
- Quantity/quality impacts (e.g. surface and type of vegetation to be removed, amount and type of wastes to be generated, noise levels, etc.);
- Identify places where specific impacts will manifest

v) Mitigation Plan
- Specify the detailed measures to mitigate the identified impacts (also by location)
- Include designs for measures requiring structural solutions (e.g. gabions, etc.);
- Include the schedule of implementation of mitigation measures in relation to the general construction schedule;
- Health and Safety Plan (detailed);
- Waste Management Plan (detailed) including decommissioning of the Existing Asbestos Cement (AC) Mains;
- Traffic Management Plan (detailed);
- Training Program (detailed);
- Accident and Emergency Response Plan (detailed);
- HIV/AIDS Awareness and Prevention Program (include only a reference to this program to be prepared by an NGO);
- Community Relations Program;
- Location and technical specifications for installation and operation of campsites, including workshops, garages, laboratories, offices, communal kitchenette / dining facilities, sanitary installations, etc.;
- Location, and technical specifications for operation of quarries and borrow pits, and procedures for negotiation with and compensation of land owners where they are located;
- Location and technical specifications for installation and operation of concrete batching, stone crushing, cement mixing and asphalt plants;
- Location and technical specifications for installation and operation of temporary and permanent dump sites.

vi) Inspection Plan
- Inspection function: specify frequency, locations and instruments (e.g. checklists, site reports, photo registry, etc.) to conduct site inspections;
- Permitting: required environmental permits and schedule to obtain them;
- Specific actions and responsibilities: what, who, where, when, how and why

vii) Monitoring Plan
- Specify, for each variable: frequency of measurement, locations, methods/equipment, units/measures, quality standards, and reporting requirements and periodicity, including establishment of trends.
- Specific actions and responsibilities: what, who, where, when, how and why.

viii) Organisation and Management
- Specify organizational structure, personnel, resource and equipment requirements, reporting requirements and periodicity, and inter-institutional communication and coordination mechanisms.
- Specific actions and responsibilities: what, who, where, when, how and why

ix) Annexes
- If the Contractor wishes to incorporate information beyond the indicated above, such as the policy, institutional and regulatory framework for environmental management in Kenya, biophysical and socio-economic

characteristics of the area of influence of the Project, etc., that information should be included as an annex and not in the body of the site-specific ESMP. Preferably, such information should not be attached and, further, if necessary, the pertinent chapter of the ESIA should be referenced.

- Annexes should be used, if necessary, to include detailed information on the specific topics of the ESMP (e.g. inspection forms or checklists, design of structural mitigation measures, photographic registry of environmental liabilities, etc.).

142. HEALTH AND SAFETY MANAGEMENT PLAN

Within 42 days of Commencement, the Contractor shall submit a project specific Health and Safety Management Plan (HSMP) for approval of the Engineer.

The Contractor must at all times comply with the National and County Laws and Regulations during the Construction and Commissioning Phases of the Project.

Site-Specific Health and Safety Management Plan

The Contractor shall appoint a full time qualified Health and Safety Manager who shall have responsibility for all safety issues on the Project. The Contractor must submit a site- specific Health and Safety Management Plan (HSMP), which shall, as a minimum, address the following:

1) Introduction (including objectives of the HSMP)
2) Hazard Prevention and Control
    i) Risk assessment (including description of risk assessment method used);
    ii) Prevention, protection and control measures (based on risk assessment performed):
        a) Personal protective equipment and clothing: safety goggles, ear plugs, work boots, dusk masks, protective clothing etc.;
        b) H&S and sanitary facilities, equipment, materials and personnel: first- aid kits and stations, health personnel, safe drinking water, sanitary facilities, accommodation, washing facilities, domestic waste disposal, etc.;
        c) On-site safety measures and procedures to protect workers against accidents and health risks in the performance of construction-related activities:
            - Site security: access, safety of visitors, separation of work and rest areas, signage, etc.
            - Handling of raw materials: earthwork, gravel, crushed rock, sand, etc.
            - Handling of other materials causing dust development, such as cement;
            - Handling of hydrated lime and other activators and additives;
            - Handling of asphalt;
            - Handling of Asbestos Cement (AC) Pipes;
            - Hazardous materials management;
            - Handling of inflammable materials;
            - Maintenance of vehicles and machinery;
            - Deep Excavation and trenching;

- Emergency prevention, preparedness and response.

iii) Contractor's participation in Health and Safety Training Program
iv) Contractor's participation in HIV/AIDS Awareness and Prevention Program
v) Provide specifics of training and instruction: topics, frequency, modalities, target audiences, instructors, training materials, etc.
vi) Potential Topics:
   a) Occupational safety risks and prevention
   b) Health risks and prevention
   c) Use of personal protective equipment
   d) Safe work procedures: general and specific.
   e) Organization and Management
vii) Organizational structure, personnel, equipment, communication and reporting requirements, accident and incident reports, and procedures and tools to verify and ensure compliance with occupational health and safety requirements.
viii) Annexes should be used, if necessary, to include detailed information on the specific topics of the HSMP, such as (illustrative list):
   a) Accident Report forms.
   b) Dangerous Occurrence forms (near misses).
   c) Safety Audit Forms.
   d) Safety Check List.
   e) Safety Rules.
   f) List of hospitals, emergency evacuation strategy and other arrangements to treat seriously injured staff.
   g) List of personnel trained in first aid and their places of deployment.
   h) List of first aid kits and locations where these will be held.

The Compliance of this Clause by the Contractor is deemed to be covered in his rates quoted in the Bid.

143. PROGRESS REPORTS

The Contractor shall submit a monthly progress report to the Engineer. The formal, content and level of detail shall be determined and agreed by the Engineer.

The Reports submitted by the Contractor shall include a section on Environment and Social Performance Reporting, under which the Contactor shall report on the aspects included in the ESMP and HSMP (Ref. Clauses 141 and 142).

If the Engineer considers it necessary, the frequency of reporting may be increased. Alternatively, the Contractor may be instructed to provide a special progress report for a particular section of works (that is significantly delayed for example), on a more frequent basis (e.g. weekly, or even daily). The Contractor’s rates in his Bid are deemed to cover these costs.

144. DAILY LOGS

The Contractor shall maintain a daily site log. The log book entries shall be prepared in triplicate, with one copy being delivered each day to the Engineer.

The content and format of the Daily Log shall be agreed with the Engineer upon

commencement of the contract. However, typically the log shall include the date, weather, numbers/movement of plant and labour, main areas of work and daily activity/progress, deliveries of plant and materials to site, tests, issues, shut-downs, key instructions, accidents, among others.

In addition, the log sheet shall have a space designated for comments by the Engineer.

The Engineer may, at his discretion, instruct the Contractor to provide daily labour and plant returns. Alternatively, the Engineer may request to review such information.

In addition, the Contractor shall provide the Engineer with copies of all delivery notes of plant and materials delivered to site. The Contractor's rates in his Bid are deemed to cover these costs.

145. TEST FORMS

The Contractor shall prepare, to the satisfaction of the Engineer, test forms to be used for the various components of the works.

All test forms shall be completed, signed and dated by the appropriate persons conducting the tests. The original copy of all test forms shall be submitted to the Engineer. The Contractor's rates in his Bid are deemed to cover these costs.

Test forms shall be submitted to the Engineer regardless of whether the test passes or fails.

146. CONTRACT DOCUMENTS

Without affecting the provisions in the Conditions of Contract, the Contractor shall print and submit at his own cost to the Employer at least ten (10) bound copies of the Contract Documents in the form and manner approved by the Employer. The Contractor's rates are deemed to cover these costs.

147. AS-BUILT AND RECORD DRAWINGS

The Contractor shall prepare, and keep up-to-date, a complete set of "as-built" records of the execution of the works, showing the exact "as-built" locations, sizes and details of the work as executed, with cross references to relevant specifications and data sheets. These records shall be kept on the Site and shall be used exclusively for the purposes of this specification. Two copies shall be submitted to the Resident Engineer prior to the commencement of the Tests on Completion of Works.

In addition, the Contractor shall prepare and submit to the Resident Engineer "as- built-drawings" of the works, showing all works as executed. The drawings shall be prepared as the works proceed, and shall be submitted to the Resident Engineer for his inspection. The Contractor shall obtain the consent of the Resident Engineer as to their format, size, the reference system, and other pertinent details such as compatibility with the Water Service Provider's GIS application.

Prior to substantial completion and Handing Over of the Works, the Contractor shall deliver to the Engineer one complete set of record ("as-built") drawings of all works constructed under the Contract, including all underground works such as pipes, services, cables and conduits.

The Engineer shall review and comment on the draft Record Drawings, and within a further two (2) weeks of receiving the comments, the Contractor shall produce a final set of drawings.

If, during the Defects Liability Period, the Contractor modifies any of the Works, the modifications shall be included as amendments to the As-Built Drawings and all other affected documentation.

Prior to the issue of any Taking-Over Certificate, the contractor shall submit to the Resident Engineer one full-size original copy, six printed copies of the relevant "as-built-drawings" and the corresponding computer files (AutoCAD, Shapefiles, Excel, MS Word, etc.) on CD-ROM and any further Construction Documents specified in the Specifications. The works shall not be considered to be completed for the purposes of Taking-Over until such documents have been submitted to the Resident Engineer.

The compliance of this Clause by the Contractor is deemed to be covered in his rates as quoted in the Bid.

2. CLEARING SITE

201. CLEARING SITE

The Contractor shall demolish, break up and remove buildings, walls, gates, fences, advertisements and other structures and obstructions, grub up and remove trees, hedges, bushes and shrubs and clear the site of the works at such time and to the extent required by the Engineer but not otherwise, subject to the provisions of Clause 15 of the Conditions of Contract: the materials so obtained shall so far as suitable be reserved and stacked for further use; all rubbish and materials for use shall be destroyed or removed from the site, as directed by the Engineer.

Where top soil has to be excavated this shall be removed and stacked on site. After completion of construction, it shall be spread over the disturbed ground, any surplus being disposed of as directed by the Engineer.

Underground structures and chambers where required to be demolished, shall be demolished to depths shown on drawings or as directed. They shall be properly cleaned out and backfilled and compacted with suitable material to the direction and approval of the Engineer.

202. VEGETATION

No allowance will be made for the cutting and removal of crops, grass, weeds and similar vegetation. The cost of all such work will be held to be included in the rates entered in the Bill of Quantities.

203. BUSHES AND SMALL TREES

All bushes and small trees, the main stem of which is less than 500mm girth at 1 metre above ground level shall be uprooted (unless otherwise directed by the Engineer) and burnt or otherwise disposed off as directed by the Engineer.

204. HEDGES

Where directed by the Engineer, hedges shall be uprooted and disposed off by burning.

205. FELLING TREES

Where shown on the drawings or directed by the Engineer, trees shall be uprooted or cut down as near to ground level as is possible. The rates entered in the Bill of Quantities shall include for cutting down, removing branches and foliage, cutting useful timber into suitable lengths, loading, transporting not more than 1 km. and stacking or disposing off all as directed by the Engineer.

For the purpose of measurement trees cut down shall be classified according to their girth at 1 metre above ground level, the cost of grubbing up roots shall be deemed to be covered by the rate for felling trees.

206. GRUBBING-UP ROOTS

Stumps and tree roots shall, unless otherwise directed, be grubbed up, blasted, burnt or removed and disposed of in approved dumps to be provided by the Contractor. Where directed by the Engineer, the holes resulting from grubbing up shall be filled with approved materials, which shall be deposited and compacted in layers not exceeding 225mm loose depth, to the same dry density as that of the adjoining soil. For the purpose of measurement, tree roots shall be classified according to the mean diameter of the stump measured across the cut.

207. WEED CONTROL

The Contractor shall take all necessary precautions against the growth on the site of weeds and remove them as necessary throughout the period of works and maintenance.

The finished base of all footways and elsewhere as directed shall be sprayed with an approved persistent total herbicide at the rate recommended by the manufacturer. The application shall be by an even spray in a high volume of water at about 0.7 to 0.11 litres per square metre. After this application the footways shall receive at least two further waterings before the surface is sealed.

3. EXCAVATION

301. DEFINITION AND CLASSIFICATION OF EXCAVATED MATERIALS

Excavation in the Bills of Quantities shall be classified in two categories:-

1) Common Excavation
Any material which in the opinion of the Engineer can be excavated by use of pick axes and hand levers shall be classified as common excavation. Water logged material shall be included in this class. Murram in any form shall be classified as common excavation.

2) Rock
The decision of the Engineer in classifying rock shall be final and binding. Rock in the Bills of Quantities will be itemised in three classes:-

Class 'A'
Soft rock of the type known locally as 'tuff' which in the opinion of the Engineer cannot be considered as hard rock but which considerably increases the amount of labour needed for its removal shall be known as Class 'A' rock.

Class 'B'
Very weathered phonolite lava containing many fissures and faults shall be known as hard rock. This type of rock contains stones and boulders of unweathered or incompletely formed blacktrap or lava. A boulder or outcrop of hard rock 1.5 cubic metres or less and grey or green building stone in a formation which is massive and geologically homogeneous, will be deemed to be Class 'B' rock.

Class 'C'
Phonolite in a formation which is massive and geologically homogeneous shall be known as Class 'C' rock.

Coral shall be classified as rock of the appropriate Class as described above depending on the hardness.

302. STORAGE AND HANDLING OF EXPLOSIVES AND BLASTING

The removal of hard materials by use of explosives will only be permitted where specified in the Bills of Quantities subject to compliance by the Contractor in all respects with the Explosives Laws of Kenya.

In the Bill of Quantities hard material is classified as rock where blasting will be permitted subject to this clause.

The Contractor shall provide proper buildings or magazines in suitable positions for the storage of explosives in manner and quantities to be approved; he shall also be responsible for the prevention of any unauthorised issue or improper use of any explosives brought on the works and shall employ only licensed and responsible men to handle explosives for the purpose of the works.

The shots shall be properly loaded and tamped and where necessary, the Contractor shall use heavy mesh blasting nets. Blasting shall be restricted to such periods and such parts of the works as the Engineer may prescribe. If, in the opinion of the Engineer, blasting would be dangerous to persons or property or to any finished work or is being carried out in a reckless manner, he may prohibit it, and order the rock to be excavated by other means and payment will be made at the rate for rock for excavation where blasting is permitted. The use of explosives by the Contractor in large blasts, as in seams, drifts, pits, or large holes, is prohibited unless authorized in writing by the Engineer. In the event of wasting of rock through any such blasting, the Contractor shall if required by the Engineer, furnish an equivalent amount of approved materials for fill, 1 cubic metre of rock in-situ being taken to equal 1.5 cubic metre of material in embankment.

303. EXCAVATION FOR FILL

Where excavation reveals a combination of suitable and unsuitable materials, the Contractor shall, wherever the Engineer considers it practicable, carry out the excavation in such a manner that the suitable materials are placed separately for use in the works without contamination by the unsuitable materials.

If any suitable material excavated from within the site is, with the agreement of the Engineer, taken by the Contractor for his use, sufficient suitable filling material to occupy after specified compaction, a volume corresponding to that which the excavated material occupied, shall, unless otherwise directed by the Engineer be provided by the Contractor from his own sources.

No excavated material shall be dumped or run to spoil except on the direction or with the permission of the Engineer who may require material which is unsuitable to be retained on site. Material used for haul roads shall not be re-used without the permission of the Engineer.

304. COMPACTION OF FILL

All materials used in fill shall be compacted to specification by plant approved by the Engineer for that purpose. Maximum compacted thickness of such layers shall not be more than 200mm.

Work on the compaction of plastic materials for fill shall proceed as soon as practicable after excavation and shall be carried out only when the moisture content is not greater than 2 per cent above the plastic limit for that material. Where the moisture content of plastic material as excavated is higher than this value the material shall be run to spoil and an equal volume of material suitable for filling shall be replaced, unless the Contractor prefers, at his own expense, to wait until the material has dried sufficiently for acceptance again as suitable material.

Nevertheless, if with any material the Engineer doubts whether compaction will be obtained within the above moisture limits he may require compaction to proceed only when the limits of moisture content for the compaction of non-plastic materials are within the range of the optimum moisture content and 3 per cent below the optimum moisture content as determined by the laboratory compaction test method described in British Standard 1377: Methods of Test for Soil Classification and Compaction.

If any such non-plastic material on excavation is too wet for satisfactory compaction and the Engineer orders the moisture content to be lowered or raised, such work shall be treated as included in the rates. All adjustments of moisture content shall be carried out in such a way that the specified moisture content remains uniform throughout compaction.

Work shall be continued until a state of compaction is reached throughout the fill, which shall have relative compaction determined according to B.S. 1377 not less than 95% of maximum dry density at optimum moisture contents. For excavation under Roads, House Drives and Car Parks the backfilling shall be compacted in 150mm layers to 100% maximum dry density.

If with non-plastic materials the compacted material has become drier in the interval between the completion of compaction and the measurement of the state of compaction, then the moisture content to be used for the calculation of the air content shall be the mean moisture content for the compaction of such materials as specified above.

305. EMBANKMENTS OVER SEWERS

In carrying embankments over sewer pipes, care shall be taken by the Contractor to have the embankments brought up equally on both sides and over the top of any such structures. Earth embankments shall be formed and compacted in layers of 200mm as the Engineer may direct. The filling immediately adjacent to structures shall be deposited and compacted in accordance with the drawings and approved by the Engineer. The cost of these works shall be included in the prices entered in the Bill of Quantities for the excavations from which embankments are formed.

306. STONE REVETMENTS (STONE PITCHING)

Where shown on the drawings, the slopes of embankments, rivers, streams, watercourses and other surfaces shall be protected against water or other action by hand-set stone facing set on end. The larger stones shall be roughly dressed on the bed and face, and roughly square to the full depth of the joints. No rounded boulder shall be used, or stones less than 225mm in depth of 0.05 cubic metre in volume. The stones shall be laid to break bond, and shall be well bedded on to a 75mm layer of gravel or fine rubble rammed to a uniform surface and the whole work finished to the satisfaction of the Engineer. Where required, a trench shall be excavated at the bottom of the slope to such a depth as will ensure a safe foundation for the revetment.

307. TIPPED REFUSE ON SITE

Tipped refuse other than artificial deposits of industrial waste or shale found on the site shall be removed and disposed off in a spoil heap to be provided by the Contractor.

308. REMOVAL OF INDUSTRIAL WASTE, ETC.

Artificial deposits of industrial waste or shale found on the site shall be removed and disposed off as directed by the Engineer. Should any particular deposits consist of or contain material which in the opinion of the Engineer is suitable for incorporation in fills, all such material shall be used accordingly and deposited in layers and compacted as specified. The prices entered in the Bill of Quantities for the excavation of the material shall include loading, transportation, disposal and compaction of same as and where directed.

309. LAND SLIPS

Remedial works and/or the removal of materials in slips, slides or subsidences and overbreaks of rock extending beyond the lines and slopes, or below the levels shown on the drawings or required by the Engineer, will not be paid for.

310. CLASSIFICATION OF MATERIAL FROM SLIPS

The classification of material from slips or slides will be in accordance with its condition at the time of removal, regardless of prior condition. Measurement of overbreak in rock excavation shall be that of the space originally occupied by the material before the slide occurred and regardless of its subsequent classification.

311. BORROW PITS

Where for any reason, it becomes necessary to form borrow pits, these shall be located and the work executed in all respects to the instructions of the Engineer. They shall be regular in width and shape and admit of ready and accurate measurement, and shall be properly graded and drained and finished with neatly trimmed slopes.

312. STREAMS, WATERCOURSES AND DITCHES

Excavations carried out in the permanent diversion, enlargement, deepening, or straightening of streams, watercourses, or ditches shall be performed as directed by the Engineer. The rates for such excavations shall include for excavated materials and all pumping, timbering works, and materials necessary for dealing with the flow of water.

313. FILLING OLD WATERCOURSES

Where watercourses have to be diverted from the sites of embankments or other works, the original channels shall be cleared of all vegetable growths and soft deposits and carefully filled in with approved materials deposited and compacted as directed by the Engineer.

314. OPEN DITCHES

Open ditches for drainage purposes shall be cut where and of such cross section as the Engineer shall direct and where so required by him they shall be constructed before the cuttings are opened or the embankments begin. The sides shall be dressed fair throughout and the bottom accurately graded so as to carry off the water to the outlet to be provided. The material excavated from the ditches shall be disposed of as directed by the Engineer.

315. CLEARING EXISTING DITCHES

Where directed by the Engineer, existing ditches shall be cleared by removing vegetable growths and deposits. The sides shall be shaped fair throughout and the bottoms properly graded. Material removed from existing ditches shall be disposed of in tips provided by the Contractor. The rates included in the Bill of Quantities for clearing ditches shall include for maintaining and keeping clean until and up to maintenance period.

316. EXCAVATION FOR FOUNDATIONS BELOW OPEN WATER

The rates for excavation for foundations below the water level shall include for the cost of all temporary close timbering and shoring, sheet piling, coffer dams, caissons, pumps and other special appliances required and for the draining of any water in the excavation.

317. TRENCHES OF GREATER WIDTH AND DEPTH THAN NECESSARY

The Contractor shall not be entitled to payment in respect of excavation to any greater extent, whether horizontally or vertically, than is necessary to receive any structure for which the excavation is intended, except where a separate item is provided for additional excavation for working space, timbering, or other temporary work. Excavation to a greater depth or width than directed shall be made good with suitable materials to the satisfaction of the Engineer and at the Contractor's cost.

318. SUPPORTS FOR TRENCHES

The sides of trenches shall where necessary be adequately supported to the satisfaction of the Engineer by timber or other approved means.

319. PROVISION OF SPOIL HEAPS

The Contractor shall provide spoil heaps at his own expense for the disposal of surplus material and all rubbish collected when clearing the site and during the construction of the works. The sites for these shall be approved by the Engineer.

320. USE OF VIBRATORY COMPACTION PLANT

Where vibratory rollers or other vibratory compaction plant is used, the mechanism for vibration shall be kept working continuously during compaction operations, except during periods when the Engineer permits or directs discontinuance of vibration.

Unless otherwise permitted by the Engineer, the frequency for vibration shall be maintained within the range of amplitude and frequency recommended by the manufacturers of the plant for the material to be compacted. The frequency shall be recorded by a tacheometer indicating speed of rotation of any shaft producing vibrations.

321. WATER IN EXCAVATIONS

All excavations shall be kept free from water, from whatever source, at all times during construction of works until in the opinion of the Engineer, any concrete or other works therein are sufficiently set. The Contractor's rates are deemed to cover compliance with this requirement.

The Contractor shall construct any sumps or temporary drains that the Engineer may deem necessary and shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner approved by the Engineer so as to ensure that excavations are kept dry.

The Contractor shall provide all plant, labour and materials required for such work and all costs incurred shall be deemed to be included in his rates for excavation.

4. PIPELINE CONSTRUCTION WORKS

401. HANDLING OF PIPES AND FITTINGS

The Contractor shall exercise care in the handling of all pipes, specials, valves etc., to prevent damage to the structure surfaces and to the ends of the pipes.

402. LOADING AND UNLOADING

Normally loading and unloading of small diameter pipes and fittings can be undertaken by hand; where mechanical means are used care should be exercised to ensure that the handling methods do not damage the pipes and fittings.

403. STORAGE

The Contractor shall comply with the manufacturer's specification regarding the storage of pipes, fittings and valves. Where storage dumps are to be provided along the route of the pipeline, these will be subject to the Engineer's approval. The cost of so providing shall be borne by the Contractor and deemed to be covered by his rates in the Bill of Quantities.

404. TRANSPORT

The Contractor shall provide such transport arrangements as will effectively cater for the lengths of pipes provided and the material of the piping. Adequate support shall be provided so as to ensure that the piping and fittings are not subject to excessive movement.

405. EXAMINATION OF PIPES AND FITTINGS

The Contractor shall examine all pipes, valves, fittings and other materials to ascertain that they are in perfectly sound condition before commencing to lay the pipes, valves etc.

406. INTERFERENCE WITH FENCES, DRAINS AND OTHER SERVICES

The Contractor shall ensure the proper reinstatement of fences, drains, telephone lines, KP&L cables etc. where affected by his work. All services shall be adequately protected and propped to the satisfaction of the Engineer. The Contractor shall be liable for any damage caused to the services due to his failure to provide adequate protection.

407. METHOD OF EXCAVATION

The Contractor is deemed to have covered in his excavation rates all the work that is necessary in order to comply with the provisions of the Specifications in general and this Clause in particular.

a) The Contractor shall excavate the pipe trenches in the line and to the depths indicated on drawings or as indicated by the Engineer. Except where otherwise indicated on the drawings or directed by the Engineer, it is intended that the trench shall be excavated to such a depth as will allow of a minimum cover of 600mm over the top of the barrel of the pipe when laid. All trenches shall be excavated in open cuttings and for trenching to uPVC piping, shall not be opened too far in advance of pipe laying.

b) For the purpose of measurement, the width of trench shall be taken as the nominated width for the particular size of sewer, irrespective of the width of trench the Contractor may choose to excavate.

Nominated trench width for:

75mm main	0.5m	300mm main	0.7m
100mm main	0.6m	400mm main	0.8m
150mm main	0.6m	500mm main	0.9m
200mm main	0.6m	600mm main	1.0m
225mm main	0.6m	700mm main	1.1m
250mm main	0.6m	800mm main	1.2m

For two or more pipes in the same trench the nominated width shall be the distance between the centres of the outer pipes plus the internal radii of the outer pipes plus 400mm.

c) Where the trench passes through grassland, arable land or gardens, whether enclosed or otherwise, the turf, if any, shall be carefully pared off and stacked, and the productive soil shall be carefully removed for a width of 600mm greater than the nominated trench width, or equal to the overall width of track of excavating machine, whichever is greater, and laid aside to be subsequently used in reinstating the surface of the ground after the trench has been refilled.

d) The bottom of the trench shall be properly trimmed off, and all low places or irregularities shall be levelled up with fine material. Where rock or large stones are encountered, they shall be cut down to a depth of at least 100mm below the level at which the bottoms of the barrel of the pipes or flanges are to be laid, and covered to a like depth with fine material, so as to form a fine and even bed for the pipes. The bottom of trenches to accommodate uPVC piping shall be hardened by tamping in gravel or broken stone in all soft spots. The bedding shall consist of soil which can be properly compacted to provide support for the pipe and to comply with Clause 409 b).

e) Joint holes shall be excavated to suit minimum dimensions as will allow the joints to be well and properly jointed.

f) The pipe trench shall be kept clear of water at all times as per Clause 321 of this Specification.

g) The Contractor shall, wherever necessary, by means of timbering or otherwise, support the sides of the trench so as to make them thoroughly secure, and afford adequate support to adjoining roads, land, buildings and property, during the whole time the trench remains open and shall remove such timbering when the trench has been backfilled. The cost of such timbering or other work shall be deemed to be included in the rates for excavation. In case the Contractor is instructed by the Engineer to leave any portion of such timber in position after backfilling the trench, he will be paid for it accordingly.

h) The clear width inside the timbering shall be at least 150mm in excess of the external diameter of the pipe being laid, in order to allow it to be freely

lowered into position, in the trench without damage to the external protection.

i) Should the excavation be taken out to a greater depth than is specified the bottom shall be made good to the correct level with Class 15/20 concrete or other material approved by the Engineer. No payment shall be made for any over excavation carried out by the Contractor nor for the cost of filling up to required levels.

j) If a mechanical excavator is used by the Contractor, he shall indemnify the Employer against all claims for damage which in the opinion of the Engineer, may be caused by the use of this plant.

k) The Contractor shall fix Sight Rails for use with boning rods at intervals of not more than 30 metres and temporary Bench Marks related to the Survey of Kenya Datum shall be provided at such intervals as directed by the Engineer.

408. PIPE LAYING

a) Pipelines shall be laid in straight lines and/or smooth curves as indicated on the drawings. The vertical profile of the pipe shall be to even gradients. Any pipes not so laid shall be removed if so directed by the Engineer, and re-laid in proper manner at the Contractor's expense.

In laying the pipes and specials care shall be taken not to damage the protective linings and the pipes shall be handled with tackle if so directed by the Engineer.

The pipes and specials shall be checked for flaws before they are lowered into the trench. After the pipes or specials have been checked they shall be cleaned and set to proper gradient and line so that there is a continuous rise from each washout to air valve.

When laying pipes, final connection at any fixed joints shall be deferred until the majority of the pipeline has been covered with backfill.

b) Where applicable, large diameter curves to mains shall wherever possible be formed by allowing for deflection at flexible joints, not exceeding 3 degrees, or as specified by the manufacturers.

c) In jointing of the pipes and specials the Contractor shall comply with the standards adopted for the various types of joints as specified.

d) In laying pipes and specials with flanged joints, flanges shall be brought together and bolted with the faces absolutely parallel. A rubber jointing gasket ring 3mm thick shall be used in each flange joint and one washer with and not provided for each bolt.

The bolts shall be tightened up gradually and equally in the customary manner in order to distribute the stress evenly over the flange. If it is found necessary to deviate slightly from the normal run of the flanged piping, the deflection shall be obtained by means of a bevelled gun metal ring washer between the flanges.

e) The Contractor shall fix the gate valves, air valves and washout pipes all in accordance with the drawings.

f) The Contractor shall, subject to approval of the Engineer, cut pipes to such lengths as directed. Pipes should be cut off clean and square with the axis. Cuts should be made with an approved cutting device dependant on the type of pipe specified. Ends of pipes should be tapered by means approved by the Engineer if mechanical joints are to be used.

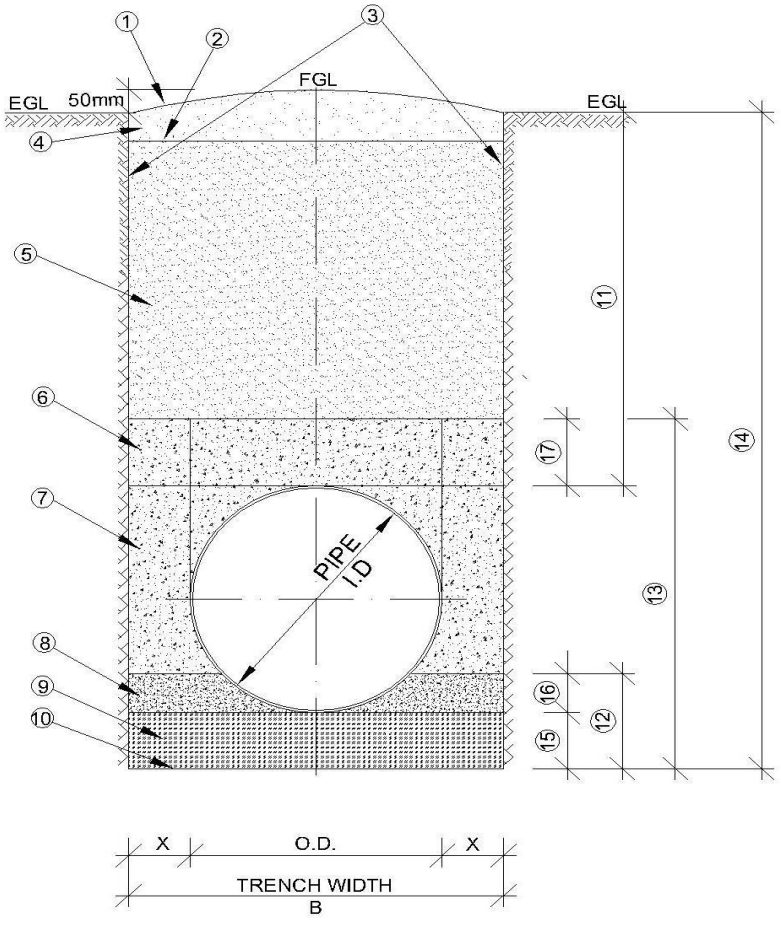
g) Equipment for tapping off the mains under pressure may be employed in the making of service or branch connections. The Contractor is required to choose a suitable method for fixing of the ferrule to the type of pipe specified, to the Engineer's approval.

409. BACKFILLING OF PIPE TRENCHES

i) Before commencing the placing of embedment in the trenches, the Contractor shall obtain approval from the Engineer as to the methods he proposes to use and he shall demonstrate by means of tests that the specified compaction can be achieved (according to BS 1377 or ISO 22476 using the "sand replacement" method). The method of compaction and the testing thereof shall be at all times to the approval of the Engineer and in general at a frequency of once every 30 metres unless this is specifically relaxed based on continuously good in-situ test results.

ii) Backfilling shall only take place with the prior approval of the Engineer.

iii) Typical trench details are shown below



1. Surface
2. Bottom of road construction (if any)
3. Trench walls
4. Top soil
5. Main backfill
6. Initial backfill
7. Sidefill
8. Upper bedding
9. Lower bedding
10. Trench bottom
11. Depth of cover
12. Depth of bedding (refer to Note iii)
13. Depth of embedment
14. Trench depth
15. Depth of lower bedding
16. Depth of upper bedding
17. Depth of initial backfill

Notes:

i) Compaction is the deliberate densification of soil during the construction process, whereas consolidation is the subsequent time-dependent densification after construction.

ii) The embedment is the arrangement and type(s) of materials(s) around the buried pipeline which contributes to its structural performance. Attaining cited minimum compaction requirements is mandatory for embedment.

iii) Minimum cover is 1000 mm for all pipes. May be reduced at Engineer's discretion.

iv) The embedment section comprises all materials below the pipe and surrounding the pipe, extending 300 mm above the crown of the pipe. All material above this point comprises the main backfill

v) The embedment section comprises the bedding (lower and upper), the side-fill, and the initial backfill (which extends from the crown of the pipe to 300 mm above the crown)

vi) The embedment material shall be free from tree roots, lumps, stones, organic matter, fragments of rock larger than 20 mm, or similar objects, which through impact or by concentrating imposed loads might damage the pipes. Black cotton soil shall not be used as embedment material.

vii) Where pipes are not to be surrounded in concrete or bedding materials (S1 to S4) described above, the pipe zone material placed around the pipes shall be selected and screened as necessary, free from and to the approval of the Engineer.

viii) Classification of embedment materials for flexible (steel, uPVC, HDPE) and semi-rigid (DI) pipes is indicated in Table below.

Embedment Class	Embedment Material Allowed	Notes
S1 and S2	Class S1: Gravel – single size Class S2: Gravel – graded	Normally processed granular materials where specified as bedding for ferrous pipes
S3 - S4	Class S3: Sand and coarse grained soil with less than 12% fines Class S4: Coarse grained soil with more than 12% fines OR Fine grained soil, liquid limit less than 50%, medium to no plasticity and more than 25% coarse grained material	These can be "as dug" soils but require particularly close control when used with low stiffness pipes. Class S3 shall be used for epoxy lined steel pipes whilst Class S4 is suitable for cement mortar lined ferrous pipes

ix) Granular material for beddings shall consist of aggregate to BS 882 and shall conform to the grading shown in Table below.

Nominal Pipe	Grading (mm)	
	S1 Lower Bedding	S2 Lower Bedding
80-100	10 single sized gravel	10 single-size gravel
150	10 to 14 single-size gravel	14 to 5 graded
200-500	10, 14 or 20 single-size gravel	14 to 5 graded or 20 to 5 graded
>500 >1000	10, 14, 20 single-size crushed rock or gravel	14 to 5 graded or 20 to 5 graded

x) The embedment material shall be in accordance with the above specifications, and not less than:

a) Class S3 material for epoxy lined steel pipes
b) Class S4 material for cement-mortar lined ferrous pipes (Ductile)
c) Class S2 material for thermoplastic pipes

xi) Where the 'as-dug' trench material meets the bedding class requirements as specified, or will meet the requirements through careful screening and processing, the Contractor may incorporate such material into the embedment, subject to the Engineer's approval. No additional payment shall be made for screening and processing.

xii) If the quantity of appropriate embedment material which can be obtained from the pipe trench excavation (with or without screening) is insufficient, the Contractor shall transport suitable material from other excavations on site, or from off-site. No additional payment shall be made for such imported material

xiii) For all bedding classes, compaction shall be not less than 90% Modified Proctor Density (MPD) at optimum moisture content (+5% 1 -2%)

xiv) The placing and compaction of pipe embedment shall only be undertaken in the presence of the Engineer, unless written authority from the Engineer has been granted.

xv) Sidefill shall be placed simultaneously on both sides of the pipe in layers not exceeding 150 mm thickness and compacted using hand rammers to achieve the required density, taking particular care to compact the material under the barrel of the pipe and around joints. Layer thickness is however subject to consistently achieving 90% MPD or better, failing which layers shall be reduced in depth as necessary to achieve the necessary compaction.

The compaction shall be in accordance with Section 3.6 of BS 1377: 1990, Part 4 using a 4.5 kg rammer. In-situ density tests shall be carried out by the sand replacement method in accordance with BS 1377: 1990, Part 9 at every 30 metres or as directed by the Engineer.

xvi) Pipes shall never be laid directly on cohesive, rocky or stony material. Where the natural trench bottom meets the bedding class required, this shall initially be loosened to a depth of 10 cm and then re-compacted to at least 90% MPD and then the surface loosened on the day of and prior to laying.

xvii) In rock excavation, the pipes shall be bedded on concrete or selected granular fill to a minimum thickness of 150 mm and the exclusion of rocks and other hard material to at least 300 mm around the pipe, leaving proper joint holes and subsequently making good with selected materials to the Engineer's approval.

xviii) The main backfill shall be filled with approved backfill material obtained from the trench excavations, free from clay lumps, boulders and rock fragments larger than 100 mm. The material shall be placed in layers not exceeding 150 mm thickness and compacted using approved mechanical rammers.

xix) The lower bedding for the pipes shall have a minimum thickness of 100 mm in normal trenches, and 150 mm where rock/stones are present and at designated road crossings. Bedding material shall be compacted in layers not exceeding 50 mm thickness.

xx) In trenches where there is a continuous accumulation of ground water the trench shall, after obtaining the approval of the Engineer, be over-excavated by 150 mm and shall be backfilled using compacted free-draining granular material.

xxi) Where mechanical-ramming of the backfill is employed, the machines shall be to the approval of the Engineer and soil shall be compacted by hand for a depth of not less than 50 cm to give sufficient cover to the pipes and obviate risk of damage to them before the mechanical rammer is brought into operation. The rammer shall not cease to be used on any length of trench until thorough compaction has been obtained.

xxii) The pipe trench shall be backfilled entirely without leaving out areas around and at pipe joints uncovered, for subsequent filling. To facilitate the subsequent location of any suspected leaking joints during pipe testing, should this become necessary, the Contractor shall provide marker pegs at regular intervals and/or use a handheld GPS to be able to relocate joint positions.

xxiii) Where minimum cover cannot be maintained, including roads and trafficked areas, then the pipe must either be laid in a protective ferrous sleeve or be protected by a 150 mm thick reinforced concrete slab above the pipe. A minimum of a 150 mm layer of appropriate grade bedding material must first be placed and compacted as a cushion above the crown of the pipe before the slab is laid, and the slab must extend at least 300 mm out beyond either side of the trench.

410. MAKING GOOD SUBSIDENCE AFTER REFILLING

Should any but very localised subsidence occur of the pipe trench after refilling and before the expiry of the maintenance period, the Contractor shall first demonstrate that such subsidence is only to the backfilling above the pipe and not to the full depth of pipe, embedment, bedding or sub-soil itself.

Should this not be so demonstrated then the Contractor at his own expense shall, excavate and remove the pipe or pipes affected and return the bottom of the trench to grade through a process of over- excavation, re-compaction or use of a lean concrete mix as determined by the Engineer, who shall also determine whether or not the affected pipes may be re-used or replaced.

The affected section or sections will in any event be liable for a further twelve months maintenance period. All refilling necessary due to subsidence in pipe trench backfill shall be thoroughly compacted by ramming.

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 topsoil has been replaced, the topsoil shall first be removed before any hollows are made up before being replaced.

411. REINSTATEMENT OF SURFACES

All surfaces of roads, fields, paths, gardens, verges, etc. whether public or private which are affected by the operations of the Contractor shall be temporarily restored by him in the first instance and permanently reinstated in the second instance when the ground has consolidated fully.

The Contractor shall be responsible for the temporary reinstatement and permanent reinstatement of all surfaces whether or not the area requiring restoration is within the limits of his excavations if the necessity for the restoration arises from causes due to the operations of the Contractor. The Contractor's prices shall include for restoring all surfaces so damaged to their original condition, as no extra payment will be made for any such work. The Contractor shall take all necessary measures to ensure that no toxic materials that may cause damage to vegetation or livestock or pollute streams or water-courses are used in any temporary restoration or permanent reinstatement and shall indemnify the Employer against any claims arising out of the use of such materials.

Temporary restoration shall be carried out immediately after the excavations have been refilled by returning the excavated material to the position from which it was removed and adding such suitable materials as may be required and consolidating the various materials as the Work proceeds in order to provide a surface that is adequate for the purpose that the original surface fulfilled. Temporary surfaces shall be maintained in a condition

satisfactory to the Engineer and/or responsible Authority until the permanent reinstatement is made. In the case of roads, the surface shall be necessary to consolidate the filling and keep the surface fit for traffic, suitable material being added to all places which have sunk or become rough.

For the purposes of temporary and permanent reinstatement in bitumen and murram or gravel surfaced roads the surface width of trenches shall be increased by 300 mm on each side of the trench for a depth of 300 mm to provide a solid abutment for the surfacing material.

Reinstatement of murram and gravel surfaced roads shall consist of approved "as dug" material placed in one layer 250 mm thick thoroughly compacted by an approved roller and surface blinded with fine material so as to leave a tight closed even surface, all to the satisfaction of the Engineer.

Temporary reinstatement of trenches in bitumen surfaced roads shall comprise a layer of compacted hardcore, of minimum thickness 150 mm, topped with a 75 mm layer of surface material taken from the original surface together with any additional material to form a satisfactory running surface. The surface shall be well rolled and sealed with a coat of approved cold applied bituminous emulsion, applied with an approved sprayer at the rate of approximately 2 litres/m2. The emulsion shall be blinded immediately with quarry dust or sand approved and then rolled with an 8 tonne roller.

The quality and grade of bitumen shall be suitable for the climatic conditions of the area and shall otherwise conform to BS 434.

Permanent reinstatement shall not be made until the ground has consolidated permanently and until approval to do so is received from the Engineer. It shall be carried out with materials similar to those that were used in the original Work to the entire satisfaction of the Engineer and/or responsible Authority. In the event of further settlement occurring after the completion of the permanent reinstatement the Contractor shall forthwith make good the reinstatement to the approval of the Engineer or responsible authority.

Trenches in open ground shall be reinstated to the condition in which the ground was found before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

In verges and other grass surfaces the topsoil shall be removed, stored and replaced after consolidation of the filling and planted or seeded with approved grass. Should subsidence occur, it shall be made good with additional topsoil and be replanted with grass or re-seeded. New grass shall be planted if for any reason the grass fails to grow or is destroyed.

The trenches, channels, gutters and kerbs shall be reinstated to the condition in which they were before excavation was commenced. The final surface of the trench shall be flush with the surrounding ground.

If at any time any trench becomes dangerous, the Engineer shall be at liberty to call upon the Contractor to restore it to a proper condition at three hours' notice and should the Contractor fail to carry out the work, have it done at the Contractor’s expense.

If the work or 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 within one week of being ordered to do so by the Engineer, any remedial work considered necessary may be undertaken by the Employer and/or the responsible authority at the Contractor's expense.

412. ANCHOR BLOCKS AND SUPPORTS

Concrete Class 15/20 shall be placed in anchor blocks at all changes of direction of the pipeline exceeding 6 degrees and wherever else required to withstand thrust resulting from internal water pressure e.g. at blank ends. Concrete in plinths shall be placed where specified.

413. CHAMBERS AND SURFACE BOXES

Gate valves, air valves and fire hydrants etc. shall be provided with suitable chambers or surface boxes in accordance with detailed drawings. In roads and footpaths the boxes shall have metal covers laid flush with the surface. Indicator posts to suit shall also be provided.

414. PRESSURE TESTING OF PIPELINES

a) The Contractor shall test a section of main as long as possible subject to the maximum length of open trench approved by the Engineer. The test shall be carried out within 12 working days of the completion of such section of the main.

b) The pipeline shall be adequately anchored during the test at stop ends or valves to prevent movement under the test pressures.

c) The test section shall be filled with water and great care should be taken to drive out all air through air valves, ferrules etc. The test pressure is to be at least 1.5 times the nominal working pressure for the class of pipe being tested and is to be applied for at least 2 hours.

d) The leakage from the mains and connections from each section tested shall be according to SRN 316, i.e. not exceeding 0.02 litres per millimetre of nominal bore per kilometre of pipeline per 24 hour per bar of applied pressure head.

The determine the rate of leakage, the Contractor shall furnish a suitable hydraulic test pump, pressure gauge, connections and water meter or other appliance, for measuring the amount of water pumped. The pressure shall be raised to the amount required and specified by the Engineer, and shall be so maintained for a period of not less than two hours or whatever longer period as required by the Engineer to examine every joint to satisfy himself that they are sound.

If the leakage is at a greater rate than that specified, the Contractor shall re- excavate the trench where necessary and shall re-make the joints and replace defective work until the leakage shall be reduced to the allowable amount.

e) The Employer shall charge the Contractor the cost of any couplings required to join up tested lengths of main if, in the Engineer’s opinion, greater lengths could reasonably have been tested or if failure under test, requires the pipe to be cut, or

other methods of laying should have been adopted.

Water used in testing the main shall be supplied by the Contractor. The Contractor shall carry out all work which may be necessary for making temporary connections to the existing mains to obtain water for testing at his own expense.

In carrying out the test for water tightness the Employer only shall authorize the operation of all valves, but the Contractor shall provide all the necessary labour to assist in the opening and closing of the valves to the Engineer's instructions, and he shall allow in his prices for all his expenses in connection with testing on completion. The Engineer shall be the sole judge of water tightness.

415. CLEANING AND STERILISING OF PIPELINES

a) When a pipeline is complete and where applicable, has successfully passed the test, it shall be thoroughly washed out, using if possible, an open end. Thereafter it shall be sterilized by being filled with a suitable solution containing not less than 20 p.p.m. of free available chlorine or such other sterilizing agent as the Engineer shall approve. After standing for 24 hours the main shall again be washed out and refilled with mains water prior to the taking of bacteriological samples. The Contractor shall provide all necessary stop-ends, fittings and chemicals for this work.

b) Emptying and washing out of the pipes shall be done in such a manner as not to damage the trench or cause undue flooding of the vicinity, and the Contractor shall supply and use piping, specials and/or hose as may be necessary to facilitate the flow of water to the nearest drain or watercourse. Water used for washing out and sterilizing may be supplied by the Employer when a suitable supply is available but all expenses should be payable by the Contractor.

Before any section of the main is put into use, a bacteriological sample or samples will be taken by the Engineer's Representative and only on receipt of a satisfactory certificate from a Medical Research Laboratory or similar organisation will the main or section of main be permitted to be put into supply and be considered as having been substantially completed.

Any expenditure involved in providing facilities or materials for the taking of samples shall be included in the Contractor's Bidding rates and the Engineer will specify and shall be the sole judge as to the number of samples required and the points at which they are to be taken.

The cost of the bacteriological examination will be borne by the Employer but if the sample or samples are not satisfactory, the cost of any subsequent analysis will be borne by the Contractor.

416. CLEARANCE OF SITE

The Contractor shall remove all surplus pipes, specials and other fittings from the site as directed by the Engineer. The site of works shall be levelled and all surplus excavation, debris, cut trees or bushes shall be carted to approved tip sites.

5. PIPES, FITTINGS, VALVES AND METERS

501. GENERAL

The approval in writing or otherwise by the Engineer of any material shall not in any way whatsoever relieve the Supplier from any liability or obligation under the Contract and no claim by the Supplier on account of the failure, insufficiency or unsuitability of any such materials will be entertained.

a) All items shall be suitable for water works purposes and for use with cold water installation and operation being in a tropical climate.

b) All items hereinafter specified shall be to such other Standard or Specification which in the opinion of the Consultant provides for a quality of material and workmanship. The Standard or Specification must be submitted to the Consultant for approval before commencement of work.

c) All ferrous pipes and fittings shall be coated with a protective paint suitable for use in and transport through a tropical climate.

d) The Supplier shall supply to the Purchaser a certificate stating that each item supplied has been subjected to the tests hereinafter laid down and conforms in all respects to the said Specification.

e) The Supplier shall provide adequate protection to all piping, flanged items and valves so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.

f) All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.

g) The Supplier should exercise diligence to provide the best material.

h) Where applicable, the manufacturer's Specification should accompany all offers. The name of the manufacturer must in every case be stated.

i) Where necessary the Supplier shall provide rubber gaskets to comply with EN 1514, DIN 2693 or DIN 2697 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.

j) Any articles required under this Contract which are found to be faulty due to a crack, flaw or any other reason or is not in accordance with the Specification stipulated will not be accepted nor will the Purchaser be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Consultant, be rendered usable, the Supplier may deal with it accordingly and include it in the Contract at a price to be mutually agreed. Straight pipes which have been cut will be accepted at the discretion of the Consultant, provided the length is not less than 4 metres or two thirds of the standard length whichever is the lesser and will be priced pro-rata.

k) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Consultant prior to the Supplier obtaining the total requirements.

502. UNPLASTICISED PVC (uPVC) PIPES

Unplasticised PVC piping shall be in accordance with BS EN 1452.

The maximum sustained working pressures to which the pipes and fittings will be subjected is based on water at a temperature of 20 degrees centigrade.

The Supplier shall submit full details of the pipes he intends to supply.

The pipes upto and including 40mm diameter can be of a solvent weld type. The pipe shall be supplied with interchangeable sockets preformed at the factory and of such internal diameter that it takes the plain end of the pipe with the same nominal diameter.

The joint shall sustain the end thrust to which the pipe shall be subjected. The Supplier shall supply sufficient quantity of the cleaner and adhesive which shall be required to make the joints with the pipes.

The pipes of 50mm diameter and over shall consist of a grooved socket at one end of the pipe. The socket shall be designed to give a clearance fit on the outside diameter of the parent pipe. The sealing medium which shall seat in the groove shall be a rubber ring.

If the formation of the socket and groove results in the thinning of the original wall thickness of the pipe, it shall be compensated for by shrinking on to the outside of the socket area a reinforcing sleeve of the same material as the pipe. The socket and groove shall incorporate no sharp angles where the stress points are created.

The joint shall take 10% deformation of the spigot at the point where it enters the socket without leakage from the pipe when subjected to the test pressure specified for the pipe. Thermal expansion of the pipe shall be accommodated in the joint. The joint shall be capable of linear deflection up to 3 degrees.

The sealing ring shall be of first grade natural rubber and the physical properties of the mix shall meet the requirements of DIN 4060, BS2494 or EN 681.

The Supplier shall supply sufficient quantity of any lubricant or other material which shall be needed to make the joint which shall be assembled by hand.

The Supplier shall submit full details of the type of joint offered and a full description of the method of jointing.

The fittings shall have the same type of joint as for the pipes to be used. The Supplier shall submit full details of the materials dimensions and test pressures of the fittings offered.

Precautions shall be taken to avoid damage to the pipes and fittings.

In handling and storing the pipes and fittings, every care shall be taken to avoid distortion, flattening, scoring or other damage. The pipes and fittings shall not be allowed to drop or strike objects. Pipe lifting and lowering shall be carried out by approved equipment only.

Special care shall be taken in transit, handling and storage to avoid any damage to the ends.

Pipes and fittings shall be marked at not greater than one metre intervals showing their class and diameter.

503. HIGH DENSITY POLYETHYLENE (HDPE) PIPES

HDPE Pressure Pipes and Fittings shall be manufactured using a pre-compounded blue pigmented PE100 resin, having a Minimum Required Strength (MRS) value of ≥ 10.0 MPa, at a service temperature of 20°C for a minimum design service life of 50 years.

The pipes and fittings shall be manufactured in accordance with EN 12201:2011, ISO 4427 / ISO 4437 or other acceptable International Standard. The Pipes and Fittings shall comply with the following:

Pipes:	Material:	Polyethylene PE100 (MRS100), density ≥0.95 kg/dm³
	Colour:	**Blue** **Black with Blue stripes** **Black with Blue outer coextruded layer**
	Pressure Rating:	SDR 17 – PN10 SDR 11 – PN16
	Supply Lengths:	All pipe sizes up to and including OD 75 mm shall be supplied in coils of 50 or 100 meters. All pipes, OD 90mm and above shall be supplied in straight lengths not exceeding 12metres.
Fittings:	Material:	Polyethylene PE100 (MRS100), density ≥0.95 kg/dm³
	Colour:	Black or Blue
	Type of Joint:	Electrofusion / Spigot type for Butt Fusion / Compression (for sizes 110mm and below)
	Pressure Rating:	SDR 17 – PN10 SDR 11 – PN16

Diameters: *as per EN 12201-2*

PE 100 (MRS10), σ_{all} = 8.0 MPa			**PN 10.0**		**PN**	
Outside Diameter (d) (mm)	**Tolerance on OD (mm)**	**Maximum Ovality (mm)**	**SDR 17 Series 8**		**SDR 11 Series 5**	
			Min. WT (mm)	**Tolerance (mm)**	**Min. WT (mm)**	**Tolerance (mm)**
16.0	0.3	1.2	-	-	-	-
20.0	0.3	1.2	-	-	**2.0**	0
25.0	0.3	1.2	-	-	**2.3**	0
32.0	0.3	1.3	**2.0**	0.3	**3.0**	0
40.0	0.4	1.4	**2.4**	0.4	**3.7**	0
50.0	0.4	1.4	**3.0**	0.4	**4.6**	0
63.0	0.4	1.5	**3.8**	0.5	**5.8**	0
75.0	0.5	1.6	**4.5**	0.6	**6.8**	0
90.0	0.6	1.8	**5.4**	0.7	**8.2**	1
110.0	0.7	2.2	**6.6**	0.8	**10.0**	1
125.0	0.8	2.5	**7.4**	0.9	**11.4**	1
140.0	0.9	2.8	**8.3**	1.0	**12.7**	1
160.0	1.0	3.2	**9.5**	1.1	**14.6**	1

PE 100 (MRS10), σ_{all} = 8.0 MPa			PN 10.0		PN	
Outside Diameter (d) (mm)	Tolerance on OD (mm)	Maximum Ovality (mm)	SDR 17 Series 8		SDR 11 Series 5	
			Min. WT (mm)	Tolerance (mm)	Min. WT (mm)	Tolerance (mm)
180.0	1.1	3.6	**10.7**	1.2	**16.4**	1
200.0	1.2	4.0	**11.9**	1.3	**18.2**	2
225.0	1.4	4.5	**13.4**	1.5	**20.5**	2
250.0	1.5	5.0	**14.8**	1.6	**22.7**	2
280.0	1.7	9.8	**16.6**	1.8	**25.4**	2
315.0	1.9	11.1	**18.7**	2.0	**28.6**	3
355.0	2.2	12.5	**21.1**	2.3	**32.2**	3
400.0	2.4	14.0	**23.7**	2.5	**36.3**	3
450.0	2.7	15.6	**26.7**	2.8	**40.9**	4
500.0	3.0	17.5	**29.7**	3.1	**45.4**	4
560.0	3.4	19.6	**33.2**	3.5	**50.8**	5
630.0	3.8	22.1	**37.4**	3.9	**57.2**	5
710.0	6.4	24.9	**42.1**	4.4	**64.5**	6
800.0	7.2	28.0	**47.4**	4.9	**72.6**	7

Performance Characteristics

The pipes shall have the following basic minimum performance characteristics:

Paramete	Unit	Val
Average Density as per ISO 1183	Gm/cm^3	≥
Melt Flow Index MFI 190°C / 50N as per ISO 1133	Gm/10 min.	0.4-0.55
Minimum Tensile Strength	N/mm^2	2
Elongation at Break	%	≥ 600%
E-Modulus (Modulus of Elasticity)	N/mm^2	120
Minimum Radius of Curvature at 20°C		25 x OD
Linear Coefficient of Thermal Expansion (VDE 0304)	$°K^{-1}$	1.3×10^{-4}

Marking and Identification

Pipes shall be clearly and indelibly marked to show the following:

- Name of Manufacturer / Brand
- Nominal Diameter x Minimum Wall Thickness
- Material Classification (i.e. PE100)
- Standard Dimension Ratio and Pressure Rating (SDR17 PN10 or SDR11 PN16)
- Reference Standard of Manufacture (e.g. EN 12201)
- Date of Manufacture

Transportation, Storage and Laying of Pipes and Fittings

Before transporting HDPE pressure pipes the loading surface of the vehicle must be cleaned and free from projecting nails, screws or other sharp objects. The bottom layer of all pipes must as far as possible be in contact with the loading surface throughout their entire length and not project beyond it. The pipes must be secured from slipping and shall not be pulled over sharp edges when loading and offloading. Pipes shall not be dragged along the ground.

Pipes, fittings and coils shall be stored in such a way that they are completely protected from direct sunlight. When covered, they must be well ventilated to avoid accumulation of heat and resultant deformation. Transparent coverings shall not be used. The storage location shall be flat and shall, for pipes, support the pipes throughout their length. Stones and sharp objects shall not be present. Pipes shall not be stacked to a height exceeding 1m. The pipes must be secured at the sides to prevent them from rolling. Contact with harmful materials shall be avoided. As far as possible, coils shall be stored in a horizontal position. The area shall be free of stones and sharp objects. If stored upright they must be secured to avoid tilting.

Prior to laying in trench the bed of the trench must provide support throughout the entire length of the pipe. The pipe shall not be laid directly on cohesive, rocky or stoney soil. Such material shall be over excavated to a depth of not less than 0.1m and shall be removed and replaced by non-cohesive soil or a special pipe support. This shall initially be recompacted and then the surface loosened on the day of and prior to laying.

Pipes supplied in coils and of up to 63mm diameter may be unrolled with the coil in the vertical position. For larger diameters an unwinding device shall be used. A turnstile can be used with the coil laid in a horizontal position on it or with the coil mounted vertically on a slow moving lorry. The pipe shall never be removed from a coil in a spiral manner as this may cause kinking. Should kinking nevertheless occur the Contractor shall cut the pipe on either side of the kink, prepare the ends, and then use an approved joint after laying. All costs of dealing with kinking shall be to the Contractor's expense. A minimum bending radii of 35 x the diameter shall be observed.

Joining Methods

A. Butt Fusion: The pipe shall be joined by the butt fusion procedure outlined in ASTM F 2620. All fusion joints shall be made in compliance with the pipe or fitting manufacturer's recommendations. Fusion joints shall be made by qualified fusion technicians.

B. Saddle Fusion: Saddle fusion shall be done in accordance with ASTM F 2620 or TR-41 or the fitting manufacturer's recommendations. Saddle fusion joints shall be made by qualified fusion technicians. Qualification of the fusion technician shall be demonstrated by evidence of fusion training within the past year on the equipment to be utilized on this project. [Saddle fusion is used to fuse branch saddles, tapping tees, and other HDPE constructs onto the wall of the main pipe] (ASTM F905).

C. Socket Fusion: Molded socket fusion fittings are only to be used for joining of HDPE pipe from 1/2 inch to 2" in size. Socket fusion shall be done in accordance with ASTM F 2620 or the fitting manufacturer's recommendations. Socket fusion is the process of fusing pipe to pipe, or pipe to fitting by the use of a male and female end that are heated simultaneously, and pressed together so the outside wall of the male end is fused to the inside wall of the female end. Qualification of the fusion technician shall be demonstrated by evidence of socket fusion training within the past year on the equipment to be utilized on this project. [*Socket fusion is not widely used, and the specifier may decide to prohibit its use*]

D. Electrofusion: Electrofusion joining shall be done in accordance with the manufacturers recommended procedure. Other sources of electrofusion joining

information are ASTM F 1290. The process of electrofusion requires an electric source, a transformer, commonly called an electrofusion box that has wire leads, a method to read electronically (by laser) or otherwise input the barcode of the fitting, and a fitting that is compatible with the type of electrofusion box used. The electrofusion box must be capable of reading and storing the input parameters and the fusion results for later download to a record file. Qualification of the fusion technician shall be demonstrated by evidence of electrofusion training within the past year on the equipment to be utilized for this project.

E. Mechanical:

- Mechanical connection of HDPE to auxiliary equipment such as valves, pumps, and fittings shall use mechanical joint adapters and other devices in conformance with AWWA Manual of Practice M55, Chapter 6.
- Mechanical connections on small pipe under 3" are available to connect HDPE pipe to other HDPE pipe, or fittings, or to a transition to another material. The use of stab-fit style couplings is allowed, along with the use of metallic couplings of brass and other materials. All mechanical and compression fittings shall be recommended by the manufacturer for potable water use. When a compression type or mechanical type of coupling is used, the use of a rigid tubular insert stiffener inside the end of the pipe is recommended.
- Mechanical couplings that wrap around the pipe and act as saddles are made by several manufacturers specifically for HDPE pipe. All such saddles, tapping saddles, couplings, clamps etc. shall be recommended by the manufacturer as being designed for use with HDPE pipe at the pressure class listed in this section.
- Unless specified by the fitting manufacturer, a restraint harness or concrete anchor is recommended with mechanical couplings to prevent pullout.
- Mechanical coupling shall be made by qualified technicians. Qualification of the field technician shall be demonstrated by evidence of mechanical coupling training within the past year. This training shall be on the equipment and pipe components to be utilized for this project

F. Joint Recording: The critical parameters of each fusion joint, as required by the manufacturer and these specifications, shall be recorded either manually or by an electronic data logging device. All fusion joint data shall be included in the Fusion Technician's joint report.

Testing

a. Hydrostatic leakage testing is recommended and shall comply with ASTM F 2164, ASTM F 1412, AWWA Manual of Practice M55 Chapter 9.
b. If the test section fails this test, the Contractor shall repair or replace all defective materials and/or workmanship at no additional cost to the Owner.

c. Pneumatic (compressed air) leakage testing of HDPE pressure piping is prohibited for safety reasons.

Cleaning and Disinfecting

a. Cleaning and disinfecting of potable water systems shall be in accordance with AWWA C651 and AWWA Manual of Practice M55 Chapter 10.

b. After installation and pressure testing, new water mains should be disinfected according to AWWA C651.

c. The disinfection chemicals should be limited to less than 12% active chlorine. The duration of the disinfection should not exceed 24 hours.

d. Upon completion, the system should be thoroughly flushed with fresh water, and retested to verify the disinfectant chlorine level has been reduced to potable drinking water concentrations in all service water tubing and branch lateral pipes.

504. POLYPROPYLENE PIPES

Propylene co-polymer pressure pipe shall comply with the relevant provisions of BS 4991 and DIN standards and, where it is to be in contact with potable water, shall be Series 1.

Polypropylene pipes shall be available in diameters from 12mm to 1400mm and shall be suitable for working use at temperatures up to 90°C, and withstand short-term use at a maximum 110°C.

505. STEEL PIPES AND SPECIALS

All piping shall be plain ended unless otherwise specified and suitable for use with flexible mechanical couplings. The grade of steel used shall comply with the requirements of BS EN 14164.

The pipes shall be welded or seamless and shall conform to BS EN 10216.

All the pipes shall be internally protected with epoxy coatings for internals of steel pipes in accordance with AWWA C210. External protection to be as specified in DIN 30671, EN 10309, AWWA C213 or NFA 49-706.

All joints shall be of the flexible mechanical type and shall be supplied complete with all bolts, nuts, washers and joint rings as may be required. All metal parts of joints shall be adequately protected with rust-proof paint. The joints shall be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

All fittings and specials shall be of such dimensions as will conform / fit with the piping supplied.

Flanged adaptors shall be pieces suitable for connecting a flanged gate valve etc. to the type of piping supplied and shall be supplied complete with all bolts, nuts, washers, gaskets and joint rings.

The spigot ends of all Tees shall be suitable for connection to the pipework supplied using the aforementioned flexible mechanical joints.

All flanges on specials shall conform to NP 16 as specified in the Price Schedules in accordance with BS EN 1092, unless otherwise detailed.

All flanged joints shall be protected from corrosion by wrapping with Denso paste and tape or a similar approved material.

506. DOUBLE WALLED CORRUGATED (DWC) PIPES

General Appearance

Double Walled Corrugated (DWC) pipes must be manufactured using two layers of either PP or PE that are bonded in the extrusion process. The pipe will have a corrugated outer skin, forming ribs and bonded to the internal skin of the pipe leaving a smooth inner surface. This inner surface will be free of cracks, deformities and will ensure smooth flow properties throughout the pipeline. The pipe shall be socketed on one side, and have a spigot on the other. The internal colour shall be a light reflective colour to reflect light to ease camera inspection. An elastomeric rubber water sealing ring will be placed on the spigot side to create a strong seal between the spigot and socket.

The pipe must have a coextruded line on the pipe of a different colour for easy identification of the fluid within the pipe. Pipes that do not have this coextruded stripe will not be accepted.

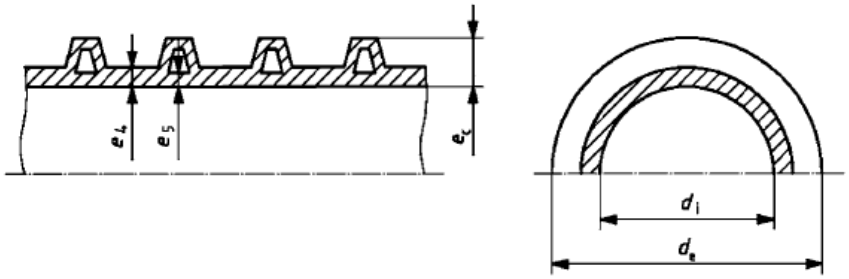
The pipe must also be produced with a reinforced air channel for added rigidity.

Manufacturing Process

The pipes shall use suitable PP or PE to acquire the required stiffness and deflection characteristics described below. The pipe will have inline socketing, with the required socket diameter to create a water tight seal with the help of an elastomeric ring.

Corrugated Construction

The pipe will have a plain smooth inside surface, with an annular ribbed external surface as shown in the diagram below:



The profile of the corrugation may change to design requirement for desired ring stiffness of the pipe.

Materials

PP (Polypropylene) material characteristics described in the table below:

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure, 140 h [a, b]	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	
		Orientation	Free	ISO 1167-2
		Number of test pieces	3	
		Circumferential stress	4,2 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	140 h	
Resistance to internal pressure 1 000 h [a, b]	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	95 °C	
		Orientation	Free	ISO 1167-2
		Number of test pieces	3	
		Circumferential stress	2,5 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	⩽ 1,5 g/10 min	Temperature	230 °C	ISO 1133:2005
		Loading mass	2,16 kg	Condition M
Thermal stability, OIT [c]	⩾ 8 min	Temperature	200 °C	ISO 11357-6

[a] For extrusion compounds this test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.

[b] For injection-moulding compounds this test shall be carried out in the form of an injection-moulded, or extruded sample in solid-wall pipe form made from the relevant material.

[c] This requirement is only valid for pipes and fittings intended to be jointed in the field by fusing or welding.

PP material of MRS 1700Mpa is advisable, and should have a minimum carbon content (for outer layer) of 2% to achieve UV resistant characteristics.

PE (Polyethylene) material characteristics described in the table below:

Characteristic	Requirements	Test parameters		Test method
Resistance to internal pressure 165 h [a, b]	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	
		Orientation	Free	ISO 1167-2
		Number of test pieces	3	
		Circumferential stress	4,0 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	165 h	
Resistance to internal pressure 1 000 h [a, b]	No failure during the test period	End caps	Type A or B	ISO 1167-1
		Test temperature	80 °C	
		Orientation	Free	ISO 1167-2
		Number of test pieces	3	
		Circumferential stress	2,8 MPa	
		Conditioning period	In accordance with ISO 1167-1	
		Type of test	Water-in-water	
		Test period	1 000 h	
Melt mass-flow rate	⩽ 1,6 g/10 min	Temperature	190 °C	ISO 1133:2005
		Loading mass	5 kg	Condition T
Thermal stability, OIT [c]	⩾ 20 min	Temperature	200 °C	ISO 11357-6
Reference density	⩾ 930 kg/m^3	In accordance with ISO 1183-1		ISO 1183-1

[a] This test shall be carried out in the form of a solid-wall pipe made from the relevant extrusion material.

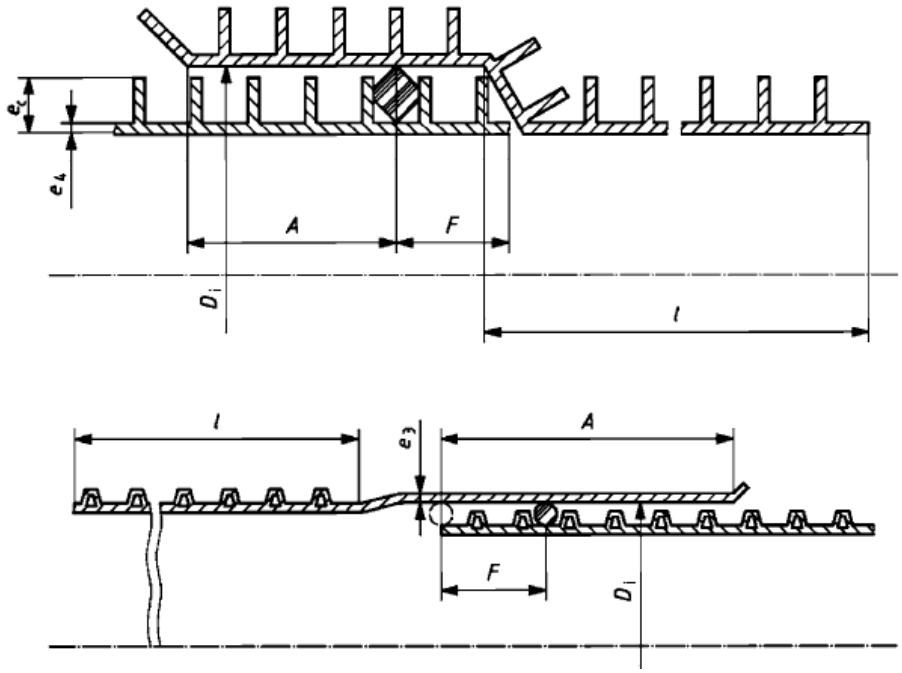
[b] For injection-moulding compounds this test shall be carried out in the form of an injection-moulded or extruded sample in solid-wall pipe form made from the relevant material.

[c] This requirement is only valid for pipes and fittings intended to be jointed in field by fusing or welding.

PE material of MRS 1000Mpa is advisable, and should have a minimum carbon content (for outer layer) of 2% to achieve UV resistant characteristics.

Typical Spigot & Socket Joint

Below are typical examples of elastomeric sealing ring joints, with the sealing ring located on the spigot.



Examples of Sealing Ring Joints

Below is a table showing the following: Nominal sizes, minimum internal diameters, thickness of inside layers and socket length. These must be strictly adhered to or exceeded under the ISO 21138 standard for structured wall pipes.

The indications for e4, e5 and A(min) can be seen on the above figure as a reference diagram.

Internal Diameter (mm)	Minimum wall thickness e4 (min) (mm)	e5 (min) (mm)	A (min) (mm)
100	1.00	1.00	32.00
150	1.30	1.00	43.00
200	1.50	1.10	54.00
250	1.80	1.50	59.00
300	2.00	1.70	64.00
400	2.50	2.30	74.00
500	3.00	3.00	85.00
600	3.50	3.50	96.00
800	4.50	4.50	110.00
1000	5.00	5.00	140.00
1200	5.00	5.00	162.00

The minimum inner skin thickness (e4) is the minimum requirement for survivability for hard sewage mediums, and integrity for the lifespan of the pipe.

In addition to the minimum required wall thickness of sockets and spigots, their ring stiffness, when determined in accordance with ISO 9969, shall conform to the following equation:

$$S_{so} + S_{sp} \geqslant SN_{pipe}$$

For the test, it is permitted to use cut-off straight spigot and socket parts even if they do not conform to the length requirement specified in ISO 9969.

Mechanical Characteristics

When tested in methods specified in the table below, using the indicated parameters, the pipe shall have the mechanical characteristics conforming to the requirements given in the table below.

The pipes shall be designated in one of the following nominal ring stiffness classes (SN):

DN ≤ 500: SN4, SN8 or SN16 DN > 500: SN2, SN4, SN8 or SN16

Characteristic	Requirements	Test parameters		Test method
Ring stiffness	⩾ relevant SN	In accordance with ISO 9969		ISO 9969
Impact strength	TIR ⩽10 %	Test temperature	(0 ± 1) °C	ISO 3127
		Conditioning medium	Water or air	
		Type of striker	d90	
		Mass of striker for [a]:		
		$d_{im,max} \leqslant 100$	0,5 kg	
		$100 < d_{im,max} \leqslant 125$	0,8 kg	
		$125 < d_{im,max} \leqslant 160$	1,0 kg	
		$160 < d_{im,max} \leqslant 200$	1,6 kg	
		$200 < d_{im,max} \leqslant 250$	2,0 kg	
		$250 < d_{im,max} \leqslant 315$	2,5 kg	
		$315 < d_{im,max}$	3,2 kg	
		Fall height of striker for [a]:		
		$d_{em,min} \leqslant 110$	1 600 mm	
		$d_{em,min} > 110$	2 000 mm	
Ring flexibility	In accordance with 9.1.2 at 30 % of d_{em}	Deflection	30 %	EN 1446
		Length of test piece	Shall incorporate at least 5 ribs/spirals [b]	
		Position of test piece	Mould split line, when applicable, at 0°, 45° and 90° from the upper plate	
Creep ratio	PVC-U: ⩽ 2,5 at 2 year extrapolation PP and PE: ⩽ 4 at 2 year extrapolation	In accordance with ISO 9967		ISO 9967
Tensile strength of seam [b]	In accordance with 9.1.3	Rate of movement	15 mm/min	EN 1979

[a] Refer to the specified $d_{em,min}$.

[b] Only applicable to spirally formed pipes.

Ring Flexibility

When tested in accordance with the test methods described in the previous table, and visually inspected without magnification

a. There shall be no decrease of the measured force
b. There shall be no cracking in any part of the wall structure
c. There shall be no wall delamination except possible delamination between the outside and inside wall of double layer pipes
d. There shall be no other types of rupture in the test piece
e. Permanent buckling in any part of the structure of the pipe wall including depressions and craters shall not occur in any direction

Tensile Strength

When tested in accordance with the test methods highlighted above, the minimum require tensile strength of the seam shall conform to the table below:

Nominal size DN/ID or DN/OD	Minimum tensile force N
DN ⩽ 375	380
400 ⩽ DN ⩽ 560	510
600 ⩽ DN ⩽ 710	760
DN ⩾ 800	1 020

The pipe should have an allowable deflection of up to 30% without any signs of cracks, or ovality during the process.

Performance Requirements

When tested in accordance with the test methods below, the joints and system shall have the characteristics conforming to the requirements given in the table below

Characteristic	Requirements	Test parameters		Test method
Tightness of elastomeric ring seal joint		Temperature Spigot deflection Socket deflection	(23 ± 2) °C 10 % 5 %	EN 1277:2003, Condition B
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	⩽ –27 kPa (–0,27 bar)	Air pressure	–30 kPa (–0,3 bar)	
Tightness of elastomeric ring seal joint		Temperature Joint deflection for: $d_e \leqslant 315$ mm 315 mm < $d_e \leqslant 630$ mm 630 mm < d_e	(23 ± 2) °C 2° 1,5° 1°	EN 1277:2003, Condition C
	No leakage	Water pressure	5 kPa (0,05 bar)	
	No leakage	Water pressure	50 kPa (0,5 bar)	
	⩽ –27 kPa (–0,27 bar)	Air pressure	–30 kPa (–0,3 bar)	
Resistance to combined temperature cycling and external loading [b]	[a]	For $d_{im} \leqslant 160$ mm: In accordance with EN 1437:2002, Method A		EN 1437:2002 Method A, hot and cold water
		For $d_{im} > 160$ mm: In accordance with EN 1437:2002, Method B		EN 1437:2002 Method B, hot water
Long-term performance of TPE seals	Tube pressure: –100 years extrapolated: ⩾ 150 kPa (1,5 bar)	Test temperature	(23 ± 2) °C	EN 14741
Watertightness [c]	No leakage	Water pressure Duration	50 kPa (0,5 bar) 1 min	EN 1053
Tensile test of welded or fused joints	No break in the joint	Minimum tensile force	In accordance with Table 15	EN 1979 [d]

[a] The following requirements apply:
- vertical deformation: ⩽ 9 %
- deviation from surface evenness in bottom: ⩽ 3 mm
- radius of bottom: ⩾ 80 % of original
- opening of weld line: ⩽ 20 % of wall thickness
- tightness at 35 kPa (0,35 bar)/15 min: no leakage allowed.

[b] Only for components in accordance with this part of ISO 21138 with DN/OD ⩽ 335 and DN/ID ⩽ 300.

[c] Only for fabricated fittings made from more than one piece. A sealing ring retaining component is not considered as a piece.

[d] This test is applicable for all pipe and fitting constructions when jointed by fusion or welding. The test pieces shall be cut longitudinally in the fusion area. The length of the test piece shall include the joint plus a length at each end sufficient to ensure a proper grip in the tensile testing machine.

Marking

The following information shall be marked on the Pipe:

- Quality Standard e.g. IS0 21138
- Manufacturer's identification
- Dimensions DN/ID series e.g. ID 200mm
- Stiffness class e.g. SN4
- Material – PE or PP
- Production date
- Country of Production

507. GLASS REINFORCED PLASTIC (G.R.P) PIPES AND SPECIALS

Glass Reinforced Plastic piping and fittings for pressure water supply shall be high stiffness and shall comply with the relevant provision of BS EN 1796. The minimum pipe stiffness shall be 5,000 N/m^2.

Pipes and fittings shall be marked in accordance with BS EN 1796.

Pipes shall only be cut by techniques which can be shown not to impair the pipes pressure regression performance. Where any pipe is cut the exposed fibres at the cut pipe end shall be resealed to prevent potential long term degradation. Methods of cutting and resealing exposed fibres shall be submitted to the Engineer for approval. Elastomeric sealing rings and foils shall comply with BS EN 681.

On delivery to site and immediately prior to installation, each pipe shall be visually inspected both externally, and where possible, internally for damage such as star cracking of the gel coat layer. Where any damage extends through the pipe wall the pipe shall be rejected or the damaged section cut out and replaced in accordance with repair methods approved by the Engineer. If in the Engineer's opinion the pipe is not suitable of repair, it shall be rejected and removed from site.

All pipes and fittings must be tested and be in compliance with the following standards:

Standard	Description
ASTM D 3681	Chemical resistance of "Fiberglass" (Fiber Reinforced Thermosetting – Resin) pipe in deflected condition (Strain corrosion performance)
BS 5480: 1990 (Appendix L)	British standard specification for fiberglass reinforced plastics (FRP) pipes, joints and fittings for use for water supply or sewerage – method for determination of long term specific ring stiffness and creep factor under ring deflection
ASTM D 4161:	Standard specification for "Fiberglass" (Fiber Reinforced Thermosetting – Resin) pipe joint using flexible elastomeric seals
ASTM D 1599:	Short time Hydraulic failure pressure of pipes, fittings and prefabricated spools
BS 5480: 1990: (Appendix J):	British standard specification for Fiberglass reinforced plastics (FRP) pipes, joints and fittings for use for water supply or sewerage – method for determination of Impact Resistance
ASTM D 2992:	Standard practice for obtaining hydrostatic or pressure design basis for "Fiberglass" (Fiber Reinforced Thermosetting – Resin) pipe and fittings. (Hydrostatic Design Basin (HDB))
ASTM D 5365:	Standard Test Method for Long-Term Ring-Bending Strain of "Fiberglass" Pipe

508. GALVANISED PIPES AND SPECIALS

All piping shall conform to SRN 823 and SRN 903 for "Medium" Piping. The pipes shall be screwed and socketted, coupled or flanged.

All specials shall be of such dimensions as will mate with the piping supplied. Screw down stopvalves shall conform to SRN 826. Barrel nipples shall conform to SRN 823

and all other specials shall conform to SRN 824.

All pipes supplied shall be certified by the manufacturer to have been tested in accordance with the relevant Standard Specification.

509. DUCTILE IRON AND CAST IRON PIPES AND SPECIALS

All cast iron piping and fittings shall conform to the requirements of SRN 200.

Ductile iron pipes and fittings shall comply with SRN 202. Where required the pipes shall be protected as specified by the manufacturer of the pipes and shall be used as recommended by the manufacturer of the pipe.

Where the requirements include for the supply of flexible couplings the Contractor shall submit for approval by the Engineer full details of the type of joint offered and a full description of the method of jointing prior to arranging for the delivery of goods on site.

All flexible couplings shall be protected from corrosion by wrapping with Denso paste and tape or by some similar approved material.

The quality of metal used for the manufacture of the pipes shall be of good quality grey cast iron and subject to the various quality control tests as specified in the relevant Standards.

All piping and fittings shall be coated internally with cement mortar lining to SRN 211. Cement mortar lining shall not contain any constituents soluble in water nor any ingredient which could impart any taste or odour whatsoever to the water after sterilization and washing out of the mains. External protection to be as specified in SRN 258.

The flanges of straight pipes shall be at right angles to axis of the pipe and the faces of the flanges shall be parallel and machine finished.

The faces of the flanges of fittings shall be at right angles to the directional axis. The bolt holes shall be concentric with the bore and located symmetrically off the centre line.

In flanged pipework the holes in one flange shall be located in line with those in the other. All flanges shall be drilled to SRN 207, unless otherwise detailed.

The weights of the pipe and fittings shall comply with the Specification in the relevant Standard.

510. CONCRETE PIPES AND SPECIALS

Concrete pipes and specials shall comply with the requirements of SRN 840. They shall carry the relevant Standards Institution registration certification trade mark, or test certificates shall be furnished by the manufacturers.

511. CONCRETE POROUS PIPES

Concrete porous pipes shall comply with the requirements of SRN 410: Concrete Porous Pipes for Under-drainage.

512. FLANGED JOINTS

Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to DIN Standards 2500, 2501, 2519, 2576, 2627, 2566, 2655-56, 2673, 2526, 2527, BS EN 1092, BS 1560 or ISO 7005: 1988., drilled to NP10 except where otherwise indicated in Price Schedules, with gaskets made of reinforced elastomer rubber to DIN Standards 2693, 2697 or EN 1514 and minimum thickness of 3mm.

All flanges on fittings and pipework where flanged connections are required must comply with the requirements of DIN Standards 2500, 2501, 2519, 2576, 2627-38, 2566, 2655-56, 2673, 2526, 2527, BS EN 1092, BS 1560 or ISO 7005: 1988 and drilled to NP 16, unless otherwise specified.

Inspection gaskets for flanged joints shall be rubber reinforced with cotton, 3mm thick and shall be in accordance with DIN Standards 2693, 2697 or EN 1514. Bolts, washers and nuts for flanged joints shall be of mild steel complying with ISO 898/1, ISO 898/2.

513. FLEXIBLE JOINTS

All flexible couplings (Viking Johnson or other approved type) shall be supplied and shall be coated with fusion bonded epoxy layer 350 microns thick, complete with rubber gaskets, bolts, nuts and washers.

Flexible couplings shall be of a mechanical type coupling consisting of a centre sleeve, two end ring flanges, two wedge shaped sealing rings of grade T Nitrile rubber, and with galvanized nuts bolts. The main components shall be made from malleable cast iron to ASTM A 47-77 for larger diameters. If specifically called for, couplings shall be provided with a suitably sized screw plugged hole in the sleeve to allow for the introduction of molten bitumen for additional internal protection. The manufacturer shall then include the necessary removable internal backing-up rings of rubber composition and shall further include for all materials for in-situ jointing and protecting both for remedial works and for internal and external protection at such joints. After jointing, the exposed part of the bolt shall be provided with a tight-fitting polythene protection cap.

514. VALVES

Isolating valves up to and including DN 300 shall be gate valves, and valves larger than DN 300 shall be butterfly valves, except where otherwise specified on drawings or in the Bill of Quantities.

All valves shall conform to EN 1074.
All valves shall bear an identification mark on the body that shall include:

i) Name of the manufacturer and/or his trade mark;
ii) Nominal diameter (DN);
iii) Nominal pressure (PN);

The manufacturer's full technical specifications shall be supplied to the Engineer by the Contractor for approval prior to confirmation of any order for valves.

The valve body shall be cleaned and shot blasted before being internally and externally protected.

All isolating valves shall be protected by fusion bonded powder epoxy or equivalent, internally suitable for potable water and to a minimum thickness of 300 microns.

All valves shall be designed to conform to the pressure rating of the pipeline section except where otherwise specified.

All valves shall close when the stem rotation is in a clockwise direction unless otherwise specified.

Bidders shall supply full technical details of the proposed valves to be supplied with their Bid. If the Engineer considers the proposed valves to be inappropriate, he will reject them and instruct the Contractor to provide a suitable alternative. No additional payment shall be made where such changes occur.

a) Gate Valves

Unless otherwise specified gate valves of nominal diameters up to and including DN 300 shall be resilient seated and made of epoxy coated cast ductile iron in accordance with BS 5163. The epoxy coating shall be not less than 150 microns thickness. The gate shall be ductile iron and completely rubber encapsulated, the gate valve being of pocketless type with a straight through port.

The gate sealing shall be ensured by compression of the rubber. Wedge/gate guides of wear resistant plastic with high gliding features shall be provided in the body, optimally placed to guarantee low wear and tear of the gate and low closing torques.

Gate valves of nominal diameter larger than DN300 shall be of metal seated design with replaceable bronze facing seal/seat rings.

Gate valves shall be provided with integral flanged ends unless otherwise indicated.

Unless otherwise specified the face to face dimensions of gate valves with integral flanged ends shall be in accordance with ISO 5752 (short series).

Gate valves shall be of the non-rising stem type except where specifically indicated otherwise. The stem seal shall be of toroidal sealing rings (O-rings) with at least two such seals. Seals shall be capable of being replaced with the valve under pressure and in the fully open position.

The bonnet gasket shall be of elastomer (suitable for potable water). The bonnet studs or Allen screws shall be corrosion-protected. In addition the studs/Allen screws shall be placed in countersunk holes in the bonnet and completely sealed with wax or a suitable material, which could be removed by low-temperature melting in case they have to be disassembled.

The gate valve body shall be cleaned and shot-blasted before being coated internally and externally. The body, the bonnet and the gate of the valve shall be made of ductile iron to EN 1564, the gate being encapsulated with elastomer EPDM, nitrile or equivalent.

The operating stem shall be made of stainless steel at least equivalent to EN 10088 Part 1.4021, except in areas of aggressive soils where this shall be to ISO 10088 Part 1.44404.

The stem nut shall normally be made of high tensile brass to BS 1981, except in areas of aggressive soils where this shall be aluminium bronze to EN 12167.

Furthermore, and in aggressive soils, outside bolts and nuts shall be made of stainless steel to EN 10088 Part 1.4301 or as detailed on drawings.

All valves shall be suitable for operation from the closed position by a 13 kg "push-pull" effort (total 26 kg) at the rim of the hand-wheel or tee key. Gearing and by-pass arrangement shall be provided for Gate Valves > 400mm dia.

Gate valves shall be of approved manufacture and pressure rating shall be as indicated on Drawings or in the Bill of Quantities. They shall be tested to 1.5 time the normal working pressure.

b) Butterfly Valves

Butterfly valves for manual operation shall comply with EN 593 and shall be double flanged, resilient and metal seated tight shut-off design and of the double eccentric disc type supported from two shafts placed in self-lubricating bearing bushes.

Butterfly valves shall be of approved manufacture and pressure rating shall be as indicated on Drawings or in the Bill of Quantities.

Butterfly valves shall operate with a clockwise closing direction. The valve disk shall rotate though an angle between 0^0 and 90^0 inclusive. Butterfly valves shall be installed with shaft in horizontal position and the bottom half of the disc opening in the direction of flow.

The sealing ring shall be made of EPDM rubber and shall be attached at the disk edge circumference by a retaining ring without adjustment to form a resilient and durable seal.

The valve disc seal shall be replaceable without dismantling the operating mechanism, disk or shafts, and without removing the valve from the pipeline.

Butterfly valves shall be equipped with an operating gear mechanism placed in a waterproof housing. **The design of the gear mechanism shall be such that once the handwheel has been operated over around 50% of the total number of turns the valve disc rotates at a lower speed if the handwheel continues to be operated at the same pace**.

The time of closure of line-valves on the transmission pipeline and inlet valves at the downstream reservoir, from valve fully open to valve fully closed, **shall not be less than ten (10) minutes.**

For this purpose, the total number of handwheel turns from valve fully open to valve fully closed shall not be less than 100 turns for butterfly valves DN 400 and larger.

The operating mechanism shall be permanently lubricated, not in contact with the water, and provided with an indicator of the disk angular position.

Valve body, disk and disk retaining ring shall be in ductile "SG" iron casting to EN 1563. Disk shafts shall be in stainless steel to EN 10088:1.4021, complete with non-corrodible bearings.

The valve body shall be cleaned and shot blasted and internally and externally protected by an epoxy coating with a minimum thickness of 150 microns.

Butterfly valves shall be works pressure tested in accordance with EN 12266 Parts 1 & 2.

a) Body test at a minimum pressure of 1.5 times the maximum permissible pressure
b) Seal test at a minimum pressure of 1.1 times the maximum permissible pressure.

Valves shall allow flow in either direction and shall be satisfactory for duties including isolation of pipeline section, frequent operation, and for applications involving valve operation after long periods of inactivity.

The Contractor shall ensure that there is sufficient clearance between the disc and the adjoining pipework to ensure that all Butterfly Valves operate freely, from fully open to fully closed and vice versa, under all conditions. closed and vice versa, under all conditions.

c) Air Release and Vacuum Break Valves

Automatic air release and vacuum break valves (air valves) shall be of the anti-shock anti-surge type designed to meet the following requirements. The required valves shall provide all of the functions described below.

Pipeline Filling - Uninterrupted high volume air discharge through the large orifice.

Pipeline Draining or Column Separation - Uninterrupted high volume air intake through the large orifice.

Pipeline Full and Operating - Discharge of dis-entrained pressurised air through the small orifice.

The air release and vacuum break valve shall be of a compact single-chamber design or of a twin-chamber design, with solid cylindrical High Density Polyethylene control floats or rubber encapsulated steel floats. These shall be housed in a stainless steel or corrosion protected body with epoxy powder coated cast iron, or stainless steel ends secured by means of stainless steel tie rods.

The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent re-joining of separated water columns. The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure.

Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

The air intake/discharge area shall be equal to the nominal size of the valve i.e. a 150 mm valve shall have a 150 mm intake/discharge orifice.

The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur when exposed to 1.5 time the designed working pressure.

The air valve shall be provided with a built-in isolating valve.

Unless otherwise specified all air valves shall be provided with an integral flanged inlet with studs appropriate to EN 1092 PN 16 or as the installation demands and complying with the appropriate nominal pressure.

Air valves shall be of approved manufacture and pressure rating shall be as indicated on Drawings or in the Bill of Quantities.

d) Altitude Valves

Altitude Valves shall control the high water level in reservoirs without the need for floats or other devices. Altitude Valves shall consist in the valve itself, a pilot (the main pilot) to control the operation of the valve, an associated circuit (small tubing) to connect the pilot to the valve and to the reservoir and an ancillary pilot (the safety pilot) to limit over-pressures during valve closure.

The valve itself shall be a hydraulically operated, diaphragm actuated, globe pattern valve consisting in three major components : body, diaphragm and plugging assembly (the only moving part) and cover.

The main pilot shall operate on the differential in forces between a spring load and the hydraulic head corresponding to the water level in the reservoir transmitted through the pilot circuit. The desired high water level shall be set by adjusting the spring force.

The Valve shall close when the high water level is reached. It shall re-open progressively when the water level decreases and shall be fully open when it reaches a preset value below the high level, typically 40 to 50 cm.

The safety pilot shall control closing of the valve by triggering the discharge out of the valve of water from the valve upper chamber (above the diaphragm) thus forcing the valve to re-open partly and temporarily, in case the upstream pressure exceeds a preset value.

The body and cover of the valve shall be made of ductile iron and shall be epoxy coated, the diaphragm shall be in synthetic material and the plugging assembly shall be in stainless steel.

The body of the pilot shall be made of bronze or another copper alloy and the pilot circuit shall be made of copper tube.

The nominal diameter and pressure rating of Altitude Valves shall be as shown on the Drawings or in the Bill of Quantities.

e) Flow Limiting Valves

Flow Limiting Valves shall be designed to limit the inflow into the downstream reservoir to the preset flowrate corresponding to the allocation of water granted to the said reservoir, regardless of the upstream hydraulic situation.
Basically the Flow Limiting Valves will differ from Altitude Valves only regarding the main pilot and the associated circuit.

A diaphragm calibrated and supplied by the valve manufacturer shall be installed at least

2 m downstream the valve. The differential pressure across the diaphragm will depend on the flowrate. The main pilot shall operate on the differential in forces between a spring load and the differential pressure.

The Valve shall partly close if the actual flowrate exceeds the preset flowrate.

The valve manufacturer shall verify that cavitation will not occur under the specified hydraulic conditions and shall propose adjustments in case of any risk.

The nominal diameter and pressure rating of Flow Limiting Valves shall be as shown on the Drawings or in the Bill of Quantities.

f) Combined Flow Limiting and Altitude Valves

Combined Flow Limiting and Altitude Valves shall offer the two functions. For this purpose they shall be equipped with two pilots and two associated circuits, each one as specified in the previous sections.

Combined Flow Limiting and Altitude Valves shall also be equipped with a safety pilot and associated circuit to avoid over-pressure during closing of the Valves.

The nominal diameter and pressure rating shall be as shown on the Drawings or in the Bill of Quantities.

g) Hand-Wheels and Valve Caps

Where hand-wheels are specified, they shall have cast into them the words 'open' and 'close', together with an arrow indicating the direction for such opening or closing.

Valves for tee-key operation shall be provided with valve caps.

515. CONSUMER WATER METERS

General

Domestic water meters for house connection shall comply with BS 5728, KS 06-248 1, 2 and ISO 4064/2 & 2 /Add.1. In addition, it shall comply with the EEC Council Directive No. 75/33/EEC.

The domestic water meters shall be suitable for both Vertical and Horizontal installation and shall be of approved rotary piston volumetric type - Class C. The meter shall provide the specified flow accuracy when installed as detailed here below.

The domestic meters shall be supplied as a complete kit comprising the following items:

- Meter, Semi-positive rotary (grooved) piston volumetric type, calibrated in cubic metres;
- Meters are to be corrosion proof copper alloy or polymer plastic where specified;
- The outer body casing shall be of the split case type. The outer casing may consist of two parts which are screwed together and a watertight seal between the two.
- Isolating/disconnection valve;
- Union sockets;

- DN 15 BSP threaded inlet and outlet tail pieces complete with unions on each end, suitable for connection to galvanised iron pipe;
- Built-in strainer
- Built-in non return valve to prevent meter reversal
- "small dial"

The meter shall be complete as a package for instant connection and use. The domestic meters shall have threaded connections.

Performance

The maximum flowrate (Q_{max}) is the highest flowrate at which the meter can function over limited periods without damage, and without exceeding the maximum permissible errors (+/-2%) and the maximum permissible value for loss of pressure (1 bar).

The nominal flowrate (Q_n) is equal to half the maximum flowrate, Q_{max}. It is expressed in cubic metres per hour and is issued to designate the meter.

At the nominal flowrate (Q_n) the meter should be able to function in normal use, i.e. in continuous and intermittent operating conditions, without exceeding the maximum permissible errors (+/-2%).

The minimum flowrate (Q_{min}) is the flowrate above which the meter must not exceed the maximum permissible errors (+/-5%), and is fixed as a function of Q_n.

The transitional flowrate (Q_t) is the flowrate which divides the upper and lower regions of the flow range and the rate of the maximum permissible error is +/-2%.

Performance Parameter		Nominal Diameter (mm)			
		15	20	25	40
Nominal Flow Rate - Q_n	m^3/h	1.5	2.5	3.5	10
Maximum Flow Rate.....Q_{max}	m^3/h	3	5	7	20
Minimum Flow Rate.....Q_{min}	l/h	15	25	35	100
Transitional Flow Rate.....……Q_t	l/h	22.5	37.5	52.5	150

Meteorological Classes

The meters performance specification shall be to ISO 4064/1 or BS 5728/1 Part 1, Class C or to equivalent internationally recognized Standard according to the value of Q_{min} and Q_t as shown in the following table:

Class	Qn=Less than $15m^3/h$	Qn=$15m^3/h$ or more
Class C		
Value of: Q_{min}	$0.01Q_n$	$0.006Q_n$
Value of: Q_t	$0.015Q_n$	$0.015Q_n$

The meters must be able to retain their accuracy when installed in either horizontal, vertical or inclined planes.
Contractor shall provide certificate of the meteorological class of the meters offered.

Sizes

For each meter size designated the corresponding fixed set of dimensions must

correspond to BS 5728, ISO 7858/1:1985 and no deviations from this shall be accepted. The lengths of water meters shall not exceed the following:

Parameter		Nominal Diameter (mm)			
		15	20	25	40
Length	mm	165	165	199	300

Tightness, Pressure and Temperature Resistance

The water meter shall permanently sustain (without leakage, malfunctioning or permanent deformation) a minimum working pressure of 10 bar (DN 15 mm) or 16 bar (DN 20 mm) and be suitable for water temperatures up to 50 degree Celsius.

Headloss

Characteristic curves of head losses plotted against the rate of flow from the minimum flow rate shall be provided by the Tenderer. The meters shall show a loss of head not exceeding 1 Bar at Q_{max} and 0.25 bar at Q_n in accordance with ISO 7858/1:1985 and ISO 4064/1.

Materials

The materials used in the construction shall be designed to withstand raw and treated (potable) water and operate for at least 5 years without normal need for maintenance or repair and without the maximum error exceeding the specified limits.

Tenderer shall specify the optimum pH and the water quality for which the meters have been designed.

They must be constructed throughout of materials which are resistant to internal and external corrosion and if necessary be protected by some suitable surface treatment. All materials of the water meter which are in contact with the water flowing through the water meter shall be non-toxic and non-tainting. Water temperature variations within the working range shall not adversely affect the materials used in the construction of the water meter.

The outer body casing shall be of the split case type. The outer casing may consist of two parts which are screwed together and a watertight seal between the two. The meter body casing must be made from materials with a life expectancy under normal use in excess of 20 years.
The water meter shall be made with materials appropriate to each specific use. The body of domestic meters (DN15 - DN25) shall be manufactured from copper alloy or polymer.

The measuring element shall be of high grade polymer to ensure minimum wear and a high degree of reliability.

Counter

The indicator shall provide for reliable and unambiguous direct reading of the volume of water measured in cubic metres or in cubic meters and litres.

The indications of volume shall be by any of the two types as follows:

Type 1 By a row of inline consecutive digits in one or more apertures (drum counters); or

Type 2 A combination of drum counters for whole units of cubic meters and pointers on circular scales for fractions of cubic meters.

Drum counters shall be black for indication of a cubic metre and its multiples shall be red for indication of fractions of a cubic metre. Visible movements of the digits shall be upwards and the actual or apparent height of the digits on the drums shall be not less than 4 mm. The advance of a digital unit shall be completed while the next lower valued digit is within the last tenth of its travel. The drums showing digits of lowest value shall move continuously in Type 1, and may move continuously in Type 2. Indicators with pointers (Type 2) shall rotate in a clockwise direction. The value of each division on the scales shall be expressed in multiples or sub-multiples of ten. Each scale shall be graduated in cubic meters or accompanied by a multiplying factor (x0.01, x0.1, x10, x100) according to the value of the scale. The symbol m^3 shall appear on the dial. The gear unit and the counter shall be combined and completely sealed.

The number drums shall be contained in a non-toxic fluid for lubrication and protection. The counter shall be placed in a window in the meter body and be placed so as to allow for ease of meter reading. Counter window shall be of minimum 7mm thickness. Black numbers on white shall denote cubic metres and white numbers on red shall denote litres. The counter shall reset to zero at a reading of not less than 10,000 m^3.

The indicator shall, as minimum requirement, record the following values:

Size of Meter(DN)	Minimum Registration (m^3)	Maximum Registration Before Se l Re- Set (m^3)
15mm	0.001	10,000
20mm to 40mm	0.001	100,000

Protection

A suitable in-built strainer (0.75 mm aperture and 2.844 mm^2 mesh area) shall protect the measuring mechanism and an in-built non return valve shall prevent meter reversal.

Marking

Each water meter shall be marked on the casing with the following information:

- Direction of flow of water on both sides of the meter
- Maximum flow rate ($3m^3$/hr)
- Individual Serial number (engraved)
- Manufacturer's name
- Country of Origin
- Year of manufacture
- WSP's name (max 10 letters)

Sealing

Water meters shall be provided with a means of sealing so that after sealing, both before and after the water meter has been properly installed, there shall be no possibility of dismantling or altering the water meter or its adjustment device without visibly

damaging the seal. The meters shall be sealed subsequent to manufacture and before delivery to the purchaser.

The preferred method of sealing is by a corrosive resistant wire inserted through 2.5 mm diameter holes in the halves of the body, and secured by a circular metal seal impressed by a device which provides a unique imprint on the seal.

Tenderer's shall provide details of the sealing wire type with proof of corrosive resistant and method proposed.

Pre-Shipment Testing

A representative sample of the meters shall undergo Pre-shipment testing at the manufacturers premise as directed by the Engineer

Packing

Packing shall be made of strong wooden crates, and inside such crate, each meter shall be packed in its own carton box.

Workmanship

The meters shall be guaranteed against defects in materials and workmanship for a minimum period of one year from date of delivery. Parts to replace those in which a defect may develop within such period shall be supplied without charge, piece for piece, upon the return of such defective parts to the supplier thereof or upon proof of such defects.

Meters should be designed for easy disassembly and re-assembly without the use of special tools or equipment and should be easy to maintain and repair. Meters designed to resist vandalism will be preferred.

516. ELECTROMAGNETIC FLOW METERS

Electromagnetic flowmeters shall be sized and installed in accordance with the manufacturer's recommendations as approved by the Engineer, and in accordance to BS 5792 and BS 6739.

The flow meters shall be supplied with a verifiable calibration certificate. Electromagnetic flow meters shall be selected and sized to give a maximum velocity of between 1 and 3m/sec. The minimum velocity achieving the stated accuracy shall be not more than 0.1m/sec.

Electromagnetic flow meters shall be of new technology microprocessor based electronic water flow meter and be capable of monitoring instantaneous and cumulative flows and flow rate in both forward and reverse flow direction. The flow meter shall have no moving parts to ensure that there is no damage from particulate matter, e.g. stones, weed, etc., nor cause any restriction in the flow path and be capable of setting adjustments without the need to stop the flow. Each metering system shall comply with BS 5792 and comprise a flow sensor mounted in the pipework line and a signal converter, wither integrally mounted or remotely located preferably within the main control panel.

The meter shall be suitable for 85 to 265 Volt AC, 40 to 400 Hz supply without the need

for link setting or voltage selection and shall be supplied with an uninterrupted power supply (UPS) inclusive of voltage protector. In addition, automatic battery backup must be included to ensure no loss of metering during AC power loss periods.

Alternatively, the meter shall be suitable for operation from two internal 3.6V Lithium batteries which provide an uninterrupted operating life of five years. It shall be possible to change the batteries in the field.

The accuracy of ±0.25% for AC meters and ±0.5% for battery meters shall be achieved. The meters shall be suitable for maximum working temperature to 70°C at pressure up to at least 24 bars. The electronics of the E/M bulk water meter should be water tight in submerged condition of up to 10 m water head.

The meters shall have GSM- equipped transmitters capable of operating in 850/ 900/ 1800/ 1900 Quad Band Ranges. The meters should have USB-Type Data output port with a USB connector cable supplied together with the meter for data downloads.

The manufacturer shall also supply a detailed list of all parts comprising the proposed meter, duly labelled in English and numbered together with the indicative unit prices for each separate component. This is to enable normal usage and cost of the spares to be taken into consideration when assessing the cost of each meter which will be factored in the selection of the meter to be used in the project.

The warranty offered for each component should be explicitly indicated.

517. ELECTRO-WELDING JOINTING MACHINE

The fusion jointing machine shall be suitable for carrying out electro- fusion welding for HDPE pipes and fittings up to 110mm diameter. The welding process is controlled and regulated with energy output compensation to account for variations in ambient temperatures.

The Unit should be complete with all accessories and shall have the following minimum general specifications;

- An internal memory with a capacity of at least 350 jointing records
- Support for USB data transfer. A USB connector cable should be supplied together with the jointing machine
- The Unit Display should be scratch resistant and dust proof, easily readable with an adjustable contrast function and give relevant information (in English) such as;
  - Recognition of fitting type, dimension and manufacturer
  - Resistance of connected fitting
  - Primary voltage and frequency
  - Actual running and final fusion duration
  - Ambient temperature, appropriate cooling time etc.
- Minimum operating range of ambient temperature of between -10°C and +45°C
- Two pairs of 4mm and 4.7mm angle adapter clips
- The complete control unit must not exceed a maximum weight of 25 kilograms including all standard primary and secondary cables
- The unit should have the relevant software and system accessories necessary for data processing and transmission
- Recognition support for different manufacturer products

- The unit should have a minimum of IP 54 Protection rating
- The unit should be supplied with a detailed operation manual written in English with clear step wise operating instructions, troubleshooting procedures, error codes and other relevant information

Site demonstration and training of the Water Company Staff on use of the equipment should be carried out.

518. BUTT-WELDED FUSION JOINTING MACHINE

The fusion jointing machine shall be self-aligning, suitable for welding under-pressure pipes for water, gas and other fluids up to 250mm diameter. The machine body shall be able to assume two working positions; inclined or horizontal and have a supporting frame, four clamps and two hydraulic cylinders with fast non-drip coupling connections.

The machine shall have the possibility to choose the best configuration for the working conditions by adjusting only 4 screws on the machine frame. Fast-locking adapters shall speed up the welding preparation time without using any additional equipment. The automatic detaching of the heating plate from the pipes / fittings shall be applicable on every welding configuration. This shall enable two rollers to be lodged very quickly on the sides of the machine body, allowing lifting of the welded pipes to make them roll and prepare a new weld.

The fusion machine shall include a Teflon-coated (PTFE) heating plate with a built-in independent thermometer, to check the working temperature, and a high-precision electrical thermoregulator (±1°C) with digital display and regulating buttons. This system shall include Led indicators to check if the machine is working normally (live tension and working temperature), contingent probe's failures and/or temperature anomalies.

The machine shall include an extractable electric milling cutter to face the heads of the pipes and/or fittings. It includes a safety micro-switch and a thermal circuit breaker. The machine shall include an electro-hydraulic gearcase protected from crashes and atmospheric corrosion by a plastic box. The gearcase shall consist of a control lever, to open and close the clamps, maximum pressure and discharge valves (useful also for the "Dual Pressure" welding process), hydraulic connection hoses with non-drip fast couplings and timer (to check the warming and welding time). The machine shall be pre-set for the connection of the electronic controller.

A milling cutter / heating plate support which shall include a high-temperature-proof bag shall be included in the components of the fusion machine as it shall be required to protect the heating element from being scratched.

6. DRAINS, SEWERS AND MANHOLES

601. EXCAVATION FOR DRAINS, SEWERS AND MANHOLES

The ground shall be excavated to the lines and depths shown on the drawings or to such other lines and depths as the Engineer may direct. Excavations taken out to a greater depth than is necessary shall be filled to the required level with approved material as specified for the pipe bed at the Contractor's own cost. Trenches shall be of sufficient width to enable the pipes to be properly laid and jointed. In case of pipes of greater diameter than 300mm, the width of trench shall be external diameter of pipe, plus 400mm. When any excavation has been taken out and trimmed to the levels and dimensions shown on the drawings or as directed by the Engineer, the Engineer shall be informed accordingly so that he may inspect the completed trench and no excavation shall be filled in or covered with concrete until it has been so inspected and the Contractor has been authorized to proceed with the work. All surplus materials from such excavations not required for refilling shall be carted away to tips, or otherwise disposed of, as directed. All excavations shall be kept dry, and all bailing and pumping, timbering, shoring and supporting of sides that may be required, and any refilling, ramming and disposal of surplus materials necessary in carrying out the excavations and backfilling of trenches shall be taken to provide a solid and even bed for barrels of the pipes and, where a concrete bed is not specified, the floor of the trench shall be properly shaped to receive the sockets and the backfill must be thoroughly rammed along the sides of the pipe.

The rate of excavation in the Bill of Quantities shall include for keeping trenches dry and for all bailing, pumping, timbering, shoring and supporting of sides that may be required.

602. SUPPORTS FOR PITS, TRENCHES AND OTHER EXCAVATIONS

The sides of pits, trenches and other excavations shall, where necessary, be adequately supported to the satisfaction of the Engineer, and all such excavations shall be of sizes sufficient to enable the pipes and bedding to be laid accurately, and proper refilling and compacting to be carried out.

The Contractor shall take all precautions necessary for the safety of adjoining structures and building by shoring, opening in short lengths or otherwise, during the time the trenches are open.

603. ROCK CUTTING IN TRENCHES FOR PIPES

Where solid rock is met within trenches, it shall be cut out to a depth of 100mm below the intended level of the bottom of the pipes, and replaced with 100mm of approved material as specified. In measuring such rock excavation the Contractor will be allowed a width of 400mm more than the external diameter of the pipes to a level of 100mm below the bottom of the pipes. The price inserted in the Bill of Quantities shall be held to cover all expenses in connection with excavating the rock, backfilling after laying of pipes and disposing of surplus material as directed by the Engineer.

604. WATER IN TRENCHES FOR PIPELINES

Trenches shall be kept free from water at all times during construction of works until, in the opinion of the Engineer, any concrete or other works therein are sufficiently set, and the Contractor shall construct any sumps or temporary drains that the Engineer may deem necessary.

The Contractor shall be responsible for the removal and disposal of all water entering the excavations from whatever source and shall deal with and dispose of such water in a manner approved by the Engineer so as to ensure that excavations are kept dry while ensuring that the disposal of this water does not cause a nuisance to adjacent plot holders or works.

The Contractor shall provide all plant, labour and materials required for such work and all costs incurred shall be deemed to be included in his rates for excavation.

605. LAYING AND JOINTING RIGID JOINTED CONCRETE PIPES

Concrete pipes shall be laid true to line and level, each pipe being separately boned between sight rails.

For spigot and socket joints, the spigot of each pipe shall be placed home in the socket of the one previously laid, and the pipe then adjusted and fixed in its correct position with the spigot of the pipe accurately centred in the socket. A ring of tarred rope yarn shall next be inserted in the socket of each pipe previously laid and driven home with a wooden caulking tool and wooden mallet, such yarn when in position shall be 25mm in depth. The socket shall then be completely filled with cement mortar 1 to 2 as specified in Clause 1010 and a fillet of the same worked all round the side. The fillet shall be levelled off and extend for a length of not less than 50mm from the face of the socket.

For 'Ogee' jointed pipes, the joints shall be thoroughly cleaned before laying, and cement mortar shall be applied evenly to the ends for jointing so as to completely fill the joint. The pipes shall then be neatly pointed with a band of cement mortar approximately 125mm wide and 20mm thick. The inside of each joint shall also be pointed up as the work proceeds.

Special care shall be taken to see that any excess of cement mortar etc. is neatly cleaned off while each joint is being made and any earth, cement or other material cleaned out of the pipes by drawing a tight-fitting wad through them as the work proceeds, or by other approved means. A properly fitting plug shall be well secured at the end of the last laid pipe and shall be removed only when pipe laying is proceeding. The trenches, pipes and joint holes shall be kept free from water until the joints are thoroughly set.

Where shown on the drawings or directed by the Engineer, concrete pipes shall be bedded and haunched or surrounded with concrete as specified in Clause 619.

The price inserted in the Bill of Quantities shall include for providing, laying and jointing of pipes.

606. PIPES LAID WITH OPEN JOINTS

Concrete porous pipes shall be laid unjointed with a space of 12mm between the spigot

and the inner end of the socket.

All pipes shall be packed and surrounded as directed by the Engineer with approved broken stone, sand or gravel aggregate, to the gradings as shown on the drawings or stated in the Bill of Quantities. The prices inserted in the Bill of Quantities shall include the trench excavation, providing and laying pipes, supplying and placing graded packing material, refilling trench and disposing of surplus all as specified.

607. DRAINS TO BE LEFT CLEAN ON COMPLETION

On completion, all drains, manholes, etc. shall be flushed from end to end with water from an approved source and left clean and free from obstructions.

608. REFILLING TRENCHES

Trenches shall be refilled with suitable excavated material of 100mm surround but not before the work has been measured and approved by the Engineer. For pipes which are not surrounded with concrete, the first layer of filling material shall be free from stones and shall not be thrown directly on to the pipes, but shall be placed and packed with care all round them. All filling shall be deposited and compacted in layers, not exceeding 225mm loose depth, to a dry density not less than that of the adjoining soil. The last 450mm of filling must be returned in the order in which it has been removed. Timber and framing shall be withdrawn ahead of the layer to be compacted, care being taken to keep the sides of the trenches solid and to fill all the spaces left by the withdrawn timber.

609. CONNECTIONS OF EXISTING SEWERS AND DRAINS

Where shown on the drawings, existing sewers and drains shall be properly extended, connected and jointed to new sewers, culverts, drains or channels. All such connections shall be made during the construction of the main sewer, drain or other work and a record of their positions kept for future use or reference. Where pipe connections are made to a sewer, stone pitched or lined channel, the pipes shall be well and tightly built into the concrete, or masonry work and be so placed as to discharge in the direction of the main sewer, drain or channel and with the end of the pipe carefully cut to the necessary angle. Where the connections are between pipe sewers or drains, special connecting pipes as shown on the drawings shall be supplied and be truly laid and properly jointed.

610. MANHOLES AND INSPECTION CHAMBERS

Manholes and inspection chambers shall be constructed in accordance with the drawings and in the position shown on the drawings or directed by the Engineer. Foundation slabs shall consist of concrete of the appropriate classes as specified on drawings. The side walls shall consist of similar concrete or building stone as specified in Clause 1007 in accordance with the drawings.

The side walls shall be fair faced or rendered internally as specified on drawings. They shall be brought up vertically to receive a precast slab formed of concrete of the appropriate classes specified and reinforced all as shown on the drawings. Cast iron manhole covers and frames as specified in Clause 1032 shall be provided and frames shall be bedded in cement mortar 1 to 3 and so set that the tops of the covers shall be flush at all points with surrounding surface of the footway, verge or carriageway, as the case may be. Any slight adjustment of the slab level which may be necessary to

accomplish this shall be effected by topping the side walls with concrete integral with the slab.

If required, half channel pipes, bends and junctions as specified in Clause 1040 shall be laid and bedded in cement mortar 1 to 3 to the required lines and levels, and both sides of the channel pipes shall be benched up with concrete of the appropriate class and finished smooth to the slopes and levels as shown on the drawings or directed by the Engineer. The ends of all pipes shall be neatly built in and finished flush with cement mortar 1 to 3. Where the depth of the invert exceeds 1 metre below the finished surface of the carriageway or the adjacent ground, step irons as specified in Clause 1033 shall be built in with alternate steps in line vertically and with such additional hand irons as the Engineer may direct.

All manholes when completed shall be watertight and to the satisfaction of the Engineer. The prices inserted in the Bill of Quantities shall include for excavation, provision of all materials, construction, refilling and disposal of surplus.

611. PRECAST CONCRETE MANHOLES

Precast concrete manholes as specified in Clause 1040 shall be supplied and laid generally in accordance with Clause 611 and the drawings.

612. GULLY CONNECTIONS

Connections from gullies to sewers and surface water drains or ditches shall consist of concrete pipes and fittings as specified in Clause 509 jointed with cement mortar 1 to 3 as specified in Clause 1010. All pipes, bends and junctions shall be laid to the lines and levels shown on the drawings or as directed by the Engineer.

613. SURFACE BOXES, COVERS ETC.

Surface boxes, manholes and other covers lying within the site of the works, shall be raised, lowered, altered or removed as directed by the Engineer.

614. GULLIES

Gullies complete with gratings and with rodding eyes where necessary all as specified in Clause 1024 shall be supplied and laid in accordance with the drawings. Where directed by the Engineer, precast concrete gullies shall be laid on and surrounded with 100mm of concrete of the appropriate grade. The concrete surround is to be brought up to the underside of the frame or flush with the top surface as the case may be. Masonry gullies shall be constructed from 225mm building stone and rendered internally. The rates included in the Bill of Quantities shall include for excavation, provision of all materials, construction, making junctions with connections to main drains, accurate setting of frames to line and level, refilling and disposal of surplus materials. Gullies shall be trapped where leading into foul sewers or into combined foul and surface water sewers.

615. COMPLETION OF DRAINAGE WORKS

All sub-soil and surface water drains shall be completed in advance of the construction.

616. TEMPORARY STOPPERS

Junction pipes which are laid but not immediately connected to gullies shall be fitted with temporary stoppers or seals, and the position of all such junctions shall be clearly defined by means of stakes or training wires properly marked and labelled.

617. PROVISION FOR FUTURE CONNECTION TO MANHOLES

Inlet pipes of the required diameters shall be built into the walls of manholes and elsewhere for future use and shall be of the diameters shown on the drawings. The external ends of all such connections shall be sealed off with temporary stoppers, approved by the Engineer. The pipes shall be laid and jointed as specified in Clause 611 and during the placing of the concrete they shall be adequately supported.

618. SURROUNDING OR HAUNCHING OF PIPES WITH CONCRETE

Surrounding or haunching of pipes shall be carried out using concrete of the appropriate grade. In carrying out this work the Contractor shall take care to pack the concrete under and around the pipes to ensure even bedding and solidity in the concrete and the concrete shall not be thrown directly on to the pipes. The upper surface of the concrete shall be struck off with a wooden screed or template and neatly finished off. The rates shall include for any formwork that the Contractor requires to use under this item.

619. INVERT BLOCK AND STONE-PITCHED DRAINS

Precast concrete invert blocks and side slabs shall be formed of concrete of the appropriate grade to the dimensions shown on the drawings. Each course of side slabs required in the Bill of Quantities shall be interpreted as one complete row of side slabs to one side of the channel concerned. Stone used for channels shall be 225mm x 100mm building stone. Drains should not normally be laid to a radius of curvature less than 10 times the actual width of the drain.

Invert block and stone-pitched drains shall be constructed in the positions and to the levels and dimensions shown on the drawings and laid to true line and even fall. Where under- filling is required it shall be in 100mm maximum thickness layers of compacted murram. The earth sides to such channels shall be neatly finished to a slope of 1 to 1 or such other slope as the Engineer may direct Invert blocks and side slabs shall be laid on a 100mm minimum thickness of compacted murram and be neatly jointed with cement mortar 1 to 3 as the work proceeds. The excavation, murram bedding, providing, laying and jointing invert blocks or stone, backfilling and disposal of surplus shall all be as specified and all in-situ connections shall be in concrete of the appropriate grade.

620. TESTING OF JOINTED PIPES AND MANHOLES

Sealed jointed drains, up to and including 600mm diameter shall be tested in sections (e.g. between manholes) by filling with water under a head of not less than 1 metre. Drains found to be water-tight after a period of 30 minutes will be passed as satisfactory but the water must be retained in the pipes until a depth of at least 450mm of filling has been deposited and compacted on top thereof. Drains failing to stand the test shall be taken out and the pipes re-laid and re-jointed until completely water-tight.

Drains exceeding 600mm in diameter shall be tested by means of a smoke test before they are covered up. Both ends of the lengths of drain to be tested shall be sealed to the

satisfaction of the Engineer, and smoke shall then be pumped into the section from an approved machine. Should any joint in the section show an escape of smoke, the section shall be taken out and the pipes re-laid and re-jointed until there is no further escape of smoke.

Should the Engineer so direct, manholes shall be tested by completely filling with water, and there shall be no appreciable loss over a period of 2 hours.

On completion of the works, or at suitable intervals during construction, infiltration tests will be carried out. The permissible amount of infiltration shall be 1 litre per hour per linear metre of nominal internal diameter.

The Contractor shall provide all labour and apparatus for the above tests.

All testing will be done in accordance with the procedure of the British Standard Code.

621. PIPES WITH RUBBER RING JOINTS

Rubber rings complying with SRN 308 will be provided by the Contractor. They will be laid in the socket and the pipes then jointed as specified. The jointing of pipes shall be carried out in accordance with manufacturer's instructions and in conformity with any modifications proposed by the Engineer.

622. LAYING, JOINTING AND BACKFILLING FOR FLEXIBLE JOINTED PIPES

The Contractor shall ensure that any hard spots and loose stones are removed from the formation prior to laying of bedding materials. The Contractor shall lay a bed of thickness
100mm consisting of granular material i.e. sand, gravel, or approved soil of friable nature.

After laying of pipes the Contractor shall lay bedding material on the sides of the pipe compacted by tamping into soffit of sewer.

After completion of this operation the Contractor shall lay the bedding material on top of the pipe in 150mm layers to a thickness of 300mm. The material is to be compacted by tamping. However, precautions are to be taken to avoid excessive tamping on top of the pipe. The remaining trench excavation is to be backfilled to comply with Clause 609 of specification.

The pipes shall be laid with flexible ring seal joints provided that solvent cement joints could be used for fittings where necessary subject to the approval of the Engineer. Pipes and fittings shall be checked for deformities prior to laying. Deformed pipes and fittings shall not be accepted.

Flexible Rubber Ring Joints

The Contractor shall ensure that the spigot end is free from grit, dust or dirt and sealing rings should be seated evenly in the socket grove. Pipe lengths and fittings are supplied with a chamfer on the spigot. Where pipes are to be cut or are supplied without a chamfer on the spigot end the Contractor shall ensure that the pipe is cut square and then form a chamfer on the spigot end with a medium file to an angle of 15 degrees. Remove

saw flashing by scraping with a pen-knife.

Expansion Gap

It is necessary to leave a gap between the edge of the spigot end and the base of the socket to allow for expansion. Moulded fittings are supplied with an embossed line indicating the correct depth of insertion. In other cases where the marking is not done, the Contractor shall ensure that an expansion gap of at least 3mm per metre length of pipe or at least 15mm per pipe length is provided. This can be done by marking spigot ends or by pushing spigot fully home, making a small mark on pipe and then withdrawing the pipe by 15mm.

After completing jointing the pipe shall be laid on the prepared bed making sure that a suitable depression is created in the bed for the socket.

Solvent Cement Joints

For solvent cement joints make sure that mating surfaces are clean and free of grease and dirt. Roughen mating surface with sandpaper, clean both surfaces with cleansing fluid using a clean cloth. Apply solvent cement on both mating surfaces. Without delay bring mating surfaces together and hold in position firmly for a few seconds. A layer of cement should be visible at the edges. Joints should not be disturbed for at least 10 minutes after assembly.

7. CONCRETE

SCOPE OF SECTION

This section covers the materials, design of mixes, mixing, transport, placing, compaction and curing of concrete and mortar required in the Works. It also covers formwork and reinforcement for concrete.

DEFINITIONS

- Structural concrete is any class of concrete which is used in reinforced, prestressed or unreinforced concrete construction, which is subject to stress.

- Non-structural concrete is composed of materials complying with the Specification but for which no strength requirements are specified and which is used only for filling voids, blinding foundations and similar purposes where it is not subjected to significant stress.

- A formed surface is a face which has been cast against formwork.

- An unformed surface is a horizontal or nearly horizontal surface produced by screeding or trowelling to the level and finish required.

- A pour refers to the operation of placing concrete into any mould, bay or formwork, etc. and also to the volume which has to be filled. Pours in vertical succession are referred to as lifts.

701. THE DESIGN OF CONCRETE MIXES

a) Cement

Cement for structural concrete shall be CEM I – 42.5 to KS EAS 18-1 and KS EAS 183

b) Classes of Concrete

The classes of structural concrete to be used in the works shall be those shown on the Drawings and designated in Table 7.1, in which the class designation includes two figures. The first figure is the nominal strength at 28 days expressed in N/mm^2 and the second figure is the maximum nominal size of aggregate in the mix expressed in millimetres.

c) Design of Proposed Mixes

The Contractor shall design all the concrete mixes called for on the Drawings, making use of the ingredients which have been approved by the Engineer for use in the Works and in compliance with the following requirements:-

Table 7.1 - Concrete Classes and Strengths

Class of Concrete	Nominal Strength	Maximum Nominal Size	Maximum Water / Cement Ratio		Trial Mixes Target Mean	Early Works Test Cubes (Clause 401 d)	
	N/mm^2	of Aggregate			Strength	Any one	Average of
		mm	A	B	(Clause 401 c) N/mm^2	Cube N/mm^2	any Group of 4 Cubes N/mm^2
10/75	10	75	0.60	0.55	13.5	8.5	13.3
15/75	15	75	0.60	0.50	21.5	12.8	20.0
15/40	15	40	0.60	0.50	21.5	12.8	20.0
15/20	15	20	0.57	0.50	21.5	12.8	20.0
20/40	20	40	0.55	0.48	31.5	17.0	27.5
20/20	20	20	0.53	0.48	31.5	17.0	27.5
20/10	20	10	0.50	0.48	31.5	17.0	27.5
25/40	25	40	0.52	0.46	36.5	21.3	32.5
25/20	25	20	0.50	0.46	36.5	21.3	32.5
25/10	25	10	0.48	0.46	36.5	21.3	32.5
30/40	30	40	0.50	0.45	41.5	25.5	37.5
30/20	30	20	0.48	0.45	41.5	25.5	37.5
30/10	30	10	0.47	0.45	41.5	25.5	37.5
40/20	40	20	0.46	0.43	51.5	34.0	47.5
40/10	40	10	0.45	0.43	51.5	34.0	47.5

NOTES: 1. Under water/cement ratio, column A applies to moderate and intermediate exposure, and column B applies to severe exposure. See NOTE after Table 7.2.

2. In case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes should be used.

   In case of concrete having a 75mm or larger aggregate, 200mm cubes should be used.

   i) The aggregate portion shall be well graded from the nominal maximum size of stone down to the 150 micron size.

   ii) The cement content shall be such as to achieve the strengths called for in Table 7.1 but in any case not less than the minimum necessary for impermeability and durability shown in Table 7.2.

iii) The workability shall be consistent with ease of placing and proper compaction having regard to the presence of reinforcement and other obstructions.

iv) The water/cement ratio shall be the minimum consistent with adequate workability but in any case not greater that that shown in Table 7.1 taking due account of any water contained in the aggregates. The Contractor shall take into account that this requirement may in certain cases require the inclusion of a workability agent in the mix.

v) The drying shrinkage determined in accordance with BS 1881 shall not be greater than 0.05 percent.

Table 7.2 - Minimum Cement Content

Minimum Cement Content - kg/m^3 of Compacted Concrete			
Class of Concrete	**Moderate Exposure**	**Intermediate Exposure**	**Severe Exposure**
10/75,15/75	200	220	270
15/40, 20/40, 25/40, 30/40	240	270	290
15/20, 20/20, 25/20, 30/20	260	300	330
40/20	300	320	330
20/10, 25/10, 30/10	300	340	390
40/10	310	340	390

Note: the minimum cement contents shown in the above table are required in order to achieve impermeability and durability. In order to meet the strength requirements in the Specification higher contents may be required.

The categories applicable to the Works are based broadly on the factors listed hereunder:

Moderate exposure — Surface sheltered from severe rain; buried concrete, concrete continuously under water

Intermediate drying — Surface exposed to driving rain; alternate wetting exposure and drying; exposure traffic; corrosive fumes; heavy condensation

Severe exposure — Surface exposed to sea water, moorland water having a pH of 4.5 or less, groundwater containing sulphates.

d) Trial Mixes

At least six weeks before commencing placement of concrete in the Permanent Works trial mixes shall be prepared for each class of concrete specified.

For each mix of concrete for which the Contractor has proposed a design, he shall prepare three separate batches of concrete using the materials which have been approved for use in the works and the mixing plant which he proposes to use for the Works. The volume of each batch shall be the capacity of the concrete mixer proposed for full production.

Samples shall be taken from each batch and the following action taken, all in accordance with BS 1881:-

a. The slump of the concrete shall be determined.

b. Six test cubes shall be cast from each batch. In the case of concrete having a maximum aggregate size of 40mm or less, 150mm cubes shall be used. In the case of concrete containing 75mm or larger aggregate, 200mm cubes shall be used and in addition any pieces of aggregate retained on a 53mm BS sieve shall be removed from the mixed concrete before casting the cubes.

c. Three cubes from each batch shall be tested for compressive strength at seven days and the remaining three at 28 days.

d. The density of all the cubes shall be determined before the strength tests are carried out.

Subject to the agreement of the Engineer, the compacting factor apparatus may be used in place of a slump cone. In this case the correlation between slump and compacting factor shall be established during preparation of the trial mixes.

The average strength of the nine cubes tested at 28 days shall be not less than the target mean strength shown in Table 7.1.

The Contractor shall also carry out tests to determine the drying shrinkage of the concrete unless otherwise directed by the Engineer.

Based on the results of the tests on the trial mixes, the Contractor shall submit full details of his proposals for mix design to the Engineer, including the type and source of each ingredient, the proposed proportions of each mix and the results of the tests on the trial mixes.

If the Engineer does not agree to a proposed concrete mix for any reason, the Contractor shall amend his proposals and carry out further trial mixes. No mix shall be used in the works without the written consent of the Engineer.

e) Quality Control of Concrete Production

i) Sampling

For each class of concrete in production at each plant for use in the works, samples of concrete shall be taken at the point of mixing and/or of deposition as instructed by the Engineer, all in accordance with the sampling procedures described in BS 1881 and with the additional requirements as set out below.

Six number 150mm or 200mm cubes as appropriate shall be made from each sample and shall be cured and tested all in accordance with BS 1881, two at seven days and the other four at 28 days.

Each sample shall be taken from one batch selected at random and at intervals such that each sample represents not more than $20m^3$ of concrete unless the Engineer agrees to sampling at less frequent intervals.

Until compliance with the Specification has been established the frequency of sampling shall be three times that stated above or such lower frequency as may be instructed by the Engineer.

ii) Testing

1) The slump or compacting factor of the concrete shall be determined for each batch from which samples are taken and in addition for other batches at the frequency instructed by the Engineer.

   The slump of the concrete in any batch shall not differ from the value established by the trial mixes by more than 25mm or one third of the value, whichever is the greater.

   The variation in value of the compacting factor, if used in place of a slump value, shall be within the following limits:

   - For value of 0.9 or more +0.03
   - For value of between 0.8 and 0.9 +0.04
   - For values of 0.8 or less +0.05

2) The water/cement ratio as estimated from the results of (a) above, determined by samples from any batch shall not vary by more than five per cent from the value established during the trial mixes.

3) The air content of air entrained concrete in any batch shall be within 1.5 units of the required value and the average value of four consecutive measurements shall be within 1.0 unit of the required value, expressed as a percentage of the volume of freshly mixed concrete.

4) Until such time as sufficient test results are available to apply the method of control described in 5) below, the compressive strength of the concrete at 28 days shall be such that no single result is less than the value shown in Table 7.1 under the heading early works test cubes' and also that the average value of any four consecutive results is not less than the value shown in Table 7.1 under the same heading.

   The 7-day cube result may be used as an early strength indicator, at the discretion of the Engineer.

5) When test cube results are available for at least 20 consecutive batches of any class of concrete mixed in any one plant, the average of any four consecutive results at 28 days shall exceed the nominal strength by not less than half the current margin (Table 7.3) and each individual result shall not be less than 85 per cent of the nominal strength.

The current margin shall be defined as 1.64 times the standard deviation of cube tests on at least 20 separate consecutive batches produced from one plant over a period exceeding five days but not exceeding six months or on at least 50 separate consecutive batches produced from one plant over a period not exceeding 12 months. If both figures are available, the smaller shall be taken.

The current margin shall in any case not be less than the figure given below:-

Table 7.3 - Minimum Current Margin For Test Cubes

	Minimum Current Margin for		
	10N/mm^2	**15N/mm^2 & above**	**20N/mm^2**
After 20 batches	3.3	5	7.
After 50 batches	1.7	2.5	5

Failure to comply with requirements:

If any one test cube result in a group of four consecutive results is less than 85% of the nominal strength but the average of the group of which it is part satisfies the strength requirement, then only the batch from which the failed cube was taken shall be deemed not to comply with the Specification.

If more than one cube result in a group of four consecutive results is less than 85% of the nominal strength or if the average strength of the group fails to satisfy the strength requirement then all the batches between those represented by the first and last cubes in the group shall be deemed not to comply with the Specification, and the Specification, and the Contractor shall immediately adjust the mix design subject to the agreement of the Engineer to restore compliance with the Specification. After adjustment of the mix design the Contractor will again be required to comply with sub- clauses 701(b) and 701(c) of this Section of the Specification.

The Contractor shall take necessary action to remedy concrete which does not comply with this Specification. Such action may include but is not necessarily confined to the following:-

i) Increasing the frequency of sampling until control is again established.

ii) Cutting test cores from the concrete and testing in accordance with SRN 117.

iii) Carrying out strengthening or other remedial work to the concrete where possible or appropriate.

iv) Carrying out non-destructive testing such as load tests on beams.

v) Removing the concrete.

702. MIXING CONCRETE

Before any plant for batching, mixing, transporting, placing, compacting and finishing concrete is ordered or delivered to site, the Contractor shall submit to the Engineer full details including drawings of all the plant which he proposes to use and the arrangements he proposes to make.

Concrete for the Works specifically for Treatment Works Units and Storage Reservoirs shall be and mixed using an automatic batching plant in one or more central location. If the Contractor proposes to use ready mixed concrete he shall submit to the Engineer for his approval full details and test results of the concrete mixes. The Engineer may approve the use of ready mixed concrete provided that:

a) the proposed mixes, the material to be used and the method of storage and mixing comply with the requirements of the Specification;
and
b) adequate control is exercised during mixing.

Approval for the use of ready mixed concrete may be withdrawn if the Engineer is not satisfied with the control of the materials being used and control during mixing.

The mixing of concrete shall be carried out at central plant located at a site remote from place of discharge of mixed concrete. The mixed concrete shall be transported from the central plant using transit lorry mixers and/or agitator trucks.

Batching and mixing plants shall be modern efficient equipment complying with the requirements of SRN 118 and capable of producing a uniform distribution of the ingredients throughout the mass. Truck mixes shall comply with the requirements of SRN 121 and shall only be used with the prior agreement of the Engineer. If the plant proposed by the Contractor does not fall within the scope of SRN 118, it shall have been tested in accordance with SRN 119 and shall have a mixing performance within the limits specified in SRN 118.

All mixing operations shall be under the control of an experienced supervisor.

The aggregate storage bins shall be provided with drainage facilities arranged so that drainage water is not discharged to the weigh hoppers. Each bin shall be drawn down at least once per week and any accumulations of mud or silt removed.

Cement and aggregate shall be batched by weight. Water may be measured by weight or volume.

The weighing and water dispensing mechanisms shall be maintained in good order. Their accuracy shall be maintained within the tolerances described in SRN 118 and checked against accurate weighs and volumes when required by the Engineer.

The weighs of cement and of each size of aggregate as indicated by the mechanisms employed shall be within a tolerance of plus or minus two percent of the respective weights per batch agreed by the Engineer.

The Contractor shall provide standard test weights at least equivalent to the maximum working load used on the most heavily loaded scale and other auxiliary equipment required for checking the satisfactory operation of each scale or other measuring device. Tests shall be made by the Contractor at least once a week or at intervals to be determined by the Engineer and shall be carried out in his presence. For the purpose of carrying out these tests, there shall be easy access for personnel to the weigh hoppers. The Contractor shall furnish the Engineer with copies of the complete results of all check tests and shall make any adjustments, repairs or replacements necessary to ensure satisfactory performance.

The nominal drum or pan capacity of the mixer shall not be exceeded. The turning speed and the mixing time shall be as recommended by the manufacturer, but in addition, when water is the last ingredient to be added, mixing shall continue for at least one minute after all the water has been added to the drum or pan.

The blades of pan mixers shall be maintained within the tolerances specified by the manufacturer of the mixer and the blades shall be replaced when it is no longer possible to maintain the tolerances by adjustment.

Mixers shall be fitted with an automatic recorder registering the number of batches discharged.

The water to be added to the mix shall be reduced by the amount of free water contained in the coarse and fine aggregates. This amount shall be determined by the Contractor by a method agreed by the Engineer immediately before mixing begins each day and thereafter at least once per hour during concreting and for each delivery of aggregates during concreting. When the correct quantity of water, determined as set out in the Specification, has been added to the mix, no further water shall be added, either during mixing or subsequently.

After mixing for the required time, each batch shall be discharged completely from the mixer before any materials for the succeeding batch are introduced.

Mixers which have been out of use for more than 30 minutes shall be thoroughly cleaned before any fresh concrete is mixed and thereafter the first batch of concrete through the mixers shall contain only half the normal quantity of coarse aggregate. This batch shall be mixed for one minute longer than the time applicable to a normal batch.

Mixers shall be cleaned out before changing to another type of cement.

703. HAND-MIXED CONCRETE

Concrete for structural purposes shall not be mixed by hand. Where non-structural concrete is required, hand mixing may be carried out subject to the agreement of the Engineer.

The mixing shall be done on a hard impermeable surface. The materials shall be turned over not less than three times dry, water shall then be sprayed on and the materials again turned over not less than three times in a wet condition and worked together until a mixture of uniform consistency is obtained.

For hand mixed concrete the specified quantities of cement shall be increased by 10% and not more than 0.5 cubic metre shall be mixed at one time. During windy weather efficient precautions shall be taken to prevent cement from being blown away during the process of gauging and mixing.

704. TRANSPORT OF CONCRETE

The concrete shall be discharged from the mixer and transported to the Works by means which shall prevent adulteration, segregation or loss of ingredients, and which shall ensure that the concrete is of the required workability at the point and time of placing. The loss of slump between discharge from the mixer and placing shall not exceed 25mm. The mixed concrete shall be transported using agitator trucks or transit truck mixers. The agitating speed of the drum shall be between 2 and 4 rpm. The interval between feeding of water into the mixer drum and final discharging of the concrete shall not exceed one hour.

The time elapsed between mixing and placing a batch of concrete shall be as short as practicable and in any case not longer than will permit completion of placing and compaction before the onset of initial set. If the placing of any batch of concrete is delayed beyond this period, the concrete shall not be placed in the Works.

705. PLACING OF CONCRETE

a) Consent for Placing

Concrete shall not be placed in any part of the Works until the Engineer's consent has been given in writing, and the Contractor shall give the Engineer at least 1 full working day's notice of his intention to place concrete.

If concrete placing is not commenced within 24 hours of the Engineer's consent the Contractor shall again request consent as specified above.

b) Preparation of Surface to Receive Concrete

Excavated surfaces on which concrete is to be deposited shall be prepared as set out in Section 3 of this Specification.

Existing concrete surfaces shall be prepared as set out in Clause 714. Before deposition of further concrete they shall be clean, hard and sound and shall be wet but without any free-standing water.

Any flow of water into an excavation shall be diverted through proper side drains to a sump, or be removed by other suitable methods which will prevent washing

away the freshly deposited concrete or any of its constituents. Any underdrains constructed for this purpose shall be completely grouted up when they are no longer required by a method agreed by the Engineer.

Unless otherwise instructed by the Engineer surfaces against which concrete is to be placed shall receive a prior coating of mortar mixed in the proportions similar to those of the fines portion in the concrete to be placed. The mortar shall be kept ahead of the concrete. The mortar shall be well worked into all parts of the excavated surface and shall not be less than 5mm thick.

If any fissures have been cleaned out as described in Section 3 of this Specification they shall be filled with mortar or with concrete as instructed by the Engineer.

The amount of mortar placed at any one time shall be limited so that it does not dry out or set before being covered with concrete.

c) Chutes

In general, transportation of concrete by the use of chutes will not be permitted unless approved by the Engineer. The chute shall have a section with round corners and shall have a proper fixed slope so as to allow the concrete to flow satisfactorily and without segregation. The lower end of chute shall be provided with a drop chute not less than 0.6m in height to avoid segregation of falling concrete. The height of drop shall not exceed 1.5m. Chutes shall be protected from direct sunlight, wind and rain.

d) Concrete Pump or Placer

The type and capacity of pump shall be determined to meet the specified requirements, taking into account the placing speed, construction schedule, quality of concrete, location to which concrete is poured, etc. Diameter of the delivery pipes shall be not smaller than 3 times of the maximum size of aggregates to be used in the concrete.

Delivery pipes shall be so installed as to permit easy removal. Before starting the pump or placer operation, about one cubic metre of mortar with the same proportion of water, admixture, cement and fine aggregate as designated for the regular concrete mix shall be passed through the pipe. The pipe shall be set as straight and horizontally as possible to prevent clogging of the concrete mix in the pipe. The supports of the pipeline shall be stiff enough to fix the pipes firmly without adverse effect on forms and reinforcing steel already set in position. Care shall be taken to prevent leakage of the concrete mix from the pipe line or any other part.

Air boosters shall not be used except in conditions where the outlet of the pipe is completely embedded at least 2 metres in fresh concrete.

e) Placing Procedures

The concrete shall be deposited as nearly as possible in its final position. It shall be placed so as to avoid segregation of the concrete and displacement of the reinforcement, other embedded items, or formwork. It shall be brought up in layers approximately parallel to the construction joint planes and not exceeding

500mm in compacted thickness unless otherwise permitted or directed by the Engineer, but the layers shall not be thinner than four times the maximum nominal size of aggregate.

Layers shall be placed so that they do not form feather edges nor shall they be placed on a previous layer which has taken its initial set. In order to comply with this requirement, a layer may be started before completion of the preceding layer.

All the concrete in a single bay or pour shall be placed in a continuous operation. It shall be carefully worked round all obstructions, irregularities in the foundations and the like so that all parts are completely full of compacted concrete with no segregation or honeycombing. It shall also be carefully worked round and between waterstops, reinforcement, embedded steelwork and similar items which protrude above the surface of the completed pour.

All work shall be completed on each batch of concrete before its initial set commences and thereafter the concrete shall not be disturbed before it has set hard. No concrete that has partially hardened during transit shall be used in the Works and the transport of concrete from the mixer to the point of placing shall be such that this requirement can be complied with.

Concrete shall not be placed during rain which is sufficiently heavy or prolonged as to wash mortar from coarse aggregate on the exposed faces of fresh concrete. Means shall be provided to remove any water accumulating on the surface of the placed concrete. Concrete shall not be deposited into such accumulation of water.

In drying weather, covers shall be provided for all fresh concrete surfaces which are not being worked on. Water shall not be added to concrete for any reason.

When concrete is discharged above its place of final deposition, segregation shall be prevented by the use of chutes, downpipes, trunking, baffles or other appropriate devices, as approved by the Engineer.

Forms for walls, columns and other thin sections of significant height shall be provided with openings or other devices that will permit the concrete to be placed in a manner that will prevent segregation and accumulations of hardened concrete on the formwork or reinforcement above the level of the placed concrete.

When it is necessary to place concrete under water the Contractor shall submit to the Engineer his proposals for the method and equipment to be employed. The concrete shall be deposited either by bottom-discharging watertight containers or through funnel-shaped tremies which are kept continuously full with concrete up to level above the water and which shall have the discharging bottom fitted with a trapdoor and immersed in the concrete in order to reduce to a minimum the contact of the concrete with the water. Special care shall be taken to avoid segregation.

If the level of concrete in a tremie pipe is allowed to fall to such an extent that water enters the pipe, the latter shall be removed from the pour and filled with

concrete before being again lowered into the placing position. During and after concreting under water, pumping or dewatering in the immediate vicinity shall be suspended if there is any danger that such work will disturb the freshly placed concrete.

f) Interruptions to Placing

If concrete placing is interrupted for any reason and the duration of the interruption cannot be forecast or is likely to be prolonged, the Contractor shall immediately take the necessary action to form a construction joint so as to eliminate as far as possible feather edges and sloping top surfaces and shall thoroughly compact the concrete already placed in accordance with Clause 706. All work on the concrete shall be completed while it is still plastic and it shall not thereafter be disturbed until it is hard enough to resist damage. Plant and materials to comply with this requirement shall be readily available at all times during concrete placing.

Before concreting is resumed after such an interruption the Contractor shall cut out and remove all damaged or uncompacted concrete, feather edges or any other undesirable features and shall leave a clean sound surface against which the fresh concrete may be placed.

If it becomes possible to resume concrete placing without contravening the Specification and the Engineer consents to a resumption, the new concrete shall be thoroughly worked in and compacted against the existing concrete so as to eliminate any cold joints.

g) Dimensions of Pours

Unless otherwise agreed by the Engineer, pours shall not be more than two metres high and shall as far as possible have a uniform thickness over the plan area of the pour. Concrete shall be placed to the full planned height of all pours except in the circumstances described in sub-clause 705(d).

The Contractor shall plan the dimensions and sequence of pours in such a way that cracking of the concrete does not take place due to thermal or shrinkage stresses.

h) Placing Sequence

The Contractor shall arrange that as far as possible the intervals between placing successive lifts of concrete in one section of the Works are of equal duration. This duration shall normally be not less than three or more than seven days under temperate weather conditions unless otherwise agreed by the Engineer.

Where required by the Engineer to limit the opening of construction joints due to shrinkage, concrete shall not be placed against adjacent concrete which is less than 21 days old.

When the drawings call for contraction gaps in concrete, these shall be of the widths and in the locations shown on the drawings and they shall not be filled until the full time interval shown on the drawings has elapsed.

706. COMPACTION OF CONCRETE

The concrete shall be fully compacted throughout the full extent of the placed layer. It shall be thoroughly worked against the formwork and around any reinforcement and other embedded items, without displacing them. Particular care shall be taken at arises and other confined spaces. Successive layers of the same pour shall be thoroughly worked together.

Concrete shall be compacted with the assistance of mechanical immersion vibrators, unless the Engineer agrees to another method.

Immersion vibrators shall operate at a frequency of between 7,000 and 10,000 cycles per minute. The Contractor shall ensure that vibrators are operated at pressures and voltages not less than those recommended by the manufacturer in order that the compactive effort is not reduced.

A sufficient number of vibrators shall be operated to enable the entire quantity of concrete being placed to be vibrated for the necessary period and, in addition, standby vibrators shall be available for instant use at each place where concrete is being placed.

Where the concrete contains aggregate with a nominal size of 75mm or more, vibrators with a diameter of 100mm or more shall be used.

Vibration shall be continued at each point until the concrete ceases to contract, a thin layer of mortar has appeared on the surface and air bubbles have ceased to appear. Vibrators shall not be used to move concrete laterally and shall be withdrawn slowly to prevent the formation of voids.

Vibration shall not be applied by way of reinforcement nor shall vibrators be allowed to touch reinforcement or other embedded items. The vibrators shall be inserted vertically into the concrete to penetrate the layer underneath at regular spacing. The spacing shall not exceed the distance from the vibrator over which vibration is visibly effective.

707. CURING OF CONCRETE

a) General

Concrete shall be protected during the first stage of hardening from loss of moisture and from the development of temperature differentials within the concrete sufficient to cause cracking. The methods used for curing shall not cause damage of any kind to the concrete.

Curing shall be continued for as long as may be necessary to achieve the above objectives but in any case for at least seven days or until the concrete is covered by later construction whichever is the shorter period.

The above objectives are dealt with in sub-clause 707(b) and (c) but nothing shall prevent both objectives being achieved by a single method where circumstances permit.

The curing process shall commence as soon as the concrete is hard enough to resist damage from the process, and in the case of large areas or continuous pours, shall commence on the completed section of the pour before the rest of the pour is finished.

Details of the Contractor's proposals for curing concrete shall be submitted to the Engineer before the placing of concrete commences in the Works.

Formed surfaces may be cured by retaining the formwork in place for the required curing period.

If the use of the foregoing methods is inappropriate, surfaces which will not have further concrete bonded to them and which are not to receive an application of a finish may be cured by the application of a curing compound having an efficiency index of at least 90 percent. Curing compounds shall contain a fugitive dye to enable the extent of the spread to be seen easily.

Curing compound is used on surfaces exposed to the atmosphere shall contain sufficient finely divided flake aluminium in suspension to produce a complete coverage of the surface with a metallic finish when applied at the rate recommended by the manufacturer.

Curing compounds shall become stable and impervious to the evaporation of water from the concrete surface within 60 minutes of application. The material shall not react chemically with the concrete surfaces for at least the first four days of the curing period.

If instructed by the Engineer, the Contractor shall, in addition to the curing provisions set out above provide a suitable form of shading to prevent the direct rays of the sun reaching the concrete surfaces for at least the first four days of the curing period.

b) Loss of Moisture

Exposed concrete surfaces shall be closely covered with impermeable sheeting, properly secured to prevent its removal by wind and the development of air spaces beneath it. Joints in the sheeting shall be lapped by at least 300mm.

If for some reason it is not possible to use impermeable sheeting, the Contractor shall keep the exposed surfaces continuously wet by means of a water spray or by covering with a water absorbent material which is kept wet, unless this method conflicts with sub-clause 707(c).

Water used for curing shall be of the same quality as that used for concrete mixing as stated in Clause 702.

c) Limitation of Temperature Differential

The Contractor shall limit the development of temperature differentials in concrete after placing by any means appropriate to the circumstances including the following:

i) limiting concrete temperatures at placing as set out in sub-clause 709(b);

ii) use of low heat cement, subject to the agreement of the Engineer;

iii) insulation of exposed concrete surface by insulating blankets. Such blankets shall have an insulation value at least equivalent to 50mm of dry mineral wool;

iv) leaving formwork in place during the curing period. Steel forms shall be suitably insulated on the outside;

v) preventing rapid dissipation of heat from surfaces by shielding from wind;

vi) avoiding the use of water sprays when such use would cause rapid cooling of the surface.

708. PROTECTION OF FRESH CONCRETE

Freshly placed concrete shall be protected from rainfall and from water running over the surface until it is sufficiently hard to resist damage from these causes.

No traffic shall be allowed on any concrete surface until such time as it is hard enough to resist damage by such traffic.

Concrete placed in the Works shall not be subjected to any loading until it has attained at least its nominal strength as defined in Clause 701.

If the Contractor desires to impose loads on newly-placed concrete, he shall make at least three test cubes and cure them in the same conditions as the concrete they represent. These cubes shall be tested singly at suitable intervals in order to estimate the time at which the nominal strength is reached.

709. CONCRETING IN HOT WEATHER

a) General

The Contractor shall prevent damage to concrete arising from exposure to extreme temperatures, and shall maintain in good working order all plant and equipment required for this purpose.

In the event that conditions become such that even with the use of the equipment the requirements cannot be met, concrete placing shall immediately cease until such time as the requirements can again be met.

b) Concrete Placing in Hot Weather

During hot weather the Contractor shall take all measures necessary to ensure that the temperature of concrete at the time of placing in the Works does not exceed 30 degrees centigrade and that the concrete does not loose any moisture during transporting and placing.

Such measures may include but are not necessarily limited to the following:-

i. Shielding aggregates from direct sunshine.

ii. Use of a mist water spray on aggregates

iii. Sun shields on mixing plants and transporting equipment.

iv. Cooling the mixing water. If ice is used for this purpose it should preferably be in flake form. Lump ice shall not be allowed to enter the tank supplying the mixer drum.

v. Covering skips closely with polythene sheet so that the latter is in contact with the concrete.

Areas in which concrete is to be placed shall be shielded from direct sunshine and rock or concrete surfaces shall be thoroughly wetted to reduce absorption of water from the concrete placed on or against them.

After concrete in any part of an area has been placed, the selected curing process shall be commenced as soon as possible. If any interval occurs between completion of placing and start of curing, the concrete shall be closely covered during the interval with polythene sheet to prevent loss of moisture.

710. FINISHES ON UNFORMED SURFACES

Horizontal or nearly horizontal surfaces which are not cast against formwork shall be finished to the class shown on the drawings and defined hereunder.

UF 1 Finish

All surfaces on which no higher class of finish is called for on the drawings or instructed by the Engineer shall be given a UF 1 finish.

The concrete shall be levelled and screeded to produce a uniform plain or ridged surface, surplus concrete being struck off by a straight edge immediately after compaction.

UF 2 Finish

This is a floated finish for roof or floor slabs and other surfaces where a hard trowelled surface is not required.

The surface shall first be treated as a Class UF 1 finish and after the concrete has hardened sufficiently, it shall be floated by hand or machine sufficiently only to produce a uniform surface free from screed marks.

UF 3 Finish

This is a hard trowelled surface for use where weather resistance or appearance is important, or which is subject to high velocity water flow.

The surface shall be floated as for a UF 2 finish but to the tolerance stated below. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface, it shall be steel trowelled under firm pressure to produce a dense, smooth uniform surface free from trowel marks.

Table 7.4 - Surface Tolerances

Class of Finish	Tolerance in mm. See notes		
	A	B	C
UF 1	N/A	10	+ 20 or - 10
UF 2	Nil	10	+ 20 or - 10
UF 3	Nil	5	+ 12.5 or -7.5

Notes:

1. Col. A is the maximum allowable value of any sudden change of level in the surface.
2. Col. B is the maximum allowable value of any gradual irregularity of the surface, as indicated by the gap between the surface and a three metre long straight edge or correctly shaped template placed on the surface.

3. Col. C is the maximum allowable value of the difference in level or position between a three metre long straight edge or correctly shaped template placed on the surface and the specified level or position of that surface.

Where dimensional tolerances are given on the drawings or in this Special Specification they shall take precedence over those given in Table 7.4.

711. MORTAR

This clause covers mortar for use ahead of concrete placing, and other uses not covered elsewhere in the Specification.

Mortar shall be composed of fine aggregate complying with Clause 721 c) and ordinary Portland cement complying with SRN 103. The mix proportions shall be as stated on the drawings or elsewhere in this Specification or if not stated shall be one part of cement to two parts of fine aggregate by weight.

Small quantities of mortar may be hand mixed but for amounts over 0.5 cubic metre a mechanical mixer shall be used.

The water content of the mortar shall be as low as possible consistent with the use for which it is required but in any case the water/cement ratio shall not be more than 0.5.

Mortar which is specified as 'dry pack' shall be mixed with sufficient water for the mix to become cohesive but not plastic when squeezed in the hand. Dry pack mortar shall be rammed into the cavity it is required to fill, using a hand rammer with sufficient force to ensure full compaction.

712. CONCRETE FOR SECONDARY PURPOSES

a) Non-structural concrete (NS concrete) shall be used only for non-structural purposes where shown on the drawings.

NS concrete shall be composed of ordinary Portland cement complying with SRN 103 and aggregates complying with SRN 108-111 including all-in aggregate within the grading limits of SRN 109 and SRN 111.

The weight of cement mixed with 0.3 cubic metres of combined or all-in aggregate shall not be less than 50 kg. The mix shall be proportioned by weight or by volume. The maximum aggregate size shall be 40mm nominal.

The concrete shall be mixed by machine or by hand to a uniform colour and consistency before placing. The quantity of water used shall not exceed that required to produce a concrete with sufficient workability to be placed and compacted where required.

The concrete shall be compacted by hand or by mechanical vibration.

b) No Fines concrete (NF concrete) is intended for use where a porous concrete is required and shall only be used where shown on the drawings or instructed by the Engineer.

The mix shall consist of ordinary Portland cement complying with SRN 115. The aggregate size shall be 40mm to 10mm only. The weight of cement mixed with 0.3 cubic metre of aggregate shall not be less than 50 kg. The quantity of water shall not exceed that required to produce a smooth cement paste which will coat evenly the whole of the aggregate.

713. RECORDS OF CONCRETE PLACING

Records, in a form agreed by the Engineer, shall be kept by the Contractor of the details of every pour of concrete placed in the Works. These records shall include class of concrete, location of pour, date of pour, ambient temperature and weather conditions during mixing and placing and concrete temperature at time of placing, moisture contents of aggregates, details of mixes, batch numbers, cement batch number, results of all tests undertaken, location of test cube sample points and details of any cores taken.

The Contractor shall supply to the Engineer four copies of these records each week covering work carried out the preceeding week. In addition he shall supply to the Engineer monthly histograms of all 28 day cube strengths together with accumulative and monthly standard deviations and any other information which the Engineer may require concerning the concrete placed in the works.

714. CONSTRUCTION JOINTS

Whenever concrete is to be bonded to other concrete which has hardened, the surface of contact between the sections shall be deemed a construction joint.

Where construction joints are shown on the drawings, the Contractor shall form such joints in those positions. The location of joints which the Contractor requires to make for the purpose of construction shall be subject to the agreement of the Engineer. Construction joints shall be in vertical or horizontal planes except in sloping slabs where they shall be normal to the exposed surface or elsewhere where the drawings require a different arrangement.

Construction joints shall be so arranged as to reduce to a minimum the effects of shrinkage in the concrete after placing, and shall be placed in the most advantageous positions with regard to stresses in the structures and the desirability of staggering joints.

Feather edges of concrete at joint shall be avoided and any feather edges which may have formed where reinforcing bars project through a joint shall be cut back until sound concrete has been reached.

The intersection of horizontal or near horizontal joints and exposed faces of concrete shall appear as straight lines produced by use of a guide strip fixed to the formwork at the top of the concrete lift, or by other means acceptable to the Engineer.

Construction joints formed as free surfaces shall not exceed a slope of 20 per cent from the horizontal.

The surface of the fresh concrete in horizontal or near horizontal joints shall be thoroughly cleaned and roughened by means of high pressure water and air jets when the concrete is hard enough to withstand the treatment without the leaching of cement. The surface of vertical or near vertical joints shall be similarly treated if circumstances

permit the removal of formwork at a suitable time.

Where concrete has become too hard for the above treatment to be successful, the surface whether formed or free is to be thoroughly scrabbled by mechanical means or wet sand blasted and then washed with clean water. The indentations produced by scrabbling shall be not less than 10mm deep and shall not extend closer than 40mm to a finished face.

If instructed by the Engineer the surface of the concrete shall be thoroughly brushed with a thin layer of mortar composed of one part of cement to two parts of sand by weight and complying with Clause 711 all as set out in sub-clause 705(b) immediately prior to the deposition of fresh concrete. The mortar shall be kept just ahead of the fresh concrete being placed and the fresh layer of concrete shall be thoroughly and systematically vibrated to full depth to ensure complete bond with the adjacent layer.

No mortar or concrete may be placed in position on or against a construction joint until the joint has been inspected and passed by the Engineer.

715. EXPANSION AND CONTRACTION JOINTS

Expansion and contraction joints are discontinuities in concrete designed to allow thermal or other movements in the concrete.

Expansion joints are formed with a gap between the concrete faces to permit subsequent expansion of the concrete. Contraction joints are formed to permit initial contraction of the concrete and may include provision for subsequent filling.

Expansion and contraction joints shall be formed in the positions and in accordance with the details shown on the drawings or elsewhere in the Specifications.

716. WATERSTOPS

All references to waterstops include grout stops.

Waterstops shall be of the material and form shown on the drawings. No waterstop material shall be brought on the site until the Contractor has submitted full details of the materials he proposes to use, including samples, and these have been tested and approved by the Engineer. All samples shall be of adequate length for testing.

Waterstops shall be made of materials which are resistant to chlorides, sulphates, or other deleterious substances which may be present in the environment of the Works.

Rubber waterstops may be of natural rubber and shall have an elongation at breaking stress of at least 500 percent at 25 degrees centigrade and shall allow a joint movement of at least 50mm.

Polyvinyl chloride (PVC) waterstops shall be extruded from an unfilled plasticised PVC polymer or copolymer which does not contain any reclaimed or scrap PVC. PVC waterstops shall have an elongation at breaking stress of at least 225 percent at 25 degrees centigrade and shall allow a joint movement of at least 10mm.

Low modulus waterstops shall be of rubber or PVC as described above but shall have an elongation of at least 200 percent at 25 degrees centigrade under a tensile stress of 6

N/mm^2 and shall allow a joint movement of at least 50mm.

Waterstops shall be supplied in lengths as long as possible consistent with ease of handling and construction requirements.

In rubber or plastic materials, joints other than butt joints shall be supplied ready made by the manufacturer. Butt joints shall be made on site in accordance with the manufacturer's instructions and with equipment supplied for the purpose by the manufacturer.

Waterstop material shall be stored carefully on site to avoid damage and contamination with oil, grease, or other pollutants. Rubber and plastic waterstops shall be stored in cool well ventilated places away from direct sunlight.

Rubber and plastic waterstops which are embedded in one side of a joint more than one month before the scheduled date of placing concrete on the other side, shall be protected from the sun.

Waterstops shall be firmly fixed in the formwork so that they cannot be displaced during concrete placing and shall be completely free of all dirt, grease, oil, etc., before placing concrete. Where eyelets are provided these shall be fully wired to the reinforcement and be the only means whereby the waterstop is fixed. In no circumstances shall a waterstop be punctured with nails etc. as a means of fixing.

Concrete shall be placed carefully round waterstops so as to avoid distortion or displacement and shall be fully compacted. Where waterstops lie in a horizontal or nearly horizontal plane the Contractor shall ensure that no voids are left on the underside of the waterstop.

Formwork around waterstops shall be carefully removed to avoid damage. If waterstops suffer any damage which cannot be properly repaired in-situ the Engineer may require a section of concrete to be removed and the waterstop replaced.

717. GROUTING OF POCKETS AND HOLES AND UNDERPINNING OF BASEPLATES

Pockets and holding-down bolt holes shall be thoroughly cleaned out using compressed air and water jet. Holes drilled by a diamond bit shall be roughened. The pockets and holes shall be filled with grout consisting of cement and clean fresh water mixed in proportion of two parts by weight of cement to one part by weight of water. The pouring of liquid grout shall cease as soon as each hole is filled and any excess grout on the surface of the concrete foundation shall be completely removed and the surface dried off before the next operation proceeds.

The space between the top surface of foundation concrete and the underside of the baseplates shall be filled with a special mortar made up in the following proportions:-

- Portland Cement ..... 50 kg.
- Fine aggregate ..... 50 kg.
- An additive acceptable to the Engineer to counteract shrinkage in proportions recommended by the manufacturer.

The special mortar shall be mixed with the lowest water-cement ratio which will result in a consistency of mix of sufficient workability to enable maximum compaction to be achieved.

The special mortar shall then be well rammed in horizontally below the baseplate and from one edge only until it is extruded from the other three sides. The mortar which has extruded shall then be rammed back to ensure complete support without voids.

718. REMEDIAL WORK TO DEFECTIVE SURFACES

If on stripping any formwork the concrete surface is found to be defective in any way, the Contractor shall make no attempt to remedy such defects prior to the Engineer's inspection and the receipt of any instructions which the Engineer may give.

Defective surfaces shall not be made good by plastering. Areas of honey combing (of a mild nature) which the Engineer agrees may be repaired shall be cut back to sound concrete or to 75mm whichever is the greater distance. In the case of reinforced concrete the area shall be cut back to at least 25mm clear distance behind the reinforcement or to 75mm, whichever is the greater distance. The cavity shall have sides at right angles to the face of the concrete. After cleaning out with water and compressed air, a thin layer of cement grout shall be brushed on to the concrete surface in the cavity and it shall then be filled immediately with concrete of the same class as the main body but with aggregate larger than 20mm nominal size removed. A form shall be used against the cavity, provided with a lip to enable concrete to be placed. The form shall be filled to a point above the top edge of the cavity.

After seven days the lip of concrete shall be broken off and the surface ground smooth. Surface irregularities which are outside the limits of tolerance set out in Clause 710 shall be ground down in the manner and to the extent instructed by the Engineer.

Severe honeycombing and defects other than those mentioned above shall be dealt with as instructed by the Engineer.

719. BENDING REINFORCEMENT

Unless otherwise shown on the drawings, bending and cutting shall comply with SRN 129.

The Contractor shall satisfy himself as to the accuracy of any bar bending schedules supplied and shall be responsible for cutting, bending, and fixing the reinforcement in accordance with the drawings. Any discrepancies should be brought to the attention of the Engineer prior to ordering the reinforcement.

Bars shall be bent cold by the application of slow steady pressure. At temperatures below 5 degrees centigrade the rate of bending shall be reduced if necessary to prevent fracture of the steel.

After bending, bars shall be securely tied together in bundles or groups and legibly labelled as set out in SRN 129.

Reinforcement shall be thoroughly cleaned and all dirt, scale, loose rust, oil and other contaminants removed before it is placed in the Works.

720. FIXING REINFORCEMENT

Reinforcement shall be securely fixed in position within a dimensional tolerance of 20mm in any direction parallel to a concrete face and within a tolerance of 5mm at right angles to a face, provided that the cover is not thereby decreased below the minimum shown on the drawings, or if not shown shall be not less than 25mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15mm or the diameter of the bar whichever is the greater.

Unless otherwise agreed by the Engineer, all intersecting bars shall either be tied together with 1.6mm diameter soft annealed iron wire and the ends of the wire turned into the body of the concrete, or shall be secured with a wire clip of a type agreed by the Engineer.

Spacer blocks shall be used for ensuring that the correct cover is maintained on the reinforcement. Blocks shall be as small as practicable and of a shape agreed by the Engineer. They shall be made of mortar mixed in the proportions of one part of cement to two parts of sand. Wires cast into the block for tying in to the reinforcement shall be 1.6mm diameter soft annealed iron.

Alternatively, another type of spacer block may be used subject to the Engineer's agreement.

Reinforcement shall be rigidly fixed so that no movement can occur during concrete placing. Any fixings made to the formwork shall not be within the space to be occupied by the concrete currently being placed.

No splices (laps) shall be made in the reinforcement except where shown on the drawings or agreed by the Engineer. Splice lengths shall be as shown on the drawings. Reinforcement shall not be welded except where required by the Contract or agreed by the Engineer. If welding is employed, the procedures shall be as set out in SRN 937 for gas welding or SRN 919 for metal arc welding. Full strength butt welds shall only be used for steel complying with SRN 126, and if used on high yield deformed bars complying with SRN 126 the permissible stresses in the vicinity of the weld shall be reduced to those applicable to plain bars complying with that Specification.

Mechanical splices shall not be used unless the Engineer agrees otherwise.

The Contractor shall ensure that reinforcement left exposed in the Works shall not suffer distortion, displacement or other damage. When it is necessary to bend protruding reinforcement aside temporarily, the radius of the bend shall not be less than four times the bar diameter for mild steel bars or six times the bar diameter for high yield bars. Such bends shall be carefully straightened before concrete placing continues, without leaving residual links or damaging the concrete around them. In no circumstances will heating and bending of high yield bars be permitted.

Bars complying with SRN 127 or other high tensile bars shall not be bent after placing in the Works.

Before concrete is placed in any section of the Works which includes reinforcement, the reinforcement shall be completely clean and free from all contamination including concrete which may have been deposited on it from previous operations.

The Engineer's approval for concrete placing is to be sought in writing for each pour, leaving adequate time to inspect and rectify any defects noted in the formwork, falsework, reinforcement, scaffolding, concreting arrangements, etc.

721. MATERIALS FOR CONCRETE

a) General

The Contractor shall submit to the Engineer full details of all materials which he proposes to use for making concrete. No concrete shall be placed in the Works until the Engineer has approved the materials of which it is composed. Approved materials shall not thereafter be altered or substituted by other materials without the consent of the Engineer.

b) Cement

Cement shall comply with the following Kenya Standards:-

- SRN 103 for Ordinary Portland cement.
- SRN 103 for Rapid Hardening Portland cement plus all special conditions to its use stipulated by the manufacturer.
- SRN 104 for Sulphate Resisting or High Alumina cement.

Cement shall be free flowing and free of lumps. It shall be supplied in the manufacturer's sealed unbroken bags or in bulk. Bagged cement shall be transported in vehicles with effective means of ensuring that it is protected from the weather.

Bulk cement shall be transported in vehicles or in containers specially built and equipped for the purpose.

Cement in bags shall be stored in a suitable weatherproof structure of which the interior shall be dry and well ventilated at all times. The floor shall be raised above the surrounding ground level and shall be so constructed that no moisture rises through it.

Each delivery of cement in bags shall be stacked together in one place. The bags shall be closely stacked so as to reduce air circulation but shall not be stacked against an outside wall. If pallets are used, they shall be constructed so that bags are not damaged during handling and stacking. No stack of cement bags shall exceed 3 metres in height. Different types of cement in bags shall be clearly distinguished by visible markings and shall be stored in separate stacks.
Cement from broken bags shall not be used in the Works.

Cement in bags shall be used in the order in which it is delivered.

Bulk cement shall be stored in weatherproof silos which shall bear a clear indication of the type of cement contained in them. Different types of cement shall not be mixed in the same silo.

The Contractor shall provide sufficient storage capacity on site to ensure that his anticipated programme or work is not interrupted due to lack of cement.

Cement which has become hardened or lumpy or fails to comply with the Specification in any way shall be removed from the site.

All cement for any one structure shall be from the same source.

All cement used in the Works shall be tested by the manufacturer or the Contractor in a laboratory acceptable to the Engineer. The tests to be performed shall be those set out in SRN 103 and the Contractor shall supply two copies of each certificate to the Engineer.

Each set of tests carried out by the manufacturer or Contractor shall relate to not more than one day's output of each cement plant, and shall be made on samples taken from cement which is subsequently delivered to the site. Alternatively, subject to the agreement of the Engineer, the frequency of testing shall be one set of tests for every 200 tones of cement delivered to site from each cement plant.

Cement which is stored on site for longer than one month shall be re-tested in the laboratory of the Materials Branch of the Ministry of Transport & Communications or at the Kenya Bureau of Standards or at any other approved laboratory at the rate of one set of tests as shown in SRN 103 for every 200 tonnes, and at monthly intervals thereafter.

Cement which does not comply with the Specification shall not be used in the Works and it shall be disposed off by the Contractor.

The Contractor shall keep full records of all data relevant to the manufacture, delivery, testing and use of all cement used in the Works and shall provide the Engineer with two copies thereof.

c) Fine Aggregate

Fine aggregate shall be clean, hard and durable and shall be natural sand, crushed gravel sand or crushed rock sand complying with SRN 108. All the material shall pass through a 5mm standard sieve and the grading shall be in accordance with Zones 1, 2 or 3 of SRN 109. In order to achieve an acceptable grading, it may be necessary to blend materials from more than one source. Fine aggregate for mortar only shall comply with SRN 135.

The fine aggregate shall not contain iron pyrites or iron oxides. It shall not contain mica, shale, coal or other laminar, soft or porous materials or organic matter unless the Contractor can show by comparative tests, on finished concrete as set out in SRN 117, that the presence of such materials does not adversely affect the properties of the concrete.

Other properties shall be as set out below:

Content passing a 75 micron standard sieve shall not exceed 3 per cent for natural or crushed gravel sand or 15 per cent for crushed rock sand.

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.05 per cent by weight expressed as chloride ion when tested as set out in SRN 107, subject also to the further restriction given in the note on total chloride content in Clause 721 (d).

Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO3, when tested as set out in SRN 601, subject also to the further restriction given in the note on total sulphate content in Clause 721 (d).

Soundness: After five cycles of the test in AASHO T104 or an approved equivalent, the aggregate shall not show a weight loss of more than 10 per cent.

Organic impurities: If the test for presence of organic impurities in aggregates described below shows that more than a trace of organic impurities is present, the fine aggregate shall not be used in the Works unless the Contractor can show by tests on finished concrete as set out in SRN 117 that the presence of organic impurities does not adversely affect the properties of the concrete.

Test for presence of organic impurities in aggregates:

This test is designed to indicate the presence of organic impurities in aggregates used for making concrete.

A 350 cc graduated bottle shall be filled to the 120 cc mark with a sample of the aggregate to be tested and a 3% solution of sodium hydroxide in water added until the volume of aggregate and liquid after shaking gives a total volume of 200 cc. The bottle shall be stoppered, shaken thoroughly and allowed to stand for 24 hours. If, after 24 hours, the colour of the solution is not darker than a pale brown, the aggregate under test may be deemed satisfactory.

d) Coarse Aggregate

Coarse aggregate shall be clean, hard and durable crushed rock, crushed gravel or natural gravel complying with the requirements of SRN 110. The material shall not contain any iron pyrites, iron oxides, flaky or laminated material, hollow shells, coal or other soft or porous material, or organic matter unless the Contractor can show by comparative tests on finished concrete as set out in SRN 117 that the presence of such materials does not adversely affect the properties of the concrete. The pieces shall be angular, rounded or irregular as defined in SRN 107.

Coarse aggregate shall be supplied in the nominal sizes called for in the Contract and shall be graded in accordance with SRN 111 for each nominal size.

Other properties shall be as set out below:-

The proportion of clay, silt and other impurities passing a 75 micron standard sieve shall not be more than one per cent by weight.

The content of hollow and flat shells shall be such as will not adversely affect the concrete quality when tested as set out in SRN 117.

The total content of aggregate shall not be more than the following:

- 40mm nominal size and above 2% of dry weight
- 20mm nominal size 5% of dry weight

- 10mm nominal size 15% of dry weight

Chlorides soluble in a 10 per cent solution by weight of nitric acid shall not exceed 0.03 per cent by weight, expressed as chloride ion when tested as set out in SRN 107 but subject also to the further restriction under the note on total chloride content hereunder. Sulphates soluble in a 10 per cent solution by weight of hydrochloric acid shall not exceed 0.4 per cent by weight expressed as SO3 when tested as set out in SRN 601 subject also to the further restriction given in the note on total sulphate content hereunder.

Soundness: After 5 cycles of the test in AASHO T104, the aggregate shall not show a weight loss of more than 12 per cent.

When tested in accordance with test C289 of the American Society for Testing of Materials, the aggregate shall be non-reactive.

Flakiness Index when tested in accordance with SRN 113 shall be as set out hereunder:

- For 40mm stone and above, not more than 40
- For 20mm stone and below, not more than 35

If the Flakiness Index of the coarse aggregate varies by more than five units from the average value of the aggregate used in the approved trial mix, then a new set of trial mixes shall be carried out if the workability of the mixes has been adversely affected by such variation.

Impact value: Not more than 45 percent when tested in accordance with SRN 107. Ten percent fines value: Not less than 50kN when tested in accordance with SRN 107.

Shrinkage: When mixed with other ingredients in the approved proportions for concrete and tested as set out in SRN 117, the shrinkage factor shall not exceed 0.05 percent.

Organic impurities: If the test for presence of organic impurities in aggregates shows that more than a trace of organic impurities is present, the aggregate shall not be used in the Works unless the Contractor can show by tests on finished concrete as set out in SRN 117 that the presence of organic impurities does not adversely affect the properties of the concrete.

Water absorption: The aggregate shall not have a water absorption of more than 2.5 percent when tested as set out in SRN 112.

Aggregate Crushing Value (ACV): Not more than 35 percent. Los Angeles Abrasion (LAA): Not more than 50 per cent.

Note: Total chloride and sulphate content:-

The total chloride content, expressed as chloride ion, arising from all ingredients in a mix including cement, water and admixtures shall not exceed the following

limits, expressed as a percentage of the weight of cement in the mix:-

For prestressed concrete, steam cured concrete or concrete containing sulphate resisting or super sulphated cement: 0.05 percent.

For any other reinforced concrete: 0.3 percent in 95 percent of all test results provided no result is more than 0.5 percent.

The total sulphate content expressed as SO3 of all the ingredients in a mix including cement, water and admixtures shall not exceed 0.4 per cent by weight of the aggregate or 4.0 percent of the weight of cement in the mix, whichever is the lesser.

e) Testing Aggregates

i) Acceptance Testing

The Contractor shall deliver to the Engineer samples containing not less than 50 kg of any aggregate which he proposes to use in the Works and shall supply such further samples as the Engineer may require. Each sample shall be clearly labelled to show its origin and shall be accompanied by all the information called for in SRN 107.

Tests to determine compliance of the aggregates with the requirements of Clause 721(c) and (d) shall be carried out by the Contractor in a laboratory acceptable to the Engineer. If the tested materials fail to comply with the Specification, further tests shall be made in the presence of the Contractor and the Engineer and acceptance of the material shall be based on such tests.

A material shall be accepted if not less than three consecutive sets of test results show compliance with the Specification.

ii) Compliance Testing

The Contractor shall carry out routine testing of aggregates for compliance with the Specification during the period that concrete is being produced for the Works. The tests set out below shall be performed on aggregates from each separate source on the basis of one set of tests for each day on which aggregates are delivered to site provided that no set of tests shall represent more than 250 tonnes of fine aggregate nor more than 500 tonnes of coarse aggregate, and provided also that the aggregates are of uniform quality. If the aggregate from any source is variable, the frequency of testing shall be increased as instructed by the Engineer.

- Grading SRN 107
- Silt and clay contents SRN 107
- Moisture content SRN 107
- Check on organic impurities

In addition to the above routine tests, the Contractor shall carry out the following tests at the frequencies stated:

Moisture content: As frequently as may be required in order to control the water content of the concrete as required by the Specification.

Chloride content: As frequently as may be required to ensure that the proportion of chlorides in the aggregates does not exceed the limit stated in the Specification.

The Contractor shall take account of the fact that when the chloride content is variable it may be necessary to test every load in order to prevent excessive amounts of chloride contaminating the concrete. For this purpose the Contractor shall use the rapid field test (the Quantab test). In the event of disagreement regarding the results of the field test, the chloride content of the aggregate shall be determined in the laboratory as described in SRN 107 (the Volhard test).

f) Delivery and Storage of Aggregates

Aggregates shall be delivered to site in clean and suitable vehicles. Different types or sizes of aggregate shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a base such that contamination of the aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be arranged so that as far as possible rapid drying out in hot weather is prevented in order to avoid sudden fluctuations in water content. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use in order to prevent fluctuations in water content of the concrete.

g) Water for Concrete and Mortar

Sea water or brackish water containing more than 1,000 ppm chloride ion or 2,000 ppm sulphate ion shall not be used for mixing or curing concrete.

Water shall be clean and free from harmful matter and shall comply with the requirements of SRN 114.

The Contractor shall carry out tests in accordance with SRN 114 to establish compliance with the Specification.

If water for the works is not available from the Employer's supply the Engineer's approval must be obtained regarding the source of supply and manner of its use. Water to be used with cement or lime shall be free from salt, oil, alkali, organic matter, and other deleterious substances.

h) Admixtures

i) General

The use of the admixtures in concrete may be required under the Contract to promote special properties in the finished concrete or may be proposed by the Contractor to assist him to comply with the Specification.

In all cases the Contractor shall submit to the Engineer full details of the admixture he proposes to use and the manner in which he proposes to add it to the mix.

The information provided shall include but not be limited to:-

i. The typical dosage, the method of dosing and the detrimental effects of an excess or deficiency in the dosage.
ii. The chemical names of the main active ingredients in the admixture.
iii. Whether or not the admixture contains chlorides, and if so the chloride ion content expressed as a percentage by weight of admixture.

iv. Whether the admixture leads to the entrainment of air when used at the manufacturer's recommended dosage, and if so, the extent to which it does so.
v. Details of previous uses of the admixture in Kenya.

The chloride ion content of any admixture shall not exceed 2 per cent by weight of the admixture nor 0.03 per cent by weight of the cement in the mix.

Admixtures shall not be mixed together without the consent of the Engineer

Calcium chloride or admixtures containing calcium chloride shall not be used in prestressed concrete.

ii) Workability Agents

Workability agents shall comply with SRN 149 and shall not have any adverse effect on the properties of the concrete.

i) Reinforcement Steel

Reinforcement which shall comply with the following Standards, covers plain and deformed bar reinforcement and steel fabric to be cast into concrete in any part of the Works but does not include prestressing tendons or any other embedded steel.

- SRN 126 for hot rolled plain bar and high yield deformed bar
- SRN 127 for cold worked steel bar
- SRN 128 for steel mesh fabric

All reinforcement shall be from an approved manufacturer and, if required by the Engineer, the Contractor shall submit a test certificate from the manufacturer.

All reinforcement for use in the Works shall be tested for compliance with the appropriate British Standard in a laboratory acceptable to the Engineer and two copies of each test certificate shall be supplied to the Engineer. The frequency of testing shall be as set out in the relevant Standard.

In addition to the testing requirements described above, the Contractor shall carry out additional tests as instructed by the Engineer.

Any reinforcement which does not comply with the Specification shall be removed from site.

All reinforcement shall be delivered to site either in straight lengths or cut and bent. No reinforcement shall be accepted in long lengths which have been

transported bent over double.

Any reinforcement which is likely to remain in storage for a long period shall be protected from the weather so as to avoid corrosion and pitting. All reinforcement which has become corroded or pitted to an extent which, in the opinion of the Engineer, will affect its properties shall either be removed from site or may be tested for compliance with the appropriate Standard at the Contractor's expense.

Dowel Bars

Dowel bars and tie bars shall consist of mild steel, or deformed bars of high yield steel all complying with SRN 126 and they shall be free from oil, paint other than bond-breaking compound, dirt, loose rust and scale.

Dowel bars and tie bars shall be of sizes as shown on the drawings and directed by the Engineer, and shall be straight, free from burred edges, or other irregularities and shall have their sliding ends sawn or, if approved, sheared.

Bond breaking compound for dowel bars shall consist of 66 per cent of 200 pen bitumen blended hot with 14 per cent light creosote oil and, when cold, brought to the consistency of paint by the addition of 20 per cent solvent naphtha or other approved compound meeting the following requirements.

i) It shall not retard or in any other way affect the setting of concrete.

ii) The average bond stress on bars coated with the compound with half their length cast into concrete specimens and subject to pull out tests at 7 days shall not exceed 0.14 newtons per square millimetre and the total movement of the dowel bar relative to the concrete shall not be less than 0.25 millimetres at that stress. The concrete specimens shall be 150 millimetres by 150 millimetres in section and 0.45 metre long and made with the same mix proportions as used in the Works

8. FORMWORK

801. FORMWORK FOR CONCRETE

Definitions

Formwork means the surface against which concrete is placed to form a face, together with all the immediate supports to retain it in position while concrete is placed.

Falsework means the structural elements supporting both the formwork and the concrete until the concrete becomes self supporting.

A formed face is one which has been cast against formwork.

An exposed face is one which will remain visible when construction has been completed.

802. CONSTRUCTION OF FORMWORK AND FALSEWORK

Before construction begins, the Contractor shall submit to the Engineer, drawings showing details of the proposed formwork and falsework.

Formwork and falsework shall be so constructed that they will support the loads imposed on them by the fresh concrete together with additional stresses imposed by vibrating equipment and by construction traffic, so that after the concrete has hardened the formed faces shall be in the positions shown on the drawings within the tolerances set out in Clause 806.

Ground supports shall be properly founded on footings designed to prevent settlement. Joints in formwork for exposed faces shall, unless otherwise specified, be evenly spaced and horizontal or vertical and shall be continuous or form a regular pattern.

All joints in formwork including formwork for construction joints shall be tight against the escape of cement, water and fines. Where reinforcement projects through formwork, the form shall fit closely round the bars.

Formwork shall be so designed that it may be easily removed from the work without damage to the faces of the concrete. It shall also incorporate provisions for making minor adjustments in position if required, to ensure the correct location of concrete faces. Due allowance shall be made in the position of all formwork for movement and settlement under the weight of fresh concrete.

Where overhangs in formwork occur, means shall be provided to permit the escape of air and to ensure that the space is filled completely with fully compacted concrete.

Formwork shall be provided for concrete surfaces at slopes of 30 degrees to the horizontal or steeper. Surfaces at slopes less than 20 degrees may be formed by screeding. Surfaces at slopes between 20 degrees and 30 degrees shall generally be formed unless the Contractor can demonstrate to the satisfaction of the Engineer that such slopes can be screeded with the use of special screed boards to hold the

concrete in place during vibration.

Horizontal or inclined formwork to the upper surface of concrete shall be adequately secured against uplift due to the pressure of fresh concrete. Formwork to voids within the body of the concrete shall also be tied down or otherwise secured against floating.

The internal and external angles on concrete surfaces shall be formed with fillets and chamfers of the sizes shown on the drawings unless otherwise instructed by the Engineer.

Supports for formwork for non-water retaining structures may be bolted to previously placed concrete provided the type of bolt used is acceptable to the Engineer. If metal ties through the concrete are used in conjunction with bolts, the metal left in shall not be closer than 50mm to the face of the concrete.

Supports for formwork for water retaining structures may be bolted to previously placed concrete provided the type of bolts and positions of fixing are acceptable to the Engineer. After concreting the Contractor shall remove all support bolts and seal all holes with well rammed cement/sand mortar containing approved waterproofing cement additive. Metal ties which would be left in the concrete shall not be permitted.

Formwork shall not be re-used after it has suffered damage which in the opinion of the Engineer is sufficient to impair the finished surfaces of the concrete.

Where circumstances prevent easy access within the form for cleaning and inspection, temporary openings for this purpose shall be provided through the formwork.

Shear keys shall be provided in all construction joints of the size and shape indicated on the drawings.

Where precast concrete elements are specified for use as permanent formwork, or proposed by the Contractor and agreed by the Engineer, they shall comply with the requirements of the Specification. Such elements shall be set true to line and level within the tolerances prescribed for the appropriate class of finish in Clause 506 and fixed so that they cannot move when concrete is placed against them.

803. PREPARATION OF FORMWORK

Before any reinforcement is placed into position within formwork, the latter shall be thoroughly cleaned and then dressed with a release agent. The agent shall be either a suitable oil incorporating a wetting agent, an emulsion of water suspended in oil or a low viscosity oil containing chemical agents. The Contractor shall not use an emulsion of oil suspended in water nor any release agent which causes staining or discoloration of the concrete, air holes on the concrete surface, or retards the set of the concrete.

In order to avoid colour difference on adjacent concrete surfaces, only one type of release agent shall be used in any one section of the works.

In cases where it is necessary to fix reinforcement before placing formwork, all surface preparation of formwork shall be carried out before it is placed into position. The Contractor shall not allow reinforcement or prestressing tendons to be contaminated with formwork release agent.

Before placing concrete all dirt, construction debris and other foreign matter shall be removed completely from within the placing area.

Before concrete placing commences, all wedges and other adjusting devices shall be secured against movement during concrete placing and the Contractor shall maintain a watch on the formwork during placing to ensure that no movement occurs.

804. REMOVAL OF FORMWORK

Formwork shall be carefully removed without shock or disturbance to the concrete. No formwork shall be removed until the concrete has gained sufficient strength to withstand safely any stresses to which it may thereby be subjected.

The minimum periods which shall elapse between completion of placing concrete and removal of forms are given in Table 8.1 and apply to ambient temperatures higher than 10 degrees centigrade. At lower temperatures or if cement other than ordinary Portland are involved, the Engineer may instruct that longer periods be used.

Alternatively, formwork may be removed when the concrete has attained the strength set out in Table 8.1, provided that the attained strength is determined by making test cubes and curing them under the same conditions as the concrete to which they refer.

Compliance with these requirements shall not relieve the Contractor of his obligation to delay removal of formwork until the removal can be completed without damage to the concrete.

Table 8.1 - Minimum Periods for Formwork Removal

Position of Formwork	Min. Period for temp over 10 Degrees Centigrade	Strength to be attained
Vertical or near vertical faces of mass concrete	24 hours	0.2 C
Vertical or near vertical faces of reinforced walls, beams and columns	48 hours	0.3 C
Underside of arches, beams and slabs (formwork only)	4 days	0.5 C
Supports to underside of arches, beams and slabs	14 days	C
Arched linings in tunnels and underground works	24 hours	4 N/mm^2

Note: *C is the nominal strength for the class of concrete used.*

If the Contractor wishes to strip formwork from the underside of arches, beams and slabs before the expiry of the period for supports set out above, it shall be designed so that it can be removed without disturbing the supports. The Contractor shall not remove supports temporarily for the purpose of stripping formwork and subsequently replace them.

As soon as the formwork has been removed, bolt holes in concrete faces other than construction joints which are not required for subsequent operations shall be completely filled with mortar sufficiently dry to prevent any slumping at the face. The mortar shall be mixed in the same proportions as the fine aggregate and cement in the surrounding concrete and with the same materials and shall be finished flush with the face of the concrete.

805. SURFACE FINISHES ON FORMED SURFACES

Classes of Finish

The surface finish to be achieved on formed concrete surfaces shall be as shown on the drawings and defined hereunder:-

a) Class F1 Finish

This finish is for surfaces against which backfill or further concrete will be placed. Formwork may be sawn boards, sheet metal or any other suitable material which will prevent the loss of fine material from the concrete being placed.

b) Class F2 Finish

This finish is for surfaces which are permanently exposed to view but where the highest standard of finish is not required. Forms to provide a Class F2 finish shall be faced with wrought thicknessed tongued and grooved boards with square edges arranged in a uniform pattern and close jointed or with suitable sheet material. The thickness of boards or sheets shall be such that there shall be no visible deflection under the pressure exerted by the concrete placed against them. Joints between boards or panels shall be horizontal and vertical unless otherwise directed. This finish shall be such as to require no general filling of surface pitting, but fins, surface discoloration and other minor defects shall be remedied by methods agreed by the Engineer.

c) Class F3 Finish

This finish is for surfaces which will be in contact with water flowing at high velocity, and for surfaces prominently exposed to view where good appearance is of special importance. To achieve this finish, which shall be free of board marks, the formwork shall be faced with plywood complying with B.S. 1088 or equivalent material in large sheets. The sheets shall be arranged in an approved pattern. Wherever possible, joints between sheets shall be arranged to coincide with architectural features or changes in direction of the surface.

All joints between panels shall be vertical and horizontal unless otherwise directed. Suitable joints shall be provided between sheets to maintain accurate alignment in the plane of the sheets. Unfaced wrought boarding or standard steel panels will not be permitted for Class F3 finish. The Contractor shall ensure that the surface is protected from rust marks, spillages and stains of all kinds.

d) Curved Surfaces

For curved surfaces where F2 or F3 finishes are called for, the formwork face shall be built up of splines cut to make a tight surface which shall then be dressed to produce the required finish.

Alternatively, single curvature surfaces may be faced with plastic or plywood linings attached to the backing with adhesive or with escutcheon pins driven flush. Linings shall not bulge, wrinkle or otherwise deform when subjected to temperature and moisture changes.

806. TOLERANCES

All parts of formed concrete surfaces shall be in the positions shown on the drawings within the tolerances set out in Table 8.2.

In cases where the drawings call for tolerances other than those given in Table 8.2 the tolerances shown on the drawings shall take precedence.

Where precast units have been set to a specified tolerance, further adjustments shall be made as necessary to produce a satisfactory straight or curved line. When the Engineer has approved the alignment, the Contractor shall fix the units so that there is no possibility of further movement.

Table 8.2 - Tolerances

Class of Finish	Tolerances in mm (See Note)		
	A	B	C
F1	10	10	+ 25 to - 10
F2	5	10	+ or - 15
F3	2	5	+ or - 10

***Note**: The tolerances A, B and C given in the table are defined as follows:*

1. *Column A is an abrupt irregularity in the surface due to misaligned formwork or defects in the face of the formwork.*

2. *Column B is a gradual deviation from a plane surface as indicated by a straight edge 3m long. In the case of curved surfaces the straight edge shall be replaced by a correctly shaped template.*

3. *Column C is the amount by which the whole or part of a concrete face is displaced from the correct position shown on the drawings.*

9. MASONRY

901. GENERAL

All masonry work shall be constructed from building stone as specified in Clause 1007.

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.

902. 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 perpends, reveals and other angles of the walling shall be built strictly true and square.

The stones shall be bedded, jointed and pointed in 1:3 cement: sand mortar in accordance with Clause 1009 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 to acceptable International Standards and/or as directed by the Engineer.

903. CAST STONEWORK

Cast stone shall be as specified in Clause 1008. 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 incorporated 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.

10. MISCELLANEOUS ITEMS AND MATERIALS

1001. GENERAL

The approval in writing or otherwise by the Engineer of any materials shall not in any way whatsoever relieve the Contractor from any liability or obligation under the Contract and no claim by the Contractor on account of the failure, insufficiency or unsuitability of any such materials will be entertained.

a) All items shall be suitable for water works purposes and for use with cold water installation and operation being in a tropical climate.

b) All items hereinafter specified shall be to such other Standard or Specification which in the opinion of the Engineer provides for a quality of material and workmanship not inferior to the Standard Reference Number (SRN) quoted. The Standard or Specification must be submitted to the Engineer for approval before commencement of work.

c) All ferrous pipes and fittings shall be coated with a protective paint suitable for use in and transport through a tropical climate.

d) The Contractor shall supply to the Employer a certificate stating that each item supplied has been subjected to the tests hereinafter laid down and conforms in all respects to the said Specification.

e) The Contractor shall provide adequate protection to all piping, flanged items and valves so as to guard effectively against damage in transit and storage and ingress of foreign matter inside the valves.

f) All pipework and fittings shall be subjected to a works hydrostatic test pressure which shall be not less than twice the maximum operating pressure.

g) The Contractor should exercise diligence to provide the best material.

h) Where applicable the manufacturer's Specification should accompany all offers. The name of the manufacturer must in every case be stated.

j) Where necessary the Contractor shall provide rubber gaskets to comply with SRN 208 and all other bolts, nuts, washers, etc. to undertake jointing at fittings etc.

k) Any articles required under this Contract which are found to be faulty due to a crack, flaw or any other reason or is not in accordance with the Specification stipulated will not be accepted nor will the Employer be liable for any charges in respect of such an article. Where any such rejected article can, in the opinion of the Engineer, be rendered usable, the Contractor may deal with it accordingly and include it in the Contract at a price to be mutually agreed. Straight pipes which have been cut will be accepted at the discretion of the Engineer, provided the length is not less than 4 metres or two thirds of the standard length whichever is the lesser and will be priced pro-rata.

l) Wherever possible, samples of pipes and fittings shall be submitted for approval of the Engineer prior to the Contractor obtaining the total requirements.

1002. SUBMISSION OF SAMPLES

As soon as possible after the contract has been awarded, the Contractor shall submit to the Engineer a list of the suppliers from whom he proposes to purchase the materials necessary for the execution of the Works. Each supplier must be willing to admit the Engineer or his representatives, to his premises during ordinary working hours for the purpose of obtaining samples of the materials in question. Alternatively, if desired by the Engineer, the Contractor shall deliver the samples of the materials to the Engineer's office without charge.

The information regarding the names of the suppliers may be submitted at different times, as may be convenient, but no source of supply shall be changed without the Engineer's prior approval once a supplier, source or material has been approved.

Samples of materials approved will be retained at the Engineer's office until the completion of the contract. Samples may be tested to destruction.

All materials delivered to site must be at least equal in all respects to approved samples, otherwise they shall be rejected. No special payment will be made for compliance with clauses specifying tests etc. to ensure quality control etc. unless specifically itemised in Bills of Quantities.

1003. ARCHITRAVES AND STOPS

Architraves and stops shall be Class 1 Mvuli matching to the frames and linings.

1004. BLOCKWORK

Building blocks shall be dense concrete blocks complying with the requirements of B.S. 2028, 1364, with faces for plastering and having a compressive strength of 14 N/sq.mm. (Table 2, Type A14).

Blocks shall be obtained from an approved manufacturer and shall be equal to sample blocks previously approved by the Engineer's Representative.

Blocks shall be carefully handled and stored on site and protected from the weather at all times.

Surfaces on which blockwork is to be built shall be kept clean. Blocks shall be well wetted before being laid and the tops of walls where blockwork has been left shall be well wetted before re-commencing. Blockwork shall be built plumb, true to line and level, with all perpends vertical and in line. Blocks shall be built in half bond and alternate courses shall be block bonded at all junctions, no cut block shall be less than half a block. Joints in concrete blockwork shall be well filled with gauged mortar and shall not exceed 10mm in width.

1005. BOLTS AND NUTS

Bolts and nuts shall comply with the relevant requirements of the British Standards as set out below:-

Black Hexagon Bolts, Screws and Nuts	B.S. 4190, Grade 4.6
Metal Washers for General Purpose	B.S. 4320
Black Cup and Countersunk Head Bolts and Screws, with Nuts	B.S. 4993

The items shall preferably have coarse metric threads but items with B.S.W. threads may be used. Bolt lengths shall be sufficient to ensure that nuts are full threaded when tightened in their final position.

1006. BONDING TIES

Bonding ties shall be 75mm wide x 250mm long galvanized bitumen-coated expanded metal strip, cast 100mm into concrete surfaces in contact with block work. The bonding tie used shall be approved by the Engineer's Representative.

1007. BUILDING STONE

All building stone shall be capable of withstanding when wet a crushing stress of 3.5 N/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 375mm 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 SRN 870 except that:-

i) The treatment shall be repeated for 10 cycles only; and

ii) The second criterion of failure shall be amended to allow for a loss of weight of not more than 20% of its original weight.

1008. CAST STONE

Cast stone shall be manufactured by an approved manufacturer to the shapes and dimensions shown on the drawings, and shall conform to the requirements of SRN 871: Cast Stone. It shall have a dense and even surface of the texture and colour detailed on the drawings or required by the Engineer. Where indicated exposed faces of the stone shall be

formed of a specially graded mix. Metal bond ties of approved manufacture shall be cast in with the stone as shown on the drawings. Samples of the completed stone shall be submitted for the Engineer's prior approval.

All stones shall be protected from damage during transport and erection by means of cement slurry coatings or by other approved methods.

1009. CEMENT GROUT

Cement grout shall consist of Portland Cement and water mixed in the proportion of one part by volume of cement and one and a half parts by volume of water. The grout shall be used within one hour of mixing.

1010. CEMENT MORTAR

Cement mortar shall consist of proportions by volume as specified of Portland Cement and natural sand or crushed natural stone or a combination of both as specified in SRN 135 and SRN 136: Building Sands from Natural Sources. The constituent materials shall be accurately gauged and mixed in an approved manner.

Cement mortar shall be made in small quantities only as and when required, and any mortar which has begun to set or which has been mixed for a period of more than one hour shall be rejected.

1011. CEMENT-LIME MORTAR

Cement-lime mortar shall consist of Portland Cement, hydrated lime and natural sand or crushed natural stone or a combination of both, as specified for cement mortar in Clause 712. The constituent materials shall be accurately gauged and mixed by volume in an approved manner in the proportions specified.

Cement-lime mortar shall be made only in small quantities as and when required. Any mortar which has begun to set or which has been mixed for a period of more than two hours shall be rejected.

1012. CONCRETE BLOCKS

Solid and hollow concrete blocks for walling shall comply with SRN 804 in every respect.

All solid and hollow concrete blocks used in the walling must be capable of withstanding a crushing pressure of not less than 0.35 kg per square millimetre after 28 days. The blocks shall be cast in Metric sizes.

1013. CONCRETE DRAIN INVERT BLOCKS

Precast concrete invert blocks shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 7.2 using maximum 12mm size aggregates. If required, cube test certificates shall be supplied by the manufacturer.

1014. CONCRETE SLABS FOR OPEN DRAINS

Precast concrete slabs for lining open drains shall be manufactured to the detail drawings supplied from concrete Class 20/10 as specified in Table 7.2 using maximum 12mm size

aggregates. If required, cube test certificates shall be supplied by the manufacturer.

1015. DAMP-PROOF COURSE (D.P.C.)

Hessian based metal cored bitumen for damp-proof courses shall be lead cored, complying with B.S. 743 paragraph 4, type D, weighing not less than 4.4 kg. per square metre. Damp-proof course shall be bedded horizontally in mortar as for blockwork with 115mm laps in length and full laps at angles.

1016. DOORS

Internal doors shall be hardwood framed solid cored flush doors constructed in accordance with B.S. 459 Part 3, faced both sides with 3mm thick Mvuli veneered plywood and lipped all round with matching hardwood lipping. Moisture content at delivery shall be 12% (+ or - 2%).

1017. ELECTRICAL INSTALLATION

The electrical installations will be carried out by Licensed Electrician and complying with the following:-

a) Regulations for Electrical Equipment of Buildings issued by the Institution of Electrical Engineers.

b) Electric Power Act.

c) The Kenya Power Company's Bye-Laws.

d) Relevant current British Standards and Codes of Practice.

e) All the relevant clauses in this Specification.

1018. FIRE HYDRANTS

Fire hydrants shall be in accordance with SRN 509. They shall be for installation underground and shall be in accordance with SRN 509.

The spindle shall be provided with a universal cast iron cap conforming to SRN 501.

The spindle of the fire hydrant shall be of the non-rising type and screwed so as to close the hydrant when rotated in a clockwise direction viewed from above. The direction of closing shall be clearly cast on the valve cap.

The flanged outlet of the outlet bend shall have a Bayonet Joint Outlet for a 63mm standpipe. The outlet of the hydrant shall be of the hooked type with hooks 112mm apart.

The outlet shall have a gun metal standpipe seating and be covered by a loose cast iron cap which shall be attached to the hydrant by means of a chain.

Both flanges shall be 63mm drilled to requirements of SRN 207.

The outlet bends shall be subject to a hydrostatic test in accordance with procedure set out in SRN 509 and shall be water-tight against a test pressure of 1.85 Pa. head of water.

1019. FIXING IRONMONGERY

The rates for supplying and fixing ironmongery shall include for all sinking, cutting, boring, mortising etc., making good, replacing damaged screws, oiling, adjusting and leaving in good working order and for mastering all keys.

1020. FIXING JOINERY

Doors shall be hung on one or one and a half pairs of butt hinges to give a maximum even tolerance of 2mm all round.

Sub-frames shall be fixed to blockwork with three fixing clamps per side and one dowel let 50mm into the floor and 50mm into the foot of each leg. Linings shall be fixed after completion of other finishings by means of screwing and pellating to sub-frames with matching hardwood pellates. Architraves and stops shall be pinned on, heads punched and filled with tinted filler.

1021. FRAMES AND LININGS

Door frames and linings shall be Class 1 Mvuli mortice and tenon jointed at angles. Sub-frames for internal doors shall be Class 1 Mvuli tongued at angles.

1022. GABIONS

Gabions shall be of the hexagonal wire mesh type, with mesh dimensions of 80 mm x 100 mm. The minimum dimension shall not exceed 83 mm. Wire shall be galvanised prior to weaving the mesh to resist corrosion from water.

All wire used in the fabrication of the gabion and in the wiring operation during construction shall be in accordance with BS 1052/1980 Mild Steel wire appended having a tensile strength of 38-50 kg/mm^2

All wire shall be galvanised to BS 443: 1982 'Zinc coatings on steel wire' with the minimum weight of Zinc coating in accordance with Table below.

	Diameter (mm)	Minimum Weight of Coating (g/m^2)
Mesh wire	2.7	260
Binding and connecting wire	2.2	240
Selvedge wire	3.4	275

All wire used in the fabrication of gabions and in the wiring operations during construction shall, after galvanising, have extruded onto it a coating of polyvinyl chloride compound referred to as PVC. The coating shall be black in colour, not less than 0.4 mm thickness and shall be capable of resisting deleterious effects of exposure.

Gabions shall be of the following standard sizes:

- 2m x 1m x 0.5m
- 2m x 1m x 1m
- 6m x 2m x 0.3m

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 a half full turns of wire, at each mesh point of the joint line.

Gabions shall be as manufactured by Maccaferri, or equivalent. Alternative materials shall be subject to the approval of the Engineer.

Rockfill for gabions shall consist of hardcore i.e. sound hard stone or broken rock. The maximum size shall be 220mm, and the minimum size shall be 120mm; however, up to 10% of some smaller blinding material (min. 75mm) to fill the internal voids between the bigger rocks will be allowed.

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 rock, the tops shall be closed and securely tied with connecting wire. 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 and final filing shall be in accordance with the instructions as issued by the manufacturer.

1023. GALVANISED WORK

Iron and steel, where galvanized, shall comply with B.S. 729, entirely coated with zinc after fabrication by complete immersion in a zinc bath in one operation and all excess carefully removed. The finished surface shall be clean and uniform.

1024. GULLY GRATINGS AND FRAMES

Gully gratings and frames shall be basically in accordance with the requirements of SRN 846, nominal size 500mm x 350mm except that the gully gratings shall be constructed of mild steel concrete filled in accordance with the standard detail drawings.

Where indicated as being kerb inlet type, the gullies shall conform to the shape and dimensions given on the detail drawings supplied, but in respect of materials and workmanship conform to SRN 846.

1025. HARDWOOD

Hardwood for joinery shall be sound, well conditioned and seasoned Mvuli complying with the requirements of B.S. 1186 Part 1, Class 1. A sample of each representative section for use in the work shall be previously submitted by the Contractor for approval by the Engineer's Representative. Moisture content shall be 12% (+ or - 2%).

1026. HYDRATED LIME

Hydrated lime shall comply with SRN 801: Building Limes, and shall be of the semi-hydrated type.

1027. IRONMONGERY

All ironmongery shall be obtained from a source approved by the Engineer's Representative. Samples shall be submitted before ordering and the articles ordered shall

match up with the approved samples. Screws of a like metal shall be used for all fittings.

1028. JOINERY

All exposed joiner's work shall have wrought faces. The prices of all joiner's work shall include for slightly rounded arises.

Where the term 'framing' or 'framed' is made use of, it shall be understood to mean all halvings, dovetails, tenons and hardwood pins and the best known means of putting the work together.

All framed work shall be put together loosely and stacked under cover where a free current of air can circulate and is not to be wedged and glued until it is required for fixing.

All joinery, when brought on the works, shall be stacked under cover.

The Engineer or his representative, shall have full right of access to the joinery works and power to condemn any work not approved and any approval expressed or implied is not to relieve the Contractor from his responsibility and liability to make good any shrinkage or other defects that may appear after the work is fixed.

All joinery to be painted shall be knotted and primed.

The Contractor shall provide all materials, labour, framing, fixing, etc., nails, screws and everything necessary for the proper execution and completion of the work.

1029. JOINT PRIMER

Joint priming compound shall be entirely in accordance with the manufacturer's recommendations for the joint sealant to be used.

1030. JOINT SEALING COMPOUND

Poured joint sealing material shall consist of an approved rubber-bitumen compound, complying with the requirements of SRN 879, or a two component, cold applied compound complying with SRN 879 as stated in the Bill of Quantities. Test Certificates, prepared by an approved testing laboratory, shall be supplied by the Contractor to show that the material does in fact comply in respect of cone penetration, flow and bond with the under-mentioned requirements:

Test Cone Penetration	Hot-poured Materials	Cold-poured Materials
0.15 kg. for 5 secs. at 25^{o} centigrade using standard grease cone	Penetration not to exceed 9mm	Penetration to be not less than 5mm not more than 27.5mm
Flow		
On a plane inclined at 75^{o} to the horizontal, 5 hours at 60^{o} centigrade	Flow not to exceed 5mm	Flow not to exceed 20mm

Bond		
25mm wide joint extended 12mm at rate of 4mm per hour at 18^{o} centigrade. No more than one specimen in three to develop a crack separation or other opening more than 4mm deep	Five cycles of extension and recompression	Three cycles of extension and recompression

Approved hot-poured materials shall also comply with a requirement whereby when heated for a period of 6 hours at a temperature of 80 degrees centigrade above recommended pouring temperature or 30 degrees centigrade below the safe heating temperature whichever is the greater shall still comply with the flow requirements of this clause.

In addition to materials complying with SRN 879, the Engineer may approve the use of alternative materials provided that they meet the requirements of this clause relating to cold-poured joint sealing compounds.

1031. LIME MORTAR

Lime mortar shall consist of proportions by volume as specified of hydrated lime and naturals and/or crushed natural stone or a combination of both as specified for cement mortar in Clause 1010. The constituent materials shall be accurately gauged and mixed in an approved manner.

1032. MANHOLE COVERS AND FRAMES

Manhole covers and frames shall be basically in accordance with the requirements of SRN 846: Cast Manhole Covers, Road Gully Gratings and Frames for Drainage Purposes except that the manhole covers shall be constructed of mild steel, concrete filled, in accordance with the standard detail drawings.

Foul water sewer manholes shall have triangular Grade "A" heavy duty covers and frames. Circular manhole covers and frames shall be used on surface water sewer manholes.

1033. MANHOLE STEP IRONS

Step irons of general purpose type shall comply in all respects with SRN 845: Malleable Step Irons.

1034. MARKER AND INDICATOR POSTS

Marker posts shall be erected at changes in direction of water mains as directed by the Engineer. Indicator posts shall be erected at valves and other fittings as directed. Marker and indicator posts shall be embedded in concrete as shown on drawings and shall be vibrated precast reinforced concrete as per dimensions shown on drawings. They should be painted in colours as indicated on the drawings.

1035. MURRAM

Murram shall be from an approved source quarried so as to exclude vegetable matter, loam, top soil or clay. The California Bearing Ratio of the murram, as determined for a sample compacted to maximum density (as defined under SRN 601) and allowed to soak in water for four days, shall not be less than 30%. This C.B.R. is a guide to quality only and the

compaction in the work will be judged by density.

1036. PAINTS

All priming, undercoating and finishing paints shall be in accordance with SRN 877 or SRN 878 as appropriate.

The painting of all building works shall comprise a special paint recommended for external work while all other paints, plastic emulsion coating etc. are to be of an approved manufacturer. All paints, distempers etc. shall be delivered on site intact in the original drums or tins, and shall be mixed and applied in accordance with the manufacturer's printed directions. The only addition which will be allowed to be made will be liquid thinners, driers etc. supplied by the makers for the purpose.

All surfaces must be thoroughly cleaned down prior to painting and decorating work and no external painting shall be carried out in rainy weather. All paint must be thoroughly well worked on and excess of paint in any coat must be avoided.

All colours will be selected by the Engineer from the standard range of colours.

1037. PENSTOCKS

Cast iron penstocks shall be all in accordance with SRN 906 and SRN 916. Seating faces shall be gun metal or bronze.

Spindles shall be threaded as necessary and non-rising unless otherwise specified. Spindles shall be of aluminium bronze, manganese bronze and extension spindles may be of mild steel.

Handwheels shall be of cast iron and words "OPEN" and "SHUT" marked on upper side with appropriate direction arrows.

1038. PLYWOOD

Plywood generally shall comply with B.S. 1455. That from sources not included in B.S. 1455 shall be of corresponding grades of veneers and types of bonding. Plywood for flush doors shall be Grade I Mvuli veneered.

1039. PRECAST CONCRETE GULLIES

Precast concrete gullies shall be unreinforced and shall comply with the requirements of SRN 854: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies.

1040. PRECAST CONCRETE MANHOLES AND INSPECTION CHAMBERS

Precast concrete manholes and inspection chambers shall comply with the requirements of SRN 854: Concrete Cylindrical Pipes and Fittings including Manholes, Inspection Chambers and Street Gullies, and they shall carry the relevant Standard Institution registered certification trade mark, or test certificates shall be furnished by the manufacturer.

1041. PRECAST CONCRETE UNITS

Precast concrete covers to be precast units for use in the works, whether instructed under the Contract or proposed by the Contractor.

a) Formwork for Precast Units

Moulds shall be so constructed that they do not suffer distortion or dimensional changes during use and are tight against loss of cement grout or fines from the concrete.

Moulds shall be set up on firm foundations so that no settlement occurs under the weight of the fresh concrete.

Moulds shall be constructed so that units may be removed from them without sustaining any damage.

Release agents used for demoulding shall not stain the concrete or affect its properties in any way.

b) Reinforcement for Precast Units

Reinforcement in precast units shall comply with the requirement of Clauses 721 i) and 719-720. When preformed cages are used the cages shall be made up on jigs to ensure dimensional accuracy and shall be carefully supported within the could in such a way that they cannot move when concrete is placed. Reinforcement complying with SRN 126 may be tack welded where bars cross to provide rigidity in the cage but reinforcement complying with SRN 127 shall not be welded.

Cover to main reinforcement shall be as shown on the drawings, or if not shown shall be not less than 25mm or the diameter of the bar, whichever is the greater. Cover on distribution steel shall not be less than 15mm or the diameter of the bar whichever is the greater.

Bars shall be spaced so that the minimum clear distance between them is the maximum nominal aggregate size plus five millimetres but in any case not less than the diameter of the bars.

Bars may be placed in pairs provided that there are no laps in the paired lengths.

c) Casting of Units

Concrete for precast units shall comply with Clauses 1039/1040 and 701-710 using the class of concrete specified on the drawings.

If lightweight aggregates are specified, they shall comply with SRN 147.

The area in which units are cast shall be adequately protected from the weather so that the process is not affected by rain, sun or drying winds.

d) Curing Precast Units

Requirements for curing shall be generally as set out in Clause 707.

The Contractor shall ensure that units do not suffer any loss of moisture or sudden

changes of temperature for at least four days after casting. If a water spray is used for curing, the water shall be at a temperature within 5 degrees centigrade of the temperature of the unit being cured.

If Contractor proposes curing at elevated temperatures, the method shall be subject to the agreement of the Engineer and shall include means whereby units are heated and subsequently cooled evenly without sudden changes of temperature.

e) Dimensional Tolerances of Precast Units

Units shall be accurately formed to the dimensions shown on the drawings unless closer tolerances are called for by the Engineer.

f) Surface Finish of Precast Units

The formed faces of precast units shall be finished to Class F3 as set out in Clause 805c) unless another class of finish is specified on the drawings.

Free faces shall be finished to Class UF2 unless another class of finish is specified on the drawings

In cases where a special finish is required a trial panel shall be constructed by the Contractor which after approval by the Engineer shall be kept available for inspection at the place of casting and production units shall thereafter match the approved pattern.

Those parts of the unit which are to be joined to other units or to in-situ concrete shall be brushed with a stiff brush before the concrete has fully hardened. Alternatively, if the concrete has been allowed to harden, the surfaces shall be roughened by sand blasting or by the use of a needle gun.

g) Handling and Storage of Precast Units

Precast units shall be handled in a manner which will not cause damage of any kind and shall be stored on a hard impermeable base.

Prestressed units and large precast normally reinforced units shall be handled and stored so that no stresses shall be induced in excess of those which they will incur in their final positions in the Works unless they have been designed to resist such stresses.

Units shall be provided with adequate lifting holes or loops, placed in the locations shown on the drawings or agreed by the Engineer and they shall be lifted only by such holes or loops. Where it is not possible to provide holes or loops, suitable sling positions shall be indicated in paint on the units.

Units shall be marked indelibly with the reference number and date of casting and shall be stacked on suitable packers which will not damage the concrete or stain the surfaces. Not more than two packers shall be placed under each unit and these shall be located either at the positions of the permanent support points or in positions such that the induced stresses in the unit will be a minimum.

h) Testing Precast Units

Precast units shall be capable of safely sustaining the loads which they have been designed to carry. The Contractor shall subject units selected by the Engineer to load tests simulating the working conditions. Details of such tests shall be agreed between the Engineer and the Contractor.

In the case of units subject to bending loads the test piece shall be supported at full span and a loading equivalent to 1.25 times the sum of the live and dead loads which were assumed in the design shall be maintained for one hour without the appearance of any signs of distress. The recovery one hour after the removal of load shall be not less than 75 per cent of the full load deflection.

If the unit fails to meet the above requirements, further tests shall be carried out on two more units. If either of these fail the whole batch of units will be rejected.

If the Engineer so requires, a test to destruction shall also be carried out which on units subject to bending shall be as follows:-

The units shall be supported at full span and a load applied in increments instructed by the Engineer up to 95 per cent of the designed ultimate load. This load shall be held for 15 minutes without failure of the unit. The deflection at the end of this period shall be not more than $1/40^{th}$ of the span. The load shall then be further increased until failure occurs.

If the unit fails to sustain the required load for the prescribed period or if the deflection exceeds the specified amount, the Engineer may order two further tests, and if either of these fail, the batch of units which they represent may be rejected.

1042. PRECAST LINTELS

All precast items shall be marked with the date of casting and shall not be built into the works until they have matured for 28 days. Ends of bar reinforcement shall be hooked or bent as required. The cover for reinforcement shall be 25mm from internal faces and 38mm from external exposed faces. The 'top' of lintels shall be numbered for identification.

Lintels shall have timber or pre-formed inserts cast in for fixing metal windows where required and shall have fair face finish on all surfaces exposed to view and hacked surfaces where plastered.

1043. PREFORMED JOINT FILLER

Preformed joint filler shall be of the thickness shown on the drawings or as stated in the Bill of Quantities.

The material comprising joint filler shall be as stated on the drawings or approved by the Engineer.

1044. STONE DUST

Stone dust for blinding shall be blacktrap screened to the following grading:-

Passing 10mm sieve	100%
Passing No. 4 sieve	85% -
100% Passing No. 100 sieve	5% - 25%

1045. STOP VALVES

All stop valves shall be in accordance with SRN 826. Samples of valves shall be submitted for test and approval to the Engineer.

1046. STRUCTURAL STEEL FOR WELDED WORK

Structural steel for riveted and welded work shall comply with the requirements of SRN 125: Structural Steel, SRN 126: The Use of Structural Steel in Building and for Welded Work, SRN 125: High Yield Stress and High Tensile Structural Steel, High Tensile (Fusion Welding Quality) Structural Steel for Bridges, etc. and General Building Construction.

1047. STRUCTURAL STEELWORK

The whole of the structural steelwork and testing shall comply with the relevant clauses of B.S. 449. The Contractor shall include for the preparation of all shop details from the drawings supplied by the Engineer. All such details shall be approved in writing by the Engineer before the work is put in hand. Every drawing shall show the number and sizes of all rivets and bolts, complete details of welds, type of electrodes, welding procedure, whether the welds are to be made in the shop or elsewhere and any other relevant information. The Contractor shall be responsible for the accuracy of his shop details and for shop fittings and site connections.

The Contractor shall take the dimensions from the structure and he shall verify all dimensions given on the drawings before the work is put in hand.

Any damage to materials on the site due to inadequate precautions being taken during the erection of the steelwork shall be made good to the satisfaction of the Engineer's Representative at the Contractor's expense.

The fabrication and erection of the steelwork shall be carried out in accordance with Part 5 of B.S. 449.

1048. TIMBER

Timber shall be sound, well seasoned and entirely free from worm, beetle, warps, shakes, splits, and all forms of rot and deadwood. Where required, all timber shall be treated with creosote, as specified in SRN 872: Coal Tar Creosote for the Preservation of Timber or an alternative approved timber preservative.

1049. WATER BARS

Water bars shall be "Dumbell" type and be of natural or synthetic rubber or extruded PVC. They shall be flexible, tough, elastic and durable and of dimensions detailed. They should

be unaffected on contact with dilute acids or alkalis. Joints and junctions shall, when possible, be prefabricated by the manufacturer, but if made at site the manufacturer's instructions including recommended adhesives shall be followed and used. Samples shall be submitted for approval of the Engineer before use of any material.

1050. WATERPROOF UNDERLAY

Waterproof underlay shall consist of either waterproof paper complying with SRN 856: Waterproof Building Paper, containing approved fibrous reinforcement, or 500 gauge polythene sheeting as stated in the Bill of Quantities.

11. PROJECT SPECIFIC INFORMATION AND CONTRACTOR'S GENERAL RESPONSIBILITY

1101. PROJECT LOCATION

The Project Site is within Machakos County in Kenya.

1102. SCOPE OF WORKS

The proposed intake works site is at Munyu area, near Thika in Kiambu County across River Ndarugu near the confluence with River Komu with raw water mains DN 450. The treatment works will comprise of a full conventional water treatment system projected to handle a capacity of approximately 6,600 m^3/day. The water supply system comprises a gravity mains conveyance system, water storage tanks, booster pump and a pumping main.

The scope of works includes the following: -

- **Intake Works**

  The proposed intake works site is at Munyu area, near Thika in Kiambu County across River Ndarugu near the confluence with River Komu, about 56Km North of Mwala Town along the Athi River at an elevation of 1417 meters above mean sea level. It consists of an intake weir.

- **Raw Water Transmission Pipeline**

  From the proposed intake works to the proposed treatment works a DN 450mm Raw Water Main pipeline is to be constructed for a length of approximately 4.48 Km.

- **New Treatment works**

  New 6,600 m^3/day capacity full conventional water treatment works located at Munyu 4.48 km downstream of the Intake including the following components;

  i. Inlet structure with flow measurement devices
  ii. Balancing reservoir and Stilling well
  iii. 1no. over and under type flocculation unit
  iv. 2no. Twin Plate Settler Sedimentation tanks
  v. 4no. Rapid gravity sand filters
  vi. 1,000m^3 Clear Water Storage/Chlorine Contact Tank
  vii. 1 no. 72m^3 Elevated Back wash tank
  viii. 4 no. Sludge drying beds
  ix. Chemical storage and dosing building
  x. Administration Building
  xi. Laboratory
  xii. Staff houses – 2No twin type D.
  xiii. Onsite ancillary works

- **Water Delivery Main System**

  A 53 Km DN 355/200 mm HDPE/Steel treated water main will be installed from the proposed Munyu treatment works to Kyuluni through Mwala town. At Kyuluni there shall be a booster pump to deliver water via a 7.0km long rising main to Muthei Hill tank from which water will be delivered to Masii and Makutano towns.

The total pipeline length is approximately 110kms. Only 88.75 Kms shall be done in the current phase of the project leaving out the Kabaa-Wamunyu pipeline which was not tendered due to financing limitations.

- **Storage tanks**

  Storage tanks located at the treatment plant, Kabaa, Mwala/Syathani, Kyuluni and Muthei Hill with a combined storage of about 2,500m^3.

  Table 11-1: Storage tanks

Tank Location	Type	Capacity (m^3)
Ndarugu Water Treatment Works	Reinforced Concrete	1,000
Kabaa	Masonry	225
Kyuluni Booster Pump	Masonry	50
Syathani/Mwala	Masonry	225
Muthei	Reinforced Concrete	1000
Total Storage		2,500

In addition, there shall be one 72m^3 elevated backwash tank at the Treatment plant.

1103. ADDITIONAL CONTRACTOR'S RESPONSIBILITIES.

Briefly, the Contractor's Additional Responsibilities will include:

- Setting out and verification survey of pipeline routes;
- Preparation of "As-Built" Drawings and O&M Manuals for the whole Project;
- Compliance with the project specific Environmental and Social Management Plan, all according to NEMA Conditions. This shall include issues such as disposal of wastes, health and safety of workers, safety of public, access and avoid nuisance to the public and property owners, confirm to emissions requirements, drainage and excessive erosion, among others;
- Maintaining the works for a pre-determined period (12 months) following hand-over, to ensure that the materials and workmanship are performing as intended.
- The Client has no land available for Contractor's Camp or Camps. The Contractor will procure / rent adequate land for his camps including offices, workshops, stores, labour camp and other facilities within the vicinity of the Project Site. The Contractor will submit probable camp site(s) location details to the Resident Engineer for approval prior to establishment.
- The Client has no land available for Storage of Materials including Pipes, Valves, Fittings, etc. The Contractor will procure / rent adequate land for proper storage and protection of all pipes, valves, fittings, etc. The Contractor will submit probable storage site(s) location details to the Resident Engineer for approval.
- The Contractor shall be responsible for locating and protecting existing utilities and services, including existing bulk water supply trunk mains, electrical power cable routes (KPLC/Kenya Power), telephone (KPTC/Telekom) and other service providers), water and sewerage pipes (the water company), roads and drains (KeNHA, KURA, KERRA). In this respect, the Contractor shall be responsible for obtaining all Permits and Approvals, and in general complying with the requirements of the individual utilities and agencies.
- The new works will be connected to the existing, operational water distribution systems. The Contractor will be required to liaise closely with the Water Company when executing the works activities. Further, strict "rules" will apply to all such tie-in works since, in general, they may require for some time, a partial shut-down of the supply system and affected consumers to be informed well in advance.
- The pipelines traverse along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, etc. The Contractor should indicate the cost of these works under the relevant item in Bill No. 1 ESHS Section or under Other Works, Obligations, Method Related Charges. If this item is not priced or inadequately priced, the Contractor's rates for Other Works will be deemed to cover this requirement.
- The Contractor shall be responsible for identifying and paying all Government Levies and Statutory costs such as training levy, licencing fee, etc. The costs of these are deemed to be covered in the Contractor's rates for the Works.

1104. CONDITIONS OF CONTRACT

The General and Particular Conditions of Contract are given in Volume I of the Bidding Document.

1105. CONSTRUCTION PERIOD

The proposed construction period will be **24 months**. Potential Contractors will note that multiple teams will be required to comply with this requirement, and will provide documentation to demonstrate adequacy of resources in this respect. Additionally, potential Contractors to note that some disruptions to scheduled work may be expected to occur during the rainy seasons. This to be allowed for in their programme of implementation.

1106. SITE AND OTHER DATA

- Average temperature in the Project Area is around 26^0C with minimum and maximum temperatures ranging from 15^0C to 32^0C.
- Average annual rainfall is 1800-2500mm with two main rainy seasons March-May and October to December but these periods can vary.
- Elevation of the Project Area varies between 1600m and 1800m above sea level.
- The works are to be executed along roads and densely populated commercial and residential areas. Working in these areas will require provision of safety barriers, warning signs and lighting, temporary accesses to properties, diversion management of traffic, etc.
- There are several major hospitals within the Project Area. The Contractor will be required to maintain basic medical facilities and transport on site for emergency use;
- Design, manufacture and construction standards will conform to recognize international Codes and Standards. Local Kenyan Codes and Regulations shall also apply.

1107. WAYLEAVE / EASEMENT FOR PIPELINE WORKS

The proposed water pipelines traverse along existing roads and are to be laid within the existing road reserves. Large sections of the road reserves also have other existing utilities such as fibre optic cables, electrical cables, water mains, sewer pipes, manholes and chambers. In some instances, the road reserve is paved with concrete / cabro / pcc slabs / asphalt. Sections of the road reserve may have encroachment by temporary structures. As-built details of the existing utilities are not available and Contractor will be required to carry out pilot excavation to determine the location and extent of the existing utilities. Contractor will liaise with person(s) who have encroached within the road reserve and obtain clear right of way prior to commencement of work and to ensure no delay occurs in the construction work programme.

Any additional space required for purposes of construction including working space for plant, other access, storage and movement of materials, excavated materials/filling, etc. will have to be appropriately arranged and paid for by the Contractor. In case of limited space in some sections, the Contractor may have to revert to manual excavation, double haulage of excavated material or any other means to execute the Works. The cost of all these exigencies will be deemed to be included in his rates for work.

The Employer will obtain and pay for the requisite permissions from Road Authorities - KeNHA, KURA, KERRA and the County Government to lay the pipes within the road reserves. However, the Contractor will allow in his rates all costs for conditions prescribed by the authorities during the construction of the pipeline and reinstatement of all reserve areas to the original condition.

1108. RESTRICTIONS ON USE OF ROADS

The Contractor shall not run tracked vehicles or tracked plant on any public or private road without the written approval of the Engineer and the responsible authority or owner and subject to such conditions as each may reasonably require.

The Contractor shall observe all weight and dimensions restrictions which apply to roads and tracks in Kenya and he shall comply with all reasonable restrictions which may from time to time be imposed by the Engineer. Where damage to roads and tracks is caused by the Contractor, this shall be repaired at the Contractor's expense. In particular, the Contractor shall fill potholes in roads with roadstone when these are deepened by his plant.

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.

1109. PREVAILING CONDITIONS

The Contractor is deemed to be fully familiar with local conditions and the potential effect (direct or indirect) on the planning and execution of the Works. The Contractor shall make his own studies / investigations in this respect.

These conditions include, but are not limited to the following:

i) Climatic Conditions
There are generally two rainfall seasons, long rains between March and May and short rains between October and December.

ii) Access
The works are to be executed along roads and densely populated commercial and residential areas. The pipelines also cross a number of rivers/ streams. Bidders to visit the Project Areas and familiarize themselves with the specific conditions in each area.

iii) Services
The Contractor shall make provision for the temporary supply of all services necessary for the execution of the works, including water, electricity, communications including Internet, fuels and consumables etc. The Contractor shall make all such applications and payments as necessary in order to obtain these services.

The Contractor is deemed to be familiar with the levels of service provided, and shall make all necessary backup provisions (such as generator sets, water tankers, on-site storage for key materials, etc.) to ensure that delays are not experienced.

iv) Local Materials
The Contractor shall be familiar with the supply of local materials with respect to sources and location, delivery times, prices, quality and standards of products, sizes, quantities available, reliability and customer service, delivery capability, etc.

With respect to quarries and borrow pits, the Contractor shall be responsible for all fees, royalties, permits and other obligations concerning such activities.

v) Laws and Regulations
The Contractor is deemed to be familiar with all laws and regulations pertaining to the implementation of the Contract, including relevant National Design And Construction Standards, Environmental Regulations, Transportation of Heavy Equipment by Road, Minimum Wage and Employment Standards, Health and Safety Regulations, Establishing / Operating / Decommissioning of Borrow Pits, Disposal of Wastes,

Procedures and Regulations related to Procurement of Imported Goods, Local Customs, etc.

vi) Local Labour
The Contractor shall liaise with Local Authorities (Chiefs, Labour Office, etc.) to recruit casuals and semi-skilled / skilled labour from the Project Area sites.

vii) Ground Conditions
The Contractor is deemed to be familiar with the site soil conditions, rock depths (whether hard or soft) including the presence of groundwater.

Approximate rock excavation quantities have been appropriately provided for in the Bills of Quantities. These quantities are re-measurable. Contractor to verify site conditions through site inspections prior to tendering.

In addition, the Contractor shall be aware of maximum flood levels in all Rivers along which works will be carried out and schedule the construction works accordingly.

1110. PROGRAM OF WORKS

If the Work Program submitted with the Bid requires revision, then the Contractor will within 28 days of signing the Contract, submit a Revised Program of Works to the Engineer for his acceptance.

The Program of Works shall be in bar chart format and shall indicate the major work components (including mobilization, any designs, procurement, substantial completion, etc.) and the main sub-activities. The program shall have a unit of time of one month (with part months indicated), unless the Engineer indicates otherwise.

The program (or, if necessary, a secondary program similarly formulated) shall clearly indicate the various work teams by discipline, including specialist sub-contracts and suppliers, as well as the Contractor's major plant and staff requirements, in order to demonstrate sequencing and non-conflict of resources.

The Engineer may request summary versions of the program, or additional detail for critical sections. The Contractor will comply with all such requests.

Once a Work Program has been approved by the Engineer it shall remain as the current version until such time as the Engineer instructs the Contractor to update or revise the program. The Contractor shall not modify his program without such instruction from the Engineer. Specifically, the Contractor's progress reports shall relate to the current program, and any delays shall be duly indicated.

The exact format of the Work Program shall be to the approval of the Engineer, but shall comprise the minimum of a detailed resource and cash flow schedule for the work, using Microsoft Project or a similar approved software system. This schedule, to be finalised and agreed between Employer and Contractor, will be used to measure Value of Work Done to enable the Contractor and Employer to monitor the progress of the project in terms of integrated cost, schedule and technical performance measures. In order for Value of Work Done to be estimated, the Contractor will provide a system that can accurately and demonstrably measure the following three fundamental factors:

i. The PLANNED VALUE COST also known as the Budgeted Cost of Work Scheduled

(BCWS). This is the amount of expenditure the Employer anticipated he would have spent at time of reporting.

ii. The ACTUAL COST of the progress made, known as the Actual Cost of Work Performed (ACWP). This is the actual amount of expenditure the Employer incurs at time of reporting.

iii. The EARNED VALUE, known as the Budgeted Cost of Work Performed. This is the percentage complete

Payment within the Contract will be based on the achievement of earned value agreed between Employer and Contractor, Independently assessed by the Engineer, in accordance with the value achieved based on measured quantities of work done.

1111. METHOD STATEMENTS

If the Method Statement submitted with the Bid requires revision, then the Contractor will within 28 days of signing the Contract, submit a Revised Method Statement to the Engineer for his Approval.

The Method Statement shall describe the Contractor's overall approach to the Contract, including issues such as type, number and layout of Contractor's buildings, stores and facilities; provision of temporary services: personnel issues including management structure, supervision and labour; Contractor's plant and equipment, and maintenance thereof; quality control management procedures; general methods for key work components such as structural works, electrical-mechanical installation, construction of pipelines etc.; working adjacent to existing River Courses and any other special considerations, etc.

From time to time the Engineer may request detailed Method Statements for specific activities. The Contractor shall comply in full with the Engineer's requirements.

1112. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

[Refer to Clause 141 in Chapter 1]

1113. HEALTH AND SAFETY MANAGEMENT PLAN

[Refer to Clause 142 in Chapter 1]

1114. PROGRESS REPORTS

The Contractor shall submit a Monthly Progress Report to the Engineer. The formal, content and level of detail shall be determined and agreed with the Engineer.

If the Engineer considers it necessary, the frequency of reporting may be increased. Alternatively, the Contractor may be instructed to provide a special progress report for a particular section of works (that is significantly delayed for example), on a more frequent basis (e.g. weekly, or even daily).

1115. DAILY LOGS

The Contractor shall maintain a daily site log. The log book entries shall be prepared in triplicate, with one copy being delivered each day to the Engineer.

The content and format of the Daily Log shall be agreed with the Engineer upon commencement of the contract. However, typically the log shall include the date, weather,

numbers/movement of plant and labour, main areas of work and daily activity/progress, deliveries of plant and materials to site, tests, issues, shut-downs, key instructions, accidents, among others. In addition the log sheet shall have a space designated for comments by the Engineer.

The Engineer may, at his discretion, instruct the Contractor to provide daily labour and plant returns. Alternatively, the Engineer may request to review such information.

In addition, the Contractor shall provide the Engineer with copies of all delivery notes of plant and materials delivered to site.

1116. TEST FORMS

The Contractor shall prepare, to the satisfaction of the Engineer, test forms to be used for the various components of the works.

All test forms shall be completed, signed and dated by the appropriate persons conducting the tests. The original copy of all test forms shall be submitted to the Engineer.

Tests forms shall be submitted to the Engineer regardless of whether the test passes or fails.

1117. MISCELLANEOUS FORMS

The Engineer and/or Contractor shall prepare other forms as necessary. These may include, but are not limited to:

i. Site Instruction Form;
ii. Request for Information / Inspection / Approval Form;
iii. Materials Supply Form;
iv. Setting Out Works Form;
v. Pipeline Final Excavation Level Form;
vi. Pipeline Laying Form;
vii. Pipeline Backfilling Form;
viii. Pipeline Testing Form;
ix. Dayworks Form; and
x. Concrete Pour Form; etc.

1118. CERTIFICATES OF COMPLETION

The Engineer shall prepare such forms in accordance with the Conditions of Contract. These include:

i. Taking-Over Certificate, issued upon successful completion of the Tests on Completion

ii. Performance Certificate, issued upon expiry of the Defects Liability Period and successful completion of defects and all other requirements under the Contract.

1119. VERIFICATION BY CONTRACTOR

Survey and Dimensional Checking

The Contractor shall be responsible for checking the following prior to carrying out construction work:

i. Confirm the alignment and elevations of each proposed pipeline. All elevations shall be related to a single bench mark;

ii. Confirm the location and elevation of existing pipelines through excavation and backfilling of trial holes

iii. Verify the locations, depths and other details of existing services along the proposed pipeline alignment

iv. Confirm extent of existing road reserve and available wayleave;

v. Confirm proposed distances and lengths;

vi. Confirm location of proposed structures and pipeline routes, including preliminary setting out. Confirm elevations of pipelines at key locations such as crossings of rivers and roads. In particular this shall include sections where pipelines shall cross these locations. The Contractor shall excavate and backfill all necessary trial holes to confirm such elevations;

vii. The Contractor shall provide the Engineer with drawings and other such documentation confirming all surveys and setting out.

12. PARTICULAR SPECIFICATIONS FOR TRANSMISSION PIPELNE WORKS

1201. GENERAL

This Specification applies in particular to the Water Transmission Pipeline and Water Distribution Pipework. Pipes, Valves and Fittings shall comply with the relevant International and/or National Specifications as stated hereinafter.

In general, the recommendations contained in EN 1295 Part 1: 8.1.1.2 (with regards to pipe design), and BS 8010, EN 1610 and BSCP 2010 or their equivalent (with regards to general pipe work and its installation) shall be followed in so far as they are relevant to the prevailing conditions. For design recommendations not covered by EN 1295, reference should be made to BS 534, EN 10224, EN 10311 and AWWA M11 for Steel Pipes, EN 545 – 2010 for Ductile Iron Pipes; BS 2782, BS EN 1452, BSCP 312, EN 921 and for uPVC; and BS3284 and EN 12201 for HDPE (PE100) Pipes.

At all times, latest editions and updated standards and procedures for design and installation shall be adopted. In the same context, the Contractor may provide, with the approval of the Engineer, superior materials using other standards not listed here provided they can demonstrate this to be the case through tests, examples and guarantee certifications.

The Contractor shall be wary of the worst-case scenarios making the installed pipes unsuitable and these can be caused by such things as unsuitable soils, shallow depths, bedding types and extraordinary traffic loads among other things and the Contractor shall inform the Engineer when they occur. Such incidences shall be remedied by using a higher class of pipe (wall thickness and/or yield stress) and/ or bedding as directed.

As a general guidance, the Pipes proposed for the Contract shall conform to the following International and National Standards unless a superior quality is demonstrated.

Standards for Pipelines

Pipeline General	EN 1295 Section 1.81.12 - Structural Design of Buried Pipelines, saving that where the Specification is silent on any pertinent matter, then the alternative relevant part of the SRN (e.g. AWWA) indicated shall be complied with.
	BS 8010 British Standard Code of Practice for Pipelines
	Part 2 Pipeline on Land: Design, construction and installation Section 2.1 1987 - Ductile Iron
	BSCP 2010- 2- Design and Construction of Steel Pipeline Inland
Steel Pipes & Fittings	BS EN 10224:2002

	Standard Steel Grades, ISO 559 (higher grades may be specified or allowed only with the written authorisation of the Engineer). Wall thickness ISO 559 as a minimum, unless otherwise indicated or specifically authorised following a design certified by the manufacturer. Flanges BS EN 1092 Coating and Lining DIN 30675 Part I for Type III soils (unless detailed field tests have proven Type I and II soils to be exclusively present).
Ductile Iron Pipes and Fittings	Pipes and Joints BS EN 545, 2010 Flanges BS EN 1092 Coating and Lining DIN 30675 Part 2 for Type III soil (unless detailed field tests have proven Type I and II soils to be exclusively present), and DIN 30674 Part 1

At Washout Locations

uPVC pipes	ISO 4422 and BS EN 1452 Fittings shall in general be Steel or Ductile Iron. Injection moulded uPVC bends and tees shall be allowed if designed to sustain equivalent pipeline pressure
HDPE Pipes & Fittings	ISO 4427 and DIN EN 12201 Fittings shall in general be Steel or Ductile Iron whilst electro-fusion jointed bends and lees shall be allowed providing these are not formed by bending straight pipe below the minimum radius specified.

Other Specific Standards are detailed in the General Specifications in Part I.

1202. CERTIFICATE AND SAMPLES FROM PIPE MANUFACTURERS

Where specifically requested by the Engineer, samples shall be provided by the Contractor. If accepted, the samples shall be used for the purpose of comparison with all components of a similar nature delivered subsequently. Any subsequent goods supplied that do not meet the standards of the sample shall be liable to rejection with all consequences to the cost of the Contractor.

The Contractor shall within 42 days of award, supply to the Engineer a signed certificate from the pipe manufacturer(s) stating that the pipes and fittings comply in all respects with the provisions of these Specification and the indicated National or International Standards, and that they shall conform to the required standards for all raw materials, processes, quality control, manufacturing, and for fully manufactured products including where appropriate, the handling to shipment. The pipe and fittings manufacturer's key personnel shall have at least three (3) years relevant manufacturing experience especially in regards to plant management, quality control/ quality assurance, application of the coating and lining systems offered in the bid. The Contractor shall have submitted reasonable documentary evidence with its bid to support statements made in the bid documents in this regard. The manufacturer shall also state that they have the ability to carry out the necessary tests during the manufacturing process and tests on the finished products as required by the respective standards.

The Contractor shall also submit a copy of the Pipe / Valve Manufacturer's Quality Assurance (QA) System complying with ISO 9000/9001/9002, together with sufficient information from the manufacturer's Quality Assurance Plan (in English) to enable the Engineer and Employer to understand the levels of performance offered.

The Contractor shall furnish the Engineer with a manufacturer's certificate in respect of every consignment of the pipeline materials, confirming that all the items of the consignment comply in all respects with the requirement of the specified standards and of this specification. The original and one copy of such manufacturer's certificate shall be delivered to the Engineer prior to shipment in the case of imported pipes and prior to dispatch from the factory in the case of local manufacture.

The original and one copy of such manufacturer's certificate shall be delivered to the Engineer prior to shipment.

1203. INSPECTION AND TESTING DURING MANUFACTURE

During manufacture and before dispatch of pipes and fittings from the place of manufacture, the Contractor shall allow for inspection by the Engineer and the Employer of all the manufacturing process and tests on raw materials and finished products. The inspection will include attendance for pressure and material tests, execution of dimensional checks and inspection of the workmanship and standard of manufacture with scrutiny or evidence of the materials used in the fabrication of the Pipeline Materials.

The Engineer and the Employer's representative shall be allowed full access to all areas at the place of manufacture or elsewhere where testing, furnishing or preparation of materials for the performance and testing of work under this Specification is taking place.

The Contractor shall furnish the Engineer with reasonable facilities and space (without charge) for the inspection, testing and obtaining of such information as he desires, respecting the character of material in use and the progress and manner of the work.

The Contractor shall arrange for such testing at his cost as may be required to be carried out at the place of manufacture according to this Specification. If there are no facilities at the place of manufacture for making the prescribed tests the Contractor shall bear the cost of carrying out the tests elsewhere or avail third party to carry out such tests.

The Contractor shall supply test certificates and shall furnish and prepare the necessary test pieces and samples and shall supply and provide all test rigs, equipment appliances, labour and any other facility required for inspection and testing.

In the duration of the Contract, the Contractor shall propose a schedule for four inspection visits to the pipe manufacturers' yard by three representatives of the Employer, the Engineer and Engineer’s Representative during the manufacturing and pre-shipment stages.

1204. THIRD PARTY INSPECTION OF MANUFACTURERS WITH ISO 9001/9002 ACCREDITATION

As quality assurance is of utmost importance to ensure extended asset lives, all manufacturers of pipes and fillings shall have facilities to conform to international standards and also carry

out tests related to raw material testing (confirmation of Steel Grades, etc.) manufacturing process, finished products and handling to shipment.

In the event during inspections and tests carried out in presence of the Employer and Engineers show inadequacies in the manufacturing process resulting in non-conformance finished products to an unacceptable level, the Employer will deploy his agent or third party inspector to carry out independent third party Inspection.

In such an event the supply and incorporation of materials from such source shall be stopped immediately until further notice and the Contractor shall instead provide materials from another approved source. The Contractor shall be required to replace at his cost all the rejected materials including the cost of this inspection in the event such third party inspection reveal non-conformance in manufacturing and quality standards. The inspectors shall be provided with full access to carry out third party inspection including the use of the in-house testing processes.

1205. ACCEPTANCE OF PIPES, VALVES AND FITTINGS

Only pipes, valves and fittings that are manufactured using acceptable materials, tested and delivered by firms which had been proven at the time of Bid to be listed under the ISO Standards hereinabove provided tor, shall be accepted as conforming to the Contract. The Client reserves the right to accept the proposed materials in the Bid. The Client may request for Third Party Inspection of specific materials prior to approval. The cost of these Third-Party Inspections will be borne by the Contractor and the Client reserves the right to accept or reject findings of the Third Party Inspection. Any other pipes, valves and fittings, other than those approved by the Client, shall be liable for rejection at the Contractor's risk, cost and responsibility.

Compliance with the provision of this Clause shall be separate and additional to the Contractor's compliance with the requirements of Kenyan Customs Authorities for pre- or post-shipment inspection of imports into Kenya. The costs for such third-party inspection shall also be fully borne by the Contractor.

1206. FERROUS PIPES – GENERAL

For ferrous pipes, emphasis is placed on corrosion protection and therefore no compromise will be accepted in pipe thicknesses, lining and coating so as to ensure that the asset life is extended beyond 50 years. Unlike plastic pipes, ferrous pipes can withstand external pressure and therefore the bedding requirements are less stringent provided they do not negatively affect the coating. It is important therefore for the Contractor to ensure that their ferrous pipe manufacturers are able to supply pipes and fittings with the specified lining and coating materials and that the manufacturing unit from where pipes are manufactured have at least five years of successful track record in supplying pipes with the required lining and coating materials. The manufacturer shall also be able to demonstrate that the lining and coating materials and application provided withstand all the necessary tests as detailed in this specification.

It is important that all international and latest updated standards are applicable for ferrous pipes so that the asset useful lives are enhanced by providing more robustness and superior lining and coating materials. Standards that provide superior materials shall therefore apply.

Except where otherwise specifically indicated, all ferrous pipes shall be barrier coated.

1207. STEEL PIPES AND FITTINGS - MATERIALS AND STANDARDS

Steel Pipes and Fittings shall generally comply with EN 10224:2002, ISO 559, AWWA C200, M11 and other international standards that specify superior pipe thickness and lining / coating materials. All latest and updated international standards pertaining to Steel Pipes and Fittings shall apply.

Standard Pipes and Fittings

Specifically Steel Pipes shall dimensionally conform to BS 534 and EN 10224, and in terms of materials properties and tests, they shall conform to BS 3600 and BS 3601 and EN 10220, EN 10216 and EN 10217, and where appropriate EN 10255. Pipe lengths shall be as per manufacturer's recommendation and adjusted as necessary to suit transport and site conditions, especially in areas with steep gradients and difficult access. Fittings shall in general conform dimensionally to BS 534, AWWA C208-01 and AWWA M11, however where specifically required the lengths of straight barrel sections may exceed or be less than standard dimensions. They shall be manufactured from pipes that have been manufactured to BS 534, EN 10224, BS 3660, EN 10220, EN 10216-1, or EN 10217-1, and successfully passed all mechanical, dimensional visual, pressure and non-destructive testing. All new welds made during the fabrication of the fittings shall be subject to non-destructive testing using either radiological, ultrasonic or dye penetrants dependent upon the geometry of the weld.

Where necessary, fittings shall be reinforced in accordance with AWWA C208-1 and AWWA M11. **The cost of reinforcement of all fittings should be included in rates for the respective fittings at time of bidding.**

Fittings may be reinforced in various ways for resistance to internal pressure. Typical fitting reinforcements are collars, wrappers and crotch plates. The design stress in the reinforcement should not be greater than the hoop stress used in the design of the pipe.

The type of reinforcement can be determined by the magnitude of the pressure-diameter value (PDV) and the ratio of the branch diameter to the main pipe diameter d/D.

The pressure-diameter value is calculated as:

$$\text{PDV} = \frac{Pd^2}{D \sin^2 \Delta}$$

Where:

P = design pressure (psi)
d = branch outside diameter (in.)
D = main pipe outside diameter (in.)
Δ = branch diameter angle of deflection

For PDV values greater than 6000, the outlet reinforcement should consist of a crotch plate. For PDV values less than 6000, the outlet reinforcement may be either a wrapper or collar, depending on the ratio of the outlet diameter to the main pipe diameter d/D. For a d/D ratio greater than 0.7, a wrapper plate should be used; for a d/D ratio less than 0.7, either a collar or a wrapper plate may be used. The ratio d/D does not include the sin Δ as in the PDV determination because the controlling factor is the circumferential dimensions. Wrappers may be substituted for collars, and crotch plates may be substituted for wrappers or collars.

Fitting ends for use with flexible couplings shall be true ended with the ends appropriately prepared for the type of coupling required.

Joints for site welding shall comprise bevelled edges to BS 534 or EN 10311 such that the lining shall be undamaged during the welding.

Any horizontal / vertical deflection below 7^0 will require mitre cutting of the plain ended pipes (one end or both ends depending on angle of deflection required), before mating ends and carrying out field butt welding at the joints. The cost of mitre cuttings is deemed to be included in the Contractor's rates for pipelaying.

All bolts shall be hot dipped zinc coated and those for bolted sleeve couplings further protected with a topcoat of aluminium pigmented organic epoxy to their respective standards, unless otherwise indicated on the drawings or in the Bills of Quantity.

The Contractor shall demonstrate that the thickness and steel grade provided in accordance with ISO 559 gives a thickness adequate for the pressure calculated in accordance with EN 1295. The thickness calculation shall take into consideration the following: the operating pressure, test pressures, pressure transients or surges if applicable, external pressures, steel pipe strength characteristics, temperature, soil condition, trench width and depth and appropriate traffic load.

The minimum Steel Grades and Steel Plate Thickness will be as follows:

Outer Dia mm	Yield Strength Mpa	Wall Thickness mm	Max Permanent Pressure Bar	Max Transient Pressure Bar
813	235	6.3	18	28
914	235	7.1	18	28
1016	235	7.1	17	25
1219	235	8.8	17	26
1422	235	9.5	17	26

Manufacture of Steel Pipes

The manufacturer shall operate a quality system relating to the manufacture of pipes, and integral joints to the required specification that shall be no less rigorous than that of EN ISO 9002 to ensure that products consistently meet the required level of quality.

Field Welding

All field welding shall only be done by welders who satisfy the requirements of BS EN 287-1:1992 or API 1104 and who have been tested and approved by an Independent Testing Authority.

Before any welding of pipeline materials commences, the qualification of welders shall have been approved, all detailed welding procedure specifications with weld diagrams required for their completion shall have been submitted for approval in a neat form, and the welding procedure qualification tests shall have been successfully concluded all in accordance with the relevant Standard Specifications.

Sufficient records shall be kept by the Contractor to ensure that all field welds can be subsequently identified with the welder concerned.

No welding shall be carried out during rain or high wind or under dusty conditions unless the welder, the weld area and the weld are adequately protected and sheltered.

Only approved welding rods which have been kept dry and uncontaminated shall be used.

Welding rods shall be of a grade and quality such that the chemical composition of weld metal and parent metal is similar. All welding rods shall be approved prior to ordering. Inspection of storage areas, storage records for issuance of welding rods and confirmation of their use will be available to the Engineer as and when required. Any contamination of supplies of such materials and use of unapproved welding rods will result in rejection of pipeline section and its replacement at Contractor's own cost.

Steel Pipelines

a) General

The out of roundness at a plane perpendicular to the pipe axis at any point along the pipeline length shall not exceed 4% of the minimum as laid inside diameter (i.e. + 2% of the nominal internal diameter) after completion of the backfilling and with atmospheric pressure inside the pipe.

Out of roundness being measured is the difference between the minimum and maximum inside diameter of the pipe at a point.

In case the above quality control on roundness of pipes and fittings is not achieved, the Contractor will provide stulls to all pipes and fittings at his own cost and to the approval of the Engineer.

b) Welded Pipelines

Pipes and specials to be joined by field welding shall be supplied with ends bevelled for welding. Field welding of joints shall conform to BS EN 288-9:1999 or API 1104.

All (100%) field welding joints shall be subjected to non-destructive testing using either radiological, ultrasonic or dye-penetrants depending on the geometry of the weld. Contract rates for supply and installation of butt-welded steel pipes and fittings shall be deemed to cover the specified non-destructive testing as specified in BS EN 288-9: 1999 or API 1104. The testing shall be carried out by an Approved / Licenced Specialist Contractor approved by the Engineer. The records of all testing shall be maintained as specified.

Before proceeding to welding of joints, pipe ends shall be completely circular and properly mated up by means of backing rings/clamps. At least 4 tack welds equally spaced around the pipe perimeter shall be applied to maintain the root gap and position of the pipe for completion of welding. A protective plastic or rubber sheet shall furthermore be placed over the coating adjacent to the joints to protect the same from damage caused by welding spatter.

Root welds shall thereafter be carried out followed by successive filler passes, and capper passes, all in accordance with the approved welding procedure. Wherever it is possible to have

entry into a pipe, inside welds shall be applied first. The inner weld bead shall not extend more than 1mm into the bore of a pipe or special.

Horizontal weld seams or spiral weld seams at pipe ends shall be placed near the horizontal diameter of the pipe or special and shall be staggered so that the circumferential distance between longitudinal or spiral welds intersecting the same circumference is greater than 90mm and not more than 130mm apart.

Defects caused by stray welding arc flashes, weld spatter etc. shall be removed by grinding provided that pipe wall thickness are not reduced to less than the specified minimum thickness, otherwise the portion containing the defect shall be cut out and repaired.

During welding of pipes, the pipe shall be protected with organic linings, mats of thick rubber felt or other suitable material which shall be placed along the pipe invert to protect the pipe lining for the full distance from the point of access up to the point of weld or weld Inspection. The mats shall be of sufficient width and shall cover a sufficiently wide area of pipe invert to protect the lining against damage due to access by staff, equipment, inspectors or fall out from arc weld. Workmen shall wear soft, rubber-soled shoes before entering lined pipes.

Care shall be taken not to stroke arcs on epoxy-lined areas and protective tapes, if any, at ends of epoxy lined pipes shall only be removed immediately prior to welding.

Pipes may be welded together alongside the edge of the trench. For factory lined and coated pipes, the maximum length so welded together shall be such that:

i) the pipe can be subsequently stored, lifted or handled without damage to lining
ii) the out of roundness at a plane perpendicular to the pipe axis at any point along the pipe length during storage, lifting or handling does not exceed 4% of the minimum inside diameter (out of roundness being measured as the difference between the minimum and maximum inside diameter of the plane at the point);
iii) safe and easy access to internal tie-in welds are assured for staff and Inspectorate with equipment;
iv) the maximum length does not exceed 36m

Snaking into the trench of butt-welded sections of pipe shall be permissible for bare steel pipes, subject to approval by the Engineer of a complete and comprehensive method statement submitted by the Contractor and provided that the out of roundness as defined and measured above during any stage of the snaking operation, does not exceed 4% of minimum internal diameter.

The linings and coatings of pre-lined and coated pipes jointed together outside the trench shall be made good at these joints outside the trench.

c) Pipelines with Flexible Couplings

Steel pipes from DN 65 to DN 600, outside chambers, may be plain ended suitable for jointing with flexible couplings and flange adapters or grooved for thrust-transmitting self-sealing joints, or with socket and spigot with rubber gaskets as described herein and as indicated in the Schedule of Prices and Unit Rates. Steel pipes from DN 650 upwards shall be plain ended suitable for jointing with flexible couplings and flange adaptors or with socket and spigot with

rubber gaskets where the joint is specifically approved in advance. Steel pipes within chambers shall be suitable for jointing as shown on Bid Drawings.

Flexible joints shall be bolted sleeve couplings to BS 534 and EN 10311 or flexible grooved joints, with a tapping boss to BSCP 2010-2 or AWWA C606, and of approved pattern. Flexible couplings shall be coated with fusion bonded epoxy layer 350 microns thick. Flexible couplings shall be of a mechanical type coupling consisting of a centre sleeve, two end ring flanges, two wedge shaped sealing rings of Nitrile rubber, and with galvanised nuts and bolts. The main components shall be made from hot rolled steel for larger diameters and malleable cast iron to EN 1562 or ductile iron for smaller diameters. If specifically called for, couplings shall be provided with a suitably sized screw plugged hole in the sleeve to allow for the introduction of molten bitumen for additional internal protection. The manufacturer shall then include the necessary removable internal backing-up rings of rubber composition and shall further include for all materials for in-situ jointing and protecting both for remedial works and for internal and external protection at such Joints. After jointing, the exposed part of the bolt shall be provided with a tight fitting polythene protection cap unless capped nuts are used.

Joints by flexible couplings shall be made only in their final laid position. Before assembling the joint, care shall be taken to ensure that pipe ends are clean and free from burrs and ridges. Such burrs and ridges shall be removed if present and linings and/or coatings made good where damaged. Pipe ends shall be mated carefully before joints are made. Pipe ends shall be concentric and perfectly lined up and the coupling shall not be relied upon to line up or to support the pipe.

Joints shall be made and couplings assembled to the manufacturer's instructions. Bolts shall be placed with bolt heads alternately pointing in opposite directions.

Half of the coupling bolts, equally spaced, shall first be partially tightened up in a regular sequence, using a short spanner. The remaining bolts shall then be similarly tightened. After checking the coupling alignment, the bolts shall then be finally tightened evenly and in a regular sequence by means of a torque wrench.

Where couplings without central registers are used, precautions shall be taken to ensure that the pipe ends are apart by the same distance as if a coupling with central register had been used and the couplings shall be carefully centred over the pipe ends.

Where a manufacturer opts for steel pipes with socket and spigot joints, or such joints are specifically called for, such joints shall in general conform to BSCP 2010-2, AWWA C200.97 or EN 10224, and the manufacturer shall submit calculations that the natural sag under 1.5 m of soil load with 90% compaction and a parked vehicle (wheel load and overload as defined above) will not exceed 2.0% on the spigot end of the pipe with the coating and lining as specified. The socket and spigot assembly shall be capable of withstanding a works test pressure of not less than 1.5 times the nominal pressure of the pipeline unless indicated otherwise on the Bid Drawings or in the Schedule of Prices and Unit Rates. Sockets shall be produced integral with the pipe and be hot formed. Rubber gaskets shall conform to EN 681. Unless a high-pressure seal, they shall have a front lip for dirt removal and a back lip for pressure sealing. Unless otherwise indicated, the internal laces of the sockets shall be coated in fusion bonded or liquid epoxy. A tight clearance shall be maintained between socket and spigot and should be in the range 1.6 mm +/- 0.8 mm.

d) Flanged Joints

Where specifically called for or deemed appropriate, flanged joints shall be utilised. They shall conform to EN 1092, drilled to NP 16 except where otherwise indicated, with gaskets made of reinforced elastomer rubber to EN 1514 and of minimum thickness of 3 mm. They shall be stored in accordance with EN 2230.

Bolts for flanged joints shall conform to ISO 4014-1 threaded to BS 3643, nuts to EN 24032 or SO 4032 and washers to BS 4320. Bolts, nuts and washers shall be protected to ISO 4032 or EN 24032 for above ground installation and to BS 3382-7 for below ground installation and in chambers. Nuts for use with self-sealing joints for steel pipes shall be as described under the section for service connections. Exposed threads of all bolts shall be filled with a light plastic cap after flange assembly.

Flanges shall be truly parallel with all bolts evenly firm before being finally drawn up with torque wrenches to water tightness. Taper gauges shall be used to check that there is a uniform gap before and after final tightening up of bolts. Bolts shall be tightened in an approved sequence with bolts equally spaced and at opposite ends tightened equally first.

The Contractor shall ensure that the correct jointing materials, i.e. gaskets, bolts and nuts are available when required. Only correct diameter and lengths of bolts and studs shall be used. Flat washers shall be used under all nuts. The length of bolts and studs shall be such that at least two threads protrude from the nut when fully tightened. The threads of bolts, studs and nuts shall be thoroughly cleaned and then coated with a graphite/grease compound immediately prior to assembly.

Flange faces shall be given two coats of an approved bituminous primer before mating. Flanged fittings shall be so installed that there are no stresses induced into the pipework, specials or fittings by forcing Ill-fitting units into position or by bolting up flanges with faces not uniformly in contact with their gaskets over their whole faces.

e) Maintenance of Cleanliness During Laying

The interior of pipes shall be perfectly clean before being laid and the Engineer may instruct pipe interiors to be cleaned or washed before the pipes are lowered into the trench. All brushes, trowels, welding rod stumps, pieces of mortar, dust and all foreign matter shall be removed from pipes immediately after laying. Once a section of pipeline has been cleaned, it shall be sealed off and shall not be entered again unless permitted by the Engineer in writing.

The Contractor shall at his own expense make good any damage to valves and fitting or clogging of off-takes or malfunctioning of fittings which result from his failure to keep the pipeline in a thoroughly clean condition.

f) Internal and External Works Protection

Pipe Coating

All coatings shall conform to DIN 30675 Part I for Type IIII soil or equal and coating thickness shall conform to DIN 30670 or equal unless a less rigorous type soil is indicated.

All coatings shall be of the factory applied barrier type.

The preferred coating for buried steel pipes shall be factory applied external protection with triple layer polythene coating (3LPE) to EN 10288 and DIN 30675 Part 1 for Type III soil comprising triple wrap system of fusion bonded or sprayed epoxy primer, an intermediate polymer adhesive layer and an extruded polyethylene coating providing an overall total film thickness that shall not be less than that specified in EN 10288 or its equal unless single layer fusion bonded epoxy to EN 10289 is indicated in the Bills of Quantity. The epoxy thickness should be sufficient to provide a holiday free surface.

For above ground steel pipes a triple layer polypropylene coating (3LPP) with polypropylene to EN 10286, AWWA-C215 or DIN 30678 shall be used, unless single layer fusion bonded epoxy is indicated in the Bills of Quantity.

Where a 3LPE or 3LPP coating is specified, the manufacturer shall demonstrate that the adhesion of the coating to the substrate does not lessen to extent that the PE coating could be easily cut or removed with time underground. The manufacturer shall carry out abrasive blast cleaning immediately before applying epoxy primer during the same work shift. In the case where steel plate or bare steel pipe is transported by sea to the place where coatings are applied, the steel or bare steel pipe as the case may be shall be subject to abrasive blast cleaning as well as phosphoric acid washing or chromate treatment immediately before applying epoxy primer during the same work shift.

All field butt welding joints shall be properly cleaned and provided with 3LPE or 3LPP coating as specified and to the Engineer's approval. The application of cold or heat process for provision of this coating has to be approved by the Engineer.

The polyethylene offered shall be HDPE.

Bidders can submit with the Bid, as an Option other coating materials with evidence and supporting standards that they are more superior and robust than the above specified coating. Bidders should also demonstrate that their manufacturers have good and long track record of providing such coating and lining materials (epoxy coating is not considered to superior to 3LPE coating). The Client reserves the right to select or reject any option for coating materials proposed by the Bidder without any justification.

A dedicated item for Cathodic Protection of Steel Pipes or Polyethylene Coating for Ductile Iron Pipes is included in the Bills of Quantities.

Protection of Site Welded Joints

Protection to site welded joints shall be by a solvent free epoxy coating to AWWA C210-97 or a tape wrap to AWWA M11 as indicated in this Specification or offered by the manufacturer and approved by the Client.

This specification covers the proper application and installation of approved Tape Systems for the external protection of buried, welded field joints.

The Contractor responsible for the application of the coating system will furnish all equipment and properly trained and supervised labour and service required for the specified application of the coating system. All equipment and tools required for the application of the coating system will be subject to the approval of the end-user company. The Contractor will follow the manufacturer's application specifications and work in harmony with

representatives of the manufacturer and the end user to alleviate any difficulties during the application and installation.

The contractor will be responsible for verifying the integrity of the coated field joint. Damaged coating will be repaired at the contractor's expense. The Contractor will supply all repair material.

The Contractor will supply a Technical Representative through an approved manufacturer of Taping Systems to assist or instruct the contractor and/or the end-user coating inspector with the proper application of the coating system.

The Technical Representative will have the authority, through the end-user representative, to suspend the application of the coating system until such time as the application satisfies application and quality control standards for the coating system.

Inspection of coated Field Joint will be performed by qualified coating inspectors appointed by the end-user. The coating system will be applied by certified trained personnel in the application of the joint coating system and meet the approval of the manufacturer.

Materials Storage - All coating material will be stored, handled and transported in such a manner as to prevent damage to individual carton containers. Cartons, tape rolls or individual repair rolls removed from the storage pallets will not be dropped, rolled, or thrown in any manner as to damage the coating material.

Cartons or tape rolls will not be handled with hooks, ropes, cables or any other mechanical devices that could damage the coating materials.

The coating material will be stored and/or transported in a dry, ventilated location. Storage temperature will be a minimum of 10° C and not exceed 60° C.

Coating materials that have been damaged or show signs of deterioration will be inspected by representatives of the manufacturer and at the discretion of the end-user, be rejected.

Primer will be stored in accordance with regulations that govern hazardous material storage. Primer inventory will rotate on a first in - first out basis. Primer containers will be marked with receiving dates.

Coating system waste material, primer containers, stub rolls, empty cartons, release liners, separator papers and related waste materials WILL NOT be discarded along the pipeline right-of-way or in the pipeline trench.

All cartons and rolls are marked with batch numbers, these batch numbers must be recorded by the applicator, each field joint that is wrapped must have the batch number of the manufacturer recorded to the weld number for easy reference.

- **Surface Preparation** - If the Cut Back surface temperature falls to below 10°c, the surface should be heated to achieve a faster cure.

- **Cut Back** - The bare Field Joint/Fitting Surface will be prepared to a recommended standard of Sa2½ - 50 - 80µm blast profile (ISO 8501-1).

Sa2½: Near White Blast Cleaning

Removal of nearly all mill scale, rust, rust scale, paint or foreign matter by the use of abrasive propelled through nozzles or by centrifi1gal wheels, to the degree hereafter specified. A Near-White Blast Cleaned Surface Finish is defined as one from which all oil, grease, dirt, mill scale, rust, corrosion products, oxides, paint or other foreign matter have been completely removed from the surface except for very light shadows, very slight streaks or slight discolorations caused by rust stain, mill scale oxides or light, tight residues of paint or coating that may remain. At least 95% (percent) of each square inch of surface area will be free of all visible residues, and the remainder will be limited to the light discoloration mentioned above.

The presence of oil, grease or tar will be determined using a water spray.

Where present, oil, grease or tar will be removed from the Field joint / fitting area using a non-oily solvent cleaner (i.e. Xylene, MEK, Ethanol) and clean, lint free rags.

If the above cleaning process has been carried out, the Field joint /fitting area will be rinsed with fresh potable water and dried before further processing.

Any defects in the steel substrate (i.e. slivers, laminations, etc.) will be highlighted to the clients' representative for disposition.

On completion of the surface preparation, all residual grit and dust will be removed using dry, clean compressed air.

- **Pipe Lining**

For sizes DN 80 up to and including DN 600, pipes shall either be protected internally in cement mortar. Cement mortar lining shall conform to BS 534, DIN 2880-1 or AWWA C205. Where the water being carried is specified as being aggressive, the internal face of the cement mortar shall be further protected by a factory applied epoxy coating.

For sizes above DN 600 pipes and fittings shall be lined in fusion-bonded epoxy conforming to EN 10339 or DIN 2614 unless otherwise directed by the Engineer. All butt welded joints shall be properly cleaned and provided with approved epoxy as specified by the Manufacturer and approved by the Engineer.

- **Fittings - Coatings and Linings**

Fittings shall be protected externally and internally by fusion-bonded epoxy to EN 10289, or AWWA C213 as specified by the manufacturer or required in the Bills of Quantity.

Flexible couplings and sell-sealing (grooved) couplings shall be protected externally and internally by fusion-bonded epoxy to EN 10289.

Self-sealing (grooved) coupling shall, where specified or otherwise allowed, conform to AWWA or BSCP2010-2. Bolts and nuts for such couplings shall be hot dipped zinc coated and capped nuts shall be provided. Bolts shall be an exact pre-determined length so that no

bolt thread is exposed but so that the capped nut fully tightens without bearing down on the top of the bolt.

If specifically called for, a polythene sleeve to ISO 8180 protruding not less than 50cm on each side of the joint shall be provided around all flexible couplings outside chambers during underground laying so as to further enhance joint protection, and shall be of minimum thickness of 200 microns. Such sleeves shall be lightly double-strapped at either end using a non-metallic strap.

- **Coating and Lining Tests**

Tests indicating the durability and robustness of the lining and coating shall be carried out as specified in DIN 30670, 30675, 30678 or equal and where relevant to the coating or lining in accordance with the requirements of the coating and lining specifications.

The supplier shall certify that their lining and coating materials conform to these tests and shall provide the Contractor testing instruments and train technicians to operate the instruments for carrying out these tests in Kenya, or if agreed at the manufacturer's premises elsewhere.

All coating and lining shall be on site tested for holiday free surfaces using the holiday testers. No pipe shall be laid having failed the holiday tests.

The Contractor shall be compensated for additional protection against corrosion required by the Engineer.

1208. DUCTILE IRON PIPES – GENERAL

For Ductile Iron Pipes, emphasis is placed on corrosion protection and therefore no compromise will be accepted in pipe thicknesses, lining and coating, so that the asset life is extended beyond 50 years. Ductile Iron Pipes can withstand external pressure and therefore the bedding requirements are less stringent provided however they do not negatively affect the coating. It is important therefore for the Contractor to ensure that the proposed pipe manufacturers are able to supply pipes and fittings with the specified lining and coating materials and that the manufacturing unit from where pipes are manufactured have at least five years of successful track record in supplying pipes with the required lining and coating materials. The manufacturer shall also be able to demonstrate that the lining and coating materials and application provided withstand all the necessary tests as detailed in this Specification.

It is important that all International and latest updated Standards are applicable for ferrous pipes so that the asset useful Lives are enhanced by providing more robustness and superior lining and coating materials. Standards that provide superior materials shall therefore apply.

1209. DUCTILE IRON PIPES AND FITTINGS - MATERIALS AND STANDARDS

Ductile Iron Pipes and Fittings shall generally comply to BS EN 545 (2010), ISO 2531 and other International Standards that specifies superior pipe thicknesses and lining / coating materials.

The Bills of Quantity specify the supply of "Self-Anchoring Ductile Iron Pipes and Fittings" which will avoid construction of large concrete thrust blocks at vertical and horizontal bends unlike the case with standard socket and spigot pipes.

a) Socketed Pipes

Ductile Iron Socketed Pipes shall be centrifugally cast in accordance with BS 8010 section 2.1 and EN 545. The minimum tensile strength shall be 420 N/mm^2 and the minimum 0.2% proof stress shall be 300 N/mm^2. The minimum elongation after fracture shall be 10% for nominal diameters DN 60 to 1000 and 7% for nominal diameters DN 1200 to 2000.

Centrifugally Cast Ductile Iron Pipes shall be individually subjected to a works hydrostatic test of not less than 10 seconds duration.

All ductile pipes shall conform to BS EN 545 – 2010.

b) Socketed Joints

Socketed joints shall be of the push-on type to BS EN 545 - 2010 and DIN 28603 unless otherwise specified. The material used for the rubber gaskets shall be either natural rubber or synthetic elastomer to EN 681 and EN 682, and they shall be stored in accordance with EN 2230.

c) Flanged Pipes

Ductile Iron Flanged Pipes shall be centrifugally cast to BS EN 545 - 2010.

They shall be joined using a rubber gasket of minimum thickness of 3 mm which shall be reinforced unless otherwise indicated on drawings or in Schedule of Prices and Unit Rates. The material used shall be either natural rubber or synthetic elastomer in accordance with EN 681 and EN 682, which shall be stored in accordance with EN 2230. Pipe thickness shall conform to BS EN 545 - 2010 unless otherwise indicated.

d) Fittings

Ductile Iron Fittings shall be sand cast in accordance with BS EN 545 - 2010. The minimum tensile strength shall be 400 N/mm^2 and the minimum 0.2% proof stress shall be 300 N/mm^2. The minimum elongation after fracture shall be 5%. All fittings shall be subjected to a works leak-tightness test using water to a pressure as given in BS EN 545 - 2010.

Socketed fittings, except for collars, shall be supplied with self-anchored push-on joints unless otherwise called for. Collars shall be supplied with mechanical joint. Flange fittings shall be fixed by rubber gaskets as indicated above for flanged pipes.

e) Marking

Each pipe, fitting or accessory shall bear the mark of the manufacturer, and indication of its casting and be marked with its nominal diameter. As appropriate, each fitting shall bear an indication of its main characteristics. Pipes, fittings and accessories with a nominal diameter of 300 mm or more shall also bear the year of manufacture. In addition, a referencing system shall be employed by the manufacturer denoting where pipes and fittings are to be stored and located along the route of the pipeline.

f) Pipe Coating

All Coating for Ductile Iron Pipes shall be barrier coatings and conform to DIN 30675 Part 2 for Type III soil or equal unless specifically indicated otherwise.

The external coating for Ductile Iron Pipes shall be a metallic zinc spray coating to DIN 30674 Part 3 applied directly to the warm film after annealing and covered by a layer of bituminous varnish to ISO 8179-2 but shall only be used with backfill material in accordance with DIN 30675 Part 2 for Type III soils to the approval of the Engineer, and his price will be deemed to have included for the cost of this. The mass of sprayed zinc metal shall be not less than 130 g/m^2 and the thickness of the bituminous varnish not less than 70 microns. Such a coating shall not be offered for highly corrosive soils with pH value under 6, or for peaty, boggy, silty or marshy soils. In the event such soils are encountered, the pipes shall be externally protected by a factory heat applied fused polyethylene coating by extrusion or sintering, to DIN 30674 Part 1 or equal.

Where the coating offered comprises zinc and bituminous varnish, a final coat of whitewash shall be applied generally in accordance to BS 7873 to reduce heat absorption. The pipe manufacturer shall also provide a polyethylene sleeve for site protection purposes. The sleeve shall conform to EN 14628 EN 14628 and be of minimum thickness of 200 microns.

Where in the opinion of the Engineer, native soil corrosion characteristics are worse than the expected, the Engineer may require additional protection to be provided involving measures such as anodic backfill material, increased standard of pipe coatings, pipe sleeving, pipe wrapping. A dedicated item for Polyethylene Coating for Ductile Iron Pipes where necessary is included in the Bills of Quantities.

g) Pipe Lining

Ductile Iron Pipes shall be internally lined with a cement mortar, centrifugally applied and conforming to BS EN 545-2010 and DIN 2880.

h) Coating and Lining Tests

Tests indicating the durability and robustness of the lining and coating shall be carried as specified in DIN 30670, DIN 30675, and DIN 30678 or equal, and in accordance with the coaling and lining specifications.

The supplier shall certify that their lining and coating materials conform to these tests and shall provide the Contractor testing instruments and train technicians to operate the instruments for carrying out these tests on site in Kenya.

i) Internal and External Protection

Bidders can specify as option other equivalent lining and coating materials with evidence and supporting standards that they are superior and more robust. Bidders should also demonstrate that their manufacturers have good and long track record of providing such coating and lining materials.

1210. TRANSPORTATION, HANDLING AND STORAGE

i) Packing for Transport

Pipes up to DN 300 may be bundled. Larger sizes shall be packed loose. Nesting of pipes is not permitted.

Containerised packing and transportation is also acceptable and if proposed shall be so indicated by the Bidder. All nuts, bolts, rubber gaskets etc. shall be packed in wooden boxes and protected against the elements.

Fittings up to and including DN 200 mm and flanged pipe pieces up to DN 200 mm and length not exceeding 1 metre shall also be packed and supplied in wooden boxes. All other fittings and flanged pipes may be packed loose. All flanges shall be protected with discs of wood, wool, fibre or timber. Bolted gland joints and flexible couplings shall be bundled if not containerised. Pipe sockets, spigots, plain ends shall be protected by suitable wrapping prior to transportation.

The Contractor shall further have described in his Bid in full detail the method(s) of offloading for imported items or on-loading for locally manufactured ex-works items, the methods of road/rail transportation and of site off-loading including the lifting methods intended. He shall further have described in his Bid in full detail the method(s) of stacking and storage. His Bid shall also be deemed to have included for the transportation as described and for the provision of all the necessary facilities for off- loading at the storage sites, and for proper stacking and storage.

ii) Storage Areas and Pipe Stacking

All pipes, valves and fittings shall be inspected upon arrival at the pipe storage areas for damage to:

a) the pipe or fitting itself;
b) external coatings (if any);
c) internal linings (if any); and
d) jointing surfaces (incl. sockets if any).

The Contractor shall repair or replace defective pipes and fittings, at the Engineer's option. All expenses in connection with such remedial works or replacements shall be deemed covered by the Contractor.

At the time of Bidding the Contractor shall also have stated the approximate areas of land required for the off- loading, stacking of the pipes, and for the storage of the fittings and of any special protection / storage facilities needed for any particular item(s). A sketch plan to be submitted with the Bid for evaluation including probable location of the storage yard.

The Contractor shall provide storage of pipes in a manner and in facilities approved by the Engineer. At the latter's discretion, ferrous pipes in diameters greater than 200 mm for laying in rural and peri-urban areas may be offloaded directly in the vicinity of the pipe trench provided the conditions and stacking method meet the requirements indicated below.

For pipes of local manufacture, storage may be provided by means of a temporary fenced-off area at the manufacturers premises, provided a Contractor in his Bid has so indicated his intention, and the area to be fenced off is shown to be sufficient for the purpose.

Pipes shall be stacked at the pipe storage areas using one or all of the following methods.

a) square stacking for small diameter pipes;
b) parallel stacking using wooden roller boards; and
c) pyramidal stacking.

All pipes shall be stacked on raised wooden battens at least 100 mm thick and 225 mm wide. A minimum of three battens per pipe for ferrous pipe lengths not exceeding 6 metres should be used with the outer battens laid 600 mm in from both pipe end and the middle batten placed equidistant between them. For ferrous pipe lengths greater than 6 metres, four battens shall be used. Pipe stacks shall be suitably wedged and the Contractor shall be deemed to have included for an adequate number of timber, wedges, etc., in his Bid.

Where socket and spigot pipes are stacked, the sockets should be placed at alternate ends of the stack with the sockets protruding.

Table below indicates the maximum stacking height allowable.

Nominal Pipe Diameter (mm)	Maximum Number of Layers in Stack	
	Ferrous Pipes	uPVC Pipes
Up to 100	16	7
150	14	7
200	12	5
250	10	5
300	8	4
350	7	-
400-450	6	-
500-600	4	-
700-800	3	-
900-1400	2	-

iii) Distribution of Pipes from Storage

Ferrous pipes of ND 200 mm and less may be distributed from storage to the trench side no more than 7 days prior to laying whilst ferrous pipes above ND 200 mm may be strung out up to 15 days prior to laying.

In all instances when along trench sides, ferrous pipes shall be supported within 1 metre of either end on sand filled bags such that no part of the wall of the pipe touches the ground, and in the case of pipes over 6 metres long with additional central sand bags.

When pipes are being loaded into vehicles care shall be taken to avoid their coming into contact with any sharp corners such as cope irons, loose nail heads, etc. Whilst in transit, pipes shall be well secured over their entire length and not allowed to project unsecured over the tailboard of the lorry.

Pipes may not be offloaded from lorries by rolling them. Pipes shall not be rolled or dragged along the ground.

1211. EXCAVATION OF PIPE TRENCHES

i) All trench excavation will, as a minimum precaution, be taped off to alert persons to its existence. Safety hoarding, lighting and warning signs to be maintained at all times.

ii) Excavations shall be made in open cut unless tunnelling or heading is specified by the Engineer

iii) The maximum length of open excavation shall not exceed 100 metres, except with prior written approval of the Engineer.

iv) Trenches for pipes shall be excavated to the lines and depths shown on the Drawings, or as directed by the Engineer, and shall be of sufficient width to give an equal clearance on both sides of the barrel of the pipe or pipes such that the total trench width is 3/2 'D' where 'D' is the outside diameter of the pipe, after allowance has been made for timbering and strutting.

v) Lesser trench widths may only be authorised if the Contractor can prove to the satisfaction of the Engineer that he can consistently achieve the required compaction for a lesser width. The minimum trench width is OD + 600 mm

vi) For pipes bedded in concrete sections, the breadth of concrete bedding for the pipes will be equal to the width of the trench. Excavation for valve chambers or any other water works structure, shall be carried out to the levels and outlines of such structures.

vii) Where pipes are not laid on concrete, the bottoms of the trenches as excavated, shall be smooth and shall be free from stones or other projections. Holes cut out at pipe joints shall be as small as possible. The trench shall be dug to within 150 mm of its formation and proper grade pegs shall then be set in the bottom of the trench by the Contractor for the accurate taking out of the rest of the excavation. Grooves about 50 mm deep shall be cut across the trench at the required positions to enable the easy removal of pipe slings.

viii) Where an imported lower bedding layer is not included, and if instructed to do so by the Engineer, the pipe trench shall be excavated to a depth of 100 mm below the invert of the pipe and be refilled with suitable 'as-dug' material free from stones greater than 20 mm dia. and foreign matter and compacted to a minimum 90% MPD in order to provide a smooth bed for the pipes.

ix) The materials excavated must not be placed so close to the edge of the trench as to impose a risk of collapse of the trench walls. The excavation and trenching section of the site-specific Health and Safety Management Plan should include criteria for the allowable conditions for placement of trench spoils, as well as maximum trench depths and side slopes of unsupported trenches, requirements for trench shoring, and restrictions on personnel working in unsupported trenches. During excavation, the Contractor shall ensure that all material suitable for re-use and which he intends for re-use are kept separate and set aside and protected as necessary to prevent loss or deterioration. Materials forming the surface and foundations of roads shall when excavated and if required for further use, be carefully separated. Paving slabs, bricks and similar surfaces shall be carefully removed and stacked for re use, or as otherwise instructed by the Engineer.

x) Where pipes are to be laid under a road formation or in open country, or in cutting, trenches shall generally be excavated after the earthwork is completed. The Engineer may permit these pipe trenches to be excavated before the earthwork is complete, but payment for the excavation of the trench will only be made upon the volume excavated below the road formation.

xi) Trenches shall be bottomed up immediately in advance of pipe laying, although at least 15 metres shall be prepared in advance of any given pipe. Trenches and joint holes shall

be kept free from water, until the pipes are laid and the joints completed and no ground water shall be allowed to enter the new pipes.

xii) If in the opinion of the Engineer delays in laying are due to the fault of the Contractor and the ground becomes weathered prior to the laying of the pipes, the Contractor shall remove the weathered soil and replace it with suitable compacted material to the original formation level at his own expense.

xiii) With the written approval of the Engineer, the Contractor may excavate rock in advance and temporarily refill the trench with the excavated material until he is ready to proceed with the laying of the pipe.

xiv) Where the trench is in rock or rocky ground the Contractor shall excavate the pipe trench to a depth of 150 mm below the invert of the pipe and refill with compacted granular fill. The Contractor shall obtain the Engineer's approval and instruction as to which sections of trench should be so treated.

xv) Rock in the form of boulders predominantly above ground level and located within 1 metre of the centre line of the pipeline shall be removed, if required by the Engineer, who shall determine in each case whether the removal of the boulder is necessary to achieve the required alignment or profile or to ensure the future safety of the pipeline.

xvi) Where trench excavation is carried out behind existing thrust blocks, adequate support arrangements shall be provided to transfer thrusts to the surrounding ground. No additional payment shall be made for such additional support works.

Headings

Where excavation for pipes in heading is permitted by the Engineer, it shall be carried out to the approval of the Engineer and to dimensions which will permit a proper inspection to be made. The heading shall be properly and securely timbered. The pipe shall be laid on a minimum thickness of 150 mm of Grade C15 concrete. After the pipe has been laid, jointed and tested the heading shall be filled in short lengths not exceeding 1 metre with Grade C15 concrete or as directed. Great care shall be taken to ensure that the heading is completely filled with concrete and hard filling shall then be rammed into the concrete at the crown of the heading. Special precautions shall be taken to prevent a slump in the concrete and to ensure that no slips or falls of the heading or in the ground above or in the shafts can take place. The Contractor shall allow for leaving in all timbering.

The Contractor shall be responsible for the proper restoration of any road surfaces, pipes, cables or other things or property which may be damaged.

1212. PIPE INSTALLATION

i) Pipes shall only be laid in the presence of the Engineer or Engineer’s Representative unless written authority from the Engineer has been granted

ii) No pipes shall be laid, nor lower bedding placed, until the formation has been inspected by the Engineer. The Contractor shall provide to the Engineer, a weekly schedule in advance indicating the dates and approximate times he expects to request such inspections

iii) Pipes generally shall be laid and jointed in accordance with the manufacturer's instructions. Extra excavation must not be carried out so as to avoid backfill, excessive deviation in joints and other irregularities. Otherwise, the pipe grade will follow the Drawings, with a continuous (but not necessarily uniform) fall towards washout-valves and rise towards air-valves.

iv) Prior to laying, damage to linings or coatings shall be repaired in accordance with the manufacturer's instructions. Where, in the opinion of the Engineer, the damage to a pipe coating is significant and notwithstanding the repairs made in accordance with the manufacturer's instructions, the complete pipe shall be further protected by a polythene sleeve. The sleeve shall conform to ISO 8180 for steel pipes and EN 14628 for DI pipes and be of minimum thickness of 200 microns. It shall be strapped beyond the joints of adjoining pipes using a non-metallic strap around the pipe.

If the damage is excessive and, in the Engineer's opinion, cannot be adequately repaired the Contractor shall replace the pipe(s).

All costs of repairs to damaged coatings and linings, and / or replacement of individual pipes, shall be to the Contractors account.

v) For DI pipes, before lowering into the trench or placing in position each pipe or casting shall be slung and sounded with a mallet to test for hair line cracks. Pipes that do not ring true will be discarded. For ferrous pipes with barrier coatings, the coating, and where appropriate the lining of every pipe shall be inspected by use of holiday detectors in accordance with NACE RP 0490. Unless otherwise authorised in writing by the Engineer to carry out such inspections in a nearby storage yard, such inspections shall be carried out at the trench side immediately prior to lowering into the trench.

Each pipe shall be thoroughly brushed inside and outside prior to laying and no foreign matter shall be allowed to enter the pipe during or after laying.

At the end of each working day the exposed pipe end shall be stoppered up with a stopper plug of appropriate diameter and not merely covered in polythene sheet tied around the end.

vi) Every pipe shall be laid separately and shall bear evenly upon the lower bedding or concrete for its full length, holes to receive sockets, couplings or flanges being cut in the bottom of the trench of such size and depth as to allow the joints to be properly made. The pipes shall be laid to true inverts, straight lines and falls, each pipe being separately boned between sight rails.

vii) All flanged joints shall be made with jointing rings, which shall be carefully inserted concentric to the bore of the pipe, so that undue stresses shall not be caused in any of the bolts or on the flanges when bolting up. The joint ring shall be compressed gradually and evenly by taking a few turns on each diagonal bolt in succession. Over-tightening shall be avoided. Where one or both of the flanges is itself of plastic, torque-wrenches shall always be used, and the bolts shall first be hand tightened and then diagonally tightened progressively to achieve 5%, 20%, 50%, 75% and finally 100% torque. For metal to metal flanges and if the Engineer is dissatisfied with the degree of care being taken, the Contractor shall provide and use torque-wrenches for this purpose at no extra cost.

viii) Mechanical joints shall be made in accordance with the manufacturer's instructions. After successful testing of pipelines, the joints will receive external protection to the Engineer's approval.

ix) The threads of any screw connections shall be coated with red lead before the joint is made.

x) Concrete anchor blocks shall be provided at bends, tees, stopped ends, etc. as shown on the drawings or as directed by the Engineer.

xi) Where a pipeline crosses roads or railway lines, the pipe shall be sleeved or surrounded with concrete as instructed by the Engineer, and Contractors shall have been deemed to have made allowance in their rates at the time of Bidding for compliance with the requirements of the relevant authority.

xii) For the insertion of valves and other fittings into existing pipelines, pipes may need to be cut. Approved tools and machines specially made for the purpose, shall be provided and used by the Contractor.

xiii) The Contractor shall provide and fix wooden drumheads to the open ends of the mains, and similar drumheads shall be used to close the ends of any pipes to exclude dirt and stones, etc. when the pipe laying is not actually in progress. Wooden markers properly inscribed, shall be left projecting out of the ground to indicate the ends of all pipes, where these are buried in the ground in open country. In public highways, a danger sign or other suitable means as approved by the Engineer shall be adopted.

1213. ADDITIONAL PROTECTION OF JOINTS ON FERROUS PIPELINES

The completion of the external protection at flexible joints on ferrous pipes and fittings shall be carried out as detailed below as appropriate and shall be to the satisfaction of the Engineer. The costs thereof shall be deemed to be allowed for within the Bid.

In all cases where the pipe joint involves the use of nuts and bolts, the exposed threads of every bolt shall first be thoroughly cleaned and then coated with an approved zinc-rich paint allowed to dry for not less than 24 hours before proceeding with further protection as indicated below.

i) Where Pipes and Fittings are to be Concreted In (Wrapping Method)

The external protection to pipes and fittings jointed by mechanical couplings, flanged joints, "Tyton" type, or Bolted Gland joint, or similar shall be completed by wrapping the joint with approved petrolatum tape, prior to which the area shall have been cleaned by an approved proprietary paste and the area protected by an approved proprietary mastic. It shall then be wrapped in PVC 'outerwrap' or similar material.

The whole joint shall first be thoroughly cleaned removing all loose rust and extraneous matter and the approved proprietary paste rubbed well over the whole of the joint and for a few centimetres either side of the joint over the pipe sheathing. A liberal amount of paste shall be left around all bolt heads, narrow cavities, etc.

The approved proprietary mastic shall be applied to cover all bolt heads and nuts, forced into the annular gap between the spigot and socket in the case of 'Tyton' type or bolted gland joints, formed as a triangular fillet against the face of socket or flanges and filled in all gaps and abrupt change in contour to provide an even contour for wrapping.

The approved petrolatum tape shall be applied circumferentially, starting and finishing at the top of the joint care being taken to smooth and eliminate any air pockets and to form the tape well into all angles and changes in contour. The tape should extend on to the pipe sheathing on either side of the joint by at least 50 mm and the tape should be applied with a minimum overlap of 25 mm.

An outer wrapping of 'PVC Outerwrap' shall be finally applied over the approved tape. This wrapping should extend at least 50 cm on to the pipe sheathing and should be applied with a

minimum lap of 50 mm. All the above mentioned materials shall be provided by the Contractor and deemed covered in his rates.

ii) Additional Protection to Flexible Couplings/ Flange Adaptors in Chambers and/or above Ground

Such mechanical joints e.g. flexible couplings, flange adaptors, etc. in chambers and/or above ground shall have been factory epoxy coated and shall after installation be cleansed by brushing away soil and then shall have an approved mastic blanket moulded around them so as to provide a contour suitable for wrapping the component with an approved petrolatum anti-corrosion tape suitable for tropical climates which shall then be done so as to achieve a clean and neat good tape finish.

iii) Protection to Flexible Couplings and Flanged Adaptors Fitted to Epoxy Coated Pipe Spigots

Where factory coated flexible couplings have been used on pipes whose exposed surfaces beyond other protection materials have been factory protected using epoxy, then such joints shall be site protected by a polythene outer wrap sheathing of minimum thickness 200 microns that shall extend beyond the pipe epoxy coating by at least 50 cm. This outer wrap shall be double strapped using a non-metallic strap to each pipe end beyond and not to the epoxy coating.

1214. BACKFILLING OF PIPE TRENCHES

[Refer to Clause 409 in Chapter 4]

1215. MAKING GOOD SUBSIDENCE AFTER REFILLING

[Refer to Clause 410 in Chapter 4]

1216. REINSTATEMENT OF SURFACES

[Refer to Clause 411 in Chapter 4]

1217. 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 as may be subsequently directed by the Engineer.

Before any filling is started, the ground on which the fill is to be placed shall be stripped of all grass and topsoil and all roots, vegetable matter and other unsuitable substances removed.

The filling to be used in the embankments and filled areas shall be material selected by the Contractor and approved by the Engineer from that arising from surplus 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 materials and/or soil placed at the top or at the surface. The Contractor may import materials if the available material is not sufficient.

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

1218. RESTORATION OF BORROW AREAS, SPOIL TIPS AND QUARRIES

Any spoil tips, quarries or other borrow areas developed by the Contractor for the purpose of the Works shall be finished to safe and fair slopes to the approval of the Engineer. Where directed by the Engineer these areas shall be re-soiled and grassed over or otherwise seeded. Operations of such borrow areas and tips shall be in accordance with the rules and regulations of the appropriate authority or the owner responsible for them.

Site clearance shall be carried out over the areas to be occupied by the permanent Works before beginning excavation or other work, and shall include the clearance of all trees, stumps, bushes and other vegetation and the grubbing out of all roots and the removal of all boulders between 0.01 m^3 and 0.2 m^3 volumes. The limits of the areas to be cleared shall be as indicated on the drawings or as will be defined by the Engineer.

Following the establishment of ground levels, the Contractor shall strip topsoil, where indicated on the drawings or as directed by the Engineer to a depth of up to 300 mm. The topsoil so removed shall be deemed to become the property of the Employer and shall be set aside for re use or disposal as directed by the Engineer.

Topsoil is defined as the surface layer of soil which by its humus content supports vegetation. This layer of soil is unsuitable, due to weathering and vegetable content, as a formation to roads and concrete structures or as a backfill or bedding material. The presence, extent and depth of topsoil that needs removal shall be agreed with the Engineer.

Subject to the requirements of this Clause 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. Where shown on the drawings or directed by the Engineer, trees shall be uprooted or cut down as near to the 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.

Bushes, undergrowth, small trees, stumps and tree roots shall, where directed by the Engineer, be grubbed out, burnt and 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.

The Engineer may require that individual trees, shrubs and hedges are to be preserved and the Contractor shall take all necessary precautions to prevent their damage.

1219. TOP SOILING AND GRASSING

Where required surfaces shall be soiled with fine sifted soil or silt not less than 100 mm compacted thickness which shall be raked and brought to a fine silt. The Contractor shall supply approved material for this purpose or use the material set aside during site clearance / top soil removal.

Surfaces required to be grassed shall be planted with approved local grass at a spacing of 200 mm x 200 mm. 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 Defects Liability Period to ensure that all planted grass is kept weeded and cut, and if necessary watered.

1220. FREE DRAINING FILL

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 cubiform and shall be between 75 mm and 25 mm in size. All smaller particles, dust, rubbish and organic matter shall be excluded.

1221. HARDCORE

Hardcore shall consist of sound hard stone or broken rock or concrete derived from excavations or demolition of structures and shall be graded from 150 mm to 50 mm in size, except that sufficient but not excessive blinding materials of smaller sizes may be permitted at the discretion of the Engineer.

1222. 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 300 mm and which shall not contain more than 5% by weight of material which will pass 10 mm BS sieve. Between these limits the material shall be reasonably well graded so as to form a free draining blanket without large voids.

1223. ROCK LINING

Rocks for lining and bedding on concrete shall be hard, durable and free from cracks and fissures obtained from approved quarries or from materials arising from the excavations.

Rocks shall be near uniform, of the size shown, and bedded in concrete as shown on the drawings. The rocks shall break joint in every direction and fine concrete shall be worked into the joints to secure the rocks.

1224. GABIONS

Gabions shall be of the hexagonal wire mesh type, with mesh dimensions of 80 mm x 100 mm. The minimum dimension shall not exceed 83 mm. Wire shall be galvanised prior to weaving the mesh to resist corrosion from water.

All wire used in the fabrication of the gabion and in the wiring operation during construction shall be in accordance with BS 1052/1980 Mild Steel wire appended having a tensile strength of 38 50 kg/mm^2

All wire shall be galvanised to BS 443: 1982 'Zinc coatings on steel wire' with the minimum weight of Zinc coating in accordance with Table below.

	Diameter (mm)	Minimum Weight of Coating (g/m^2)
Mesh wire	2.7	260
Binding and connecting wire	2.2	240
Selvedge wire	3.4	275

All wire used in the fabrication of gabions and in the wiring operations during construction shall, after galvanising, have extruded onto it a coating of polyvinyl chloride compound referred to as PVC. The coating shall be black in colour, not less than 0.4 mm thickness and shall be capable of resisting deleterious effects of exposure.

Gabions shall be of the following standard sizes:

- 2m x 1m x 0.5m
- 2m x 1m x 1m
- 6m x 2m x 0.3m

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 a half full turns of wire, at each mesh point of the joint line.

Gabions shall be as manufactured by Maccaferri, or equivalent. Alternative materials shall be subject to the approval of the Engineer.

Rockfill for gabions shall consist of hardcore i.e. sound hard stone or broken rock. The maximum size shall be 220mm, and the minimum size shall be 120mm; however, up to 10% of some smaller blinding material (min. 75mm) to fill the internal voids between the bigger rocks will be allowed.

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 rock, the tops shall be closed and securely tied with connecting wire. 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 and final filing shall be in accordance with the instructions as issued by the manufacturer.

1225. MISCELLANEOUS CLAUSES

i) Assistance by Pipe Manufacturer

The Contractor shall utilise the technical services of the pipe manufacturer, unless he already has in his proposed site team a person or persons of appropriate competence with proven experience in the laying of pipes of the type and magnitude to be provided.

The Contractor shall therefore either have clearly stated in his Bid that he has such a person or persons who shall be named and their CV's provided or he shall indicate the extent, nature and duration of the technical assistance he proposes to obtain from the pipe supplier. This shall include details of the personnel to be provided, and the time when such shall be available during the laying and jointing, external pipe protection work, trench backfilling and testing periods.

The cost of the above shall be deemed to have been included by the Contractor in his Bid.

ii) Assistance by Pipe Coating Manufacturer

The Contractor shall utilise the technical services of the pipe coating manufacturer, unless he already has in his proposed site team a person or persons of appropriate competence with proven experience in the laying of pipes of the type and magnitude to be provided.

The Contractor shall therefore either have clearly stated in his Bid that he has such a person or persons who shall be named and their CV's provided or he shall indicate the extent, nature and duration of the technical assistance he proposes to obtain from the pipe coating supplier. This shall include details of the personnel to be provided, and the time when such shall be available during the laying and jointing, external pipe protection work, trench backfilling and testing periods.

The cost of the above shall be deemed to have been included by the Contractor in his Bid.

iii) Working Width

Prior to excavation, the Contractor shall agree with the Engineer the overall width required for pipe installation. Clearance shall be limited to this area. However in areas of limited access the Engineer reserves the right to restrict this width and the Contractor shall not claim for additional monies due to inconvenience associated with such limitations, e.g. for double handling of materials, supporting of trench sides, movement of pipes into position, etc.

iv) Location of Underground Services, etc.

The Contractor shall locate existing services prior to excavation. Notwithstanding this obligation and should damage occur, it will be the Contractors further obligation at his own cost to urgently liaise with the utility organization concerned and to bear the full cost of the repair or replacement of the damaged article to the entire satisfaction of the Utility concerned.

v) In-Situ Welding of Steel Fittings and Flanges

Wherever it is necessary to undertake in-situ welding of steel fittings and flanges the work shall be undertaken under cover, temporary or otherwise. Outside of buildings, the cost of providing such cover shall be deemed included in the Contractors rates. Only suitably qualified welders shall be employed.

Welding procedures used shall comply with ISO 15607 and EN 288-9.

Prior to deployment of any welder he shall within the preceding 3 months have satisfactorily undergone an 'approved testing' in accordance with EN 287-1 and certification thereof shall be provided to the satisfaction of the Engineer. Each welder deployed shall at intervals of not more than 6 months undergo similar approved retesting and only those who pass such retesting will be allowed to continue to undertake the in-situ welding works.

All testing and retesting will be deemed to be covered in the Contractors rates.

1226. THRUST BLOCKS

Pipelines with flexible joints shall be adequately restrained at bends, tees, sluice or butterfly valves, tapers, blank ends, etc. Thrust blocks shall be constructed from Class 20 concrete to the dimensions indicated on Drawings unless otherwise directed by the Engineer. All thrust blocks shall be allowed to cure for at least 7 days and surrounding soil shall be compacted thoroughly before the hydraulic testing of the pipeline.

Support blocks shall be constructed from Class 20 concrete.

Thrust blocks at proposed tie-in points between old and new pipework will be cast at least 7 days prior to the proposed tie-in works and pipeline testing, except that where this is impracticable, in which case a thrust wall shall be constructed (similarly in advance) and the connecting fitting propped initially against this thrust wall by means of a horizontal steel joist with the contact face curved to the outside diameter of the fitting, and fitted with a protective rubber insert. Immediately upon completion, the space between the thrust wall and the propped fitting shall be filled with class 20 concrete, thereby permanently encapsulating the steel joist.

1227. PIPE SUPPORTS

Pipe supports shall meet the requirements of BS 3974-1, PNFS 0001 and MSS SP 58.

1228. HYDROSTATIC TESTING OF PRESSURE PIPELINES

All new pipelines shall be pressure tested. For pipelines within a trench, such tests shall be

made before backfilling is reinstated. Unless otherwise approved, all joints shall be clear of earth, timber, etc. to allow visual inspection during the test. Testing shall commence immediately upon completion of installation and preliminary backfill, and construction of thrust blocks. Pressure testing shall be carried out for sections of convenient length which shall be approved by the Engineer prior to testing. Such lengths shall not exceed 1.2km.

On completion of pipeline testing in sections and completion of all valving connections and other works, the whole pipeline shall be pressure tested up to the maximum working pressure of the pipeline.

The Contractor shall supply all necessary materials to carry out the test in accordance with the requirements including force pumps, water pressure gauges, as well as tools for the use of the Engineer, interconnecting pipework, feeding tank, blank flanges, temporary stop-ends, struts and water for the test. The test section shall be capped or flanged off at each end and all branches. Testing shall not take place against closed valves.

For a pipeline incorporating flexible joints, testing shall not commence until after all the permanent thrust blocks along the pipeline have been constructed, cured, and soil around them backfilled and compacted. Capped or flanged ends along the pipeline shall also be anchored adequately to withstand the force due to test pressure. The Contractor shall submit his proposals for temporary anchoring to the Engineer's approval.

After the main has been clear of debris, and all necessary stop-ends and gauges fitted to the Engineer's approval, the Contractor shall fill up the pipe with water free from silt, sand and grit and bring steadily up to the nominal pressure of the pipe or incorporated fittings, whichever is the lesser, (except for old pipelines where a lower value may be specified by the Engineer), and this shall be maintained it with a force pump for 24 hours.

The pressure shall then be increased steadily in increments of 1.0 kg/cm^2 with a pause of one minute between each increment to the specified test pressure for the section. Unless otherwise specifically mentioned, the applied test pressure shall be measured at the lowest point along the section being tested.

Where the test pressure has not been specified, it shall be assumed to be 80% in excess of the nominal pressure at the lowest point of the section being tested.

After a period of half an hour, the fall in test pressure shall be recorded and sufficient water again pumped into the line under test to bring the pressure back to the test pressure. The procedure shall be repeated every half-an-hour for a total period of 3 hours, or longer, if the Engineer so directs, and the amount of water pumped in shall be recorded.

The rate of leakage shall be calculated from the amount of water pumped in during testing and if it is less than 1 litre of water per 10 mm diameter of pipe per km of length of pipeline, for each 24 hours and for every 30m head, the pipe line will be considered to have passed the test. Leaks exceeding permissible amounts shall be made good, and faulty pipes, fittings, and

specials, shall be replaced by the Contractor at his own expense and the section tested again before approval is given for backfilling. Payment for the section will not be certified, until the test has been passed and any remaining backfilling completed.

1229. FLUSHING AND STERILISATION

This shall be done in accordance with the recommendations set out in BS EN 806-4:2010. All tested pipework shall be flushed, cleaned and sterilised.

1230. TRENCHLESS ROAD AND RAILWAY CROSSINGS

For crossing of major paved roads and railways, Trenchless Road Crossing methods are to be adopted. The method allowed for in the design drawings involves construction of a reinforced concrete tunnel with the crown of the tunnel located at least 1.2m below the road surface. The tunnel will be made up of 200mm wide precast concrete segments arranged to form a lined microtunnel. The tunnel will have a rectangular cross section shape with an arched crown.

The space between the precast concrete lining and the excavation will be grouted on completion of placing the segments.

The Bidder may propose an alternative method of Trenchless Road/Railway Crossings including Horizontal Directional Drilling or any other suitable method. Details of any alternative method proposed by the Bidder should be submitted with the bid.

1231. TIE-IN WORKS

i) General

This Clause shall apply to any tie-in works. The tie-in works will involve closing down of part or the entire system. It shall further apply to any new works that have been incorporated into an existing operational pipeline.

The Contractor shall be responsible for the execution of the works except under circumstances where the execution of the tie- in operation is assumed by Engineer or Employer.

The Contractor shall notify the Engineer at least 14 days in advance of all tie-in works.

ii) Pipes and Fittings

The Contractor shall take delivery of any pipes and fittings required at the tie-in works not less than 96 hours before the commencement work. The Contractor shall check the suitability of such fittings including checking of all dimensions. The Contractor shall certify the suitability of such materials to the Engineer not less than 48 hours before the commencement of tie-in operations.

The Contractor shall prepare a schedule of fittings including those on existing pipes that are to be used for such tie-in or redeployed elsewhere as instructed on the drawings and shall obtain approval of the Engineer not less than 48 hours before the commencement of tie in operations of such schedule.

The Contractor shall ensure that all materials are at the site of the works not less than 24 hours before the commencement of the tie-in operation and shall inform the Engineer who shall check the material against the schedule as approved where he deems this necessary.

Any non-standard fittings which are required for the execution of the tie-in works shall be fabricated under the Engineer's supervision and shall be hydro statically tested to at least one and a half times the maximum working pressure.

iii) Personnel

The Contractor shall ensure that at least one senior member of his field supervisory staff who has proven experience of such operations and fluent in English and the language of his labourers is on site throughout the whole duration of the tie in operation.

The Contractor shall also ensure that all necessary skilled artisans are on site for the whole duration of the tie-in operation. If necessary, shifts of skilled artisans shall be available to ensure continuous work.

The Contractor shall furnish the Engineer's Representative a list of the key personnel to be involved in the tie-in at least 48 hours before the commencement, and shall get the Engineer's approval at least 24 hours before the commencement in respect of such personnel. To gain this approval the Engineer may require that operative is tested in the performance of his duties in the operation of the plant for which he is in attendance.

iv) Plant

The Contractor shall prepare a schedule of the plant and equipment which he proposes to have on site either to use, including stand-by units and shall obtain the approval of the Engineer not less than 48 hours before the commencement of the tie-in operations.

The Contractor shall also ensure that all plant is on site not less than 24 hours before the commencement of the tie-in operation and shall inform the Engineer who shall check the plant against the schedule as approved where he deems this necessary.

The Contractor shall demonstrate availability of fuel supply and other consumables, and/or electricity supply including standby generators if necessary.

v) Pre Tie-In Works

The Contractor shall execute all works possible before the commencement of the tie-in operations which shall include:

i) Excavation and supports to the excavation.

ii) Concrete blinding to the bottom of the excavation and (where instructed by the Engineer) immediate working areas.

iii) Provision of any required drains and sump of adequate size from which any accumulating water is to be pumped out

iv) Casting the floor of any chamber which is to be constructed around such tie-in works

v) Casting of any thrust blocks or thrust walls or any other works necessary for effective execution of the tie-in works as may be required by the Engineer. Concrete works shall be cast sufficiently far in advance to allow adequate strength to develop to withstand the loads for which it is intended.

The Contractor shall complete these works at least 96 hours before the commencement of the tie-in operation or within a period that may be otherwise set by the Engineer upon issue of the Engineer's instruction to perform the tie-in works, and obtain the Engineer's approval not less than 24 hours before commencement of the tie-in operations.

The Contractor shall prepare a programme and method statement, giving details of the proposed scheduling and sequencing of tie-in works. Approval of such programme by the Engineer shall be obtained not less than 72 hours before commencement of the tie-in operation. The method statement shall identify all risks associated with the procedure and provide appropriate mitigating and/or back-up plans.

vi) <u>Actual Tie-In Works</u>

The Contractor, unless relieved of the responsibility by the Employer or the Engineer, shall first empty the section of the main on which the tie-in is to be made and shall ensure that the nearest air valves and washouts immediately upstream and downstream are open and the washout dry.

Where the Contractor is relieved of this operation, which shall be notified to him by the Engineer not less than 96 hours before the tie-in operation is due to commence, he shall check that air-valves and washouts mentioned above are in the state described.

When the Engineer is also satisfied that the main is empty of water he shall verbally give the order to commence the works from which time the Contractor shall be solely responsible for the execution and completion of the tie-in works unless relieved of such responsibility by the Engineer.

In event that the Engineer directs that the tie-in works be carried out during the night, the Contractor shall provide lighting (including standby and emergency) and any other measures as the Engineer may direct. The Contractor shall make no claim when such instructions are carried out. It should be for all works under ‘tie-in’works.

The Contractor shall provide all the insurance normally required by the Engineer and the Condition of Contract and shall obtain an endorsement if necessary to ensure that the insurances remain valid in the event that the Engineer takes over the direction of the works.

When the Engineer is satisfied that the tie-in works are completed, he shall give notice for the

main to be recommissioned. When this has been satisfactorily accomplished the Contractor shall re-deploy his staff on the Engineer's verbal instructions of completion of the tie-in.

vii) Post Tie-In Works

Within 48 hours of the completion of the tie-in works the Contractor shall have completed all permanent works required to support the plant installed during the tie-in operation and shall remove all temporary supports within a further 48 hours after the permanent support works have been approved by the Engineer. The temporary supports shall not be removed before such approval has been given.

Within 14 days from the date of the completion of the tie-in the Contractor shall have completed all the other permanent works required to allow operation of the plant installed during the tie-in operation and shall obtain the approval of the Engineer on the completion of such works.

The Engineer shall issue the Contractor with a notice stating the operations for which the plant installed during the tie-in operation may be used, which shall remain in force for a period extending for 28 days from the date of approval of the completion of the Post tie-in works as described above.

Before the expiry of the 28 day period described above the Contractor shall obtain the approval of the Engineer for the completed works when the Engineer shall issue a notice allowing full operation of the plant on the expiry of the above mentioned period upon which the Contractors responsibility for the works, unless requested otherwise shall cease.

1232. VALVES

Isolating valves up to and including DN 300 shall be gate valves, and valves larger than DN 300 shall be butterfly valves, except where otherwise specified on drawings or in Schedule of Prices and Unit Rates.

All valves shall bear an identification mark on the upper body that shall include:

i. Name of the manufacturer and/or his trade mark;
ii. Nominal diameter (DN);
iii. Nominal pressure (PN);
iv. Project Name or Client's name embossed and

The manufacturer’s full technical specifications shall be supplied to the Engineer in triplicate by the Contractor for approval prior to confirmation of any order for valves.

The valve body shall be cleaned and shot blasted to ISO 8503 Parts Ito 4 before being internally and externally protected.

All isolating valves shall be protected by fusion bonded powder epoxy or equivalent, internally

suitable for potable water and to a minimum thickness of 300 microns.

All valves shall be designed to conform to the pressure rating of the pipeline section (PN16, PN25 or PN40) except where otherwise specified. All valves shall close when the stem rotation is in a clockwise direction unless otherwise specified.

Bidders shall supply full technical details of the proposed valves to be supplied with their Bid. If the Engineer considers the proposed valves to be inappropriate, he will reject them and instruct the Contractor to provide a suitable alternative. No additional payment shall be made where such changes occur. All valves for use in water supply shall conform to BS EN 1074.

i) Gate Valves

Unless otherwise specified gate valves of nominal diameters up to and including DN 300 shall be resilient seated and made of epoxy coated cast ductile iron in accordance with BS 5163 Parts I and 2. The epoxy coating shall be not less than 150 microns thickness. The gate shall be ductile iron and completely rubber encapsulated, the gate valve being of pocketless type with a straight through port.

The gate sealing shall be ensured by compressing of the rubber. Wedge/gate guides of wear resistant plastic with high gliding features shall be provided in the body, optimally placed to guarantee low wear and tear of the gate and low closing torques.

Gate valves of nominal diameter larger than DN300 shall be of metal seated design with replaceable bronze facing seal/seat rings.

Gate valves shall be capable of sustaining a maximum permissible differential working pressure as indicated on drawings or in Schedule of Prices and Unit Rates. Gate valves shall be provided with integral flanged ends unless otherwise indicated.

Unless otherwise specified the face to face dimensions of gate valves with integral flanged ends shall be in accordance with EN 558 and EN 12627 basic series 14 (short) or basic series 15 (long).

Gate valves shall be of the non-rising stem type except where specifically indicated otherwise. The stem seal shall be of toroidal sealing rings (O-rings) with at least two such seals. Seals shall be capable of being replaced with the valve under pressure and in the fully open position. The bonnet gasket shall be of elastomer (suitable for potable water). The bonnet studs or Allen screws shall be corrosion-protected. In addition, the studs/allen screws shall be placed in countersunk holes in the bonnet and completely sealed with wax or a suitable material, which could be removed by low-temperature melting in case they have to be disassembled.

The gate valve bodies shall be works cleaned and shot-blasted in accordance with ISO 8503 Parts Ito 4 before being coated internally and externally. The body, the bonnet and the gate of the valve shall be made of ductile iron to EN 1564, the gate being encapsulated with elastomer

EPDM, nitrile or equivalent.

The operating stem shall be made of stainless steel at least equivalent to ISO 10088 Part 1.4021, except in areas of aggressive soils where this shall be to ISO 10088 Part 1.44404.

The stem nut shall normally be made of high tensile brass to BS 1981, except in areas of aggressive soils where this shall be aluminium bronze to EN 12167.

Furthermore, and in aggressive soils, outside bolts and nuts shall be made of stainless steel to ISO 10088 Part 1.4301 or as detailed on drawings.

Stuffing boxes shall be designed to have soft packing fitted and arranged so that it can be re-packed under pressure.

All valves shall be suitable for operation from the closed position by a 13 kg "push-pull" effort (total 26 kg) at the rim of the hand-wheel or tee key. Gearing and by-pass arrangement shall be provided for Gate Valves > 400mm dia.

Valves shall be tested to 1.5 times the normal working pressure.

ii) Butterfly Valves

Butterfly valves for manual operation shall comply with BS 5155 and EN 593 and shall be double flanged, resilient and metal seated tight shut-off design and of the eccentric disc type supported from two shafts placed in self-lubricating bearing bushes. Gearing and by-pass arrangement shall be provided for Butterfly Valves > 400mm dia.

Butterfly valves shall be capable of sustaining a maximum permissible differential working pressure as indicated on drawings or in Schedule of Prices and Unit Rates.

Butterfly valves shall operate with a clockwise closing direction. The valve disk shall rotate though an angle between 0^0 and 90^0 inclusive. Butterfly valves shall be installed with shaft in horizontal position and the bottom half of the disc opening in the direction of flow.

The sealing ring shall be made of EPDM rubber and shall be attached at the disk edge circumference by a retaining ring without adjustment to form a resilient and durable seal.

The valve disc seal shall be replaceable without dismantling the operating mechanism, disk or shafts, and without removing the valve from the pipeline.

Butterfly valves shall be equipped with an irreversible and proportional worm gear operator. This shall be either with or without an additional primary reduction gear placed within a waterproof housing depending upon nominal valve diameter and maximum working conditions. The time of closure from valve fully open to valve fully closed shall not be Less Than FOUR MINUTES for valves in the Raw Water Pipeline and TEN MINUTES for valves

in the Treated Water Pipeline.

The operating mechanism shall be permanently lubricated, not in contact with the water, and provided with an OPENED/CLOSED proportional position indicator in order to indicate the disk angular position. The mechanism shall be sized in order to minimise torque for ease of manual operation under maximum differential pressure and shall be with high class enclosure IP67 to ISO 60529. They shall be self-locking and designed to hold the valve in any intermediate position between fully open and fully closed without creep.

Valve body, disk and disk retaining ring shall be in ductile "SG" iron casting to EN 1563 or EN 1564. Disk shafts shall be in stainless steel to EN 10088:1.4021, complete with non-corrodible bearings.

The valve body shall be cleaned and shot blasted to SSRN 937 and internally and externally protected with paint suitable for potable water.

Butterfly valves shall be works pressure tested in accordance with BS 6755 and EN 12266 Parts 1 and 2.

a) Body test at a minimum pressure of 1.5 times the maximum permissible pressure
b) Seal test at a minimum pressure of 1.1 times the maximum permissible pressure.

Butterfly valves shall be suitable for flange connections. Wafer type valves may be used where appropriate to suit the existing pipework arrangement.

Valves shall allow flow in either direction and shall be satisfactory for duties including isolation of pipeline section, frequent operation, and for applications involving valve operation after long periods of inactivity.

Butterfly valves shall have resilient disc seating and shall be drop tight.

The Contractor shall ensure that there is sufficient clearance between the disc and the adjoining pipework to ensure that all Butterfly valves operate freely, from fully open to fully closed and vice versa, under all conditions.

iii) Air Release and Vacuum Break Valves

Automatic air relief and vacuum break valves (air valves) shall be of the anti-shock anti-surge type (Ventomat or similar) designed to meet the following requirements. The required valves shall provide all of the functions described below.

Pipeline Filling - Uninterrupted high volume air discharge through the large orifice.

Pipeline Draining or Column Separation - Uninterrupted high volume air intake through the large orifice.

Pipeline Full and Operating - Discharge of dis-entrained pressurised air through the small orifice.

The air release and vacuum break valve shall be of a compact single chamber design with solid cylindrical High Density Polyethylene control floats. These shall be housed in a tubular stainless steel or corrosion protected body with epoxy powder coated cast iron, or stainless steel ends secured by means of stainless steel tie rods.

The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of separated water columns. The limitation of pressure rise must be achieved by deceleration of approaching water prior to valve closure. Relief mechanisms that act subsequent to valve closure are unacceptable.

Large orifice sealing shall be effected by the flat face of the control float seating against a nitrile rubber '6' Ring housed in a dovetail groove circumferentially surrounding the large orifice. Discharge of pressurised air shall be controlled by the seating and unseating of a small orifice on a natural rubber seal affixed to the control float.

The intake/discharge area shall be equal to the nominal size of the valve i.e. a 150 mm valve shall have a 150 mm intake/discharge orifice.

The valve construction shall be proportioned with regard to material strength characteristics, so that deformation, leaking or damage of any kind does not occur by submission to twice the designed working pressure.

The valve design shall incorporate an over pressure safety feature that will fail without an explosive effect, as is normally the case when highly compressed air is released suddenly.

This feature shall consist of easily replaceable components such as gaskets, seals or the like.
The air valve shall be provided with a built-in separate isolating valve.

Unless otherwise specified all air valves shall be provided with an integral flanged inlet with studs appropriate to EN 1092-1 NP 10 or as the installation demands and complying with the appropriate nominal pressure.

All air valves at new installations shall be fitted to an air accumulator fitting, with the branch diameter not less than 60% of the diameter of the main. Where necessary, a concentric taper either integral with or as a separate fitting shall be inserted between the branch and the isolating valve immediately beneath the air valve and an abrupt diameter change between branch and isolating valve shall be avoided.

Air valves shall be of approved manufacture and pressure rating indicated on drawings or in Schedule of Prices and Unit Rates.

iv) Hand-Wheels and Valve Caps And Valves

Where hand-wheels are specified, they shall have cast into them the words 'open' and 'close', together with an arrow indicating the direction for such opening or closing. Valves for tee-key operation shall be provided with valve caps.

v) Valve Keys

These shall be of mild steel with ends to suit either valves to BS 5163 Parts 1 and 2, valves to EN 593 or valves to EN 12360 or 12288 fitted with valve caps, dimensioned to the appropriate Bid Drawing.

vi) Valve Chambers

New chambers shall be constructed in accordance with the drawings, and where indicated, shall incorporate thrust walls.

Notwithstanding the size and shape of the valve to be supplied, the Contractor shall ensure that the minimum clearance as indicated on the drawings are provided within the chamber, and that where chambers have pre-cast roofs the manhole cover provided shall be of a size sufficient to allow for the removal and replacement of the valve without disassembly and dismantling.

vii) Valve Chamber Covers

Unless otherwise indicated in the Schedule of Prices and Unit Rates, valve chamber covers shall be antitheft lockable ductile iron or antitheft lockable reinforced concrete with a weight of minimum 50 kg per piece and provided with embedded steel device for lifting at each end. They shall be supplied complete with antitheft locks and lifting keys. Except where a chamber is provided with pre-cast roof slabs to facilitate placing and removal of the valve or valves within the chamber, the clear opening in the chamber cover shall in all cases allow for this. It will be the Contractor's responsibility to ensure that the covers he provides are of an appropriate clear opening size.

viii) Surface Boxes

These shall be of cast iron, (hinged and locked) and from an approved manufacturer to BS 5834. They shall be sized to suit the purpose required and as otherwise shown on the relevant drawings.

The number of keys required (if any) is indicated in the Schedule of Prices and Unit Rates.

13. STANDARD REFERENCE NUMBERS

1. Standards

The Contractor shall observe these Specifications and shall carry out all work in a skilled and workmanlike manner in keeping with modern methods of mechanical and construction Engineering.

In addition, the Contractor shall conform with all conditions currently in force with regard to the execution of construction work and shall follow all instructions issued by the competent Authorities, the Employer and the Engineer.

Where Standard Specifications are referred to in the Text of the Specifications this is done by reference to a Standard Specification Reference Number (SRN). In this Section, a table of comparison is given where the SRN is cross-referenced to Standard Specifications issued by the International Standards Organization (ISO) and to National Standard Specification that will be accepted in their English version by the Engineer as providing for the quality of workmanship etc. required.

The Bidder shall at his discretion base his Bid on one or other of the National Standard Specifications indicated in that table save that where a relevant Standard Specification issued by the ISO exists at the date of Bid, such an International Standard should as a minimum be compiled with. As the National Standards referred to in the table of comparison may expand on or strengthen further the requirements of ISO, Bidders choosing not to comply with one of the National Standards indicated may either indicate an alternative National Standard with which they shall comply or provide with their Bid a full and detailed description of the Standards they propose to attain.

Where a Bidder offers a particular item to a National Standard not specified in the table of comparison he shall comply with the requirements of the Instructions to Bidders in this respect and shall enclose a copy in English of the alternative National Standard offered with his Bid. Alternative National Standards or Bidder's own detailed description of the Standards they propose shall be subject to the approval of the Engineer.

2. List of National Specification Cross Referenced

The list has been sub-divided into sections as follows: -

SRN No.	Specification
100-199	Concrete
200-299	Metallic Pipes and Fittings
300-399	Plastic Pipes and Fittings
400-499	Other Pipes and Fittings
500-599	Valve, Meters, Hydrants and Other Specials
600-649	Testing Methods and Equipment
650-699	Site Work Codes of Practice
700-749	Drawing Practice, Standard Symbols, etc.
750-799	Glossary
800-899	Building Materials (exclu. In-situ Concrete)
900-999	Miscellaneous

3.1 CONCRETE

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
100	METHOD FOR SPECIFYING	1045	TBL. 1	5328	TBL. 3	KS 02-594	
101	STANDARD OF MATERIAL & WORK - GENERAL	See	VOB	8110		VOB 2	
102	STANDARDS OF MATERIAL, WATER RETAINING		SUB. NO.	8007			
103	ORDINARY PORTLAND CEMENT	1164	1	12		KS 02-1262 & KS 02-	
104	SULPHATE RESISTANT CEMENT	1164	1;CL. 4	4027			
105	MORTAR CUBES - COMPRESSIVE STRENGTH	1164	1;CL. 4-4	12	METHOD 2 CL.7.3	ISO 3893	
106	CEMENT - TEST FOR SOUNDNESS		6, EN.112	12	CL.9		
107	SAMPLING AND TESTING OF AGGREGATES	4226	1-4	812	1, 2, 3	BS EN 1097-3 BS EN 932-1	BS 812 Part 1 Replaced by BS 882 Part 2 Replaced by BS EN 1097-3 Part 102 Replaced by BS EN 932-1 but remains current
107	SAMPLING AND TESTING OF	1045		812	101-119		
108	FINE AGGREGATE FOR CONCRETE - GENERAL	4226	1-4	882	CL.4.1		
108	FINE AGGREGATE FOR CONCRETE - GENERAL (CONT.)	1045					
109	FINE AGGREGATE FOR CONCRETE - GRADING	4226	1-4	882	TBL.2		
110	COARSE AGGREGATES FOR CONCRETE	4226		882	CL.4.1		
110	COARSE AGGREGATES FOR CONCRETE	1045					
111	COARSE AGGREGATES FOR CONCRETE	4226		882	TBL.2		
111	COARSE AGGREGATES FOR CONCRETE	1045					
112	COARSE AGGREGATES FOR CONCRETE	4226		812	2	ISO 6783 BS EN 1367	BS 812 Part 120 Replaced by BS EN
112	COARSE AGGREGATES FOR CONCRETE	1045					
113	COARSE AGGREGATES FOR CONCRETE	4226		812	105.1		
113	COARSE AGGREGATES FOR CONCRETE	1045					
114	WATER FOR MAKING CONCRETE	4226		3148			
114	WATER FOR MAKING CONCRETE (CONT. 1)	4030					
114	WATER FOR MAKING CONCRETE (CONT. 2)						
115	CONCRETE MIX DESIGN - GENERAL			5328			
		1084	1				
116	TRIAL MIXES - CUBES	1048		1881	108		
117	SAMPLING & TESTING OF CONCRETE	1048		1881	5, 114, 121, 122	ISO 1920, 4012, 4108, 4013	
118	CONCRETE BATCH MIXER			1305			BS 1305 Obsolescent
119	CONCRETE BATCH TYPE MIXERS	459		3963			BS 3963 Obsolescent
120	STRUCTURAL USE OF R/C IN	1045		8110	1		
121	CONCRETE TRUCK-MOUNTED	1084	3	4251	Withdrawn		BS 4251 Withdrawn
122	BITUMEN RUBBER JOINT SEALING COMPOUND			2499	TYPE A1		
123	POLYSULPHIDE JOINT SEALING COMPOUND			4254			BS 4254 Obsolescent
124	WATERPROOF BUILDING PAPERS			1521	(CLASS B)		
125	IMPACT TESTING OF MILD STEEL	488	3	7613 7668	Grade NDI, CL.B		BS 4360 Withdrawn. Replaced by BS 7613, BS 7668, BS EN 10029 Parts 1 to 3 of BS EN 10113, BS EN 10155, BS EN 10210-1
126	STEEL R/F HOT-ROLLED STEEL	488	1-3	4449			
127	STEEL R/F COLD TWISTED	488	1-3	4449			
128	STEEL R/F STEEL FABRIC	488	4-5	4483			
129	BAR REINFORCEMENT AND			4466			
130	SAND FOR INTERNAL PLASTERING	4226		1199			
131	PLYWOOD SHUTTERING	68791		6566	1-8		BS 6566 Withdrawn. Replaced by various BS EN standards on the same subject
131	PLYWOOD SHUTTERING (CONT.)	68792					
132	CONCRETE COMPACTION	4235	1,2				
133	CONCRETE - SITE QUALITY	1084	1				
134	DESIGN OF CONCRETE MIXES	52171		See HMSO		HMSO RD	
135	SAND FOR MORTAR	4226		1200			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
136	SAND FOR RENDERING	4226		1199			
137	HOT APPLIED JOINT SEALER			2499			
138	WATER STOPS AND WATER BARS	7865	1, 2	8007			
139	TESTING CONCRETE STATIC MODULES (COMPARISON			1881	121		
140	TESTING CONCRETE - WATER ABSORPTION			1881	122		
141	TESTING CON-SAMPLING, TESTING FRESH CONCRETE,	1048		1881	101-110 & 113	KS 02-595 : 1-8	
142	PRECAST CONCRETE COMPONENTS (COPING UNITS)			5642/2	2		
143	STRUCTURAL USE OF CONCRETE DESIGN &			8110	1		
144	STRUCTURAL USE OF CONCRETE - SPECIAL CIRC.						
145	IN-SITU CONCRETE DIAPHRAGM	4126					
146	TEST SIEVES FOR AGGREGATES			410			
147	LIGHT WEIGHT AGGREGATES FOR CONCRETE	4226	2, 3	3797	2		BS 3797 Partly Replaced by BS EN 1744-1: 1998
148	SUPERSULPHATED CEMENT			4248 (4550)			BS 4248 Partly Replaced by Parts and Section of BS 4550
149	CONCRETE ADMIXTURES			5075			
150	GRADUATE MEASURING CYLINDER			604		ISO 4788	
151	COLD REDUCED STEEL WIRE FOR THE REINFORCEMENT OF			4482			
152	FUSION BONDED EPOXY COATED CARBON STEEL BARS FOR THE			7295	1 & 2		Part 1: Coated bars Part 2: Coatings

3.2 METALLIC PIPES AND FITTINGS

SRN	SUBJECT	DIN	PAR	BSS	PAR	OTHER	REMARKS
200	GREYCAST IRON PRESSURE PIPES AND FITTINGS			1211		ISO 13; ISO 49	BS 1211 Obsolescent Partially replaced by BS 4772
200	GREY IRON PIPES AND FITTINGS (CONT)			4622		ISO 13	BS 4622 Obsolescent
201	CAST IRON FLANGED PIPES & FITTINGS			2035		ASME/ANS I B16.1 -	BS 2035 Obsolescent Partially replaced by BS 4772
202	DUCTILE IRON PIPES & FITTINGS (WATER)					ISO 2531, EN 545	
202	DUCTILE IRON PIPES & FITTINGS (SEWERAGE)					EN 598	
202	DUCTILE IRON PIPES & FITTINGS					EN 969	
203	STEEL TUBES WITH PLAIN OR THREADED ENDS			1387		ISO 65	
203	STEEL TUBES WITH THREADED ENDS (CONT)	2440					
203	STEEL TUBES WITH THREADED ENDS	2441					
203	STEEL TUBES WITH THREADED ENDS (CONT)	2442					
203	STEEL TUBES WITH THREADED ENDS- THREADS	76	2	21		ISO 7/1:1982;	
204	WROUGHT STEEL PIPE FITTINGS TO SSRN 203			1740	1	ISO 4145	
204	TH. STEEL PIPE FITTINGS TO SSRN	2980					
204	TH. STEEL PIPE FITTINGS TO SSRN 203- LONG THREAD	2981					
204	TH. STEEL PIPE FITTINGS TO SSRN 203- NIPPLES	2982					
204	TH. STEEL PIPE FITTINGS TO SSRN 203- BENDS	2983					
204	TH. STEEL PIPE FITTINGS TO SSRN 203- TEES ETC.	2987	1, 2				
204	W. STEEL PIPE FITT. TO SSRN 203- BUSHINGS	2990					
204	W. STEEL PIPE FITT. TO SSRN 203- PLUGS	2991					
204	TH. STEEL PIPE FITTINGS TO SSRN 203- SOCKETS	2986				ISO 7-2:1982	
204	W. STEEL PIPE FITT. TO SSRN 203- RED'NG SOCKETS	2988					
205	COPPER TUBES FOR WATER					EN 1057, ISO 8493 (TESTS)	
205	COPPER TUBES FOR WATER (CONT)	1754	3				
205	COPPER TUBES FOR WATER (CONT)	1755	3				
206	COPPER TUBES - GENERAL PURPOSE			2871	2	ISO 196:1978	
206	COPPER TUBES - GENERAL PURPOSE (CONT)	1754	1,2				
206	COPPER TUBES - GENERAL PURPOSE (CONT)	1755	1,2				
207	FLANGES FOR FERROUS PIPES - STEEL BY PN	2500		4504	3-3.1	ISO 7005-1:1992	BS 4504 Part 3: Sections 3.2 (1989) Withdrawn. Replaced by BS EN 1092-2 (1997)
207	FLANGES FOR FERROUS PIPES - STEEL BY CLASS	2501	1	1560	3-3.1	ISO 7005:1988;	
207	FLANGES FOR FERROUS PIPES - C.I. BY CLASS	2519	1	1560	3-3.2	ISO 7005-2	
207	FLANGES FOR FERROUS PIPES - C.I. BY PN				2	EN 1092, ISO 2531:1991; ISO 7005-2:1988	
207	FLANGES FOR FERROUS PIPES- SLIP ON FOR WELDING	2576					
207	FLANGES FOR FERROUS PIPES- WELDING NECK	2627-38					
207	FLANGES FOR FERROUS PIPES- SCREWED	2566					
207	FLANGES FOR FERROUS PIPES- LAPPED- PLAIN COLLAR	2655-56					
207	FLANGES FOR FERROUS PIPES- LOOSE- WELDING NECK	2673					
207	FLANGES FOR FERROUS PIPES- CONTACT SURFACE	2526					
207	FLANGES FOR FERROUS PIPES- BLANK	2527					

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d)				1	EN 1514	
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT)				2	EN 1514	
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT)				3	EN 1514	
208	GASKET DIMENSIONS TO SSRN 207 (a) & (d) (CONT)				4	EN 1514	
208	GASKETS-FOR GROOVED FLANGES	2693					
208	GASKETS-GROOVED O-RINGS	2697					
209	C.I. PIPE FITTINGS, MALLEABLE, SCREWED					ISO 49:1994	
210	STEEL PIPES & FITTINGS - GENERAL			534			
210	STEEL PIPES - WATER-GENERAL	2460		534		EN 10224, AWWA C200-97, NFA 49-150 JIS G 3460-88	
210	STEEL PIPES & FITTINGS - DESIGN	2413	1, 2	8010 2.1		AWWA M11	
210	STEEL PIPES & FITTINGS - WELDING JOINTS	2559	1, 2, 3	8010 2.1		AWWA M11 ASTM A333/A333M-	
211	CEMENT MORTAR LINING - D.I. PIPES			EN 545		EN 545, AWWA	
211	CEMENT MORTAR LINING - D.I. PIPES	2614					
211	CEMENT MORTAR LINING - D.I. PIPES (CONT)					DVGW W343 ISO 4179:1985,	
212	CEMENT MORTAR LINING - STEEL PIPES	2614		534		AWWA C 205, NFA 49-701DVGW-W343/W34	
212	CEMENT MORTAR LINING - STEEL PIPES (CONT)	2614				AWWA C 602-95 ISO / DIS 8324	
213	S. PIPES & TUBES-MATERIAL, PROP., TESTS	1629		3600		AWWA C200-97	
213	CARBON STEEL PIPES AND TUBES			3601		ISO 2604/2 /3 /6	
213	STEEL PIPES AND TUBES-SPECIAL REQUIREMENTS	1626					
213	STEEL PIPES AND TUBES-SEAMLESS	2448					
213	STEEL PIPES AND TUBES-WELDED	2458					
214	BITUMEN PROTECTION TO IRON AND STEEL - HOT			4147		(BS 4147 type I, grade 'd')	
214	BITUMEN PROTECTION TO IRON AND STEEL- COLD			3416		(BS 3416 type II)	
214	BITUMEN PROTECTION TO STEEL PIPES ETC.	30673	Type E4				
214	BITUMEN PROTECTION TO DUCTILE IRON PIPES	30674	4				
215	EXT. PROTECTION - IRON & STEEL- EPOXY C.			none		AWWA C210-97	
216	STEEL FITTINGS - REINFORCING			none		AWWA C208-59 AWWA M11	
216	STEEL FITTINGS - DIMENSIONS			534		AWWA C208-59 AWWA M11	
217	D.I. PIPES & FITT.-SCREWED GLAND JOINTS					See SSRN 219	
218	D.I. PIPES & FITT.-BOLTED GLAND					See SSRN 219	
219	D.I. PIPES & FITT.-S & S JOINTS			8010	2-2.1		
219	D.I. PIPES & FITT.-S & S JOINTS					EN 545	
219	D.I. PIPES & FITT.-S & S JOINTS	28603					
219	PIPELINES ON LAND; DESIGN, CONSTRUCTION AND INSTALLATION: STEEL FOR OIL			8010	2.8		
220	D.I. PIPES-ZINC COATING & PROT. SHEATHS	30674	3	none			
221	IRON AND STEEL PIPES-ENAMEL-HOT APPLIED			7873		AWWA C203-97	
221	STEEL FLANGED PIPES & FITTINGS- ENAMELLED	2873					
222	ELASTOMERIC JOINTS RINGS- REQUIREMENTS			2494			Partly replaced by BS 7874 and BS EN 681-1
222	ELASTOMERIC JOINTS RINGS- VULCANISED				1	EN 681	
222	ELASTOMERIC JOINTS RINGS-DRAINS & SEWERS	4060					
223	PIPE THREADS-TUBES & FITT. (WATERTIGHT	See ISO DIN		21		ISO 7/1:1982;	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
224	CAST IRON S & S PIPES AND FITTINGS			78	2		BS 78 Withdrawn, Replaced by BS 4622 Part 2 Obsolescent, Partially replaced by BS 4772
225	STEEL PIPES-HOT DIP GALVANISING					EN 10240	
226	CARBON STEEL FITTINGS - BUTT- WELDING-GENERAL	2609		1965	1		BS 1965 Part 2 Withdrawn
226	STEEL FITTINGS - BUTT-WELDING-	2615	1, 2				
226	STEEL FITTINGS - BUTT-WELDING- REDUCERS	2616	1, 2				
226	STEEL FITTINGS - BUTT-WELDING-	2617					
227	POLYTHENE SLEEVING FOR STEEL PIPES	none		none		ISO 8180:1985	
227	POLYTHENE SLEEVING FOR D. I.	30674	5				
228	ST. PIPES-DIMENSION & MASSES-PRESS. PURPOSE	2413	1, 2	3600			
228	S. PIPES-DIMENSION & MASSES-PRESS. (CONT)	2460					
229	STAINLESS STEEL TUBES AND			1554			
229	STAINLESS STEEL TUBES AND WIRES (CONT)			4825	1	ISO 2037:1980	
229	STAINLESS STEEL TUBES AND WIRES (CONT)			6362		ISO 7598	
229	STAINLESS STEEL TUBES AND WIRES (CONT)	17457					
229	STAINLESS STEEL TUBES AND WIRES (CONT)	17440					
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT	2460		CP2010-2		EN 10224, ISO 559	
230	STEEL PIPES FOR WATER FLEXIBLE SOCKET & SPIGOT	2460		CP2010-2		EN 10224, AWWA C200-	
231	FERROUS P. DEFINITION OF NOMINAL PRESSURE			none		ISO 7268:1983	
232	STEEL PIPELINES - TAPE COATING SYSTEMS	30672	1	none		AWWA C214-95	
233	BURSTING DISCS & DEVICES			2915		ISO 6718:1991	
234	STEEL PIPES FOR PETROLUEM AND GAS INDUSTRY	17172				EN 10208-2, API 5L	
235	FITTINGS TO STAINLESS STEEL			4825	2	ISO 2851:1973	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	3	ISO 2852:1974	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	4	ISO 2853:1976	
235	FITTINGS TO STAINLESS STEEL TUBES (CONT)			4825	5		
236	FITTINGS TO BRASS TUBES			2051	1		
237	RUBBER GASKET MATERIAL JOINTS FOR PIPELINES			2494		ISO 4633; ISO 6447; ISO 6448	
238	STORAGE OF VULCANISED RUBBER			none		ISO 2230:1973	
239	BITUMINOUS VARNISH TO DUCTILE IRON PIPES			none		ISO 8179-2:1995	
240	FOUNDING - SPHEROIDAL GRAPHITE CAST IRON					EN 1563	
240	FOUNDING - AUSTEMPERED DUCTILE IRON CASTINGS					EN 1564	
241	FUSION BONDED EPOXY COATINGS FOR STEEL PIPES	30671		none		EN 10309, AWWA C213, NFA 49-706	
241	FUSION BONDED EPOXY LININGS FOR STEEL PIPES					AWWA C213	
242	FLEXIBLE BOLTED SLEEVE			534		AWWA C219	
243	FLEXIBLE GROOVED AND SHOULDERED COUPLINGS					AWWA C606	
244	SPHERICAL JOINTS FOR WELDING, STEEL PIPES			534		UNI 6363	
245	BIT. SEAL COAT'GS ON D.I. PIPE CEM. MOR. LINING			7892			
246	POLYMERIC FILM PROT. SLEEV'G FOR IRON PIPES	30674	5	6076		EN 534	
247	HOT ENAMEL COATING TO IRON & STEEL PIPES			7873			
248	EXTERNAL ZINC COATINGS ON DI	2444		none		ISO 8179-1:1995	
249	BOLTS & NUTS FOR PIPELINES	2507		none			
250	STEEL PIPELINES - THERMOSET PLASTIC COATINGS	30671		BGC/CW6		AWWA C213, NFA 49-706	

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
251	STEEL PIPES - POLYPROPYLENE COATING	30678		none		EN 10286, NFA 49-711	
252	STEEL TUBES - ELECTROMAGNETIC TESTING -				1	EN 10246	
253	TWO & THREE LAYER POLYTHENE COATINGS FOR STEEL PIPES	30670		534		AWWA C215, NFA 49-704, NFA	
254	LIQUID EPOXY COATINGS FOR STEEL PIPES					AWWA C210	
255	LIQUID EPOXY LININGS FOR STEEL PIPES					AWWA C210, NFA	
256	LIQUID POLYURETHANE COATINGS FOR STEEL PIPES	30671				AWWA C222	
257	LIQUID POLYURETHANE LININGS FOR STEEL PIPES					AWWA C222, NFA	
258	EXTRUDED POLYTHENE COATINGS FOR D.I. PIPES	30674	1	EN 545		EN 545	
259	CEMENT MORTAR COATINGS FOR D.I. PIPES	30674	2				
260	LIQUID EPOXY COATINGS FOR D.I. PIPES			EN 545		EN 545	
261	FUSION BONDED EPOXY COATINGS & LININGS FOR D.I. FITTINGS					AWWA C116	
262	LIQUID POLYURETHANE COATINGS FOR D.I. PIPES			EN 545		EN 545	
263	LIQUID POLYURETHANE LININGS FOR D.I. PIPES			EN 545		EN 545	
264	TWO LAYER EPOXY-NYLON COATINGS & LININGS FOR STEEL PIPES					EN 10310, AWWA C224	

3.3 PLASTIC PIPES AND FITTINGS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
300	uPVC PIPES FOR COLD WATER	19532		3505		ISO 2505, 3114, 3606	
300	uPVC PIPES FOR COLD WATER (CONT. 1)	8062				ISO 3472, 3472, 3473, 3474	
300	uPVC PIPES FOR COLD WATER					ISO 161/1	
300	uPVC PIPES FOR COLD WATER					KEBS 06-149:2	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES	8063	1, 12	4346	1-3	ISO 2035, 2044	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES	16450				ISO 2045, 2048, 2536	
301	JOINTS AND FITTINGS FOR uPVC PRESSURE PIPES	16451					
302	uPVC PIPELINES - LAYING AND	16928		See CP		CP 312	
303	uPVC PIPELINES - PRESSURE	4279	1, 7				
304	uPVC PIPELINES - ADHESIVES FOR JOINTING	16970					
305	uPVC PIPES - GENERAL	8061		3505			
305	uPVC PIPES - GENERAL (CONT. 1)	8062		3506			
305	uPVC PIPES - GENERAL (CONT. 2)	19532					
306	uPVC PIPES - PRESSURE TESTS TO DESTRUCTION			4728		ISO 1167	Obsolescent (but still remains current) Replaced by BS EN 921 and partially replaced by BS EN 2782 Part II method 1127P - 1997 but remains current
307	HDPE PIPES, JOINTS, FITTINGS	16963	1-3	3284 (6572)			Obsolescent - Partially replaced by BS
308	RUBBER RINGS FOR MECHANICAL JOINTS			2494			
309	uPVC UNDERGROUND DRAIN PIPES & FITTINGS			4660			Partially replaced by BS EN 1401-1
310	uPVC PIPES IMPACT TEST 20 DEGREES CENTIGRADE			3505		ISO 3127	
311	uPVC PIPES SHORT TERM HYDROSTATIC TEST			3505			
312	uPVC PIPES LONG TERM HYDROSTATIC TEST			3505			
313	uPVC PIPES INTERNAL PRESSURE ENDURANCE TEST	8061					
314	uPVC WATER ABSORPTION TEST	8061				ISO 2508	
315	uPVC PIPES - VARIOUS OTHER TESTS					ISO 2505, 3114, 3472, 3473, 3474	
316	PIPES - RATE OF LEAKAGE			8010:2			
317	G.R.P. PIPES			6464		BS EN 1796	
318	PLASTICS PIPES AND FITTINGS FOR USE AS SUB SOIL FIELD			4962			
318	POLYPROPYLENE WASTE PIPE AND FITTINGS (EXTERNAL DIAMETER 34.6MM,			5254			
319	THERMOPLASTICS WASTE PIPE AND FITTINGS			5255			
320	GLASS REINFORCED PLASTICS (GRP) PIPES, JOINTS AND FITTINGS FOR USE FOR WATER			5480			
321	UNPLASTICIZED PVC PIPE AND FITTINGS FOR GRAVITY SEWERS			5481			
322	PLASTICS PIPEWORK (THERMOPLASTICS MATERIALS)			5955	6		Part 6: Installation of unplasticized PVC pipework for gravity drains and sewers
323	BLUE POLYETHYLENE PIPES UP TO NOMINAL SIZE 63 FOR BELOW GROUND USE FOR POTABLE			6572			
324	BLACK POLYETHLENE PIPES UP TO NOMINAL SIZE 63 FOR ABOVE GROUND USE FOR COLD			6730			

3.4 OTHER PIPES AND FITTINGS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES	19800	1-3	486		ISO 160 BS EN 512	BS 486 Withdrawn Replaced by BS EN 512
401	ASBESTOS CEMENT (A/C) PRESSURE PIPES (CONT.)			4624			
402	A/C SEWER PIPES, JOINTS, FITTINGS			3656		ISO 881 BS EN 588-1	BS 3656 Withdrawn Replaced by BS EN 588-1
402	A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 1)						
402	A/C SEWER PIPES, JOINTS, FITTINGS (CONT. 2)	19850	1, 2				
403	A/C PIPES FOR THRUST BORING					ISO 4488	
404	A/C PIPES - GUIDE FOR LAYING			5927		ISO 4482	
405	A/C PIPES - FIELD PRESSURE	4279	1, 6, 9, 10	5886		ISO 4483	
406	PIPE SUPPORTS	See DVGW		3974	1	DVGW 310 PT. 2	
407	UNREINFORCED CONCRETE PIPES (OGEE)	4032		5911	3		
408	PRESTRESSED CONCRETE PRESSURE PIPES	4035		4625			
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS	4032		5911	1, 3		
409	PRECAST CONCRETE PIPES - DRAINS & SEWERS (CONT.)	4035					
410	CONCRETE POROUS PIPES - UNDER DRAINS			5911	114		
411	NON-PRESSURE DUCTILE IRON PIPES ETC.					ISO 7186	
412	RUBBER AND PLASTIC HOSES AND ASSEMBLIES					ISO 7751	
413	CONCRETE CYLINDRICAL PIPES & FITTINGS METRIC			5911	1-3	AWWA C602-83	BS 5911 Part I: 1981 Withdrawn Replaced by BS 5911 Part 100: 1988 BS 5911 Part 200: 1989
414	CLAY PIPES (SEWERAGE)			65			
415	TESTING OF JOINTED PIPES AND MANHOLES			2005			BS 2005 - Obsolescent
416	CONCRETE PRESSURE PIPES INCLUDING JOINTS AND					BS EN 639	

3.5 VALVES, METERS, HYDRANTS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
501	DOUBLE FLANGED C.I. GATE VALVES (WATER)			5163		AWWA C203-78	
501	DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 1)	3230	1-3				
501	DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 2)						
501	DOUBLE FLANGED C.I. GATE VALVES (WATER) (CONT. 3)	3352	1, 4				
502	C.I. GATE VALVES - GENERAL			5150			
502	C.I. GATE VALVES - GENERAL	3352	1, 4				
503	C.I. (PARALLEL SLIDE) GATE VALVES - GENERAL			5151			
504	C.I. GLOBE VALVES - GENERAL	3356	1-5	5152			
505	C.I. CHECK VALVES - GENERAL	3202		5153		AWWA C508-82	
505	C.I. CHECK VALVES - GENERAL (CONT.)	See DVGW		6282	1, 4	DVGW-W376	
506	C.I. AND STEEL BUTTERFLY VALVES - GENERAL	3354	1-4	5155		BS EN 593: 1998	BS 5155 Withdrawn Replaced by BS EN 593,: 1998
507	BOURDON TYPE PRESSURE GAUGES			1780		BS EN 837: 1998	BS 1780 Withdrawn Replaced by BS EN 837-1: 1998
508	FLOAT OPERATED VALVES N.D.			1212	1, 2, 3		
509	FIRE HYDRANTS	3221	1, 2	750			
510	WATER METERS	19648	1-3	5728	1, 2	ISO 4064-1	BS 5728 Part 1 Withdrawn Replaced by BS 5728: Part 7
510	WATER METERS (CONT.)					KS 06-248 1, 2	
511	COPPER ALLOY GATE, CHECK, ETC. VALVES	3352	11				
511	COPPER ALLOY GATE, CHECK, ETC. VALVES (CONT.)			5154			
512	FIRE HOSE COUPLINGS &	14244		336			
513	SURFACE BOXES			5834	2, 3		
513	SURFACE BOXES (CONT. 1)						
513	SURFACE BOXES (CONT. 2)						
513	SURFACE BOXES (CONT. 3)						
513	SURFACE BOXES (CONT. 4)						
514	METALLIC BALL VALVES	3357	1-7				DIN 3357 Part 6, 7 Witihdrawn
515	uPVC VALVES	3441	2				
517	FIRE HYDRANT SYSTEMS FOR BUILDINGS			5041	1-5		
518	BUTTERFLY VALVES			5155			
519	DIAPHRAGM VALVES			5156			
520	CAST IRON PLUG VALVES			5158			
521	UNDERGROUND STOPVALVES FOR WATER SERVICES			5433			

3.6 TESTING METHODS AND EQUIPMENT

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
600	NON-DESTRUCTIVE TESTING OF WELDS (TUBES)	8564	1	3889 (6072)	1, 2A	AP15LS	BS 3889 Partially Replaced by 6072
600	NON-DESTRUCTIVE TESTING OF WELDS (TUBES) (CONT.)	50120	1, 2	6072			
601	SOILS FOR CIVIL ENGINEERING PURPOSE -	18196		1377			
602	TESTING OF PIPELINE FOR WATER (INTERNAL	4279	1-7, 9, 10				
603	TESTING OF CEMENT	See EDIN		4550	1, 2, 3	BS EN 196-7 EDIN EN75, 112, 114, 15	BS 4550 Part 1 & Part 2 Withdrawn Replaced by BS EN 196-7: 1992
604	MATERIAL TESTING - DOCUMENTATION					ISO 404, EURONORM	
605	MEASUREMENT OF WATER FLOW (WATER METERS)					ISO 4064/3	
606	DRINKING WATER QUALITY -					KS 05-459:5	
607	RECOMMENDATIONS AND CLASSIFICATION FOR			3882			
608	METHODS OF TESTING MORTARS, SCREEDS AND			4551			
609	STRUCTURAL FIXINGS IN CONCRETE AND MASONRY			5080	1 & 2		Part 1: Method of test for tensile loading Part 2: Method for determination of resistance to
610	SIZE OF HARDWOODS AND METHODS OF MEASUREMENT			5450			
611	RECOMMENDATIONS FOR TESTING OF AGGREGATES			5835	1		Part 1: Compactibility test for graded aggregates

3.7 SITE WORK CODES OF PRACTICE

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
650	SITE INVESTIGATIONS	18196		5930			
650	SITE INVESTIGATIONS (CONT.)	18307					
651	WATER SUPPLY	2000	See BS	BS 6007		CP 310	CP 310 Withdrawn Replaced by BS 6007
651	WATER SUPPLY (CONT. 1)	2425	3, 5	BS 8301		CP 301	CP 301 Withdrawn Replaced by BS 8301
651	WATER SUPPLY (CONT. 2)	4046					
651	WATER SUPPLY (CONT. 3)	19630					
652	BUILDING DRAINAGE	1986	2-4	BS 8301		CP 301	CP 301 Withdrawn Replaced by BS 8301
653	WATER PIPELINE CONSTRUCTION	19630					
654	TRENCHING FOR PIPELINES	4124					
655	SEWAGE PIPELINE CONSTRUCTION						
656	WALLING (BRICK & BLOCK MASONRY)	18330	See BS	5390 5628		CP 121	CP 121 Withdrawn Replaced by BS 5390 and BS 5628 Part 3
657	USE OF STRUCTURAL STEEL IN BUILDING	18203	1, 2	449 BS 5950	2	GB 7101-91 SABS 1431	BS 449 Parts 1 and 2 Withdrawn Part 2: Addendum No. 1 (1975) Replaced by BS 5950 Part 5 (1987)
658	SEWERAGE			8005		BS EN 1610	
659	SMALL SEWAGE TREATMENT WORKS AND CESSPOOLS			6297			
660	TEST PUMPING OF WATER WELLS			6316			
661	METHODS OF MEASUREMENT OF LIQUID FLOW IN OPEN CHANNEL			3680	1-10	BS ISO 748 BS ISO 1100-2 ISO TR 8363	BS 3680 Part 3A Withdrawn Replaced by BS ISO 748: 1997 BS 3680 Part 3C Withdrawn Replaced by BS ISO 1100-2 BS 3680 Part 3G Withdrawn Replaced by ISO TR 8363 BS 3680 Parts 3J, 8F, 8G Withdrawn
662	MEASUREMENT OF FLOW IN CLOSED CONDUITS (BY CURRENT METERS OR PITOT					ISO 7194	
663	CONSTRUCTION AND DEMOLITION OF CONCRETE					ANSI A10, 9-1983	
664	DRAINAGE OF ROOFS AND PAVED AREAS			6367			
665	FOUNDATIONS			8004		CP 2004	CP 2004 Withdrawn Replaced by BS 8004
666	STRUCTURAL USE OF TIMBER			5268		CP 112, 2	CP 112, 2 Withdrawn Replaced by BS 5268 Part 2 BS 5268 Part 3
667	RETAINING WALLS	4085					
668	WATERPROOFING OF BUILDINGS & STRUCTURES	18195	1-4				
669	WATER QUALITY - SAMPLING					ISO 5667/2/3	
670	WELDING PROCEDURES - APPROVAL TESTING			4870	1	BS EN 288-3 BS EN 288-4	BS 4870 Part 1 Withdrawn Replaced by BS EN 288-3 BS 4870 Part 2 Withdrawn Replaced by BS EN 288-4
671	WELDING - APPROVAL TESTING			4871	1	BS EN 287-1 BS EN 287-2	BS 4871 Part 1 Withdrawn Replaced by BS EN 287-1 BS 4871 Part 2 Withdrawn Replaced by BS EN 287-2
672	LOGGING OF ROCK CORES					Logging of rock cores for engineering purposes, geol. Soc. of london	
673	TEST FOR STABILISED SOILS			1924			
674	DRAIN AND SEWER SYSTEMS OUTSIDE BUILDINGS				1, 2 & 3	BS EN 752	Part 1: Generalities and definitions Part 2: Performance requirements Part 3: Planning
675	CONSTRUCTION AND TESTING OF DRAINS AND					BS EN 1610	
676	IDENTIFICATION OF PIPELINES AND SERVICES			1710			
677	WELDING OF STEEL PIPELINES ON LAND AND OFFSHORE			4515			
678	PERFORMANCE REQUIREMENTS FOR JOINTS AND COMPRESSION FITTINGS FOR USE WITH			5114			
679	STRUCTURAL USE OF TIMBER			5268	2, 3 & 5		Part 2: Permissible stress design, materials and workmanship Part 3: Trussed rafter roof Part 5: Preservative treatment of structural timber

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
680	STAIRS, LADDERS AND WALKWAYS			5395	1, 2 & 3		Part 1: Design of straight stairs Part 2: Design of helical and spiral stairs Part 3: Design of industrial type stairs, permanent ladder and walkways
681	INTERNAL PLASTERING			5492			
682	GUIDE TO ACCURACY IN BUILDING			5606			
683	SAFE USE OF EXPLOSIVES IN THE CONSTRUCTION			5607			
683	USE OF MASONRY			5628	3		Part 3: Materials and components, design and workmanship
684	EARTHWORKS			6031			
685	PAINTING OF BUILDINGS			6150			
686	LOADING FOR BUILDINGS			6399	1		Part 1: Dead and imposed loads
687	GUIDE TO INSTALLATION AND USE OF VALVES			6683			
688	DESIGN, INSTALLATION, TESTING AND MAINTENANCE OF SERVICES SUPPLYING WATER FOR DOMESTIC USE WITHIN			6700			
689	GUIDE FOR STRUCTURAL DESIGN OF PAVEMENTS CONSTRUCTED WITH CLAY OR CONCRETE BLOCK PAVER			7533			
690	SEWERAGE			8005	1		Part 1: Guide to new sewerage construction
691	PROTECTION OF STRUCTURES AGAINST WATER FROM THE			8102			
692	DESIGN AND INSTALLATION OF DAMP- PROOF COURSES IN THE MASONRY CONSTRUCTION			8215			
693	CODE OF PRACTICE FOR BUILT-UP FELT ROOFING			8217			

3.8 DRAWING PRACTICE, STANDARD SYMBOLS ETC.

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
700	IDENTIFICATION OF PIPELINE ACCORDING TO FLUID	2403					
701	GRAPHICAL SYMBOLS FOR GENERAL ENGINEERING -	2406		1553	1		
701	GRAPHICAL SYMBOLS FOR GENERAL ENGIINEERING - PIPING SYSTEMS (CONT.)	2429	1				
702	PROJECT NETWORK TECHNIQUES			4335			
703	DRAWING OFFICE PRACTICE - ARCHITECTS			1192	1-4		BS 1192 Part 2 Obsolescent
704	CONSTRUCTION DRAWING			1192	1-4		BS 1192 Part 2 Obsolescent
705	ENGINEERING DRAWING PRACTICE			308	1	ISO 128, 2162, 2203	
706	DRAWING PRACTICE FOR ENGINEERING DRAWINGS			5070	1-3	BS EN 61082	BS 5070 Part 1 Partially Replaced by BS EN 61082-1 BS 5070 Part 2 Withdrawn
707	BUILDING AND CIVIL ENGINEERING TERMS			6100	1-6		
708	WATER SUPPLY - MAPS AND PLANS	2425	3, 5				
709	CARTOGRAPHIC REPRESENTATION OF CLIMATE	50019	1				
750	CONCRETE (INC. R/F) - GLOSSARY			6100	6.2, 6.3		
751	VALVES - GLOSSARY						
752	IRON AND STEEL - GLOSSARY FOR PIPES			6562	1-2		

3.9 BUILDING MATERIALS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
801	LIME FOR MORTAR	1060	1, 2, 3	890	CL.B		DIN 1060 Part 2 & 3 Withdrawn
802	QUARRY TILES FOR SILLS			6431		BS EN ISO 10545- 2, 3, 4, & 6	BS 6431 Parts 10, 11, 12 & 14 Replaced by BS EN ISO 10545-2, BS EN ISO 10545-3 BS EN ISO 10545-4 BS EN ISO 10545-6
803	DAMP-PROOF COURSE (BITUMINOUS FELT)			743 (6398: BS 6398, BS 6515 and BS			BS 743 Partially Replaced by
804	CONCRETE BLOCKS			6398		KENYA M.O.W. ST.	
804	CONCRETE BLOCKS (CONT.)			6073	1, 2		BS 6073 Partially Replaced by BS EN 772-2
805	HOLLOW CLAY PARTITION BLOCKS	278		3921			BS 3921 Partially Replaced by BS EN 772-3 & 7
806	BRICK WALLING	105	1-5	3921			BS Partially Replaced by BS EN 772-3 & 7
806	BRICK WALLING (CONT.)	106	1, 2				
807	ASBESTOS ROOF SLATES AND SHEETING			690	3, 4		BS 690 Part 3 & 4 Withdrawn Replaced by BS EN 494 and 492 respectively
808	FIXING BOLTS & SCREENS FOR ROOFING						
809	INSULATION BOARD AND HARD BOARD			1142	1, 2, 3	ISO 766/7/9, 818/19, 2695, 3340, 3546, 3729	BS 1142 Partially Replaced by BS EN 120, 310, 316-323, 324: 1 & 2,
809	INSULATION BOARD AND HARD BOARD (CONT.)						
810	BLOCKBOARD	68705	1, 3	3444		ISO 1096, 97, 98, 2074, 2426-30	DIN 68705 Part 1 Withdrawn
811	PLYWOOD (TROPICAL HARDWOOD)	4078		6566	1-8	ISO 1096, 1097	BS 6566 Replaced by various BS EN Standards on the same subject
811	PLYWOOD (TROPICAL HARDWOOD) (CONT.)	68705	1, 5			ISO 1098	DIN 68705 Part 1 Withdrawn
812	SEALING OF EXT. WALL JOINTS	18540	SH. 1, 2, 3				

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
813	CHIPBOARD	68761	4	5669			BS 5669 Part 1 Partially Replaced by BS EN 120, 309, 310, 311, 312, Parts 1-6 and 317 BS 5669 Part 4 Partially Replaced by BS EN 634-2 & BS EN 1328 BS 5669 Part 5 Withdrawn Replaced by BS 7916
813	CHIPBOARD (CONT.1)	68763					
813	CHIPBOARD (CONT. 2)	68764					
814	LAMINATED PLASTIC SHEETING	16922		3794		BS EN 438	BS 3794 Withdrawn Replaced by BS EN 438 Parts 1 & 2
814	LAMINATED PLASTIC SHEETING (CONT. 1)						
814	LAMINATED PLASTIC SHEETING (CONT. 2)						
815	WOOD WOOL SLABS	1101		1105			BS 1105 Obsolescent
815	WOOD WOOL SLABS (CONT. 1)	1102					
816	QUALITY OF TIMBER -	68141		1186	2		
817	MATERIAL FOR FLUSH DOORS	68706		459			BS 459 Part 3 Withdrawn
817	MATERIAL FOR FLUSH DOORS	18101					
817	MATERIAL FOR FLUSH DOORS						
818	WATERPROOF ADHESIVE	53255		1203	TYPE MR		
819	STRUCTURAL STEEL & METALWORK			4360 7316 7668		ISO 630, 6891 BS EN 10029: 1-3 BS EN 10113 BS EN 10155 BS EN 10210-1	BS 4360 Withdrawn - Replaced by BS 7316, BS 7668, BS EN 10029 Parts 1 to 3 BS EN 10113, BS EN 10155 and BS EN 10210-1
819	STRUCTURAL STEEL & METALWORK (CONT. 1)					JIS G30101-87	
820	SPLIT RING TIMBER CONNECTORS			1579			
821	METAL WINDOWS			6510			
822	GLASS FOR GLAZING	1249	1	952	1		
822	GLASS FOR GLAZING (CONT.)	18301					
823	GALVANISED M.S. TUBING (MILD	2440		1387		ISO 65, 7/1, 7/2	
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 1)	2441		21			
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 2)	2442					
823	GALVANISED M.S. TUBING (MILD STEEL) (CONT. 3)	2999	1				
824	FITTINGS TO M.S. TUBING MILD	2460		1256, 143			
824	FITTINGS TO M.S. TUBING MILD			143		BS EN 10242	
824	FITTINGS TO M.S. TUBING MILD STEEL (CONT. 2)			1740	1		
825	POLYTHENE TUBING FOR COLD WATER SERVICES	19533		2782		ISO 161-1 BS ISO 4065 BS ISO 11922-1	
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 1)	8072		6572 6730			
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 2)	8073					
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 3)	8075					
825	POLYTHENE TUBING FOR COLD WATER SERVICES (CONT. 4)	8074					
826	BRASSWORK & FITTINGS FOR TAPS & STOP VALVES			1010	2		
827	BALL VALVES FOR CISTERNS			1212	3		
828	PLASTIC FLOATS FOR BALL VALVES			2456			
829	CAST IRON SOIL, WASTE & VENT			416			
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 1)						
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 2)						
829	CAST IRON SOIL, WASTE & VENT PIPES (CONT. 3)	19522	1, 2				
830	GALVANISED MILD STEEL COLD WATER TANKS			417	2 CL.A		
831	ENAMELLED CAST IRON BATH			1189			
831	ENAMELLED CAST IRON BATH						
831	ENAMELLED CAST IRON BATH	4774					
832	PILLAR TAPS	7572		1010	2		
833	GLAZED VITREOUS CHINA W.C. PAN	1387		5503			
833	GLAZED VITREOUS CHINA W.C. PAN (CONT.)	1381					
834	HINGED PLASTIC SEAT TO W.C. PAN			1254			
835	GLAZED VITREOUS CHINA LAVATORY BASIN	4462		1188			
835	GLAZED VITREOUS CHINA LAVATORY BASIN (CONT.)			5506	2		
836	STAINLESS STEEL SINK	4465		1244	2		

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
837	BRASS "S" AND "P" TRAPS			1184			BS 1184 Obsolescent
839	A/C DRAIN PIPES AND FITTINGS	19831		3656		BS EN 588-1	BS 3656 Withdrawn Replaced by BS EN 588-1
839	A/C DRAIN PIPES AND FITTINGS (CONT. 1)	19841					
839	A/C DRAIN PIPES AND FITTINGS (CONT. 2)	19850	1, 2				
840	CONCRETE DRAIN PIPES	See 409		2870			
841	PITCH FIBRE DRAIN PIPES			2760			BS 2760 Withdrawn
842	CAST IRON DRAIN PIPES	19500		437		ISO 6594	
842	CAST IRON DRAIN PIPES (CONT. 1)	19501					
842	CAST IRON DRAIN PIPES (CONT. 2)	19502					
842	CAST IRON DRAIN PIPES (CONT. 3)	19503					
842	CAST IRON DRAIN PIPES (CONT. 4)	19504					
842	CAST IRON DRAIN PIPES (CONT. 5)	19505					
842	CAST IRON DRAIN PIPES (CONT. 6)	19506					
842	CAST IRON DRAIN PIPES (CONT. 7)	19507					
842	CAST IRON DRAIN PIPES (CONT. 8)	19508					
842	CAST IRON DRAIN PIPES (CONT. 9)	19509					
842	CAST IRON DRAIN PIPES (CONT. 10)	195010					
842	CAST IRON DRAIN PIPES (CONT. 11)	195011					
842	CAST IRON DRAIN PIPES (CONT. 12)	195014					
842	CAST IRON DRAIN PIPES (CONT. 13)	195019					
842	CAST IRON DRAIN PIPES (CONT. 14)	19521					
843	JOINTING COMPOUND FOR C.I. DRAIN PIPES			BS 6956	1, 5, 6, 7		
844	C.I. S & S FITTINGS FOR DRAINS	19519		437			
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS	1211	1	1247			
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 1)	1212	1				
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 2)	1213					
845	STEP-IRONS TO MANHOLES & SEPTIC TANKS (CONT. 3)	4281					
846	C.I. MANHOLE COVERS AND FRAMES	1229		497	1	BS EN 124	BS 497 Withdrawn Replaced by BS EN 124
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 1)	4271	1, 3				
846	C.I. MANHOLE COVERS AND	19593	1, 2, 3				
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 3)	19594	1, 2				
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 4)	19596					
846	C.I. MANHOLE COVERS AND FRAMES (CONT. 5)	19597					
847	STEEL LADDERS FOR PERMANENT ACCESS	3620		4211			
848	HANDRAILING	24533		6180			
849	GALVANISED CHAIN LINK FENCING	11991		1722	1		
850	OPEN MESH STEEL FLOORING			4592	1		
851	MASTIC ASPHALT FOR ROOFING			6925			
852	ALUMINIUM FOR LOUVRE WINDOWS			1470		BS EN 485 BS EN 515 BS EN 573	BS 1470 Withdrawn Replaced by BS EN 485 Parts 1-4, BS EN 515, BS EN 573
853	FIXING ACCESSORIES FOR BUILDING PURPOSES			1494	1		BS 1494 Part 2 Withdrawn
854	PRECAST CONCRETE MANHOLES	4034		5911	2, 3		BS 5911 Part 1 Withdrawn Replaced by BS 5911 Part 100 (1988) Bs 5911 Part 200 (1989) and BS 5911
855	PRECAST CONCRETE KERBS & CHANNELS	483		7263	1		
856	WATERPROOF BUILDING PAPERS	4122		1521			
856	WATERPROOF BUILDING PAPERS (CONT. 1)	52126					
856	WATERPROOF BUILDING PAPERS (CONT. 2)	52127					
856	WATERPROOF BUILDING PAPERS (CONT. 3)	52128					
856	WATERPROOF BUILDING PAPERS (CONT. 4)	52129					
856	WATERPROOF BUILDING PAPERS (CONT. 5)	52130					
857	METAL TIES FOR CAVITY WALL			1243			
858	A/C BUILDING PRODUCTS (TESTS	274	1-4	4624			
859	PRECAST CONCRETE FLAGSTONES	485		7263	1		
860	ASBESTOS CEMENT RAIN WATER GOODS	19831	1-9	569			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
860	ASBESTOS CEMENT RAIN WATER GOODS (CONT. 1)	19841	1-6				
860	ASBESTOS CEMENT RAIN WATER GOODS (CONT. 2)	19850	1				
861	LINTELS - PREFABRICATED			5977	2		
862	uPVC SOIL AND VENT PIPES, FITTINGS, ETC.	1187		4514			
863	STRUCTURAL STEEL IN BUILDINGS			449 (5950)	2		BS 449 Part 2 Withdrawn Replaced by BS 5950 Part 5
864	PROTECTIVE BARRIERS IN AND ABOUT BUILDINGS			6180			
866	BITUMENS FOR BUILDING & CIVIL ENGINEERING			3690	1, 3		
867	SOLAR WATER HEATERS					AS 2813-85	
868	FLOORING - INITIAL TREAMENT			6263	2		
869	RIGID FLAT SHEET BUILDING MATERIALS						
870	BUILDING STONE			1438			
871	CAST STONE			1217			
872	WOOD PRESERVATIVES - CREOSOTE			144			
873	WASTE TRAPS - PLASTIC			3943			
874	COPPER FLOATS FOR FLOAT OPERATED VALVES			1968			
875	VITREOUS CHINA SANITARY			3402			
876	PAINTS - LEAD BASED			2523 (5082, 5358)			BS 2523 Obsolescent, Partially Replaced by BS 5082 and BS 5358
877	READY MIXED OIL-BASED PRIMING PAINTS			2521/4 (See 2523)			
878	READY MIXIED OIL-BASED UNDERCOATING AND FINISHING						
879	COLD POURED SEALING MATEIALS FOR CONCRETE			5212			
880	GULLY TOPS AND MANHOLE TOPS FOR VEHICULAR PEDESTRIAN AREAS. DESIGN REQUIREMENTS, TYPE TESTING,					BS EN 124	
881	STRUCTURAL TIMBER. STRENGTH CLASSES			338			
882	CLAY ROOFING TILES AND FITTINGS			402	1		Part 1: Specification for plain tiles and fittings
883	BITUMEN ROAD EMULSIONS (ANIONIC AND CATIONIC)			434	1		Part 1: Bitumen road emulsions
884	DRESSED NATURAL STONE KERBS, CHANNELS,			435			
885	CONCRETE ROOFING TILES AND FITTINGS. PRODUCT					BS EN 490	
886	AIR BRICKS AND GRATINGS FOR WALL VENTILATION			493			
887	EAVES GUTTERS AND FITTINGS MADE OF PVC-C					BS EN 607	
888	EAVES GUTTERS AND RAINWATER DOWN-PIPES OF					BS EN 612	
889	PLYWOOD					BS EN 635	
890	TIMBER IN JOINERY					BS EN 942	
891	PRESSED STEEL GUTTERS, RAINWATER PIPES, FITTINGS AND			1091			
892	WC FLUSHING CISTERNS (INCLUDING DUAL FLUSH CISTERNS AND FLUSH PIPES)			1125			
893	NAILS			1202	1, 2 & 3		Part 1: Steel nails Part 2: Copper nails Part 3: Aluminium
893	FIXING ACCESSORIES FOR BUILDING PURPOSES			1494	1		Part 1 Fixings for sheet, roof and wall coverings
894	AUTOMATIC FLUSHING CISTERNS FOR URINALS			1876			
895	WASTES (EXCLUDING SKELETON SINK WASTES) AND			3380			
896	LIGHTWEIGHT AGGREGATES FOR MASONRY UNITS AND STRUCTURAL CONCRETE			3797			
897	TERRAZO TILES			4131			
898	WELDABLE STRUCTURAL STEELS			4360			
899.1	UNPLASTICIZED POLYVINYL CHLRIDE (PVC-U) RAINWATER GOODS AND ACCESSORIES			4576			

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
899.2	INDUSTRIAL TYPE METAL FLOORING, WALKWAYS AND STAIRS TREADS			4592	1, 2, 3 & 4		Part 1: Open bar gratings Part 2: Expanded metal grating panels Part 3: Cold formed planks Part 4: Glass reinforced plastics
899.3	READY-MIX BUILDING MORTARS			4721			
899.4	INTERNAL AND EXTERNAL WOOD DOORSETS, DOOR LEAVES AND			4787	1		Part 1: Dimensional requirements
899.5	HOT-ROLLED STRUCTURAL STEEL SECTIONS			4848	2 & 4		Part 2: Hot-finished hollow sections Part 4: Equal and unequal angles
899.6	URINALS			4880	1		Part 1: Stainless steel slab urinals
899.7	MORTAR ADMIXTURES			4887	1 & 2		Part 1: Air-entraining (plasticizing) admixtures Part 2: Set retarding admixtures
899.8	SOFTWOOD GRADES FOR STRUCTURAL USE			4978			
899.9	COATED MACADAM FOR ROADS AND OTHER PAVED AREAS			4987	1 & 2		Part 1: Constituent materials and mixtures Part 2: Transport, laying and compaction
899.10	WATER-BORNE PRIMING PAINTS FOR WOODWORK			5082			
899.11	MASONRY CEMENT			5224			
899.12	EXTERNAL RENDERINGS			5262			
899.13	SOLVENT-BORNE PRIMING PAINTS FOR WOODWORK			5358			
899.14	WALL AND FLOOR TILING			5385	1, 2, 3, 4 & 5		Part 1: Design and installation of internal ceramic wall tiling and mosaics in normal conditions Part 2: Design and installation of external ceramic wall tiling and mosaics (including terra cotta and faience tiles) Part 3: Design and installation of ceramic floor tiles and mosaics Part 4: Tiling and mosaics in specific conditions
899.15	STONE MASONRY			5390			
899.16	SPECIFICATION FOR LOW-RESISTANCE SINGLE TAPS AND COMBINATION TAP ASSEMBLIES			5412			
	SUITABLE FOR OPERATION AT PN 10 MAX. AND A MINIMUM FLOW PRESSURE OF 0.01 MPa (0.1 BAR)						
899.17	VITREOUS CHINA WASHDOWN WC PANS WITH HORIZONTAL OUTLET			5503	1 & 2		Part 1: Connecting dimensions Part 2: Materials, quality, performance and dimensions other than connecting dimensions
899.18	VITREOUS CHINA BOWL URINALS (RIMLESS TYPE)			5520			
899.19	PRESERVATION OF TIMBER			5589			
899.20	PLASTIC CONNECTORS FOR USE WITH HORIZONTAL OUTLET VITREOUS CHINA WC PANS			5627			
899.21	STILES, BRIDLE GATES AND KISSING GATES			5709			
899.22	GLAZING FOR BUILDINGS			6262			
899.23	MANUFACTURE OF GLUED STRUCTURAL COMPONENTS FOR TIMBER AND WOOD BASED PANEL			6446			
899.24	POLYETHYLENE DAMP-PROOF COURSES FOR			6515			
899.25	INSTALLATION OF CHMICAL DAMP- PROOF COURSES			6576			
899.26	PORTLAND PULVERIZED-FUEL ASH CEMENTS			6588			
899.27	PRECAST CONCRETE PAVING			6717	1		Part 1: Paving blocks
899.28	EXTERIOR WOOD COATING SYSTEMS			6952	1		Part 1: Guide to classification and selection
899.29	PRECAST CONCRETE FLAGS, KERBS, CHANNELS, EDGINGS			7263	1 & 2		Part 1: Specification Part 2: Code of practice for laying
899.30	IN-SITU FLOORINGS			8204	2		Part 2: Concrete wearing surfaces

3.10 ELECTRICAL / MECHANICAL

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
001	FRACTIONAL HORSE-POWER MOTORS (DIMENSIONS)	42021		2048	1		
002	CURRENT FRANSFORMERS			7626		IEC 60185	
003	VOLTAGE TRANSFORMERS			7625		IEC 60186/186A	
004	CIRCUIT BREAKERS 1 kV A.C.			5311		IEC 60056/267	
005	CIRCUIT BREAKERS A.C. VOLT. OPERATED			842		BS EN 61008-1	
006	CIRCUIT A.C. CURRENT OPERATED			4293		BS IEC 1008-2-2	BS 4293 Partially Replaced by BS EN 61008-1 and BS IEC 1008-2-
007	FUSE SWITCHES (AIR BREAK)			5419		IEC 408	BS 5419 Withdrawn Replaced by BS EN 60947-3
008	MOTOR STARTERS AND CONTROLLERS	46062		587			BS 587 Withdrawn Replaced by BS EN 60947-4-1 and BS 5856-1
009	MOTOR STARTERS ABOVE 1000 V.A.C.			5856	1	IEC 60632-1	
010	ELECTRIC MOTOR DIMENSIONS	42673	BL. 1-4	4999	10	IEC 60072, 72A	
011	INDUCTION MOTORS FOR GENERAL PURPOSE	42673	BL. 1-4	5000	10	IEC 60072	
012	ENCLOSURE PROTECTION SWITCH / CONTROL GEAR	40050	BL. 2, 6, 9, 10	5420		IEC 60144 (IP32)	BS 5420 Withdrawn Replaced by BS EN 60947-1
013	MOTOR STARTERS NOT EXC. 1000 V.A.C.	46062		4941	1, 3, 4	IEC 292, 1, 2, 3, 4	BS 4941 Withdrawn Replaced by BS EN 60947-4-1
014	ELECTRICITY METERS			37	1, 5, 8		BS 37 Withdrawn Replaced by Parts 1-4 of BS 5685
015	WATT-HOUR METERS			5685		IEC 521	BS 5685 Part 1 (1979) and Parts 2, 3 & 4 (1986) all Obsolescent
016	ACCEPTANCE TESTS FOR PUMPS (CLASS C)	4325		5316	1	ISO 2548 IEC 198	
017	ACCEPTANCE TESTS FOR PUMPS (CLASS B)	4325		5316	2	ISO 3555 IEC 198	
018	CODE OF PRACTICE, ELECTRICAL WIRING					IEE W. REGS (15^{TH} ED)	
019	ELECTRICAL PROTECTIVE RELAYS			142			BS 142 Part 1 Section 1.5 Sub-Section 1.5.1 - 1.5.3 all renumbered as BS 60255-21-1,
020	FACTORY BUILT SWITCHGEAR ASSEMBLIES	57670	TL. 6	5486	1, 2, 3, 13	IEC 439-2	BS 5486 Part 1 Withdrawn Replaced by BS EN 60439-1
021	RECIPROCATING INT/COMB. ENGINES			5514	1, 2	ISO 3046, PT. 1, 2	BS 5541 Part 2 (1988) 'Test Methods' Withdrawn - Replaced by BS 5514
022	MACHINES FOR MISCELLANEOUS APPLICATIONS			5000	99		
023	INSULATING MATERIALS FOR ELECTRICAL MACHINES			2757		IEC 85	
024	PCV INSULATED CABLES NOT EXCEEDING 1900 V.A.C.	57207	4, 5	6346			
025	ROTATING ELECTRICAL MACHINES - GENERAL			4999	1, 2, 3	IEC 34-1, 34-8, 72, 72A	Renumbered as EN 60034-4
026	CONCRETE CABLE COVERS			2484			BS 2484 Obsolescent
027	ELECTRIC POWER SWITCHGEAR (LOW VOL. N.E. 1kV)	57660		5486 5727 7354			
028	SAFETY ISOLATING TRANSFORMERS			3535			
029	ROTATING ELECTRICAL MACHINES - RATING PLATES	42961		4999	4	IEC 60034-1	
030	ROTATING ELECTRICAL MACHINES - ENCLOSURES	40050		4999	20	IEC 60035-5	
031	ROTATING ELECTRICAL MACHINES - CONDITIONS			4999	31	IEC 60034-1	
032	ROTATING ELECTRICAL MACHINES - TEMPERATURE LIMITS	See E DIN		4999	32	IEC 60034-1 E DIN	
033	ROTATING ELECTRICAL MACHINES - VIBRATION	See DIN		4999	50	ISO 2373	
034	ROTATING ELECTRICAL MACHINES - TESTS			4999	60	IEC 60034-1	
035	GENERATORS DRIVEN BY I/C ENGINES	See VDMA		5000	3	VDMA 6280	
036	MACHINES WITH FLAMEPROOF ENCLOSURES	22418		5000	17		
037	MAINTENANCE OF ELECTRICAL SWITCHGEAR (V.N.E. 14 kV)			6626			
038	PROTECTION PROVIDED BY ENCLOSURES (CLASS N OF DEG.)			5490		IEC 600529, BS EN 60529	BS 5490 Withdrawn Replaced by BS EN 60529
039	ELECTRICAL EQUIPMENT OF INDUSTRIAL MACHINES			2771		EN 60204, Part 1	BS 2771 Part 1 Replaced by EN 60204-1 (1993) but remains current for use as a reference standard for BS EN 60204-3-1: 1992
040	SWITCHGEAR AND CONTROL GEAR UPTO 1000V			4752		IEC 600157-1, 600157-1A	BS 4752 Withdrawn Replaced by BS EN 60947-2

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
041	PVC INSULATED CABLES FOR SWITCHES AND CONTROL GEAR			6231			
042	BASIC ENVIRONMENTAL TESTING PROCEDURES			2011	1.1	IEC 60068-1	BS 2011 Parts Withdrawn and Replaced by Parts of BS EN 60068
043	DEFINITIONS AND GENERAL REQUIREMENTS					IEC 60051-1	
044	PANEL MOUNTED INSTRUMENTS - DIMENSIONS					IEC 600473	
045	CELLULOSIC PAPERS FOR ELECTRICAL PURPOSES			5626	1, 2, 3	IEC 600554	
046	COMMISSIONIING, OPERATION AND MAINTENANCE OF STORAGE PUMPS					IEC 600805	
047	RUBBER INSULATED CABLES					IEC 600245	
048	VOLTAGE FLUCTUATION LIMITS - GUIDE					IEC 600827	
049	ELECTRIC CABLES - ARMOURING - WIRE FOR					KS 04-290	
050	ROTATING ELECTRICAL MACHINES FOR HARZARDOUS AREAS (“N”)			5000	16		
051	POWER TRANSFORMERS - GENERAL					BS EN 60076-1	
052	ELECTRIC CONDUIT - STEEL			4568	2		
053	BUS BARS			159			
054	NON-METALLIC CONDUITS			4607 (6099)	2		Partially Replaced by BS 6099 Part 1 and BS 6099 Section 2.2
055	PVC CABLES IN CONDUITS			6004			
056	INSULATED FLEXIBLE CORD			6500			
057	M.I.C.C. CABLES			4782	1		
058	FLUSH SWITCHES			3676			
059	ELECTRIC SOCKETS			1363			Part 3: 1989 Replaced by BS 1363 Part 3 (1995) but remains current
060	FUSED SPUR BOXES			1362			
061	CONTACTORS			775			Part 1 (1969) Withdrawn Replaced by BS 5424: Part 1 1977
062	SECURITY LIGHTING INSTALLATION					CP 1004	Renumbered as BS 5498
063	ALUMINIUM SOLID CONDUCTORS			3988			

3.11 MISCELLLANEOUS

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
900	ZINC SPRAY PROTECTION	55928	1-9	2569	1	ISO 2063 BS EN 22063	BS 2569 Withdrawn Replaced by BS EN 22063
900	ZINC SPRAY PROTECTION (CONT.)			5493		BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
901	METALLIC ZINC RICH PRIMER			4652			
902	COLOUR OF FINISH (BUILDING MATERIALS)	See VOB		4800		VOB pt. C	
903	HOT DIP GALVANIZING ON IRON &			729		ISO 1459	
903	HOT DIP GALVANIZING ON IRON & STEEL (CONT.)			5493		ISO 1461 BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
904	BLACK BITUMEN SOLUTION (COLD APP.) FOR WATER TANKS		See DVGW	3416	TYPE II	DVGW-GWS	
905	WELDABLE STRUCTURAL STEELS	1025	1-5	4360		ISO 630	BS 4360 Withdrawn - Replaced by BS 7613, BS 7668, BS EN 10113, BS EN 10155 & BS EN 10210
906	CLASSIFICATION OF GREY CAST IRON			1452		ISO 185	BS 1452 Withdrawn Replaced by BS EN 1561
907	BEARING DESIGN LIFE						
908	BITUMEN - HOT APPLIED - COATINGS FOR IRON AND	30673		4147			
908	BITUMEN - HOT APPLIED - COATINGS FOR IRON AND			5493			
909	PRESSED STEEL RECTANGULAR			1564			
910	GREY IRON CASTINGS FOR MANHOLE COVERS			1452	GRADE 10		
911	MALLEABLE CAST IRON			6681		ISO 5922	BS 6681 Withdrawn - Replaced by BS EN 1562
911	MALLEABLE CAST IRON (CONT.)					ASTM A 47-77	
912	ROLLED STEEL			4360		ISO 630	BS 4360 Withdrawn - Replaced by BS 7613, BS 7668, BS EN 10113, BS EN 10155 & BS EN 10210
912	ROLLED STEEL (CONT.)						
913	STRUCTURAL STEEL SECTIONS	1025	1-5	4	1		BS 4 Part 2 (1969) Withdrawn Replaced by BS 4848 Part 2
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS	267	1, 2	4190		ISO 272, 4759-1, 3	BS 4160 Obsolescent
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS (CONT					ISO 885, 888	
914	ISO METRIC BLACK HEXAGONAL BOLTS, SCREWS AND NUTS (CONT					ISO 898/2, 898/1	
915	SIZES FOR FERROUS & NON- FERROUS BARS			6722			
916	MECHANITE IRON, GRADE E					ASTM A48, No. 308	
917	CORROSION PROTECTION OF STEEL STRUCTURES - GENERAL	55928	1-9	5493		BS EN ISO 12944	BS 5493 Proposed for Obsolescence Partially Replaced by Parts 1-8 of BS EN ISO 12944
918	INGOT ZINC			3436		ISO 752 BS EN 1179 (1996)	BS 3436 Withdrawn Replaced by BS EN 1179 (1996)
919	WELDING OF STEELS (METAL ARC)	8528	1-2	5135	1		BS 5135 Partially Replaced by BS EN 1011-1 (1998)
919	WELDING OF STEELS (METAL ARC) (CONT 1)	8553		499	1		BS 499 Part Obsolescent / Withdrawn
919	WELDING OF STEELS (METAL ARC) (CONT 2)	8558	1				
919	WELDING OF STELLS (METAL ARC) (CONT 3)	50120	1				
920	STEEL PLATE, SHEET AND STRIP			1449	1 (Withdrawn)	ISO 3573	BS 1499 Parts Withdrawn Replaced by BS EN 10111, 10209, BS EN 10149-2 & 3, 10051, 10131, 10139, 10149-2 & 3, 10048, 10140, 10029, 10258 & 10259
920	STEEL PLATE, SHEET AND STRIP (CONT 1)					ISO 3574	
920	STEEL PLATE, SHEET AND STRIP (CONT 2)						
920	STEEL PLATE, SHEET AND STRIP (CONT 3)						
920	STEEL PLATE, SHEET AND STRIP (CONT 4)						
920	STEEL PLATE, SHEET AND STRIP (CONT 5)						
920	STEEL PLATE, SHEET AND STRIP (CONT 6)	1614					
920	STEEL PLATE, SHEET AND STRIP	1632	2				

SRN	SUBJECT	DIN	PART	BSS	PART	OTHER	REMARKS
	(CONT 7)						
920	STEEL PLATE, SHEET AND STRIP (CONT 8)	1624					
921	ELECTROPLATED COATINGS ON THREADS -			3382	1-6		
922	ELECTROPLATED COATINGS ON THREADS -			3382	7	ISO-DIS 4042	
923	ISO METRIC SCREW THREADS			3643	1-2	ISO 68, 261, 724, 965/1, 965/3, 262	
923	ISO METRIC SCREW THREADS					ISO 1106-3, 7438	
924	ISO METRIC PRECISION HEXAGON BOLTS, SCREWS			3692		ISO 887	BS 3692 Obsolescent
925	METAL WASHERS FOR GENERAL ENGINEERING			4320		ASS 2602: 83 2603: 83 - ISO/12 887	
926	STEEL STRUCTURES - PAINTS FOR POLYURETHANE						
927	SHEAR TEST FOR METALS	50141					
928	WELDED STEEL TANKS FOR OIL STORAGE					APS 650	
929	LIFTING APPLIANCES - OVERHEAD TRAVELLING					ISO 7752/5	
930	HIGH STRENGTH FRICTION GRIP			4325			
931	ELECTRODES FOR MANUAL ARC WELDING			639		BS EN 499	BS 639 Withdrawn Replaced by BS EN 499
932	BLACK CUP COUNTERSUNK BOLTS, SCREWS WITH NUTS			4933			BS 4933 Obsolescent
933	METAL LATHING			1369			
934	ROLLED ASPHALT HOT PROCESS FOR ROADS			594			
935	BINDER DIST. FOR ROAD SURFACE DRESSING			1707			
936	BITUMINOUS ROOFING FELT			747		CP 114: 3	CP 114:3 Withdrawn
937	GAS WELDING			2640			
938	METALLIC COATINGS. HOT DIP GALVANISED COATINGS ON FERROUS MATERIALS					BS EN 1460	
939	METHOD FOR SPECIFYING ELECTROPLATED COATINGS OF ZINC AND CADMIUM ON IRON			1706			
940	DIMENSIONS OF GASKETS FOR PIPE FLANGES TO BS 4504			4865	1		Part 1: Non-metallic flat gaskets (including gaskets for flanges to BS 4722)
941	BONDING AGENTS FOR USE WITH GYPSUM PLASTERS AND CEMENT			5270	1		Part 1: Polyvinyl acetate (PVAC) emulsion bonding agents for indoor use with
942	FALSEWORK			5975			
943	TUBULAR POLYETHYLENE FILM FOR USE AS A PROTECTIVE SLEEVING FOR BURIED IRON PIPES			6076			
944	FLEXIBLE JOINTS FOR GREY OR DUCTILE CAST IRON DRAINPIPES AND FITTINGS (BS 437) AND FOR DISCHARGE AND VIENTILATING PIPES AND FITTINGS (BS 416)			6087			
945	HOT ROLLED PRODUCTS OF NON-ALLOY STRUCTURAL STEELS			10025			
946	STAINLESS STEELS			10088	2		Part 2: Technical delivery conditions for sheet/plate and strip for general purposes

4.1 DIN

DIN	SRN	DIN	SRN	DIN	SRN	DIN	SRN	DIN	SRN
105	806	2000	651	2988	204	4279	405	19630	651
106	806	2403	700	2990	204	4279	602	19648	510
267	914	2406	701	2991	204	4281	845	19800	401
278	805	2410	213	2993	204	4325	017	19850	402
459	119	2413	210	2999	203	4325	016	19850	839
483	855	2413	228	2999	823	7572	832	19850	860
488	128	2425	708	3202	502	7865	138	22418	036
488	127	2425	651	3202	505	8061	305	28500	201
488	126	2429	701	3202	501	8061	314	28500	200
488	125	2440	203	3221	509	8061	313	28601	217
1025	905	2440	823	3230	501	8062	300	28602	218
1025	913	2441	203	3352	501	8062	305	28603	219
1045	108	2441	823	3352	502	8063	301	30670	227
1045	107	2442	203	3352	511	8072	825	30671	215
1045	110	2442	823	3354	506	8073	825	30672	221
1045	120	2444	225	3356	504	8074	825	30673	214
1045	111	2448	213	3357	514	8075	825	30673	908
1045	113	2458	213	3441	515	8528	919	30674	220
1045	112	2460	210	3620	847	8553	919	40050	012
1048	116	2460	213	4030	114	855	919	40050	030
1048	117	2460	824	4032	407	8564	600	42021	001
1060	801	2500	207	4032	409	8565	220	42673	010
1084	115	2501	207	4033	655	1045	100	42673	011
1084	121	2505	216	4034	854	16450	301	42961	029
1084	133	2519	207	4035	409	16451	301	46062	008
1101	815	2526	207	4035	408	16922	814	46062	013
1102	815	2559	210	4046	651	16928	302	50019	709
1164	103	2566	207	4060	222	16963	307	50120	600
1164	106	2605	226	4078	811	16970	304	50120	919
1164	105	2615	226	4085	667	18101	817	50141	927
1164	104	2615	216	4124	654	18195	668	50976	903
1187	862	2616	226	4126	145	18196	601	52128	856
1199	849	2616	216	4226	109	18196	650	52129	856
1211	845	2617	216	4226	110	18203	657	52130	856
1212	845	2617	226	4226	108	18301	822	53255	818
1229	846	2632	207	4226	107	18307	650	55928	900
1230	414	2633	207	4226	130	18330	656	55928	917
1249	822	2673	207	4226	111	18540	812	57207	024
1381	833	2693	208	4226	136	19522	829	57660	027
1387	833	2695	208	4226	114	19532	300	57670	020
1614	920	2696	208	4226	113	19532	305	68705	811
1623	920	2697	208	4226	112	19533	825	68706	817
1624	920	2873	221	4226	135	19593	846	68761	813
1626	213	2950	209	4235	132	19594	846	68763	813
1629	213	2980	204	4271	846	19596	846	68764	813
1754	205	2986	203	4279	202	19597	846	68791	131
1986	652	2987	204	4279	303	19630	653	68792	131

4.2 BSS

BSS	SRN	BSS	SRN	BSS	SRN	BSS	SRN	BSS	SRN
4	913	1188	835	2494	308	4466	129	5486	020
12	103	1189	831	2499	137	4483	128	5493	900
12	106	1192	703	2439	122	4504	207	5493	908
12	105	1192	704	2569	900	4514	862	5493	917
21	203	5911	410	2640	937	6811	012	5506	835
21	223	1199	130	2757	023	4550	603	5514	021
21	823	1199	136	2871	206	4568	052	5626	045
5685	014	1200	135	2871	205	4592	850	5642	142
65	414	1203	818	3148	114	4607	054	5669	813
78 (4772)	224	1211 (4772)	200	3284 (6811)	307	4622	200	5685	015
143	824	1212	508	3382	921	4624	401	5728	510
144	872	1212	827	3382	922	4624	858	5834	513
159	053	1217	871	3402	875	4625	408	5856	009
308	705	1243	857	3416	904	4652	901	5886	405
336	512	1244	836	3444	810	4660	309	5911	407
368	859	1247	845	3505	311	4670	938	5911	409
410	146	1254	834	3505	310	4800	902	5911	413
416	829	1256	824	3505	300	4870	670	5911	854
417	830	1363	059	3505	305	4871	671	5927	404
437	844	1369	933	3505	312	4999	030	5930	650
437	842	1377	601	3506	305	4999	033	5977	861
459	817	1387	203	3535	028	4999	034	6004	055
499	919	1362	060	3600	213	4999	031	6072	600
534	210	1387	823	3600	228	4999	010	6073	804
534	212	1438	870	3601	213	4999	029	6100	707
569	860	1449	920	3643	923	4999	025	6100	750
594	934	1521	124	3656	839	5000	011	6180	864
604	150	1521	856	3676	058	5000	022	6231	041
690	807	1553	701	3680	661	5000	036	6263	868
729	903	1554	229	3690	866	5000	035	6282	505
743	803	1564	909	3692	924	5000	050	6297	659
747	936	1579	820	3889	600	5041	517	6316	660
750	509	1707	935	3921	805	5070	706	6346	024
775	061	1722	849	3921	806	5075	149	6367	664
812	107	1740	204	3941	003	5135	919	6398	804
812	112	1740	824	3943	873	5150	502	6431	802
812	113	1881	139	3988	063	5151	503	6464	317
842	005	1881	140	3974	406	5152	504	6500	056
882	108	1881	141	4027	104	5153	505	6510	821
882	109	1881	116	4147	214	5154	511	6626	037
882	110	1881	117	4147	908	5163	501	6722	915
882	111	1924	673	4211	847	5212	879	6746	024
890	801	1968	874	4248	148	5311	004	6925	851
952	822	2011	042	4293	006	5316	016	8007	102
1010	826	2048	001	4320	925	5316	017	8010	316
1010	832	2494	318	4335	702	5328	100	8110	101
1105	815	2521	877	4346	301	5328	115	8110	143
1142	809	2456	828	4395	930	8007	138		
1186	816	2494	222	4449	126	5419	007		

4.3 OTHER STANDARDS

OTHER STANDARDS	SRN	OTHER STANDARDS	SRN
AAS 2602:83, 2603:03	926	ISO 2035, 2044	301
AGMA 5T 510	907	ISO 2045, 2048, 2536	301
ANSI A10 9-1983	663	ISO 2063	900
AP15LS	234	ISO 2505, 3114, 3472, 3473, 3474	315
APS 650	928	ISO 2531	202
AS 2813-85	867	ISO 2531	207
ASTM A 47-77	911	ISO 2548 ICE 198	016
ASTM A 48, No. 308	916	ISO 272, 4759-1, 3	914
AWWA C. 508-82	505	ISO 3046, PARTS 1, 2	021
AWWA C.104A, C602-76	211	ISO 3114, 3606	300
AWWA C.200-75	210	ISO 3127	310
AWWA C.200-75	230	ISO 4042	922
AWWA C.203-78	221	ISO 4179, 6600, DVGW W342	211
AWWA C.205 DVGW-W-342-71	212	ISO 4200	228
AWWA C.214-83	232	ISO 4633	222
AWWA C.602-83	212	ISO 49	209
AWWA C.602-89	413	ISO 7/2	203
CP 1004	062	ISO 7005/2, 3	207
CP 112, 2	666	ISO 7-1/2	223
CP 2004	665	ISO 7186	411
CP 2005	658	ISO 7194	662
CP 301	652	ISO 7268	231
CP 310	651	ISO 752	918
CP 312	302	ISO 7751	412
CP 499	848	ISO 7752/5	929
IEC 60072	011	ISO 8493	205
IEC 60072, 72A	010	ISO 881	402
IEC 600805	046	ISO 885, 888	914
IEC 600827	048	ISO 887	925
IEC 60085	023	ISO 898/2, 898/1	914
IEE W. REGS (15TH EDITION)	018	ISO 965/3, 262	923
ISO 1106-3, 7438	924	ISO DIS 4042	921
ISO 1167	306	KENYA M.O.W. STANDARD SPEC.	804
ISO 128, 2162, 2203, 5455, 5457	705	KS 04-290	049
ISO 13	200	KS 05-459:5	606
ISO 160	401	KS 06-149:2	300
ISO 161/1	300	KS 06-248 1, 2	510
ISO 161-1	825	VDB 2	101
ISO 185	906	VDB PART C	902
ISO 1920, 4012, 4108, 4013	117	VDMA 6280	035
ISO 196 (TESTS)	206		

SECTION 2: ENVIRONMENTAL, SOCIAL, HEALTH AND SAFETY (ESHS) SPECIFICATIONS

Specifications for Environmental, Social, Health and Safety Management (ESHS) of the Works

1. Essential ESHS issues of worksite management

The ESHS topics identified during the Environmental and Social Impact Assessment study of the project, which present a major risk for the worksites management are:

a)	ESHS resources and facilities and ESHS monitoring organization	YES
b)	Project Areas management (base camps, quarries, borrow pits, storage areas)	YES
c)	Health & Safety on worksites	YES
d)	Local recruitment and ESHS trainings of local staff (capacity building), ESHS trainings of subcontractors and local partners (transfer of knowledge)	YES
e)	Relations with stakeholders, information and consultation of local communities and authorities	YES
f)	Traffic management	YES
g)	Hazardous products	YES
h)	Wastewater (effluents)	YES
i)	Protection of water resources	YES
j)	Atmospheric emissions, noise and vibrations	YES
k)	Waste management	YES
l)	Biodiversity: protection of fauna and flora	YES
m)	Site rehabilitation and revegetation	YES
n)	Erosion and sedimentation	YES
o)	Control of infectious and communicable diseases (HIV/AIDS, malaria, etc.)	YES

2. ESHS Requirements not applicable under this Contract

The ESHS norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations shall apply to the Contract: Yes ❑ / No ☑

The following Clauses of the ESHS Specifications shall not apply to this Contract and shall not be priced by the Bidder under the specific ESHS Cost Schedule:

Number of the non-applicable Clause	Description
9.2 and 9.3 - Norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations, as described in ESHS Specifications	Sub-Clause 9.1 remains applicable: The Contractor shall be required to comply with applicable norms, standards, and discharge limit values according to the regulations of the country where the work is performed.
26 – Dangerous substances	*The Project will not require or generate any dangerous substances*

Throughout the present ESHS Specifications (hereinafter called "**the ESHS Specifications**"), a reference to Conditions of Contract, abbreviated by CC, means a reference to both the General Conditions of Contract and the Particular Conditions of Contract. Readers should apply due care, when being referred to a specific Clause or Sub-Clause, to:

- Read first the Clause or Sub-Clause text from the General Conditions of Contract;
- Then check whether this text has been amended by the Particular Conditions of Contract, and if so, to which extent.

As per CC Sub-Clause 1.5 – Priority of Documents, when interpreting the Contract, the terms of the Particular Conditions of Contract prevail over those found in the General Conditions of Contract.

Any term in these ESHS Specifications which is identical to a term in the Conditions of Contract shall have the same meaning as the one defined in the Conditions of Contract.

Any term in capital letters in these ESHS Specifications is defined in CC Sub-Clause 1.1 – Definitions.

Table of Contents

A. Environmental, Social, Health and Safety Management System

1 Responsibilities and Liabilities

1.1 In conjunction with his obligations defined under the Contract, the Contractor will plan, execute and document construction works pursuant to the Environment, Social, Health and Safety (ESHS) Specifications.

1.2 The Contractor is liable for all damages to natural resources caused by the execution of the Works or the methods used for execution, unless it is established that the execution or methods were necessary, according to the provisions of the Contract or an Engineer's instruction.

1.3 Under the Contract and as introduced by the ESHS Specifications, the term "Project Area" means:

a) The land where work will be carried out; or

b) The land necessary for the implantation of construction facilities (work camp, workshops, offices, storage areas, concrete production plants) and including special access roads; or

c) Quarries for aggregates, rock material and riprap; or

d) Borrow areas for sand and other selected material; or

e) Stockpiling areas for backfill material or other demolition rubble; or

f) Any other location, specifically designated in the Contract as a Project Area.

The term "Project Area" encompasses any individual Project Area or all Project Areas.

For the sake of clarity, Project Area is a different concept than Site under CC Sub-Clause 1.1.6.7.

Project Area defines an area within which the Contractor is to comply with environmental, social, health and safety obligations defined in the ESHS Specifications.

Site is the places where the Permanent Works are to be executed and to which Plant and Materials are to be delivered, and where right of access to, and possession of, is to be given by the Employer to the Contractor. The Employer is under no similar obligation for any area located outside the Site, even if within the Project Area, where access is at Contractor's risk.

In term of physical footprint, the CC Sub-Clause 1.1.6.7 Site is included in the Project Area. The Project Area is then of greater geographical extent than the Site.

1.4 The ESHS Specifications refer to the entire area of influence for the Works:

a) Protection of the natural environment (water, air, soil, vegetation, biological diversity) in areas within any Project Area and its surroundings, i.e. including but not limited to access roads, quarries, borrow areas, stockpiling of backfill material, camps or storage areas;

b) Health and safety conditions to be maintained for the Contractor's personnel and any other person present on the Project Areas, or along access routes;

c) Working practices and the protection of people and populations living near the Project Area, but exposed to the general disturbance caused by works.

1.5 Subcontractors:

The ESHS Specifications apply to the Contractor and unless explicitly agreed with the Engineer, all Subcontractors used for the execution of the Works. Pursuant to Sub-Clause 4.4 of the CC, the Contractor is fully liable for all actions, non-compliance and negligence by Subcontractors, their representatives, employees and workers, to the same degree as it would be held liable for its own actions, non-compliance or negligence or that of its own representatives, employees or workers.

1.6 Applicable regulations:

The Contractor must identify all regulations in relation to the protection of the environment (water, air, soils, noise, vegetation, fauna, flora, waste, groundwater) and, pursuant to Clauses 4 and 6 of the CC, the protection of people (labour law, indigenous populations, standards on occupational exposure, other). The Contractor must list all texts, standards and other regulatory limitations in its Worksite Environmental and Social Management Plan (Worksite - ESMP as specified in Sub-Clause 2.1 of the ESHS Specifications) and specify the means taken for compliance.

2 ESHS Planning Document

2.1 Worksite Environmental and Social Management Plan (Worksite - ESMP)

2.1.1 The Contractor prepares and ensures prior validation by the Engineer, implementation and regular update of a Worskite Area Environmental and Social Management Plan (Worksite - ESMP).

2.1.2 The Worksite - ESMP represents the unique reference document in which the Contractor defines in detail all organisational and technical provisions implemented to satisfy the obligations of the ESHS Specifications.

2.1.3 The Contractor defines in the Worksite - ESMP the number, the locations and the type of Project Area as defined in Sub-Clause 1.3 of the ESHS Specifications. For each of the identified Project Area, unless otherwise agreed by the Engineer, the Contractor establishes an Environmental Protection Plan (EPP). The EPP(s) are annexed

to the Worksite - ESMP.

2.1.4 The Worksite - ESMP covers the entire period from the Contract Agreement signature date to the date of issue of the Performance Certificate by the Engineer.

2.1.5 Unless agreed otherwise by the Engineer, the Worksite - ESMP is written in the language of communication defined under Sub-Clause 1.4 of the CC.

2.1.6 The first draft version of the Worksite - ESMP is to be provided by the Contractor to the Engineer within 28 days from the date of execution of the Contract Agreement.

2.1.7 No physical work or activity shall commence on any Project Area until such time the Worksite - ESMP, and the annexed EPP corresponding to the Project Area, are approved by the Engineer.

2.1.8 During the execution of the Works, whenever instructed by the Engineer, the Worksite - ESMP will be updated by the Contractor and reissued to the Engineer. The revised version shall highlight the new elements incorporated in the document.

2.1.9 The Worksite - ESMP (and the EPP) is structured according to the plan specified in Appendix 1 to the ESHS Specifications.

3 Management of non-conformities

3.1 In application of Clause 5, non-conformities detected during inspections carried out by the Contractor or Engineer are subject to a process adapted to the severity of the situation. The non-conformities will be defined as deviations from the requirements of the applicable regulations, the ESHS Specifications, the ESMP, and the Worksite - ESMP. Non-conformities are divided into 4 categories as follows:

3.1.1 Notification of observation of minor non-conformities. The non-conformity results in a notification to the Contractor's Representative, followed-up by a signed notification of observation prepared by the Engineer. The multiplication of notifications of observation at the Project Area, or absence of corrective actions by the Contractor, can result in the severity of the non-conformity being raised to that of level 1.

3.1.2 Level 1 non-conformity: Non-conformities that present a moderate and non-immediate risk for health, environment, social or safety. The non-conformity is identified in writing to the Contractor and shall be resolved within five (5) days. The Contractor addresses to the Engineer the proof explaining how the non-conformity has been corrected. Further to an inspection and a favourable evaluation of effectiveness of the corrective action, the Engineer validates in writing the close-out for the non-conformity. In all cases where a non-conformity of level 1 is not resolved within one (1) month, the severity of the non-conformity is raised to level 2.

3.1.3 Level 2 non-conformities: applies to all non-conformities that represent a moderate and immediate risk or with significant consequences to health and/or the environment, social or safety. The same procedure as for level 1 non-conformities is applied.

Corrective action shall be taken by the Contractor within three (3) days. All level 2 non-conformities which are not resolved within one (1) month, are raised to level 3.

3.1.4 Level 3 non-conformities: applies to all non-conformities that have resulted in damage to health or the environment, or which represent a high risk for health, safety, environmental or social hazards. The highest levels of the Contractor's and Engineer's hierarchies present in the Employer's country are informed immediately and the Contractor has twenty-four (24) hours to bring the situation under control. Pursuant to Clause 14.7 of the CC, a level 3 non-conformity results in the suspension of interim payments until the non-conformity has been resolved. If the situation requires, and in pursuance to Clause 8.8 of the PC, the Engineer can order the suspension of work until the resolution of the non-conformity.

4 Resources allocated to environmental management

4.1 ESHS supervisors and Manager:

4.1.1 Pursuant to Sub-Clause 4.18 of the CC and in addition to the provisions of Sub-Clause 6.7 of the CC, the Contractor appoints one (or two depending on the case) Environment, Social, Health and Safety Manager(s) in charge of implementing the ESHS Specifications. Several experts may be assigned to fulfill this position. The manager(s) will be the Key ESHS Personnel identified in the bidding process, if any.

4.1.2 The ESHS Manager is permanently based at the Project Area for the full duration of the Works as of Contractor's mobilisation until Taking-Over Certificate is issued.

4.1.3 This manager holds the power within the Contractor's organisation to be able to suspend the Works if considered necessary in the event of level 2 or 3 non-conformities, and allocate all resources, personnel and equipment required to take any corrective action considered necessary.

4.1.4 The ESHS Manager speaks fluently the language of communication of the Contract, and the official language of the Employer's country, if the language of communication of the Contract is not the official language. The ESHS Manager will hold a relevant University degree or a significant experience of at least five (5) years in designing and monitoring the implementation of an environmental and social management plan for construction works.

4.1.5 ESHS supervisors are appointed in sufficient numbers and represent the ESHS Manager within work teams. Their role is to ensure that the Works are carried out pursuant to the ESHS Specifications and notify the ESHS Manager of any detected non-conformities.

4.2 Person in charge of relations with external stakeholders:

4.2.1 The Contractor appoints a person responsible for relations with external stakeholders: local communities, administrative authorities, religious and other representatives. If necessary, a team

will be created.

4.2.2 Administrations and local authorities will be informed of the existence of this person as of the start of works and will be provided with contact details so as to be able to contact this person if a problem arises during the execution of works, or concerning the behaviour of the Contractor's Personnel, inside or outside the Project Area.

4.3 The team, including the ESHS supervisors and manager, and the person in charge of relations with external stakeholders, will be allocated the necessary resources to operate independently (travel, office equipment and communication).

5 Inspections

5.1 In addition to the ESHS Manager's own inspections, an ESHS inspection will be carried out on the facilities and Project Area on a weekly basis jointly with the Engineer.

5.2 A written report will be drafted for each weekly inspection, in a format approved by the Engineer, addressing non-conformities detected on the Project Area as specified in the ESHS Specifications.

5.3 Each non-conformity will be documented by a digital photograph with captions to provide a visual illustration, explicitly indicating the location, date of inspection and the non-conformity in question.

6 Reporting

6.1 As part of the Progress Report specified in Sub-Clause 4.21 of the CC, the Contractor submits an ESHS activity report summarising all ESHS initiatives implemented in relation to the execution of the Works during the reporting period to the Engineer on a monthly basis. The activity report is a separate document from the update of the Worksite - ESMP, which is updated at the intervals indicated in Sub-Clause 2.1.8 of the ESHS Specifications.

6.2 The ESHS activity report is written exclusively in the language of communication defined under Sub-Clause 1.4 of the CC.

6.3 Pursuant to Sub-Clause 4.21 of the CC, the ESHS activity report is submitted at the latest 7 working days after the last day of the month in question. The report contains the following information.

6.3.1 List of ESHS personnel present at the Site at the end of the month.

6.3.2 Construction works activities conducted during the month.

6.3.3 Inspections carried out (location and intervals).

6.3.4 Non-conformities detected during the month with descriptions of the root cause analysis and corrective actions taken.

6.3.5 Description of actions conducted and measures taken during the month to remedy non-conformities and to manage environmental, social, health and safety risks and impacts.

6.3.6 Description of stakeholder engagement activities undertaken with neighbouring populations, local authorities, governmental agencies.

6.3.7 Monitoring results for the following indicators:

a) Effluent quality (Sub-Clause 12.5 of the ESHS Specifications), if applicable;

b) Drinking-water quality, if applicable;

c) Hazardous and non-hazardous waste generation;

d) Air and noise emissions, if applicable;

e) Project Area state (Sub-Clause 20 of the ESHS Specifications);

f) Recruitment, number of positions and hours worked by local Contractor's Personnel (Sub-Clause 39.3 of the ESHS Specifications);

g) Health & safety statistics: in pursuance to Clauses 4 and 6 of the CC, number of fatal accidents, lost-time accidents, number of accidents without lost-time, serious illness, frequency of accidents, and serious misconduct by Contractor's Personnel (record sheet attached as an appendix to the activity report, pursuant to Sub-Clause 7.7 of the ESHS Specifications); including root cause analysis and corrective actions taken.

6.3.8 Where appropriate, description of the formal or informal complaints (negative media attention, strikes or labour disputes, protests, complaints from communities, NGO or workers or formal notice from authorities, etc.) related to environmental, social, health and safety risks and impacts of the Works; including root cause analysis and corrective actions taken.

6.3.9 Report on training activities (topic, number and duration of sessions, number of participants).

6.3.10 Provisional environmental, social, health and safety actions for the coming months.

6.4 Notification of ESHS events:

6.4.1 The Engineer is informed within one hour of any accident, (i) involving serious bodily injury to a member of personnel, a visitor or any other third party, caused by the execution of the Works or the behaviour of the personnel of the Contractor, or (ii) any significant damage to private property, or (iii) any significant damage to the environment.

6.4.2 The Engineer is informed as soon as possible of any near-accident relating to the execution of the Works which, in slightly different conditions, could have led to bodily injury to people, or damage to private property or the environment.

7 Rules of Procedure

7.1 Rules of procedure are established by the Contractor for the Project Areas, addressing the following: safety rules, zero tolerance for substance abuse (refer to Clause 37), environmental sensitivity of areas around the Project Areas, the dangers of STDs with HIV/AIDS, gender issues (in particular sexual harassment) and respect for the beliefs and customs of the populations and community relations in general (drawing special attention to the risks of prostitution and human trafficking).

7.2 The rules are clearly displayed at the different Project Areas.

7.3 The rules confirm the Contractor's commitment to implementing the ESHS provisions provided for in the Contract.

7.4 New Contractor's Personnel and existing Contractor's Personnel are made aware and acknowledge their understanding of the rules of procedure and the associated provisions. Rules of procedure document are initialed by all Contractor's Personnel prior to the start of any physical work at any Project Area.

7.5 Pursuant to Clauses 6.9 and 6.11 of the CC, the rules of procedure include a list of acts considered as serious misconduct and which must result in dismissal from any Project Area by the Contractor, or by the Engineer if the Contractor is not acting in due course, should a Contractor's Personnel repeatedly commit an offence of serious misconduct despite awareness of the rules of procedure, and this is without prejudice to any legal action by any public authority for non-compliance with applicable regulations:

a) Drunkenness during working hours;

b) Drug use;

c) Punishable statements or attitudes, and sexual and mental harassment in particular;

d) Violent behaviour;

e) Intentional damage to the assets and interests of others, or the environment;

f) Repeated negligence or imprudence leading to damage or prejudice to the environment, the population or properties, particularly breaching provisions intended to prevent the spreading of STD with HIV/AIDS;

g) Possession and/or consumption of meat or any other part of an endangered animal or plant as defined in the Washington convention (CITES) and national regulations.

7.6 Serious misconduct, such as organization of sex trade (pimping), committing pedophilia, rape, physical aggression, drug trafficking, deliberate and severe pollution, trading and/or trafficking in all or part of protected species, shall lead to immediate dismissal as of the first report of misconduct is detected, in application of the rules of procedure and labour laws.

7.7 The Contractor establishes a record for each case of serious misconduct, and a copy will be provided to the Contractor's Personnel in question, indicating all action taken to terminate the misconduct by the Contractor's Personnel in question and to bring the attention of other Contractor's Personnel to the type of incident detected. This record will be provided to the Engineer as an attachment to the ESHS activity report (see Sub-Clause 6.3 of the ESHS Specifications).

8 ESHS Training

8.1 The Contractor prepares a training and capacity building program for its Contractor's Personnel, as described in the Worksite - ESMP and

documented each month in the ESHS activity report.

8.2 The Contractor also details in the training program the actions and ESHS training for Subcontractors and other members of the joint venture when applicable.

8.3 Training sessions are two-fold: introductory sessions for starting work at the Project Area, and technical training as required in relation to the execution of the Works.

8.3.1 Starting work sessions are organised for each Contractor's Personnel and shall cover as a minimum:

a) Rules of procedure;

b) Safety rules on Project Areas;

c) Protection of areas adjacent to Project Area;

d) Risks relating to sexually transmitted diseases (Sub-Clause 6.7 of the CC), prostitution, human trafficking, and sexual harassment;

e) Basic health: combating malaria (if prevalent) and waterborne diseases, improving hygiene;

f) Emergency response procedures or evacuation.

8.3.2 Technical training:

a) Training in the skills needed for tasks requiring a work permit (Clause 24 of the ESHS Specifications);

b) Training in first aid and transporting the injured in order to achieve the targets defined in Sub-Clause 29.1 of the ESHS Specifications on the number of first aid officers per Project Area and per team;

c) Ability to drive on rough ground.

8.4 The Contractor prepares an awareness program, where applicable, for local communities adapted to the main risks relating to the Works. This program will be included in the training program described in Sub-Clause 8.1 of the ESHS Specifications.

9 Standards

9.1 The Contractor complies with all norms, standards and discharge limit values defined in the national regulations of the Employer’s country regulations and pursuant to Sub-Clause 1.6 of the ESHS Specifications.

9.2 The Contractor comply with norms, standards and discharge limit values recommended by the specialised international organisations affiliated to the United Nations, as described in Sub-Clause 9.3 below of the ESHS Specifications. In the event of discrepancies in between international standards and national regulations, the Contractor shall comply with the most stringent requirements.

9.3 The specialised international organisations affiliated to the United Nations referred to in Sub-Clause 9.2 of the ESHS Specifications include:

- World Bank, including the IFC and its Environmental, Health and Safety guidelines available from http://www.ifc.org/ehsguidelines.

For matters not addressed in the IFC above document, the most stringent of the norms, standards and discharge limit values of the following institutions shall apply:

- World Health Organization (WHO);
- International Labour Organization (ILO) (in particular in pursuance to Sub-Clauses 6.20, 6.21, 6.23 and 6.24 of the CC);
- International Maritime Organization (IMO).

B. Protection of the Environment

10 Protection of adjacent areas

10.1 Pursuant to Sub-Clause 4.18 of the CC, and unless instructed otherwise by the Engineer, the Contractor uses construction methods and means of protection in order to avoid or minimize adverse effects that are incurred on vegetation, soils, groundwater and surface water, biodiversity, natural drainage and the water quality in areas within any Project Area and its surroundings for the entire duration of the Works.

10.2 Wetland areas include marshes, fens, mires or natural or artificial bodies of water, whether permanent or temporary, where water is stagnant or flowing, fresh, saline or briny, including seawater with a low-tide depth of six metres or less. Filling of all or part of a wetland area is not permitted, unless the Works are necessary according to the provisions of the Contract or the instructions of the Engineer.

10.3 With the exception of access roads, or unless instructed otherwise by the Engineer, the entire perimeter of land sites with a surface area of less than 2 hectares is physically demarcated with a fence or tape. For Project Area with a surface area of more than 2 hectares, the perimeter will be physically demarcated by a perimeter track, road, signs or any other means leaving no possible ambiguity as to the location of the Project Area perimeter.

10.4 Unless instructed otherwise by the Engineer, the Contractor defines the perimeter of the Project Area at a distance of at least:

a) 50 m from any permanent water course and outside of floodable areas;

b) 300 m from sensitive urban services and buildings (health centre, school centres, water supply for populations);

c) 200 m from any housing; and

d) 300 m from housing in the specific case of work requiring the use of explosives.

10.5 If the footprint of the Works do not respect the distances mentioned in the situations a) to d) of Sub-Clause 10.4 above of the ESHS Specifications, and unless agreed upon otherwise by the Engineer, the Contractor will contract a bailiff to make a sworn statement regarding the existence and conditions of residential buildings situated around the Site with a distance specified in paragraph b) to d) of Sub-Clause 10.4

of the ESHS Specifications. The bailiff's sworn statement is prepared and provided to the Engineer with the EPP.

11 Selection of borrow areas, backfill material stockpile sites and access road

11.1 The Contractor will submit to the Engineer for prior approval, within the framework of the EPP (provided in Clause 2.1.3), (i) the location of proposed borrow areas or areas to be excavated, (ii) proposed backfill material stockpile locations or zones designated for the rubble from demolition works.

11.2 The access routes to the Project Areas will be shown on a map and approved by the Engineer prior to the start of the corresponding Works.

12 Effluents

12.1 Effluents consist of liquid discharges, including infiltration, from Project Area, transporting a pollutant (dissolved, colloidal or particles).

12.2 A pollutant is a given chemical compound that is at a concentration that is greater than the limit values recognised for that compound according to Clause 9 of the ESHS Specifications.

12.3 If no recognised threshold exists pursuant to Sub-Clause 12.2 of the ESHS Specifications, the Contractor provides proof that the charges are harmless.

12.4 No effluent is discharged by the Contractor into water courses, soils, lakes or the marine environment without prior treatment and without monitoring of the treatment's performance to guarantee the absence of pollution.

12.5 The Contractor carries out or contracts the monitoring of the effluent quality pursuant to Sub-Clause 12.4 of the ESHS Specifications. In the first case, the Contractor provides the ESHS Manager with the means and skills to carry out in-situ monitoring and laboratory analysis of the performance indicators. In the second case, the Contractor establishes a contract with a specialised contractor, accredited with the Employer's country authorities for this activity.

12.6 The physical and chemical parameters of the effluent that are monitored are those that are listed in the applicable regulations according to the provisions of Clause 9 of the ESHS Specifications. The parameters have prior approval from the Engineer.

12.7 The Contractor will list, locate, and characterise (flow, expected quality, discharge frequency) all sources of effluents and outlets in the natural environment in the Environment Protection Plan(s).

12.8 The Contractor will submit to the Engineer an effluent monitoring report on a monthly basis, including documentation for the following for each effluent discharge point: (i) average flow rates of discharged effluents, (ii) discharge frequencies and durations over the month, and (iii) the physical and chemical quality of the effluent discharged, for the conformity parameters listed in Sub-Clause 12.1 above of the ESHS Specifications.

12.9 The special case of rainwater run-off:

12.9.1 Run off consists of the rainwater flow on the surface or the soil and other technical surfaces at Project Areas.

12.9.2 In the context of the Contract, run-off is considered as an effluent and will be treated in accordance with Sub-Clause 12.4 above, unless demonstrated otherwise, as documented and substantiated by the Contractor, and approved by the Engineer.

12.9.3 Particular attention will be given to all platforms with installed generators, hydrocarbon storage tanks, refuelling stations and concrete plants (cover, containment, settling, pH neutralization).

13 Atmospheric emissions and dust

13.1 Emissions refer to any discharge into the air of solid substances, aerosols, gases, radiation, or energy, whether point sources (e.g. incineration stack) or diffuse (e.g. fugitive dust emissions from road use by trucks).

13.2 The Contractor will use equipment and adopt construction and transport methods with atmospheric emissions which are not in excess of the threshold emission values recommended in the applicable regulations according to the provisions of Clause 9 of the ESHS Specifications.

13.3 The fleet of vehicles or equipment emitting combustion gases will be maintained at the intervals and according to the methods specified by the manufacturer.

13.4 The Contractor will document the maintenance records for its fleet of vehicles, machinery and equipment. The records will be in the language of communication defined under CC Sub-Clause 1.4, or any other language approved by the Engineer, and will be at the disposal of the Engineer.

13.5 On unpaved roads used by the vehicles and machinery of the Contractor:

13.5.1 The Contractor takes action to abate fugitive dust emissions generated by vehicles or mobile equipment in residential areas and on roads within the Project Area perimeter.

13.5.2 The Contractor will implement the necessary measures, as described in the Worksite - ESMP, to avoid or limit dust generation: dust removal, regular watering, reduction of Contractor's vehicles speed as specified in Sub-Clause 44.9 of the ESHS Specifications.

13.6 When storage, handling and transportation of bulk materials is made in the open air and exposed to the wind, the Contractor implements the necessary dust abatement measures, including one or several of the following techniques: vegetation of the surface, covering of the surface, humidification of the surface, covering the trucks, etc.

14 Noise & vibration

14.1 The Contractor uses equipment and adopts construction and transport methods so not to generate noise levels in excess of values recommended in the applicable regulations according to the provisions of Clause 9 of the ESHS Specifications.

14.2 Except as otherwise provided in the Contract or unless waived by the Engineer, high noise generating works (e.g. pile driving, blasting, rock clearing, drilling, percussion drilling) which may impact occupied receptor areas are carried out during normal working days, but

prohibited at night. A receptor area is defined as an area used for nocturnal socioeconomic activities (e.g. accommodation camps, residential areas, hotels, health centres).

14.3 The use of heavy vehicles at night is specified in Sub-Clause 44.9 of the ESHS Specifications.

15 Waste

15.1 The Contractor is responsible for identifying, collecting, transporting and treating all waste produced on the Project Areas by its personnel, Subcontractors and visitors.

15.2 Waste management should be based on the following hierarchy: prevention of waste generations, reuse, recycling and disposal. The Contractor selects suppliers having a voluntary and documented policy to reduce the volume and weight of packaging, and to select recyclable or biodegradable packaging.

15.3 The Contractor establishes and maintains a waste register which is at the disposal of the Engineer. This register will record all waste management operations: production, collection, transport, treatment. The following aspects are documented in this register:

a) Type of waste, using the nomenclature specified in Sub-Clause 15.7 of the ESHS Specifications;

b) Waste quantities;

c) Name and address of the third party waste management facilities receiving waste or parties taking possession of the substances no longer considered as waste;

d) Name and address of waste transport contractors;

e) Planned waste treatment.

15.4 The Contractor files and maintains at the disposition of the Engineer the waste manifests for the collection, transport, treatment and/or elimination of waste.

15.5 The waste register is established and available as of the Contractors mobilisation to any Project Area. This register will be archived for at least 1 year after the Taking-Over Certificate for the Works is issued.

15.6 The Contractor implements specific waste management practices adapted to the level of danger for human health or the natural environment. Three waste categories are identified for Project Areas and in tracking documents:

a) Hazardous waste: any waste with one or several dangerous properties as listed in Appendix 2 to the ESHS Specifications;

b) Non-hazardous waste: any waste with no properties rendering it hazardous. Non-hazardous waste contaminated by hazardous material will be considered as hazardous waste, unless instructed otherwise by the Engineer;

c) Inert waste: any waste unaffected by any significant physical, chemical or biological modifications, which does not decompose, burn or produce any physical or chemical reaction, is not

biodegradable and does not damage any substance with which it comes into contact in a manner likely to cause damage to the environment or human health.

15.7 The Contractor assesses, document and effectively implements any local recycling or re-use options for its waste.

15.8 Waste is categorised and stored separately prior to removal from the Project Areas, depending on the level of danger, phase (liquid, solid or gas), the waste management solution to be applied and its potential in terms of recycling or reuse.

15.9 Waste is collected from each Project Area at the same rate that it is produced and is placed in temporary locations meeting the following criteria:

a) Located at a distance of over 100 m from any natural sensitive area and over 500 m from any socioeconomic sensitive area (school, market, healthcare centre, water well or catchment area), with the exception of waste storage area in camps;

b) Protected from moving machinery and vehicles, but easy to access for regular collection;

c) Located on a flat impervious surface to prevent infiltrations;

d) Under cover for non-inert waste;

e) Stored in containers of the appropriate size, tightness and level of resistance depending on the danger and phase (solid, liquid, gas) of the waste;

f) Liquid wastes storage is equipped with secondary retention with a volume at least equal to the greater of the following two values (i) 100% of the capacity of the largest reservoir and (ii) 50% of the overall capacity of the associated reservoirs;

g) Hazardous waste stored pursuant to Sub-Clause 26.8 of the ESHS Specifications.

15.10 Waste is removed from Project Areas and transported to recycling, treatment and waste management facilities on a regular basis. The frequency of removal, approved by the Engineer, guarantees:

a) No overflow from containers;

b) No unpleasant odour or emissions which are dangerous for human health;

c) No proliferation of insects, rodents, dogs or other animals which are harmful or dangerous for human health;

d) Regular cleaning of containers and surfaces on which they are located.

15.11 Unless otherwise specified in the Contract or instructed by the Engineer, waste incineration is prohibited on Project Areas. Two exceptions are medical waste and green waste, which unless instructed to the contrary by the Engineer, are managed pursuant to

Clauses 15.15.1 and 16.1.3 of the ESHS Specifications.

The use of third party waste management services is subject to a documented prior audit of the treatment, storage and recycling facilities by the Contractor, to guarantee the conformity with the provisions of the ESHS Specifications on waste.

15.12 Pursuant to Sub-Clause 1.5 of the ESHS Specifications, the provisions applicable to the Contractor regarding waste management also apply to any third party waste management Subcontractor. The Engineer reserves its right to inspect third party waste management facilities and prohibit the Contractor from using the facilities if considered unacceptable.

15.13 The management of non-hazardous waste complies with the following conditions:

15.13.1 Inert waste is removed or treated on-site and can be disposed in a permanent or temporary landfill with unused backfill material. The location, capacity and environmental protection measures, particularly for water courses, implemented by the Contractor or any Subcontractor, will comply with the provisions of the ESHS Specifications, and will be described in the EPP and validated by the Engineer.

15.13.2 Non-hazardous waste that cannot be recycled is disposed of to landfill, complying with the following criteria:

a) Walls and base sealed by a geo-membrane or a layer of compacted clay with a permeability 10^{-7} cm/s;

b) Drained for the recovery of leachates, which are routed to a lagoon aerobic/anaerobic treatment prior to discharge into the natural environment or collected in a temporary storage prior to regular collection and transfer to a treatment unit (septic tank or wastewater treatment plant);

c) Regularly compacted and covered by earth to limit odours and the proliferation of insects;

d) When the landfill has reached full capacity, vents are installed to evacuate gases, and the landfill covered by a geo-membrane with a minimum thickness of 1 mm, or a layer of compacted clay, and a top layer of 1.5 m of topsoil, which is revegetated.

Any other proposal must first be validated by the Engineer.

15.14 The Contractor's hazardous waste is managed by a specialised waste Subcontractor, accredited in the Employer's country for this activity.

15.15 In the absence of an existing waste management solution for hazardous waste satisfying the provisions of Sub-Clause 15.14 of the ESHS Specifications, the Contractor takes the following action:

15.15.1 Medical waste is incinerated in a specific facility constructed and accredited for this purpose. The Contractor will submit the technical specifications of the facility to the Engineer before

importing or procuring the equipment.

15.15.2 Hydrocarbons, lubricants, paints, solvents and batteries are transported in drums to the capital city, or any other city where suitable waste management facilities are available. Sludge from settling tanks/ponds, septic tanks or oily water skimmers will also be managed in the same way.

15.15.3 Contaminated soils from construction/demolition and drilling muds will be treated, stabilised and disposed of to landfill. Prior approval is required from the Engineer regarding the method and site location. The Contractor obtains authorisation from the competent local authorities prior to any disposal to landfill.

15.15.4 Prior approval from the Engineer is required before implementing waste management solutions on any other hazardous waste.

15.15.5 Prior to the issue of the Taking-Over Certificate for the Works, the Contractor provides documentation on hazardous waste landfilled at other sites than accredited third party waste management facilities. The documentation includes a plan showing the location of landfill sites. The document is provided to the competent local authorities whose jurisdiction covers the landfill sites.

16 Vegetation clearing

16.1 The Contractor describes in the Worskite - ESMP the planned methods and schedule for vegetation clearing. Specific agreement from the Engineer is obtained prior to any clearing works.

16.1.1 Vegetation clearing using chemicals is not permitted.

16.1.2 Vegetation clearing using bulldozer is not permitted in zones less than 30 m from areas designated as sensitive by the Engineer, where only manual clearing is authorised.

16.1.3 Unless otherwise specified in the Contract or if otherwise instructed by the Engineer, burning vegetation is not permitted. Green waste can be burnt with prior approval from the Engineer regarding the location, method and schedule.

16.2 Areas cleared prior to undertaking earthworks are shown on a plan with a minimum scale of 1/10,000. Plans are submitted to the Engineer for validation prior to starting clearing works.

16.3 The Contractor undertakes physical demarcation of zones to be cleared using a method approved by the Engineer.

16.4 Trees not to be cut down are identified in relation with the Engineer. Such trees are marked with paint and protected against clearing machinery using a method approved by the Engineer.

16.5 Clearing is undertaken without damage to adjacent non-cleared areas. Topsoil is stored within the cleared areas at the edge of the cleared zone. Clearing is undertaken working from the edge of the zone inwards.

16.6 Wood with economic value:

16.6.1 During clearing, the Contractor stockpiles separately: (i) tree trunks with a diameter at chest height greater than the size defined by the

Engineer, and (ii) trunks with a smaller diameter, branches, leaves, stumps and roots.

16.6.2 Unless instructed otherwise by the Engineer when validating the plans of Sub-Clause 16.2 of the ESHS Specifications or unless specified otherwise in the Employer's country regulations, the trunks of trees exceeding the diameter defined by the Engineer are made available to the local communities, according to the methods defined with the Engineer.

17 Biodiversity

17.1 The Contractor shall ensure that all personnel are informed and aware of the importance to protect fauna and flora. Information and awareness training is documented.

17.2 The Contractor shall ensure that all personnel are informed and aware of wildlife encounters procedures. Information and awareness training is documented.

17.3 The Contractor shall define in the Worksite – ESMP the method with regards to fauna and flora management prior to clearing activities. This method must notably address the work schedule, which sometimes can be adjusted to limit impacts on fauna and flora.

17.4 Where possible, areas shall be cleared from one side to another, or from the inside out, to prevent animals becoming trapped.

17.5 The Contractor personnel shall not approach, injure, hunt, capture, possess, feed, transport, rear or trade wild animals and/or collect eggs while working on the Project Areas.

17.6 The Contractor personnel shall not collect flora species while working on the Project Areas.

17.7 The Contractor shall report any sighting or finding of wounded or dead wildlife to the Engineer immediately.

17.8 The Contractor shall protect excavations to prevent injury to animals.

17.9 The Contractor shall release any trapped uninjured animals immediately.

17.10 The Contractor shall not disturb natural habitats outside the Project Areas.

17.11 The Contractor shall only use designated roads or paths and abide by speed limits.

17.12 The Contractor shall not start forest fires.

17.13 The Contractor shall not introduce Invasive Alien Species (IAS).

17.13.1 All construction machinery imported from overseas shall be inspected to detect IAS and washed before dispatching to the Project Areas.

17.13.2 If the presence of topsoil contaminated with IAS is detected, that topsoil shall only be stored or re-spread in the area from where it was removed.

17.13.3 When earthworks are carried out in IAS contaminated areas,

vehicles shall be washed before moving them to other areas.

17.13.4 Where necessary, the Contractor shall develop IAS control procedures (e.g. physical removal, slashing, mulching, herbicides, etc.). Methods used to control or prevent such species shall not cause adverse impacts on the environment or communities.

17.13.5 To limit the risk of introducing marine invasive species, the Contractor shall control the ballast water and anti-fouling systems of vessels arriving from other bioregions in accordance with International Maritime Organization (IMO) conventions and guidelines.

18 Erosion and sediment transport

18.1 The Contractor plans earthworks and optimises the management of space to ensure that all cleared surfaces and areas exposed to soil erosion are minimised on all Project Areas.

18.2 Topsoil:

18.2.1 Unless indicated otherwise by the Engineer, the top 25 centimetres of the soil will be considered as topsoil.

18.2.2 Earthworks for the temporary occupation of the Project Area are preceded by the clearing of topsoil and the storage of this soil separately from the underlying sterile soil.

18.2.3 Topsoil is stored according to the provisions approved by the Engineer to enable reuse during Project Area rehabilitation.

18.2.4 The refurbishment must be done in accordance with the provisions of Clause 19.

18.3 Draining and treatment of rainwater run-off:

18.3.1 The gradient of Project Areas allows the collection and drainage of rainwater from the entire surface area to one or several discharge points. No pools of water are created.

18.3.2 Suspended solids in rainwater are removed using sediment traps / settling ponds. Rainwater from vehicle parking areas, machinery areas, workshops is subject to treatment with oily water separators.

18.3.3 Rainwater treatment units are sized, cleaned, maintained and accessible to ensure compliance with the effluent quality criteria defined in Sub-Clause 12.9 of the ESHS Specifications and to allow monitoring of performance.

18.4 Sediment control:

18.4.1 The Contractor installs sediment control barriers to slow the flow of water and control sediment transport at Project Areas with (i) a gradient of more than 20%, and (ii) where land is disturbed by the Works or where stockpiled mineral material are susceptible to erosion.

18.4.2 Sediment control barriers are installed on the slope or at the base of the slope to protect the natural drainage system from sediment accumulation at levels higher than the natural situation. These

barriers comply with the following principles:

a) Made with geotextiles or straw bales or any other means pre-approved by the Engineer;

b) Deployed before the start of works and removal of topsoil. Barriers can be used for the physical demarcation of working areas;

c) Installed, cleaned, maintained and replaced according to manufacturer recommendations;

d) Drainage surface area does not exceed 1,000 m² per 30 m of barrier. The length of the slope behind the barrier is less than 30 m, and is not used for flows in excess of 30 l/s.

18.4.3 For the dredging of marine sediments, unless specified otherwise in the Contract, or instructed otherwise by the Engineer, and particularly if the working area is exposed to currents, the Contractor will install a geotextile silt curtain, or any other technique approved by the Engineer to control turbidity clouds.

18.5 Backfilling and stockpiling of backfill materials:

18.5.1 In the EPP of these temporary and permanent stockpiles, the Contractor defines the proposed arrangements (height, slope, drainage, revegetation, etc.) to guarantee stability and erosion resistance.

18.5.2 For permanent backfill material stockpiles, the stockpile is shaped and compacted to ensure long-term stability.

18.5.3 Temporary stockpiles likely to result in strong erosion (duration of storage, rainy season, presence of downstream issues, etc.) are protected against runoff erosion by (i) revegetation using fast growing grass species, either by direct seeding or by hydro-seeding, or (ii) using other natural anti-erosion cover with prior approval from the Engineer.

19 Site rehabilitation

19.1 Unless instructed otherwise by the Engineer, the Contractor will rehabilitate all Project Areas disturbed by the Works, prior to the provisional acceptance of the Works.

19.2 All buildings and free standing and underground structures (e.g. piping, underground tanks, sumps and basins) are removed pursuant to the provisions of Sub-Clause 4.23 of the CC. All waste and rubble is removed in accordance to the provisions of Clause 15 of the ESHS Specifications. After removal of buildings structures and rubble, the Contractor returns Project Areas to their original condition, according to the following provisions.

19.2.1 Land is adjusted to ensure that run-off water drains without eroding soil or stagnating in pools. Unless instructed otherwise by the Engineer, the gradients of restored sites (excluding backfill as defined in Sub-Clause 18.5 of the ESHS Specifications) must be as for the adjacent undisturbed land.

19.2.2 Rehabilitated Project Areas do not represent hazards for people.

Areas near steep drops at quarries are indicated with permanent concrete signs. Holes are refilled. Sharp or unstable items are rendered inoffensive.

19.2.3 Unless specified otherwise in the Contract, or instructed otherwise by the Engineer, the Contractor undertakes revegetation of all Project Areas disturbed by the Works and bears the cost of such work.

19.2.4 Topsoil set aside during initial earthworks pursuant to Sub-Clause 18.2 of the ESHS Specifications, is evenly spread over cleared areas. The surface of compacted soils on Project Areas is loosened by scouring (using rakes or other acceptable methods).

19.2.5 The Contractor describes in the Worskite - ESMP the planned revegetation works to ensure sustainable Project Area rehabilitation: methods, plant species to be used and their origins, activity schedule based on a progressive taking over of Project Areas.

19.2.6 Prior approval by the Engineer is required regarding the origin of seeds and plants proposed by the Contractor. The species used for revegetation must be suitable for the local environmental conditions, and selected according to the rehabilitation program: stabilisation of backfill, landscaping, drainage, prevention of erosion, etc.

19.2.7 Revegetation is undertaken throughout the duration of construction Works, and is not limited to the rehabilitation of Project Areas at completion of the Works.

20 Documentation on the Project Area condition

20.1 The Constructor documents changes in condition of all Project Areas from the start of Works until the Performance Certificate is issued. Documentation comprises dated and geo-referenced colour photographs taken from a constant angle and viewpoint.

20.2 The Project Area condition is documented as a minimum for the following stages:

a) Before any Project Area disturbance at the start of works;

b) On completion of Works, but prior to starting rehabilitation;

c) On completion of rehabilitation and revegetation, if necessary, but prior to the Taking-Over Certificate issuing;

d) After the end of the Defects Notification Period and prior to the Performance Certificate issuing.

20.3 The Contractor specifies in the Worskite – ESMP: (i) the list of viewpoints to be used, (ii) areas to be photographed, and (iii) methods used for taking and archiving photographs.

20.4 Adjacent areas (100 m from the perimeter of the Project Area) are included in photographic documentation.

20.5 Unless instructed otherwise by the Engineer, structures to be buried are photographed weekly until covered. As a minimum the structures are photographed twice for Works with duration of less than 7 days, and at

least once a week for Works with a longer duration.

20.6 Photographs subject to the present Clause 20 are archived in digital format and provided to the Engineer on a monthly basis under the CC Sub-Clause 4.21 monthly progress report.

20.7 The nomenclature of electronic files for photographs explicitly indicates the Project Area, date and structure documented.

C. Health & Safety

21 Health and Safety Plan

21.1 In application of Clauses 4 and 6 of the CC, the Contractor describes in the Health and Safety Plan section of the Worskite - ESMP its organisation for managing health and safety (section 7 of Worksite – ESMP as described in Appendix 1 to the ESHS Specifications), pursuant to its Health and Safety Management System (HSMS).

21.2 Pursuant to Clause 6 of the CC, the plan identifies and specifies:

a) All health and safety risks relating to the execution of the Works, by also identifying gender-specific risks;

b) Prevention and protection measures to control risks related to the execution of the Works, by differentiating, where necessary, measures concerning the protection of women and men;

c) Human and material resources involved;

d) Works requiring work permits; and

e) Emergency plans to be implemented in the case of an accident.

21.3 In addition, this Health and Safety Plan describes how workers are trained in health and safety aspects.

21.4 The Contractor implements prevention, protection and monitoring measures, as described in the Health and Safety Plan.

22 Daily and weekly meetings

22.1 The Contractor organises as a minimum one health and safety meeting per Project Area per week (or at another frequency approved by the Engineer) with all the personnel assigned to the Project Area. This applies only to Project Areas where work is ongoing. At the meeting accidents and incidents that occurred in the previous week are discussed and feedback provided. Means of improvements are identified, documented and assessed to establish corrective actions. The Engineer is invited to participate at all health and safety meetings. Meeting reports are provided to the Engineer.

22.2 The Contractor organises daily (or at another frequency approved by the Engineer) health and safety meetings per team at all Project Areas, prior to the start of the daily work. The meeting establishes the health and safety risks associated with the day's tasks and activities, and means of prevention and protection to be implemented. Minutes of the meetings shall be recorded.

23 Equipment and operating standards

23.1 The facilities and equipment used by the Contractor are installed, maintained, revised, inspected and tested pursuant to the manufacturer's recommendations. The recommendations are available in the language of communication defined under CC Sub-Clause 1.4 (or any other

language approved by the Engineer).

23.2 The Contractor lists and describes in the Health and Safety Plan the national and international standards, guidelines and industry codes of practice, applied during the execution of works.

24 Work permit

24.1 Unless otherwise provided in the Contract, or unless otherwise instructed by the Engineer, work requiring work permits are defined in the Health and Safety Plan. Work permits will be documented and saved.

24.2 The Contractor puts in place a work permit procedure to manage risks through the implementation of prevention and protection measures prior to the starting of work. This procedure is subject to validation by the Engineer.

25 Personal protective equipment

25.1 The Contractor ensures that all personnel, visitors or third parties entering a Project Area are equipped with Personal Protection Equipment (PPE) pursuant to the practices and standards specified in Clause 9.

25.2 The Contractor describes in the Health and Safety Plan the PPE to be used per Project Area and per activity.

25.3 Personnel and visitors to Project Areas are equipped with a safety helmet, safety shoes and a reflective jacket as a minimum.

25.4 Adequate quantities of PPE are available on the Project Areas. Storage conditions must be compatible with usage pursuant to the provisions of Sub-Clause 23.1 of the ESHS Specifications.

25.5 Contractor personnel are trained in how to use and care for PPE and the Engineer must be able to obtain the training reports.

26 Dangerous substances

26.1 A substance is considered dangerous if one or several of its properties render it dangerous, as defined in Appendix 2 to the ESHS Specifications. The Contractor identifies and manages dangerous substances planned for use on the Project Area in the manner described in the present Clause 26.

26.2 Details of risks and related prevention and protection measures are included in the Health and Safety Plan.

26.3 The assessment of the impact of the toxicity of dangerous substances on the reproductive functions of women and men must be taken into account.

26.4 The transport to the Project Area and use of dangerous substances requires prior authorisation from the Engineer.

26.5 The Contractor obtains all necessary authorisations and/or licenses for the storage and use of dangerous substances from local authorities. A copy of the authorisations is provided to the Engineer.

26.6 For each dangerous substance used, the Contractor will implement the recommendations described (i) in the Material Safety Data Sheets (MSDS), and (ii) by the Globally Harmonized System of Classification and Labelling of Chemicals established by the United Nations for

hazardous chemicals.

26.7 Copies of MSDSs are kept on the Project Area, and made available to personnel. The Contractor's staff is aware of the health and safety risks related to hazardous materials. The Contractor provides the Engineer with copies of all MSDSs and training reports.

26.8 Storage of dangerous substances

26.8.1 Storage area are designed and equipped by the Contractor based on the chemical and physical properties of the substances, on the types of containers stored, the number of people requiring access, the ventilation requirements, the quantities of the substance used and potential chemical reaction with other substances (see Sub-Clause 26.8.5 of the ESHS Specifications).

26.8.2 Pursuant to Sub-Clause 15.6 of the ESHS Specifications, the Contractor anticipates and plans for the storage and management of hazardous waste.

26.8.3 Storage areas for dangerous substances are subject to strict rules, which are regularly checked by the ESHS Manager appointed pursuant to Sub-Clause 4.1.4 of the ESHS Specifications. The rules include the following as a minimum:

a) Access to the storage area is limited to trained and authorised individuals;

b) An inventory is maintained up-to-date;

c) MSDSs must be available for all stored dangerous substances, and the substances must be clearly labelled;

d) A strict and methodical storage system is implemented (storage plan posted, large or heavy packaging may not be stored at heights, equipment and tools may not be stored in the dangerous substance storage room);

e) Compliance with product expiry dates and implementation of a disposal procedure for substances which are not needed or which have expired;

f) Entrances, exits and access to emergency equipment are kept clear at all times.

26.8.4 Storage areas are clearly identified with warning signs at the entrance. The Contractor displays the storage plan (location of the different products, maximum inventory), a summary of labelling system and information on chemical incompatibilities.

26.8.5 Chemicals which could react together (leading to explosions, fire, projections or the emission of dangerous gases) are physically separated.

26.8.6 Products that react violently with water are stored so as to prevent contact with water, even in the event of flooding.

26.8.7 Inflammable products are stored separately in a dedicated area with adequate ventilation at all times.

26.8.8 Buildings used to store large quantities of dangerous substances are isolated from other buildings to avoid the spreading of fire. Such buildings are constructed using solid and non-combustible building materials, and are equipped with evacuation systems and the appropriate firefighting equipment. Access to the buildings is clear, allowing for rapid evacuation in the event of an accident. The electrical systems are reduced to the essential minimum, and access points are equipped with adequate lighting (300 lux).

26.8.9 All storage areas are equipped with secondary retentions. Each storage area acts as a general secondary retention. Suitable absorbents (neutralising and non-combustible) are available in the storage area to clean up any spills and leaks.

26.8.10 The Contractor maintains the storage area at a suitable temperature for storing dangerous substances at an appropriate level to avoid any deterioration of the containers.

27 Planning for emergency situation

27.1 The emergency plan required in application of Sub-Clause 21.2 of the ESHS Specifications covers the following emergency situations as a minimum:

a) Fire or explosion;

b) Structural failure;

c) Loss of the containment of dangerous substances;

d) Safety incident or malicious act;

e) Natural disasters.

27.2 The Contractor details the emergency plan in the Health and Safety Plan.

27.3 The Contractor ensures that all personnel are informed and aware of how to react in an emergency situation, and responsibilities are defined. Information and awareness training are documented, and available on all Project Areas.

27.4 The Contractor organises and documents emergency simulation exercises within 3 months of the physical start of the Works, and subsequently once every 12 months up to the issue of the Taking-Over Certificate. The Engineer is invited to participate in each of these exercises.

27.5 Fire extinguishers are made available in each building at clearly identified locations.

28 Medical check-ups

28.1 The Contractor organises medical check-ups for all Contractor's Personnel prior to the initial mobilisation to the Project Area to check aptitude for the work. Medical check-ups are adapted to the anticipated occupied positions and carried out pursuant to the recommendations of the International Labour Organization. Subsequent to the check-up, a written medical certificate is issued declaring the aptitude of the worker for the allocated tasks.

28.2 Hearing tests are conducted for the Contractor's personnel exposed to specific risks (such as noise levels above 80 dB(A), exposure to

hazardous materials, etc.) in order to establish an initial state of health. Annual tests are carried out to monitor any changes and detect any deterioration.

28.3 The Engineer can request additional medical examinations for the Contractor's Personnel if considered necessary, and all associated costs shall be borne by the Contractor.

28.4 A medical examination is carried out on any Contractor's Personnel returning to work after leave caused by a work related accident. A written medical certificate is issued confirming the Contractor's Personnel's aptitude to return to work at the designated workstation.

28.5 The Contractor can produce a copy of its Contractor's Personnel's work aptitude certificates at the request of the Engineer or any competent authority.

28.6 Specific arrangements for tasks' assignments or workstations shall be made for pregnant Personnel.

29 First aid

29.1 The Contractor ensures that at least one first aid officer is present at all times during working hours per Project Area and per team of 10 to 50 workers present, and one extra first aid officer for each additional 100 workers.

29.2 The Project Area must be equipped with a communication system available immediately and primarily for the purposes of communication with the first aid services. Information on how to communicate with the first aid services is clearly indicated near the communications equipment.

30 Health care centre & medical personnel

30.1 For Project Areas with more than 35 workers present at any one time and where it is not possible to reach a hospital, medical clinic or the Contractor's health centre within a period of 45 minutes, by land and in normal conditions:

30.1.1 The Contractor sets up a health care centre at its own cost. This centre is:

a) Operational and easy to access all times;

b) Kept clean and in good condition;

c) Equipped with appropriate heating or air-conditioning;

d) Equipped with sanitary facilities and drinking water;

e) Equipped with instruments, equipment, medicines and material required to examine and treat injured or sick workers in emergency conditions;

f) Equipped with the supplies and furnishing required to allow medical personnel to provide first aid and fulfil their other functions.

30.1.2 A doctor is present on-site at all times, working full-time during normal day hours. The doctor is on-call when more than 20 workers are working simultaneously outside of normal day hours.

30.1.3 The doctor has the following profile:

a) At least 5 years' experience on large-scale construction works at sites located at a distance from a hospital;

b) Trained in infectious diseases, waterborne and epidemiological diseases prevalent in the Employer's country;

c) Able to lead training sessions on occupational health and first aid;

d) Trained in management and logistics for a remote health care centre;

e) Able to speak the same working language used by most members of personnel fluently (communication in emergency situations);

f) In good physical condition, able to access remote working areas.

30.1.4 The Contractor allocates a road or air vehicle for first aid purposes to the first aid station pursuant to standard NF EN 1789/2007.

30.1.5 The Contractor ensures the presence of at least one nurse to assist the doctor per team with 200 - 800 workers allocated, and one extra nurse for each additional 600 workers allocated to this team. Over and above 500 workers per team, the Contractor ensures the presence of an extra doctor for each additional 500 workers allocated to this team.

31 First aid kits

31.1 Each Project Area must be equipped with an adequate number of first aid kits to ensure that all workers can access these kits in approximately 5 minutes. Kits must be available at all times.

31.2 Each vehicle is equipped with a first aid kit.

31.3 First aid equipment complies with attached specifications.

32 Emergency medical evacuations

32.1 The Contractor establishes, and provides the Engineer within one month of the physical start of works a copy of an agreement with a specialised company for the handling of personnel in the event of a serious accident requiring an emergency medical evacuation, which cannot be organised using the first aid vehicle specified in Sub-Clause 30.1.4 of the ESHS Specifications without endangering the life of the patient.

32.2 The agreement includes a convention with a referring hospital where the member of personnel evacuated in emergency conditions will be treated.

32.3 The agreement covers the use of air transportation in order to evacuate the injured patient(s) to the referring hospital.

33 Access to health care

33.1 The Contractor guarantees access to health care as defined in Clause 30 for all personnel in necessary cases of accident or illness occurring during the execution of the Works, i.e.:

a) Medical check-ups: initial (recruitment), annual and upon returning to work after sick leave;

b) Screening, vaccinations and preventive healthcare;

c) General healthcare during the execution of the Works;

d) Medical assistance in the event of an accident and assistance for emergency evacuations.

33.2 Subcontractor's personnel, other contractors, the Employer or the Engineer, present at the Project Area, must never be refused medical assistance, under the pretext that they are not directly employed by the Contractor. The Contractor may however define a unit rate cost per medical act for personnel, other than its own Contractor's Personnel, display this rate in the healthcare centre and forward the information to the Engineer.

33.3 In the event of accident or serious illness, medical personnel must be trained, available and equipped with the necessary material, medicines and consumables to provide first aid for the patient, stabilise their condition, until the patient is:

a) Either treated or discharged; or

b) Hospitalized at the camp or in a larger hospital; or

c) Evacuated to a medical centre which is well equipped for intensive care, if necessary.

34 Health monitoring

34.1 The Contractor cannot recruit workers in poor health.

34.2 The initial pre-recruitment examination must confirm that applicants carry no infectious diseases and are physically able to carry out the tasks required for the position.

34.3 The detection of pregnancy during the initial pre-recruitment examination of female applicants shall not constitute grounds for declining recruitment, unless medical risk is proven.

34.4 The Contractor organises annual medical check-ups for its Contractor's Personnel and keeps up to date a medical record for each Contractor's Personnel. The presence of Contractor's Personnel for medical check-ups, treatment and hospitalisation is incorporated into the Contractor's planning.

34.5 The Contractor provides the Contractor's Personnel with prophylaxis and vaccinations against local diseases and vectors. In particular, the Contractor will promote the use of impregnated mosquito nets by its Contractor's Personnel in camps or off-site lodging, and distributes these nets appropriately.

34.6 The Health and Safety Plan includes a Contractor's Personnel health risk assessment based on exposure to specific risks (such as noise levels above 80dB(A), exposure to hazardous materials, etc.) and describes the medical monitoring implemented.

35 Sanitary repatriation

35.1 The Contractor is responsible for the sanitary repatriation of Contractor's Personnel in the event of a serious injury or illness. The Contractor will take out the necessary insurance to cover the cost of the sanitary repatriation of its Contractor's Personnel.

36 Hygiene, accommodation and food

36.1 Drinking water:

36.1.1 Pursuant to Sub-Clause 6.14 of the CC, the Contractor provides personnel with drinking water at all Project Areas. The quantity and quality of this water complies with the standards of the World Health Organization at supply points.

36.1.2 Unless the supply of drinking water is provided by a certified supplier, the quality of the drinking water provided to workers is tested at least at the start of the Works and then on a monthly basis. The protocol for taking and analysing samples is based on the recommendations of the World Health Organization. The results shall be documented and made available on the Project Areas.

36.2 Accommodation conditions:

36.2.1 The accommodation provided for non-resident Personnel in a camp or an alternative structure outside of the Project Areas, such as a hotel or rented house, will comply with the conditions of Sub-Clause 36.2 of the ESHS Specifications in pursuance of Sub-Clause 6.6 of the CC.

36.2.2 Unless specified otherwise in the Contract, or instructed otherwise by the Engineer, Personnel are housed in rooms. Rooms do not host more than 4 individuals, with no bunk beds, and with 0.5 m^3 of storage space available per person.

36.2.3 Rooms shall not be mixed: separate rooms must be made available for both men and women.

36.2.4 Rooms are lit and equipped with power sockets, beds and windows fitted with mosquito nets. Flooring is of a hard and impervious material.

36.2.5 The temperature in rooms and common areas shall be kept at an appropriate level during occupied hours.

36.2.6 Night-time noise levels to which personnel are exposed comply with the limits recommended by the World Health Organization.

36.2.7 The Contractor provides one drinking water tap per 10 Contractor's Personnel, one shower per 10 Contractor's Personnel as a minimum, one individual toilet for 15 Contractor's Personnel as a minimum, and one urinal per 25 Contractor's Personnel at accommodation camps. Separate showers, toilets and locker-rooms must be made available for women.

36.2.8 The Contractor constructs and maintains a shared leisure area in each camp and a sports field for use by Personnel.

36.3 Hygiene in shared areas:

36.3.1 Sanitary areas (showers, sinks, urinals, toilets) are cleaned and disinfected by the Contractor's cleaning service at least once every 24 hours. Cleaning operations are documented.

36.3.2 The canteen, kitchen and kitchen utensils are cleaned after each meal service.

36.3.3 The number and location of toilets on Project Areas shall be adapted to the number of employees and the configuration of the Project Areas (distance, isolated area, etc.). Separate toilets will be made available for women.

36.4 Food:

36.4.1 In application of Sub-Clause 6.13 of the CC and Sub-Clause 41.1 of the ESHS Specifications, the Contractor provides meals at a reasonable cost to its Contractor's Personnel in a canteen area and according to a procurement system which complies with the provisions of Sub-Clause 36.4 of the ESHS Specifications.

36.4.2 The Contractor defines and implements actions in order to guarantee (i) the quality and quantities of food stuffs, (ii) compliance with health rules when preparing meals, (iii) fitting out and servicing premises and equipment, both in the kitchen and food storage areas.

36.4.3 The Contractor inspects the cleanliness of food transport vehicles, temperature control and the cold chain, as well as best before dates, and takes the necessary corrective actions. The temperatures of chillers are regularly checked.

36.4.4 The Contractor checks that health requirements are met for food storage conditions in the kitchen or other locations, food cooking times and temperatures, and the conditions in which prepared products are left prior to consumption, to ensure no health risks. No food remains are to be reused.

36.4.5 The Contractor recruits trained canteen personnel and ensures that supervisors monitor compliance with sanitary instructions. The Contractor ensures that canteen personnel have means of ensuring compliance with health rules (changing rooms, linen, hand washers, the condition of flooring and paint, and the existence of a cleaning plan).

36.5 The ESHS Manager carries out an audit on all Project Areas every 3 months, and documents the results, and includes the conditions of hygiene in which meals are prepared and food conserved. The results of this audit are provided to the Engineer.

36.6 The ESHS Manager regularly informs Contractor's Personnel on appropriate behaviour in terms of workplace hygiene. This information is documented and saved.

37 Substance abuse

37.1 Pursuant to Sub-Clause 6.16 of the CC, the use, possession, distribution or sale of illegal drugs, controlled substances (as per local regulations) and alcohol is totally prohibited on the Project Areas. The Contractor implements a zero tolerance policy for the consumption of these substances.

37.2 Any person suspected by the Engineer to be under the influence of alcohol or controlled substances on any Project Area is immediately suspended from his position by the Contractor, pending the results of medical tests.

D. Local Labour and Relations with Local Communities

38 Labour conditions

38.1 The Contractor should ensure decent labour conditions for workers and notably compliance with applicable law and regulations in the country of implementation of the contract, and with the fundamental conventions of the International Labour Organisation (ILO). This includes workers' rights related to wages, working hours, rest and leave, overtime, minimum age, regular payment, compensation and benefits. The Contractor should respect and facilitate workers' rights to organise and provide a grievance mechanism for all direct and indirect workers. The Contractor should implement non-discrimination and equal opportunity practices, and ensure prohibition of child or forced labour.

39 Local recruitment

39.1 Local recruitment is defined as the number of positions actually allocated to people residing in the region of the Works, which must be defined by the Contractor in its offer according to relevant criteria by giving priority to populations living in the area of influence or in the immediate proximity of the Project Area.

39.2 Pursuant to Sub-Clause 6.1 of the CC, the Contractor implements a voluntary local recruitment policy for its personnel for the duration of the Works and shall enforce this policy to its Subcontractors.

39.3 The Contractor demonstrates the effective implementation of this voluntary policy to the Engineer in its monthly activity report as defined in Sub-Clause 6.3 of the ESHS Specifications.

39.4 Pursuant to Clause 8 of the ESHS Specifications, the Contractor shall develop a training program. This training program must be open to women and men and be adapted to their level of education and needs of each group to occupy the positions proposed during the Works.

39.5 Local labour needs are estimated prior to the start of Works and described in the Worskite - ESMP with the following information:

a) Identification of positions that could be filled by local staff and the level of qualification required;

b) Definition of the planned procedure for the effective recruitment of these members of staff;

c) Establishment of mechanisms to ensure non-discrimination of women in accessing recruitment procedures. This mechanism must cover the definition of the positions, the methods of communication on the positions to be filled, etc.;

d) Deployment schedule for these positions;

e) Initial training to be provided by the Contractor for each job description.

39.6 In order to prevent outsiders from entering the Project Area, local recruitment at the Project Area, including at the entrance, is prohibited.

39.7 Local recruitment office:

39.7.1 Prior to the start of works, the Contractor establishes a local recruitment office in the district where the main Project Area is

located, at a location pre-approved by the Engineer.

39.7.2 A representative of the Contractor is present in this office at least two mornings each week, from the start of the Works to a date pre-approved by the Engineer.

39.7.3 The representative provides information on job vacancies with the Contractor for the execution of the Works (required qualifications, duration, and location) and on the information to be provided in applications.

39.7.4 Lists of local candidates are drafted by the representative allocated to the office and forwarded to the Contractor's humans resources manager on a weekly basis.

39.8 The Contractor's Human Resources manager selects candidates listed by the local recruitment office based on requirements for the Works and the Contractor's recruitment procedures. A written contract between the Contractor and the local Contractor's Personnel is drafted, signed and archived by the Contractor.

39.9 If the Project Areas are located near to several different communities, the Human Resources manager ensures a fair distribution of local recruitment between the different communities, by giving priority to the people affected by the project.

39.10 The Human Resources manager will ensure that recruitment campaigns in local communities have been spread to women and that the latter have not been discriminated in recruitments.

39.11 Pursuant to Sub-Clause 6.22 of the CC, the Contractor maintains one record per local Contractor's Personnel indicating the hours worked per person allocated to the Works, the type of tasks carried out, the wages paid and any training taken. Records are available at the main Project Area at all times, so the Engineer and the authorised representatives of the government can assess the content.

40 Transport & accommodation

40.1 Unless specified otherwise in the Contract, or instructed otherwise by the Engineer, the Contractor provides or enables access to daily transport for Contractor's Personnel living more than 15 minutes' walk from the Project Area and more than one hour by land transport.

40.2 The transport is organised under conditions which comply with local regulations and which ensure the safety of the people transported.

40.3 The Contractor organises collective transport: pick-up times and locations are defined and services organised appropriately.

40.4 If the Project Area is moved during the working season and if the Contractor retains the local personnel trained at the start of the Works, the accommodation of the Contractor's Personnel is managed by the Contractor:

a) Within a mobile camp with the other non-local Contractor's Personnel; or

b) In villages located near to the mobile Project Area, in this case, each local Contractor's Personnel will receive a housing allowance

in addition to his wages.

41 Meals

41.1 Food supplies for the meals of the Contractor personnel will exclude any meat obtained from hunting or poaching, with the exception of fish.

41.2 The Contractor provides at least two meals per day to local Contractor's Personnel pursuant to the hygiene conditions specified in Clause 36 of the ESHS Specifications, at reasonable price.

42 Damage to people and property

42.1 The Contractor shall not disturb or interfere with the inhabitants of local communities close to or in the Project Area, and shall respect their houses, cultures, animals, properties, customs and practices.

42.2 Pursuant to Sub-Clauses 4.14 and 17.1 of the CC, the Contractor is responsible for damages to people and property caused by the execution of the Works or the procedures used for execution.

42.3 Access to the Project Areas is prohibited to unauthorized persons. The Contractor is responsible for the security and access control of the Project Areas.

42.4 The Engineer is informed of any damage caused to people, or the property of individuals, other than the Contractor's personnel, within 6 hours of the event, regardless of the value of the prejudice.

42.5 Housing existing before the start of the Works, located within a minimum radius of 800 m around the perimeter of the quarries and within a minimum radius of 500 m around the other Project Areas that will be subject to blasting, will be examined by a bailiff unless agreed upon otherwise with the Engineer.

42.6 The bailiff's sworn statement is prepared and provided to the Engineer with the EPP.

42.7 Should any problems be detected due to the intensity of blasting, the Engineer is entitled to request that the Contractor carry out seismic measurements of the intensity of the vibrations induced by the blasting, at variable distances from the blasting points, under the supervision of the Engineer, and at the cost of the Contractor.

43 Land acquisition and land take

43.1 Pursuant to Sub-Clause 7.8 of the CC, the Contractor will cover (i) occupancy indemnities for the extraction or use of construction materials and (ii) the cost of acquiring or temporarily occupying the necessary land to stockpile excess backfill material.

43.2 The Contractor provides compensation for any prejudice suffered by the owners and users of this land, if these users are not the same parties as the owners.

43.3 The Contractor demonstrates to the Engineer (i) who are the owner and the users, if different parties have been identified, and (ii) a written agreement governing the temporary occupancy or acquisition of this land has been negotiated and duly paid up to the two parties, if different.

44 Traffic

44.1 The Contractor defines a Traffic Management Plan in Worksite - ESMP (section 11 as defined in Appendix 1 to the ESHS Specifications).

44.2 The Traffic Management Plan:

a) includes the characteristics of its fleet of vehicles and site machinery; and

b) defines the itineraries used on a map for each route between the different Project Areas that must be validated by the Engineer.

44.3 The Contractor requests that the Employer obtain the authorisations of the competent administrative authorities if public roads are used. Any Engineer's instruction to update the Traffic Management Plan shall be implemented.

44.4 Within one month of the physical start of Works, the Contractor informs the administrative authorities of areas crossed by the Contractor's vehicles, of the itinerary and characteristics (frequency of passing, size and weight of trucks, materials carried) of the Contractor's fleet of vehicles.

44.5 If public roads are used, and unless approved otherwise by the Engineer, the Contractor mandates a bailiff to make a sworn report regarding the state of the road prior to use by the Contractor's vehicles. The report is annexed to the Traffic Management Plan.

44.6 The Contractor describes in the Traffic Management Plan the expected traffic created by its fleet of vehicles (frequency of trips between Project Areas, working hours, convoys).

44.7 The Contractor also describes the number and positioning of flagmen.

44.8 Unless specified otherwise in the Contract or instructed otherwise by the Engineer, heavy vehicles (i.e. with a GVWR of more than 3.5 tons) may not be used at night between 22:00 and 06:00.

44.9 Speed limits:

44.9.1 The Contractor takes action to limit and check the speed of all vehicles and machinery used to execute the Works.

44.9.2 The maximum speed of all machinery and vehicles of the Contractor comply with the lowest of the following: the speed limit defined according to the Employer's country regulations or the following limits.

a) 10 km/h within the Project Area;

b) 30 km/h in villages or hamlets, in towns, from 100 m before the first house;

c) 80 km/h on unpaved roads outside of towns, villages, hamlets and camps.

44.9.3 Pursuant to Sub-Clause 4.15 of the CC, and in coordination with the competent Employer's country authorities, the Contractor provides and installs signs for the fleet of vehicles along public roads, when public signs are inadequate.

44.9.4 The Contractor provides each of its drivers with a map at the appropriate scale of the roads authorised for the execution of the Works, clearly indicating the maximum speeds authorised, and

ensures their understanding.

44.10 It is strictly prohibited to transport people, equipment or products other than those required for the Works and the management of Project Areas, on board any of the Contractor's vehicles. This provision also applies to the transport of live animals and meat obtained from hunting, fishing or poaching.

44.11 The trailers and skips used to carry materials which could be projected (sand, crushed material, aggregates, selected materials) are covered with a tarpaulin for the entire itinerary between two Project Areas.

44.12 The Contractor carries out regular inspections along the roads used by its fleet of vehicles to ensure compliance with the provisions of Clauses 44.8 to 44.11 of the ESHS Specifications. The Contractor records these inspections and the results and transmits a summary of checks carried out for the previous month to the Engineer on a monthly basis.

APPENDIX 1 – Contents of Worksite - ESMP

1. Environmental policy

- Declaration of ESHS policy signed by the managing director of the Contractor and clearly defining the commitment of the Contractor in terms of (i) ESHS management for its construction sites and (ii) compliance with the ESHS Specifications of the Contract.

2. Worksite -ESMP

- Target and content of the Worksite Environmental and Social Management Plan
- Preparation and updating schedule
- Quality assurance and validation

3. ESHS resources

- Human resources:
  - ESHS Manager
  - ESHS Supervisors
  - Person in charge of relations with stakeholders
  - Medical personnel
- Logistics & communications:
  - ESHS vehicles
  - IT stations
  - In situ noise, air and water measuring equipment
  - Analysis laboratory used
- Reporting:
  - Weekly inspections
  - Monthly
  - Accident / Incident

4. ESHS regulations

- Definition of standards for the applicable national ESHS regulations and the ESHS recommendations of institutions affiliated to the United Nations (WHO, ILO, IMO, IFC), applicable to the execution of works:
  - Discharge standards
  - Minimum wage
  - Day and/or night traffic restrictions
  - Other
- Definition of ESHS standards for the industry applied

5. ESHS operational inspection resources

- Site tracking procedure:
  - Frequency
  - Personnel
  - Assessment criteria
- Non-conformity handling and detection procedure:
  - Distribution information
  - Notification depending on the level of importance allocated to non-conformities
  - Tracking of the closing of the non-conformities
- Management of data on tracking and non-conformities:
  - Archiving
  - Use as a performance indicator

6. Project Areas

- Description of Project Areas (as per definition in Sub-Clause 1.3 of the ESHS Specifications):
  - Number
  - Location on a topographical map
  - Activities
  - Opening & closing schedule
  - Access
- Reference to the Appendix: an Environment Protection Plan (EPP) for each Project Area

7. Health and Safety Plan

- Identification and characterisation of health and safety risks, including the exposure of personnel to chemicals, biological hazards and radiation
- Description of working methods to minimise hazards and control risks

		➢ List of the types of work for which a work permit is required. ➢ Personal protection equipment. ➢ Presentation of the medical facilities at Project Areas: – Healthcare centre, medical equipment and allocation of medical staff – Medical acts that can be carried out on-site – Ambulance, communications – Referring hospital ➢ Evacuation procedure for medical emergencies. ➢ Description of the internal organisation and action to be taken in the event of an accident or incident.
8.	**Training plan**	➢ Basic training for non-qualified staff ➢ Health & safety training
9.	**Labour Conditions**	➢ Description of Human Resource Policy for construction works of direct and indirect workers
10.	**Local recruitment**	➢ Local labour requirements: – Job descriptions and the levels of qualifications required – Recruitment procedure and deployment schedule – Initial training to be provided by the Contractor for each job description ➢ Location and management of the local recruitment office(s)
11.	**Traffic Management Plan**	➢ Description of the fleet of vehicles/machinery used for the execution of the Works ➢ Deployment (Project Area & schedule) and maintenance sites for each vehicle and machine ➢ Mapping of itineraries, travel times, and areas where speeds are limited ➢ Dust suppression: – Mapping or road sections where dust reduction initiatives apply – Water points identified or to be created for refuelling tanker trucks – Capacity of the tanker trucks used and calculation of the number of trucks required – Width of the track to determine if one watering run or equivalent is adequate (narrow track) or if two runs are required (wide track) – Number of watering or equivalent operations proposed per day depending on the climate
12.	**Dangerous products**	➢ Inventory of dangerous products per Project Area and per period ➢ Transport and storage conditions and chemical incompatibility
13.	**Effluents**	➢ Characterisation of effluents discharged to the receiving environment ➢ Facilities for the treatment or pre-treatment of effluents ➢ Measures for reducing the sediment content of rainwater runoff ➢ Measures for monitoring the efficiency and performance of facilities for reducing sediment content of rainwater runoff ➢ Resources and methods for monitoring effluent and rainwater runoff quality
14.	**Noise and vibrations**	➢ Estimation of the frequencies, duration, days of the week and noise levels per Project Area
15.	**Waste**	➢ Inventory of waste per Project Area and per period ➢ Collection, intermediate storage, handling and treatment methods for ordinary or inert waste ➢ Storage and handling methods for dangerous waste
16.	**Clearing and revegetation**	➢ Methods & schedule for clearing vegetation and earthwork activities ➢ Methods, species and schedule for the revegetation of Project Areas disturbed by the Works
17.	**Biodiversity**	➢ Schedule for adequate fauna and flora management ➢ Measures for minimizing impact on fauna and flora species based on the Contracting Authority procedures ➢ Measures for monitoring the efficiency and performance of the plan in place ➢ Measures for limiting IAS ➢ Measures for monitoring the efficiency and performance of the plan in place
18.	**Prevention of erosion**	➢ Location of zones suffering from erosion ➢ Methods and schedule for the implementation of anti-erosive actions, including topsoil storage

19. Documentation on the Project Area condition

- List and cover of viewpoints
- Imaging method
- Archiving photographs

20. Rehabilitation

- Method and schedule for Project Area rehabilitation

21. Appendices

- Environment Protection Plans (number and location specified in Section 6 "Project Areas" above):
  - Marking out of the Project Area perimeter on a map
  - Definition of zones for vegetation clearing, zones for the storage of usable timber, zones for burning of green waste
  - Definition of on-site activities: construction, storage areas, accommodation areas, offices, workshops, concrete making units
  - Layout of activity areas on the Project Area: construction works, production/operation areas, rehabilitation and closure
  - Zones for the storage of topsoil, spoil from earthworks, materials
  - Access routes and checkpoints
  - Project Area occupancy schedule
  - Organisation of Project Area preparation
  - Liquid discharge outlet points
  - Proposed sampling points for monitoring water quality
  - Atmospheric emission outlet points
  - Location of the storage site for dangerous products
  - Location and mapping of waste treatment facilities when handled by an external service provider
  - Any other information relating to the environmental management of the Project Area
- Emergency plan:
  - Description of facilities
  - Characterisation of hazards
  - Emergency situations
  - Organisation structure - roles and responsibilities
  - Emergency procedures
  - Human and material resources
  - Triggering of the plan
  - Reporting
- Bailiff's sworn reports as specified in Sub-Clauses 10.5, 42.4 and 44.5 of the ESHS Specifications.

APPENDIX 2 – Properties rendering a product dangerous[1]

1.	**Explosive**	substances and preparations which could explode in the presence of a flame or which are more sensitive to impacts and friction than dinitrobenzene.
2.	**Combustive**	substances and preparations which, when in contact with other substances, particularly inflammable substances, undergo strongly exothermic reactions.
3.	**Easily inflammable**	substances and preparations (i) in liquid phase (including extremely inflammable liquids), with a flash point below 21°C, or which can heat up to the extent of spontaneous combustion in ambient air; or (ii) in solid phase, which can burst into flames easily in the brief presence of a source of inflammation and which will continue to burn after the removal of the source of inflammation or (iii) in gaseous phase, which are inflammable in air at normal pressure; or (iv) - which, when in contact with moist air or water, produce dangerous quantities of gases which are easily inflammable.
4.	**Inflammable**	liquid substances and preparations, with a flash point equal to or above 21°C and less than or equal to 55°C.
5.	**Irritant**	non-corrosive substances and preparations which, when in immediate, extended or repeated contact with the skin and mucosa, can cause inflammation.
6.	**Harmful**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to risks of limited severity.
7.	**Toxic**	substances and preparations (including highly toxic substances and preparations), which, in case of inhaling, swallowing or cutaneous penetration, can lead to serious, acute or chronic risks, and even death.
8.	**Carcinogenic**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to or increase the frequency of cancer.
9.	**Corrosive**	substances and preparations which, in case of contact with living tissues, can destroy the latter.
10.	**Infectious**	substances containing viable micro-organisms or their toxins, for which it is known or we have good reasons to believe that they cause disease in humans or other living organisms.
11.	**Harmful to reproduction function**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can induce or increase the frequency of undesirable non-hereditary effects in offspring or have a negative effect on reproductive functions and abilities.
12.	**Mutagenic**	substances and preparations which, in case of inhaling, swallowing or cutaneous penetration, can lead to hereditary genetic disorders or increase the frequency of these disorders.
13.	**React with water**	substances and preparations which, in case of contact with water, air or an acid, release a toxic or highly toxic gas.
14.	**Sensitising**	substances and preparations which, in case of inhaling or cutaneous penetration, can lead to a hypersensitisation, so that renewed exposure to the substance or preparation will cause characteristic harmful effects. This property can only be considered if test methods are available.
15.	**Ecotoxic**	substances and preparations with inherent or potential immediate or deferred risks for one or several environmental components.
16.	**Dangerous for the environment**	substances and preparations which are likely, after elimination, to lead to another substance, by any means, e.g. a lixiviation product, with one of the above characteristics.