CHAMBESHI – LUKANGA SANITATION PROJECT

TECHNICAL SPECIFICATIONS

FOR

PROCUREMENT OF WORKS

Construction of Faecal Sludge Treatment Plant (FSTP) for Mpulungu Town

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Issued on: 03rd November 2020

NCB No.: *IFP/SNV/WASH-FSTP/2020/MPL/001*

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Technical Specifications

Table of Contents

PART 1 - GENERAL INFORMATION

TABLE OF CONTENTS

Part 1 – General Information

1.1 Definitions

For the purpose of all parts of the present technical specifications the following definitions are made:

i) "Contractor" for the purposes of this Contract is the Contractor appointed to fulfill the Scope of Works in compliance with the technical specifications and requirements set out in the tender dossier.

ii) "Drawings" means tender and/or contract drawings provided by SNV, whether issued with this document or separately.

iii) "Employer" SNV Netherlands Development Organisation Zambia

iv) "Client" Chambeshi Water Supply and Sanitation Company

v) "Engineer" is Chambeshi Water Supply and Sanitation Company or its delegated supervisory representative(s).

vi) "Project" means the works to be implemented under the present contract package.

vii) "Programme" means the entire Chambeshi – Lukanga Sanitation Sub – Programme of the WASH SDG with its different contracts for design, supervision and implementation.

viii) "Subcontractor" means companies appointed by the Contractor to provide specified services (subcontractor's agreement) under this Work Package.

ix) "Suppliers" and "Manufacturers" means companies appointed by the Contractor to supply goods, materials or equipment under this Work Package.

x) "Working Drawings" or "Shop Drawings" or "Construction Drawings" mean the drawings prepared by the Contractor (or his Supplier / Manufacturer / Subcontractor) to supplement and complete the drawings for the purposes of this Work Package. The overall responsibility, however, lies with the main Contractor.

xi) "Work Package" means the works defined in this document together with the associate documents named herein and forming part of the project.

1.2 General Requirements

All materials and workmanship shall be in accordance to their respective international standards irrespective of whether the standard is listed or not listed in this technical specification

a) The minimum standards for satisfying the general and particular requirements for construction of faecal sludge treatment plant are outlined in the following General and Particular Technical Specifications. Where there are any differences between the General Technical Specifications and the Particular Technical Specification, the Particular Technical Specification shall take precedence.

b) It shall be the responsibility of the Contractor to construct all the structures or units in compliance with the present Technical Specifications for civil and building works to ensure that the Contractor's works are fit for the purpose.

1.2.1 Failure to Achieve the Specified Performance

a) If at the site test, the performance of the completed works and installations do not meet the specified duty, the Contractor shall take such steps as may be necessary to modify them in order to achieve the specified duty performance.

1.2.2 Scope of Works

The works included in this contract comprises the following:

1.2.3 Construction of faecal Sludge Treatment Plant (FSTP) for Mpulungu Town

The designated site for construction of the FSTP is located near the refugee camp. The construction works for the FSTP will involve construction of a reception facility for receiving the sludge, sludge drying beds, anaerobic baffled reactor, horizontal flow constructed wetland planted (HFCWP), polishing ponds and a co- composting facility.

Construction Works include but not limited to:

1. Construction of a reception facility for pit latrine sludge with screens
2. Construction of sludge drying beds
3. Anaerobic Baffled Reactor (ABR)
4. Construction of Horizontal Flow Constructed Wetland Planted
5. Construction of Polishing Ponds
6. Construction of a co-composting facility

1.2.4 Program of Works

The program of all works (new construction, civil works, supply of equipment etc.) to be completed under this contract shall be divided into the following parts:

Part I: Confirmation of Material quantities and placing of orders:

- The required quantities of materials to complete the works in this contract will be confirmed and finalized as stated in the bill of quantities prior to placement of orders from material suppliers.
- Note: The contactor shall be responsible of confirming the accuracy of the quantities of materials stated in the BOQ

Part II: Local and Offshore Procurement of Materials:

- This shall include manufacture/ preparation for shipping, shipping, customs clearing, transportation to site and offloading to appropriate storage facilities.

Part III: Mobilization Period:

- The processing of required project submittals which includes administrative (performance guarantee, insurance, advance payment etc.), samples and any other submittals required in these specifications shall be completed at this stage.

Part IV: Construction Works Period:

- Major items of the works shall be sufficiently itemized to allow continuous monitoring of the of the progress of works.
- Note: prior to commencement of the actual construction works, site clearance and excavations shall be carried out as required.

Part III: Site testing:

- All completed hydraulic works such as flow channels, anaerobic filters etc. shall be tested in the presence of the Engineer before being put into operation.

Part IV: Tests on Completion:

- All installed equipment and completed works shall be adjusted to comply with the operation requirements and actual conditions.
- Note: Tests on Completion (Taking Over) shall not take place before the Contractor has finalized all the works including testing.

The Contractor will be required to submit and maintain with monthly updates, a procurement schedule for all materials. This should be submitted at the same time the monthly schedule update is submitted.

The Contractor shall construct the works as summarized in the Invitation to Tender and as detailed in the drawings, Bill of Quantities and Technical Specifications upon mobilization onsite.

1.2.5 Description of Scheme

The contract comprises the construction of the faecal sludge treatment plant.

1.2.6 Associated Documents

This Part 1 "General Information" shall be read in conjunction with the following documents which, together and in combination, define a Work Package:

- Part 2: General Civil Specification;
- Part 3: Particular Specification for the Works;
- Schedule of Technical Particulars for the Works;
- Drawings for the Works;
- Bill of Quantities incl. Preamble.

1.2.7 Equipment and Material

a) The Contractor shall guarantee all materials and workmanship against faulty or inadequate design, improper assembly or erection, as well as leakage, breakage or other failure. Materials used shall be suitable for operational conditions.

b) All equipment shall be designed, manufactured, and assembled in accordance with recognized and acceptable engineering and shop practice, and selected for long life and minimum maintenance. Individual parts shall be manufactured to standard sizes to ensure easy sourcing of replacement parts.

1.2.8 Standard Specifications

a) All materials shall comply with those standards and specifications laid down by internationally recognized and accepted institutions for the water industry. Preference will be given to manufacturers that are quality certified to ISO 9001

b) Reference to any national standard or publication in these specifications is intended to indicate general configuration, type and quality. Goods may be furnished which meet other internationally accepted standards, provided that overall quality will be at least equal to that required by the standard specified. Supporting documentation and certificates shall be submitted hereto.

c) Reference is made throughout the Specifications to BS (British standards) and DIN (English translated version of the Germany standards). Such references should be deemed to include the words "or equivalent standard subject to the prior certification in writing by the Engineer". Wherever reference is made to part of a certain BS or DIN, this BS or DIN shall apply in full, including all its subsections.

d) If the Contractor proposes the use of alternative standards, he shall allow enough time for the Engineer to check such standards and for carrying out any tests as directed by the Engineer in order to confirm that materials to be supplied under alternative standards are of equivalent standard. No claim for delay arising as a result of time required for carrying out such tests will be accepted.

e) Goods and materials delivered to site shall comply with the requirements of the latest issue (with up to date amendments) of the relevant standard.

f) Goods and materials not manufactured to the specified standard shall be of a quality not inferior to that described in the relevant standard.

g) Unless otherwise specified and subject to the approval of the Engineer the use, installation, application or fixing of materials and components shall be in accordance with all applicable recommendation of the manufacturers. Where appropriate, the Contractor shall make use of any technical advisory services offered by manufacturers.

1.2.9 Metric Standardization

a) The entire project shall be completed in accordance with the metric system and metric units. Drawing components, dimensions and calibrations shall be in metric units and generally in accordance with the SI unit standard.

1.2.10 Suitability of Equipment and Material

a) During the selection of equipment, materials and installations, attention shall be given to the following:

i. Safety of operation and easy maintenance;

ii. Well-proven and reliable components;

iii. Ability to withstand the service conditions;

iv. Inaccessibility for vermin, dust and humidity;

v. Precautions to minimize corrosion;

vi. Odor control;

vii. Availability of spares in local market;

viii. Availability of service facilities in the local market;

ix. Minimization of noise.

b) Materials, workmanship and machinery shall be selected based on compatibility with existing equipment/or structures and achieving the closest possible match between the specifically rated duty point and the optimum performance of the equipment. No potential operating point in the specific duty range shall lie outside the operating envelope of the machinery.

1.2.11 Ambient Conditions, Condensation etc.

a) The Contractor shall be deemed to have considered all possible weather conditions when preparing his program of works, and he will not be entitled to any additional payments whatsoever as a result of any meteorological phenomena normally and reasonably encountered in the project area. Exceptional, weather conditions will be considered extreme if they exceed statistical records of weather conditions over the past 10 years.

b) The Contractor shall make suitable arrangements to protect the works, temporary works, constructional plant and materials stored on site against the effects of the weather (including storm).

c) Where there is a risk of condensation, equipment shall be provided with drainage holes placed in the lower part of the equipment.

d) Moreover, equipment shall be designed to prevent the intrusion of insects, vermin and smaller reptiles.

1.2.12 Working Hours

a) The Contractor shall perform his construction work only during normal working hours on construction sites according to the labor law being currently in force in Zambia and in compliance with the Particular Conditions of Contract.

b) In case the Contractor wishes to carry out works outside normal working hours or on Sundays and public holidays, he shall obtain the approval of the Engineer.

c) Work outside the normal working hours shall be carried out only after the Contractor has obtained the Engineer's agreement on the Contractors written request, submitted at least 48 hours prior to the intended time.

1.3 Drawings & Information

1.3.1 Working Drawings to be Provided

a) The Contractor shall, in his tender, advice any changes needed to the basic design provided in these tender dossiers which are required to guarantee the work performance.

b) After signature of contract, the Contractor shall submit to SNV detailed working drawings or every part of the proposed rehabilitation and upgrade works including any required equipment installations or any other works as may be required by SNV

or Supervising Engineer in order to institute the entire work of adequate strength in every respect for the purpose for which it is intended.

c) In case the Contractor failed to provide technical details with his tender, the Contractor is obliged to submit all necessary documentation a) prior to the ordering of the respective goods, b) prior to the commencement of the respective works (whatever is earlier) without having rights for extra time and/or payment.

1.3.2 Detailed Working Drawings for Approval

a) After receiving the "Letter of Commencement of the Works" the Contractor shall submit to the Engineer: complete working / shop drawings including structural calculations (where necessary and/or if changes to the provided drawings are been made by the Contractor); detailed working program including cash-flow schedule and assigned machinery, equipment and staff (all in MS Project); details on construction equipment and equipment / material to be installed (permanently and temporary); safety measures; dimensions for foundations, plinths, recesses, chases, bolt holes, and other provisions required to be made in line with the works to be executed. All drawings and information necessary for the design of the modifications and rehabilitations to the existing structures, including dimensions, location and size of all openings for connecting piping and valves, protective and ancillary equipment, shall be submitted in triplicate for the approval of the Engineer. After approval, the Contractor shall supply each four (4) final prints (2 x SNV, 2 x Engineer).

b) Any drawings submitted for approval will be inspected and stamped for return to the Contractor within 14 days from receipt of the drawings by the Engineer.

c) Drawings from sub-contractors shall be duly checked and signed by the Contractor before being submitted by the Contractor to the Engineer. The Engineer shall deal in all respects exclusively with the Contractor.

d) When the Engineer has approved a working drawing, he shall return a copy marked "Approved" to the Contractor, who shall then insert the date of approval on the tracing and furnish the Engineer with four (4) prints of the working drawings as approved.

e) Approval of a working drawing by the Engineer will only signify his general approval of the working or shop drawings and shall not make him liable for any error of the Contractor during construction. Where errors, deviations and/or omissions are discovered later, they shall be made good by the Contractor irrespective of any approval by the Engineer.

f) Any modifications to the approved drawings found necessary on the Site shall be agreed with the Engineer and confirmed in writing as record, by Site Instruction or other means. If any approved drawing needs to be amended later, the amended drawing shall be submitted for approval in accordance with the aforesaid.

g) The Engineer may require the Contractor to submit for approval drawings, samples, patterns, models and technical details of items additional to those mentioned above to the extent reasonably necessary for him to satisfy himself that the items are suitable for their intended purpose.

h) Numbering system

The Contractor shall design a document numbering system for all documentation. The system shall include all documents, manuals and drawings and shall be comprehensive.

Issue and submittal of all sub-contractors' documentation shall be in accordance with the approved system.

The Contractor shall design the tag numbering system for all equipment, processes and locations.

- ☐ All documents and manuals;
- ☐ All drawings;
- ☐ All equipment;

The Engineer shall approve the numbering / tag systems.

1.4 Final Documentation

1.4.1 As-Built Documents

a) The Contractor shall prepare and submit to the SNV and Engineer for approval, duly amended, three (3) copies of the as-built documents in soft (AutoCAD and pdf) on a flash and hardcopies in colour.

b) The as-built documents are a set of documents submitted by a Contractor upon completion of a project or a section. The documents shall reflect all changes made in the specifications and working drawings during the construction process, and show the exact dimensions, elevations, geometry, location and other pertinent details of all elements of the work completed under the contract.

c) The Engineer shall return to the Contractor 2 copies of the documents showing the amendments required by the Engineer. Within 21 days of receipt of the amended drawings the Contractor shall issue to the Engineer 5 copies and 1 negative of the amended drawings.

d) All final approved documents including all drawings shall also be submitted in an electronic version on USB flash.

1.5 Co-ordination

a) It is the responsibility of the Contractor to coordinate all work on site between the general rehabilitation and new construction works as well as civil works, and to ensure that all works are executed in a coordinated manner.

b) The Contractor shall be responsible for all sub-contractors and suppliers of materials under this contract.

c) It is the responsibility of the Contractor to ensure that sub-contractors and suppliers comply with the Contract Document.

d) The Contractor shall appoint and provide experienced mechanical and electrical engineers to monitor and co-ordinate all aspects of the mechanical and electrical work.

1.6 On-site Manufacturing

a) The Contractor shall not manufacture on site without the prior consent of the Engineer and if permission is granted the Contractor shall provide all equipment considered necessary for on-site manufacturing and shaping of materials and

equipment within the working area. The working site may be used as intermediate storage for equipment at the Contractor's own risk.

1.7 Protection and Packing for Dispatch

a) The Contractor shall ensure before dispatch from the manufacturer's works that all plant is adequately protected by painting or by other approved means for the whole period of transit, storage and erection, against corrosion and accidental damage

1.8 Unloading, Erection and Running of Works

The Contractor shall make allowance for the following commitments:

a) Making his own arrangements for all appropriate skilled and unskilled labor necessary to unload, move into position or storage all items of equipment and plant supplied. The Contractor shall be responsible for any damage occasioned.

b) Provide all equipment required to unload and place in storage and to load from storage and move into position and erect all items including equipment and plant detailed in his obligations.

c) Supplying all steps, trestles, ladders, scaffolding, shoring, supports, safety measures etc. that may be required during the implementation.

d) Providing the necessary qualified and skilled and unskilled labor for the erection of each part of the Works including equipment and apparatus so that it can be all installed complete and left in good working order.

e) Providing the necessary technical personnel either from the manufacturers or his own staff for the installing testing and setting to work of specialist equipment

f) Providing adequate protection for the Works and ensuring shortest installation of any material from the time it is delivered to Site, ensuring shortest temporary storage and erection periods until the Take-over Certificate is issued. (The Contractor shall provide and fix adequate sheeting etc. to prevent the ingress of dust and dirt both during erection and whilst finishing works are carried out after erection).

g) Inspecting related structures and obtaining the Engineer's agreement to the proposed program prior to erection of any item of equipment.

1.9 Foundations, Builders Work and Setting out

1. The Contractor shall be responsible (in accordance with the General Civil Specification and contract and working drawings) for providing and preparing all necessary foundations and bases for the various Work items.,. The Contractor shall be responsible for the accuracy of the particulars given on the Working Drawings.

2. Only when the foundations are completed, and the structure is in a suitable condition as agreed by the Engineer, the Contractor shall proceed with construction of associated structure components or parts.

3. The Contractor will be responsible for the grouting and final building in, of the proposed structure, the Contractor shall take all responsibility for the satisfactory nature of this work and shall have a representative present while the concrete is being put in.

4. If it is necessary to build in any item before the erection of the main structure the Contractor shall be responsible for these to be timely available on Site to meet the work program.

1.10 Delivery Program

a) The Contractor shall be responsible for informing his suppliers, at the time of placing an order, of the period during which items shall be delivered and available to the Site.

b) The Contractor is responsible to familiarize himself about the local conditions and times needed to import, transport etc. goods.

1.11 Location and Alignment

a) Where separate items of interconnected works depend upon correct alignment for satisfactory operation, then each item shall be positively located in its correct operational position.

1.12 Onsite Storage and Safe Keeping

a) The Contractor shall be entirely responsible for the security and maintenance of equipment and material during any periods of storage. Contractor shall be responsible for inspecting all equipment and materials after transportation to site and prior to storage, and he shall arrange for any damaged equipment or material to be rectified prior to delivery to the on-site store.

b) All storage arrangements require the approval of the Engineer and shall, at a minimum, comply with the following minimum requirements.

1.13 Corrosion Protection

1.13.1 General

a) Mechanical and metallic equipment/ or material shall be protected against corrosion by selection of materials, protective layer, galvanizing, painting, or other convenient treatment to a degree sufficient for the intended function and placement of the actual works.

1.13.2 Galvanizing

a) Steel or wrought iron is to be hot-dip galvanized, it shall be carried out by the hot-dip process and shall conform in all respects with BS 729.

b) Attention shall be paid to the detail of members in accordance with BS 4479. Adequate provisions for filling, venting, and drainage shall be made for assemblies manufactured from hollow sections. Vent holes shall be suitably plugged after galvanizing.

c) All surface defects in the steel, including cracks, surface laminations, laps, and folds, shall be removed in accordance with BS 4360. All drilling, cutting, welding, and forming of unit members and assemblies shall be completed before the items are galvanized. The surface of the steel to be galvanized shall be free from welding slag, paint, oil, grease, and similar contaminants.

d) During off-loading and erection, utmost care must be taken in order to avoid any damage to the galvanized surfaces. Galvanized items in stock shall be stacked so as to provide adequate ventilation to avoid wet storage staining.

e) Small areas of damaged galvanized coating may, with the approval of the Engineer, be restored by:

f) Cleaning of the area of any weld slag and thoroughly brushing to provide a clean surface

g) Application of two coats of zinc-rich paint, or application of a low melting point zinc alloy repair rod or powder to the damaged area, which is heated at 300°C.

h) Where galvanized steel will be in contact with aggressive solutions and/or atmospheres, the galvanized surfaces shall receive further protection by painting in accordance with the paint specifications given below.

i) The geometry of galvanized steel parts shall be thoroughly checked after galvanizing. Any deformations shall be corrected without damaging the zinc layer.

1.13.3 Preparation and Painting of Steel Work

a) Works preparation shall be carried out when all machining has been completed and all traces of grease removed. In the case of welded steel works, all slag and splatter shall be removed from the area of welds by chipping prior to sandblasting and priming.

b) All steel other than stainless steel, shall be sandblasted to grade SA 2½, and given a prime coat of an approved polyamide cured Zinc Phosphate Epoxy – two-pack to provide a dry film thickness of at least 50 microns above peaks. The prime coat shall be applied with an airless spray process within 4 hours after sandblasting.

c) All steel is to be wire brushed and any loose scale, dirt or grease shall be removed before any painting is commenced. One coat of red oxide primer Type A to B.S. 2523 shall be applied at the shop.

d) Any damage to the priming paint shall be made good to the Engineers satisfaction**.**

1.14 Erection

a) The Contractor shall make his own arrangements for unloading of equipment and materials supplied and shall be responsible for any damage that may occur. The Contractor shall provide all tools, meters, gauges, temporary provisions, as well as skilled and unskilled labour for the erection of the mechanical installations at his own expense, so that it can be installed complete and in good working order.

1.15 Co-ordination of Site Testing Program

a) The Contractor shall be responsible for coordinating the program of site testing of all items and to ensure that all parties concerned are present during any tests to obligate their responsibilities.

1.15.1 Site Testing

After completion of the works, the Contractor shall test fully the main items of equipment and shall include provision for

a) All appropriately skilled and qualified operating and test staff for the testing of all equipment;

b) All measuring and testing instruments needed to demonstrate equipment operation to the fulfillment of the works tests;

c) All loading weights for the load testing of all lifting equipment installations;

d) All tests shall be carried out by the Contractor but shall be supervised by the Engineer and the Engineer shall be satisfied with all tests

1.15.2 Commissioning

a) Following the successful site testing of all equipment and works, the Contractor shall provide all skilled personnel for the commissioning of the equipment/ or works and shall demonstrate to the Engineer that the complete installation or work package can meet the design requirements. Also, during the commissioning period, the Engineer's staff shall receive not less than fourteen calendar days instruction in the operation of all equipment.

b) All tools and other loose items of equipment shall be checked.

c) The Contractor shall maintain on site all necessary Engineering and technical supervision for a period of seven calendar days after the successful commissioning to affect any adjustments that may be necessary, or fourteen calendar days after commencement of staff instruction whichever shall be the longest.

1.16 Schedules of Particulars

a) Given in the schedules shall be binding for the Contractor and may not be varied, except with the Engineer’s written approval. The Engineer’s approval shall not in any way relieve the Contractor of any of his obligations under the Contract.

1.17 Standards

a) All goods, materials and workmanship shall comply with the requirements of the latest issue (with up to-date amendments) of the appropriate BS, or in exceptional cases and with the Engineers approval with other standards.

b) If the Contractor should wish to supply material or execute work to an alternative national standard or international specification, he shall give full details of his proposal, in writing, to the Engineer, together with authenticated English translation.

1.18 Equipment and Manufacture

a) All equipment shall be designed, manufactured, and assembled in accordance with recognized and acceptable engineering and shop practice, and selected for long life and minimum maintenance. Individual parts shall be manufactured to standard sizes to ensure easy sourcing of replacement parts.

b) Mechanical equipment shall be new and shall not have been in operation at any time prior to delivery, except as required by tests.

TECHNICAL SPECIFICATIONS

PART 2 - GENERAL CIVIL SPECIFICATIONS

Issued: 03rd November 2020

PART 2 - GENERAL CIVIL SPECIFICATIONS

TABLE OF CONTENTS

2 CIVIL ENGINEERING WORKS

1.1 General Information

2.1.1 Record of Site Condition

a) The Contractor shall keep records including digital photographs, to be agreed by the Engineer of the condition of the of the existing structures and site surfaces before commencing rehabilitation and construction works. These records will be used to determine the degree of rehabilitations and construction works done to restore the existing structures to normal working conditions.

2.1.2 Site for Contractor's Accommodation, Stores and Additional Working Area

a) The Contractor is responsible to provide a suitable site for his camp.

b) Notwithstanding any space or site at proposed site for construction of a Faecal Sludge Treatment Plant being appointed or made available by the client, it shall be the Contactor's responsibility to arrange, take possession an alternative site where he will setup his camp for the execution of the Works.

2.2 Setting Out of Work

a) The Contractor shall be responsible for the setting out of the Works. All dimensions and levels shown on the drawings or referred to in any document forming part of the Contract shall be verified by the Contractor on site. He shall be responsible for pointing out promptly any discrepancy or error in such dimensions or levels.

b) The Contractor shall prepare detailed setting out drawings and data sheets as necessary and submit them to the Engineer for approval. Any modification of these drawings or data sheets required by the Engineer shall be made by the Contractor and resubmitted for final approval.

2.3 Working Methods.

2.3.1 Opening of Excavations

a) The Contractor shall plan and organize his work in such a way that all excavations of any nature during the rehabilitation and construction works are carried out in a coordinated manner and in the shortest reasonable time. All excavation works to be carried out shall be reviewed and identified and a detailed program prepared. The program shall take into account to carry out the works requiring the deepest excavation first, then the next deepest and so on until the work is completed. The need to re-excavate for different parts of the work shall be avoided

2.3.2 Removal of Surplus Excavated Material and Debris

a) The Contractor shall take every precaution and make adequate provisions to prevent excavated material or other debris from being deposited in unproved locations or sites.

b) Surplus excavated material and construction material shall be regularly removed from Site by the Contractor to an approved official public dumping site. Under no circumstances, shall such materials be allowed to collect in such quantities or over periods of time that they cause nuisance or obstruction on the work site. If in the opinion of the Engineer, nuisance is caused, the Contractor shall forthwith remove the materials from site. If the Contractor fails to do so, arrangements will be made to remove the offending materials.

c) The Contractor, may, at his option, establish temporary collection sites for such materials to facilitate removal from the working areas. Such sites shall be approved by the Engineer. The Contractor shall either provide security at these sites to prevent dumping of other wastes by the public or accept to clean the sites at his costs of all material that is dumped there.

2.3.3 Roads and Site to be Kept Clean

a) The Contractor shall take particular care and all reasonable precautions to ensure that roads and thoroughfares used by him, either for the construction of the works or for the transport of plant, labor and material, are not made dirty as a result of such construction or transport and shall take all necessary and immediate steps to clean them when required or instructed by the Engineer.

b) Each individual site must be kept clean during the work and must be thoroughly cleaned up daily on completion.

2.3.4 Use of Mechanical Equipment

a) The use of mechanical equipment shall always take into account the local conditions and surroundings. At any locations where the use of such equipment may cause damage or unacceptable disruption of any sort, then the contractor shall use manual methods. The Contractor will be held responsible for all damages caused by him during and arising out of the execution of the Works.

2.3.5 Fencing and Securing of the Works

a) The Contractor shall fence the works in a manner enough for the protection of the public and livestock and property during the progress of the works and shall satisfy the Engineer and SNV in this respect. The fence shall be surrounded by warning signs and strips where necessary.

b) The Contractor shall erect and maintain adequate safety measures around all trenches and other open excavations in a sufficient manner to provide maximum safety to site workers and other visitors. Open excavations shall be surrounded by warning strip tapes at least 1 m.

c) The Contractor shall maintain on Site when excavation works are in progress, enough timber, metal sheets and other materials to shore the excavation works and provide adequate barriers and fencing to ensure the safety of the Works.

2.3.6 Existing Site Utilities

a) Existing pipes and services within the treatment plant premises affected by the construction and rehabilitation activities must be adequately secured in coordination with the plant workers.

b) The Contractor shall acquaint himself with the position of all existing services and structures before any excavation or other work likely to affect the existing services or structures commences. The Contractor shall obtain the necessary plans and/or assistance from the owners of the services and structures (includes as built drawings of the plants) to locate all existing services prior to the start of excavations.

c) Unrecorded services such as power service cables, both formal and informal, may exist within the sites The Contractor shall inspect all working areas before commencing excavations to identify the presence and location of all services within the excavations as far as possible. Other services may be encountered during excavation. All services encountered shall be protected.

2.3.7 Completion of the Works in Sections

a) If the Contract requires sections of the Works to be completed and handed over to the Contractor shall develop a detailed program for completion of sections of the Works. The program is subject to the Engineer's approval.

2.3.8 Access to the Work

a) The Contractor shall always allow free access to the works by authorized representatives of SNV or Engineer for the respective parts of the Works. Any instructions or requirements of these representatives requiring changes in the Works require the written confirmation of the Engineer or SNV

2.4 Materials

2.4.1 Quality of Materials and Workmanship

a) All materials to be used in the permanent works shall be new, of the latest production line and of the required specifications. The workmanship shall be of the specified quality, all to the approval of the Engineer.

2.4.2 Approval of Suppliers of Materials

a) Before entering into any sub-contract for the supply of any materials or goods, the Contractor shall obtain the Engineer's approval in writing of the proposed sub-contractor /supplier/manufacturer from whom he intends to obtain such materials or goods. Where necessary the Engineer may request the contractor to arrange for physical inspection of the materials at manufacturers workshop.

2.4.3 Samples

a) In addition to specific provisions in the specifications for sampling and testing of materials, the Contractor shall submit to the Engineer, as he may require, samples of all materials which he proposes to use in the works. When approved, these will be retained by the Engineer.

b) Samples to be submitted shall be accompanied by an approved form on which all information about specifications, description, location of use, manufacturer etc. are stated.

c) The Contractor shall submit a "Materials Procurement Program" for all materials and equipment which are deemed to be used in the permanent works indicating dates for sampling, approval, ordering, and delivery to site.

d) The Engineer may reject any materials or goods which in his opinion are inferior to the samples submitted.

e) The Engineer's approval of manufacturers or material for the works, whenever required by the specifications, shall not relieve the Contractor of his responsibilities under the Contract.

2.4.4 Tests

a) The Engineer may examine and may require testing of any materials or goods to be used in the works The Contractor shall give the Engineer unrestricted access to his, his sub-contractors' / suppliers' / manufacturers' premises for such purposes always.

b) The Contractor shall afford the Engineer all facilities, assistance, labor and appliances necessary for the convenient examination, testing, weighing or analysis of all materials and goods. The Contractor shall prepare all test samples the Engineer may require.

c) Tests carried out off the site shall not relieve the Contractor of the responsibility of ensuring that the materials pass any required tests on site and when they are incorporated in the permanent works.

d) The costs for all tests as prescribed in the specifications and as directed by the Engineer are to be borne by the Contractor and are deemed to be included in his contract prices.

2.5 Working Program

a) Before commencing rehabilitation and construction works the Contractor shall record (sketches, photographs including descriptive notes) any existing damage to adjacent buildings and structures and notify the Engineer. Failing to do so, the Contractor may become liable to make good such damage as it may be considered a result of his activities.

b) The Contractor shall submit detailed working programs and method of working for each section of the works for approval.

2.6 Construction/ Working Drawings

a) Construction / working drawings shall be prepared by the Contractor and approved by the Engineer. The works shall agree in all particulars with the Drawings unless otherwise approved in writing by the Engineer.

b) The Contractor shall verify all dimensions, quantities and details shown on the drawings or other data received from the Engineer and shall notify him immediately of any error, discrepancy or conflict found therein. Failure to discover such errors, discrepancies or conflicts shall not relieve the Contractor neither from his full responsibility for unsatisfactory work, nor from rectifying such work.

c) The Contractor shall incorporate in the Drawings all openings, ducts, recesses, anchor holes, etc., as required for the mechanical and electrical installations where required. All related costs are considered to be included in the Contract Price.

d) Working drawings shall be provided by the Contractor for the following work items not determined in the Contract Drawings:

- Covered Drying Bed Roof Construction: Drawing showing roof structure details and connections, including arrangements for gutters and rainwater outlets, format to be agreed with Engineer.
- Steel Connection Details: Drawing showing the connection details of all structural steel and roof connection details.
- Plumbing and Pipeline sections: Drawing showing pipes and plumbing fitting details for all the water supply connection works and drainage pipe connections to existing pipes and sewer lines.

e) The title block shall be as on the Contract Drawings and shall show in addition the Contractor's name and the descriptive name of the works shown on the drawing. Materials and material standards shall be indicated on the drawings.

2.7 Survey Records and As-Built Drawings

a) During the progress of the works and after clearing the site, the Contractor shall take and record levels in the manner directed by and in the presence of the Engineer of the site and works. Such levels, when approved by the Engineer, shall be recorded by the Contractor on drawings and/or schedules which shall be signed as a true record by the Contractor and the Engineer and shall form the basis of the measurement of the Contractor's work.

b) Excavation works shall not commence before such records are certified by the Engineer.

c) Before the issue of the Taking-Over Certificate the Contractor shall prepare as-built drawings of all works and installations under the Contract and submit them to the Engineer for approval. All as-built drawings are to be of good quality (min. 100 g/m²) to allow copying.

d) In addition, the Contractor shall provide two (2) copies of all as-built drawings in certified virus free digital format (AutoCAD and pdf).

2.8 Photographic Records

a) The Contractor shall provide digital photographic records of the execution of the works by having photographs taken at monthly intervals from such points as the Engineer may specify from time to time. The number of such photographs shall generally not exceed twenty (20) per month.

2.9 Contractor’s Compounds

a) An item is provided in the Bill of Quantities to cover the Contractor’s costs of providing and maintaining a camp within or outside the work sites necessary for the proper organization and superintendence of the works.

b) The camp their contents shall be dismantled and cleared away by the Contractor upon completion of the Contract.

c) The Contractor shall provide, erect and maintain sign boards at locations as directed by the Engineer. They shall be lettered in English; the sign board shall be not smaller than 3 m x 2 m in size. The sign board shall be solid construction, durable at least for the duration of the Contract. The wording shall be as directed by the Engineer.

2.10 Connection to Public Services

a) The Contractor shall be responsible to obtain in time all necessary approvals from the relevant Government Authorities to connect the works as described to the services provided by the Authorities, and in such a manner as required and approved by these Authorities. SNV will assist in obtaining such approvals. The costs involved shall be borne by the Contractor.

2.11 Water Supply (Temporary)

a) Where possible the contractor shall be allowed to use existing portable water points within the sites if they are conveniently located for his usage requirements. This source if required to pay the contractor shall pay as billed. Notwithstanding this, the contractor shall provide at his expense, a temporary supply of potable and other water required as prescribed in Conditions of Contract, for any portion of the works. He shall provide, operate and maintain the supply throughout the duration of the works. Quality of water shall be in accordance with the common standards for potable water and to the satisfaction of the Engineer.

2.12 Electricity Supply for Power and Lighting (Temporary)

a) The Contractor shall arrange for and pay all costs in connection with the temporary supply of electricity he may need for the duration of the Contract. If the Contractor intends to provide his own electricity supply, the regulations of the Local / National Electrical Authority are to be observed and the permission of this Authority is to be obtained.

2.13 Other Services

a) The Contractor shall make his own arrangements for any services required during the duration of the Contract.

2.14 Sanitary Arrangements

a) The Contractor shall provide and maintain sufficient sanitary conveniences for all operatives and site staff engaged on the works. These shall be in accordance with any requirements and regulations applicable and be subject to the approval of the Engineer. The location shall be thoroughly disinfected at the end of the Contract and whenever it becomes necessary.

b) The Contractor shall ensure that all operatives and site staff are aware that the sanitary conveniences must be used by all personnel, and the Engineer reserves the right to require the dismissal of any person committing a nuisance on or about the site by failing to properly use the conveniences provided.

2.15 Contractor's Health and Safety Services

a) The Contractor shall be responsible for the safety and health of all workmen and other persons in or around the works, to the satisfaction of the Engineer. Such measures shall include, but not be limited to the following:

   i. Provision of proper safety and emergency facilities and procedures; fire, gas and electric shock prevention, stretchers and fully equipped first aid box together with rescue facilities generally at each place of work;

   ii. Adequate supports and braces for all excavations;

iii. Provision of sufficient safety helmets for all staff including the Engineer, his staff, and any authorized visitor to the site;

iv. Provision and maintenance of safe, sound ropes, slings, pulleys and other lifting equipment, each having an up-to-date test certificate;

v. Provision of good and safe access to the works;

vi. Provision of warning notices to the public in English, warning them of the existence of any dangers related to the works.

vii. Adequate sanitary facilities and maintenance of these in a clean and hygienic state for use by all persons employed by SNV, Engineer, Contractor or other contractors on the Site. They must be gender separated.

viii. Reporting details of any accident to the Engineer and competent authorities as soon as possible after its occurrence.

ix. Effective measures to prevent of non-site personnel from entering the work areas.

b) The Contractor shall ensure that employees are available at each site to administer emergency first aid in (1) above, and that all employees are aware of their names. The Contractor shall provide for the transport of serious cases to hospital. All medical facilities shall also be to the satisfaction of any properly appointed medical officer authorized by the Government to inspect medical facilities at the site.

c) The Contractor shall ensure that all his employees are fully conversant with the regulations and emergency procedures and shall enforce the rule that any employee committing a serious breach of such regulations shall be immediately dismissed from site and shall not be re-employed.

d) The Contractor is required to produce a Health and Safety Management Plan (HSMP) covering the hazards that may apply during the Contract, the rules and standards to be used in assessing risk and in undertaking work and the methods that will be employed to ensure compliance with this plan.

2.15.1 Health and Safety Management Plan

a) The Contractor shall submit a detailed, site-specific Health and Safety Management Plan (HSMP) based on all relevant health and safety provisions found in the [Technical Specifications] and [Schedules] and applicable Laws to the Engineer within 28 days after receiving the notice for Commencement of Works. The HSMP must be approved by the Engineer prior to commencement of the execution of the Works. Unless the Engineer, within 21 days after receiving the Health and Safety Management Plan, gives notice to the Contractor stating the extent to which it does not comply with the Contract, the Contractor shall proceed in accordance with the Health and Safety Management Plan.

b) The Contractor shall also implement the health and safety requirements of the approved HSMP and comply with instructions issued as a result of periodic inspections to be undertaken as part of the supervisory role required of the Engineer.

c) If, at any time, the Engineer gives notice to the Contractor that all or any portion of the HSMP fails (to the extent stated) to comply with the Contract, the Contractor

shall submit a revised HSMP to the Engineer. The HSMP shall include but not be limited to the following:

i. Details of all potential risks and the proposals for dealing with such hazards; Controls to regulate risks that occur during all construction, testing and commissioning activities;

ii. Measures to avoid health risk in connection with the use, handling, storage and transportation of hazardous and harmful substances such as dried and settled feacal sludge;

iii. Safety equipment and training proposals in respect of equipment referred to above; and

iv. How the Contractor intends to ensure the health and safety of members of the public in the vicinity of the areas of work, including those with special needs.

a) The HSMP shall provide a statement attesting the firm's understanding of, and means of ensuring due compliance with, the statutory regulations relating to construction work in Zambia, specifically in regard to compliance with:

b) All safety and industrial health legislation including, without limitation, the Rules and Regulations of Zambia and the authorities having jurisdiction;

c) All current environmental laws and regulations - be they International (international conventions), national or local – related but not necessarily limited to:

i. Noise;

ii. Air pollution and odour;

iii. Water contamination;

iv. Solid waste disposal;

v. Hazard waste disposal/ or reuse in this for dried and settled faecal sludge

vi. Liquid waste disposal which might include wastewater;

vii. Sanitary conditions (water supply, sewerage, etc.);

viii. Use of explosives; and

ix. Gender mainstreaming, HIV/AIDS, TIP policies and regulations

d) The Contractor shall restore areas citing temporary plants and other areas of construction to their original condition on completion of Project Works. This shall include the clean-up of spillage and debris before leaving construction site.

2.16 Site Clearance and Preparatory Work

2.16.1 Clearing Site

a) The Contractor shall remove overburden and vegetation, pilled debris and rubbish, fell trees cut down hedges and bushes and grub up roots, all as directed by the Engineer. All rubbish and material unsuitable for re-use must be removed

from the site to an approved disposal area provided and paid for by the Contractor and all work that has been disturbed must be made good.

b) All disposal of material shall be carried out in accordance with the environmental legislation in effect in the country and to the approval of the relevant environmental authorities.

2.16.2 Felling Trees

a) Where directed by the Engineer, trees to be cutdown shall be uprooted and holes shall be filled with approved material and well compacted. Rates for removal shall allow for haulage.

2.17 Demolitions and Alterations

2.17.1 General

a) The work shall be carried out in such a manner as to cause as little inconvenience as practicable to the occupants of the premises or treatment plant workers and adjoining premises and the public.

b) The demolition debris shall be sprinkled with water to prevent dust arising and all proper screens and protection shall be provided to the satisfaction of the Engineer.

c) The Contractor must provide all necessary requisite shoring, needling and strutting or other supports incidental to the demolition and/or alteration work and alter and adapt all such temporary works as may be necessary from time to time, and finally clear away and make good all that which is disturbed.

d) Where materials from the demolitions and dismantling are described as "remove from site" they shall become property of the Contractor. He shall include in his rates for the disposal of such materials together with all associated costs.

2.17.2 Program of Demolitions and Alterations

a) A program of the demolitions and alterations shall be drawn up by the Contractor and agreed SNV or the engineer. Any divergence from this program requires prior agreement from these parties and close liaison shall be maintained through the Engineer.

2.18 Excavation and Backfilling

2.18.1 General

a) The Contractor shall examine the site and familiarize himself with the nature of the ground, groundwater levels, excavation and shoring methods as well as precautions for safeguarding of existing buildings and structures to be applied and physical obstructions and conditions on site that may affect his work and prices. His rates shall allow for all operations and costs required and encountered when carrying out the works in accordance with the Contract.

b) The Contractor shall not execute any earthwork or excavation without having obtained the Engineer's approval of the methods which he proposes to employ. He shall not thereafter modify such methods without the Engineer's consent.

2.18.2 Definitions

a) "Excavation" shall for the purpose of the Contract be deemed to refer to the excavation of all the materials of whatever geological formation, quality, consistency or description. Excavation shall be carried out neatly to the lines and levels which are specified on the drawings or as instructed by the Engineer.

b) Excess excavation beyond the specified lines and levels shall be limited to an absolute minimum making do allowance for working space and the necessary temporary works. The Contractor shall take all possible precautions to prevent slips in excavations and embankments and to protect and support structures which may be endangered

c) Any excess excavation, over break or slip beyond the limits of the specified excavation shall be removed and made good on the Contractor's own cost with such material as directed by the Engineer.

d) Excavation shall be carried out manually if excavation by mechanical means is not reasonably practicable or may endanger or damage structures or property.

e) Excavated material shall, if in the opinion of the Engineer suitable and required for use on site, be stockpiled or, if possible, immediately placed or shall, if not suitable or required, be removed immediately from site.

f) The word "rock", wherever used as the name of a material to be excavated, shall mean only boulders and pieces of concrete or masonry exceeding 0.3 m^3 in volume, or solid ledge material which, in the opinion of the Engineer, requires for its removal drilling and blasting, wedging, sledging, barring, or breaking up with a power-operated tool and cannot be excavated with manual methods of excavation such as the use of picks and shovels.

g) Soft or disintegrated material which can be removed with a hand pick (pick axe) or power-operated excavator or shovel, no loose, shaken, or previously blasted material or broken stone in material fillings or elsewhere, and no material exterior to the maximum limits of measurement allowed, which may fall into the excavation, will be measured or allowed as "material".

2.18.3 Excavation

I. Excavation Rates

a) The rates for excavation shall include for:

i. Excavation in any material other than rock as defined in Section 2.18.2;

ii. Handling of groundwater, surface water, rainwater and/or any other kind of water including de-watering (excavation is always to be kept free of water);

iii. Bulking of excavated material which is suitable for backfilling (structures only);

iv. Removal of surplus material to approved site;

v. Temporary shoring-up of excavations if required;

vi. Safeguarding of adjacent buildings, structures against any damages;

vii. Additional excavation to accommodate the temporary supports and all working space necessary to carry out the work together with all subsequent backfilling and compaction using approved excavated material;

viii. Trimming, compacting and protecting the formation level;

ix. Formation of all temporary spoil heaps and all double handling necessary, and carting away excess material to tip;

x. Protection of the works as in Section 2.3.5.

b) All surface areas which have been disturbed by the Contractor's work or operations shall be reinstated to the original condition including providing and laying topsoil to a minimum thickness of 150 mm.

c) Dewatering and keeping the excavations clear of all types of water (rain, groundwater and sewage) shall be included in the relevant bill items.

II. Trench Excavation

a) The line and level of trenches shall be as shown on the drawings or as directed by the Engineer. Before commencing excavation, the alignment of the trench shall be pegged out accurately and the ground level shall be agreed with the Engineer.

b) Trench excavation shall be carried out by such methods and to such lines, dimensions and depth as required for the proper construction of the works.

c) Rock excavation shall be carried out to such width and depth to allow a working width of w = outer pipe diameter (ON) plus 600 mm and to allow placing of foundation and bedding as specified. Any excavation outside these limits shall be considered as over break.

III. Trimming Excavation

a) When excavation to specified levels for the foundation of structures or open channels or to the specified limits for the face of any structure requires to abut undisturbed soil, the Contractor shall not finish the final excavation until immediately before commencing the constructional work, except where the Engineer shall permit otherwise.

b) Before commencement of any construction work, all loose material shall be removed from the excavation by hand so as to ensure that the work rests on a solid and perfectly clean foundation or abuts against solid soil.

IV. Unsuitable Material

a) The Contractor shall be responsible for forming a sound foundation for concrete surface beds and concrete footings. Any additional excavation ordered by the Engineer to be carried out and the subsequent refilling with suitable material shall be measured and priced at Contract rates.

b) Should the material forming the bottom of any excavation, while acceptable to the Engineer at the time of his inspection, subsequently become unacceptable to him due to exposure to weather conditions or have become puddle, soft, loose during the course of the works, the Contractor shall remove such unsound material by hand.

c) Unsuitable material shall be removed from site and disposed of as instructed by the Engineer.

2.18.4 Supporting Excavation

a) If required or instructed by the Engineer, all sides of excavation shall be supported to prevent settlement or slip falls of ground, structures, and services adjacent to the excavation. Excavation required providing space for supports and working area as well as slip falls and settlement of ground adjacent to excavation are to be considered as over break. Remedial measures, repairs and related costs encountered due to settlement, slip falls, damages are to be carried out.

2.18.5 Disposal of Excavated Material

a) Excavated material which is not required immediately or is unsuitable for reuse in the works shall be disposed of. The Contractor shall give the Engineer adequate notice of his intention to spoil. Material ordered to be disposed of shall remain the property of SNV and shall be deposited at places approved by the Engineer.

b) Subject to any specific requirements of the Contract, the disposal of excavated material within the site shall be at the Contractor's discretion but shall be arranged as to be acceptable to the Engineer and to suit the overall requirements for the construction of the works. The Contractor shall ensure that no excavated material which is suitable for and is required for reuse in the works is disposed of outside the site.

c) The term "excavation" shall be deemed to include for disposing of excavated material in any of the following ways:

i. Backfilling to excavation and completed structures, other than trench excavation, using suitable excavated material and including placing in temporary spoil tips and any double handling required;

ii. Transporting selected excavated material to locations within the site where embankments are to be constructed or where filling around structures is specified to be constructed as embankment including tipping ready for spreading and compacting;

iii. Disposal of surplus excavated material outside the site;

iv. Topsoil and excavated material suitable for grassing shall be deposited in temporary separate spoil tips within the site;

v. Unsuitable material shall be disposed of as approved by the Engineer.

2.18.6 Blasting

a) No blasting will be permitted without the prior approval of Local Authorities and the Engineer. Blasting, if required, shall be carried out carefully and in such manner as to avoid damage to existing nearby structures within the site. The Contractor will familiarize himself with and conform to any local Authorities regulations concerning blasting. Costs for blasting including all administrative works, safety measures etc. are deemed to be included in the Contractor’s rates.

2.18.7 Existing Services

a) Notwithstanding any relevant information furnished by the Engineer or SNV or any public authority, the Contractor shall be solely responsible for ascertaining from his own inspection of the site and from the respective supply authorities and other public or private bodies the position of all pipes and cables whether underground or

overhead, within or near the site. SNV will assist wherever possible in obtaining all available information on existing services.

b) Where excavation is carried out close to or across or below existing sewers, pipes, cables or other services within the site, the Contractor shall, where required, provide temporary supports or slings. Where such sewers, pipes, cables or other services are damaged, the Contractor shall arrange for any repair works, replacement or costs resulting from such damages.

2.18.8 Excavation to be Kept Free from Water

a) The Contractor shall always keep the excavation free from flooding, whether above or below the groundwater table, by storm water, percolating water, subsoil water, sewage water or sewage effluent by pumping, bailing or other means. The Contractor shall always provide onsite enough pumping equipment for the needs of the Works.

b) The Contractor shall take all precautions to avoid undermining of any part of the works or other properties by pumping or else, but should undermining occur, he shall repair to the satisfaction of the Engineer.

c) In all cases where permission to use existing water courses, sewers, pipes for the discharge of liquids has been granted, it will be under the condition that the Contractor cleans out such facilities after completion of the works at the respective site.

2.18.9 Backfilling

a. Backfilling of the excavations shall not be carried out without the consent of the Engineer.

b. Excavation shall be carried out in such a manner that material which is unsuitable for backfilling and compaction shall be excavated separately and removed from the site.

c. Examples of unsuitable material for backfilling are the following:

   i. Materials from swamps, marshes and bogs;

   ii. Vegetable matter, timber or similar material liable to decomposition;

   iii. Materials susceptible to spontaneous combustion;

   iv. Clay or earth having excess liquid content;

   v. Any kind of soft, non-homogeneous fill material;

   vi. Rock over 100 mm in any dimension;

   vii. Polluting material.

d. Material for backfilling shall be deposited and compacted in layers of a maximum thickness of 250 mm and be appropriate to the compaction plant used. Thickness measured prior to compaction. Compaction shall be so carried out to ensure a value of 90% Proctor is achieved. The compaction methods and plant shall be selected to

avoid any damage to the permanent Works. All layers should be tested around the structure.

e. Supports to the excavation shall be carefully removed as the filling proceeds, but the removal of such supports shall not relieve the Contractor of his responsibility for the safety and stability of the works.

2.18.10 Offensive Matter

a) Any offensive matter found in the excavation shall be dealt with immediately by the Contractor. He shall remove, disinfect with chloride of lime or other strong disinfectant and cart away such matter to an approved site for burial or otherwise completely dispose of as necessary. Other precautions may be detailed by the Engineer.

2.18.11 Hardcore

a) Hardcore shall be graded hard limestone or other hard stone from an approved quarry, closely packed with all interstices filled in. When required, the top surface shall be finished to correct levels, irregularities broken off and a smooth surface shall be prepared to receive blinding, building paper or the like.

2.19 Supply of Materials

2.19.1 General

a) All materials shall be supplied from approved manufacturers only. The Contractor may be requested to submit a list of suppliers that he intends to use, together with the Tender Bid.

b) The Contractor shall also submit on request and for the approval of the Engineer, before ordering of materials: types of material to be used, dimensions, thickness, lengths, shape, weight, class, tolerance limits and quality; standards to which the item is manufactured, details of specials, adaptors, fittings and joints; and coating and lining methods.

2.19.2 Handover of Surplus Materials

a) Upon completion of the Works, the Contractor shall collect from the Site any surplus pipes and fittings, which have been provided. Where the purchase of these materials has been approved and paid for, the surplus pipes and fittings shall be handed over to SNV. Where the purchase of these materials has not been approved, they shall be removed from site and no payment made to the Contractor for them.

b) Where these surplus materials have been imported free of customs and duties under the project, the Contractor shall either pay the relevant customs and duties to the responsible authorities or else re-export the material out of the country.

2.19.3 Inspection by the Engineer

a) The Engineer reserves the right to inspect goods prior to delivery to site. The Contractor shall, on request, provide all necessary facilities to the Engineer to carry out such inspection.

b) Inspection or approval by the Engineer of any equipment or materials shall not release the Contractor from any of his obligations under this Contract.

2.19.4 Valves and Penstocks

I. General

a) The Contractor shall furnish all valves and penstocks and including the associated accessories for connections and installation as specified herein and as shown on the drawings and in the Bill of Quantities. All valves and other accessories shall be of the size specified and, as far as possible; all valves of the same type shall be of one manufacturer.

b) All valves and accessories shall have the name/trademark of the manufacturer, working nominal pressure (NP), nominal diameter (DN) and direction of flow cast on the body. All flanges for pipes, fittings, valves shall comply with BS 5163 for PN10/ 16. Manufacturer's full technical leaflets shall be supplied to the Engineer in triplicate by the contractor for approval prior to confirmation of any order. All valves shall be protected by fusion bounded powder or equivalent.

c) Stuffing boxes shall be of the O-ring or packing type, unless otherwise specified.

d) The Contractor shall submit construction / shop drawings to the Engineer for approval. Construction / shop drawings shall include:
   i. list and schedules of materials;
   ii. details of joints (and adaptors if necessary);
   iii. names of manufacturers; and
   iv. size, details, materials and thickness of all items.

e) All valves and accessories shall be designed for a working pressure of not less than 15 bar, unless otherwise specified such as on drawings and in the Bills of Quantities.

f) The Contractor shall submit a certificate from the manufacturer certifying that each valve meets the requirements of these specifications.

g) Valves shall be equipped with hand lever, hand wheel, operating nuts, or as specified. Operating nuts shall be approximately 50 mm square. Valves shall have arrows cast thereon to indicate the direction of rotation for opening the valve.

h) Except as otherwise provided herein, steel for bolts, anchor bolts and cap screws shall be in accordance with BS Standards and shall meet the following additional requirements: The nut material shall be free cutting steel, and the nuts shall be capable of developing the full strength of the bolts; All bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series; Bolts, nuts and washers shall conform to the flange schedule; Gaskets shall conform to the flange schedule and shall be of a rubber composition free of corrosion ingredients, either alkaline or acid.

i) Unless otherwise specified the face to face dimensions of Valve ends shall be flanged ends either basic series (14) or basic series 15 (long). Screws and rubber ring gaskets shall be provided by the Contractor, as necessary to join the valve with the pipe material supplied.

j) Unless specified all valves shall be made of cast ductile iron in accordance with mechanical 501 and shall have a coal tar epoxy coating, approved for use for wastewater, shall be applied to the ferrous part of the valve wastewater passages, except finished or bearing surfaces. Surfaces shall be clean, dry and free from grease

before application. Three spray coats shall be applied. Minimum dry coating thickness shall be 0.20 mm (8 mils).

II. Gate/ Sluice Valves

a) Valves shall be wastewater works Standard to BS 5163, and other relevant DIN Standards. All valves for the project shall be from one manufacturer.

b) Sluice valves shall be of the double-flanged ductile iron wedge-gate type unless otherwise specified. They shall have a ductile cast iron body with renewable gun metal faces on body and wedge and bolt-on cast iron bonnet Rising stem valves shall also incorporate a combined yoke.

c) Valves are to be hand-wheel operated and shall have anti clockwise opening.

d) Unless otherwise specified each valve shall be provided with a suitable hand wheel of adequate diameter for the duty required and gearing shall be supplied where necessary to ensure that the required operating force applied by hand to the rim of the wheel does not exceed 500 Nm.

e) Hand wheels shall have smooth rims and the direction of closing (cast into them words 'open' or 'closed', which shall be anti-clockwise, shall be cast on them. Vandal and weatherproof clear polycarbonate tube covers shall be securely fitted to protect the threads of rising stems and spindles and tubes shall be clearly and permanently engraved to indicate the position of the valve.

f) Valve stems shall be of stainless steel, machined all over and with a machine cut robust trapezoidal or square form thread and operating in a gunmetal nut.

g) Stem seals shall be of the stuffing box and gland form arranged for early replacement of packing and shall be accessible for maintenance without removal of the valve from service.

h) All hand wheels, headstocks, foot brackets, guide brackets and thrust tubes shall be of ductile iron.

i) Fixing nuts and bolts supplied by the manufacturer shall be as specified in the appropriate sections herein and in accordance to BS or DIN Standards.

j) Valves shall carry identification marks and/or plates in accordance with the BS or DIN Standards and those for use on process plant shall carry an additional brass plate carrying valve identification and a brief description of its function.

k) Valves shall be sized such that the velocity through the valve when fully open does not exceed 2.25 meters per second and the rated throughput. They shall have flanges and shall be capable of withstanding the same test pressure as the pipeline on which they operate. All nuts and studs subject to vibration shall be fitted with spring washers or locking tabs.

l) All valves shall be prepared and painted in accordance with the specification herein for painting and protective coating

III. Penstocks (Slide Gates)

a) Penstocks must be rectangular faced with full frame, standard invert and non-rising stem.

b) Penstocks shall be clockwise closing.

c) Penstocks shall be watertight under the conditions stated for head and direction of flow.

d) Metal parts exposed to the atmosphere shall be manufactured from stainless steel to BS 970 Part 1, Grade 316 S31.

e) The frame shall be fixed to the wall using nuts and bolts Grade 316 S31 stainless steel.

f) The door of the penstock shall be manufactured from corrosion resistant stainless steel (Grade 316 S31).

g) The seals used on corrosion resistant penstocks shall be suitable for the wastewater in which the penstock is immersed. Flexible rubber seals shall not be used on penstocks immersed in raw sewage for example, where sharp objects and grit may destroy the seal at the high velocities experienced when opening and closing the doors.

h) Frames and gates shall be made of cast-iron. The stem, stem extension and stem guides shall be made of stainless steel according to DIN 17440.

i) Bevel-gear boxes are to be mounted fully on the frame.

j) Floor pillar and hand wheel to be made of cast iron.

2.19.5 Pipes and Fittings

I. General Requirements

a) Where corrosion or abrasion may be expected from contact with wastewater, sediments or from any other cause, the Contractor shall supply suitably resistant materials. Any material showing signs of corrosion or distortion before the expiry of the defect's liability period shall be replaced with material approved by the Engineer, at the Contractor's own expense.

II. Polyvinyl Chloride (PVC) Pipes and Fittings (for Anaerobic filters and drainage)

a) Polyvinyl Chloride pipes and fittings shall be in accordance with DIN 8061, DIN 8062, BS EN 1401-1 and DIN 19534 or equivalent locally applied standards.

b) The pipes and fittings shall be Class 3 (6 bar), in which the nominal diameter and minimum wall thickness of pipes are indicated in the following table:

Diameter and Walls Thickness uPVC Pipes

Nominal Diameter	Wall Thickness
110	4.0
160	4.7
200	5.9
225	6.6
250	7.3
110	4.0
315	9.2
355	10.4

400	11.7
450	13.2
500	14.6

c) All joints on uPVC pipes runs shall be bell sealed with elastomeric gaskets. The ring type gaskets shall be of the type, which allow for expansion and contraction of the piping.

2.19.6 Storage and Testing on Site

a) All materials provided by the Contractor shall be stored in a proper storage area subject to the approval of the Engineer. The Contractor shall be responsible for cleaning, levelling and enclosing the storage site and shall provide all necessary security.

b) The Contractor shall at all reasonable times allow the Engineer free access to any place for inspection and testing. In all cases the Contractor shall satisfy the Engineer that all plant has been delivered in good and clean condition, and that identification markings are clear, and that stock piling is in an approved manner.

c) The Contractor shall keep detailed records in a form to be approved by the Engineer of all materials onsite showing the quantities of each type and class, which have been:

- received by the Contractor during the works;
- declared on delivery to be faulty, damaged or deficient,
- broken, damaged or lost during65 the works;
- found to be surplus to the requirements and held by the Contractor.

d) Such records shall be updated and delivered by the Contractor to the Engineer on a monthly basis.

e) The Contractor shall comply with the Engineer's instructions as to the disposal, repair or replacement of any pipe, fitting or valve which has been notified as being faulty, damaged or missing.

2.19.7 Handling Materials

I. Handling and Transport

a) The Contractor's arrangements for handling, lifting and transporting of all construction materials shall ensure that these items are brought to their final place on site, undamaged and in good order.

b) Pipes and pre-cast concrete parts shall be handled with utmost care and the Contractor shall provide means and methods approved by the Engineer wherever it is necessary to lift or lower pipes or other specials.

II. Distribution at the Site

a) In distributing the material at the site of works, each piece shall be unloaded adjacent or near to the place where it is to be laid.

b) The Contractor shall keep all construction materials, pipes and the appurtenances clean during the progress of the work. Dirt, debris or other foreign material shall be removed before installation of any material.

III. Inspection before Installation

a) All pipes and materials shall be carefully inspected and examined for cracks and other defaults installation in final position.

b) Material found to be damaged or defective shall be rejected and removed from the site. Any materials, which fail or become damaged, must be replaced with new or repaired materials as decided by the Engineer and without cost to SNV.

IV. Pipe Cutting and Handling

a) Pipe shall be cut from measurements taken at the site and shall be cut in a neat manner, without damage to the pipe. Cuts shall be smooth, straight and at right angles to the pipe axis. All pipe cutting shall be done with a fine-toothed hacksaw, or a portable power-driven saw with a steel blade or abrasive discs. Cut ends shall be beveled using a plastic pipe-beveling tool, which cuts the correct taper automatically. Methods for cutting and beveling the pipe shall be acceptable to the Engineer.

b) If damage occurs to any pipes, fittings or pipe accessories in handling, the damage shall be brought forthwith to the Engineer's attention. The Engineer shall prescribe corrective repairs or reject the damaged items. The Contractor shall stand the expense of repairing and replacing the same.

2.20 Drainage Pipe Laying

2.20.1 Pipeline Alignments

a) The Contract drawings show the alignment of the drainpipes. Before laying any section of the drainpipe, the Contractor or his representative shall inspect on site in company with the Engineer and obtain from him instructions in this respect.

2.20.2 Requirements for Pipe Laying

a) In as much as possible, the drain pipes shall be laid along the edge of the drying bed on the lowest side and buried with the filter bed material.

b) All pipes shall be laid in accordance with the alignment, levels and gradients as finally authorized by the Engineer. The finished drainpipe line shall run straight between along the edge or mid of the drying bed as shown in the contract drawings.

c) Perforated uPVC pipes shall be used for subsoil drains as required in these technical specifications or the contract drawings and shall be laid with no gaps between their ends.

d) A subsoil drain includes any type of drain designed to collect groundwater whether this is rising from below or percolating from the surface and may or may not include a pipe. It may also include impermeable membranes above or below the pipe or permeable filter membranes all as detailed on the drawings.

e) Trenches for subsoil drains shall not be less than 0.3 m wide or the outside diameter of the pipe plus 0.15 m whichever is the greater.

f) The Contractor shall lay the pipe in accordance to professional practice and install all fittings and specials as may be necessitated for the proper execution of the works. The Contractor shall joint the pipes in accordance with the Specification and to the Engineer's satisfaction.

2.20.3 Connections with Existing Piping

a) Connections between new work and existing piping shall be done using suitable fittings for the conditions encountered.

b) Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with existing operations.

c) Care shall be taken to avoid damage to the existing facilities. The Contractor shall be liable for making good any damage occurred.

d) Details for the connections to the existing pipes shall be provided by the contractor as part of the working drawings.

2.20.4 Pipe Flexibility

a) Unless noted otherwise on the Drawings pipes passing out of or into manholes, and under or from under structures, shall have their first flexible joint at a position not greater than one pipe diameter from the manhole or vertical line through the face of the overlying structure.

2.20.5 Junction and Drain Connections

a) All junctions are to be oblique and unless the connection is to be laid at the time the junction is laid, are to be fitted with suitable stoppers obtained from the manufacturer of the pipe.

b) No saddles shall be used except with the prior approval of the Engineer which will only be given in exceptional circumstances. If the Contractor omits to lay a junction as directed, then the Engineer may require the necessary pipe or pipes to be taken out and placed with the proper junction all at the Contractor's expense.

2.20.6 Grip bonding of uPVC Pipes and Fittings

a) All uPVC pipes and fittings passing through or into concrete shall be grip bonded in order to get a satisfactory bond with the concrete. This is achieved by painting the surface with solvent cement and, whilst it is still wet, sprinkling with dry coarse sand or grit. Once the surface has dried, it is ready to bond directly to concrete.

2.20.7 Concrete Encasement of Pipes

a) Concrete encasement of pipes will be provided where shown on the Drawings or as instructed by the Engineer. The dimensions of the encasement shall be as shown on the drawings. For wide crossings pipes will be encased in concrete and in addition protected by gabion bed. Where pipes are encased in concrete, they will be wrapped with PE sleeve.

2.21 Manholes and Inspection Chambers

2.21.1 General

a) Where the expression manhole is used, it shall apply equally to the rehabilitation of existing manholes and inspection chambers unless otherwise indicated. Location and dimensions of manholes and chambers are indicated in the contract drawings.

2.21.2 Materials

a) All manholes requiring rehabilitation shall be constructed using material similar or compatible with the original material used to construct the manhole or inspection chamber. The manhole covers shall be prefabricated concrete.

b) Sulphate resistant Portland cement shall be used for all concrete and mortar subjected to contact with sulphate and/or chloride containing soils or subjected to contact with sewage or sewage gas.

c) Manholes will be inspected by the Engineer only after completion of rehabilitation and construction works and of all connections.

2.21.3 Workmanship

a) All inlet and outlet pipes shall be joined to manholes by means of inlet and outlet wall pieces cast into the concrete.

b) The cover for manholes shall be reinforced prefabricated concrete slab complete with handles and of size as shown in the drawings.

c) The Contractor shall exercise extreme caution not to cause further damage to the existing manholes. Where instructed, the Contractor shall replace the manhole covers with the approved type for the project.

d) Inspection chamber covers shall be reinforced precast concrete complete with handles and of sizes as shown in the drawings.

e) Manholes and inspection chambers shall be visually inspected for water tightness against infiltration after backfilling operations have been completed and when the water table is at its highest. Under these conditions no infiltration flow shall be admissible.

2.22 Concrete

2.22.1 General

a) The standard of materials and of workmanship shall be not inferior to the recommendations of the standards referred to in technical specifications. All concrete works shall comply with the following standards:

☐ DIN 1045 Reinforced concrete structures design and construction

☐ DIN 1048 Testing methods for concrete

☐ DIN 1084 Quality control of concrete structures

☐ DIN 4235 Compacting concrete by vibrating

☐ ACI 305 Hot weather concreting

b) The costs of all tests of concrete and/or its components shall be deemed to be included in the rates.

c) All equipment employed for concrete works require the approval of the Engineer prior to dispatching to the Project.

2.22.2 Materials

I. Cement

a) The cement to be used in the works shall be obtained from an approved manufacturer and shall comply with the requirements of DIN 1164.

b) All cement to be used in works being in contact with treatment plant effluent, anaerobic gas emissions or below ground level shall be sulphate resisting Portland cement (SRPC).

II. Certificate for Cement

a) For each delivery of cement, the Contractor shall furnish, free of cost, a test certificates as directed by the Engineer, relating to the cement to be used on the work. Analyses of the cement shall be shown.

III. Storage of Cement

a) The Contractor shall provide a well-ventilated waterproof shed or sheds to store the required amount of cement. Each shed shall have a suitable floor built at such a height that the cement is always kept dry. Delivery and stacking shall be arranged in such a way that the various consignments can be used in the order of their delivery. Cement shall not be taken from the shed until immediately before its use in the works.

b) Different types of cements shall be stored in separate compartments. If intermixing occurs all cement concerned will be condemned by the Engineer and shall be removed immediately from site.

c) No cement which, in the opinion of the Engineer, has deteriorated or hardened shall be used on the works and such cement shall be immediately removed from site.

d) Any cement which is stored on site for a period in excess of 28 days shall be tested in accordance with the relevant Standard prior to use.

IV. Natural Aggregate

a) All aggregates shall comply with the requirements of DIN 4226.

b) The fine aggregate shall consist of siliceous natural sand, having hard, strong durable particles and shall come from an approved source. It shall be clean and free from salt or organic matter.

c) Coarse aggregate shall consist of gravel, crushed gravel, or other approved inert materials of similar characteristics and shall be clean, hard and sound. No material of a shale or schistose nature shall be used.

d) Aggregates shall not contain more than 0.5% by weight of clay. The sulphate content shall not exceed 1% by weight.

e) Aggregates shall be screened or washed, if so directed by the Engineer.

f) Each type and grading of aggregate shall be stored separately in bins of a type and size approved by the Engineer. They shall be provided with flooring of concrete or other approved material having sufficient slope to ensure adequate drainage of surplus water.

g) The chloride and sulphate content of the aggregate shall be determined and in all cases be considered together with the content in the mixing water.

h) Sieve and sedimentation tests shall be carried out when the first delivery is effected and thereafter at intervals as directed by the Engineer.

V. Water for Concreting

a) The water used for mixing or curing of concrete and washing the aggregates shall be clean and free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances. No salty water shall be used. DIN 4030 shall apply.

b) A thorough chemical water analysis shall be done before using a certain water source for concrete mixing and test certificates from an independent laboratory shall be approved by the Engineer.

c) When comparative tests are done with distilled water of known quality, any indications of unsoundness, marked change in time of set, or reduction of more than 10% in mortar strength shall be sufficient cause for the rejection of the water under test.

d) The Contractor shall not take water for use in concrete from shallow, muddy or marshy sources.

VI. Admixtures and Additives

a) Preliminary strength tests shall be carried out to ensure that admixtures and additives do not adversely affect the concrete to which they have been added.

b) Additives may be added to the concrete if they do not adversely affect the strength and durability of the concrete and the corrosion protection of the reinforcement.

c) In no case shall admixtures or additives be added to concrete, cement mortar or grout without the express permission of the Engineer in writing.

d) Additives and admixtures, if approved by the Engineer, shall be used strictly in accordance with the manufacturers' instructions.

e) Chloride based admixtures will not be allowed.

2.22.3 Concrete Mixes

I. Quality of Concrete

a) The class of concrete required is specified in the following tables, on the drawings and/or in the Bills of Quantities for the particular position of the works to be constructed.

b) The quantity of water added shall only be sufficient to produce a dense concrete which

c) can be fully compacted without undue difficulty, due allowance being made for the moisture content of the aggregates.

d) The strength class of concrete shall be as designated in the following Tables:

Concrete Strength Class	Minimum Nominal Compressive Strength of each test cube after 28 days of hardening [N/mm2]	Minimum Average Standard Compressive Strength of each series of test cubes [N/mm2]	Remarks
B5	5	8	only for lean concrete
B10	10	15	only for lean concrete
B15	15	20	for blinding concrete in normal structures and
B25 *	25	30	for R.C. in structure including water retaining structures and concrete in direct contact with sewage or treatment plant effluent.
B35	35	40	Where specified or detailed

Or

Concrete Strength Class	Minimal Nominal Compressive Strength of each test cylinder fck,cyl [N/mm2]	Minimal Nominal Compressive Strength of each test cube fck,cube [N/mm2]]
C8/10	8	10
C12/15	12	15
C16/20	16	20
C20/25	20	25
C25/30	25	30
C30/37	30	37
C35/45	35	45

II. Design of Concrete Mixes

a) Before commencing any concrete work, the Contractor shall design the mixes for the concrete which he proposes to incorporate in the Permanent Works. Each mix shall be designed to produce the required class of concrete having a characteristic strength not less than the appropriate value specified above. Each design mix shall fulfil the following requirements:

i) The combined grading of coarse and fine aggregate shall be continuous;

ii) The proportions and properties of the mix shall be within the limits set out for the various classes and types of concrete described in this Specification;

iii) The water/cement ratio shall be consistent with attaining the average strength but without the ratio exceeding the specified maximum. The aggregate/cement ratio shall be suitable to achieve the minimum workability consistent with proper compaction by the methods specified.

b) When submitting his proposals for design mixes to the Engineer, the Contractor shall provide, in addition to details of his cement, aggregates and water as specified earlier, details of:

   i) The proportions in which the dry materials are to be mixed, including the aggregate/cement ratio, cement per cubic meter of compacted concrete and the sieve analyses of the individual and combined aggregates;

   ii) The water/cement ratio to be adopted;

   iii) The workability of the mix and the range in which it is to be maintained;

   iv) The 28-day individual and average strengths for at least six previously obtained test cubes;

   v) The individual and average densities of the six cubes;

   vi) The dates on which the cubes were made and tested;

   vii) Any other relevant information.

c) Following the Engineer's approval of the design mixes, the Contractor shall prepare trial mixes of each class of concrete in the presence of the Engineer's Representative. Each batch shall be not less than 0.5 m^3 of concrete and shall be mixed in the same mixer which the Contractor proposes to use throughout the construction of the Works. Sieve analyses and moisture content determination shall be done on the aggregates. The batches of concrete shall be mixed as specified herein and tested.

d) The Contractor shall allow sufficient time in his program for designing and preparing trial mixes and testing test cubes obtained there from.

e) If during the course of the works the concrete fails to comply with the specified requirements or the source of aggregate or cement should differ from those with which the preliminary design mixes were carried out, the Engineer will instruct the Contractor to prepare further design mixes, which will be tested in accordance with the above procedure.

III. Water-Retaining Concrete and Concrete in Contact with Effluent

a) Waterproof concrete for components with a thickness of 100 mm to 400 mm shall be so dense (impermeable) that the greatest depth of water penetration on testing in accordance with DIN 1048 does not exceed 50 mm.

b) The water/cement ratio shall be not more than 0.50 for components with a thickness of about 100 mm to 400 mm and not more than 0.45 for sections more than that.

c) The cement content of waterproof concrete of a class less than B35 (or C30/37) shall not be less than 370 kg/m^3. The grading of the aggregate shall be within the favorable range according to Fig. 2 or 3 of DIN 1045.

d) Where waterproof concrete is required, the Contractor shall take full responsibility for ensuring that such construction is completely waterproof (crack-free). Any leaks appearing during the construction and maintenance period of the Contract shall be completely repaired by the Contractor. The method proposed by the Contractor for dealing with shrinkage cracks, leaks, or other defective work shall have no adverse effect on the finished structure. Treatments of internal and external concrete surfaces of water retaining structures, etc. (coatings or toppings) does not relieve

the Contractor of this obligations under the Contract. These treatments shall be considered as an additional step for waterproofing and/or resistance to chemical attack.

e) Special attention shall be given to the elimination of cracking due the shrinkage of the concrete. In this connection consideration should be given to the following:

   i) Cement content should not exceed 400 kg/m³;

   ii) Reduction of cement content (The minimum cement content is 370 kg/m³);

   iii) Curing of concrete. In this connection it should be understood that if all formwork is left in position for protracted periods, proper curing cannot be carried out;

   iv) Provision of construction/contraction of watertight joints at intervals not exceeding 7m.

f) Testing for water tightness shall be performed as described in relevant section.

IV. Pre-Cast Concrete

a) Concrete for pre-cast sections shall be Class B25 (or C20/25), unless stated otherwise.

V. Concrete with High Resistance to Chemical Attack

a) All concrete to be used in sewage, in contact with sewage gas or ground water retaining structures shall conform to Class B35 (or C30/37). This type of concrete shall be so dense that the greatest water penetration depth on testing (of at least 3 samples) does not exceed 5 cm. These structures are considered under "strong" chemical attack. The water/cement ratio must not exceed 0.50 for any case.

b) Concrete which is exposed to strong chemical attack for a substantial length of time should be protected against direct access of the aggressive substances. In addition, this concrete should be as composed as is required for strong attack.

c) Only sulphate resistant Portland cement (SRPC) shall be used for concrete, grout, benching, etc.

VI. Concrete in Contact with Plant Effluent, sludge or Sewerage

a) All concrete in contact with sludge, sewage or plant effluent shall be water retaining and shall have high resistance to “strong” chemical attack in accordance with the clauses of this specification document

VII. Weigh Batching

a) All materials used in the production of concrete shall be measured by weight, except in the case of small quantities of low-grade concrete volume where batching may be used, subject to the Engineer's approval. Coarse and fine aggregate shall be measured separately using approved weigh-batching machines capable of measuring increments of not more than 5 kg.

b) The concrete mixer shall be fitted with a water tank and a proper device for the accurate measurement and easily controlled adjustment of the quantity of water to be added to the mix. The quantity of water added to each batch shall be accurately measured and so adjusted for changes in the moisture content of the aggregate to maintain the correct water content of the mix.

c) Where the Engineer has approved the measurement of small quantities of low-grade concrete by volume, the gauge boxes shall be accurately calibrated and of robust construction. They shall have closed bottoms, be as deep as practicable in shape and clearly marked for the mix and aggregate for which they are intended.

VIII. Concrete Mixing

a) The Contractor shall include in his rate for making daily tests to determine the grading of the aggregates and the proportions of the various mixes will then be adjusted as required. The quantities shall be arranged to suit the use of approved weigh-batching plant or when approved, gauge boxes.

b) The mixing of the concrete in the machine shall continue for at least one minute after the last of the ingredients composing the batch have been added.

c) The concrete shall be placed as soon as possible after having been mixed. If the mixer is stopped for any period over twenty (20) minutes, it shall be washed out before being re-used. In all cases half of the coarse aggregate shall be omitted from the first batch in a clean mixer at the commencement of concreting.

d) Hand mixing may be allowed where small quantities of concrete are required and where approved by the Engineer. It shall be done on a watertight platform and in such a manner as to ensure a uniform distribution of the materials throughout the mix. Mixing shall be continued until a homogeneous mixture of the required consistency is obtained. When hand mixing is authorized then an extra 10% of cement shall be introduced into the concrete mix.

e) Truck mixers can be used if authorized by the Engineer. They shall be of the revolving type, watertight and so constructed that the concrete can be mixed to ensure a uniform distribution. When truck mixers are approved to supply concrete to a distant location, the Contractor shall ensure that the following information is supplied on an approved delivery form:

   i) Type of concrete and ingredients used;

   ii) Water/cement ratio;

   iii) Type and quantity of approved additives to the concrete mix;

   iv) Time of departure from batching plant;

   v) Slump;

   vi) Signature of plant manager.

f) No concrete shall remain in a revolving truck mixer for more than 1½ hours.

g) The rate of delivery of concrete during concreting operations shall be such as to provide for proper handling, placing and finishing of the concrete as well as the continuous non-stop concreting for the same member or location until its completion.

2.22.4 Transportation of Concrete

a) Concrete shall be discharged from the mixer and transported to the works by means approved by the Engineer and shall prevent adulteration, segregation or loss of ingredients and ensure that concrete is of the required workability at the point and

time of placing. All concrete shall be conveyed from the mixer to the place of deposit in the works as quickly as possible

b) Where approved by the Engineer, the Contractor may use a suitable concrete pump for transporting the concrete from the mixer to where it is to be deposited, in which case the specified mix proportions shall be suitably adjusted and agreed with the Engineer. The concrete shall be fed directly from the mixer into the hopper of the pump. Once concreting has commenced the rates of the flow and mixing must be such as to ensure continuous movement of the concrete in the pipe work which shall have as few bends as practicable. Frequent slump tests shall be carried out at the delivery end to ensure the consistency of workability at the point of placing. All equipment must be thoroughly cleaned at the end of each operation. The water used for this purpose shall be discharged outside the shuttering and clear of all other Works.

2.22.5 Placing of Concrete

a) The Contractor shall submit in due time for approval by the Engineer a schedule of the proposed working procedure, indicating time and sequence of concreting sections. Placing of concrete shall start only after written authorization of the Engineer and with the Engineer's or his representative's attendance.

b) The Contractor shall keep on site a complete record showing the date when any concrete was placed. This record shall always be available to the Engineer.

c) If ordered by the Engineer, because of better weather conditions, concreting may be done at nighttime. In such case enough lighting shall be installed by the Contractor.

d) In preparation for the placing of concrete all sawdust, chips and other construction debris and extraneous matter shall be removed from the interior of forms. Struts, stays and braces, serving temporarily to hold the forms in correct shape and alignment, shall be entirely removed from the forms during the progress of the concreting and not buried in the concrete.

e) Concrete shall be placed in such manner so as to avoid segregation of the materials and the displacement of the reinforcement. The use of long troughs chutes and pipes for conveying concrete from the mixer to the forms shall be permitted only on written authorization of the Engineer. Open troughs and chutes shall be metal lined. All chutes, troughs and pipes shall be kept clean and free from coatings of hardened concrete.

f) The concrete shall be placed promptly, with a minimum of handling, to avoid the segregation of aggregates or the displacement of the reinforcement. Where concrete is being placed, a competent steel fixer shall be in continuous attendance to adjust and correct the position of any reinforcement bars which may be displaced.

g) Where placing involves dropping the concrete more than 2 m, it shall not be freely dropped vertically, but must be deposited through sheet metal or other approved pipes.

2.22.6 Compaction of Concrete

a) All concrete shall be compacted by mechanical vibrators. The vibration shall be carried out with internal vibrators of a type, size and design approved by the Engineer.

b) The Contractor shall provide a enough vibrators, including replacement, to properly compact each batch immediately after it has been placed in the forms, and shall at all times have standby vibrators in case of breakdown. Concreting shall not commence until a enough vibrators are available.

c) Vibrating shall be applied at the point of deposit and in the area of freshly deposited concrete. The vibrators shall be inserted and withdrawn from the concrete slowly. Vibrating shall be sufficiently long and intensive to ensure thorough compaction of the concrete but short enough to avoid its segregation.

d) Vibrating shall not be applied directly on the reinforcement. It shall not be used to work the concrete along the forms of in such a way as to damage the forms or other parts of the structures or displace the reinforcement or other embedded items.

e) The provisions of this clause shall also apply to precast members except that, if approved by the Engineer, external vibrating or manufacturer's methods of vibrating may be used.

f) Lean concrete for blinding course may be compacted by tamping.

g) Once compaction of the concrete is completed, the Contractor shall take all precautions necessary to avoid any disturbance of the concrete from walking upon, wheeling over, or by vibrations of the shuttering in any way until the concrete is thoroughly set and hardened. No traffic of any kind will be permitted on the concrete for a period of at least 7 days. Special care shall be taken to ensure that the reinforcement projecting from the concrete is not disturbed in any way whilst the concrete is hardening.

2.22.7 Resumption of Work at Joints

a) Concreting shall be carried out continuously up to joints, the position and arrangement of which shall be as indicated on the Drawings or as approved by the Engineer.

b) When concreting has been interrupted before completion of the pour the surface of the concrete shall be cut away as directed by the Engineer and laitance removed.

c) The bonding of fresh concrete on or against older concrete, which has hardened, shall be done in the following manner:

   i) When the older concrete is not more than 4 hours old, the fresh concrete shall be placed without further preparation, but half of the coarse aggregate shall be omitted from the first layer of concrete placed.

   ii) When the older concrete is more than 4 hours old, the surface of the hardened concrete shall be roughened, wire brushed or, if possible, sand blasted to expose the coarse aggregate without leaving loose particles at the surface. This surface shall be washed.

   iii) Before placing the new concrete, a thin layer of cement mortar (slurry) shall be applied to the surface of the older concrete. The mortar shall consist of cement

and sand mixed in the proportion contained in the concrete mix, i.e. omitting the coarse aggregate. The fresh concrete shall be placed against the layer of mortar while it is still plastic, but half of the coarse aggregate shall be omitted from the first layer of concrete.

2.22.8 Hot Weather Conditions

a) The Contractor's attention is drawn to ACI 305 entitled "Hot weather conditions". The Contractor's methods shall comply with the recommendations in that document as modified and supplemented below.

b) When the shade temperature is above 35°C, special precautions shall be taken during concreting and curing to the satisfaction of the Engineer. In this case, and as far as may be necessary, water and the aggregate should be cooled.

c) The temperature of fresh concrete must not exceed 30°C.

d) Concreting shall not be carried out when the shade temperature is above 40°C. It shall then preferably be carried out at night.

2.22.9 Curing and Protection

a) In hot dry weather suitable means shall be provided to avoid premature stiffening of concrete placed in contact with hot dry surfaces. Where necessary the surfaces, including reinforcement, against which concrete is to be placed shall be shielded from the direct rays of the sun and shall be sprayed with water to prevent excessive absorption of water from the fresh concrete by the surfaces against which it is placed.

b) During placing and the first stages of hardening, concrete shall be protected against the effects of sunshine, drying winds and rain.

c) For the purpose of strength attainment, desired impermeability and shrinkage crack prevention, concrete surfaces shall be protected and kept moist. The covering shall be placed as soon as the concrete has hardened sufficiently to support the covering without damage. The type of covering provided shall be that in the judgement of the Engineer is best suited to the conditions.

d) If, in the judgement of the Engineer it is necessary to use pump, piping, and hose for proper curing, the Contractor shall provide adequate water distribution to all parts or the Works so that complete and efficient curing can be achieved throughout the whole period of construction.

e) Concrete surfaces shall be protected and cured in the following manner:

   i) The concrete shall be kept moist for a continuous period of at least 14 days after placing by covering it with moist sand, wet sacks, canvass, fiber mats or other satisfactory material capable of retaining the moisture, or by providing a sprinkler system.

   ii) Utilizing an approved non-bituminous pigmented liquid curing compound of an adequate type. The compound shall be applied strictly in accordance with the recommendations of the manufacturer. This compound shall not be applied on concrete surfaces of movement or construction joints.

2.22.10 Excessive Heat of Hydration

a) The Contractor should take all measures and precautionary actions to allow for proper and sufficient means for transfer of heat evaluated by hydration of cement in the concrete mix, especially in thick sections and massive concrete casting.

b) These measures and actions shall be proposed by the Contractor for approval of the Engineer.

2.22.11 Testing of Concrete

I. General

a) The approval of the Engineer of any materials, proportions or results given under this section shall not relieve the Contractor from his obligations in connection with the requirements for permanent works concrete.

b) Concrete for testing shall be taken from the point of placing. Sampling shall be carried out and tests made in accordance with an approved procedure.

c) The Contractor is responsible for the provision of the molds and assisting the Engineer in taking concrete samples for the execution of the tests and for considering the results of such tests in the execution of the Works.

II. Testing of Fresh Concrete

a) Compacting Factor Test. This test shall be carried out at the preliminary testing stage and whenever a concrete sample is taken for the making of works test cubes. Values for acceptable factors are indicated in the table following "Slump Test".

b) Slump Test. This test shall be carried out regularly as an aid to maintaining uniform consistency of concrete during the progress of the Works. Acceptable values of the slump are indicated in the following table:

Purpose	Compaction Factor	Sump (mm)
High-strength concrete sections, paving and mass concrete compacted by vibration	0.78 - 0.85	50 – 75
Normally reinforced concrete sections compacted by vibration. Hand- compacted mass concrete in normally reinforced slabs, beams, columns and walls	0.85 – 0.92	75 – 100
concrete in normally reinforced slabs, beams, columns and walls	0.92 – 0.95	100 – 130
Heavily reinforced concrete sections compacted without vibration and work	over 0.95	100 - 130

III. Testing of Hardened Concrete

a) General: The Contractor's methods shall comply with BS EN 12390 "Testing hardened concrete" as modified and supplemented below.

i) Concrete test cube results shall be used to determine the suitability from strength considerations of concrete to be incorporated in the permanent works. Hardened concrete shall be deemed to be unacceptable for the Works should the corresponding test cube results fail to meet the Specification and in this event

the Contractor shall take all necessary remedial measures as directed by the Engineer.

ii) For the making of test cubes the Contractor shall provide a enough but at least 12 nos. of 200 mm standard steel molds. The costs of assisting the Engineer in taking samples and providing the molds shall be included in the Contractor's rates for concrete and no additional payment for such assistance shall be made.

b) Preliminary Test Cubes shall be taken from the proposed mixes as follows:

i) For each class a set of 6 cubes shall be made from each of 3 consecutive trial batches. 3 from each set of 6 shall be tested at an age of 7 days and 3 at an age of 28 days.

ii) The cubes shall be made, cured, stored, transported, and tested in accordance with approved standards.

iii) At each age of test no cube strength shall fall below the appropriate specified minimum for preliminary strength tests.

c) Works Test Cubes:

i) These cubes shall be made from works concrete samples taken from the point of placing as and when directed by the Engineer. Normally for each grade of concrete, 6 cubes shall be made from concrete taken at random, 3 cubes from each set shall be tested at an age of 7 days and 3 at an age of 28 days.

ii) Cubes will generally be required at least as follows:

- For every 25 m^3 of concrete placed;
- For each important structural member;
- As otherwise directed by the Engineer.

i) The cubes shall be made, cured, stored, transported, and tested as specified.

ii) A record of such tests identifying the test cubes with the part of the work executed shall be kept on the Site by the Engineer and made available to the Contractor.

iii) The appropriate strength requirement shall be considered to be satisfactory if none of the strengths of the three cubes tested at each age is below the specified cube strength, or if the average strength of the three cubes is not less than the specified cube strength and the difference between the greatest and the least strengths is not more than 20% of that average.

iv) If the expected 28day cube strength is to be estimated from the 7day cube strength in preliminary tests and quality control tests, this may in general be done by applying the factors given in the table below, to the values of the 7day cube strength:

Cement Strength Class	**28-Day Cube Compressive Strength ßw28**
Z 35	1.4 x ßw7
Z 35 L	1.3 x ßw7
Z 35 F; Z 45 L	1.2 x ßw7
Z 45 F; Z 55	1.1 x ßw7

(according to DIN 1045)

or:

Cement Strength Class		Compressive Strength [N/mm²]			
		2 days	7 days	28 days	
32,5	N	---	☐ 16	☐ 32,5	☐ 52,5
	R	☐ 10	---		
42,5	N	☐ 10	---	☐ 42,5	☐ 62,5
	R	☐ 20	---		
52,5	N	☐ 20	---	☐ 52,5	---
	R	☐ 30	---		

(according to DIN EN 197-1)

v) The hardening test gives an indication of the strength of the concrete in the structure at a particular time and thus also gives guidance as to the formwork stripping time as determined in the following table:

Cement Strength Class	**Lateral Formwork of Beams and Formwork of Walls and Columns [days]**	**For the Formwork of Ceiling Slabs [days]**	**For the Formwork of Beams, Frames and Wide Spread Slabs [days]**	**For Lateral Formwork of Walls for Water Retaining Structures * [days]**
Z 25	4	10	28	28
Z 35 L	3	8	20	20
Z 35 F, Z 45 L	2	5	10	10
Z 45 F, Z 55	1	3	6	6

* For design requirement, walls of closed tanks should not be subjected to any lateral forces before the final hardening of the roof slab due to the propping action induced by the slab.

vi) The hardening can be determined, in accordance with approved standards, on test specimens or by non-destructive means.

vii) The specimens for these tests shall be made from the concrete intended for the structural components in question and be stored directly beside or on these components and be cured in the same manner (influence of temperature and humidity). At least three specimens shall be made for the hardening test, but it is advisable to make more specimens so that if the strength determined in the test is found to be inadequate the test can be repeated.

viii) Components whose dimensions vary significantly from those of the test specimens may attain a different degree of hardening from that of the specimens, e.g. due to differences in heat evolution in the concrete. Due account should be taken of such factors when assessing test results.

ix) If, due to lack of compressive strength test results, or if there is reason to doubt the strength of concrete in any particular section, it may be necessary to determine the compressive strength of the concrete by taking specimens from the structure or, if authorized by the Engineer, by non-destructive testing performed on the finished component or by both methods. In connection with such tests the age and the conditions of hardening (temperature, humidity) of the concrete in the structure shall be considered.

2.22.12 Surface Finish and Treatment

I. General

a) Before any concreting commences the Contractor shall submit details and calculations for all shuttering necessary for the carrying out of the work. Any damage due to insufficient strength of shuttering is to be made good by the Contractor.

b) Shuttering shall be so designed and constructed that the concrete can be properly placed and thoroughly compacted and that the hardened concrete while still supported by the shuttering shall conform accurately to the required shape, position, and level, subject to the tolerance and to the standards of finish specified.

c) The rates for concreting shall include shuttering and for all types of cutting and waste and for forming of 25 mm x 25 mm chamfers at all exposed arises or as otherwise indicated on the Drawings.

d) The qualities of finish shall not be inferior to those hereafters described. If minor porosity is evident on removing shuttering, the Engineer may approve a surface treatment by rubbing down with cement and fine aggregate mortar of the same richness as in the concrete in that particular portion of the Works. This treatment shall be carried out immediately after removing the shuttering.

II. Shuttered Surfaces

a) All surfaces of concrete, especially those exposed to view, including all pre-cast structures, shall be cast against steel or planed timber formwork. All visible edges shall be chamfered as ordered by the Engineer.

b) Where necessary and ordered by the Engineer, the surface shall be rubbed with a carborundum stone or an abrasive of equal quality to remove form marks and projections, thereby leaving a smooth, dense surface without pits or irregularities.

c) Any surfaces, irrespective of the shuttering employed, which show honeycombing, voids or air holes, shall be made good to the satisfaction of the Engineer. Cutting back the concrete behind the reinforcement or to such depth as is required and/or the Engineer may specify, and any other repair, shall not be started without the inspection and approval of the Engineer. Resin grouting or other approved suitable materials may be applied.

d) All concrete surfaces shall be protected against damage and disfigurement and the Contractor shall remove all blemishes and repair all such damages to the satisfaction of the Engineer.

e) All costs for making good honeycombed and defective concrete and repairing damaged surfaces shall be deemed to be included in the rates.

III. Surfaces Not Requiring Shuttering

a) All upper surfaces of concrete shall be thoroughly worked during the placing operation to produce a smooth finish free from water, coarse aggregate and air pockets or honeycombs.

b) The Contractor shall be required to prepare tests or samples under the direction of the Engineer, and the method and manner of finish, the choice and selection of the aggregate and other features affecting the work, shall be approved before any further work is done.

c) The surfaces shall be formed by placing an excess of concrete within the forms and removing or striking of such excess with a wooden template. The surface shall then be tamped to an even finish, aided where indicated by approved floats to give a dense surface with a minimum of cement and fine materials. The tamping shall not be done to the extent of bringing an excess of fine materials to the surface. The use of mortar topping shall only be permitted when indicated on the Drawings.

d) The final finish of concrete surfaces shall be executed in the following ways, as shown on the Drawings and/or Bills of Quantities or as directed by the Engineer:

   i) Rough finish: Shall consist of levelling and screeding concrete to produce a uniform and plain surface for structural members such as lean concrete, subsequent stages of construction, bonded concrete, surfaces with mortar topping and paving.

   ii) Scratched finish: As before, but the surface shall be roughened before the final set to increase the future bond between structural members.

   iii) Floated finish: After the concrete has been struck off, the surface shall be floated with a fine or rough wooden plasterer's float. Cork floats may be used. This finish shall be used on tops of foundations, columns, beams and all normal structural members.

   iv) Troweled Finish: In line with the above, the final troweling shall be carried out after floating using a steel trowel to produce a finished surface free of trowel marks, uniform, smooth in texture and appearance. This finish shall be used for floors surface of water retaining structures as well as for floors where specified and/or directed by the Engineer.

   v) Broom or belt finish: In line with the above, the surface shall be finished to produce a non-skid, coarse transversal score texture. This finish shall be used for slabs of pedestrian access and in other locations where specified and/or directed by the Engineer.

IV. Treatment with Chemical Hardeners

a) Where specified in the Bill of Quantities, the surface of slabs requiring high wearing resistance shall be treated with chemical hardeners. Only approved materials from recognized manufacturers withstanding medium to heavy stress and strain and resistant to chemicals, which have been approved by the Engineer may be used. The application of chemical hardeners shall be in strict accordance with the manufacturer’s instructions.

b) After the curing of concrete slabs with broom finish or other finish already executed, the surfaces are to be washed and brushed down with water to clean all dirt, oil, grease and dust, and then allowed to dry before application of the chemical hardener.

c) The hardener is to be poured on the totally dry slab and spread evenly with a broom. When the hardener has been fully absorbed, but before the slab is dried out, all surplus material is to be swilled off. Second and third coats are applied similarly.

V. Damp Proof Protection

a) To protect surfaces of footings, tie walls, tie beams, column necks against aggressive soil, all surfaces of concrete in contact with earth shall be protected by the use of cold bitumen solution type D complying with BS 743 applied in two coats to give uniform and impervious finish.

2.22.13 Joints in Concrete

I. General

a) The Contractor is referred to the various types of joints required in the various structures and which are indicated in the drawings.

b) Only those joints itemized in the Bill of Quantities or specifically ordered by the Engineer will be measured and paid for as separate items otherwise they are deemed to be included in the rates for concrete.

c) The cost of the joints shall include for all labor and materials in forming the joint as shown on the drawings including, where required:

i) Shuttering, notching for passage of reinforcement if necessary and cutting for passage of water stop

ii) Water stop and jointing;

iii) Expansion joint filler;

iv) Formation of grooves and sealing with approved sealing compound;

v) 20 mm dowel bars, 1 m long, with sleeve and packing, where shown on the drawings;

vi) Adequate grout checks.

II. Construction (Day) Joints

a) Concrete bond across the joint shall be effected by removing the surface laitance and exposing the aggregate on the joint face as soon as the concrete has hardened. The surface shall be thoroughly washed with clean water and reinforcement steel (where present) must be properly cleaned prior to the resumption of concreting.

b) The proposed position of the construction joints shall be submitted to the Engineer and approved by him before construction of each separate structure is commenced. A joint shall be made wherever concreting is finished for the day, or whenever concreting is stopped for any reason.

c) All joints of water retaining structures shall be made watertight by introducing 200 mm wide rubber water stop bar placed and fixed in the middle of the section width. The rubber water stops (or metallic if required) shall have the approval of the Engineer for its type and quality.

d) The cost of construction joints shall be deemed to be included in the rates for concrete.

III. Movement Joints

a) Movement joints, if required, shall be constructed in the positions as shown on the drawings or as directed or approved by the Engineer.

b) Movement joints are measured separately, and items are included in the Bill of Quantities for the various joints in each of the structures.

c) Where indicated on the drawings, dowel bars shall be positioned across the joint. They shall have sawn ends and shall be provided with and secured to steel cradles on each side of the joint. They shall be placed with the midpoint of the longitudinal axes intersecting the plane of the joint at right angles, half the length of the bars being suitably coated to prevent bonding. Fitted over the coated length shall be a loose cardboard or plastic sleeve, closed and packed with glass fiber for a depth of 75 mm at the end of the bar remote from the joint.

d) Where shown on the drawings or as directed by the Engineer, joints shall be sealed on one or both faces as required. On the face or faces requiring sealing, a groove of the shape and dimensions shown on the standard joint details shall be formed. Not earlier than fourteen days after the placing of the concrete, or when otherwise directed by the Engineer, the groove shall be cleaned, dried if necessary, primed and filled with a suitable approved mastic sealing compound to the underside of the chamfers. The sealer shall be prepared and applied strictly in accordance with the manufacturer's instructions.

e) Partial contraction joints (for water retaining structures only) to be proposed by the contractor for the approval of the Engineer with a maximum span of 7.0 m.

2.22.14 Joint Sealing

a) This section covers the work involved in delivery and placing of jointing material and joint sealing in concrete structures.

I. Jointing Materials

a) Expansion joints shall be filled with an approved jointing material which shall be compressible and resistant to weathering and extrusion.

b) The jointing material shall be kept back from the face as indicated in the joint detail drawings, formed recesses shall be primed and sealed with an approved sealing compound.

c) The Contractor shall be held responsible for the quality of all materials, including the adhesion of the joint sealing. Joint sealings, which are too soft, too brittle or which lack the prescribed adhesion and resistance shall be replaced by the Contractor. The approval of material by the Engineer does not relieve the Contractor of his obligations under the Contract.

II. Synthetic Joint Sealing Material

a) All joints of concrete members shall be sealed with mastic as specified and/or as directed by the Engineer.

b) The Contractor shall select permanent elastic, synthetic mastic sealing compound, which has a high degree of extensibility, optimum elastic force and good adhesion to concrete. Products consisting of one or two components, on the basis of polysulphide liquid polymer, silicone rubber and polyurethane or others, may be used; however, only proprietary materials (made by fully recognized manufacturers), which are resistant to aging, oxygen, irradiation with ultra-violet light, water, oil, grease, chemicals and biodegradation and which have been approved by the Engineer may be used.

c) Concrete grey mastic shall be used for joints in exposed concrete areas. Joints in concrete areas not exposed to the eye may be filled with dark colored mastic.

d) The mastic shall be stored in sealed containers in a dry and cool place prior to use, strictly in accordance with manufacturer's instructions.

e) Mastic sealing compound used for expansion joints in water tanks shall be:

f) Physiologically safe, i.e. it shall not contain any substances which may be considered a substrate for water bacteria;

g) Resistant to any detergents used in water tanks;

h) Complying with the health requirements for potable water.

i) Mastic sealing compound used for expansion joints of sewage tanks, sewers and any other structural elements exposed to the effect of chemicals (e.g. varnishing unit, oil traps etc.) shall be resistant to chemicals such as alkali, acid and solvents etc. and to biodegradation resulting from attack by bacteria normally present in sewage and sewage sludge.

III. Workmanship

a) The joints shall be prepared and primed as indicated by the manufacturer of the sealing compound.

b) The depth of the joint sealing shall be as indicated on the drawings, but at least 20 mm or equal to the width of the joint. In case of beveled joint edges, the sealing shall only be placed between the parallel joint faces.

c) In compliance with the instructions of the manufacturer, the mastic sealing shall be applied - within the time span specified after priming and from top to bottom in vertical joints - with a sealing gun equipped with a nozzle fitting the width of the joint. Surplus material must be removed before hardening of the mastic.

2.22.15 Tolerances of Concrete Construction

I. General

a) The following tolerances of concrete constructions after completion of the work shall be permitted. All concrete work shall be executed in the required dimensions, shapes, position and level shown on the drawings. The Engineer may apply other tolerances if required.

II. Dimensions Tolerances

a) Tolerance for dimensions of columns, walls, beams slabs: - 0 mm / + 10 mm

III. Concrete Cover to Reinforcement Tolerances

i) Concrete cover of 30 mm: - 0 mm / + 5 mm

ii) Concrete cover of 35 mm: - 0 mm / + 10 mm

iii) Concrete cover of 50 mm: - 0 mm / + 10 mm

2.22.16 Cement Mortar and Grout

I. General

a) Cement mortar and grout under bearing plates and to fill in pockets shall be composed of cement, fine aggregate (natural sand) and water. If required, admixtures and/or additives shall be used. All components shall comply with the requirements of the Specifications for concrete.

II. Strength

a) The compressive strength of mortar and grout, which must in all cases be determined on three specimens, shall in preliminary tests and in quality control tests conform to the following requirements:

   i) Lowest compressive strength for each specimen: 25 N/mm²;

   ii) Lowest limit for the average compressive strength for each series of specimens: 30 N/mm².

b) The compressive strength of mortar and grout is determined on specimen (diameter 100 mm, height 120 mm) at an age of 28 days.

III. Mixing

a) Mixing of mortar and grout shall be done in an approved mechanical mixer, the amount of water added being just sufficient to give the consistency and workability desired for the use to which they are to be put. Mixing shall be carried out as specified for concrete

b) Hand-mixing will only be permitted when very small quantities are required, and the approval of the Engineer has been obtained.

c) All mortar and grout must be in their final position in the structures within 30 minutes.

d) Grout and mortar shall be composed of one-part cement and two parts well graded sand or as approved by the Engineer.

e) Shrink-resistant grout shall be used under heavy machinery equipment, subject to vibrating, reciprocating and pulsating movement and to set structural steel and pre-cast concrete members and in all members where shrinkage inherent in normal cement grout cannot be tolerated. Non-shrink grout shall be obtained as a pre-mix ready requiring only the addition of water to produce a free-flowing grout which, when cured, will completely fill the pockets in which it has been placed. The grout shall be so formulated to provide high resistance to the long-term effects of machinery operating stresses. The grout shall be obtained from a manufacturer approved by the Engineer.

f) Shrink resistant grout shall be free from iron compounds which can result in rust staining and subsequent corrosion and expansion.

IV. Workmanship

a) Grouting shall not be carried out until the steelwork or equipment has been finally levelled and plumbed, the bases being supported meanwhile by steel wedges.

b) Immediately before the operation of grouting, the entire area covered by the bearings, including pockets for holding down bolts, and enough extra area around to prevent contamination, shall be thoroughly cleaned by washing with water from hose pipes, compressed air, etc., and all dust, loose and deleterious matter shall be removed. All surplus water shall then be dried off by mopping and the use of compressed air and the surfaces left damp. Freshly mixed mortar as directed, of suitable consistency, shall then be introduced to fill the pockets for the holding down bolts and the space beneath the bearing plates. The mortar shall be well punned into the space, working from one side with suitable penners until the mortar appears on the opposite side and every care shall be taken to ensure that the entire void is filled, giving complete support to the bearings over the entire area, without air holes, etc. To ensure this, wooden screeds shall be introduced around the edges of the grouting space to contain the mortar during the punning operations, any mortar which may foul the treads of bolts, nuts, or affect their bearing on washers and plates shall be carefully removed without disturbing the mortar already placed and, on completion of the operation, the edges of the mortar shall be trimmed. The whole shall then be covered with wet sacks or hessian which shall be kept continuously damp for a period of not less than 7 days, after which they shall be removed and all loose, adherent or projecting mortar liable to reduce the efficiency of the bearings carefully removed. After 28 days all holding down, and other bolts shall be tightened as directed.

2.22.17 Falsework

a) If the Contractor intends to use a wooden falsework construction, all timber shall be of sound wood and well-seasoned. Other types of formwork construction, e.g. steel or tubular steel scaffolding may be used.

b) Reinforced concrete shall not be poured directly against an excavated face, but only against suitable formwork.

c) All concrete, especially which exposed to view including all precast concrete members shall have fair faced finish. Steel shuttering or plywood panels approved for concrete works may be used if they are free from defects likely to detract from the general appearance of the finished surface. Joints between boards and panels shall be horizontal and vertical or as directed by the Engineer.

V. Design of Falsework and Forms

a) The Contractor shall submit to the Engineer for approval, details of the formwork intended to be used before commencement of the works.

b) The submission of such details shall not relieve the Contractor of responsibility for the sufficiency and strength of the falsework and forms.

c) It is the Contractor's responsibility to dimension the footings in a way that settlement of the subsoil under concreting loads will be kept small and symmetrical

d) Settlement of falsework and footings is to be measured and recorded while concreting. Provisions shall be made to permit the compensation of unexpected

settlements and the uniform release of the falsework by means of hydraulic jacks or at least wedges.

VI. Construction Requirements for Forms

a) Forms shall be of such quality and strength that they maintain rigidity throughout placing and vibration of concrete. Within the allowable tolerance the finished concrete shall coincide in the required shape, position and level with the drawing.

b) In order to prevent adhesion of concrete, forms shall be oiled with form oil approved by the Engineer. The oil shall be applied according to the recommendations of the manufacturer. Form oil shall be of such quality that it will not discolor the surface of exposed concrete. Care shall be taken to prevent the reinforcement from being contaminated.

c) Forms shall be thoroughly wetted on both sides in advance of placing the concrete. Standing water in the forms will not be permitted. Joints shall be sufficiently tight to prevent leakage of grout.

d) All dirt, chips, sawdust and other foreign matter shall be thoroughly removed from between the forms before any concrete is placed. Where the inside of the bottom of the forms is inaccessible, the lower form boards shall be left loose so that they may be removed for cleaning out extraneous material immediately before placing concrete.

e) In water retaining structures, the use of internal ties as anchorages w

f) Where it is required in non-water retaining structures to use internal ties, their position and the filling of cavities shall be approved by the Engineer, especially in case of exposed concrete. Ordinary wire ties shall not be permitted.

g) The specification for forms shall apply with equal force to metal forms. The metal used for forms shall be of such thickness that the forms remain true to shape. Metal forms which do not present a smooth surface or line up properly, shall not be used. Special care shall be exercised to keep metal forms free from rust and grease.

VII. Removal of Falsework and Forms

a) The removal of falsework and forms shall be executed in accordance with DIN 1045. The specified number of days between placing of concrete and removal of falsework and forms shall closely be

b) adhered to. Depending on curing and weather conditions longer times may be necessary if the strength of the concrete is still low. In no case shall the removal of falsework and forms be done without the approval and direction of the Engineer.

c) The removal shall be carried out in such a manner that the concrete is not disturbed or in any way damaged.

d) Any required repairs of concrete shall be done only after inspection by the Engineer.

2.23 Reinforcement

2.23.1 Certificates for Reinforcement

a) All deliveries of steel reinforcement shall be accompanied by the manufacturer's certificate giving the results of tests carried out in accordance with the requirements

of the relevant standard. The Engineer may require the Contractor to submit samples of steel from each delivery to an approved Authority for testing, the costs of all samples and tests shall be deemed to be included in the Contractor's rates for reinforcement.

2.23.2 Material

i) Mild Steel Bars: Main round steel bars; yield stress minimum 250 N/mm²; from diameters of 6 mm to 8 mm

ii) High Yield Bars: Deformed steel bars; yield stress minimum 460 N/mm²; from diameters of 10 mm to 32 mm,

iii) Steel Fabric: Hard drawn welded wire fabric; yield stress minimum 400 N/mm².

a) Reinforcing drawings and bar bending schedules shall, unless otherwise indicated or provided on the drawings, be prepared by the Contractor and checked and approved by the Engineer.

b) Special attention should be paid to hooks, splices, bending radii, anchorage lengths and concrete cover.

2.23.3 Storage and Protection

a) All reinforcing steel shall be stored on elevated platforms or other supports and must not be laid on the ground. It shall be stored in an orderly manner to facilitate inspections; each diameter and quality being kept separate.

b) Reinforcing steel shall be protected at all times from damage and, when placed in the structure, shall be free from dirt, loose mill and rust scale, paint, oil and other foreign substance.

2.23.4 Bending

a) The Contractor's attention is drawn to BS 8666 entitled "Scheduling, dimensioning, bending and cutting of steel reinforcement for concrete" The Contractor's methods shall comply with the recommendations in that document.

b) Steel reinforcing bars shall be cut and bent by competent workmen. They shall be bent cold to templates which shall not vary appreciably from the shape and dimensions shown on the Drawings. All sharp bends shall be avoided and in no case shall the bending radius be less than 80 mm for reinforcing bar diameters less than 20 mm and 200 mm for reinforcing bar diameters equal or larger than 20 mm and less than 28 mm.

c) Distance from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be of suitable material of approved shape and dimensions. Special distance holders may be used for waterproof concrete of water tanks, etc. The holders shall be short enough to permit their ends to be covered with concrete. Reinforcing bars shall be securely wired together in such a manner that they will maintain their exact designated position during placing of concrete. The ends of all wires shall be turned into the concrete away from the face.

2.23.5 Splicing

a) All steel bars for concrete reinforcement with a total length of less than 12 m shall be furnished in the full length indicated on the Drawings. Steel bars with splices shown on the Drawings shall be spliced and steel bars with a total length exceeding 12 m may be spliced as given on the Drawings and as directed by the Engineer.

b) Welding of steel bars shall only be carried out if authorized by the Engineer.

2.23.6 Approval of Reinforcement

a) No concrete shall be placed until the reinforcement has been checked and approved by the Engineer. The Contractor shall give a minimum period of notice of 24 hours before the scheduled commencement of concreting in order to allow the Engineer time to carry out a full and detailed inspection of the reinforcement.

b) All reinforcement steel must be clean and rust-free at the time of concreting.

c) If in the Engineer's opinion additional reinforcement is required, this shall be placed as directed by the Engineer.

2.24 Paintwork

2.24.1 General

a) All paints shall be obtained from an approved manufacturer. Where paint is to be used on the site samples shall be provided for the Engineer's approval prior to delivery. Details of the type and manufacture of the paint shall be provided for all items which are painted prior to delivery to site.

b) All material shall be delivered in sealed containers bearing the manufacturer's name and description of contents

c) All paints shall be applied strictly in accordance with the manufacturer's instructions.

d) The color of the paints shall be to the approval of the Engineer and where possible alternative coats shall be of different shades.

e) All preparation and painting is to be carried out under dry conditions.

f) The Engineer may take samples from painter's kettles for analysis and testing. No thinners or other materials shall be added to the paint without the consent of the Engineer.

2.24.2 Materials

I. Oil Paint Finish

a) Oil paint finish for interior use to corridors plastered walls.

b) Primer shall be lime resistant pigments.

c) Undercoat shall be alkyd resin based suitable for use with the finishing coat.

d) Finishing coat shall be two coats hard gloss alkyd resin based.

II. Emulsion Paint Finish

a) Emulsion paint finish for interior use to plastered walls surface or ceilings.

b) Emulsion paint shall be high grade acrylic resin emulsion suitably pigmented applied in 2 coats or enough to hide plaster shadowing completely.

III. Cement Paint

a) For outside use to exposed surfaces of fair faced concrete.

b) Cement paint shall be white or colored Portland cement adjusted for use as a paint with the necessary additives for outside use.

c) Applied in under coat and finished coat.

IV. Tyrolean Paint Finish

a) For use to exterior surfaces of building and to boundary walls surfaces as indicated on the drawings.

b) External Tyrolean finish shall be a colored purpose-made material to the approval of the Engineer.

c) Tyrolean finish shall be applied to rendering under coat which have been applied and cured properly. The Tyrolean finish shall be applied by machine in accordance with the manufacturer's instructions.

V. Acrylic Paint

a) Acrylic paint finish for interior use shall be 100% pure acrylic base not less than 20% of total weight:

b) Lusterless (flat) acrylic finish, 2 coats over filler coat with total dry film thickness not less than 65 µ, excluding filler coat;

c) Filler coat: solvent thinned filler for porous surfaces;

d) First and second finish coats: Acrylic Emulsion.

2.25 Site Works

2.25.1 Paving

a) Embankments and fills shall be constructed only of material approved by the Engineer and obtained from cuts, quarries or borrow pits. While the material is being spread and compacted, it shall be graded to the specified level and thickness. Where water needs to be added, it shall be applied in an even manner.

b) The subgrade shall be kept continuously drained and any damage caused by water accumulating on or running off the surface shall be made good.

c) Should water accumulate on any part of the subgrade, particularly in ruts caused by construction traffic, the Engineer may order the Contractor to remove any material which has become saturated or cannot then be compacted to the required density and to replace it.

d) The subgrade shall be cleaned of all foreign matter and any pot-holes, loose material, ruts, corrugations, depressions and other defects which have appeared in the subgrade layer due to improper drainage, traffic or any other cause shall be corrected and if directed by the Engineer, the Contractor shall scarify, water, grade and re-compact the subgrade to line and level all.

e) No surfacing shall be carried out until the subgrade has been inspected and approved by the Engineer.

f) The subgrade layers shall be compacted from slope stake to slope stake at the optimum moisture content.

g) The maximum compacted thickness of any layer which shall be laid, processed and compacted at one time shall be 250 mm or else as ordered by the Engineer, depending on type of compacting equipment.

h) The layer shall be scarified, and water shall be mixed in or the material allowed to dry out to the correct moisture content. The layer shall then be compacted. The final surface of each subgrade layer shall be graded to level, parallel to the cross fall or camber and profile shown on the drawings or as directed by the Engineer.

i) Where shown on the drawings or directed by the Engineer that the formation shall be completed without the addition of any wearing course, sub-base, base or shoulders, the Contractor shall finish off the subgrade by grag, trimming, watering if necessary, and compacting with four complete passes of a 10 to 12 Mg smooth-wheeled roller so that the top of the subgrade is correct to line and level and there are no irregularities in the top of the subgrade in excess of 12 mm when measured from a 3 m long straight edge placed longitudinally or from a chamber board transverse to the road. This work shall be carried out over the entire subgrade, including shoulders, or, if only a thin wearing course is ordered without raising the sheath

j) The back filing for construction shall be carried out in layers in accordance with the lines, grades and cross sections. Excavation includes any disintegrated soil material or non-homogeneous base material and the disposal thereof. Earthwork and preparation of sub grade soil shall be carried out in accordance with the applicable standard specifications and requirements, to activate the highest density at optimum moisture content according to the proctor compaction test. The compacted prepared layer thickness is not to be less than 300 mm. The excavation is to include the disposal of distinguished materials.

2.25.2 Plain Concrete Cement Curbs

a) Supply and construction of plain concrete curbs with the dimensions as shown on the drawings or otherwise agreed,

b) The concrete strength of the curbs to be not less than 300 kg/cm² after 28 days and the cement content not to be less than 350 kg/m³.

2.26 Fencing and Gates

2.26.1 General

a) Fences shall be erected at the locations shown in the Drawings, with gates placed in the locations as indicated to the approval of the Engineer.

2.26.2 Walls and Gates

I. General

a) Walls shall be erected at the locations shown in the drawings, with gates placed in the locations as indicated to the approval of the Engineer.

II. Walls

a) Walls will be constructed to the details shown on the drawings. The foundations of the walls and the columns will be constructed of reinforced concrete Class C25/30, blinding will be Class C12/15 (or B15). Concrete works will be in accordance with Section 2.23 "Concrete" of this specification. Maximum center to center spacing between concrete columns shall be 5.0 meters.

b) Infill between columns will be constructed of concrete hollow blocks 400 x 200 x 200 mm laid and jointed in mortar. Blockwork will be in accordance with Section 2.28 "'Blockwork – Plastering – Coping" of this specification. Surface finishing to the walls will be in accordance with the finishing schedules shown on the drawings or as directed by the Engineer.

c) A precast concrete coping will be placed along the top of each blockwork wall panel.

III. Gates

a) Gates shall be made of steel panels and bars and shall be of heavy-duty design, to the dimensions shown on the drawings. Gates will be double leaf; each gate will be hinged at three places on each column. A drop (ground) bolt will be installed for each leaf of the gate. Gates will be coated / painted in accordance with the finishing schedules shown on the drawings or as directed by the Engineer.

2.27 Blockwork - Plastering - Coping

2.27.1 Precast Concrete Blocks

a) Precast concrete blocks shall be manufactured locally with aggregates, sand and cement in an approved vibrating pressure machine. The mix proportions shall comply with DIN 1045 or BS EN 206. The sand shall have the following grading:

Sieve Size	Passing [% per weight]
2.4	> 100
1.2	95 -100
0.6	25 – 85
0.3	5 - 50
0.15	0 - 10

b) The blocks shall be hard, sound, with sharp well defined arises, and shall be 40 cm long by 20 cm high by the specified thickness, unless otherwise instructed by the Engineer. The sandy bricks shall be 25 cm by 12 cm by 6 cm of uniform color.

c) Immediately after molding, the blocks shall be placed on a clean level pallet and shall be cured by being continuously sprayed with water or other approved means.

d) For a sample of twelve blocks, randomly selected, the average compressive strength shall not be less than 3 N/mm2, and no block of the twelve shall be less than 2.4 N/mm2. If these requirements are not met, the whole batch from which the twelve blocks were selected will be rejected.

2.27.2 Workmanship

a) All blockwork shall be set out and built to the respective dimensions, thickness and heights as shown on the drawings.

b) All blocks shall be carefully handled to prevent damage and protected as necessary. No cracked, chipped or broken block will be used in the Works.

c) In dry weather, the suction rate of all concrete blocks shall be adjusted by wetting before being used, and the tops of walls left unfinished shall be wetted before work is recommenced.

d) All blocks shall be well buttered with mortar after being laid and all joints shall be thoroughly flushed up as the work proceeds.

e) Blockwork shall be carried up in a uniform manner, no one portion being raised more than one meter above another at one time. All perpends, quoins etc., shall be kept strictly true and square and the whole properly bonded together and levelled round at each floor or agreed height. Bats shall not be used except where required for bonds. A full joint of mortar is to be made where blockwork abuts concrete or masonry.

f) Jambs of openings in hollow block walling shall be built in solid blocks.

g) Stainless (galvanized) steel anchor ties to connect block walls to concrete columns shall be dovetail slots, with prior approval of the Engineer.

2.27.3 Mortars and Plasters

a) The mixes of mortars and plasters for blockwork, plastering and for external rendering shall be as per the following table:

Mix Properties

Cement Mortar	Cement	Lime	Sand
Grade A	350	---	1m³
Grade B	300	---	1m³
Grade C	250	---	1m³
Grade D	150		1m³

b) The ingredients for cement mortars shall be measured in proper gauge boxes on a boarded platform, the ingredients being turned over twice dry and twice whilst water is added through a sprinkler rose. Alternatively, mixing may be by means of an approved mechanical batch mixer.

c) Cement and sand mortar mix shall be used within 2 hours after starting addition of water; any amount of mix remaining should be collected and disposed.

d) The mortar plasticizer shall be of an approved make and shall be used in the proportions and manner recommended by the manufacturer. The proportions of the mortar mix shall if necessary be adjusted in accordance with the manufacturer's recommendations.

e) Where colored mortar or rendering is specified the pigment shall be of an approved manufacture and shall not be injurious to other ingredients of the mortar. It shall be mixed with care to ensure even coloring throughout the mixture and a sufficient quantity shall be made to ensure completion of an area of rendering in one operation.

2.27.4 Finishing

a) The preparation of the surfaces for plastering includes raking out joints of concrete surfaces or blockwork to form key, dubbing out all uneven surfaces as required, temporary rules and boards, working around pipe clips and other similar obstructions, working behind pipes.

b) All surfaces are to be finished true and smooth. (wood or steel trowel finish as specified)

c) External angles, where not protected by metal angle beads, shall be properly formed rounded angles to 10 mm radius unless otherwise directed.

d) All joints between block walls and concrete members, all routes of electric or sanitary piping should be covered by 20 cm wide metal lath strip, this will be included in the rates.

e) The prices shall include for 1 m x 1 m sample panels if so directed by the Engineer.

f) Plasters and Mortars shall be to the grades and mix proportions specified.

g) Plastering to internal walls and surfaces shall be composed of the layers, as hereafter detailed, to make up the complete thickness of 20 mm.

h) Backing coat shall consist of approximately 15 mm thick cement mortar Grade "C" and scratched to form key.

i) Finishing coat shall consist of a 5 mm thick layer mortar Grade "C" and finished with a steel float to approval.

j) Cement rendering shall be cement mortar Grade "A "and shall be applied in two or three coats.

k) Undercoats shall not exceed an average thickness of 10 mm and finishing coats an average thickness of 6 mm. Two coat rendering shall be to a total thickness of 16 mm and three coats rendering to a total thickness of 25 mm.

l) Where rendering is to be applied to concrete surfaces such faces shall be suitably treated to provide an adequate mechanical key for the rendering. The surface of brickwork blockwork or masonry to be rendered shall be thoroughly prepared before the first undercoat is applied by raking out the joints to form an efficient key for rendering.

m) Surfaces shall be thoroughly brushed down to clean off all dust and loose material. Particular attention shall be paid to the removal of mold oil or other deleterious substances prior to rendering. Each undercoat shall be scored to form an adequate key for subsequent coats. The surface of blockwork shall be thoroughly wetted with fresh water before rendering is applied.

n) Each rendering coat shall be kept moist for at least 48 hours and then given adequate time to dry out thoroughly before the application of any subsequent coats. The surface shall then be wetted immediately before the application of any further coat.

o) The finishing coat shall have a steel float finish to true planes and regular curves and to an even and polished surface. Arises shall be rounded and in true alignment and a hollow fillet shall be run at internal angles.

p) The finished rendering shall be protected and cured as specified for concrete.

2.27.5 Copings

a) Copings shall be laid true to line and level bedded on and jointed with cement, joints being flush pointed as the work proceeds.

b) Precast concrete copings shall be in accordance with Section 2.23 "Concrete", and as shown on the drawings they shall be shaped as detailed on the drawings. The top edges shall be chamfered 15 mm x 15 mm.

2.28 Metalwork

2.28.1 Materials

a) Structural steelwork shall comply with recognized standards for general structural purposes.

b) Bolts, washers etc. for use with structural steel shall be black bolts. Fastenings, including bolts, for use with materials having a galvanized finish shall be sherardized or have an alternative approved protective metal coating.

c) Before ordering or fabricating any item of metalwork, the Contractor shall submit to the Engineer for his approval shop drawings showing all details and dimensions required for fabrication, assembly and erection. Fabrication shall only commence after the approval of the Engineer has been obtained.

d) Angles, channels, flats and all standard steel sections shall be to the sizes given on the drawings.

e) Angles or channels used for framing of openings in concrete structures or for guides shall be provided with steel fixing lugs securely welded to the frame or guide prior to galvanizing.

f) Corrosion protection shall be as detailed on the drawings and to the quality and standard specified.

2.29 Roofing

a) The drying beds are to be provided with transparent roof cover supported by steel columns as shown on the contract drawings. Roofs shall be protected as shown on the drawings with the following specifications for the cover sheeting:

   i) Fiber glass roof sheeting and accessories shall conform to BS EN 1013-3 standards for light transmitting profiled sheeting (i.e. specific requirements and test methods for sheets of glass fiber reinforced polyester resin). The type of sheeting shall be transparent with a light transmittance of 80 – 85 percent,

standard thickness of 0.8 – 1.2mm and UV resistance. The fiber shall be approved by the engineer prior to supply of such sheeting.

ii) Translucent plastic roof sheeting material shall conform to the standards used for covering greenhouse in agriculture or shall be of the same standard as the one to be replaced. Installation shall be as directed by the supplier or manufacturer. The material shall be transparent double layered 100% HDPE woven plastic with UV protection. The cover shall be provided with complete accessories for installation such as rope reinforced hem, heat sealed edges, eyelets at intervals of one meter and corners reinforced with triangle plastic sheets.

iii) The sheets shall be fixed to timber purlins with 8mm galvanized gimlet pointed screws 115mm long and to steel angle purlins with 8mm diameter galvanized hook bolts and nuts 50mm longer in the shank than the depth of the steel purlin to which they are fixed and all screw and bolts fixings shall have "seawater" plastic washers or other equal and approved or following the manufacturer's installation instructions.

iv) Ridges and other accessories shall be as shown on the drawings and shall be fixed to timber and steel purlins as described above.

v) All roof surfaces shall be kept clean and protected and handed over watertight at completion.

vi) Softwood shall generally be Podocarpus or Cedar complying with BS 1186: Part 1 or other equal approved timber.

2.30 Geotextile Filter Membrane

a) The geotextile for use in filter drains and soak ways shall comply with the following:

i) Sustain a tensile load of not less than 5.0 kN/m at break and have a minimum failure strain of 10% when determined in accordance with BS 6906: Part 1;

ii) Have a minimum puncture resistance of 1,200 N when determined in accordance with BS 6906;

iii) Have a minimum tear resistance of 200 N when determined in accordance with ASTM D4533-95;

iv) Have a size distribution of pore openings such that the apparent opening size 090 when determined in accordance with BS 6906; or another appropriate test

v) Allow water to flow through it, in either direction, normal to its principal plane at a rate of not less than 30 liters/m²/sec under a constant head of water of 100 mm and a maximum breakthrough head of 50 mm when determined in accordance with BS 6906:

vi) Geotextile filter membrane shall be paid for at the unit rates for the square meter as contained in the Bill of Quantities. The unit price shall constitute full compensation for furnishing and placing all materials and for all labor, equipment, tools, supplies and incidentals necessary to complete the Work.

vii) If the contractor wishes to deviate in any way from the materials and liners specified the responsibility shall rest with the contractor to obtain official written permission from the local Environmental Agency. Such permission shall be submitted with the proposed deviations for the Engineer's approval

2.31 Drying Beds Drainage System

2.31.1 Perforated HDPE Pipe

a) Perforated HDPE pipes shall be class SDR17 PN10. Unless otherwise approved by the Engineer, all pipes shall be semi perforated or slotted. No slots shall be wider than 4 mm or less than 0.6 mm, and holes not greater than 10 mm nor less than 3 mm diameter. The total area of the holes shall be not less than 1,000 mm²/m length of pipe. The slot width / perforation size and layout shall be approved by the Engineer.

b) The pipes and fittings shall be substantially made of high-density polyethylene (HDPE) in accordance with ISO Standards.

c) Wall Thicknesses of Perforated HDPE Pipes are as shown in the table below:

Diameter	**Wall Thickness**	
	Class SDR 17	**Class SDR 21**
110	6.6	5.65
125	7.4	6.35
140	8.3	7.1
160	9.5	8.15
180	10.7	9.10

a) The dimensions are based on ISO 4427 and tolerances shall be in accordance with SANS ISO 4427 Specifications.

b) All pipes shall be indelibly marked. The marking shall be imprinted longitudinally to show the information in the order stated as follows:

   i) The Manufacturer's Identification;

   ii) The Number of ISO Standard to which the pipes are made;

   iii) The nominal size and class of pipe.

c) The pipes shall be bedded in lean concrete Class B15 (or C12/15).

2.31.2 Filter Material (for drying beds and anaerobic filter)

a) The filter material shall be of the sizes and layer thickness shown on the contract drawings and where required shall conform to the following grading: Gradation of Filter Material around Perforated HDPE Pipes

Sieve Size mm [No.]	% Passing by weight
25	100
20	90-100
10	20-25
4	0-10
8	0-5

b) Filter material shall consist of hard, clean, crushed rock or gravel. The aggregate crushing value of the material shall not exceed 30%. Any material passing the No.

40 sieve shall be non-plastic. At least 15% of the bedding material shall be large in particle size than twice the maximum dimension of the pipe perforations.

2.31.3 Subsoil Drainage Membrane

a) The subsoil drainage membranes shall be construction grade geotextiles conforming to the following requirements:

   i) 2mm thick HDPE membrane.

   ii) Joints in sheeting shall be treble folded with and welded through methods such as butt or fillet welds or as approved by the engineer. The sheeting shall not be stretched but shall be laid loose with enough wrinkles to permit shrinkage up to 15%.

2.32 Plumbing

2.32.1 General

a) The Contractor shall make all arrangements with SNV to ensure any connection is laid and metered to the Commercial Utility's standards.

b) Catalogue cuts and specifications for all plumbing items shall be submitted to the Engineer for approval. Any item shipped without prior approval may be subject to rejection and replaced at the Contractor's expense.

2.32.2 External Plumbing

a) uPVC sewer and vent pipes and fittings shall be of spigot and socket type, with rubber gasket joints.

b) uPVC rainwater pipes and fittings shall be of spigot and socket type, with rubber gasket joints.

c) Joints shall be provided with an approved rubber gasket joint, pipes secured with wrought iron holder-bats in two sections, bolted together, built into wall, wedged and neatly pointed.

d) Each connection of tubing to cold water storage tank shall be made by drilling a hole on tank side and using a long screw, union and two back nuts all well screwed-up in red lead. Joints of tubing to flanged and bossed connections of hot water cylinders or boilers shall be made with a boiler screw, union and back nut screwed-up in red lead.

2.32.3 Internal Plumbing

a) Pipes and fittings for water and sanitation shall be uPVC.

b) Holderbats, where required, shall be brass school board pattern with tails for building into wall or brass brackets for plugging and screwing to wall.

c) Stopcocks shall be made of brass.

d) Bib and pillar taps shall be hot pressed brass, chromium plated with easy clean shield, crutch or capstan head.

e) Ball valves to cisterns of sanitary fittings shall be low pressure type.

f) Fittings which are to be chromium plated shall be a standard factory item.

g) The sanitary fittings required as shown on the drawings and/or in the Bill of Quantities shall be obtained from an approved firm.

h) Lavatory basins, unless otherwise described, shall be white vitreous china Type B DIN 1386, minimum dimension 55 x 40 cm, complete with chromium plated 15 mm diameter pillar tap, gap overflow, white plastic-coated support brackets, 35 mm diameter chrome plated waste outlet, chrome plated chain and plug, 35 mm diameter chrome plated bottle trap.

i) Toilet systems of the oriental (squat) type shall be white vitreous china suitable for floor installation and be planned with water flushing. The flush tank shall have a float valve, be installed at a height of

j) approximately 2 m and have a capacity of at least 6 liters. The flushing pipe shall have an internal diameter of 32 mm, be led in a straight line to the toilet basin and shall have a water distributor at the end which shall distribute the water in a radial fashion throughout the basin. An odor trap shall be installed at the outflow of the basin.

k) Each WC room should have a 13 mm water tap on adjacent wall 40 cm high from floor level.

l) Each WC room should have a toilet roll holder, chrome plated, fixed on wall at 50 cm height from floor level.

m) Toilet systems of the western type shall be white vitreous china consisting of:

- Ceramic wash down pan;
- Solid plastic seat and cover;
- Flushing cisterns;
- 13 mm hose pip;
- Paper roll holder;
- All necessary valves, fittings, materials, connection to water supply and wastewater system.

n) Shower installation shall comprise a self-closing shower valve fitting in molded brass chromium plated finish. Push button operation beneath self-closing automatic valve allowing 40 seconds operation, complete with regulator for running time adjustment. Showerhead water circle approximately 1 m at a height of 2.30 m. The whole to be set over and including a cast iron enamel white shower tray complete with outlet connection, overall size 900 x 900 mm (DIN 4488)

o) Each shower unit should have a towel rail 25 mm diameter chrome plated pipe and end brackets plugged and screwed to wall.

p) Each shower unit should have a soap holder dish vitrified china fixed to wall at 1.20 m from floor level.

q) Sink units shall comprise stainless steel sink with double drain and cupboards and drawers below. Sink units shall be installed complete with taps, water and waste connections as shown on the drawings.

TECHNICAL SPECIFICATIONS

PART 3 – PARTICULAR SPECIFICATIONS

Issued: 03rd November 2020

PART 3 – PARTICULAR SPECIFICATIONS

TABLE OF CONTENTS

3 PARTICULAR SPECIFICATIONS

3.1 Project Description

a) The works to be undertaken are construction of the Faecal Sludge Treatment Plant in Mpulungu town for treatment of faecal sludge.

b) The FSTP is designed to treat pit latrine sludge and septage from vacuum tankers.

3.2 Site Description

3.2.1 General Description

a) The project works are set in Mpulungu town to the site which is sharing the boundaries with the refugee camp. The site is a bare land and is also next to a piece of land that has been earmarked for construction of a Secondary school.

b) The site is approximately 8 km away from Mpulungu town centre. Access to the site is through a gravel road which is in good shape and it is characterized by a gentle slope towards a stream which can be utilized for treated effluent discharge located about 200m away.

3.2.2 Faecal Sludge Treatment Plant Construction (FSTP) Works

a) The construction works include:

i. Construction of a reception facility

ii. Construction of sludge drying beds

iii. Construction of an anaerobic baffled reactor

iv. Construction of Horizontal Flow Constructed Wetland Planted

v. Construction of a Polishing Pond

vi. Construction of a co-composting facility

The construction works of the FSTP will improve the management of faecal sludge from onsite sanitation facilities in Mpulungu District.

3.3 Construction Programme

a) The Contractor shall include with his tender a preliminary programme on the prescribed form to be completed by all Tenderers. The programme shall be in the form of a simplified bar chart with sufficient details to show clearly how the works will be performed within the time for completion.

b) The Contractor shall be deemed to have allowed fully in his tendered rates and prices as well as in his programme for all possible delays due to normal adverse weather conditions and special non-working days. The Programme shall be drawn up in accordance with the Conditions of Contract using the Programme Evaluation and Review Technique (PERT) or the Critical Path Method (CPM). The programme shall be prepared using Microsoft Project software. No other form of Programme shall be allowed or approved.

c) As a compliment to the Programme, the Contractor shall submit at the same time schedules of equipment and labour indicating the projected numbers and types of Contractor's equipment and labour to be utilised on the Works to enable compliance with the Programme. The schedules shall be itemised under the same heads of items of work as are used in the Programme.

3.4 Site Facilities Available

3.4.1 Contractor's camp site and depot

a) The Contractor's office for this contract shall be as required to fulfil his obligations under the Contract.

b) The Contractor is responsible to provide a suitable site for his camp. If SNV or Chambeshi Water and Sanitation Company can make any specific site available to the Contractor, such site will be pointed out to the contractor.

3.4.2 Accommodation of Employees

a) The Contractor shall provide and maintain suitable ventilated and weather-proof shelters and mess rooms for the Contractor's workmen, together with a sufficient number of proper latrines, which shall be properly and regularly cleaned and kept in thoroughly sanitary conditions and adequately screened from public view.

b) Camps for workmen, if provided, shall comply with all relevant Government Regulations and shall be laid out in an approved and orderly manner.

c) At the time of Bidding, bidders will clearly indicate the type, nature and building materials that will be used in providing such accommodation. Bidders will also confirm that such structures will be demolished and suitably disposed of and the area returned to its pre-use condition to the satisfaction of SNV and its representatives.

d) Proper provision shall be made for the disposal of all waste and refuse, and there shall be an adequate supply of water for washing, cooking and drinking purposes. Quarters shall be properly ventilated and lighted, and the whole camp shall always be maintained and cleansed to the satisfaction of the Government Medical Officer of Health and SNV and in accordance with the Contractor's approved Health and Safety Programme.

3.4.3 Power supply, water and other services

a) The Contractor shall make his own arrangements concerning the supply of electrical power, water and all other services. No direct payment will be made for the provision of electricity, water and other services. The cost thereof shall be deemed to be included in the rates and amounts tendered for the various items of work for which these services are required.

3.5 Site Facilities Required

3.5.1 Temporary offices and Equipment

a) The contractor will make provision for a computer/laptop with AutoCAD, Word and Excel.

b) No separate office buildings are required for the Engineer otherwise a temporal working space would be sufficient.

Provision of facilities for engineer's inspection

a) The Contractor shall provide the necessary tackle, access, and labour to enable the Engineer and/or the Engineer's Representative conveniently to carry out such inspections as they always deem necessary during the currency of the Contract.

3.5.2 Facilities for the engineer's representative to take samples

a) The Contractor shall provide all facilities and equipment for the Engineer's Representative to take samples for testing of any of the materials. Such samples may be taken before incorporation into the works or at any time during Construction, at the discretion of the Engineer's Representative.

b) No claims for delays due to the taking of samples by the Engineer's Representative will be entertained.

c) The taking of any samples by the Engineer's Representative shall not relieve the Contractor of responsibility that all materials and workmanship comply with the Specification, nor shall it relieve the Contractor from any duties under the Contract.

3.5.3 Works site public health facilities

a) "Facilities" are those that are necessary for the wellbeing of all workers on a construction site.

b) For individual small sites and as a minimum these must include drinking water, and toilet facilities, while for major sites, and in addition, there shall be washing, rest and changing facilities, and somewhere clean to eat and drink during rest breaks. Some of these facilities might be available at some sites, but where not available or if facilities are non-functional, the contractor is expected to make his own arrangements.

I. Drinking Water

a) A readily accessible and plentiful supply of clean, drinkable water must be available to all workers.

b) Where a mains water supply connection is not possible, drinking water may be provided using containers marked "Drinking Container". These containers should be emptied and refilled daily from a wholesome source.

c) Drinking water facilities must be separated from toilet and washing facilities to ensure adequate hygiene.

II. Toilets

a) Toilets must be kept clean and tidy.

b) To provide an acceptable standard of hygiene and privacy, the toilet must be:

i) Conveniently located and readily accessible to all on-site workers

ii) Soundly constructed of material that can be easily cleaned and is weatherproof Well-lit and well ventilated, either naturally or artificially

iii) Provided with a hinged seat and lid

iv) Provided with a door which can be locked from inside, and outside when no workers are on site

v) Provided with a well-drained floor above ground level which is covered with a durable waterproof material

vi) Provided with a plentiful supply of toilet paper provided with soap, water and paper towels

3.5.4 First aid outfits

a) During the progress of the Works the Contractor shall at each place of work provide an adequate First Aid Outfit that shall always be easily accessible, and which shall include the following: -

Range of bandage sizes	plasters
Antiseptic ointment	thermometers
Scissors	cotton wool
Aspirins	safety pins
Anti-malaria tablets	sticking plasters

b) and shall replenish and maintain as use demands, at the Contractor's own cost. The provision of these kits shall be considered part of the Contractor's obligations in setting up the Contractor's camp. The first aid kits shall be available for use by the Engineer's staff as well as the Contractor's staff on site of the works, at camps and wherever the Contractor's staff may regularly live and work. The Contractor shall ensure that there are persons available to all such places with knowledge of simple first aid procedures.

3.6 Features Requiring Special Attention

3.6.1 Quality control and quality assurance measures

a) The contractor will be solely responsible to produce work that complies with the Specifications to the satisfaction of the Engineer.

b) To this end it will be the full responsibility of the Contractor to undertake appropriate quality control and quality assurance measures on site.

c) The Engineer will audit the Contractor's quality assurance (QA) system on a regular basis to ensure that adequate independent checks and tests are being carried out and to ensure that the Contractor's own control is enough to identify any possible quality problems, which could cause a delay or failure.

3.6.2 Quality of materials and workmanship

a) The materials and workmanship shall be of the best of their respective kinds and shall be to the approval of the Engineer.

b) In the reading of this Specification the word "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.

3.6.3 Rejected materials

a) Should any materials or manufactured articles be brought on to the Site of the Works by the Contractor which are in the judgement of the Engineer unsound or of inferior quality including defects or damage sustained in transit or in any way unsuited for the Works 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.

3.6.4 Existing Services

a) The Contractor shall acquaint himself with the position of all existing services and structures before any excavation or other work likely to affect the existing services or structures commences. The Contractor shall obtain the necessary plans and/or assistance from the owners of the services and structures (includes as built drawings of the plants) to locate all existing services prior to the start of excavations.

b) The Contractor will be held responsible for any damage to known existing services and structures caused by or arising out of his operations and any damage shall be made good at his own expense. Damage to unknown services shall be repaired as soon as possible.

3.6.5 Survey beacons

a) The Contractor shall take special precautions to protect all permanent survey beacons or pegs such as benchmarks, stand boundary pegs and trigonometrical beacons, regardless whether such beacons or pegs were placed before or during the execution of the contract.

b) If any such beacons or pegs have been disturbed by the Contractor or his employees, the Contractor shall have them replaced by a registered land surveyor at his own cost.

3.6.6 Disposal of spoil or surplus material

a) The Contractor is responsible to arrange for the necessary permission and to spoil all surplus and unsuitable material, as well as other objectionable material at a legal site of his choice. He shall be responsible for all arrangements necessary to obtain such spoil sites.

3.6.7 Overhaul

a) No payment will be made for overhaul on this contract unless provision is made thereof in specific items.

3.6.8 Security

a) The Contractor shall provide security watchmen for the contract as he deems fit at no extra cost to SNV. This will include for all materials, temporary works and barricading. The Contractor must ensure that all his employees as well as the employees of his subcontractors are able to identify themselves as members of the construction team.

3.6.9 Health and Safety Requirements

a) It is a requirement of this contract that the Contractor shall provide a safe working environment and to direct all his activities in such a manner that his employees and any other persons who may be directly affected by his activities are not exposed to hazards to their health and safety.

b) The Contractor shall observe and cause the Contractor's employees to observe health and safety standards commensurate with the nature of the Works and in accordance to the World Bank health and safety guidelines as well as the health and safety regulations of the country. To this end the Contractor shall appoint a Safety Officer one of the Contractor's senior staff who shall have specific knowledge of safety regulations and have had experience of safety precautions, and occupational health on similar works and who shall advise the Contractor on all aspects of safety and health on Site.

c) The Contractor shall provide the Contractor's employees with:

   i) Overalls, boots or shoes with reinforced toe caps.

   ii) Reflective vests.

   iii) Hard hats suitable for a construction site.

   iv) Other protective equipment such as gloves, earmuffs, goggles, foul weather protective clothing, etc. as are necessary for work.

d) Adequate sanitary facilities and maintenance of these in a clean and hygienic state for use by all persons employed by SNV, Engineer, Contractor or other contractors on the Site. They must be gender separated. (latrines minimum of 20 m from inhabited structures and water supply for hand washing close by.

e) Reporting details of any accident to the Engineer and competent authorities as soon as possible after its occurrence.

f) Effective measures to prevent of non-site personnel from entering the work areas.

g) The Contractor shall further provide hard hats for the Engineer and his staff, and for the use of site visitors up to ten in number.

h) The Contractor is required to produce a Health and Safety Management Plan (HSMP) covering the hazards that may apply during the Contract, the rules and standards to be used in assessing risk and in undertaking work and the methods that will be employed to ensure compliance with this plan.

i) To this end the Contractor shall conform to all the stipulations as set out in this document and all statutory Acts and Regulations, the Contractor's rates will be deemed to allow for all related activities and equipment.

3.6.10 Contract Escalation

a) The tender price will be fixed for the duration of the contract and no escalation will be added.

3.6.11 Adverse weather Conditions

a) Normal rainfall conditions are not regarded as circumstances that may entitle the Contractor to claim for extension of the specified time for completion.

b) Extension of time will however be considered for climatic conditions which can be regarded as abnormal, in which case the following formula will be used:

$$V = (Nw - Nn) + \frac{(Rw - Rn)}{20}$$

Where:

V = Extension of Time in calendar days in respect of the calendar month under consideration.

Nw = Actual number of days during the calendar month under consideration on which a precipitation of more than 10 mm has been recorded.

Rw = Actual total rainfall in mm recorded during the calendar month under consideration.

Nn = Average number of days, derived from the rainfall records, on which a precipitation of more than 10 mm has been recorded during the relevant calendar month as per the nearest weather station.

Rn = Average total rainfall in mm for the relevant calendar month, derived from rainfall records, according to the nearest weather station.

c) Where the extension of time due to abnormal rainfall has to be calculated for a portion of a calendar month, pro rata values shall be used. Should V be negative for any month and should its absolute value exceed the corresponding value of Nn then V shall be taken as being equal to minus Nn. The total extension of time to be granted shall be the algebraic sum of all the monthly extensions provided that if this total is negative then the extension of time to be granted for abnormal rainfall is taken as zero.

3.7 Drawings

a) The Drawings for this Contract are listed in the Book of Drawings and are part of the Contract Documents.

3.7.1 Construction drawings

a) These are drawings Issued for construction, are sets of detailed design drawings prepared by the Design Consultant, which are an integral part of the Contract Document.

b) The Drawings define the scope of what is to be constructed. The Contractor will be issued Construction Drawings during the project, which confirm that the drawings and specifications have been approved by SNV and that these are the plans by which the project will be constructed.

c) SNV shall issue these drawing in both hard (A3 size) and soft copy. The Contractor may use the soft copy to print enlarged drawing as he deems necessary.

3.7.2 Shop/ Working Drawings

a) These are sets of drawings prepared by the Contractor and the relevant sub-contractors to be issued to SNV and supervising engineer for approval in adherence to the issued drawings, which show how a specific assembly or installation is to be done.

b) In special circumstances, the Engineer may demand that the Contractor provides Shop Drawings to illustrate his proposed construction/ installation method prior to construction/installation. Under this contract the required working drawings will be as stated in these technical specifications.

c) Where the Contractor is required to furnish drawings, they shall be provided in accordance with the Conditions of Contract and Contract Data.

3.7.3 As-built Drawings

a) As built drawings will be prepared by the Contractor and will show all the works as built. The drawings shall be supplied in both hard and soft copy. The soft copy shall be AutoCAD files

b) To this extent, he will be required to provide the necessary survey and other data to mark-up the drawings and to provide enough draughtsman (proficient in the use of AutoCAD) on a continuous basis throughout the contract period to update the electronic copy of drawings, under the direction of the Engineer's Representative.

c) As-built drawings shall be issue for review by the Engineer, 1 month after receiving the Taking Over Certificate.

d) The Contractor shall be deemed to have allowed for the costs arising from the preparation of Shop Drawings and As-built drawings in the contract price.

3.8 Works Requiring Special Attention

3.8.1 Filter layers for drying beds

i) The filter layers for drying beds will be placed as shown on the contract drawings.

ii) The filter media (sands and gravels) shall be composed of hard and durable grains, preferably rounded, free from clay, loam and any organic matter.

iii) Sands shall have a minimum silica content of 96% and a uniformity coefficient of less than 2 (preferably 1.25).

iv) Gravels shall be hard stones with a specific gravity of at least 2.5.

v) All the filter material must be inspected and certified to the satisfaction of the Engineer.

The top final layer of the drying bed comprises prefabricated concrete slabs of size 500mm x 500mm placed on top of the sand layer. The concrete slabs shall be placed 100mm apart and the spacings filled with sand as shown on the detailed drawings.