



**THE REPUBLIC OF UGANDA**  
**MINISTRY OF WATER AND ENVIRONMENT**  
**INTEGRATED WATER MANAGEMENT AND DEVELOPMENT**  
**PROJECT (PROJECT ID NO: P163782)**

**WORKS FOR CONSTRUCTION OF GASPA, MUTUNDA AND**  
**NYAKABAALE SOLAR POWERED PIPED WATER SUPPLY AND**  
**SANITATION SYSTEMS IN KIRYANDONGO REFUGEE HOSTING**  
**DISTRICT**

**REFERENCE NO.: MWE/WRKS/2-23/00005**

**VOLUME 3**

**Technical Specifications**

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# Technical Specifications

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## **1. GENERAL CLAUSES**

### **1.1 General**

Chapters 1, 2, 3, 7, 8 and 10 are particular to the Contract and shall take precedence over Chapters 4, 5, 6, 9 and the 4th Edition of the Civil Engineering Specification for the Water Industry (CESWI) and the CESWI Appendix, which contain standard specification clauses.

Clauses refer to all Parts of the works unless specified otherwise.

### **1.2 Purpose and Location of the Works**

The Purpose of The Works is to Construct Solar Powered Piped Water Supply Systems and Sanitation Facilities in Refugee Settlements and Host Districts in West Nile and Northern Uganda in Kiryandongo District. This assignment will cover the Rural Growth Centres of Gaspa, Mutunda and Nyakabaale in Kiryandongo District.

The Works will be in three Parts, as described below:

#### **Part 1: Water Supply Pipe Laying**

Supply and laying of new pipelines and associated fittings.

#### **Part 2: Buildings, Reservoirs, and Mechanical -Electrical Works**

The construction of borehole pump houses, water offices, reservoir, and guard houses.

#### **Part 3: Sanitation**

The construction of Public Sanitation Facilities.

### **1.3 General Description of the Works**

The Contract is for the supply and installation of water pipes, the civil works and the supply and commissioning of mechanical and electrical plant for the borehole pump houses booster stations, chemical house and public sanitation facilities. The extent of the Works is specified in Chapter 2.

A brief description of the facilities to be provided under this Contract in the two Parts of the Works is given below.

#### **Part 1 Water Supply Pipe Laying**

Part 1 of the Works comprises the supply and laying of water pipes, as shown on the Issued

Drawings, and will consist of the following items.

- Supply and laying of pipes and fittings;
- Supply and installation of bulk flow meters;
- Supply and installation of washouts, air valves and associated chambers;
- Supply and installation of consumer connections, and service pipes;
- Further details of the work to be undertaken are given in Clause 2.1.

## **Part 2 Buildings, Reservoirs, and Mechanical -Electrical Works**

Part 2 of the Works comprises the civil, mechanical and electrical works for the booster station, chemical house, and reservoirs. The details are in the Issued Drawings and summarised as follows:-

### Gaspa RGC

- Construction of one (1) water office block and associated site works
- Construction of one (1) borehole pump houses
- Construction of one (1) guard and pump attendant house, and associated site works
- Construction of a 200m<sup>3</sup> Steel Reservoir a 15m high steel tower.

### Mutunda RGC

- Construction of one (1) water office block and associated site works
- Construction of one (1) borehole pump houses
- Construction of one (1) guard and pump attendant house, and associated site works
- Construction of a 150m<sup>3</sup> Steel Reservoir a 15m high steel tower.
- Construction of a 100m<sup>3</sup> Steel Reservoir a 15m high steel tower.

### Nyakabale RGC

- Construction of one (1) water office block and associated site works
- Construction of two (2) borehole pump houses

- Construction of two (2) guard and pump attendant house, and associated site works
- Construction of a 150m<sup>3</sup> Steel Reservoir a 15m high steel tower.
- Further details of the work are given in clause 2.2.

### **Part 3: Sanitation**

Part 3 of the Works comprises the civil works for public sanitation. The details are in the Issued Drawings and summarised as follows:-

- Construction of public sanitation facilities and associated site works
- Further details of the work are given in clause 2.3

### **1.4 Other Contracts**

No other contracts are foreseen.

### **1.5 Plant Design**

#### **Part 2**

The whole of the Plant shall be designed and constructed to the best standard.

A manufacturer's standard design may be used for a Plant item where such a design is available and where it is at least equal to and compatible with that required by the Specification.

The Plant shall be new, of sound workmanship and robust design, and of a grade and quality suitable for the duty concerned and for the climatic conditions at the Site.

The Plant shall be designed to provide adequate protection against the entry of vermin and dust and to minimise fire risk and consequential fire damage.

All parts, which can be worn or damaged by dust, shall be totally enclosed in dust proof housings.

All equipment shall operate without excessive vibration and with minimum of noise.

All similar items of Plant and their components together with spare parts shall be made from the same materials and shall be fully interchangeable.

All manually operable Plant not located inside a building shall be provided with facilities for making it tamper proof. This is in addition to any requirements of the Specification for securing Plant under operational conditions.

The standards of workmanship and finish shall be uniform throughout and the final colours shall be designated by the Engineer.

Materials used in the Works which are or can be in contact with the untreated or treated water shall not contain any matter which could impart taste or odour or toxicity or otherwise be harmful to health or adversely affect the water conveyed. Approval by the National Water Council UK or the Uganda National Bureau of Standards will generally be regarded as satisfactory evidence of suitability.

## **1.6 Design Life**

### **Part 1 and 2**

All materials and equipment shall be designed for long life and continuous operation during prolonged periods with a minimum of maintenance and the Contractor may be called upon to demonstrate this for any component either by the service records of similar equipment elsewhere or by records of extensive type tests.

Routine maintenance and repair shall, as far as possible, not require the services of highly skilled personnel.

The materials of construction of the Plant shall be selected, taking into consideration their location and duty, such that the economic life of the Plant is not less than 25 years.

Except for consumable items such as gland packing, carbon brushes etc. which normally require replacement more frequently, no part subject to wear shall have a life from new to replacement or repair of less than three years of continual operation. Where major dismantling is required to replace a part, such life shall be not less than five years.

## **1.7 Regulations, Standards, Codes and Standard Specifications**

The Contractor shall obtain at least one copy of each DIN, ISO, BS, CP or other approved standard and reference work which is referred to in the Specification, and of each other standards which applies to materials which are being supplied to, or workmanship executed on, the Works. These standards and reference works shall be supplied to the Engineer within 90 days of the Engineer's Order to Commence the Works and will be available to the Contractor at all reasonable times.

### **Parts 1 and 2**

Wherever reference is made in the Contract to specific standards and codes to be met by the materials, plant, and other supplies to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the contract. Where such standards are national, or relate to a particular country or region, other authoritative standards, which ensure

a substantially equal or higher performance than the standards and codes specified will be accepted subject to the Engineer's prior review and written approval. Differences between the standards specified and the proposed alternative standards must be fully described in writing by the Contractor and submitted to the Engineer at least 28 days prior to the date when the Contractor desires the Engineer's approval. In the event that the Engineer determines that such proposed deviations do not ensure equal or higher quality, the Contractor shall comply with the standards specified in the documents.

All standards used will be the current version. A Contractor proposing to use alternative versions of specified standards and codes shall submit the alternative version to the Engineer for approval in accordance with the requirements outlined in the above paragraph.

All materials and workmanship not fully specified herein or covered by an approved standard shall be such kind as is used in first class work and suitable to the climate in the project area. Where the requirements of any such standard specification or regulation conflict with the requirements of this Specification or any item on the Drawings, then the Contractor should refer to the Engineer for clarification before proceeding with that section of the Works.

Materials, installation and testing of pipelines and their associated works shall be in accordance with the Civil Engineering Specification for the Water Industry, 4th Edition.

## **Part 2**

Except where otherwise specified all materials and workmanship shall comply with current national standards provided that these standards are not less stringent than the equivalent German Standards, British Standards or Codes of Practice or provided that they comply with the requirements of the International Organisation for Standardisation (ISO) or the International Electro-Technical Commission (IEC), as appropriate.

The electricity installation shall comply with all relevant statutory regulations and standards current at date of the bid, unless otherwise indicated within this Specification. Electrical installations shall, where relevant, be in accordance with the IEE Regulation for Electrical Installations, 16th Edition.

## **1.8 Drawings**

### **Parts 1**

The Drawings comprise the following:

- **Issued Drawings**

The Issued Drawings as hereinafter described.

- **Approved Drawings**

Approved Drawings as hereinafter described. Installation of pipelines and other works for which Approved Drawings are required shall not begin until the appropriate Approved Drawings are available. The plant shall be installed in accordance with the Approved and Engineer's Drawings.

- **Engineer's Drawings**

The drawings issued from time to time by the Engineer.

- **Other Drawings**

## **Parts 2**

The Drawings comprise the following.

- **Issued Drawings**

The Issued Drawings as hereinafter described.

- **Bid Drawings**

The Bid Drawings as hereinafter described.

- **Approved Drawings**

Approved Drawings as hereinafter described. Manufacture of the Plant shall not begin, nor shall erection of the Plant commence, until the appropriate Approved Drawings are available. The Plant shall be manufactured and erected in accordance with the Approved and Engineer's Drawings.

- **Engineer's Drawings**

The drawings issued from time to time by the Engineer.

- **Record Drawings**

Record Drawings as hereinafter described.

- **Other Drawings**



### **1.9 Issued Drawings**

These are drawings issued to the Contractor with the Bid Documents for the purposes of preparing a bid.

Such drawings shall be deemed to have been issued for the guidance of bidders, and shall be referred to for the interpretation of the Contract only where the drawings supplied by the Contractor at the time of bidding and incorporated in the Contract are insufficient.

### **1.10 Bid Drawings**

The Bid Drawings are supplied by the Contractor for the purpose of illustrating his bid, namely:

- a layout of the whole scheme, scale 1 : 100;
- drawings and technical details of the Plant in sufficient detail to illustrate that the several items of Plant are suitable for their intended purpose.

Where Bid Documents including Bid Drawings show features not in compliance with this Specification, and where such features are not listed in the Technical Schedules then the requirements of the Issued Documents will be taken as the basis of the Contract.

### **1.11 Approved Drawings**

With reference to Sub-Clause 1.25 of the General Conditions the Contractor shall submit, for approval, each drawing in the following categories and schedule.

#### **Parts 1**

- **Pipe Laying Drawings**

For the installation of service connections, fittings, valves, pipelines and service pipes, these drawings shall include details of all service connections to be installed by the Contractor. Where water pipelines and service pipes are to be laid these drawings shall show the position, material, class, diameter, length and pipe invert and ground levels above mean sea level, other services to be encountered or crossed by the pipeline and any structures to be constructed along it including valve/meter chambers, manhole chambers, trench cut-offs and anchor blocks.

#### **Part 2, 3**

- **Preliminary Layout Drawings**

- ◆ These shall be submitted within 1 month of the Commencement Date.
- ◆ These drawings shall show locations of major structures and site layouts.

- **Preliminary Civil Outline Drawings**

These shall be submitted within 2 months of the Commencement Date.

These drawings shall include information to allow the structural design to commence.

These drawings shall inform the Engineer of the basic physical shape, including channel sizes, and positions relative to one another, of the structures, and confirm the hydraulic levels through the plant.

They shall indicate in broad terms the locations for plinths and pipelines (greater than DN 250 mm) through walls. Location, line and level of major equipment/structures shall be positioned to an accuracy of  $\pm 300$  mm. They shall not detail final position for equipment and loadings or wall thicknesses and the like.

Loadings' accuracy for major plant shall not be less than final load nor greater than 120% of final load.

- **Detailed General Arrangement Drawings**

These shall be submitted within 3 months of the Commencement Date.

These drawings shall include information required to allow all major structural design and civil general arrangement drawings to be completed.

These drawings shall comprise:

- ◆ general arrangement drawings to scale of site plans showing each structure and building, principal routes for cables, pipes and chemical ducts and services;
- ◆ drawings of each building/structure shown in plan and elevation to show position of major items of plant.

- **Final Civil Outline Drawings**

- ◆ These shall be submitted within 4 months of the Commencement Date.
- ◆ These drawings shall include information to allow all major civil detail drawings to be completed.
- ◆ These drawings shall include final positions and loadings and dimensions of major plant.

- **Plant Drawings**

These shall be submitted within 5 months of the Commencement Date and shall include but not be limited to:

- ♦ general arrangement drawings to illustrate the position of the Plant in relation to the appropriate part of the Works in sufficient detail to show all the principal dimensions, methods of support and other relevant information;
- ♦ drawings of the Plant in sufficient detail for the Engineer to satisfy himself that jointly and severally the items of the Plant are suitable for their intended purpose;
- ♦ sectional drawings of each major item of the Plant, with a parts list and a list of materials to be used for each part. General arrangement of electrical panels with foundation and cable access details;
- ♦ diagrammatic outline and detail drawings of all services to, from and between the several items of the Plant, including potable and process water supplies, pipework, connections and fittings, electrical single line and schematic diagrams, cable schedules and site cable layout, connections and fittings, and drainage pipework and fitting;
- ♦ requirements for incoming supplies, services etc and details of interface connections in respect of the Plant, particularly where such connections are at the limit of Contract;
- ♦ details of wastes, effluent discharges, etc. and details of interface connections in respect of the Plant, particularly where such connections are at the limit of Contract;
- ♦ detailed drawings of the Plant and data in sufficient detail as may be reasonably required for the Engineer to satisfy himself as to the stability, durability and safety of the works and for ascertaining of inspection of the Plant during construction that it is in conformity with the Contract;
- ♦ fully detailed installation drawings giving complete dimensions of pedestals, cuts, chases, bolt holes, ducts and other provisions to be made in the civil structures and on site of fixing the Plant.

### **1.12 Procedure for Approval of Drawings**

Unless otherwise indicated within this Specification preliminary copies of drawings for approval shall be submitted to the Engineer.

Any alterations required by the Engineer to be made to drawings submitted for approval shall be made by the Contractor without extra charge, or extension of time, provided such alterations are not consequential upon a change in the requirements of the Contract.

Drawings when approved will be stamped with the Engineer's approval stamp and one copy

of each such approved drawing will be returned to the Contractor.

Acceptance of Bid Drawings shall not be deemed to confer the Engineer's approval upon them.

### **1.13 Record Drawings**

#### **Part 1, 2 and 3**

The Contractor shall provide a set of as built drawings for the works. He shall submit four hard copies of the drawings, a soft copy (digital format), a print out of the co-ordinates of the fixtures (e.g. valves, bends, manholes, etc.) and an electronic copy of the co-ordinates. The Contractor shall agree the details of the electronic copies with the Engineer

#### **Part 2 & 3**

A coloured and framed drawing showing all valves, pipe runs etc., together with detailed operating instructions for use in the pumping station and four full sets of Record Drawings will be required by the Employer on the completion of the work. The Drawings and one soft copy (digital format) shall be fully dimensioned, general arrangement and detail drawings together with electrical wiring diagrams. All drawings submitted for approval shall be included in the record drawings. Revised drawings shall be submitted within one month of any amendments made during erection. The record drawings shall be submitted with the operating instruction manuals as specified in Clause 1.21.

### **1.14 Contractor's Calculations and Technical Details**

#### **Part 2 & 3**

Within two months of the Commencement Date the Contractor shall submit to the Engineer design calculations and technical details of the Plant and structures further to those accepted with his Bid, in sufficient detail for the Engineer to satisfy himself that the items of the Plant and the structures are jointly and severally suitable for their intended purpose.

The design calculations and technical details shall include design calculations, piping and instrumentation diagrams, hydraulic flow diagrams, technical details and schedules of major plant and structures.

The Contractor shall also provide such additional details and calculations and other data as may be reasonably required by the Engineer to satisfy himself to the stability, durability and safety of the works and for ascertaining and inspection of the plant and structures during construction that it is in conformity with the Contract.

The Contractor shall submit as part of his technical details, the magnitude and frequency of all out of balance forces of the plant to allow them to be taken into account in the structural

design of civil and building structures.

## **1.15 Programme**

### **Parts 1, 2 & 3**

Before commencing the Works the Contractor shall, submit to the Engineer for his approval a programme showing the order in which he proposes to carry out the Works. The programme shall be in the form of a bar chart, or any other form as may be agreed by the Engineer, and shall be co-ordinated to take into account transportation and delivery times for the materials and for climatic and other conditions to provide for the completions of the Works in accordance with the Contract. The programme shall clearly indicate the following:

- the sequence of each activity, the proposed start and completion dates of each activity, the rate of progress and the cumulative quantity of percentage of work expected to be achieved on each activity by the end of each month;
- dates by which major drawings requiring the Engineer's approval will be submitted (a period of three weeks shall be allowed from date of receipt of these drawings for such approval);
- the time allocated for work by others, including those of the Employer and by utility undertakings.

Sufficient space should be provided in the programme for recording the actual progress against the programmed progress for each activity.

The programme shall be submitted with details of the following:

- a statement giving the numbers and categories of supervisory and technical staff and skilled and unskilled workers to be employed on the Works;
- a list and type details of major Constructional Plant (including vehicles) which the Contractor proposes to employ on the Works;
- details of the Contractor's methods of working for all operations;
- a statement giving the proposals for location or locations and sizes of accommodation, offices, workshops and stores;
- details of the programme for the Works from the date of receipt of the Engineer's order to commence the Works including a complete resource allocation showing the number of units and allotted times for each unit of Constructional Plant, materials and labour allocated to each part of the Works.

### **1.16 Progress Meetings and Reports**

During the period of the Contract, the Contractor shall allow for all consultations with the Employer and the Engineer and his staff in Gaspa RGC, Mutunda RGC and Nyakabaale RGCs, Kiryandongo District, Kamapala or elsewhere as necessary.

From the commencement of the work on Site there will be a series of monthly Site progress meetings to coordinate the civil and plant works. Representatives of the Contractor, approved by the Engineer, shall attend monthly progress meetings on Site or at the offices of the Employer. In addition, approved representatives of the Contractor shall attend further meetings in cases of emergencies or for other reasons when called upon by the Employer.

The Contractor shall submit to the Engineer each month a report on his progress in the performance of the Contract. The report shall include a copy of the approved programme with the current progress for each activity shown.

### **1.17 Organisation of Activities**

#### **Parts 1, 2 & 3**

The Contractor shall organise his activities within the Contract Area in such a way as to minimise disruption to both the public, to water consumers and his sequence of working shall be clearly indicated in the Programme. The Contractor shall submit a fully detailed programme of work to the Engineer for approval.

### **1.18 Notice of Operations**

The Contractor shall give full and complete written notice of all important operations to the Engineer sufficiently in advance of not less than 48 hours and in a form approved by the Engineer, to enable the Engineer to make such arrangements, as he may consider necessary for inspection or for any other purpose. The Contractor shall not commence any important operation without the written approval of the Engineer.

The Notice of Operation shall be followed by a Request for Inspection/Approval, in a form approved by the Engineer, in which the Contractor shall seek permission for executing any part of the Works.

Important works shall include all operations occurring on the site outside the following hours:

- Monday to Friday: 8:00 am to 5:00 p.m. These shall be the normal site working hours.

### **1.19 Public Holidays**

The Contractor shall allow in his programme for the following 14 public holidays per calendar year as observed in the Republic of Uganda and upon which days the Contractor shall not be permitted to work:

- (a) New Year's Day (1<sup>st</sup> January),
- (b) NRM Anniversary Day (26<sup>th</sup> January),
- (c) Janani Luwum Day (16<sup>th</sup> February),
- (d) Eid al-Fitr,
- (e) Women's Day (8<sup>th</sup> March),
- (f) Good Friday,
- (g) Easter Monday,
- (h) Labour Day (1<sup>st</sup> May),
- (i) Martyrs' Day (3<sup>rd</sup> June),
- (j) Heroes' Day (9<sup>th</sup> June),
- (k) Independence Day (9<sup>th</sup> October),
- (l) Eid al-Aduha,
- (m) Christmas Day (25<sup>th</sup> December),
- (n) Boxing Day (26<sup>th</sup> December).

### **1.20 Site Management**

The Contractor shall keep complete and accurate records, using a form approved by the Engineer, of Works and associated activities/events on Site. These records shall include, but are not limited to, details of the Works executed; delivery to Site of Materials, Plant and Contractor's Equipment; removal from Site of any item of Contractor's Equipment and weather conditions.

The Contractor shall prepare monthly progress reports and submit them to the Engineer in three copies. The first report shall cover the period up to the end of the first calendar month following the Commencement Date. Reports shall be submitted monthly thereafter, each within 7 days after the last day of the period to which it relates.

Reporting shall continue until the Contractor has completed all work which is known to be outstanding at the completion date stated in the Taking-Over Certificate for the Works.

Each report shall include

- a) Charts and detailed descriptions of progress, including each stage of design (if any), Contractor's Documents, procurement, manufacture, delivery to Site, construction, erection and testing; and including these stages for work by each nominated Subcontractor,
- b) Photographs showing the status of manufacture and of progress on the Site;
- c) For the manufacture of each main item of Plant and Materials, the name of the manufacturer, manufacture location, percentage progress, and the actual or expected dates of:
  - i) commencement of manufacture,
  - ii) Contractor's inspections,
  - iii) tests, and
  - iv) shipment and arrival at the Site;
- d) Records of Contractor's Personnel and Equipment;
- e) Copies of quality assurance documents, test results and certificates of Materials;
- f) Safety statistics, including details of any hazardous incidents and activities relating to environmental aspects and public relations; and
- g) Comparisons of actual and planned progress, with details of any events or circumstances which may jeopardise the completion in accordance with the Contract, and the measures being (or to be) adopted to overcome delays.

### **1.21 Packing and Protection**

Before any item is despatched from a manufacturer's factory it shall be adequately protected and packed so as to arrive at the Site intact and undamaged. The Engineer shall be given at least 14 days' notice that packing will commence. The method of protection and packing must be suitable to withstand the conditions, which may be experienced in shipment and delivery to the Site. It should also be suitable to withstand long periods of storage out of doors.

No one crate or package shall contain items of Plant intended for incorporation in more than one part of the Works.

All items shall be clearly marked for identification against the packing list, which shall be placed in every crate or package and protected in a waterproof envelope.

All crates and packages shall be clearly marked with a waterproof pen and weather-proof



material to show the weight and where the weight is bearing, and where the sling should be attached. They shall also be marked to identify the packing lists.

Bright parts and bearing surfaces shall be protected from corrosion by the application of a rust-preventive lacquer, high melting point grease or similar. A sufficient quantity of appropriate solvent shall be supplied with the Plant for the removal of this protection.

Each crate or package shall have a clear indelible and, as far as possible, indestructible unique identification cypher, also quoted on the packing list inside it. Three copies of the packing list shall be posted separately to the Engineer at the time of shipment.

All flanges and mating surfaces shall be protected by means of a wooden template or similar. The bolts for securing this template shall not be secured by the bolts, screws etc, which form part of the final installation.

## **1.22 Commissioning**

The Contractor is required to provide suitable personnel, to be approved by the Engineer, to operate each section of the Works during commissioning, i.e. the setting to work and testing of individual components of the Works or the complete Works. This shall include Tests on Completion as more fully defined in Chapter 7. Commencing during the commissioning period the Contractor shall instruct the Employer's staff in the operation and maintenance of each section of the Works as specified in Chapter 8.

## **1.23 Operating Instructions**

### **Part 2 & 3**

The Contractor shall provide five sets of instruction manuals for each of the sections of the Works to cover all items of the Plant and process. The manuals shall describe the installation and operation as a whole and give step by step procedures to enable the Employer to carry out any operations likely to be required during the life of the Plant including erection, commissioning, testing, operation, maintenance, dismantling and repairs. The instructions shall include the operation of valves, etc. existing or provided by others where the operation of these items is part of or associated with any aspect of the Plant operation.

The maintenance instructions shall include lubrication charts, testing and replacement procedures to be carried out daily, weekly, monthly, and at other intervals to ensure trouble-free operation. Where applicable, fault location charts should be included to facilitate finding the cause of imperfect operation or breakdown.

Sections of the manuals shall be devoted to each size and type of equipment with relevant detailed descriptions of construction, maintenance and operation with lists of parts and procedures for ordering spares.

The Contractor shall supply five sets of manuals and record drawings for each section of the

Works to the Engineer two months before starting the tests on completed plant systems. Where appropriate preliminary draft copies of instructions shall be submitted during erection to facilitate erection and testing of equipment prior to Plant commissioning. Two complete sets of manuals shall be submitted to the Engineer for approval including certification of equipment, three months before the final submission described above.

The manuals shall be fully bound and indexed to A4 size with the name of the Employer, Contractor, the Contract number and name of the scheme clearly marked. A collection of manufacturer's descriptive leaflets will not be acceptable as an instruction manual.

## **1.24 Water and Electricity Supply**

### **Parts 1, 2 & 3**

The Contractor shall make his own arrangements for the supply of water and electricity for the purposes of the Works.

In the event of a reservoir or pipeline failing on hydraulic test, the Contractor shall be responsible for disposing of the test water to allow repairs to be carried out, and for costs of any water tankers required for supplying water for subsequent re-tests.

Water and wastewater derived from the construction, testing and completion of the Works shall be disposed of to the satisfaction of the Engineer so as to cause no damage or complaint.

The Contractor shall supply the disconnected water consumers during construction works with potable water. The Contractor can bill for these services as provided for in the Bills of Quantities.

## **1.25 Contractor's Facilities**

The Contractor shall provide all site facilities including offices, workshops, stores, accommodation, washing, sanitation etc. necessary for use by his own staff, for the execution of the Works.

The Contractor shall be responsible for making all arrangements for drainage from his site facilities and shall be responsible for payment of all charges in connection therewith.

## **1.26 Storage of Plant**

### **Part 2 & 3**

The Contractor shall be responsible for and bear all costs of securely storing the Plant and Equipment, both on and off site, in suitable environmental conditions to prevent deterioration of the Plant and Equipment until it is incorporated into the Works. The standard of storage to be provided by the Contractor for the Plant and Equipment shall be as follows.

All electrical Plant and Equipment and moving mechanical Plant and Equipment shall be stored by the Contractor in suitable wind and watertight buildings to be provided by the Contractor at his own expense. The stores shall be dust free and shall be adequately ventilated and heated by the Contractor at his own expense, to prevent condensation and deterioration of the Plant and Equipment. The heating shall be provided by a thermostatically controlled heating system. The stores shall also be adequately lit. The stores and its services shall be approved by the Engineer. The giving of such approval shall not relieve the Contractor of his liabilities for the safe and proper storage of the Plant and Equipment under the Contract.

All other Plant and Equipment shall be stored by the Contractor in secure compounds to be provided by the Contractor at his own expense. Such Plant and Equipment shall be protected as appropriate to prevent its deterioration while in store.

While the Plant and Equipment is in store the Contractor shall take all necessary precautions to maintain the Plant and Equipment in a serviceable condition and these precautions shall be to the approval of the Engineer. Such minimum precautions shall include, but not be limited to, the measures described below.

- Motors shall be stored under polythene with their heaters energised at all times. Packing strips shall be inserted in the air gaps to prevent rotors from resting on stator cores and bearings shall be removed.
- Circuit breaker panels, motor control centres and switchboards shall be stored under polythene and the heaters shall be energised at all times.
- Oil-filled transformers shall be pressurised with an inert gas.
- All flanges shall be closed off with metal caps and all small openings shall be stopped with plastic plugs or caps.
- All shaft exits from casing and bearing housings shall be sealed with Denso tape moulded into place. All closures shall be taped over and the tape painted with three coats of tretoplast sac to form a complete seal.
- All exposed ferrous non-stainless machined surfaces shall be coated with a bitumen solution.
- Thrust and journal bearings shall be removed from the pump and packed in the pump. Journal bearings shall be stored as a matched pair.
- Plant and Equipment shall be inspected every three months to ensure that the packing is intact and that the Plant has not been contaminated by the ingress of moisture.
- The Plant and Equipment shall be examined every six months and desiccants replaced. All rolling elements of Plant and Equipment shall be given 1.25 turns at each inspection.

Notwithstanding the above requirements, the Contractor shall be liable for the safe and proper storage of all Plant and Equipment under the Contract.

### 1.27 Level Datum

This was obtained by use of a combination of stationary GPS and Total Station, leading to measurement of traverses along the proposed water lines, as well as proposed water storage sites.

The GPS information was measured using Magellan ProMark X-CM in stationary differential mode and the processing done using Magellan Mstar professional GPS software.

A report containing the co-ordinates of the points, the point description of reference benchmarks and the point description of new established traverse points will be handed over by the Engineer to the Contractor.

This notwithstanding, the Contractor has to check the points and will be fully responsible for the surveying works.

All levels stated shall be related to existing and temporary benchmarks and traverse points established during the design of the works.

The level Datum for the project area provided in Arc1960N is shown in Table 1-1

**Table 1-1 Level Datum**

|    | <b>Northing (N)</b> | <b>Easting (E)</b> | <b>Elevation (Z)</b> | <b>Remarks</b> | <b>RGC</b> |
|----|---------------------|--------------------|----------------------|----------------|------------|
| 1  | 208035.5            | 405570.7           | 1060.725             | Bm01           | GASPER     |
| 2  | 209623.7            | 408046.9           | 1085.383             | Bm02           | GASPER     |
| 3  | 210165.2            | 408552.1           | 1079.324             | Bm03           | GASPER     |
| 4  | 211579              | 409245.5           | 1110.651             | Bm04           | GASPER     |
|    |                     |                    |                      |                |            |
| 5  | 237507.1            | 418365.9           | 1072.042             | MUT 01         | MUTUNDA    |
| 6  | 236251.7            | 420078.3           | 1059.102             | MUT 02         | MUTUNDA    |
| 7  | 232068              | 422815.1           | 1060.712             | MUT 03         | MUTUNDA    |
| 8  | 229279.4            | 422862.6           | 1044.15              | MUT 04         | MUTUNDA    |
|    |                     |                    |                      |                |            |
| 9  | 199170.9            | 380905.4           | 1072.528             | AP01           | NYAKABAALE |
| 10 | 199058.4            | 377827.5           | 1097.544             | AP02           | NYAKABAALE |
| 11 | 202362.6            | 378773.4           | 1145.084             | AP03           | NYAKABAALE |
| 12 | 206586.7            | 379742.2           | 1114.721             | AP04           | NYAKABAALE |

### 1.28 Climatic Data and Location Level

The Contractor shall take account of the following site climatic conditions at the site of the Works both in the design and selection of all plant and equipment and the construction of the

Works.

Kiryandongo District has bi-modal rainfall pattern with average annual rainfall of 1200mm. The highest rainfall is received in March – May and August – November. The sub counties of Kigumba, Kiryandongo and Mutunda receive between 800 to 1000mm.

The Contractor shall take account of the following site climatic conditions at the site of the Works both in the design and selection of all plant and equipment and the construction of the Works.

- Average temperature 23.8°C
- Average Location Level 1295 m AMSL.

### **1.29 Contamination of Water Supplies**

Before any person is engaged on work involving a risk to the purity of potable water supplies or deemed to involve such a risk by the Engineer, he shall be tested to indicate that he is not a carrier of typhoid or other water-borne disease and he shall be informed of the dangers of contamination. The Contractor shall notify the Engineer of any person who has been certified by a doctor as suffering from an illness associated with looseness of the bowels, and no such person shall be employed on such work until the Employer's medical adviser is satisfied that it is safe for him to be so employed.

The Contractor shall comply with the provisions of 'Safeguards to be Adopted in the Operation and Management of Waterworks' published by HMSO (UK).

### **1.30 Site Access and Boundary**

It is the Contractor's responsibility to make provision for any additional accommodation, any special or temporary way leave, or any tip for the disposal of surplus materials, or any borrow pit or quarry required by him outside the Working Areas to carry out the Works.

For the purposes of this Clause, 'accommodation' shall be deemed to include housing, offices including office accommodation for the Engineer, workshops, warehouses, and storage areas.

In the event of the Contractor making use of any special or temporary way leave or additional accommodation required by him or any tip for the disposal of surplus materials, or any borrow pit or quarry, he shall obtain the written consent of the owner, occupier or authority having charge of the land in which such way leave, accommodation or tip is situated and shall make a record agreed by the owner, occupier or authority as aforesaid of the condition of the surface of that land before entering thereon.

The Contractor shall permit the Engineer and any person authorised by the Engineer access for the purposes of the Contract to any such special or temporary way leave or additional accommodation.

In the event of the Contractor making use of any special or temporary way leave or additional

accommodation made available to him for the purpose of the Contract, the land in which such way leave or accommodation is situated shall be deemed to be part of the Site.

The extent of the site is indicated below. The Contractor shall not use the site for any purpose not required by the Contract.

### **Parts 1**

The site generally comprises Working Areas in each street or field sections where the various Works are to be constructed. Working Area boundaries will be as directed by the Engineer and will generally compose a strip extending not more than 5 metres from excavations under the Contract.

### **Parts 2 & 3**

Access to the Site will be as follows:

Using the new site roads or existing roads to be constructed as shown on the Issued Drawings. The Contractor shall at all times confine his operations to those areas identified on the Issued Drawings as within the Site boundaries.

The Contractor shall execute the Works in such manner as to minimise interruption and interference with the operation of the existing facilities. Access to the existing facilities shall be maintained to the satisfaction of the Engineer at all times.

The Contractor shall apply to the Engineer in writing at least 28 days before starting any work which involves interference with existing structures, equipment, etc. or otherwise interferes with or interrupts the Employer's normal operation. The Contractor shall not execute such work until he has received permission to proceed in writing from the Engineer.

### **1.31 Use of Public Highways and Roads**

The Contractor shall ensure that roads and thoroughfares used by him in any way are not dirtied as a result of such use and in the event of their becoming thus dirtied in the opinion of the Engineer, the Contractor shall take all necessary steps to clean them, at no extra cost to the Employer. The Contractor shall obtain all permits required for carrying out the Works on public roads and shall liaise with the appropriate authorities with regard to the timing and execution of the road works.

The Contractor shall be responsible for establishing and maintaining temporary road diversions for the duration of the roadwork. The road shall be kept open at all times during the road works period, and the work shall be carried out in such a manner as to minimise the disruption to traffic.

**1.32 Private Property**

The Contractor shall make a record, to be agreed by the Engineer, of the condition of the surfaces of any private property, private lands or of any public cultivated or maintained lands over which access to the Site lies before any work is commenced, to make them suitable for access. He shall keep such surfaces in a reasonable state of cleanliness and repair during the execution of the Works. On the termination of the Contractor's use of such access he shall restore the surfaces to a condition at least equal to that existing before his first entry on them.

The Contractor shall not first enter any part of the Site in private lands without the prior permission of the Engineer and without first having obtained the consent of the owner of such lands. The Contractor shall give a minimum of two weeks' notice to the Engineer of his intention to begin works in any area.

The Contractor shall provide and maintain at all times, vehicular and pedestrian access to all properties, private and public, to the satisfaction of the Engineer, and not impede access to any properties.

**1.33 Clearance of the Site**

The Contractor shall clear the Site to the extent required by the Engineer for checking the setting out. Clearance of the Site shall also include the demolition and removal of all articles, objects and obstructions, which are expressly required to be cleared. The Contractor shall not clear the Site of any structure without the prior written permission of the Engineer. The Contractor shall remove the material arising from such clearance and dispose of it in a manner and at a location, on or off the Site, to the approval of the Engineer.

The Contractor shall fill and make good with appropriate materials those cavities and losses of soil, which result from clearing the parts of the Site not subsequently to be occupied by the Permanent Works.

**1.34 Condition of the Site**

The Contractor shall maintain the Site in a clean, tidy and healthy condition for the whole of such time as he is responsible for the care of the Works.

The Works shall be kept in a dry state and any water entering the Works from any source shall be collected and discharged in a safe manner approved by the Engineer.

**1.35 Access for the Employer and Engineer**

The Contractor shall permit the Employer and the Engineer and any person authorised by the Employer or the Engineer, including workmen of the Employer, other contractors or utility undertakings, access for the purposes of the Contract, or performing their normal duties, to all areas of the Site and to any additional accommodation or temporary way leave for the

duration of the contract period.

### **1.36 Noise**

The background sound level at any point along the boundary of the Site or Working Areas, arising from the operation of any mechanical equipment, with the exception of the diesel generators, shall not exceed 70 dB (A). The background sound level at any point along the boundary of the Site, arising from the operation of the diesel generators for standby generation shall not exceed 80 dB (A).

No item of Plant and Equipment, shall produce a sound pressure level exceeding 85 dB(A) when measured at a distance of 1 m from the reference surface of that item requirement of ISO 3746 'Acoustic Determination of Sound Power Levels of Noise Services - Survey Methods' or the equivalent ANSI SI.36.

Sound pressure levels shall be measured in dB (A), using a calibrated sound meter meeting the requirements of BS 5969 with the responses speed set to 'slow'. The background noise level shall be at least 10 dB (A) below the operating noise level of the machine or other item of Plant and Equipment.

The Contractor shall produce certified evidence from the manufacturer that the appropriate tests have been carried out on all items of the same type which is in all relevant respects similar to the item to be supplied. Such relevant respects would include the running speeds, the power input under the loading conditions which would produce the most noise, the power input under normal operating conditions (if different from the foregoing), the number of stages (for rotary machines) or the number of cylinders (for reciprocating machines).

If an item in its standard build does not comply with the above requirement, the Contractor shall be required to reduce the sound pressure level by providing improved or additional silencers or fitting sound insulating materials to the item.

### **1.37 Temporary Works**

The Contractor shall submit to the Engineer for approval full details of his proposals for temporary works at the Site, at least 14 days prior to the intended start of such work.

The Contractor shall not proceed with such work until he has received the Engineer's written approval of his proposals for the temporary works. Such approval shall not relieve the Contractor of his obligations and liabilities under the Contract.

### **1.38 Latrines**

Throughout the period of construction of the Works the Contractor shall provide, maintain and clean suitable and sufficient latrines for use by his employees. He shall ensure that his employees do not foul the site but make proper use of the latrines. Cost for the provision and



maintenance thereof shall be included in the Contract Price.

Where practicable the latrines shall be connected to the nearest sewer, or if this is not practicable the Contractor shall provide an adequately sized septic tank and soak away or alternative approved by the Engineer.

### **1.39 Photographs**

The Contractor shall supply digital copies of photographs and un-mounted positive prints of not less than 250 x 200 mm of such portions of the Works, in progress and completed, as may be directed by the Engineer and specified herein. The digital copies and prints shall not be altered. The digital copies shall be the property of the Employer and shall be delivered to the Engineer with the prints. No prints or digital copies shall be supplied to any other person without the written permission of the Engineer.

If so directed by the Engineer, the Contractor shall supply transparencies and colour prints in lieu of colour digital copies and prints.

The photographs shall be in two categories:

- (i) Progress photographs taken every two days and submitted on a monthly basis for all work aspects.
- (ii) Record photographs taken at completion and supplied at the time of substantial completion and commissioning of the works.

Both categories of photographs shall be properly referenced to the approval of the Engineer and on the back of each print shall be recorded the date of the photograph, the direction in which the camera was facing, an identifying description of the subject and the reference.

Photographs taken for record purposes as ordered by the Engineer or as specified herein shall be supplied with three prints, having the reverse of one subscribed with the signatures of the Contractor and the Engineer (or their authorised representatives) for the purpose of attestation. If required, the Contractor may at his own expense have an additional print similarly attested for his retention.

The Contractor shall supply three CDs / DVDs containing the digital copies and three prints of each progress/record photograph ordered by the Engineer. He shall supply two additional prints of progress/record photographs selected by the Engineer for incorporation in albums. He shall supply two sets of albums, mount the prints, and title the prints and albums all to the approval of the Engineer.

The taking of photographs of the Works by the Contractor for any other purpose whether for use in Uganda or in any other country shall not be carried out without written approval from the Engineer.

The cost of taking, developing and supplying the photos shall be borne by the Contractor and should be incorporated in the rate for the preparation of the as-built drawings.

#### **1.40 Setting out**

##### **Part 1**

Final horizontal and vertical alignment of all pipelines shall be agreed with the Engineer prior to the commencement of works as detailed in Chapter 3 of this Specification.

#### **1.41 Units of Measurement**

All designs, drawings, specifications and manuals shall use SI (kg, m, s) units and all measurements, dimensions and performance data shall be quoted in those units.

#### **1.42 Languages**

All drawings, instructions, signs, notices, name-plates etc for use in the operation and maintenance of the completed works shall be in English.

Warning signs shall be in English.

#### **1.43 Contract Signboard**

The Contractor shall supply and erect at least two contract signboards at locations to be specified by the Engineer. The signboards shall be of substantial construction to the approval of the Engineer and the lettering shall be black on a white background. The layout and dimensions of the signboards shall be approved by the Engineer. The sign boards must be erected not later than four weeks after contract commencement.

#### **1.44 Advertising**

The Contractor shall not use any part of the Site for any form of advertising without the prior written approval of the Engineer.

#### **1.45 (a) Safety and Health Regulations on Site**

The Contractor shall comply with all statutory and other regulations concerning the safety of his site staff, operatives, staff of the Employer and Engineer and members of the public, as a result of his operations. He shall obtain copies of all regulations and shall make them available on Site for inspection by the Engineer.

Notwithstanding the above the Contractor shall ensure that the following primary site safety rules are adhered to at all times.

- All open excavations shall be fenced off with temporary fencing at all times, and shall be

adequately lit at night.

- Excavating and earthmoving plant and equipment must not encroach on live carriageways at any time. The Contractor shall ensure that all items of plant working adjacent to live carriageways are accompanied by a Banksman at all times.
- Construction materials, bedding material and excavated material stored adjacent to the pipe trench must be safely and securely stored, and must not encroach onto the live carriageways, pedestrian footpaths, private or public access ways or watercourses, unless prior approval is given by the Engineer.
- Provision of sanitary accommodation and PPE including orientation of workers on use of equipment.

#### **1.45 (b) Occupational Health and Safety Risks**

- The Contractor shall prepare and implement an occupational safety and health plan for all sites, approved by the developer.
- The Contractor shall provide safety guidelines to all operations prior to start of work.
- 
- Strict adherence to safety measures and procedures are required to minimise (or eliminate) risks of accidents or hazardous developments occurring and ensure healthy and safe conditions for all persons working on the site. To ensure occupational health and safety on construction sites, the Contractor shall be obliged to comply with all applicable Ugandan construction Health and Safety Standards as required by the Occupational Safety and Health Act of 2006. These include provisions of the Factories Act, Labour Unions Act and Workman's Compensation Act.
- 
- Training will be conducted on how to prevent and manage incidences. This should involve proper handling of electricity, water etc. and sensitization on various modes of escape, conduct and responsibility during such incidences. All must fully be aware and mentally prepared for potential emergency.
- 
- Regular drills will be constantly followed on various possible incidences. This will test the response of the involved stakeholders. Such drills will keep them alert and they will become more responsive in case of incidences.
- 
- Personnel on duty shall at all times wear appropriate PPE, such as safety glasses with side shields, face shields, hard hats/helmets, and safety boots be required for all site staff.
- 
- The Contractor shall establish emergency entrances, exits and amenities.
- 
- The Contractor shall ensure access to first aid kits.
- 
- The Contractor shall ensure safe working heights through provision of work platforms, scaffolds and adequate supervision by ensuring regular inspection of formwork, false work and temporary supports before loading or pouring concrete.

- The Contractor shall secure site boundaries with fences or hoardings as appropriate.
- The Contractor shall install caution signage around the site to discourage the public from being close to the site, for example, “falling debris”, “keep off the site” etc.
- 
- The Developer through the Construction Supervisor will continually monitor Contractors’ compliance with Health and Safety measures.
- An Accident Log will be maintained onsite to register all injuries and to investigate their causes during both the construction and operation phases of the project.
- The manufacturer's instructions and Material Safety Data Sheets (MSDS) shall be followed for the storage of all chemicals used in water treatment. Storage must conform to compatibility restrictions.
- Work force shall be subjected only to standard work shifts/hours. Overtime allowances, if applicable/warranted shall be paid with ceiling limits. Working beyond such ceiling limits shall be discouraged, even if, so desired workforce or contractor.

#### **1.46 Protection of Existing Public and Private Services**

The Contractor shall notify all public authorities, utility companies and private owners of proposed works, which will affect them not less than one week before commencing the Works.

The Contractor shall adequately protect, uphold, maintain and prevent damage to all services and shall not interfere with their operation without the prior consent of the public authorities, utilities, utility companies, private owners, or the Engineer as appropriate.

If any damage to services results from the execution of the Works, the Contractor shall immediately carry out the following:

- Notify the Engineer and appropriate public authority, utility company or private owner.
- Make arrangements for the damage to be made good without delay to the satisfaction of the public authorities, utility company or private owner as appropriate. The Contractor shall be liable for all costs for making good such damage.

The Engineer may issue instructions or make other such arrangements, as he deems necessary, to repair rapidly any essential services damaged during the execution of the Contract. Such arrangements shall not affect any liability to pay for making good the damage.

#### **1.47 Permits**

The Contractor shall be fully responsible for obtaining all necessary permits, licences and permissions required for the execution of the Works, prior to the commencement of the Works. Payment for the permits should be included in the contractor’s respective rates.

#### **1.48 Insurance**

The Contractor is required to maintain insurance for the Works in accordance with the Conditions of Contract, including insurance of all pipework, fixtures, fittings, valves and meters etc. supplied by others, for which the Contractor is solely responsible. In addition, the Contractor is required to maintain the value of his insurance cover and Performance Security in respect of the rise and fall of costs, in accordance with the Conditions of Contract.

#### **1.49 Environmental Protection**

The Contractor shall enforce environmental mitigation measures, as listed below. However, the Contractor shall not be limited to the listed mitigation measures.

**Table 1-2 Mitigation Measures and Environmental Management Plan during Construction****(a) GASPA RURAL GROWTH CENTRE**

| Impact/Risk   | Mitigation /Enhancement commitments   | Responsibility | Estimated Cost (UGX)                                       |
|---|---|----------------|--|
| <b>POSITIVE IMPACTS – CONSTRUCTION PHASE</b>                                |   |                |  |
| Provision of direct jobs (casual workers) for locals - youth, women and men | • Recruit locals for construction jobs according to their skills.   | • Contractor   | Embedded in contractor's fees                              |
|   | • Promote labour-intensive construction methods to create more jobs.  | • Contractor   |  |
|   | • Adhere to the local labour laws of 30% women in employment and remuneration of workers above the minimum wage.                            | • Contractor   |  |
|   | • Ringfence some jobs such as cleaning and cooking specifically for local women.  | • Contractor   |  |
|   | • Encourage qualified females to apply for jobs.  | • Contractor   |  |
|   | • Gender sensitive facilities such as bathrooms, toilets and breastfeeding spaces to be provided to create a conducive working environment. | • Contractor   | 5,000,000  |
| <b>NEGATIVE IMPACTS – CONSTRUCTION PHASE</b>                                |   |                |  |
| Land use/cover change   | • Restrict water transmission and distribution lines to road reserves.  | • Contractor   | -  |
|   | • Compensate for land as per Ugandan laws on Land Acquisition and in line with World Bank's OP 4.12.  | • MWE          | As determined in the RAP Valuation Report.                 |
|   | • Movement of vehicles and equipment must follow designated pathways or agreed upon access roads.   | • Contractor   | -  |
| Land acquisition and resettlement   | • Implement the RAP in line with Ugandan laws and the World Bank's ESS5   | • MWE          | 221,960,000 Estimate from RAP for all 3RGCs in Kiryandongo |
|   | • Engage local communities to provide land voluntarily especially for the distribution lines  | • MWE          | Covered in RAP implementation budget                       |
|   | • Select land requiring minimal or no relocation at all   | • MWE          |  |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk                                   | Mitigation /Enhancement commitments   | Responsibility | Estimated Cost (UGX)                                   |
|---|---|----------------|--|
|   | • Use road reserves for pipe works  | • Contractor   | -  |
|   | • Provide a fair and prompt compensation to the affected people   | • MWE          | 304,952,275 as determined in the RAP Valuation Report. |
|   | • Determine the extent of property lost or destroyed and provide fair and prompt compensation to the effected people.                         | • MWE          | Covered in RAP implementation budget                   |
| Deterioration of landscape and visual quality | • Obtain murrum and subsoil from a NEMA/ DLG licensed source.   | • Contractor   | Within contractor's bid budget                         |
|   | • Install berms and drainage channels to control surface water run-off during earthworks.   | • Contractor   |  |
|   | • Restore of borrow pits and revegetate with native species.  | • Contractor   |  |
|   | • Close monitoring of impact on natural resources with enforcement of contract or legislative options.  | • DLG/ MWE     | 10,000,000   |
| Soil Erosion                                  | • Limit vegetation clearance to localities required for development.  | • Contractor   | -  |
|   | • Hoard off construction sites and instate soil barriers before excavations to intercept any eroded material and any soil material.           | • Contractor   | Within contractor's bid budget                         |
|   | • Remove topsoil prior to carrying out excavations and stockpile separately so that it is used last in backfilling of the excavated areas.    | • Contractor   |  |
|   | • Backfill all trenches immediately after laying the pipes and compact such areas as to near level prior to excavation.                       | • Contractor   |  |
|   | • Remove excess excavated soil material which will not be used for construction works in a timely manner and deposit at an approved site      | • Contractor   |  |
| Loss of Vegetation and degradation of Habitat | • Ensure proper landscaping and vegetation restoration is carried out using native species to further reduce the possibility of soil erosion. | • Contractor   |  |
|   | • Limit vegetation clearance to localities required for development.  | • Contractor   | -  |

| Impact/Risk                                       | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX)           |
|---|---|--|--------------------------------|
|   | <ul style="list-style-type: none"> <li>Avoid and minimise cutting of trees at all project sites.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Movement of vehicles and equipment must follow designated pathways or agreed upon access roads.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Remove and destroy any encountered invasive species</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Sensitise all project workers to minimise damage to vegetation and fauna.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>If wild animals are encountered, the Contractor shall notify UWA so that it is picked and taken to a secure place.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Disturbance and degradation of wetland ecosystems | <ul style="list-style-type: none"> <li>Use existing road corridors for construction and operational access wherever possible.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Where the alignment requires the suspension points for the water pipes to be located in the swamp and in areas which cannot be easily accessed, build temporary access to wetland areas not easily accessible from existing roads or causeways, that will be removed after.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Obtain wetland user permits from NEMA before constructing across or along wetlands and follow all guidelines given.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | 150,000                        |
|   | <ul style="list-style-type: none"> <li>All project workers should be sensitized to minimize damage to flora and fauna.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Close monitoring and supervision of the construction operations to ensure compliance to the NEMA permit conditions and avoid causing further damage to undesignated project areas.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | -                              |
| Generation of waste                               | <ul style="list-style-type: none"> <li>The Contractor shall develop and implement a Waste Management Plan</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 15,000,000                     |
|   | <ul style="list-style-type: none"> <li>All sorts of waste generated during construction such as HPDE and uPVC offcuts and other accessories associated with water and sanitation projects shall be collected by the contractor and delivered to recycling facilities. Other forms of waste which are inert must be collected by NEMA gazetted waste handlers and</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 10,000,000                     |



| Impact/Risk   | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX)                      |
|---|---|--|---|
|   | taken to a NEMA gazetted waste disposal facilities for disposal.  |  |   |
|   | <ul style="list-style-type: none"> <li>All organic waste generated at eating places during construction such as food stuffs shall be collected and transported by the contractor to designated district landfills for disposal.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |
|   | <ul style="list-style-type: none"> <li>All plastic waste generated during construction, such as mineral water bottles, polyethene bags, jerricans and cups shall be collected and taken for recycling in plastic collectors in Kiryandongo for onward transmission to plastic recyclers.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |
|   | <ul style="list-style-type: none"> <li>Human excreta shall be managed using a mobile toilet and then disposed at the waste stabilisation ponds at Kiryandongo Hospital.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 10,000,000                                |
|   | <ul style="list-style-type: none"> <li>The contractor will work with Kiryandongo district Local government to facilitate sound waste handling and disposal. All wastes must be taken to the approved waste disposal facilities. Proof of delivery and safe disposal of waste will be provided and records maintained at all times.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
| Risk of contamination due to flooding of borehole DWD 77383 | <ul style="list-style-type: none"> <li>The production well should be constructed with a water tight casing above the water table</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
|   | <ul style="list-style-type: none"> <li>The design and construction of the pump house at source DWD 77383 should incorporate a raised apron slab above the ground by the required height for the predicted flood depth of the area.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Part of the Design Consultant's work      |
|   | <ul style="list-style-type: none"> <li>Aprons should be constructed with deep foundation edges to avoid erosion</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        |   |
|   | <ul style="list-style-type: none"> <li>A water source protection plan has been developed to ensure sustained water quality and quantity for the project.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Part of ESIA, RAP & SPP Consultant's work |
| Noise and Vibrations  | <ul style="list-style-type: none"> <li>Workers should be provided with the necessary personal protective equipment (PPE) such as ear muffs.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
|   | <ul style="list-style-type: none"> <li>Periodic medical hearing checks should be performed on workers exposed to high noise levels.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |

| Impact/Risk            | Mitigation /Enhancement commitments   | Responsibility  | Estimated Cost (UGX)           |
|------------------------|---|---|--------------------------------|
|                        | <ul style="list-style-type: none"> <li>Sites must be hoarded to curb noise impacts to neighbouring communities.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                |                                |
|                        | <ul style="list-style-type: none"> <li>Works should be undertaken during day time i.e. from 8am to 6pm.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | -                              |
|                        | <ul style="list-style-type: none"> <li>Works near schools or health centres should be done in periods like weekends in order for noise and vibrations not to interfere with learning environment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | -                              |
|                        | <ul style="list-style-type: none"> <li>Weekly monitoring of noise levels at active sites should be carried out by the contractor.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | Within contractor's bid budget |
| Air Pollution          | <ul style="list-style-type: none"> <li>Travel speeds of construction vehicles along the road especially at trading/business centres will be controlled and should not exceed 50 km/h on the highway and 40 km/h off the highway.</li> </ul>             | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | -                              |
|                        | <ul style="list-style-type: none"> <li>Trucks will be covered during haulage of construction materials to reduce on spillage of materials and wherever dust suppression is necessary, water will be sprayed over dusty areas.</li> </ul>                | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | Within contractor's bid budget |
|                        | <ul style="list-style-type: none"> <li>Workers will be provided with PPE and the use of PPE shall be enforced.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                |                                |
|                        | <ul style="list-style-type: none"> <li>All surfaced roads shall be subject to road cleaning and un-surfaced roads to dust suppression, the methodology and frequency of which shall be included in the Contractor's Traffic Management Plan.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                |                                |
|                        | <ul style="list-style-type: none"> <li>Stockpiles of friable material will be grassed in order to prevent wind erosion.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | -                              |
|                        | <ul style="list-style-type: none"> <li>A maintenance programme for equipment and vehicles will be implemented, to ensure air emissions like particulates, SO<sub>2</sub> and NO<sub>2</sub> are minimised.</li> </ul>                                   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | Within contractor's bid budget |
| Reduced Traffic Safety | <ul style="list-style-type: none"> <li>The Contractor shall develop and implement a traffic management plan to be approved by the supervision engineer</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                | 11,000,000                     |
|                        | <ul style="list-style-type: none"> <li>All road closures shall be separately notified and agreed with the subcounty administration.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor/<br/>Subcounty</li> </ul> | -                              |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk                              | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX)           |
|--|--|--|--------------------------------|
|  |  | Council  |                                |
|  | <ul style="list-style-type: none"> <li>Vehicular access to and from hospitals, police stations, and other public institutions shall be maintained through the use of steel road plates over open trenches. Pedestrian access to schools, health facilities, and other premises frequently accessed by the public will be maintained with the use of walking boards.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | Within contractor's bid budget |
|  | <ul style="list-style-type: none"> <li>To minimize interference with traffic, half of the road shall be closed to enable vehicles use one half as the other half is being excavated and installed with pipe work.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | -                              |
|  | <ul style="list-style-type: none"> <li>Road safety and site safety training should be done involving construction workers, police and local community.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor/<br/>Police/ LC</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Conspicuous signage shall be well placed on roads and the Contractor's Traffic guides on ground shall direct traffic in case of diversions or open trenches.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | Within contractor's bid budget |
|  | <ul style="list-style-type: none"> <li>All company vehicles used in the transportation of construction workers, material and equipment to and away from the site shall be in sound mechanical conditions. Evidence shall always be provided by recording the status of the vehicle in the Daily Vehicle Inspection Form before usage.</li> </ul>                               | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | -                              |
|  | <ul style="list-style-type: none"> <li>All drivers to be employed by the Contractor shall be qualified, skilled with valid driving permits.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | -                              |
|  | <ul style="list-style-type: none"> <li>The vehicle speed shall be limited to a maximum of 30km/hr areas near sensitive facilities.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | -                              |
|  | <ul style="list-style-type: none"> <li>Works near sensitive facilities like schools and health centres shall only be limited to day time (7am to 6pm).</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | -                              |
| Risk of misinformation due to failure to | <ul style="list-style-type: none"> <li>Prepare a comprehensive Stakeholder Engagement Plan (SEP);</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                 | 5,000,000                      |
|  | <ul style="list-style-type: none"> <li>Community liaison activities;</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>                        | 20,000,000                     |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk                                 | Mitigation /Enhancement commitments  | Responsibility  | Estimated Cost (UGX)           |
|---|--|---|--------------------------------|
| engage stakeholders                         | <ul style="list-style-type: none"> <li>Undertake radio talk shows to communicate progress of the project to local stakeholders.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>                 | 3,000,000                      |
| Conflicts due to influx of immigrant labour | <ul style="list-style-type: none"> <li>The contractor will be required to develop a Labour Influx Management Plan and/or a Workers' Camp Management Plan.</li> </ul>                                     | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | 7,000,000                      |
|   | <ul style="list-style-type: none"> <li>contractors shall be required to have an HIV/AIDS policy and a framework (responsible staff, action plan, etc.) to implement during project execution.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Create awareness local communities prior to start of construction works.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Efforts to be geared toward instilling attitudes of tolerance, support and understanding of labour immigrants by the local communities</li> </ul>                 | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Sensitize workers on proper social behaviour and conduct with regard to community systems and the acceptable societal norms;</li> </ul>                           | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Put in place a grievance redress committee or a Public Complaints Desk to receive any complaints about the construction activities;</li> </ul>                    | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Implement a strict employment code of conduct.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
| Risk of violence against children (VAC)     | <ul style="list-style-type: none"> <li>Develop a strict employment code of conduct to protect the girl child.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Sensitize employees on dangers of molestation of children, especially the girl child.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Sensitize the Contractor against child labour and implement the child labour act;</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Demand birth certificate or any identify that clearly shows the age of a job applicant;</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Issue each worker with an applicant letter with well spelt out terms of engagement.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|   | <ul style="list-style-type: none"> <li>Monitoring school attendance</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor/<br/>DLG</li> </ul> | -                              |

| Impact/Risk  | Mitigation /Enhancement commitments  | Responsibility  | Estimated Cost (UGX) |
|--|--|---|----------------------|
|  | <ul style="list-style-type: none"> <li>Sensitization in schools</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |
|  | <ul style="list-style-type: none"> <li>Reporting mechanisms in place such as a whistleblowing system.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |
| Risk of Sexual and Gender Based Violence (SGBV) - e.g. physical assault, Sexual abuse, and sexual harassment | <ul style="list-style-type: none"> <li>The Contractor should have a sexual harassment policy and mainstream it to ensure strict adherence to established mechanisms to avoid the emergence of these challenges;</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |
|  | <ul style="list-style-type: none"> <li>MWE should ensure that social safeguards personnel are recruited as part of the project implementation personnel to supervise contractors and to continuously engage communities;</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>                 | -                    |
|  | <ul style="list-style-type: none"> <li>Put SGBV reporting mechanisms in place;</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |
|  | <ul style="list-style-type: none"> <li>Community sensitization among men and women.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |
| HIV/AIDS risks   | <ul style="list-style-type: none"> <li>Sensitize workers on proper social behaviour and conduct with regard to community norms, HIV/AIDS and other sexually transmitted diseases. HIV/AIDS policies should be developed at the workplace. Free HIV/AIDS testing, counselling and condom distribution be encouraged for both workers, sex workers and local community. The pathways for transmission of HIV/AIDS and STIs are well known, foreseeable and can be mitigated.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |
|  | <ul style="list-style-type: none"> <li>Social bonds are not readily controlled, and the permanence of HIV/AIDS transmission makes this particular impact of social bonding both negative and also positive. Social bonds leading to lasting marriages and children occur in such situations; early pregnancies and sexual exploitation can also occur. It is therefore important to tackle the issue of social bonding with firmness and fairness, forbidding powerful relationships, which lead to exploitation of mostly women and children, while encouraging relationships that may lead to permanent situations.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor/<br/>DLG</li> </ul> | -                    |
| Risk of Contracting and Spreading COVID-   | <ul style="list-style-type: none"> <li>Sensitize all project employees about the signs and symptoms of COVID-19 as well as the ways to control its spread.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                    |

| Impact/Risk | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) |
|-------------|--|--|----------------------|
| 19          | <ul style="list-style-type: none"> <li>Screen local employees/contractors for COVID-19 during recruitment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Screen all visitors to construction sites using a temperature gun and enforce washing of hands before entry and wearing of approved masks.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Management of potential COVID-19 cases – in case, any workers develop the above symptoms, isolate them and immediately contact the respective District Health Officers (DHOs) to pick and transport the patients for treatment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Reduce site traffic – prohibit entry for any non-essential visitors. In addition, utilize staggered start and finish times for workers to limit site congestion and physical contact. Further, restrict the number of people in attendance at any site inductions, and consider holding them outdoors whenever feasible.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Practice social distancing – Consistently monitor points of worker interactions such as dining areas to ensure social distancing guidelines (2-4 meters apart) are being met.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Prioritize sanitation – Enforce workers to wash their hands with soap and water for at least 20 seconds or to use sanitizers before entering and after leaving the worksite, as well as before and after handling all goods, materials and equipment. Routinely clean any common contact surfaces on-site (e.g. scanners, turnstiles, screens, telephones and desks). Lastly, be sure to temporarily remove or disable any site entry systems that require skin contact (e.g. fingerprint scanners).</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Limit physical contact – Make sure that the contractor stagger break times to reduce congestion and physical contact in eating areas. Require workers to keep at least 2-3 metres of distance between one another while eating.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Enhance whole-of-society coordination mechanisms to support preparedness and response, including the health, transport, travel, trade, finance, security and other sectors. Involve public health Emergency Operations</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |

| Impact/Risk   | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX)           |
|---|--|--|--------------------------------|
|   | Centres and other emergency response systems early.  |  |                                |
|   | <ul style="list-style-type: none"> <li>Continuously sensitize the workers and pass on any new guidelines by Government and the WHO.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Risk of not engaging stakeholders in project monitoring | <ul style="list-style-type: none"> <li>Bring onboard the relevant stakeholders including Kiryandongo DLG to participate in routine project monitoring.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | -                              |
| Decommissioning of auxiliary facilities                 | <ul style="list-style-type: none"> <li>Demolish all auxiliary facilities</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Remove all obsolete equipment, vehicles, trucks and machinery shall be removed from sites</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Backfilling all openings with overburden soil</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Planting fast-growing trees and grasses to stabilize the excavated areas</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Fencing off the re-vegetated areas is recommended until the reinstated vegetation has reached maturity</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Clean-up of the site and safe disposal of any construction waste.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| <b>NEGATIVE IMPACTS AND RISKS – PHASE CROSSCUTTING</b>  |  |  |                                |
| Occupational Health and Safety Risks                    | <ul style="list-style-type: none"> <li>The Contractor shall prepare and implement an occupational safety and health plan for all sites, approved by the developer.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>The Contractor shall provide safety guidelines to all operations prior to start of work.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Strict adherence to safety measures and procedures are required to minimise (or eliminate) risks of accidents or hazardous developments occurring and ensure healthy and safe conditions for all persons working on the site. To ensure occupational health and safety on construction sites, the Contractor shall be obliged to comply with all applicable Ugandan construction Health and Safety Standards as required by the Occupational Safety and Health Act of 2006. These include provisions of the Factories Act, Labour Unions Act and Workman's</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |

| Impact/Risk | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX)                       |
|-------------|--|--|--|
|             | Compensation Act.  |  |  |
|             | <ul style="list-style-type: none"> <li>Training will be conducted on how to prevent and manage incidences. This should involve proper handling of electricity, water etc. and sensitization on various modes of escape, conduct and responsibility during such incidences. All must fully be aware and mentally prepared for potential emergency.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>Regular drills will be constantly followed on various possible incidences. This will test the response of the involved stakeholders. Such drills will keep them alert and they will become more responsive in case of incidences.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>Personnel on duty shall at all times wear appropriate PPE, such as safety glasses with side shields, face shields, hard hats/helmets, and safety boots be required for all site staff.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget             |
|             | <ul style="list-style-type: none"> <li>The Contractor shall establish emergency entrances, exits and amenities.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>The Contractor shall ensure access to first aid kits.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 3,000,000                                  |
|             | <ul style="list-style-type: none"> <li>The Contractor shall ensure safe working heights through provision of work platforms, scaffolds and adequate supervision by ensuring regular inspection of formwork, false work and temporary supports before loading or pouring concrete.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget             |
|             | <ul style="list-style-type: none"> <li>The Contractor shall secure site boundaries with fences or hoardings as appropriate.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget             |
|             | <ul style="list-style-type: none"> <li>The Contractor shall install caution signage around the site to discourage the public from being close to the site, for example, "falling debris", "keep off the site" etc.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget             |
|             | <ul style="list-style-type: none"> <li>The Developer through the Construction Supervisor will continually monitor Contractors' compliance with Health and Safety measures.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Within supervision consultant's bid budget |
|             | <ul style="list-style-type: none"> <li>An Accident Log will be maintained onsite to register all injuries and to</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |



| Impact/Risk | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) |
|-------------|---|--|----------------------|
|             | investigate their causes during both the construction and operation phases of the project.  |  |                      |
|             | <ul style="list-style-type: none"> <li>The manufacturer's instructions and Material Safety Data Sheets (MSDS) shall be followed for the storage of all chemicals used in water treatment. Storage must conform to compatibility restrictions.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |
|             | <ul style="list-style-type: none"> <li>Work force shall be subjected only to standard work shifts/hours. Overtime allowances, if applicable/warranted shall be paid with ceiling limits. Working beyond such ceiling limits shall be discouraged, even if, so desired workforce or contractor.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                    |

**(b) MUTUNDA RURAL GROWTH CENTRE**

| Impact/Risk   | Mitigation /Enhancement commitments   | Responsibility | Estimated Cost (UGX) & Remarks                             |
|---|---|----------------|--|
| <b>POSITIVE IMPACTS – CONSTRUCTION PHASE</b>                                |   |                |  |
| Provision of direct jobs (casual workers) for locals - youth, women and men | • Recruit locals for construction jobs according to their skills.   | • Contractor   | Embedded in contractor's fees                              |
|   | • Promote labour-intensive construction methods to create more jobs.  | • Contractor   |  |
|   | • Adhere to the local labour laws of 30% women in employment and remuneration of workers above the minimum wage.                            | • Contractor   |  |
|   | • Ringfence some jobs such as cleaning and cooking specifically for local women.  | • Contractor   |  |
|   | • Encourage qualified females to apply for jobs.  | • Contractor   |  |
|   | • Gender sensitive facilities such as bathrooms, toilets and breastfeeding spaces to be provided to create a conducive working environment. | • Contractor   | 5,000,000  |
| <b>NEGATIVE IMPACTS – CONSTRUCTION PHASE</b>                                |   |                |  |
| Land use/cover change   | • Restrict water transmission and distribution lines to road reserves.  | • Contractor   | -  |
|   | • Compensate for land as per Ugandan laws on Land Acquisition and in line with World Bank's OP 4.12.  | • MWE          | 304,952,275 as determined in the RAP Valuation Report.     |
|   | • Movement of vehicles and equipment must follow designated pathways or agreed upon access roads.   | • Contractor   | -  |
| Land acquisition and resettlement   | • Implement the RAP in line with Ugandan laws and the World Bank's ESS5   | •              | 221,960,000 Estimate from RAP for all 3RGCs in Kiryandongo |
|   | • Engage local communities to provide land voluntarily especially for the distribution lines  | • MWE          | Covered in RAP implementation budget                       |
|   | • Select land requiring minimal or no relocation at all   | • MWE          |  |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk                                   | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks                         |
|---|---|--|--|
|   | <ul style="list-style-type: none"> <li>Use road reserves for pipe works</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|   | <ul style="list-style-type: none"> <li>Provide a fair and prompt compensation to the affected people</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | 304,952,275 as determined in the RAP Valuation Report. |
|   | <ul style="list-style-type: none"> <li>Determine the extent of property lost or destroyed and provide fair and prompt compensation to the effected people.</li> </ul>                         | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Covered in RAP implementation budget                   |
| Deterioration of landscape and visual quality | <ul style="list-style-type: none"> <li>Obtain murram and subsoil from a NEMA/ DLG licensed source.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget                         |
|   | <ul style="list-style-type: none"> <li>Install berms and drainage channels to control surface water run-off during earthworks.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |
|   | <ul style="list-style-type: none"> <li>Restore of borrow pits and revegetate with native species.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |
|   | <ul style="list-style-type: none"> <li>Close monitoring of impact on natural resources with enforcement of contract or legislative options.</li> </ul>  | <ul style="list-style-type: none"> <li>DLG/ MWE</li> </ul>   | 10,000,000   |
| Soil Erosion                                  | <ul style="list-style-type: none"> <li>Limit vegetation clearance to localities required for development.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|   | <ul style="list-style-type: none"> <li>Hoard off construction sites and instate soil barriers before excavations to intercept any eroded material and any soil material.</li> </ul>           | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget                         |
|   | <ul style="list-style-type: none"> <li>Remove topsoil prior to carrying out excavations and stockpile separately so that it is used last in backfilling of the excavated areas.</li> </ul>    | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |
|   | <ul style="list-style-type: none"> <li>Backfill all trenches immediately after laying the pipes and compact such areas as to near level prior to excavation.</li> </ul>                       | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |
|   | <ul style="list-style-type: none"> <li>Remove excess excavated soil material which will not be used for construction works in a timely manner and deposit at an approved site</li> </ul>      | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |
| Loss of Vegetation and degradation of         | <ul style="list-style-type: none"> <li>Ensure proper landscaping and vegetation restoration is carried out using native species to further reduce the possibility of soil erosion.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |

| Impact/Risk                                       | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks |
|---|---|--|--------------------------------|
| Habitat   | <ul style="list-style-type: none"> <li>Limit vegetation clearance to localities required for development.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Avoid and minimise cutting of trees at all project sites.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Movement of vehicles and equipment must follow designated pathways or agreed upon access roads.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Remove and destroy any encountered invasive species</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Sensitise all project workers to minimise damage to vegetation and fauna.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>If wild animals are encountered, the Contractor shall notify UWA so that it is picked and taken to a secure place.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Disturbance and degradation of wetland ecosystems | <ul style="list-style-type: none"> <li>Use existing road corridors for construction and operational access wherever possible.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Where the alignment requires the suspension points for the water pipes to be located in the swamp and in areas which cannot be easily accessed, build temporary access to wetland areas not easily accessible from existing roads or causeways, that will be removed after.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Obtain wetland user permits from NEMA before constructing across or along wetlands and follow all guidelines given.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | 150,000                        |
|   | <ul style="list-style-type: none"> <li>All project workers should be sensitized to minimize damage to flora and fauna.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Close monitoring and supervision of the construction operations to ensure compliance to the NEMA permit conditions and avoid causing further damage to undesignated project areas.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | -                              |
| Generation of waste                               | <ul style="list-style-type: none"> <li>The Contractor shall develop and implement a Waste Management Plan</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 15,000,000                     |
|   | <ul style="list-style-type: none"> <li>All sorts of waste generated during construction such as HPDE and uPVC offcuts and other accessories associated with water and sanitation projects shall</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 10,000,000                     |

| Impact/Risk   | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks            |
|---|---|--|---|
|   | <p>be collected by the contractor and delivered to recycling facilities. Other forms of waste which are inert must be collected by NEMA gazetted waste handlers and taken to a NEMA gazetted waste disposal facilities for disposal.</p>  |  |   |
|   | <ul style="list-style-type: none"> <li>All organic waste generated at eating places during construction such as food stuffs shall be collected and transported by the contractor to designated district landfills for disposal.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |
|   | <ul style="list-style-type: none"> <li>All plastic waste generated during construction, such as mineral water bottles, polyethene bags, jerricans and cups shall be collected and taken for recycling in plastic collectors in Kiryandongo for onward transmission to plastic recyclers.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |
|   | <ul style="list-style-type: none"> <li>Human excreta shall be managed using a mobile toilet and then disposed at the waste stabilisation ponds at Kiryandongo Hospital.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 10,000,000                                |
|   | <ul style="list-style-type: none"> <li>The contractor will work with Kiryandongo district Local government to facilitate sound waste handling and disposal. All wastes must be taken to the approved waste disposal facilities. Proof of delivery and safe disposal of waste will be provided and records maintained at all times.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
| Risk of contamination due to flooding of borehole DWD 77383 | <ul style="list-style-type: none"> <li>The production well should be constructed with a water tight casing above the water table</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
|   | <ul style="list-style-type: none"> <li>The design and construction of the pump house at source DWD 77383 should incorporate a raised apron slab above the ground by the required height for the predicted flood depth of the area.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Part of the Design Consultant's work      |
|   | <ul style="list-style-type: none"> <li>Aprons should be constructed with deep foundation edges to avoid erosion</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        |   |
|   | <ul style="list-style-type: none"> <li>A water source protection plan has been developed to ensure sustained water quality and quantity for the project.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Part of ESIA, RAP & SPP Consultant's work |
| Noise and Vibrations  | <ul style="list-style-type: none"> <li>Workers should be provided with the necessary personal protective equipment (PPE) such as ear muffs.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |

| Impact/Risk            | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks |
|------------------------|---|--|--------------------------------|
|                        | <ul style="list-style-type: none"> <li>Periodic medical hearing checks should be performed on workers exposed to high noise levels.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                        | <ul style="list-style-type: none"> <li>Sites must be hoarded to curb noise impacts to neighbouring communities.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                        | <ul style="list-style-type: none"> <li>Works should be undertaken during day time i.e. from 8am to 6pm.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                        | <ul style="list-style-type: none"> <li>Works near schools or health centres should be done in periods like weekends in order for noise and vibrations not to interfere with learning environment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                        | <ul style="list-style-type: none"> <li>Weekly monitoring of noise levels at active sites should be carried out by the contractor.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
| Air Pollution          | <ul style="list-style-type: none"> <li>Travel speeds of construction vehicles along the road especially at trading/business centres will be controlled and should not exceed 50 km/h on the highway and 40 km/h off the highway.</li> </ul>             | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                        | <ul style="list-style-type: none"> <li>Trucks will be covered during haulage of construction materials to reduce on spillage of materials and wherever dust suppression is necessary, water will be sprayed over dusty areas.</li> </ul>                | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|                        | <ul style="list-style-type: none"> <li>Workers will be provided with PPE and the use of PPE shall be enforced.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                        | <ul style="list-style-type: none"> <li>All surfaced roads shall be subject to road cleaning and un-surfaced roads to dust suppression, the methodology and frequency of which shall be included in the Contractor's Traffic Management Plan.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                        | <ul style="list-style-type: none"> <li>Stockpiles of friable material will be grassed in order to prevent wind erosion.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                        | <ul style="list-style-type: none"> <li>A maintenance programme for equipment and vehicles will be implemented, to ensure air emissions like particulates, SO2 and NO2 are minimised.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
| Reduced Traffic Safety | <ul style="list-style-type: none"> <li>The Contractor shall develop and implement a traffic management plan to</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 11,000,000                     |

| Impact/Risk | Mitigation /Enhancement commitments  | Responsibility  | Estimated Cost (UGX) & Remarks |
|-------------|--|---|--------------------------------|
|             | be approved by the supervision engineer  |   |                                |
|             | <ul style="list-style-type: none"> <li>All road closures shall be separately notified and agreed with the subcounty administration.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor/ Subcounty Council</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>Vehicular access to and from hospitals, police stations, and other public institutions shall be maintained through the use of steel road plates over open trenches. Pedestrian access to schools, health facilities, and other premises frequently accessed by the public will be maintained with the use of walking boards.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>To minimize interference with traffic, half of the road shall be closed to enable vehicles use one half as the other half is being excavated and installed with pipe work.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | -                              |
|             | <ul style="list-style-type: none"> <li>Road safety and site safety training should be done involving construction workers, police and local community.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor/ Police/ LC</li> </ul>        | -                              |
|             | <ul style="list-style-type: none"> <li>Conspicuous signage shall be well placed on roads and the Contractor's Traffic guides on ground shall direct traffic in case of diversions or open trenches.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>All company vehicles used in the transportation of construction workers, material and equipment to and away from the site shall be in sound mechanical conditions. Evidence shall always be provided by recording the status of the vehicle in the Daily Vehicle Inspection Form before usage.</li> </ul>                               | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | -                              |
|             | <ul style="list-style-type: none"> <li>All drivers to be employed by the Contractor shall be qualified, skilled with valid driving permits.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | -                              |
|             | <ul style="list-style-type: none"> <li>The vehicle speed shall be limited to a maximum of 30km/hr areas near sensitive facilities.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | -                              |
|             | <ul style="list-style-type: none"> <li>Works near sensitive facilities like schools and health centres shall only be</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                    | -                              |

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**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk  | Mitigation /Enhancement commitments  | Responsibility | Estimated Cost (UGX) & Remarks |
|--|--|----------------|--------------------------------|
|  | limited to day time (7am to 6pm).  |                |                                |
| Risk of misinformation due to failure to engage stakeholders | • Prepare a comprehensive Stakeholder Engagement Plan (SEP);   | • Contractor   | 5,000,000                      |
|  | • Community liaison activities;  | • MWE          | 20,000,000                     |
|  | • Undertake radio talk shows to communicate progress of the project to local stakeholders.   | • MWE          | 3,000,000                      |
| Conflicts due to influx of immigrant labour                  | • The contractor will be required to develop a Labour Influx Management Plan and/or a Workers' Camp Management Plan.                                     | • Contractor   | 7,000,000                      |
|  | • contractors shall be required to have an HIV/AIDS policy and a framework (responsible staff, action plan, etc.) to implement during project execution. | • Contractor   | Within contractor's bid budget |
|  | • Create awareness local communities prior to start of construction works.   | • Contractor   | -                              |
|  | • Efforts to be geared toward instilling attitudes of tolerance, support and understanding of labour immigrants by the local communities                 | • Contractor   | -                              |
|  | • Sensitize workers on proper social behaviour and conduct with regard to community systems and the acceptable societal norms;                           | • Contractor   | -                              |
|  | • Put in place a grievance redress committee or a Public Complaints Desk to receive any complaints about the construction activities;                    | • Contractor   | -                              |
|  | • Implement a strict employment code of conduct.   | • Contractor   | -                              |
| Risk of violence against children (VAC)                      | • Develop a strict employment code of conduct to protect the girl child.   | • Contractor   | -                              |
|  | • Sensitize employees on dangers of molestation of children, especially the girl child.  | • Contractor   | -                              |
|  | • Sensitize the Contractor against child labour and implement the child labour act;  | • Contractor   | -                              |
|  | • Demand birth certificate or any identify that clearly shows the age of a job applicant;  | • Contractor   | -                              |



| Impact/Risk  | Mitigation /Enhancement commitments   | Responsibility  | Estimated Cost (UGX) & Remarks |
|--|---|---|--------------------------------|
|  | <ul style="list-style-type: none"> <li>Issue each worker with an applicant letter with well spelt out terms of engagement.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>Monitoring school attendance</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor/<br/>DLG</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Sensitization in schools</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>Reporting mechanisms in place such as a whistleblowing system.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
| Risk of Sexual and Gender Based Violence (SGBV) - e.g. physical assault, Sexual abuse, and sexual harassment | <ul style="list-style-type: none"> <li>The Contractor should have a sexual harassment policy and mainstream it to ensure strict adherence to established mechanisms to avoid the emergence of these challenges;</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>MWE should ensure that social safeguards personnel are recruited as part of the project implementation personnel to supervise contractors and to continuously engage communities;</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>                 | -                              |
|  | <ul style="list-style-type: none"> <li>Put SGBV reporting mechanisms in place;</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>Community sensitization among men and women.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
| HIV/AIDS risks   | <ul style="list-style-type: none"> <li>Sensitize workers on proper social behaviour and conduct with regard to community norms, HIV/AIDS and other sexually transmitted diseases. HIV/AIDS policies should be developed at the workplace. Free HIV/AIDS testing, counselling and condom distribution be encouraged for both workers, sex workers and local community. The pathways for transmission of HIV/AIDS and STIs are well known, foreseeable and can be mitigated.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>Social bonds are not readily controlled, and the permanence of HIV/AIDS transmission makes this particular impact of social bonding both negative and also positive. Social bonds leading to lasting marriages and children occur in such situations; early pregnancies and sexual exploitation can also occur. It is therefore important to tackle the issue of social bonding with firmness and fairness, forbidding powerful relationships, which lead to exploitation of mostly</li> </ul> | <ul style="list-style-type: none"> <li>Contractor/<br/>DLG</li> </ul> | -                              |

| Impact/Risk  | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|--|--|--|--------------------------------|
|  | women and children, while encouraging relationships that may lead to permanent situations.   |  |                                |
| Risk of Contracting and Spreading COVID-19   | <ul style="list-style-type: none"> <li>Sensitize all project employees about the signs and symptoms of COVID-19 as well as the ways to control its spread.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Screen local employees/contractors for COVID-19 during recruitment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Screen all visitors to construction sites using a temperature gun and enforce washing of hands before entry and wearing of approved masks.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Management of potential COVID-19 cases – in case, any workers develop the above symptoms, isolate them and immediately contact the respective District Health Officers (DHOs) to pick and transport the patients for treatment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Reduce site traffic – prohibit entry for any non-essential visitors. In addition, utilize staggered start and finish times for workers to limit site congestion and physical contact. Further, restrict the number of people in attendance at any site inductions, and consider holding them outdoors whenever feasible.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Practice social distancing – Consistently monitor points of worker interactions such as dining areas to ensure social distancing guidelines (2-4 meters apart) are being met.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Prioritize sanitation – Enforce workers to wash their hands with soap and water for at least 20 seconds or to use sanitizers before entering and after leaving the worksite, as well as before and after handling all goods, materials and equipment. Routinely clean any common contact surfaces on-site (e.g. scanners, turnstiles, screens, telephones and desks). Lastly, be sure to temporarily remove or disable any site entry systems that require skin contact (e.g. fingerprint scanners).</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| <ul style="list-style-type: none"> <li>Limit physical contact – Make sure that the contractor stagger break times to reduce congestion and physical contact in eating areas. Require workers to</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul>   | -  |                                |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk   | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|---|--|--|--------------------------------|
|   | keep at least 2-3 metres of distance between one another while eating.   |  |                                |
|   | <ul style="list-style-type: none"> <li>Enhance whole-of-society coordination mechanisms to support preparedness and response, including the health, transport, travel, trade, finance, security and other sectors. Involve public health Emergency Operations Centres and other emergency response systems early.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Continuously sensitize the workers and pass on any new guidelines by Government and the WHO.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Risk of not engaging stakeholders in project monitoring | <ul style="list-style-type: none"> <li>Bring onboard the relevant stakeholders including Kiryandongo DLG to participate in routine project monitoring.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | -                              |
| Decommissioning of auxiliary facilities                 | <ul style="list-style-type: none"> <li>Demolish all auxiliary facilities</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Remove all obsolete equipment, vehicles, trucks and machinery shall be removed from sites</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Backfilling all openings with overburden soil</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Planting fast-growing trees and grasses to stabilize the excavated areas</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Fencing off the re-vegetated areas is recommended until the reinstated vegetation has reached maturity</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Clean-up of the site and safe disposal of any construction waste.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| <b>NEGATIVE IMPACTS AND RISKS – PHASE CROSSCUTTING</b>  |  |  |                                |
| Occupational Health and Safety Risks                    | <ul style="list-style-type: none"> <li>The Contractor shall prepare and implement an occupational safety and health plan for all sites, approved by the developer.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>The Contractor shall provide safety guidelines to all operations prior to start of work.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Strict adherence to safety measures and procedures are required to minimise (or eliminate) risks of accidents or hazardous developments occurring</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |

| Impact/Risk | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|-------------|--|--|--------------------------------|
|             | and ensure healthy and safe conditions for all persons working on the site. To ensure occupational health and safety on construction sites, the Contractor shall be obliged to comply with all applicable Ugandan construction Health and Safety Standards as required by the Occupational Safety and Health Act of 2006. These include provisions of the Factories Act, Labour Unions Act and Workman's Compensation Act. |  |                                |
|             | <ul style="list-style-type: none"> <li>• Training will be conducted on how to prevent and manage incidences. This should involve proper handling of electricity, water etc. and sensitization on various modes of escape, conduct and responsibility during such incidences. All must fully be aware and mentally prepared for potential emergency.</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>• Regular drills will be constantly followed on various possible incidences. This will test the response of the involved stakeholders. Such drills will keep them alert and they will become more responsive in case of incidences.</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>• Personnel on duty shall at all times wear appropriate PPE, such as safety glasses with side shields, face shields, hard hats/helmets, and safety boots be required for all site staff.</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>• The Contractor shall establish emergency entrances, exits and amenities.</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>• The Contractor shall ensure access to first aid kits.</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | 3,000,000                      |
|             | <ul style="list-style-type: none"> <li>• The Contractor shall ensure safe working heights through provision of work platforms, scaffolds and adequate supervision by ensuring regular inspection of formwork, false work and temporary supports before loading or pouring concrete.</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>• The Contractor shall secure site boundaries with fences or hoardings as appropriate.</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>• The Contractor shall install caution signage around the site to discourage the public from being close to the site, for example, "falling debris", "keep off the</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul> | Within contractor's bid budget |

| Impact/Risk | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks             |
|-------------|---|--|--|
|             | site” etc.  |  |  |
|             | <ul style="list-style-type: none"> <li>The Developer through the Construction Supervisor will continually monitor Contractors’ compliance with Health and Safety measures.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Within supervision consultant’s bid budget |
|             | <ul style="list-style-type: none"> <li>An Accident Log will be maintained onsite to register all injuries and to investigate their causes during both the construction and operation phases of the project.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>The manufacturer's instructions and Material Safety Data Sheets (MSDS) shall be followed for the storage of all chemicals used in water treatment. Storage must conform to compatibility restrictions.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>Work force shall be subjected only to standard work shifts/hours. Overtime allowances, if applicable/warranted shall be paid with ceiling limits. Working beyond such ceiling limits shall be discouraged, even if, so desired workforce or contractor.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |  |

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| Impact/Risk   | Mitigation /Enhancement commitments   | Responsibility | Estimated Cost (UGX) & Remarks                             |
|---|---|----------------|--|
| <b>POSITIVE IMPACTS – CONSTRUCTION PHASE</b>                                |   |                |  |
| Provision of direct jobs (casual workers) for locals - youth, women and men | • Recruit locals for construction jobs according to their skills.   | • Contractor   | Embedded in contractor's fees                              |
|   | • Promote labour-intensive construction methods to create more jobs.  | • Contractor   |  |
|   | • Adhere to the local labour laws of 30% women in employment and remuneration of workers above the minimum wage.                            | • Contractor   |  |
|   | • Ringfence some jobs such as cleaning and cooking specifically for local women.  | • Contractor   |  |
|   | • Encourage qualified females to apply for jobs.  | • Contractor   |  |
|   | • Gender sensitive facilities such as bathrooms, toilets and breastfeeding spaces to be provided to create a conducive working environment. | • Contractor   | 5,000,000  |
| <b>NEGATIVE IMPACTS – CONSTRUCTION PHASE</b>                                |   |                |  |
| Land use/cover change   | • Restrict water transmission and distribution lines to road reserves.  | • Contractor   | -  |
|   | • Compensate for land as per Ugandan laws on Land Acquisition and in line with World Bank's OP 4.12.  | • MWE          | 304,952,275 as determined in the RAP Valuation Report.     |
|   | • Movement of vehicles and equipment must follow designated pathways or agreed upon access roads.   | • Contractor   | -  |
| Land acquisition and resettlement   | • Implement the RAP in line with Ugandan laws and the World Bank's ESS5   | •              | 221,960,000 Estimate from RAP for all 3RGCs in Kiryandongo |
|   | • Engage local communities to provide land voluntarily especially for the distribution lines  | • MWE          | Covered in RAP implementation                              |

| Impact/Risk                                   | Mitigation /Enhancement commitments  | Responsibility | Estimated Cost (UGX) & Remarks                         |
|---|--|----------------|--|
|   | • Select land requiring minimal or no relocation at all  | • MWE          | budget   |
|   | • Use road reserves for pipe works   | • Contractor   | -  |
|   | • Provide a fair and prompt compensation to the affected people  | • MWE          | 304,952,275 as determined in the RAP Valuation Report. |
|   | • Determine the extent of property lost or destroyed and provide fair and prompt compensation to the effected people.                      | • MWE          | Covered in RAP implementation budget                   |
| Deterioration of landscape and visual quality | • Obtain murram and subsoil from a NEMA/ DLG licensed source.  | • Contractor   | Within contractor's bid budget                         |
|   | • Install berms and drainage channels to control surface water run-off during earthworks.  | • Contractor   |  |
|   | • Restore of borrow pits and revegetate with native species.   | • Contractor   |  |
|   | • Close monitoring of impact on natural resources with enforcement of contract or legislative options.                                     | • DLG/ MWE     | 10,000,000   |
| Soil Erosion                                  | • Limit vegetation clearance to localities required for development.   | • Contractor   | -  |
|   | • Hoard off construction sites and instate soil barriers before excavations to intercept any eroded material and any soil material.        | • Contractor   | Within contractor's bid budget                         |
|   | • Remove topsoil prior to carrying out excavations and stockpile separately so that it is used last in backfilling of the excavated areas. | • Contractor   |  |
|   | • Backfill all trenches immediately after laying the pipes and compact such areas as to near level prior to excavation.                    | • Contractor   |  |
|   | • Remove excess excavated soil material which will not be used for construction works in a timely manner and deposit at an approved site   | • Contractor   |  |
| Loss of Vegetation                            | • Ensure proper landscaping and vegetation restoration is carried out using  | • Contractor   |  |

| Impact/Risk                                       | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks |
|---|---|--|--------------------------------|
| and degradation of Habitat                        | native species to further reduce the possibility of soil erosion.   |  |                                |
|   | <ul style="list-style-type: none"> <li>Limit vegetation clearance to localities required for development.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Avoid and minimise cutting of trees at all project sites.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Movement of vehicles and equipment must follow designated pathways or agreed upon access roads.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Remove and destroy any encountered invasive species</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Sensitise all project workers to minimise damage to vegetation and fauna.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>If wild animals are encountered, the Contractor shall notify UWA so that it is picked and taken to a secure place.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Disturbance and degradation of wetland ecosystems | <ul style="list-style-type: none"> <li>Use existing road corridors for construction and operational access wherever possible.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Where the alignment requires the suspension points for the water pipes to be located in the swamp and in areas which cannot be easily accessed, build temporary access to wetland areas not easily accessible from existing roads or causeways, that will be removed after.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Obtain wetland user permits from NEMA before constructing across or along wetlands and follow all guidelines given.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | 150,000                        |
|   | <ul style="list-style-type: none"> <li>All project workers should be sensitized to minimize damage to flora and fauna.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>Close monitoring and supervision of the construction operations to ensure compliance to the NEMA permit conditions and avoid causing further damage to undesignated project areas.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | -                              |
| Generation of waste                               | <ul style="list-style-type: none"> <li>The Contractor shall develop and implement a Waste Management Plan</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 15,000,000                     |



| Impact/Risk   | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks            |
|---|--|--|---|
|   | <ul style="list-style-type: none"> <li>All sorts of waste generated during construction such as HPDE and uPVC offcuts and other accessories associated with water and sanitation projects shall be collected by the contractor and delivered to recycling facilities. Other forms of waste which are inert must be collected by NEMA gazetted waste handlers and taken to a NEMA gazetted waste disposal facilities for disposal.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 10,000,000                                |
|   | <ul style="list-style-type: none"> <li>All organic waste generated at eating places during construction such as food stuffs shall be collected and transported by the contractor to designated district landfills for disposal.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |
|   | <ul style="list-style-type: none"> <li>All plastic waste generated during construction, such as mineral water bottles, polyethene bags, jerricans and cups shall be collected and taken for recycling in plastic collectors in Kiryandongo for onward transmission to plastic recyclers.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |   |
|   | <ul style="list-style-type: none"> <li>Human excreta shall be managed using a mobile toilet and then disposed at the waste stabilisation ponds at Kiryandongo Hospital.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 10,000,000                                |
|   | <ul style="list-style-type: none"> <li>The contractor will work with Kiryandongo district Local government to facilitate sound waste handling and disposal. All wastes must be taken to the approved waste disposal facilities. Proof of delivery and safe disposal of waste will be provided and records maintained at all times.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
| Risk of contamination due to flooding of borehole DWD 77383 | <ul style="list-style-type: none"> <li>The production well should be constructed with a water tight casing above the water table</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget            |
|   | <ul style="list-style-type: none"> <li>The design and construction of the pump house at source DWD 77383 should incorporate a raised apron slab above the ground by the required height for the predicted flood depth of the area.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Part of the Design Consultant's work      |
|   | <ul style="list-style-type: none"> <li>Aprons should be constructed with deep foundation edges to avoid erosion</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        |   |
|   | <ul style="list-style-type: none"> <li>A water source protection plan has been developed to ensure sustained water quality and quantity for the project.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Part of ESIA, RAP & SPP Consultant's work |

| Impact/Risk          | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks |
|----------------------|---|--|--------------------------------|
| Noise and Vibrations | <ul style="list-style-type: none"> <li>Workers should be provided with the necessary personal protective equipment (PPE) such as ear muffs.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|                      | <ul style="list-style-type: none"> <li>Periodic medical hearing checks should be performed on workers exposed to high noise levels.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                      | <ul style="list-style-type: none"> <li>Sites must be hoarded to curb noise impacts to neighbouring communities.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                      | <ul style="list-style-type: none"> <li>Works should be undertaken during day time i.e. from 8am to 6pm.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                      | <ul style="list-style-type: none"> <li>Works near schools or health centres should be done in periods like weekends in order for noise and vibrations not to interfere with learning environment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                      | <ul style="list-style-type: none"> <li>Weekly monitoring of noise levels at active sites should be carried out by the contractor.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
| Air Pollution        | <ul style="list-style-type: none"> <li>Travel speeds of construction vehicles along the road especially at trading/business centres will be controlled and should not exceed 50 km/h on the highway and 40 km/h off the highway.</li> </ul>             | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                      | <ul style="list-style-type: none"> <li>Trucks will be covered during haulage of construction materials to reduce on spillage of materials and wherever dust suppression is necessary, water will be sprayed over dusty areas.</li> </ul>                | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|                      | <ul style="list-style-type: none"> <li>Workers will be provided with PPE and the use of PPE shall be enforced.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                      | <ul style="list-style-type: none"> <li>All surfaced roads shall be subject to road cleaning and un-surfaced roads to dust suppression, the methodology and frequency of which shall be included in the Contractor's Traffic Management Plan.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> |                                |
|                      | <ul style="list-style-type: none"> <li>Stockpiles of friable material will be grassed in order to prevent wind erosion.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|                      | <ul style="list-style-type: none"> <li>A maintenance programme for equipment and vehicles will be implemented, to ensure air emissions like particulates, SO<sub>2</sub> and NO<sub>2</sub> are</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |

| Impact/Risk            | Mitigation /Enhancement commitments  | Responsibility  | Estimated Cost (UGX) & Remarks |
|------------------------|--|---|--------------------------------|
|                        | minimised.   |   |                                |
| Reduced Traffic Safety | <ul style="list-style-type: none"> <li>The Contractor shall develop and implement a traffic management plan to be approved by the supervision engineer</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | 11,000,000                     |
|                        | <ul style="list-style-type: none"> <li>All road closures shall be separately notified and agreed with the subcounty administration.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor/<br/>Subcounty<br/>Council</li> </ul> | -                              |
|                        | <ul style="list-style-type: none"> <li>Vehicular access to and from hospitals, police stations, and other public institutions shall be maintained through the use of steel road plates over open trenches. Pedestrian access to schools, health facilities, and other premises frequently accessed by the public will be maintained with the use of walking boards.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | Within contractor's bid budget |
|                        | <ul style="list-style-type: none"> <li>To minimize interference with traffic, half of the road shall be closed to enable vehicles use one half as the other half is being excavated and installed with pipe work.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | -                              |
|                        | <ul style="list-style-type: none"> <li>Road safety and site safety training should be done involving construction workers, police and local community.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor/<br/>Police/ LC</li> </ul>            | -                              |
|                        | <ul style="list-style-type: none"> <li>Conspicuous signage shall be well placed on roads and the Contractor's Traffic guides on ground shall direct traffic in case of diversions or open trenches.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | Within contractor's bid budget |
|                        | <ul style="list-style-type: none"> <li>All company vehicles used in the transportation of construction workers, material and equipment to and away from the site shall be in sound mechanical conditions. Evidence shall always be provided by recording the status of the vehicle in the Daily Vehicle Inspection Form before usage.</li> </ul>                               | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | -                              |
|                        | <ul style="list-style-type: none"> <li>All drivers to be employed by the Contractor shall be qualified, skilled with valid driving permits.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | -                              |
|                        | <ul style="list-style-type: none"> <li>The vehicle speed shall be limited to a maximum of 30km/hr areas near</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul>                            | -                              |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk  | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|--|--|--|--------------------------------|
|  | sensitive facilities.  |  |                                |
|  | <ul style="list-style-type: none"> <li>Works near sensitive facilities like schools and health centres shall only be limited to day time (7am to 6pm).</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Risk of misinformation due to failure to engage stakeholders | <ul style="list-style-type: none"> <li>Prepare a comprehensive Stakeholder Engagement Plan (SEP);</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 5,000,000                      |
|  | <ul style="list-style-type: none"> <li>Community liaison activities;</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | 20,000,000                     |
|  | <ul style="list-style-type: none"> <li>Undertake radio talk shows to communicate progress of the project to local stakeholders.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | 3,000,000                      |
| Conflicts due to influx of immigrant labour                  | <ul style="list-style-type: none"> <li>The contractor will be required to develop a Labour Influx Management Plan and/or a Workers' Camp Management Plan.</li> </ul>                                     | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 7,000,000                      |
|  | <ul style="list-style-type: none"> <li>contractors shall be required to have an HIV/AIDS policy and a framework (responsible staff, action plan, etc.) to implement during project execution.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|  | <ul style="list-style-type: none"> <li>Create awareness local communities prior to start of construction works.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Efforts to be geared toward instilling attitudes of tolerance, support and understanding of labour immigrants by the local communities</li> </ul>                 | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Sensitize workers on proper social behaviour and conduct with regard to community systems and the acceptable societal norms;</li> </ul>                           | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Put in place a grievance redress committee or a Public Complaints Desk to receive any complaints about the construction activities;</li> </ul>                    | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Implement a strict employment code of conduct.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Risk of violence against children (VAC)                      | <ul style="list-style-type: none"> <li>Develop a strict employment code of conduct to protect the girl child.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Sensitize employees on dangers of molestation of children, especially the girl child.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Sensitize the Contractor against child labour and implement the child labour act;</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |

| Impact/Risk  | Mitigation /Enhancement commitments   | Responsibility  | Estimated Cost (UGX) & Remarks |
|--|---|---|--------------------------------|
|  | <ul style="list-style-type: none"> <li>• Demand birth certificate or any identify that clearly shows the age of a job applicant;</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>• Issue each worker with an applicant letter with well spelt out terms of engagement.</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>• Monitoring school attendance</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor/<br/>DLG</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>• Sensitization in schools</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>• Reporting mechanisms in place such as a whistleblowing system.</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
| Risk of Sexual and Gender Based Violence (SGBV) - e.g. physical assault, Sexual abuse, and sexual harassment | <ul style="list-style-type: none"> <li>• The Contractor should have a sexual harassment policy and mainstream it to ensure strict adherence to established mechanisms to avoid the emergence of these challenges;</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>• MWE should ensure that social safeguards personnel are recruited as part of the project implementation personnel to supervise contractors and to continuously engage communities;</li> </ul>   | <ul style="list-style-type: none"> <li>• MWE</li> </ul>                 | -                              |
|  | <ul style="list-style-type: none"> <li>• Put SGBV reporting mechanisms in place;</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>• Community sensitization among men and women.</li> </ul>  | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
| HIV/AIDS risks   | <ul style="list-style-type: none"> <li>• Sensitize workers on proper social behaviour and conduct with regard to community norms, HIV/AIDS and other sexually transmitted diseases. HIV/AIDS policies should be developed at the workplace. Free HIV/AIDS testing, counselling and condom distribution be encouraged for both workers, sex workers and local community. The pathways for transmission of HIV/AIDS and STIs are well known, foreseeable and can be mitigated.</li> </ul> | <ul style="list-style-type: none"> <li>• Contractor</li> </ul>          | -                              |
|  | <ul style="list-style-type: none"> <li>• Social bonds are not readily controlled, and the permanence of HIV/AIDS transmission makes this particular impact of social bonding both negative and also positive. Social bonds leading to lasting marriages and children occur in such situations; early pregnancies and sexual exploitation can also occur. It is</li> </ul>   | <ul style="list-style-type: none"> <li>• Contractor/<br/>DLG</li> </ul> | -                              |

| Impact/Risk                                | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|--|--|--|--------------------------------|
|  | therefore important to tackle the issue of social bonding with firmness and fairness, forbidding powerful relationships, which lead to exploitation of mostly women and children, while encouraging relationships that may lead to permanent situations.   |  |                                |
| Risk of Contracting and Spreading COVID-19 | <ul style="list-style-type: none"> <li>Sensitize all project employees about the signs and symptoms of COVID-19 as well as the ways to control its spread.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Screen local employees/contractors for COVID-19 during recruitment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Screen all visitors to construction sites using a temperature gun and enforce washing of hands before entry and wearing of approved masks.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Management of potential COVID-19 cases – in case, any workers develop the above symptoms, isolate them and immediately contact the respective District Health Officers (DHOs) to pick and transport the patients for treatment.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Reduce site traffic – prohibit entry for any non-essential visitors. In addition, utilize staggered start and finish times for workers to limit site congestion and physical contact. Further, restrict the number of people in attendance at any site inductions, and consider holding them outdoors whenever feasible.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Practice social distancing – Consistently monitor points of worker interactions such as dining areas to ensure social distancing guidelines (2-4 meters apart) are being met.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|  | <ul style="list-style-type: none"> <li>Prioritize sanitation – Enforce workers to wash their hands with soap and water for at least 20 seconds or to use sanitizers before entering and after leaving the worksite, as well as before and after handling all goods, materials and equipment. Routinely clean any common contact surfaces on-site (e.g. scanners, turnstiles, screens, telephones and desks). Lastly, be sure to temporarily remove or disable any site entry systems that require skin contact (e.g. fingerprint scanners).</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |

| Impact/Risk   | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|---|--|--|--------------------------------|
|   | <ul style="list-style-type: none"> <li>Limit physical contact – Make sure that the contractor stagger break times to reduce congestion and physical contact in eating areas. Require workers to keep at least 2-3 metres of distance between one another while eating.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Enhance whole-of-society coordination mechanisms to support preparedness and response, including the health, transport, travel, trade, finance, security and other sectors. Involve public health Emergency Operations Centres and other emergency response systems early.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Continuously sensitize the workers and pass on any new guidelines by Government and the WHO.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| Risk of not engaging stakeholders in project monitoring | <ul style="list-style-type: none"> <li>Bring onboard the relevant stakeholders including Kiryandongo DLG to participate in routine project monitoring.</li> </ul>  | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | -                              |
| Decommissioning of auxiliary facilities                 | <ul style="list-style-type: none"> <li>Demolish all auxiliary facilities</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Remove all obsolete equipment, vehicles, trucks and machinery shall be removed from sites</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Backfilling all openings with overburden soil</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Planting fast-growing trees and grasses to stabilize the excavated areas</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Fencing off the re-vegetated areas is recommended until the reinstated vegetation has reached maturity</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|   | <ul style="list-style-type: none"> <li>Clean-up of the site and safe disposal of any construction waste.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
| <b>NEGATIVE IMPACTS AND RISKS – PHASE CROSSCUTTING</b>  |  |  |                                |
| Occupational Health and Safety Risks                    | <ul style="list-style-type: none"> <li>The Contractor shall prepare and implement an occupational safety and health plan for all sites, approved by the developer.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|   | <ul style="list-style-type: none"> <li>The Contractor shall provide safety guidelines to all operations prior to start of work.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |

**Construction of Solar Powered Water Supply and Sanitation Facilities in Refugee Settlements and Host Communities in Kiryandongo District**

| Impact/Risk | Mitigation /Enhancement commitments  | Responsibility   | Estimated Cost (UGX) & Remarks |
|-------------|--|--|--------------------------------|
|             | <ul style="list-style-type: none"> <li>Strict adherence to safety measures and procedures are required to minimise (or eliminate) risks of accidents or hazardous developments occurring and ensure healthy and safe conditions for all persons working on the site. To ensure occupational health and safety on construction sites, the Contractor shall be obliged to comply with all applicable Ugandan construction Health and Safety Standards as required by the Occupational Safety and Health Act of 2006. These include provisions of the Factories Act, Labour Unions Act and Workman's Compensation Act.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>Training will be conducted on how to prevent and manage incidences. This should involve proper handling of electricity, water etc. and sensitization on various modes of escape, conduct and responsibility during such incidences. All must fully be aware and mentally prepared for potential emergency.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>Regular drills will be constantly followed on various possible incidences. This will test the response of the involved stakeholders. Such drills will keep them alert and they will become more responsive in case of incidences.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>Personnel on duty shall at all times wear appropriate PPE, such as safety glasses with side shields, face shields, hard hats/helmets, and safety boots be required for all site staff.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>The Contractor shall establish emergency entrances, exits and amenities.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -                              |
|             | <ul style="list-style-type: none"> <li>The Contractor shall ensure access to first aid kits.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | 3,000,000                      |
|             | <ul style="list-style-type: none"> <li>The Contractor shall ensure safe working heights through provision of work platforms, scaffolds and adequate supervision by ensuring regular inspection of formwork, false work and temporary supports before loading or pouring concrete.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |
|             | <ul style="list-style-type: none"> <li>The Contractor shall secure site boundaries with fences or hoardings as appropriate.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor's bid budget |



| Impact/Risk | Mitigation /Enhancement commitments   | Responsibility   | Estimated Cost (UGX) & Remarks             |
|-------------|---|--|--|
|             | <ul style="list-style-type: none"> <li>The Contractor shall install caution signage around the site to discourage the public from being close to the site, for example, “falling debris”, “keep off the site” etc.</li> </ul>   | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | Within contractor’s bid budget             |
|             | <ul style="list-style-type: none"> <li>The Developer through the Construction Supervisor will continually monitor Contractors’ compliance with Health and Safety measures.</li> </ul>   | <ul style="list-style-type: none"> <li>MWE</li> </ul>        | Within supervision consultant’s bid budget |
|             | <ul style="list-style-type: none"> <li>An Accident Log will be maintained onsite to register all injuries and to investigate their causes during both the construction and operation phases of the project.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>The manufacturer’s instructions and Material Safety Data Sheets (MSDS) shall be followed for the storage of all chemicals used in water treatment. Storage must conform to compatibility restrictions.</li> </ul>  | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |
|             | <ul style="list-style-type: none"> <li>Work force shall be subjected only to standard work shifts/hours. Overtime allowances, if applicable/warranted shall be paid with ceiling limits. Working beyond such ceiling limits shall be discouraged, even if, so desired workforce or contractor.</li> </ul> | <ul style="list-style-type: none"> <li>Contractor</li> </ul> | -  |

## **2. GENERAL REQUIREMENTS OF THE WORKS**

### **2.1 Extent of the Works - Part 1**

The Works to be executed by the Contractor shall include the following:

#### **1. GASPA**

##### **Borehole Pumping Mains System**

- Supply, laying, testing and commissioning of 6,617m of borehole pumping main in OD 160 uPVC PN 10 and associated fittings,

##### **Distribution Network**

- Supply, laying, testing and commissioning of 2,935m of OD160 uPVC PN10 main distribution lines and associated fittings
- Supply, laying, testing and commissioning of 24m of OD110 uPVC PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 5,141m of OD90 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 7,724m of OD63 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 2,096m of OD50 HDPE PN10 main distribution lines and associated fittings,

##### **Intensification Network**

- Supply, laying, testing and commissioning of 2,000m of OD40 HDPE PN10 main intensification lines and associated fittings,
- Supply, laying, testing and commissioning of 2,000m of OD32 HDPE PN10 main intensification lines and associated fittings,
- Supply, laying, testing and commissioning of 2,000m of OD25 HDPE PN10 main intensification lines and associated fittings,
- Supply and installation of 3 No. bulk flow meters,
- Construction of 240 No. Consumer Connections
- Construction of 15 No. Public Stand Posts

## **2. MUTUNDA**

### **Borehole Pumping Mains System**

- Supply, laying, testing and commissioning of 9040m of borehole pumping main in OD 160 uPVC PN 10 and associated fittings,
- Supply, laying, testing and commissioning of 6,370m of borehole pumping main in OD 110 uPVC PN 10 and associated fittings,

### **Distribution Network**

- Supply, laying, testing and commissioning of , 6,972m of OD160 uPVC PN10 main distribution lines and associated fittings
- Supply, laying, testing and commissioning of 1,670m of OD110 uPVC PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 6,463m of OD90 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 2,505m of OD75 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 3,681m of OD63 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 8,029m of OD50 HDPE PN10 main distribution lines and associated fittings,

### **Intensification Network**

- Supply, laying, testing and commissioning of 5,000m of OD40 HDPE PN10 main intensification lines and associated fittings,
- Supply, laying, testing and commissioning of 5,000m of OD32 HDPE PN10 main intensification lines and associated fittings,
- Supply, laying, testing and commissioning of 5,000m of OD25 HDPE PN10 main intensification lines and associated fittings,
- Supply and installation of 3 No. bulk flow meters,
- Construction of 600 No. Consumer Connections,

- Construction of 15 No. Public Stand Posts

### **3. NYAKABAALE**

#### **Borehole Pumping Mains System**

- Supply, laying, testing and commissioning of 7,643m of borehole pumping main in OD 160 uPVC PN 16 and associated fittings,
- Supply, laying, testing and commissioning of 5,449m of borehole pumping main in OD 90 HDPE PN 16 and associated fittings,

#### **Distribution Network**

- Supply, laying, testing and commissioning of , 742m of OD160 uPVC PN10 main distribution lines and associated fittings
- Supply, laying, testing and commissioning of 5,767m of OD110 uPVC PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 1,245m of OD90 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 417m of OD75 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 1,183m of OD63 HDPE PN10 main distribution lines and associated fittings,
- Supply, laying, testing and commissioning of 4,755m of OD50 HDPE PN10 main distribution lines and associated fittings,

#### **Intensification Network**

- Supply, laying, testing and commissioning of 3,830m of OD40 HDPE PN10 main intensification lines and associated fittings,
- Supply, laying, testing and commissioning of 3,830m of OD32 HDPE PN10 main intensification lines and associated fittings,
- Supply, laying, testing and commissioning of 3,830m of OD25 HDPE PN10 main intensification lines and associated fittings,
- Supply and installation of 3 No. bulk flow meters,
- Construction of 15 No. Public Stand Posts

- Construction of 460 No. Consumer Connections

## **2.2 Extent of the Works - Part 2**

The Works to be executed by the Contractor shall include the following.

### **2.2.1 Civil Works for Water Office**

- Construction of 1 No. water office blocks each with floor area of 59m<sup>2</sup> in the RGCs of Gaspa, Mutunda and Nyakabaale

### **2.2.2 Civil Works for Water Supply Reservoir**

- Construction of a new 200m<sup>3</sup> Steel Reservoir in Gaspa elevated on a 15m high steel tower,
- Construction of a new 150m<sup>3</sup> Steel Reservoir in Popora, Mutunda RGC elevated on a 20m high steel tower,
- Construction of a new 100m<sup>3</sup> Steel Reservoir in Teyago, Mutunda RGC elevated on a 15m high steel tower,
- Construction of a new 150m<sup>3</sup> Steel Reservoir in Nyakabaale RGC elevated on a 15m high steel tower,

### **2.2.3 Mechanical / Electrical Works for Water Supply**

The following submersible water pumps will be supplied and installed.

- Borehole DWD 77380 will be fitted with a submersible pump with a flow of 30.0m<sup>3</sup>/hr. at 116m head
- Borehole DWD 77378 will be fitted with a submersible pump with a flow of 45.0m<sup>3</sup>/hr. at 149m head.
- Borehole DWD 77383 will be fitted with a submersible pump with a flow of 10.0m<sup>3</sup>/hr. at 178m head.
- Borehole DWD 77382 will be fitted with a submersible pump with a flow of 20.0m<sup>3</sup>/hr. at 216m.

#### **2.2.4 Tools and Equipment for Water Supply**

Supply to store tools and equipment for operation and maintenance of the water supply system including:

- Water Office Equipment,
- Plumbing Tools and Equipment,
- Water Quality Test Kit,
- Miscellaneous Tools,
- Chemical Equipment and Chemicals.

#### **2.3 Extent of the Works- Part 3**

The Works to be executed by the Contractor shall include the following.

##### **2.3.1 Sanitation**

###### **Gaspa**

- Construction of 2 No 4 Stance Waterborne Public Toilet Blocks.
- Construction of 1No. 5 Stance VIP latrine for boys and 1No. 5stance VIP latrine for girls

###### **Mutunda**

- Construction of 1 No 4 Stance Waterborne Public Toilet Blocks.
- Construction of 1No. 5 Stance VIP latrine for boys and 1No. 5stance VIP latrine for girls

###### **Nyakabaale**

- Construction of 1 No 4 Stance Waterborne Public Toilet Blocks.
- Construction of 1No. 5 Stance VIP latrine for boys and 1No. 5stance VIP latrine for girls

#### **2.4 Work to be executed by others - Part 1**

There is none.

#### **2.5 Work to be executed by others - Part 2**

Work to be executed by UMEME.

The transformer will be installed by the Contractor and energised by UMEME.

**2.6 Work to be executed by others - Part 3**

There is none.

### **3. PARTICULAR SPECIFICATIONS**

This chapter is divided into three parts, each corresponding to a part of the Works as defined in chapter 1. Clauses relating to Part 1, 2 and 3 of the Works are prefixed 3.1, 3.2 and 3.3 respectively.

References to clauses are to those of the 4<sup>th</sup> Edition of the Civil Engineering Specification for the Water Industry (CESWI), unless stated otherwise.

#### **3.1 Part 1: Water Supply Pipe Laying**

##### **3.1.1 General Description of the Works**

The works consist of pipe laying. The layouts of all the pipe works to be done are given in the Drawings as listed below:

- Drawing GPA/WS/0.0.0 series shows the general water system layout and distribution network for Gaspa RGC.
- Drawing MUT/WS/0.0.0 series shows the general water system layout and distribution network for Mutunda RGC.
- Drawing NYA/WS/0.0.0 series shows the general water system layout and distribution network for Nyakabaale RGC.

The pipelines shall be laid to the alignment shown in the drawings, and shall be tested, and disinfected as described in these specifications.

The Contractor shall lay intensification pipework at locations as directed by the Project Manager. The new connections shall be made with new materials, of acceptable quality, and at the most convenient locations as agreed on site.

##### **3.1.2 Transmission System**

The transmission mains for the boreholes will deliver water from the boreholes to the respective water reservoirs. Flexibility will be allowed to provide raising mains of either steel, DI, uPVC or HDPE of the same pressure rating to the approval of the Engineer.

The borehole pumping mains will have the following properties:

###### **Gaspa RGC**

- Borehole DWD 77380 will be fitted with a submersible pump with a flow of 30.0m<sup>3</sup>/hr. at 116m head with a borehole riser pipe of DN 100 Steel PN16, 100m long and transmission main of uPVC- OD 160 PN10, 6,617m long.

###### **Mutunda RGC**



- Borehole DWD 77378 will be fitted with a submersible pump with a flow of 45.0m<sup>3</sup>/hr. at 149m head, with a borehole riser pipe of DN100 Steel PN16, 60m long.
- A transmission Main uPVC- OD 160 PN16, 2,080m long from the borehole to a Junction T1 that has the manifold that separates the transmission mains to the respective reservoirs.
- A transmission Main uPVC- OD 160 PN16, 6920m long from the Junction T1 that has the manifold to Popora west reservoir tank.
- A transmission Main uPVC- OD 110 PN16, 6,370m long from the Junction T1 that has the manifold to Teyago west reservoir tank.

### Nyakabaale

- Borehole DWD 77383 will be fitted with a submersible pump with a flow of 10.0m<sup>3</sup>/hr. at 178m head with a borehole riser pipe of DN 65 Steel PN25, 100m long and transmission main of HDPE- OD 90 PN16, 5,449m long.
- Borehole DWD 77382 will be fitted with a submersible pump with a flow of 20.0m<sup>3</sup>/hr. at 216m head with a borehole riser pipe of DN 100 Steel PN25, 100m long and transmission main of uPVC- OD 160 PN16, 7,643m long.

The contractor shall lay the transmission mains in the above stated sizes and the entire transmission line shall be laid to a controlled alignment as described in these specifications.

The contractor shall note the following:

- (a) Most of the line runs along existing roads. The programme for pipe laying in these locations shall be agreed with the Project Manager so as to result in the minimum of traffic flow disruption.
- (b) Part of the line is laid across country in fields where regular vehicle access is not available. The contractor shall arrange for his own access and the cost of this shall be deemed to be included in his rates. In addition, pipe markers shall be installed along the cross-country pipeline route as directed by the Engineer.

### 3.1.3 Distribution System

The distribution network for the project area will be gravity fed from the respective reservoir tanks. Error! Reference source not found. shows the summary of the distribution mains of the project area.

**Table 3-1 Gaspa Distribution Network**

| Pipe Details     | Length (mm) |
|------------------|-------------|
| OD 160 uPVC PN10 | 2,935       |
| OD 110 uPVC PN10 | 24          |

| Pipe Details    | Length (mm)   |
|-----------------|---------------|
| OD 90 HDPE PN10 | 5,141         |
| OD 63 HDPE PN10 | 7,724         |
| OD 50 HDPE PN10 | 2,096         |
| <b>Total</b>    | <b>17,920</b> |

**Table 3-2 Mutunda Distribution Network**

| Pipe Details     | Length (m)   |               |
|------------------|--------------|---------------|
|                  | Diima        | Kakwokwo      |
| OD 225 uPVC PN10 | 0            | 0             |
| OD 160 uPVC PN10 | 0            | 6,972         |
| OD 110 uPVC PN10 | 15           | 1,655         |
| OD 90 HDPE PN10  | 0            | 6,463         |
| OD 75 HDPE PN10  | 1,105        | 1,400         |
| OD 63 HDPE PN10  | 2,856        | 825           |
| OD 50 HDPE PN10  | 4,181        | 3,848         |
| <b>Total</b>     | <b>8,157</b> | <b>21,162</b> |

**Table 3-3 Nyakabaale Distribution Network**

| Pipe Details     | Length (mm)   |
|------------------|---------------|
| OD 160 uPVC PN10 | 742           |
| OD 110 uPVC PN10 | 5,767         |
| OD 90 HDPE PN10  | 1,245         |
| OD 75 HDPE PN10  | 417           |
| OD 63 HDPE PN10  | 1,183         |
| OD 50 HDPE PN10  | 4,755         |
| <b>Total</b>     | <b>14,110</b> |

### 3.2 Network Intensification and Service Connections

The alignment of the lines could change in light of new obstacles to pipe laying. The Contractor must give at least a week's notice before commencing work on any road crossings and the roads shall be reinstated to the satisfaction of the authority responsible for the roads.

#### 3.2.1.1 Intensification Pipe work

Where directed by the Project Manager, the Contractor shall lay intensification pipelines to densify the distribution network.

The intensification lines are in areas of anticipated demand, and the decision as to whether they shall be laid or not is demand driven, and shall be made by the Project Manager on site against proven demand, (i.e. applications for new connections or existing areas with excessively long service pipes). The final required fittings for the lines are therefore not precisely known, and shall be determined on site.

#### 3.2.1.2 Consumer Connections

The Project Manager will issue a list of properties requiring consumer water connections (yard taps, public standposts) to be made. The Contractor shall install these consumer connections complete with consumer meters, and including tapping the main lines and laying of the service pipes, on all these properties. The details of the meter installation shall be as given in the standard drawings. The bill of quantities contains provisional quantities of materials for service connections. The Project Manager will determine the final quantities required and direct the Contractor to order them. The Contractor shall therefore not order these materials without approval from the Project Manager.

Public stand posts will also be constructed in areas agreed upon by the community members. Each will have four tap outlets embedded in a concrete support as shown in the drawing. Each standpost will consist of a water meter installation and a meter protection box. The details of the meter installation shall be as given in the standard drawings. All works will be done according to the drawings and to the satisfaction and approval of the project manager.

### **3.2.2 Survey of Highways, Properties, Lands and Crops**

The Contractor shall provide the Project Manager with the details of all the property that may be destroyed in the course of the execution of the works, four weeks prior to commencing works in the affected areas. This will allow adequate time for the Employer to compensate the owners of the property before the works commence. The Employer shall not be held liable for any delays in the works arising from late presentation of this information to the Project Manager or delays arising out of inaccuracies of the information presented by the Contractor to the Project Manager.

### **3.2.3 Traffic Requirements**

The Contractor shall comply with the provisions of the highway and road safety codes issued by the Government of the Republic of Uganda.

### **3.2.4 Surface Boxes and Guards**

All valves, unless otherwise stated, shall be provided with surface boxes. The surface boxes shall be of those type given in the Standard Details Drawings. The cover of the surface box shall be lockable and the cover shall be fixed to the base by a welded bolt.

### **3.2.5 Excavation**

Trenches for all pipes laid in the road reserves or underneath roads shall have a minimum cover of 1.2 m over the crown of the pipe. Trenches for ductile iron pipes, or steel pipes or HDPE or uPVC pipes laid in open fields not subject to traffic loading shall have a minimum cover of 0.90 m above the crown of the pipe.

Scrub, hedges, debris and other obstacles such as huts, trees etc. along the routes of the pipelines shall be cleared to the satisfaction of the Project Manager. The Project Manager reserves the right to restrict the width of clearance due to the proximity of roots, houses, public utilities or other such permanent obstructions. All trees within 2 m of the pipeline centre lines shall be felled and the roots grubbed up. Trees with a girth of less than 0.5 m shall be deemed to be included in the clearance of scrub etc. and shall not be paid for separately.

Before excavating across any public road, the Contractor shall give 10 days' notice in writing of his intention to excavate, shall satisfy the Project Manager, the Police and other traffic authorities, as to the precautions he proposes to take and the signs and lights to be provided and operated. The Contractor shall further give the Project Manager 24 hours' notice before excavating across any private road or track. The cost of providing all diversions, signs, signals, operations, flagmen and the like will be at the Contractor's expense, and shall be deemed to be included in the Contract, whether these are expressly billed or not.

All surfaces of roads, paths, fields, gardens, verges etc. whether public or private, which are disturbed during the execution of the Contract, shall be initially restored on a temporary basis by the Contractor. Permanent reinstatement shall commence only when the backfilled material has properly consolidated. The cost of restoration shall be deemed to be included in the Contract whether these have been expressly billed or not.

Permanent restoration shall not commence until the Project Manager has given written permission to proceed. It shall be carried out with materials similar to those which were used in the original surface and to the satisfaction of the Project Manager and/or the responsible owner or Authority.

Trenches, channels, and kerbs shall be reinstated to the condition in which they were before excavation was commenced. The final surface of the trench shall be flush with surrounding ground. The width of reinstated surfaces, due to be measured for payments, shall correspond to the specified width at that location.

For the purposes of the 4<sup>th</sup> edition of the Civil Engineering Standard Method of Measurement, hereinafter referred to as CESSM4, the classification of excavation shall be as follows.

- Topsoil shall be regarded as any soil which, on visual examination, can be seen to have been broken down by agricultural cultivation, and/or is capable of supporting plant growth.
- Rock shall include any material which, in the opinion of the Project Manager, requires for its removal the use of explosives, sledgehammers and wedges, breaking tools or which cannot be removed by a 145 kW tractor with rear mounted heavy duty ripper.

Individual boulders, each greater than 0.2 m<sup>3</sup> in volume shall be included in this class when their nature and size are such that they cannot be removed without recourse to the stated methods. Where their aggregate volume is 50% or more of the total volume of material removed it shall be measured as rock throughout.

### **3.2.6 Pipe Bedding**

The Contractor shall give notice to the Project Manager after completion of trenching of his intention to lay the pipeline. The Project Manager will jointly with the Contractor inspect the trenches and determine the type of bedding for various sections of the trenches as follows:

- Pipes which will be bedded on the original ground.

- Pipes which will be bedded on selected excavated material (depth as shown on Standard Detail SD 121).
- Pipes which will be bedded on imported material (depth as Standard Detail SD121).

### **3.2.7 Concrete Protection to Pipes**

All pipes at public road crossings shall be provided with a class C15 concrete surround (see Standard Detail SD121). All pipes where the cover stipulated in clause 3.1.6 of the specifications is not achievable shall be provided with a class C15 concrete surround.

### **3.2.8 Completion of Pipe Surround**

The Contractor shall give notice to the Project Manager after completion of trenching of his intention to lay the Pipe. The Project Manager will jointly with the Contractor inspect the trenches, and determine the type of pipe surrounds required for different sections of the trenches. The types of surrounds will be as follows:

- non selected excavated material other than the top soil, rock or artificial hard material;
- selected excavated material;
- imported granular material.

Indicative quantities of surrounds in the various categories have been included in the Contract. The final quantities shall be as determined on site.

### **3.2.9 Protection of Ferrous Pipes, Joints and Fittings**

External painting of pipe fittings is not deemed adequate protection, and therefore shall not be permitted. The Contractor shall present to the Project Manager a sample of the material he intends to use for approval, prior to ordering fittings. Protections shall be provided to all fittings falling in this category, and the cost of so doing shall be deemed to be included in the Contract.

### **3.2.10 Marker and Indicator Posts**

Marker posts for fittings and pipeline structures shall be of design as shown in the drawings, and shall be located within 3 m of the fittings, and to minimise the possibility of traffic/pedestrian damage, and damage from future pipe laying/fitting repair operations. Marker plaques shall be aluminium plates 150 x 150 x 3 mm inscribed in water blue permanent colour. They shall be engraved with the pipeline diameter and offset distance prior to installation.

### **3.2.11 Precautions Prior to Testing Pipelines**

Pressure testing of pipelines against a closed valve shall be avoided. If the circumstances are such this is not avoidable, the Contractor shall seek the approval of the Project Manager prior to undertaking such a test.

### 3.2.12 Testing of Pressure Pipelines

The pipelines shall be subjected to a hydrostatic testing prior to commissioning. The test pressure shall be:

- **Transmission pumping line:** Operation pressure or static pressure plus 5 bar, whichever is greater, but at least nominal pressure plus 5 bar.
- **Distribution network:** nominal pressure plus 5 bar,
- **Thermoplastic pipes:** as per the manufactures instructions or DIN.

The operation pressure includes the pressure of surge effects.

For concrete or cement-mortar lined pipelines, the section under test shall be filled with water to the required pressure and allowed to stand for 24 hours before the test procedure commences.

For the initial construction period the lengths of pipelines to be tested shall not exceed 0.5 km. At the discretion of the Project Manager this length may, as the Contract proceeds, be extended to a maximum of 1.5 km.

Before testing commences, all anchorages shall be in position, all concrete thrust blocks shall have attained their required strength and, where pipe joints are deflected to produce large radius curves, the backfill between the pipe body and the trench side shall be compacted to the final requirements. The Contractor shall provide for transmitting the unsupported end thrusts to solid ground.

The Contractor shall fill the pipe with water and shall steadily increase the pressure to the working pressure of the main. The pressure shall then be increased in increments of 1.0 bar, with a pause of one (1) minute between each increment until the specified test pressure is achieved. After a period of thirty (30) minutes, the quantity of water required to restore the pressure back to the test pressure shall be measured. This process shall continue for a minimum period of three (3) hours.

If the amount of make-up water in the three hours test exceeds the specified quantity, the Contractor shall locate and repair the leaks, then repeat the test all at his own expense. The test on each section shall be repeated until the specified degree of water tightness has been obtained.

### 3.2.13 Disinfection of Water Mains

The Contractor shall disinfect all new mains intended for conveyance of potable water before

they are put into service.

Pipelines that are to convey potable water and have successfully passed the hydrostatic test, shall be scoured out until the wash water runs clear. They shall then be recharged with potable water containing at least 50 mg/l of free chlorine. The chlorine shall be derived from a 1% solution of calcium hypochlorite in water. The solution shall be added in a manner and rate approved by the Project Manager.

The pipeline shall then be allowed to stand for a period of at least 24 hours during which period all intermediate in-line valves shall be operated at least once. After this period, the residual free chlorine shall be measured at the end of the pipeline furthest from the point of injection of the chlorine solution. If the free residual chlorine is less than 10mg/l, the sterilisation process shall be repeated until this value is achieved.

The Employer will supply sufficient potable water for one sequence only of the scouring, sterilising, re-charging and commissioning procedures as defined. The Contractor shall be deemed to have allowed in his rates the cost for the potable water and shall be also deemed to have allowed in his rates, for any re-sterilisation including the cost of potable water, deemed necessary by the Project Manager.

#### **3.2.14 Survey of Pipeline Routes**

The Project Manager has carried out a preliminary survey of pipeline and fixed the appropriate route as indicated on the Drawings.

The Contractor, in conjunction with the Project Manager, shall set out and agree the final pipeline route and shall undertake a detailed survey of the agreed route prior to the commencement of construction work. The Contractor shall submit the results of the survey to the Project Manager in the form of longitudinal sections and plans drawn to a scale to be decided by the Project Manager. They shall conform to the following.

- The length of the route shall be accurately measured and chainage markers (50 mm x 50 mm timber pegs or similar approved) fixed at 25 to 50 m intervals and clearly marked with the chainage at that point.
- Using modern survey equipment approved by the Project Manager, ground levels shall be taken at intervals agreed with the Project Manager. Generally a 25 m interval will be acceptable though this is to be reduced as necessary to ensure any abrupt changes in level are recorded.
- Levels shall relate to the datum given in Chapter 1 of this Specification, and permanent benchmarks shall be established, clear of the proposed pipeline, at intervals along the pipeline route.

The Project Manager will review the pipeline profile and amend it where necessary including any revisions to the number and position of air valves and washouts.

Route surveying shall be completed, and approved Pipe Laying Drawings issued and

approved, before excavation and pipe laying begin. All submitted drawings shall be in print and AUTOCAD format.

### **3.2.15 Pipe Laying - Controlled and Non-Controlled Sections**

The criteria for the level and gradient to which pipe shall be laid are divided into two categories as follows.

“Controlled Sections” comprise those sections of the pipeline where pipe gradients will be subject to the following.

- The cover above the crown of the pipe to ground level shall be a minimum of that stated in Clause 3.1.6.
- The upward gradient shall be steeper than 1 in 500 with flow, or steeper than 1 in 300 against the flow.
- The positions of the high and low points shall be determined from the Contractor’s detailed route survey and shall be as far apart as ground levels permit, with the depth of the pipe being increased from the minimum by as much as 1,000 mm to avoid high points at small undulations.

The Contractor shall ensure that the required pipe levels and gradients along “controlled” sections comply with the above criteria.

“Non-Controlled Sections” shall comprise the remaining sections of the pipeline which shall be laid to stipulated cover as specified in Clause 3.1.5.

### **3.2.16 Pipeline Materials**

All pipelines of size equal to or bigger than DN 100 shall be in uPVC or equivalent quality material in the distribution network. Pipes of smaller size have been specified as HDPE. However, any pipeline of equal or better quality will be acceptable. House connections shall be in HDPE.

The transmission pumping line shall be in HDPE/uPVC/ductile iron/steel according to the Contract agreement. Material specifications are given below:

#### **3.2.16.1 Quality and Origin of Material**

All materials needed for the delivery and installation works are part the Tender and will be installed on site at the cost and responsibility of the Contractor in order to assure that the work is carried out within the stipulated time. Additional materials for items in the BOQ must have the best quality obtainable, be faultless and installed with professional workmanship. They shall have distinctive labels or plates for purposes of identification of material, its data and country of origin.



Only materials approved and accepted by the Supervisor shall be supplied and installed. Materials which are refused shall immediately be removed from the construction site at the cost of the Contractor.

### **3.2.16.2 Pipes, Pipe-Fittings and Joints**

Uniformity of materials shall be maintained throughout the manufacturing process for each pipe size to the end, so that the test samples are representative of the entire output. All pipes, specials, fittings and accessories supplied under the Contract shall be manufactured in accordance with the EN, ISO or DIN Standards.

For all items of supply the Contractor shall submit to the Supervisor a certificate of compliance with the specified Standard. Pipes, T-Pieces and bends shall be preferably from the same manufacturer.

All Supplies shall be new and of appropriate grade and quality suitable for and adequately protected against the prevailing climatic conditions and the water quality. Any supply which is found to be unsuitable for use under these conditions shall be removed and replaced by suitable one entirely at the expense of the Contractor.

All materials, components and workmanship used throughout, except where amended by the Specification, shall comply with the latest relevant EN, ISO and DIN-Standards current at the date of closing tenders. Where other Standards are proposed, they shall be equal or superior to the relevant EN or ISO-Standard. Two copies of each of such Standard (in English) shall be submitted with the Tender.

The acceptance of a Tender based on such Standards shall only signify the Supervisor's general approval to the use of the standards and shall not make him liable to accept any Standard subsequently found inferior to the corresponding ISO, EN and DIN-Standards. The Supervisor shall be empowered to reject any material, components and workmanship found to be inferior to the appropriate EN, ISO and DIN-Standard and the Contractor shall make good the deficiency at his own expense.

Nomenclature, classification, symbols, conditions of manufacturing, characteristics and tolerances, conditions for the preparation of specimen, test rules, identification labels and acceptance clauses of pipes and pipe-fittings must conform to the latest relevant EN, DIN or ISO standards.

Pipes, pipe-fittings and joints must be able to withstand normal working conditions especially inner pressure, external strains, overloads and reactions from soil or supports.

They must have a smooth internal surface, irregularity of the surface are not acceptable unless they are accidental and local and do not impair the quality of the piece or violate admissible tolerances; such faults are not to be repaired without previous authorization of the Supervisor.

Equipment must withstand all strains that may occur during operation or tests without damage. Tightness must be assured under all operational or test conditions. Equipment must show permanent resistance to all external factors as such and have interior linings which protect it against the effect of water and exterior coatings to protect it against influences from the soil or other ambient influences.

Equipment must not in any way modify the physical, chemical, bacteriological or organoleptic quality of the water which normally flows through the network. A NON-TOXICITY certificate of all components must be provided.

All equipment such as pipes, valves, fittings and other important components must display the following information:

- a) Name of factory
- b) Stamps or labels stating material identification and nominal admissible pressure
- c) Nominal diameter
- d) Material properties

If considered necessary, the Contracting Authority or his Representative shall inspect pipes, fittings, accessories, at the works of manufacturers. Equipment and laboratory to carry out tests shall be provided by manufacturers. Authority for shipment has to be obtained from the Supervisor according to the General and Special Conditions of Contract.

Pipes, pipe-fittings and joints shall be interchangeable with the materials currently used by the Contracting Authority or the new system (joint system) be standardised; their dimensions and drilling templates must absolutely meet the standards required.

The payable length of the pipes corresponds to their nominal laying length i.e. total length minus socket length.

### 3.2.16.3 Ductile Cast Iron Pipes and Pipe-fittings

#### 3.2.16.3.1 DI Pipes Standard

DI pipes shall be centrifugally cast, standard length 6 m, with socket and spigot, EPDM rubber gaskets, according to EN 545, or DIN 28600 till DIN 28646 or equivalent ISO 2531, 4179, 6600.

All pipes and welding work shall be class K9 and C30 and C40.

#### 3.2.16.3.2 DI pipes Class C30 and C40

The joints of ductile iron (DI) pipes and fittings of class C30 and C40 shall be standard joints of the TYTON type according to the above mentioned standards and as indicated on the Drawings and in the Bill of Quantities.

Outside protection coating shall be of 400 g/m<sup>2</sup> metallic zinc+aluminium (85%+15%) plus epoxy finishing coat according to EN 545:2002, suitable for ground condition I and II.

Inside protection lining shall be of sulphate resisting blast furnace cement mortar according to DIN 2614, ISO 4179 – 1985.

Dimensions shall be according to DIN 28610, Part 1 as follows or according to equivalent standards as indicated on the Drawings

**Table 3-4 Ductile Cast Iron Pipe Specifications for Pipes Classes C30 and C40**

| DI DN<br>[mm] | Class | Outside Diameter<br>[mm] | Wall Thickness<br>[mm] | Cement Lining<br>[mm] | PFA<br>[bar] |
|---------------|-------|--------------------------|------------------------|-----------------------|--------------|
| 150           | C40   | 170                      | 5.0                    | 5.0                   | 62           |
| 200           | C40   | 222                      | 5.4                    | 5.0                   | 50           |

|     |     |     |     |     |    |
|-----|-----|-----|-----|-----|----|
| 300 | C40 | 326 | 6.2 | 5.0 | 40 |
| 400 | C30 | 429 | 6.5 | 5.0 | 30 |

### 3.2.16.3.3 DI pipes class K9

Class K9 pipes shall be used for sections with operating pressure (PFA) greater than 20 bars as indicated in the longitudinal profiles.

The joints of ductile iron (DI) pipes and fittings of class K9 for high pressures shall be Universal joints resisting the same pressure as indicated in the table below, according to the above mentioned standards and as indicated on the Drawings and in the Bill of Quantities.

Outside protection coating shall be of 200 g/m<sup>2</sup> metallic zinc plus bitumen according to DIN 30674, part 3, or ISO 8179 – 1995, suitable for ground condition I and II.

Inside protection lining shall be of sulphate resisting blast furnace cement mortar according to DIN 2614, ISO 4179 – 1985.

Dimensions shall be according to DIN 28610, Part 1 as follows or according to equivalent standards as indicated on the Drawings

**Table 3-5 Ductile Pipe Specifications for Pipes K9**

| DI DN<br>[mm] | Class | Outside Diameter<br>[mm] | Wall Thickness<br>[mm] | Cement<br>Lining<br>[mm] | PFA<br>[bar] |
|---------------|-------|--------------------------|------------------------|--------------------------|--------------|
| 200           | K 9   | 222                      | 6.3                    | 3                        | 62           |
| 300           | K 9   | 326                      | 7.2                    | 3                        | 49           |
| 400           | K 9   | 429                      | 8.1                    | 3                        | 42           |

### 3.2.16.3.4 DI Pipes for Slope Sections

DI pipes and accessories as described before for installation at steep slope sections shall have self restrained push-in joints, System TIS – K/NOVOSIT or Universal joints, or similar.

Supply of such pipes shall include for cutting pipes, preparing ends for jointing, and supply of adapting pieces between TYT and TIS - K/NOVOSIT or Universal joints, or similar.

Dimensions shall be according to DIN 28610, Part 1, or equivalent standard as given on the Drawings or Specifications. Maximal deflection shall be 3°.

### 3.2.16.3.5 Fittings and Accessories

All fittings and accessories made of DI shall comply with DIN 28600 till DIN 28646 or equivalent ISO 2531, 4179, 6600, DIN 545 Part 1, and with DIN 16451 for all DI fittings.

The joints of ductile iron (DI) fittings shall be according to the above mentioned standards, flanged or socket (TYTON), and as indicated on the Drawings and in the Bill of Quantities.

Flanges shall be drilled to DIN 2501 / EN 1092-2 - PN 16, PN25 or PN40 as specified.

Bolts shall be according to EN 24016 and nuts to EN 24034.

Outside protection shall be according to DIN 30674, bituminous coating, suitable for ground condition I and II) or epoxy powder coated for all DI fittings.

Inside protection shall be according to DIN 2614, with cement lining, or epoxy powder coated for all DI fittings.

All gaskets shall be of EPDM rubber, flat gaskets of NBR rubber, according to ISO 4633-1996. A NON-TOXICITY certificate of all components must be provided.

Flat gaskets shall be fibre reinforced for PN16, steel reinforced for PN25 and PN40.

Identification shall be according to DIN Abbreviations as follows or according to equivalent standards as indicated on the Drawings or in the Particular Specifications:

**Table 3-6 DIN Abbreviations for Fittings for DI and Steel Pipes for Transmission Mains**

| ITEM                          | DIN Abbreviation | Detail     | DIN      |
|-------------------------------|------------------|------------|----------|
| Wall Piece                    | E-               |            | WN       |
| Flange Socket Piece           | EU-              |            | 28622    |
| Flange Spigot Piece           | F-               |            | 28623    |
| Slip over Coupling            | U-               |            | 28624    |
| Double Socket Bend 11°        | MMK 11           | 11 1/4°    | 28629    |
| Double Socket Bend 22°        | MMK 22           | 22 1/2°    | 28628    |
| Double Socket Bend 45°        | MMK 45           | 45°        | 28626    |
| Double Socket Bend 90°        | MMQ              | 90°        | 28625    |
| Socket Spigot Bend 11° to 45° | MK 11 to 45      | 11° to 45° | WN       |
| Socket Spigot Bend 90°        | MQ               | 90°        | WN       |
| Flanged-Flanged Bend 11°      | FFK 11           | 11 1/4°    | WN       |
| Flanged-Flanged Bend 22°      | FFK 22           | 22 1/2°    | WN       |
| Flanged-Flanged Bend 45°      | FFK 45           | 45°        | 28639    |
| Flanged-Flanged Bend 90°      | Q                | 90°        | 28637    |
| Duck Foot Bend                | N                | 90°        | 28638    |
| Socket-Flange-Socket T Piece  | MMA              |            | 28630    |
| Flange-Flange-Flange T Piece  | T                |            | 28643    |
| Double Socket Taper           | MMR              |            | 28634    |
| Double Flanged Taper          | FFR              |            | 28645    |
| ITEM                          | DIN Abbreviation | Detail     | DIN      |
| Blind Flange                  | X                |            | 28646    |
| Treaded Flange                | XG               |            | WN       |
| Reducing Flange               | XR               |            | WN       |
| Spare Flange, normal          | AF               |            |          |
| Spare Flange, restrained      | ZK               |            |          |
| Flange-Flange Pipe            | FFG              |            | 28614    |
| Socket-Flange-Socket T Piece  | MMA-KS           |            | 16451 T2 |
| Double Socket Taper           | MMR-KS           |            | 16451 T5 |

### 3.2.16.4 Steel pipes and Steel pipe-fittings

Spiral Welded Steel Pipes shall be according to DIN 2461, DIN 2448/2458 and EN 10224 with spigot ends, standard length either 6 or 12 m, steel quality St 37.0 minimum, and welding work according to standard.

For purpose of the present project, Spiral Welded Steel Pipes shall be applied for installations at pump stations and reservoirs as specified in the drawings, only.

Outside protection coating shall be of epoxy powder coating and with epoxy hard glue applied polyethylene film (if specified for ground condition III, only) to normal thickness for ground condition I and II.

Inside protection lining shall be of epoxy powder coating – min. 60µm according to DIN 30677 Part 2.

Dimensions shall be according to EN 10224, as follows or according to equivalent standards as indicated on the Drawings or in the Particular Specifications:

Sheet metal used for spiral welded steel pipes must have the same quality over the whole length of the tube; beads must have no sharp, cutting or protruding edges neither on the inside nor the outside. They shall be continuously welded. Tubes must be exposed to a hydraulic pressure test at the factory which, unless specified otherwise, shall be carried out at such pressures that the strain which the metal is subjected during tests will not exceed 48% of the minimum breaking strength. These tests are to be carried out correctly and the Contractor will furnish proof that factory tests were duly carried out.

Non-welded tubes shall be manufactured by hot rolling. If sleeve joints are required the sleeves must be manufactured in the factory by means of hot process. Parts whose surfaces show dents, cracks, slivers, scales or other imperfections shall not be acceptable. Repairs with welding or any other means are formally not allowed. Tubes shall not be delivered before undergoing an assembly line pressure test which, unless otherwise specified, uses the following pressures:

- up to nominal diameters of 150mm incl.      60 bar
- from 200 to 250 mm incl.                              50 bar
- from 300 to 400 mm incl.                              40 bar

The jointing of the pipes shall be by on site welding for distances of maximum 120 m, and installation of a standard range coupling joint each section of 120 m and as indicated on the Drawings and in the Bill of Quantities.

Pipe-fittings and pipe-joints (flanges, fittings, pipe bends, tee branches, adapters etc.) shall be either delivered as finished products by the factory, or, where special parts are required, prefabricated components from the factory shall be assembled at the construction site.

In every case, however, joints must have linings or additional linings both on their insides and their outsides which are fitted either in the factory or at the construction site and whose protective qualities must be equal to the pipes of which they are component parts.

### 3.2.16.4.1 Material

The steel for the pipes and fittings shall have a minimum ultimate strength of 350 N/mm<sup>2</sup>, a reduction of 10% maximum is accepted for the welding connections. It must be suitable for gas welding and for electric arc welding.

Dimensions: The following outside diameter “d” and minimum wall thickness “s” of all pipes and fittings are to be provided.

**Table 3-7 Dimensions of Steel Pipes Grade X 42**

| Nominal Diameter<br>(mm) | Outside Diameter, d<br>(mm) | Wall Thickness, s<br>(mm) |
|--------------------------|-----------------------------|---------------------------|
| 100                      | 114.3                       | 4.78                      |
| 125                      | 141.3                       | 5.56                      |
| 150                      | 168.3                       | 5.16                      |
| Nominal Diameter<br>(mm) | Outside Diameter, d<br>(mm) | Wall Thickness, s<br>(mm) |
| 200                      | 219.1                       | 7.04                      |
| 250                      | 273.0                       | 7.80                      |
| 300                      | 323.9                       | 8.38                      |
| 350                      | 355.6                       | 8.74                      |
| 400                      | 406.4                       | 9.25                      |
| 500                      | 508.0                       | 7.92                      |
| 600                      | 609.6                       | 8.74                      |
| 700                      | 711.2                       | 9.52                      |
| 800                      | 713.1                       | 11.5                      |

The pipes are to be provided according to DIN 2458 and EN 10224, high tensile, spiral welded.

### 3.2.16.4.2 Joints

#### 3.2.16.4.2.1 Socket & Spigot Joints

Joints shall be slip joints (socket and spigot), joints shall meet all radiography, X-ray, thickness, dimension, mechanical and other requirements of DIN.

The thickness of the slip joint, which must be part of the pipe, shall be greater than or equal to the pipe thickness.

The joint shall be welded externally in the field and shall be completed internally by a rubber ring built into the socket. The length of the socket shall be such that the rubber ring does not undergo any damage during the field welding operation.

The jointing ring shall be of ethylene propylene rubber (EPDM) or styrene butadiene rubber (SBR) to an approved shape and shall be securely fitted, by gluing in the plant into the sockets against the cement mortar lining.

All welded and flanged joints of steel pipes shall be protected and coated with the same coating material of pipes.

### **3.2.16.4.2.2 Flanged Joints**

As welding on flanges; from DN 100 up to DN 150 according to DIN 2633, and from DN 200 up to DN 700 according to DIN 2632.

### **3.2.16.4.2.3 Screwed Connections**

With bolts and nuts of steel galvanized according to DIN EN 24016/24034 and gaskets of rubber according to DIN EN 1514-1, min  $s = 3$  mm, fibre reinforced for PN16, steel reinforced gaskets for PN25 and PN40.

### **3.2.16.4.2.4 Elbows**

According to DIN 2605 with a radius  $R = 1.5d$ .

### **3.2.16.4.2.5 Welded Connections**

As built seams: both ends prepared with bevels; to be welded with root, intermediate layer and covering layer.

With sleeves: both ends of the pipe or fitting prepared square, with cement mortar lining flush to ends; fillet welds with root, intermediate and covering layer.

### **3.2.16.4.3 Coating**

#### **3.2.16.4.3.1 Internal Coating**

Welded steel pipes and fittings shall be sand blasted and lined with approved epoxy powder coating minimum of  $60\mu\text{m}$  according to DIN 30677 Part 2 which shall be odourless and tasteless suitable for the passage of chlorinated potable water 0-5 ppm  $\text{Cl}_2$ . Any coating material must have the approval "Used for drinking water".

#### **3.2.16.4.3.2 External Coating**

External coating of buried steel pipes and fittings shall be polyethylene sheathing (reinforced type) according to DIN 330670, designation: Reinforced sheathing.

The polyethylene sheathing shall be applied at manufacturers works (Plant) extruded and melted on and homogeneous to steel pipes with API 5L-X42 for buried installation.

Between the polyethylene sheathing and the pipe steel there shall be an adhesive film which is applied Electro-statically.

The polyethylene sheathing shall be made continuous extrusion and adhesive films shall be firmly bonded to the steel surface. The coating shall be spark-free when tested with a detector at 25,000 volts. The minimum coating thickness shall be 3.0 mm for pipes up to DN 500 and 3.5 mm for pipes of  $\text{DN} > 600$ .

In addition to test to DIN 30670 for coating and coating materials, the coating shall be tested for cathodes disbanding. The polyethylene coating shall be capable of operating at a continuous temperature up to 50 C without any effect on coating and bonding. The polyethylene and adhesive shall stop at a distance of 100 mm plus the insert of the pipe for the spigot and 100 mm for the end of the socket of the pipe.

The internal and external coating for bevel-ended pipes shall stop 150 mm from each end of the pipes.

### 3.2.16.4.3 Steel Pipes, DN 15 to DN 80

These pipes are to be provided in galvanized milled steel (GMS) according to DIN 2441 threaded at both ends, standard length 6.0 m, threads according to DIN / EN.

### 3.2.16.5 High-Density Polyethylene Pipes (HD-PE)

HDPE pipes shall be according to DIN 8074 / 8075, PN 16 and 19 533, with working pressure 20°C, resistant against UV radiation and frost. They may be delivered in coils, on reels or in rigid tubing up to a diameter of ISO 125 mm. Pipes delivered in rigid tubing shall be of 5,60m max. length in order to fit into 20 ft containers. The inner diameter of pipe coils depends on the outside diameter of the pipes and has to conform to the requirements defined by the manufacturer. Material of pipes must be PE100.

HDPE pipes shall be in black colour with blue stripes and must be marked with producer, type, pressure and production date as well as length of each coil (if applicable) printed on each pipe.

Diameters and minimum wall thickness of HD-PE pipes are specified below (in mm):

**Table 3-8 High Density Polyethylene Pipes - Dimensions**

| Nominal Diameter (mm) | External Diameter (mm) ISO | Wall Thickness (mm) |
|-----------------------|----------------------------|---------------------|
|                       |                            | PN16                |
| 15                    | <b>20</b>                  | <b>2.3</b>          |
| 20                    | <b>25</b>                  | <b>2.8</b>          |
| 25                    | <b>32</b>                  | <b>3.6</b>          |
| 50                    | <b>63</b>                  | <b>7.1</b>          |
| 100                   | <b>125</b>                 | <b>11.4</b>         |

HDPE pipes shall be resistant against UV-radiation and shall have black colour with blue stripe indicating PN10, and red stripe indicating PN16. Pipes shall be marked with dimension, and running meters, producer, type and pressure nominal.

**Table 3-9 Standard Length of Rolls of HDPE Pipes shall be as follows**

| HDPE ISO | Pipe length on roll [m] |
|----------|-------------------------|
| 20       | 100                     |
| 25       | 100                     |
| 32       | 100                     |
| 63       | 50                      |
| 125      | 50                      |



### 3.2.16.6 Galvanized Milled Steel (GMS) Pipes

Galvanized milled seamless steel pipes shall be heavy duty and comply with DIN 2441, ISO 65 or BS 1387, standard length 6 m, with threaded ends. The threaded end shall be protected against damage.

Supply and installation shall include for all cutting, threading, jointing and for all fittings and accessories necessary for laying and installation as shown in the Drawings.

Dimensions shall be according to DIN 2441 as follows or according to equivalent standards as indicated on the Drawings

**Table 3-10 GMS Pipes - Dimensions**

| Nominal Diameter<br>(mm) | External Diameter<br>(mm) | Wall Thickness<br>(mm) |
|--------------------------|---------------------------|------------------------|
| 15                       | 21.3                      | 3.2                    |
| 20                       | 26.9                      | 3.2                    |
| 25                       | 33.7                      | 4.0                    |
| 50                       | 60.3                      | 4.5                    |

The galvanization shall be by hot dip zinc process according to DIN 1706 and shall satisfy the copper sulphate test procedure according to DIN 50952, also prescribed in Appendix C of BS 1387 latest addition.

### 3.2.16.7 Lining of Pipes and Fittings

Pipes and all joining elements, fittings, valves, equipment etc., must be protected against corrosion both internally and externally. Interior and exterior protections in general have to be in faultless conditions before the pipes are laid. If necessary, the Contractor will renew the protections without waiting for a request by the Supervisor. Otherwise the Supervisor has the right to refuse pipes with defective protection.

External protective linings must adhere firmly to the surface of the base material, fully enclose the same and protect it effectively against the influence of the soil or generally against any other environmental influence.

All interior linings must have food quality and transfer neither taste nor smell or colour to the water they transport. The Contractor must supply a confirmation of non-toxicity of the linings.

In addition, inner linings must have a smooth and even surface and effectively protect the pipes against water corrosion, even if the water is aggressive. Linings are to be applied by centrifugation. The use of bituminous paints is strictly forbidden.

Linings must be applied to surfaces which are dry, degreased and show no evidence of mill scale or fine rust.

The following linings are to be used; other linings may be used if their quality and properties are at least equivalent to those specified below.

### **3.2.16.7.1 Ductile Iron Pipes**

Cast iron pipes have to be carefully sandblasted before lining.

#### **3.2.16.7.1.1 External protection**

Zinc spray coating with minimum 200g/m<sup>2</sup> and adhesive bituminous coat for tropical zones with 0.1 mm thickness for Class K9 pipes.

Zinc aluminium coating (85%-15%) with 400g/m<sup>2</sup> and epoxy finishing coat for class C30 and C40.

#### **3.2.16.7.1.2 Internal Protection**

Cement mortar CHF for zero- or low water aggressiveness

Alumina cement mortar for very aggressive water

DN80 - DN300 : 3 mm; above DN300 : 5 mm

### **3.2.16.7.2 Steel Pipes (laid above ground)**

Pipes have to be carefully sandblasted before lining.

#### **3.2.16.7.2.1 External Protection**

either: + one coat of polyethylene, minimum thickness of the coat is 40 % of the thickness of the pipe. The polyethylene shall have an electrical resistance of 40 kV/mm

or: + one coat on the basis of synthetic resin

application in the factory: 2 coatings of 5 m<sup>2</sup>/kg of an anti-rust primer

application before installation: 2 coatings of 5 m<sup>2</sup>/kg, second coat in a colour accepted by the Supervisor

#### **3.2.16.7.2.2 Internal Protection:**

either: + special coat on the basis of epoxy resin (non toxic) (thickness minimum 300 microns)

or: + cement mortar ND80 - ND300: 3 mm and above DN 300: 5 mm

### **3.2.16.7.3 Steel pipes (underground)**

#### **3.2.16.7.3.1 External protection:**

- Primary adhesive coating on the basis of bitumen, coal pitch or synthetic resin on the sandblasted pipe
- one or several protective coatings on bitumen or coal pitch basis eventually reinforced
- one or several glass fabric or glass cloth reinforcements for each protective coating
- one solar protection coating

- minimum thickness of coatings is 4 mm on the pipe body and 2.5 mm on the seams

These protective coatings may be substituted by a self-adhesive band of rubber applied to the first bitumen coating.

#### **3.2.16.7.3.2 Internal protection:**

See pipes laid above ground.

#### **3.2.16.7.4 Hot-galvanized steel pipes**

Hot-galvanized components, especially steel and electro-galvanized pipes as well as flame-sprayed pipes must conform to current standards.

A minimum of 500 g/m<sup>2</sup> of zinc must be used both for internal and external protection.

#### **3.2.16.7.5 PVC and PE Pipes**

Apart from careful transport and backfilling of the trench no further protection is required. If pipes have to be laid above ground for technical reasons protection against ultraviolet rays is required.

#### **3.2.16.7.6 Steel or Cast Iron Fittings**

Before lining couplings have to be sandblasted or steel shot abraded.

##### **3.2.16.7.6.1 External protection:**

Epoxy powder coating according to standard, see above.

The external coating must be made good after welding of pipes with an internal and external coating with epoxy powder painting according to standard.

##### **3.2.16.7.6.2 Internal Protection**

Either + by special pure epoxy resin-based lining (non-toxic) applied hot to sandblasted or steel shot abraded beforehand (minimum thickness 300 micron)

Or + by CHF cement mortar for waters with zero or low aggressiveness

|      |   |                |           |
|------|---|----------------|-----------|
| +    | by alumina cement mortar for very aggressive waters | DN 80/DN 300:  | 3 mm      |
| min. |   | above DN 300 : | 5 mm min. |

#### **3.2.16.8 Pipe joints**

See chapters above.

##### **3.2.16.8.1 Ductile Iron Pipes**

Either: push-in joints with TYTON-rubber gasket or similar. If requested self-anchoring push-in joints (TYTON SIT gasket or TYTON TIS-K with retaining ring)

Or: flanged joint connection with rubber or elastomer gaskets according to ISO4633-1996 (for drinking water). For the primary network the gaskets shall be steel reinforced.

### **3.2.16.8.2 Steel Pipes**

Flanged joint connection or socket joint connection with rubber or elastomer gaskets.

If welding is necessary (only with Supervisor's consent) the Contractor will duly make sure that interior linings are properly repaired after welding. Pipes shall be designed in such a way as to allow easy retro-fitting of interior linings after welding.

#### **3.2.16.8.2.1 Galvanized Steel Pipes**

Connection by means of threaded connection.

#### **3.2.16.8.3 Rigid PVC Pipes**

Non-bonded socket connection push-in joint with rubber or elastomer gaskets, or flanges with rubber gasket.

#### **3.2.16.8.4 HD-PE Pipes**

- Cast iron fittings for polyethylene tubes with anchor and support gasket for connection with pipes or fittings in other material.
- Welded connection for PE-pipe connection

### **3.2.16.9 Shipping, Packaging, Protection**

PVC, HD-PE and galvanized steel pipes and other equipment will be shipped in 20 ft welded containers only.

All cast iron or steel pipes to be shipped in bundles in order to facilitate handling, with wrappings suitable for conditions of transport and adequate protection, according to DIN / EN delivery standard.

Ductile cast iron and steel pipes shall be delivered with a plastic stopper at each end of the pipes.

Handling and storage on site must conform to manufacturer's recommendations and standards. Open-air interim storage of cast iron pipes is permissible if proper positioning is maintained; lined steel pipes as well as PVC and HD-PE pipes must be protected against sunlight.

Materials delivered will be accepted only if proper storage provisions have been made and if equipment which was damaged during shipment is either repaired or replaced.

Generally and unless otherwise specified, containers shall be sealed on leaving the factory and opened only at their final point of destination without opening of the packaging at the port of arrival. Containers therefore have to bear distinctive labels specifying the project they belong to.

### **3.2.16.10 Specifications for Hydraulic Equipment and fittings**

Hydraulic equipment and fittings must conform to specified models and fulfil the conditions of these technical specifications. Moulded parts must have perfect outer surfaces without chips and must be finished by means of debarring or filing.

Connecting surfaces of all flanges have to be machined. Flanges must also have one or several

circular grooves in order to facilitate grip.

All surfaces which are subject to friction must be machined, bore holes in covers, blind flanges, and flanges which connect pipes have to be produced by means of drills. Manual precision grinding of valve seats and surfaces of sluice valves is required for purposes of stability and accurateness of shut-off elements. Threads of spindles must be machined with straight edges, and have no defects or scarcity of material.

Manufacturer's marks, flow diameter and an arrow indicating flow direction must be visible on the device's outer surface.

Punched or forged special elements will have this information stamped upon them.

### **3.2.16.11 Flange Connection**

All technical characteristics concerning flanges, machining, diameters, properties of connecting elements, contact surfaces have to conform with ISO 2531 for cast iron pipes and ISO 2584 for steel pipes.

For any other flanged connection, see chapters above.

Flanges will be supplied complete with bolts and nuts and gaskets. Flanges and all other pipe fittings and valve equipment must be able to withstand pressures to which they will be subjected especially when tested at the construction site.

All flange accessories (bolts) must also withstand test pressures. Bolts must be galvanized, have threads and their diameters must conform to standards.

Contractors must check before delivery for completeness before dispatching them with special attention to the quality of the equipment and drilling templates in order to assure that the components of pipelines, pipe-fittings and valves of each lot are complete and that all components of one lot belong together.

### **3.2.16.12 Bolts and Nuts**

All bolts and nuts necessary for assembly shall be according to EN 24016 / EN 24034, furnished together with the equipment and conform to the standards which apply to the said equipment.

Bolts and nut have to be protected against corrosion and:

either be made of stainless steel or or have surface protection (zinc- or cadmium plating)

### **3.2.16.13 Blind Flanges**

#### **3.2.16.13.1 Ordinary Blind Flanges**

Pipe end shall be covered with blind flanges (round pieces) made of the same material as the pipes and drilled in the way specified above for flanges. The blind flanges shall be epoxy powder coated, as well.

Deliveries will include sealing equipment and bolts for assembly. Blind flanges will have the same corrosion protection as pipes.

### **3.2.16.13.2 Blind Flanges with Central Boss and Threads**

Apart from the properties of flanges described above these flanges shall have a central reinforced part with a threaded orifice with 63 (DN50) or for larger 114 mm (DN100 St) diameter and 30 mm minimum length.

These flanges must be machined and supplied complete with stopper.

The contractor must procure or design and manufacture the piece locally according to the above specifications; different solutions shall, however, be acceptable.

The threaded flanges shall be epoxy powder coated as well.

### **3.2.16.14 Installation Devices, Gaskets, Joints etc.**

These devices are to be supplied according to type and number of joints required by the Contractor for the delivered goods, with a minimum reserve of 10 %. Delivery shall also include additional fittings which are cut at the construction site, installation equipment, welding rods etc.

Gaskets must be made of "drinking water quality" elastomer, flat gaskets shall be fibre reinforced for PN16 and steel reinforced for PN25 and PN40.

### **3.2.16.15 Valves and Accessories**

#### **3.2.16.15.1 General**

Valves and accessories must conform to current EN, DIN standards or ISO standards with respect to nomenclature, classification, symbols, and conditions of manufacturing, properties and tolerances, conditions for the preparation of specimen, test rules, identification labels and acceptance clauses.

Moulded pieces must have perfect outer surfaces without chips and must be finished by means of debarring or filing.

Connecting surfaces of all flanges have to be machined. Flanges must also have one or several circular grooves in order to facilitate grip. All surfaces which are subject to friction must be machined; bore holes in covers, blind flanges, and flanges which connect pipes have to be produced by means of drills. Manual precision grinding of valve seats and surfaces of sluice valves is required for purposes of stability and accuracy of shut-off elements.

Operating stems must be made of stainless steel. They must be machined complete with straight edges and show no defects or scarcity of material. Toric ring seals must be used for sealing.

Seal bush must be replaceable under pressure.

Manufacturer's marks, flow diameter and an arrow indicating flow direction must be visible on the device's outer surface.

Punched or forged special elements will have this information stamped upon them.

Before materials are accepted or used the Contractor may be required to supply the Supervisor with a sample piece of every hydraulic equipment, fitting, valve and accessory, etc.... that he wishes to install.

All shut-off devices shut in a clockwise sense. This will be indicated by 'O' (open) and 'C' (closed) with arrows either on the hand wheel or the head of a piece. Operation of shut-off devices must be easy both for opening and closing. All valves will be flanged.

The following nominal pressures are stipulated:

**Table 3-11 Nominal Pressure**

| Nominal pressure | Pressure Test |                |
|------------------|---------------|----------------|
|                  | body          | seat (sealing) |
| 10 bar           | 16 bar        | 10 bar         |
| 16 bar           | 25 bar        | 16 bar         |

### 3.2.16.15.2 Valves

#### 3.2.16.15.2.1 Sluice Valves (gate valves)

Resilient Seated Gate Valves with smooth straight-through bore for use with water pipelines shall be made of ductile cast iron EN-GJS-400-18 / EN-JS 1030 according to EN 1563 (GGG 400 – DIN 1693) and EN 558-1 GR 14-short, (DIN 3202 F 4), smooth straight-through bore, wedge gate encapsulated with vulcanized EPDM, inside and outside epoxy powder coated according to DIN 30677-T2 in accordance with DIN 3476 and all quality and test requirements of RAL quality mark 662, suitable for under-ground installation, suitable for nominal working pressure of 16 bars, according to Drawings, Specifications and Bill of Quantities.

Resilient Seated Gate Valves shall be provided with suitable non-rising stainless steel spindles (St 1.4021 / X20Cr13).

The wedge shall be made of ductile iron EN-GJS-400-18 according to EN 1563 (GGG 400 – DIN 1693), inside and outside fully rubberised with vulcanised of elastomer, suitable for potable water, with drain hole. The wedge guide shall be of wear resistant plastic with high gliding features; optimally placed design guarantees lowest wear and tear and lowest closing torques; the wedge nut shall be of dezincification resistant brass CuZn36Pb3As, generous over sizing of the required thread length in the wedge nut shall guarantee highest possible breaking torques; O ring bush of Ms 58; O rings of elastomer, suitable for potable water, embedded in non-corrosive material (according to DIN 3547-T1) and replaceable under pressure (according to ISO 7259); Back seal of elastomer, suitable for potable water; Allen screws St 8.8 DIN 912 (body) shall be absolutely corrosion protected by being sunk into the body and sealed, and by passing through bonnet gasket.

Extension spindles shall be galvanised steel and the associated guide brackets shall be of approved type (PE) and shape, manufactured from fabricated steel (galvanized after manufacture). All universal joints shall be supplied and installed in accordance with the details stated on the Drawings and in the Bill of Quantities.

Sluice valves shall be flanged to DIN 28605, drilled to EN 1092-2 PN16 and DIN 2501 – PN25.

Minimum life cycle shall be 250 cycles according to DIN 1074.

Hand wheels shall be suitable for particular valves, epoxy powder coated and have closing

and opening indicators.

### 3.2.16.15.2 Butterfly Valves

Butterfly valves shall be according to DIN and EN 593, double eccentric type with face to face dimensions to EN 558-1 GR 14-short (DIN 3202-F4), flange dimensions and drilling to EN 1092-2 PN 16, PN25 and PN40 (DIN 28605 / DIN 2501) and shall be suitable for a nominal working pressure of 16, 25, 40 bars as specified.

Body and disk shall be of ductile iron EN-GJS-400-18 / EN-JS 1030 acc. to EN 1563 (GGG 400 - DIN 1693) and shall be inside and outside epoxy powder coated with a minimum coating thickness of 150µm. Buried valves shall be inside and outside epoxy powder coated complying in general with DIN 30677 Part 2, coating thickness shall be minimum 250µm, freedom from imperfections shall be tested by high-voltage method.

Shaft, body seat, bolts and pins shall be made of stainless steel 304 (minimum 1.4021) (or 316 (minimum 1.4462)) or body seat wear nickel welded overlay, micro finished.

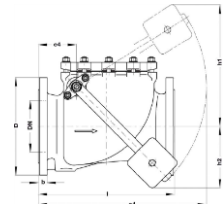
Endless profile sealing ring and O-rings shall be of EPDM or NBR suitable and approved for potable water.

All butterfly valves shall be equipped, if not otherwise requested in the bill of quantity, with gear box and hand wheel.

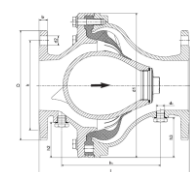
### 3.2.16.15.3 Non-Return Valves

Non return Valves shall be with face to face dimension to EN 558-1 GR 48 (DIN 3202 part 1 - F6), flange dimensions and drilling to EN 1092-2 PN 16, PN25, PN40 (DIN 28605 / DIN 2501) and shall be suitable for a nominal working pressure of 16, 25, 40 bars as specified.

Body and disc of ductile iron EN-JS 1030 (GGG 40), fluidised bed epoxy powder coated inside and outside to DIN 30677-Part 2 in accordance with the quality and test requirements of RAL-Quality Mark 662. The coating thickness shall be minimum 250µm freedom from imperfections shall be tested by high-voltage method. The shaft, all bolts, nuts and washers shall be made from stainless steel. The disc gasket made from EPDM. They are equipped with a ductile iron removable top mounted with bolts and stud bolts and give access to the flap.



For special applications (e.g. reduction of water hammer effects) in pump stations, diaphragm non return valves with rubber membranes instead of flaps or steel-reinforced disks shall be used - as indicated in the drawings and the BoQ. Working pressures are standardized to PN16, PN25 and PN40.



### 3.2.16.15.4 Air Valves

#### 3.2.16.15.4.1 Single Air Valve DN 50

Air Valves shall be single automatic air valves, PN 16, with body/bonnet of Acetal with PE shield for UV protection as specified on the Drawings.

Air Valves shall be either with DN 50 female thread or with Flange DN 80 in accordance with



the details stated on the Drawings and in the Bill of Quantities

#### **3.2.16.15.4.2 Double Air Valve DN 100**

Double orifice air valves shall be of the triple function type with a flanged inlet to EN 1092-2 PN 16 (or 10) (DIN 28605 / DIN 2501/BS 4504) and shall be suitable and approved for the use with potable water at a nominal working pressure from 1 to 16 bar.

Body and cover shall be of ductile iron EN-GJS-400-18 acc. to EN 1563 (GGG 400 - DIN 1693) and shall be inside and outside epoxy powder coated complying in general with DIN 30677 part 2, coating thickness shall be minimum 250µm, freedom from imperfections shall be tested by high-voltage method.

Orifice and float balls shall be of corrosion free material (stainless steel or plastic), all seals shall be of EPDM or NBR suitable and approved for potable water.

#### **3.2.16.15.5 Float Valves (Level Control Valve)**

Float valves shall be made of GG-500, epoxy powder coated, elbow type, with flange connections as specified on the Drawings and in the Bill of Quantities.

Piston, gear and floater shall be stainless steel.

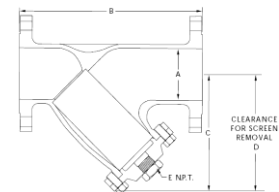
The flanges of the float valves shall be drilled to DIN 2501 - PN 16.

#### **3.2.16.15.6 Strainers**

Strainers shall be made of GG-250, epoxy powder coated, with flange connection as specified on the Drawings and in the Bill of Quantities.

The screen of the strainer shall be stainless steel mesh. Max mesh size: DN50-100 1.2mm; DN $\geq$ DN100 3.2mm.

The flanges of the strainers shall be drilled to DIN 2501 - PN 16



#### **3.2.16.15.7 Screens**

Screens for Reservoir outlets shall be made of GG-250, epoxy powder coated, with flange connection, without non-return valve, as specified on the Drawings and in the Bill of Quantities.

The screen of the strainer shall be stainless steel.

The flanges of the screens shall be drilled to DIN 2501 - PN 16

#### **3.2.16.15.8 Bulk Meters**

The body of bulk meters shall be made of GG-400, epoxy powder coated, with flange connection. The flanges shall be drilled to DIN 2501 - PN 16 (for pumping mains of the primary system PN 25/40 are required accordingly).

The meter shall be a Woltmann type meter with interchangeable mechanism. It shall be of approved metrological Class B according to EEC 75/33 standards.

The body shall be outside and inside epoxy powder coated (minimum thickness 200 micron).

The dialler shall be connected with a magnetic coupling. Working temperature 30°C with

security up to 50°.

Clockworks shall be under vacuum with glass cover and copper capsule IP 68, and shall be able to rotate by 360°.

The meters shall be pre equipped for impulse emitter.

### 3.2.16.15.9 Surge Valve (Water Hammer protection Valve)

For protection from water hammer impacts in case of sudden shut-off of pumps (e.g. electricity cut-off), each pumping main pipe shall be equipped with a Surge Valve that cuts off overpressures.

The Surge Valve shall be an instantaneously opening, steel spring supported diaphragm valve, suitable for potable water at max operating pressures PN 16 or PN 25, PN40, for a working temperature of up to 60°C. Flanges drilled acc. to EN 1092-2 and ISO 7005-2 to ISO PN 16 or PN 25, PN40.

Surge valves  $\geq$ DN150 pilot valve controlled.

Valve body (1) and bonnet (2+3) made of ductile iron EN –GJS 450-10 / cast iron EN –GJL 250 - acc. to EN 1561 and EN 1563, internally and externally epoxy powder coating. Spring (9+16) made of steel. Valve seat (6+13) and valve disc (7+14) made of polyurethane / carbide – insensitive to abrasion. Diaphragm (8+15) made of textile reinforced chloroprene. Steel-made fine-adjustment key (10) lockable. With pressure gauge / pressure sensor isolating valve (11).

Dimensioning of size, position and opening pressure of the surge valve shall be made by the Contractor, who shall also submit his detailed calculation of pressure surge- / water hammer effects – all for approval by the Engineer (dimensioning based on flow rate, working pressure, pipeline length, -DN, -material, -profile and pumps' characteristics)

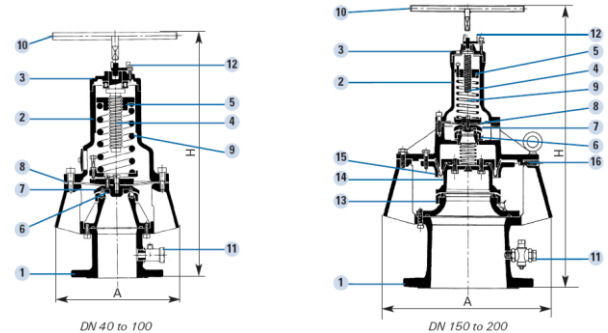
The surge valve shall be installed on a T-piece installed to a branch line from the pumping main (washout). For maintenance purpose it shall be isolatable from the T-piece by a gate valve. Water overflowing from the surge valve shall be collected in a chamber for proper drainage from the site.

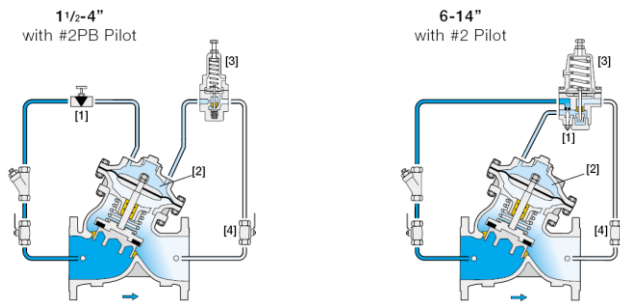
All surge valves must be dimensioned and adjusted accordingly by the manufacturer through a surge calculation carried out by the manufacturer of such valves.

### 3.2.16.15.10 Pressure Reduction Valve (PRV)

Pressure reduction valves shall be provided with diaphragm made of CR/polyamide fabric or EPDM. Control pipes shall be made of high-grade stainless steel. Body shall be made of ductile cast iron, internally and externally epoxy powder coating. Instead of pressure gauge assemblies, pressure sensors (for data transmission to SCADA) shall be installed with ball valves at the inlet and the outlet side. Pressure sensors at the inlet shall be for range 0-25 bar and at the outlet shall be for range 0-16 bar.

Secondary pressure shall be adjustable for range from 1 to 15 bar.





### 3.2.16.16 Hydrants

#### 3.2.16.16.1 Below ground fire hydrants

Below ground fire hydrants and their surface boxes shall conform to DIN 3221 PN 10/16, to DIN 2501 Part 1 and to the requirements of the appropriate local authority responsible for fire fighting.

It is foreseen to install the hydrant in an assembly consisting of the hydrant-T Piece, connection fittings, gate valve inclusive extension spindle, duckfoot bend, double flanged extension pipe of DI in specified length of 50 to 100 cm , and road surface chamber. Lengths of below ground fire hydrants are indicated in the Drawings and 'Bill of Quantities'.

Above ground fire hydrants shall have two (2) outlets suitable for the connection of hose pipes as required by the local authority responsible for fire fighting.

Hydrant bodies shall be of gray cast iron or ductile cast iron and shall be properly corrosion protected by bituminous painting. Hydrant spindles shall be of stainless steel or high tensile brass. Spindle nuts and body seating shall be of gunmetal or high tensile brass. Screw-down valve seats shall be of the resilient type. Stem caps shall be of cast iron and suitable for tee key operation. Hydrants shall show no visible leakage when pressure tested in accordance with the approved standards.

#### 3.2.16.16.2 Above ground fire hydrants

Above ground fire hydrants, type 'rigid', shall conform to EN 14384, EN 1074-6 Tested acc. to ÖVGW /DVGW, max. working pressure 16 bar, and to the requirements of the appropriate local authority responsible for fire fighting.

Standard Pipe-Cover: 1.00 m

It is foreseen to install the hydrant in an assembly consisting of the hydrant, T-Piece and connection fittings, gate valve, and duck foot bend. Lengths of above ground fire hydrants shall be for a standard pipe cover of 1.00 m.

Above ground fire hydrants shall have two (2) outlets according to BS 336, suitable for the connection of hose pipes as required by the local authority responsible for fire fighting.

British standard BS 336 specifies a 2½" (65mm) instantaneous



connection 2½" couplings are available with hose tails.

Hydrant head shall be of gray iron or ductile cast iron and shall be properly corrosion protected with epoxy powder and UV resistant coating in RAL 3000, according to DIN 1843.

Hydrant stand pipe shall be of steel tube steel 1.0037 galvanized, UV resistant coated RAL 3000, fire-red.

Operating controls and all inner parts shall be all stainless steel or corrosion free. Hydrant head to be turned from 0° to 360°.

Automatic drain off system with pressure control, drain time less than 10 min, drain outlet connection possible with HDPE pipe ISO32 (DN25)

Hydrant head shall be grey iron (EN 1503-3) and painted in fire-red colour RAL 3000.

### **3.2.16.17 House Connections and Public Taps**

#### **3.2.16.17.1 House Connections**

Customer Connections shall be installed with materials as specified above according to DIN, EN and ISO Norm, in Galvanized Milled Steel or HDPE.

Connections to the distribution system shall be made with pipe saddles corresponding with the main pipe's material and outside diameter.

Drillings shall be made with special equipment, specially designed pipe drilling machines for under pressure drilling.

The Invert level of the connection pipe shall be 90 cm minimum below the surface, if required the connection has to be lowered to the required depth.

The Customer Water Meters shall be generally installed inside a compound (in the basement or a separate chamber), on a "Goose Neck" including stop cock. Chambers shall be constructed in concrete and equipped with cast iron covers. The water meters shall be sealed with a copper wire and lead seal.

#### **3.2.16.17.2 Pipe Saddles**

Pipe saddles for under pressure drilling shall be of the Universal Type with flexible strap for DI, DI, Steel and AC pipes PN 16, for PE and PVC pipes the pipe saddles shall be of the HAKU Type or similar, and shall be suitable and approved for the use with potable water at a nominal working pressure of 16 bar.

The outlet of the saddle shall be female thread and specially protected to avoid corrosion and incrustation.

The body of the pipe saddle shall be of ductile iron EN\*-GJS-400-18 acc. to EN 1563 (GGG 400 DIN 1693), inside and outside epoxy powder coated complying in general with DIN 30677 part 2, coating thickness shall be minimum 250µm, freedom from imperfections shall be tested by high-voltage method.

Saddle strap and bolts/nuts/washers shall be made of stainless steel 304 (minimum 1.4021) or 316 (minimum 1.4462). Strap shall be rubber lined to avoid direct contact between the stainless steel strap and the pipe.

Gaskets shall be of EPDM or NBR suitable and approved for potable water.

### **3.2.16.17.3 Service Valves**

Service Valves shall be suitable for a direct mounting on the pipe saddle and shall allow a temporary shut-off of the house connection line in case of emergency.

Service valves shall be of the resilient seated gate valve type with a male thread inlet for connection to the pipe saddle and an integrated or adopted restraint push-on outlet for connection to HDPE pipes according to DIN 8074/8075 and female threads for GMS pipe connection, and shall be suitable and approved for underground installation and for the use with potable water.

Valve bodies shall be of GG 250, the bonnet of GGG 400, epoxy powder coated, and non-rising stainless steel spindle (1.4021). The sealing of the restraint socket for connection to HDPE pipes according to DIN 8074/8075 shall be done by an O-ring made from EPDM or NBR (suitable and approved for potable water), grip ring shall be of Poly-acetate.

The service valves shall be installed with an appropriate Extension Spindle made of steel with PE-protection tube to the street surface, additionally protected by a PVC pipe and a service valve surface box.

### **3.2.16.17.4 Electrofusion Connections**

#### **3.2.16.17.4.1 General**

Connection design, limitations and manufacturer's joining procedures must be observed. Tools and components required to install joints shall be in accordance with the best installation practices and manufacturer's recommendations all in accordance with e.g. ASTM – F 1055-98 Standard Specifications for electro fusions type polyethylene fittings "for outside diameter controlled polyethylene pipe and tubing". However, field connections shall be controlled by and are the responsibility of the field installer, and shall be performed by, or under the supervision of experienced personnel provided by the pipe manufacturer or distributor (proof of personnel qualifications shall be provided by the Contractor by means of an official certificate from a certified trainer, upon request by the Engineer) with proper equipment in addition the procedures recommended by Plastic Pipe Institute (PPI) shall be taken into consideration.

#### **3.2.16.17.4.2 Electrofusion Jointing**

Electrofusion fittings, saddles, tees, connectors and Elbows shall be produced from polyethylene material (designation PE 100) PN16 colour black and comply with ISO 4427/1996 or equivalent and shall be installed in accordance with the requirements of the manufacturers instructions using appropriate jointing welding equipment.

#### **3.2.16.17.4.3 Fusion Compatibility**

Compound designated PE 100 having MFR (190°/5 kg) within the range 0.2g/10 min. to 1.3g/10 min. shall be considered compatible for fusion to each other.

Polyethylene fittings designed as PE 100 PN16 shall be used to join pipes with different designations.

- 1) All fittings shall be injection moulded from recognized top quality resin PE 100 complying with ISO 4427/1996.
- 2) All fittings must be packed in such a way to allow instant use on site without additional cleaning.
- 3) No heating coil may be exposed and is to be fully imbedded into the body of the fitting for protection purposes during assembly.
- 4) All fittings must have moulded-in identification and product information.
- 5) A limited path style fusion indicator as visual recognition of completed fusion cycle shall be incorporated into the body of the fitting.
- 6) Quality control test results regarding “Wire temperature coefficient” and “Heating element and wire resistance” shall be provided by manufacturer.
- 7) All fitting shall have barcodes.
- 8) The pipe and fittings shall be of the same material.
- 9) Contractor shall provide certificates from manufacturers on the pressure rating for the electrofusion connection to be at least PN16.

#### **3.2.16.17.4.4 General Procedures**

The component ends and surfaces to be connected must be clean, dry and free of detrimental surface defects before the connection is made.

#### **3.2.16.17.4.5 Cleaning**

Before joining, and before any special surface preparation, surfaces must be clean and dry.

General dust and light soil shall be removed by wiping the surfaces with clean, dry, lint free cloths. Heavier soil shall be washed or scrubbed off with soap and water solutions, followed by through rinsing with clean water, and drying with dry, clean, lint free cloths.

#### **3.2.16.17.5 Domestic Water Meters**

Domestic water meters for DN 15 (½”) and DN 20 (¾”) shall be of the single jet meter type, metrological class B and shall be approved according to EEC 75/33 standards. The meter body shall be made of casted brass (OT58). Body shall be epoxy powder coated.

Roller counter design for single jet meters: 4 black digits before the point, 3 red digits and one counter-wheel behind the point, and one low flow indicator. Roller counter further prepared for afterward installation of Reed- or Radio modules.

Domestic water meters for DN 25 (1”) to DN 50 (2”) shall be of the multi jet full dry meter type, metrological class B and shall be approved according to EEC 75/33 standards. Internal filter must be exchangeable without dismounting the meter. Body shall be epoxy powder coated.

Roller counter design for multi jet meters: 5 digits black, 4 pointers red and one low flow indicator. Roller counter further prepared for afterward installation of Reed- or Radio modules. Roller counter repairable.

For all meters the nominal working pressure (PN) shall be 16 bars. The meters must comply

with Jordanian National standards.

Dimensions shall be as follows:

**Table 3-12 Domestic Water Meter Data**

|             |   |   |            |
|-------------|---|---|------------|
| DN 15 (½")  | Q <sub>n</sub> = 1.5 m <sup>3</sup> /h  | Q <sub>max</sub> = 3 m <sup>3</sup> /h  | L = 110 mm |
| DN 20 (¾")  | Q <sub>n</sub> = 2.5 m <sup>3</sup> /h  | Q <sub>max</sub> = 5 m <sup>3</sup> /h  | L = 130 mm |
| DN 25 (1")  | Q <sub>n</sub> = 3.5 m <sup>3</sup> /h  | Q <sub>max</sub> = 7 m <sup>3</sup> /h  | L = 160 mm |
| DN 32 (1¼") | Q <sub>n</sub> = 5.0 m <sup>3</sup> /h  | Q <sub>max</sub> = 10 m <sup>3</sup> /h | L = 160 mm |
| DN 40 (1½") | Q <sub>n</sub> = 10.0 m <sup>3</sup> /h | Q <sub>max</sub> = 20 m <sup>3</sup> /h | L = 300 mm |
| DN 50 (2")  | Q <sub>n</sub> = 15.0 m <sup>3</sup> /h | Q <sub>max</sub> = 30 m <sup>3</sup> /h | L = 300 mm |

### 3.2.16.17.6 Stop Cocks Upstream of Meters

The stop cocks shall have spherical taps with integrated passage and quarter turn opening.

#### Design characteristics:

Body: brass

Tap: anti-lime deposit material or metal with anti-lime lining

Seals: Teflon or Perbunan

Stem: brass

Handle: butterfly type, stainless steel

They must be designed for 16 bar working pressure.

### 3.2.16.18 Washouts

The types of Washout specified for this Contract, whether in concrete chambers or buried type, are as shown on the drawings. All Washouts shall be constructed as indicated on the drawings or as instructed by the Engineer.

If the flow cannot be discharged by gravity, manholes can also be constructed beside concrete wash-out chambers. Additional excavation and backfilling works shall be included in the unit rates of the washout.

The lengths of washout discharge lines may vary according to the location requirements on site and shall be agreed with the Engineer's Representative prior to installation. Discharge lines shall be paid for as per unit rates of pipelines included in the Bills of Quantities.

At place shown on the drawings or directed by the engineer, wash-outs shall be installed as follows:

- a) For ductile iron main pipeline, the Contractor shall install a suitable flanged tee (T) to install the flanged washout valve. The branch shall be ½ of diameter of the main pipe diameter.
- b) The washout shall have a gate valve installed directly at the branch from the main pipe and a flap valve at the end where necessary to avoid dirt or animals entering the washout pipe. The flap valve shall be protected by a small concrete wall as per

drawings.

- c) The wash-out pipes shall be extended to such a length and reach discharge area as is required for every particular site condition as not to flood the trenches or cause any damage to the surrounding area.

The unit rate washout pipe work shall include for the outlet structure and riprap, as shown on the standard drawings, unless noted otherwise.

### **3.2.16.19 Pressure Gauges**

Pressure gauges shall be installed at all pressure reducing valves upstream and downstream of the valve and at selected strategic points in the distribution system for monitoring pressure fluctuation. They shall be of the bourdon tube type with sensor (for positive and negative pressures) and transmitter for connection to a data logger specified hereunder. All moving parts shall be of stainless steel and shall comply with BS 1180. The dial face diameter shall be 160 mm and the accuracy class 1.6. The gauge must be suitable for a pressure range up to 16 bars, in pump station to 25 or 35 bars.

The installation of the gauge shall be complete and shall include the connecting fittings to the main pipe, the gauge inlet pipe with 3 way cock and screwed joints.

The output of the pressure sensor-transmitter equipment shall be analogue 4-20 mA, electrically insulated.

The Contractor shall install a pressure transmitter of appropriate range in the suction and delivery sides of each of the pumps.

Suitable provision shall be made in the pipe work to accept the pressure transmitter. The transmitter shall be of the electronic type and shall provide on Output a local analogue pressure indicator and a 4-20 mA signal for transmission to the SCADA outstation.

The local pressure indicator shall be supplied and installed by the Contractor.

Cabling between the transmitter and outstation shall be means of a screened twisted pair cable.

### **3.2.16.20 Dismantling Joints**

Dismantling joints shall be installed where indicated on the drawings for convenient installation or re-installation of valves or similar items.

For prevention of any movement of the pipe joints adjacent to closed valves, dismantling joints shall be provided in general by restrained dismantling pieces (short version) according to DIN 2541 or DIN 2547 or flanged adaptors (see 2.8) as indicated on drawings or as directed by the Engineer.

Body and glands of steel welded dismantling pieces shall be capable of standing a working pressure of 16, 25 and 40 bars (according to specs and drawings) with bolts and nuts of stainless steel. The surface protection shall be epoxy powder coating. Rubber sealing rings made of Perbunan material, nitrile rubber or equivalent quality shall be used.



### **3.2.16.21 Spare Flanges, Flange Adaptors, Couplings, Restrainer Clamps**

All spare flanges, flange adaptors and couplings made of GGG or GG shall comply with DIN equivalent ISO Norm and EN-GJS-400-18 / EN 1563 as indicated on the Drawings and in the Bill of Quantities.

Flanges shall be drilled to DIN 2501 / EN 1092-2 - PN 16 and PN25 where specified.

All flanges and couplings shall be epoxy powder coated according to DIN 30677 Part 2.

Seals shall be made of EPDM or NBR suitable and approved for potable water.

Restrained Flanges shall have a grip ring of steel for DI and ST pipes and a grip ring of Ms 58 (CuZn36Pb3) for uPVC pipes.

Wide range coupling or flange adaptors for Asbestos Cement / DI connections as indicated on the Drawings and in the Bill of Quantities.

Restrainer Clamps for UPVC pipes (socket to pipe) shall be epoxy powder coated, made of GGG with grip ring made of Ms 58 (CuZn36Pb3).

Couplings shall be made of Steel, epoxy powder coated, with sealing rubber rings and lock-head bolts.

For connection of the existing to the new pipeline system, flexible couplings shall be installed as indicated on the drawings or as directed by the Engineer.

### **3.2.16.22 Reinforced Concrete Chambers**

Cost of construction of reinforced concrete chambers shall be included in the unit price quoted for valves, air valves, bulk meters, pressure reducing valves and/or wash-out ....etc.

All external pipe work before entering and after exiting a reinforced concrete chamber shall be fitted with flexible joints at a minimum distance of 300 mm from the external face of the chamber.

Chambers of reinforced concrete shall be constructed for all valves with diameter > 200 mm, air valves in pipes with diameter > 200 mm, all bulk meters and pressure reducing valves.

Chambers and similar structures shall be built into the pipelines as demanded and in accordance with the standard drawings. Given dimensions on the drawings are to be verified by the Contractor so as to suit the pipe installation and the prevailing condition on site.

All chambers shall be placed on a blinding layer of concrete class C with a thickness of 10 cm. The chambers shall contain a pump sump of 40x40x30 cm in one corner of the chamber and shall facilitate appropriate drainage through the ground of the chamber.

Suitable supports for pipes, valves and any other fittings shall be placed at appropriate locations inside the chamber under the direction of the Engineer (even if not shown on the standard drawings). The entire pipe works of the water supply pipes inside the chambers shall only consist of DI.

Cast iron manhole covers with frames shall be installed for all chambers as specified or shown on the drawings. The manhole covers must be of circular shape only with a minimum internal diameter of 60 cm. The wording on each cover shall be agreed with and approved by the

Engineer prior to ordering.

Covers to be used in surfaces which are subject to vehicular traffic shall be tested for a load of 400 kN.

Manhole covers with bearing capacities of 400 kN and 250 kN according to DIN 1229 shall be installed as instructed by the Engineer.

Diameter of manholes (M.H) shall be as follows, if not otherwise indicated: Ø 800 mm

Two pairs of keys for use with each type of cover shall be handed over by the Contractor after completion of the Contract at no extra cost.

All appurtenance chambers shall be equipped with step irons, as indicated on the standard drawings of as directed by the Engineer.

Step irons shall be malleable cast iron, according to DIN 1211 galvanized iron or as directed by the Engineer.

Types of drainage for the chambers shall be according to the standard drawings or decided on site.

Penetration holes with G.S sleeve pipes shall be inserted in the ceiling slabs, details of which are shown on the standard drawings, so as to incorporate the extension spindles of the valves inside the concrete chambers.

Ventilation pipes of DN100 mm or DN150 mm as instructed shall be installed at the highest possible point in all valve chambers (considering traffic load) and lead to the nearest convenient outlet above ground. End of pipe to be flanged with a stand pipe DN100/150 mm of ductile iron equipped with protection cap including non-corrosive insect screen. Lengths of ventilation pipes up to 3 m shall be covered by the lump sum price of the valve chamber.

If approved by the Engineer, the ends of ventilation pipes may be constructed as a double flanged bend as shown on the drawings.

Exposed parts of vent pipe are to be painted with a weather-proof material as instructed by the Engineer.

Structural calculations including reinforcement drawings for all chambers shall be made by the Contractor and submitted for approval by the Engineer. These calculations are to take into consideration the prevailing load and soil conditions.

Reinforcement for concrete chambers shall be included in the unit rates of chambers.

All items as described above as well as additional excavation and backfilling works shall be included in the unit rates for the valves and other appurtenances.

### **3.2.16.23 Valve Indicator Plates**

#### **3.2.16.23.1 General**

Valve indicator plates shall be installed for all valves.

#### **3.2.16.23.2 Specifications**

Valves Indicator Plates shall have the following specifications:

The size of the Plates shall be 140 mm by 200 mm. The number of removable plates shall be

fixed on concrete pillars with concrete head and the sizes shall be sized for the plates. Indicator plates shall be of plastic, impact resistant, weatherproof with interchangeable characters and shall be of blue colour whereas letters and numbers shall be of white colour.

The Indicator Plates shall provide the following information:

- Valve ID Number.
- Distance to the left or right in meter (with one decimal up to maximum 99.9m).
- Distance to the front in meter (with one decimal up to maximum 99.9m).

The Valve Indicator Plates shall be scratch, impact and corrosion-resistant, made of non-ageing, UV-resistant and weatherproof material.

All fields shall be exchangeable and fixed by self-locking system. Blank fields shall be available as single double and triple units.

Letters and numbers on fields shall be fully impregnated and coloured through.

The Valve Indicator Plate shall be fixed on a ground plate of non-corrosive, non-ageing, UV-resistant and weatherproof material by means that do not allow unauthorised removal of the Valve Indicator Plates.

Ground plates shall be fixed to the walls or pillars or marker posts by non-corrosive screws.

### 3.2.16.23.3 Locations

For all valves, Valve Indicator Plates shall be mounted onto concrete pillars or marker posts installed for this purpose.

Marker posts shall be precast reinforced concrete as per detail drawings.

The position of the Valves Indicator Plates needs to be marked on the as-built drawings as well as details measurements of each Valve Indicator Plate needs to be recorded separately.

### 3.2.16.24 Identifiers

#### 3.2.16.24.1 General

Electronic identifiers shall be installed over proposed underground steel, ductile iron and polyethylene pipelines where instructed and in accordance with the following specifications.

#### 3.2.16.24.2 Specifications

The design and construction of the electronic identifiers shall be rugged, reliable and durable. The cross section area shall be small in order to fit in tight places. The following is the required specification:

| Colour                | Frequency | Range (Depth) | Operating Temp. | Storage Temp. | Housing     | Life Expectancy | Field Trials | RCL Circuit  |
|-----------------------|-----------|---------------|-----------------|---------------|-------------|-----------------|--------------|--------------|
| Blue ( <u>Water</u> ) | 145.7 KHz | 60-150 cm     | -40° to +70°C   | -40° to +85°C | Water Proof | 45 Years Min.   | Required     | Ferrite Core |

Samples of electronic identifier shall be submitted by the Contractor to be approved by the Engineer without any additional cost.

### **3.2.16.24.3 Installation**

Electronic Identifiers shall be installed in the following both manners:

- Vertically within the top of the soft backfill layer (bedding) over the pipe at a depth not exceeding 90 cm from ground surface.
- Horizontally: one identifier every (12) meters maximum for straight pipeline and (4) meters in long curves and where there are more than one pipeline in the area to the satisfaction of the Engineer.

When all identifiers are installed (before backfilling to surface and after surface reinstatement) a locator shall be used to verify that all identifiers have been installed properly. The locator shall be supplied by the Contractor at his own expense and shall be the property of WAJ after completion.

Identifiers shall be positioned 10 cm minimum away from metallic or magnetic materials.

All water pipeline record drawings shall have note on each, stating that the pipeline in those drawings had electronic identifiers.

For special fixtures (such as valves, meters, bends, tees ..etc.) two identifiers shall be installed (one on each side of the fixture) 50-100 cm apart symmetrically across the main.

### **3.2.16.24.4 Payment**

The cost of supply and installation of the electronic identifiers shall be deemed to be included in the Contract unit price.

### **3.2.16.25 Warning Tape**

50 cm above the pipelines a polyethylene tape of 500 microns  $\pm$  5 % thickness shall be laid. The width of this tape shall not be less than 200 mm. The top surface of this tape shall be printed in English with a suitable font with the following:

The breaking strain per 150 mm of width shall not be less than 75 kg.

For primary pipelines yellow coloured tape shall be used and blue for secondary pipeline.

### **3.2.16.26 Painting & Metal Protection**

All items of equipment shall be painted or otherwise protected as detailed in this specification. The Contractor shall be responsible for bringing to the notice of all various suppliers the appropriate clauses concerning the painting and/or protection of their equipment.

All right metal parts shall be covered before shipment with an approved protective compound and adequately protected during shipment to site. After erection these parts shall be cleaned.

### **3.2.16.27 Surface Boxes**

Cast Iron surface boxes with round lid according to DIN 4056 shall be supplied for operation

of valves as described. Surface boxes shall be suitable for a 400 kN load.

The surface box made of cast iron or ductile iron shall be situated at ground level on the road or pavement.

The hinge of the lid shall be of non-corrosive material. Circular lids shall be used for valves (gate and butterfly).

Surface boxes shall have a cold applied bituminous black paint coating.

Surface boxes shall be supported by reinforced concrete slabs of 40 x 40 x 26 cm according to standard drawings to suit the surface box.

### **3.2.16.28 Pressure Relief Valve**

Flanged pressure relief (reducing) valves and appurtenances shall be complete and operable, in accordance with the specifications.

DI pipes DN 200 shall be reduced to DN 150, DN 150 pipes to DN 100. HDPE DN 100 pipes shall not be reduced. The required armatures (valves, strainer, PRV, bulk meter, DCI pipes) shall be accordingly DN100 or DN150, before expanding the diameter again to the original diameter.

Pressure reducing valves shall be installed in chambers included in the unit price according to the detailed standard drawings, where requirement is specified and.

#### **3.2.16.28.1 Valve Characteristics**

The pressure relief valve shall open when the inlet pressure exceed a set maximum level it shall maintain that level and gradually close as the inlet pressure drops below the maximum pressure. The valve shall be a hydraulically operated, adjustable, pilot controlled, diaphragm or piston type globe or angle valve as indicated. All necessary repairs shall be possible without removing the valve from the pipeline.

#### **3.2.16.28.2 Valve Body**

Pressure relief valves for use with water pipelines shall be made of ductile cast iron EN-GJS-400-18 according to EN 1563 (GGG 400), epoxy powder coated, suitable for nominal working pressure for PN25, PN40 bars, according to Drawings, Specifications and Bill of Quantities.

Pressure relief valves shall be provided with suitable two numbers of manometers (glycerine) inclusive an optical indicator of the valve position. All seats shall be stainless steel as well as all operational and adjustment pipes.

Flanges shall be drilled to DIN 28605, EN 1092-2 PN16 and DIN 2501 - PN16 for up to DN300, above to PN25.

#### **3.2.16.28.3 Factory Tests and Warranty**

Valves shall be factory testes with hydrostatic test and a functional test and certificate shall be submitted to the Engineer prior to delivery of the valves. Each valve shall be warranted for a period of (3) years from the date of shipment to be free of defects in materials and workmanship.

### 3.3 Part 2 - Buildings, Reservoirs, and M & E Works

#### 3.3.1 Borehole and Pump House

##### 3.3.1.1 Borehole Details

The drilled boreholes have properties as shown in the table below

**Table 3-13 Drilled Borehole Details**

| Borehole                          | Gaspa     | Mutunda   | Nyakabaale |           |
|-----------------------------------|-----------|-----------|------------|-----------|
|                                   | DWD 77380 | DWD 77378 | DWD 77382  | DWD 77383 |
| Borehole depth (m.b.g.l)          | 115       | 96        | 138        | 133       |
| Pump Installation Depth (m.b.g.l) | 100       | 60        | 100        | 100       |
| Size of casing (mm)               | 150       | 150       | 150        | 150       |

##### 3.3.1.2 Borehole Pump house

The contractor shall construct 4 No pump houses, (1No in Gaspa and Mutunda and 2No. in Nyakabale) as detailed in Drawings GPA/W/1.1.0, MUT/W/1.1.0, and NYA/W/1.1.0 series to house the fittings on the pumping mains from the submersible pumps and the mechanical and electrical switch gear. The pump houses will be constructed adjacent to the boreholes.

The submersible borehole water pumps will be powered with Alternating Current (AC) and will have the following main parameters:-

**Table 3-14 Borehole pump details**

| Borehole                  | Gaspa     | Mutunda   | Nyakabaale |           |
|---------------------------|-----------|-----------|------------|-----------|
|                           | DWD 77380 | DWD 77378 | DWD 77382  | DWD 77383 |
| Flow (m <sup>3</sup> /hr) | 30        | 45        | 20         | 10        |
| Head (m)                  | 116       | 149       | 216        | 178       |

The pumps will be operational for a maximum of 16 hours a day thus a consistent power source will be required. Power to the pump will be supplied by a connection to the National Electricity Power Grid and back up from solar.

#### Gaspa RGC

Borehole DWD 77380: The system will consist of multi crystalline PV solar panels rated at 280pW 24 Volts DC, 162No. cells, with a control unit, support structure, and electrical

accessories and cabling at the pump station; and 1No. 100 KVA diesel generator at the pump station

### **Mutunda RGC**

Borehole DWD 77378: The system will consist of multi crystalline PV solar panels rated at 280pW 24 Volts DC, 270No. cells, with a control unit, support structure, and electrical accessories and cabling at the pump station; and 1No. 150 KVA 11,000 Volts / 433Volts, 50Hz, 3 phase transformer; a 1.5 Km extension of the 33KV overhead power line with 3-line conductors at the pump station

### **Nyakabaale RGC**

Borehole DWD 77382: The system will consist of multi crystalline PV solar panels rated at 280pW 24 Volts DC, 216No. cells, with a control unit, support structure, and electrical accessories and cabling at the pump station; and 1No. 100 KVA 11,000 Volts / 433Volts, 50Hz, 3 phase transformer; a 2.3 Km extension of the 33KV overhead power line with 3-line conductors at the pump station

Borehole DWD 77383: The system will consist of multi crystalline PV solar panels rated at 280pW 24 Volts DC, 81No. cells, with a control unit, support structure, and electrical accessories and cabling at the pump station; and 1No. 50 KVA 11,000 Volts / 433Volts, 50Hz, 3 phase transformer; a 0.4Km extension of the 33KV overhead power line with 3-line conductors at the pump station

### **3.3.1.3 Pump Attendant and Guard House**

The contractor shall construct 4No pump attendant and guard house as detailed in Drawings house the personnel who will operate and guard the facilities.

The house which will have a 3.0m X 3.0m floor area will contain the following:

- a) A pump attendant / guard residential room.
- b) Semi-detached Ecosan Toilet and bathroom.

The following general finishes shall apply in addition to those contained in the drawings:

- The house will have a 700mm wide, 80mm thick splash apron constructed in class 20 concrete and finished with 20mm thick steel floated screed.
- The ceiling shall be in expanded metal and cement mortar and painted with approved colour for the entire building.

- The external doors to the residences shall be mild steel doors constructed from 75 x 50 x 2mm hollow steel sections primed with red oxide paint, and painted with three coats of high gloss paint.
- The door to the Ecosan will be in approved solid hardwood with three coats of polyurethane varnish.
- The windows will be mild steel casement windows constructed from standard steel sections primed with red oxide paint, and painted with three coats of high gloss paint.
- The whole building shall be painted and decorated.
- Additional finishes include constructing 20x100mm high 1:3 cement-sand skirting, C20 concrete window cills, a 1500 litre (1.5m<sup>3</sup>) Polyethylene tank, elevated up to 1.0m above ground level on a rendered brickwork platform, complete with a DN 15mm Brass outlet tap, inlet DN 80 uPVC pipe work from overhead rain water gutters, DN 80 uPVC overflow and drainage pipework to a soak pit.

#### **3.3.1.4 Road Works**

The Contractor shall construct an access road to the sites, as shown on the drawings. Parking spaces shall also be constructed at the pump house.

The road shall be constructed on firm ground base where possible. Where an imported sub-base is required, this shall be compacted as provided for in the general specifications. The works shall be laid out to enable rapid drainage of run-off, and at the appropriate location drainage channels shall be provided. The wearing course shall be gravel.

#### **3.3.1.5 Fencing**

The Contractor shall erect chain link perimeter fences around the entire works for both pump houses. The fences shall be erected on a dwarf wall that shall partly serve as a flood protection wall with three lines of barbed wire fixed to the top of the fence. Each site shall be provided with a double leaf gate at the location directed by the Project Manager.

#### **3.3.2 Chemical House**

A chemical house will be constructed in the same compound as the storage reservoir. Chlorine will be used for disinfection. A room within the chemical house will be used for storage and dosing, as shown in the Drawings.

Disinfection is to be effected at the main storage reservoir. Disinfection of the water is meant to leave residual chlorine of 0.3-0.5 mg/l at the furthest ends of the distribution network. A number of chemicals containing chlorine have been used for disinfection. Calcium Hypochlorite (Ca(OCl)<sub>2</sub>), which is commercially available in powder form containing 60 to 70% active chlorine, is the preferred disinfectant.



- The disinfection system consists of:
- A chemical house containing a dosing room and chemical store,
- In line chemical doser of the DOSATRON / CHEMILIZER type,
- Mixing and Dosing Tanks with associated pipework and fittings.

A resting room / office shall also be provided for the private operator in chemical house.

The following general finishes shall apply in addition to those contained in the drawings:

- The chemical house will have a 600mm wide, 80mm thick splash apron constructed in class 20 concrete and finished with 20mm thick steel floated screed.
- The ceiling shall be in expanded metal and cement mortar and painted with approved colour for the entire building.
- The whole building shall be painted and decorated.
- Additional finishes include constructing 20x100mm high 1:3 cement-sand skirting, C20 concrete window cills, 2 no. drainage manholes of internal dimension 700x700mm with OD 110 PVC drainage pipework to soak pit, 300mm x 1380mm x 100mm thick reinforced concrete cover slabs over inlet pipe channel.

### **3.3.3 Water Offices**

The office blocks shall have the following furnishings:-

#### **Floors**

- Screed finish, 25mm thick.
- glazed ceramic tile finish of approved colour for the toilet.

#### **Walls**

- plaster finish internally.
- plaster finish externally.
- under coat and two cover coats of vinyl silk paint internally.
- under coat and two cover coats of weather guard paint externally.
- glazed ceramic tiles to 2.1 m height in toilet.

- Cement mortar skirting internally to a design approved by the Project Manager.
- All the external windows and doors shall be burglar proofed to the Project Managers satisfaction.

### **Roof**

- Blue pre-painted GCI gauge 26 sheeting on hard wood trusses.
- vermin proofed eaves.
- OD112 uPVC guttering to down pipes to entire roof, draining to surface water channels.

### **Ceiling**

- The ceiling shall be in expanded metal lathe and painted with approved colour.
- Under coat and three overcoats of matt emulsion paint of approved colour.

### **Sanitary Ware**

- Low level ceramic cistern and seat type water closets as in Vitreous UK White glazed.
- Ceramic wash basin as in Vitreous UK White glazed with 13mm diameter chromium plated pillar tap.
- toilet paper holder and towel rail.

### **Plumbing**

- Water supply tank mounted on 4m high steel stand, 1,000 litre capacity.
- DN 15/20 galvanised iron//PPR fresh water pipework to contractor's design and Project Manager's approval.
- OD 110 PVC drain pipe work to septic tank, manholes, all to the Project Manager's satisfaction.

### **Doors**

- Mahogany faced flush doors to toilets, complete with mahogany frames, iron-mongery, locks, etc.

- Mild steel frame external doors with burglar proofing grills, frame design to Project Manager's approval; include all iron monger, locks, glazing etc.

### **Windows**

- Mild steel casement frame windows, complete with iron mongery glazing, etc.; frame design to Project Manager's approval.

### **Drainage**

- Surface water drains to fall, stone pitched lined.
- Foul water drainage to 5.9m<sup>3</sup> capacity septic tank, manholes, pipe work, soak pit, etc. as necessary.

#### **3.3.3.1 Special Facilities**

- Three racks of hardwood timber 3.0m x 0.7m x 1.5m high storage shelves on 4mm thick steel angle frames fixed to the store wall as directed by the Project Manager.
- Soft board notice board fixed to the wall, area 1.5 m<sup>2</sup>.
- Wheel chair access ramp at office entrance.

#### **3.3.3.2 Road Works**

The Contractor shall construct an access road to the site, as shown on the drawings. Parking spaces shall also be constructed at the office block.

The road shall be constructed on firm ground base where possible. Where an imported sub-base is required, this shall be compacted as provided for in the general specifications. The works shall be laid out to enable rapid drainage of run-off, and at the appropriate location drainage channels shall be provided. The wearing course shall be lime stabilized gravel.

#### **3.3.3.3 Fencing**

The Contractor shall erect a chain link perimeter fence around the entire works. The fence shall be erected on a dwarf wall that shall partly serve as a flood protection wall with three lines of barbed wire fixed to the top of the fence. The site shall be provided with a double leaf gate at the location directed by the Project Manager.

#### **3.3.4 Reservoirs**

### 3.3.4.1 Storage Reservoirs

The details of the reservoirs are given in the drawings.

The new reservoir will be made of square cold pressed steel panels of length 1.22m. The reservoir shall be provided with inlet, overflow, outlet, and drain pipe work. The following fittings shall also be provided for the reservoir;

- i) Internal ladder of galvanised steel,
- ii) Wall mounted level indicator,
- iii) Vents on the tank roof,
- iv) Roof level access cover of galvanised steel.

The access covers shall be at least 100 mm above the finished level of the roof and shall be lockable. The roof vents shall be similarly set out and shall be fitted with vermin proofing and mosquito proofing fabric.

The overall internal dimensions of the Gaspa reservoir (200m<sup>3</sup>) are as follows:-

- Length - 8.54m,
- Width - 7.32m,
- Depth - 3.66m.

The pipework (rated PN10) of the reservoir shall be in Epoxy Coated Steel Pipework as follows;

- Inlet - DN 150,
- Outlet - DN 150,
- Overflow - DN 150,
- Drain - DN 100.

Due to the topography of the town and the low pressures experienced in the distribution network around the tank and in some of the far reaches of the network, it is recommended to erect the reservoir tank on a 15m high steel tower.

The overall internal dimensions of the Popora reservoir (250m<sup>3</sup>) are as follows:-

- Length - 8.54m,
- Width - 8.54m,
- Depth - 3.66m.

The pipework (rated PN10) of the reservoir shall be in Epoxy Coated Steel Pipework as follows;

- Inlet - DN 150,
- Outlet - DN 150,
- Overflow - DN 150,
- Drain - DN 100.

Due to the topography of the town and the low pressures experienced in the distribution network around the tank and in some of the far reaches of the network, it is recommended to erect the reservoir tank on a 20m high steel tower.

The overall internal dimensions of the Teyago reservoir (100m<sup>3</sup>) are as follows:-

- Length - 6.10m,
- Width - 4.88m,
- Depth - 3.66m.

The pipework (rated PN10) of the reservoir shall be in Epoxy Coated Steel Pipework as follows;

- Inlet - DN 150,
- Outlet - DN 150,
- Overflow - DN 150,
- Drain - DN 100.

Due to the topography of the town and the low pressures experienced in the distribution network around the tank and in some of the far reaches of the network, it is recommended to erect the reservoir tank on a 15m high steel tower

The overall internal dimensions of the Nyakabale reservoir (300m<sup>3</sup>) are as follows:-

- Length - 9.76m,
- Width - 8.54m,
- Depth - 3.66m.

The pipework (rated PN10) of the reservoir shall be in Epoxy Coated Steel Pipework as follows;

- Inlet - DN 150,
- Outlet - DN 150,
- Overflow - DN 150,
- Drain - DN 100.

Due to the topography of the town and the low pressures experienced in the distribution network around the tank and in some of the far reaches of the network, it is recommended to erect the reservoir tank on a 15m high steel tower

#### **3.3.4.2 Main Reservoir Site Works**

The site works at the reservoir consists of the following:

- i) The general earthworks,
- ii) The site pipe work,
- iii) The site drainage,
- iv) Miscellaneous works.
- v) The outlet from the reservoir shall be fitted with a new bulk flow meters.

The detail specifications for pipework and drawings provided for in Part 1 and 2 of these specifications shall apply for the site pipework.

The Contractor shall excavate the site to the extent of the formation level of the tank. The

ordinary excavated material and topsoil shall be reserved for filling within the site, and the balance disposed of. The Contractor shall identify his own disposal sites.

A "Woltman" Helix Type Bulk Flow Meter shall be installed on the reservoir outlet. The bulk flow meter installed shall be of a design to accept flow and pressure data loggers.

The drains and overflow from the new reservoir shall be connected to acceptable outfalls.

The Contractor shall erect a chain link perimeter fence around the entire works housing the reservoir and chemical house. The fence shall be erected on a dwarf wall that shall partly serve as a flood protection wall with three lines of barbed wire fixed to the top of the fence. The site shall be provided with a double leaf gate at the location directed by the Project Manager.

### **3.3.5 Water Supply System - Mechanical and Electrical Works**

#### **3.3.5.1 Mechanical and Electrical Works**

The Mechanical and Electrical Works shall consist of a new submersible pumps, and booster pumps, valves and pipework in the pumping station and their related accessories. All LV process electrical gear and cabling will be new.

##### **3.3.5.1.1 Borehole Pump**

The works include the supply and installation of 4No electric submersible pumps, one in each of the boreholes.

##### **3.3.5.1.2 Chlorination**

As stated above, disinfection is to be effected at the main storage reservoir. Disinfection of the water is meant to leave residual chlorine of 0.3-0.5 mg/l at the furthest ends of the distribution network. A number of chemicals containing chlorine have been used for disinfection. Calcium Hypochlorite ( $\text{Ca}(\text{OCl})_2$ ), which is commercially available in powder form containing 60 to 70% active chlorine, is the preferred disinfectant.

- The disinfection system consists of:
- A chemical house containing a dosing room and chemical store,
- In line chemical doser of the DOSATRON / CHEMILIZER type,
- Mixing and Dosing Tanks with associated pipework and fittings.

### **3.3.5.1.3 Instrumentation, Control, Automation (ICA)**

Operation of the plant and processes will normally be from local control panel in the Pumping Station. Instruments will be used to monitor plant parameters and alarm abnormal operations on local panel.

The operation of the works will generally be automatic, with manual stand-by. Some of the specific controls are:

Pumping station, prevention of pumps from running dry.

The system shall be designed for safe shut down in case of power failure.

Electrical works include supply and installation of a transformer and all onsite cabling including the provision of ducts conduits and general electrical fittings.

### **3.3.5.1.4 Buildings and Site Works**

Electrical works include new installation to buildings and provision of security

### **3.3.5.2 Power Supply from UEDCL/UMEME**

The nearest power source to the borehole is indicated in the BoQ. The Contractor shall liaise with UEDCL/UMEME to construct an overhead power line to reach all the borehole sites and water sump site. The line will terminate in a transformer which will be connected to the Main Control Panels in the Pump Houses.

### **3.3.5.3 Solar Power Supply and Installations**

The Contractor shall supply and install PV Solar Panel equipment as detailed herein.

#### **3.3.5.3.1 PV Solar Panels**

Solar Energy will also be provided by Supply and Installation of additional mono crystalline PV Solar panels rated at 280pW 12 Volts DC, include: PV solar panel support structure for mounting solar panels; all electrical accessories; to the Engineer's approval

Each Solar Panels unit shall be protected against lightning and short circuit-voltage by appropriate earthing. The cost of this protection shall be included in each unit.

#### **3.3.5.3.2 Cables**

The cabling for outdoor use shall be Ultra violet resistant cable with copper conductor of generous size to minimize voltage drops.



### **3.3.5.3.3 Support Structures**

The Contractor shall supply and install Steel Frames for burglary protection and support to the PV Solar Panels supplied, to the Engineer's approval. The Contractor shall be responsible for taking all measurements on site that are necessary for the manufacture of and installing of the Steel Frames. Each Solar Panel unit shall have adjustable steel Burglar-proof rack mounted on an independent steel structure.

All supports and brackets shall be wire brushed and painted one coat of red oxide paint and two coats of high gloss paint prior to and after erection. All nuts and bolts shall be sherardized.

### **3.3.5.3.4 Power Control Unit**

As far as is practicable, all controls and indicator lamps shall be grouped and mounted together in a floor or wall mounted panel.

No sharp edges or corners will be allowed, and all exposed screws, bolts or other fittings shall have rounded heads with protective and decorative plating. Panels shall be adequately stiffened and reinforced as necessary to ensure rigidity. All surfaces shall be properly prepared before final finishing and the external appearance shall be of a high standard.

All indicating lamps, instruments and controls shall be, as far as is practicable, of the same manufacture and style to provide uniformity of appearance and to facilitate maintenance.

Externally visible equipment shall be flush mounted, with minimum projection and fixed securely to the front panels or other members. Internal equipment shall be secured to purpose made rails or mounting bars. All fixing shall incorporate shake proof washers or other vibration resistant fastenings.

The precise sitting of the control panels shall be agreed with the Engineer and whilst providing good visibility of the plant shall not interfere with the facilities for maintenance and cleaning of equipment.

Internal wiring shall be coded and in general shall be bunched and run on trays or in purpose-made slotted plastic cable trunking. Positive fixing of cable ends shall be ensured by purpose made clamps, or pinch type terminals, or by the use of crimped cable tags or other approved termination devices. All cable ends shall be permanently identified.

Grouped terminal blocks of adequate capacity with permanent labels shall be provided for all wires leading to equipment outside the cubicle or panel. Removable covers or other facilities shall be provided for the entry of incoming cables, conduits, trunking, etc., with means of effective earthing to the panel chassis.

If main power terminals are incorporated within the control panel, soldered socket type terminals shall be provided.

Fuses shall be grouped and mounted so as to be readily accessible without danger. Fuses, terminal blocks and all items of equipment shall be readily identified by means of clearly visible labels secured to them by screws or by other approved methods.

All items on the outside face of the panel shall be identified by means of attached white laminated plastic labels engraved with black ciphers.

The layout of the control panel shall be agreed with the Engineer before manufacture. A neat and orderly arrangement is required.

The control cubicle panel, as far as is practicable, shall be manufactured, equipped, wired and tested before delivery to site.

#### **3.3.5.4 Mechanical – Data for the Pump**

The Consultant has selected submersible pump sets for the Boreholes and centrifugal pumps as booster pumps.

Only alternatives of equivalent manufacture will be considered in the submission of the tender.

The pump make, manufacture and configuration details must be submitted in full with the tender and no tender submitted without complete details on the selected pump set will be considered for evaluation.

- Electric multistage centrifugal submersible borehole pump of diameter not exceeding 100mm, capacity 30m<sup>3</sup>/hr at a head of 116m complete with power cable, DOL starter, delivery pressure gauge, pressure switch, dry run protection, and all accessories as Grundfos or equal approved for borehole DWD 77380 in Gaspa RGC
- Electric multistage centrifugal submersible borehole pump of diameter not exceeding 100mm, capacity 45m<sup>3</sup>/hr at a head of 149m complete with power cable, DOL starter, delivery pressure gauge, pressure switch, dry run protection, and all accessories as Grundfos or equal approved for borehole DWD 77378 in Muntunda RGC
- Electric multistage centrifugal submersible borehole pump of not exceeding diameter 100mm, capacity 20m<sup>3</sup>/hr at a head of 216m complete with power cable, DOL starter, delivery pressure gauge, pressure switch, dry run protection, and all accessories as Grundfos or equal approved for borehole DWD 77382 in Nyakabaale RGC
- Electric multistage centrifugal submersible borehole pump of diameter not exceeding 100mm, capacity 10m<sup>3</sup>/hr at a head of 178m complete with power cable, DOL starter, delivery pressure gauge, pressure switch, dry run protection, and all accessories as Grundfos or equal approved for borehole DWD 77383 in Nyakabaale RGC.

### 3.3.5.5 Electrical Controls

There will be pump control panels located in the pump houses and will control all the pump electrical equipment.

- The pump shall be started and stopped locally from the panel door with push buttons if the selector switch is in the manual position.
- When the selector switch is in the automatic position the pump will be switched on and off by means of a 24 hour timer. A restart timer must be installed in parallel with the 24-hour timer. Should the pump trip-out on an over-pressure condition when the ball valve in the reservoir closes, the system must be operated on the restart timer. The pump will be set to a 2-hour restart cycle initially. The restart timer must be adjustable from 1 hour to 12 hours.
- An emergency stop shall stop the drive and trip the supply to the motor from an emergency stop station on the panel door and shall prevent power to be switched back as long as the switch is activated.
- A high delivery pressure shall trip the motor virtually instantaneous. The high delivery pressure signal from the delivery side of the pump shall be wired through a timer adjustable between 1s and 60s. The pump running signal from the starter shall activate the timer. Once the timer timed out, a high delivery pressure signal from the pressure switch shall trip the pump motor.
- A trip from the following signals shall latch a remote fault indication on the panel door, which can be manually reset.
  - ◆ High delivery pressure signal
  - ◆ Motor overload

The Motor Control Centre will have the following meters, switches and indicator lights.

- Light indicators
  - ◆ “ON” - green
  - ◆ “OFF” – red
  - ◆ “TRIPPED” – Amber
- “Emergency Off” button
- Indicator lights for the following pumps off conditions:
  - ◆ Low water level in borehole.

- ◆ No flow in delivery pipe.
- ◆ Low pressure in delivery pipe.
- Hour meter
- Volt meter
- Amp meter
- 16 Amp 3 pin switches outlet
- 32 Amp 5 pin interlock switched socket outlet completed with plug top.

#### **3.3.5.5.1 Electronic stabilizers**

The borehole pumps shall be protected by an electronic stabilisers as follows:

25KVA - 150KVA Electronic stabilizers rated at 400V, 50Hz 3 phase, input voltage +/-25%, output voltage +/-5%, complete with independent phase control, input/output isolators and bypass switch and all accessories as made by Orteo of Italy or equal approved.

### **3.3.6 Drawings, Documents and Maintenance Scheme**

#### **3.3.6.1 Contract Drawings**

- The Contractor shall submit to the Project Manager in triplicate the following drawings for approval:
  - ◆ Electrical Drawings: On the basis of the simplified documents, the Contractor shall prepare the following planning records as supplements to the VOB DIN 18382 Standards:

Wiring diagram and construction plans and drawings, installation plans, complete cable lists, clamping plans, etc. as well as lists of parts, clearly indicating material and type of proposed equipment.

This also applies to the control and signal circuits as well as interlocking and interrelated control of other technical sectors. A clear illustration according to pertinent standards is imperative.

A complete documentation (lists of parts, descriptions, maintenance and operating instructions, test reports and certificates, etc.) shall be submitted, in five copies each, prior to the commencement of installation.

- ◆ Copies of proposed panel layouts.

- Two copies will be retained for record purposes whilst one copy will be returned to the Contractor stamped "APPROVED" and/or supplement with any necessary modifications or revisions. The Contractor shall provide four further copies of finally approved drawings.

### **3.4.6.2 Record Drawings**

- Within a period of three weeks following the issue of the "Take-over" Certificate the as-built drawings shall be provided. One set shall be reproducible on plastic (or equivalent) and three sets shall be prints of:
  - ♦ Works and general plant layout,
  - ♦ As-constructed drawings,
  - ♦ Comprehensive diagrams for the control panel showing scheduled functions and diagram of connection,
  - ♦ Overall mechanical/electrical and control schedules for the Works with details of interconnections between the various units of the plant,
  - ♦ Actual (not typical) section drawings where applicable,

### **3.3.6.2 Operating and Maintenance Manuals**

- Comprehensive operating and maintenance manuals in English language covering all items of Plant and including all manufacturer's instruction, references, lists, etc. shall be compiled. The manuals have to cover the pumping station.
- The manuals shall be submitted in five copies and shall cover the testing, operation, control, maintenance, dismantling and repair of all the Plant provided in the Works. All information shall be supported by:
  - ♦ Catalogues and brochures,
  - ♦ Dimension drawings,
  - ♦ Data sheets,
  - ♦ Descriptive text,
  - ♦ Comprehensive drawings, sketches, plans, sections as required.

The greatest importance shall be drawn to the completeness and clearness of presentation.

- It is emphasized that a collection of standard pamphlets of general nature unaccompanied by drawings and descriptive matter will not be acceptable. In particular, information supplied by Sub-Contractors and manufacturers employed by a Contractor shall be co-ordinated in the comprehensive manual. Cross-references of descriptive texts, drawings and spare part lists must be complete.
- The Contractor shall deliver to the Project Manager in duplicate loose leaf copies of draft operational and maintenance manuals for the Plant two months before start-up of the works. The manuals shall be divided into several volumes (e.g. function, operation, maintenance, overhaul) and shall fully and clearly set out the Contractor's own recommendations and instructions for the satisfactory operation, maintenance and overhaul of the Plant as applicable to each of the installations and devices supplied.
- The text or accompanying diagrams shall in addition show the electrical wiring, handling and erection instructions. Draft manuals shall, during the testing and commissioning of the Works, be carefully checked by the Contractor and updated and modified to ensure that they are fully descriptive and applicable to the final lay-out of plant and process under operational conditions.
- The draft manuals may include manufacturer's standard literature but the Contractor shall fully supplement the literature by his own descriptive text, drawings, tables, figures, characteristic curves and the like.
- The final approved manuals for the Works shall be submitted prior to the commencement of the Period of Maintenance. They shall be securely bound in A4 sized loose-leaf binders, clearly titled, index linked and cross referenced.
- The final manuals shall incorporate instructions, recommendations and advice for the operation of the entire process covering the full range of flow and shall include advice on the joint operation and control of the water supply system. No section of the Works will be certified by the Project Manager as completed unless this requirement has been met. The contents of the final manual may be subdivided into the following sections:
  - ◆ Basic data of the works,
  - ◆ Description of the different units of the Works including supporting sketches,
  - ◆ Setting to work procedures,
  - ◆ Normal operation,
  - ◆ Taking out of service procedures
  - ◆ Emergency operation (electricity failure etc.)
  - ◆ Water quality monitoring programme including sampling schedule and sampling locations, draft of quality reporting forms according to WDD/WSDF-Central Standard and description of standard methods used for analysis.

- If during the Period of Maintenance, the Contractor or the Project Manager has found that the manual should require modification or enlargement as a result of subsequent operational and maintenance experience in the Works, the Contractor shall provide the approved modification for each manual.
- The manuals shall include explanations of the function and purpose of each item supplied and the operational, mechanical and electrical procedures for:
  - ♦ Lubrication, checking, calibration (including charts), testing adjustment of each item,
  - ♦ Attention at daily, weekly, monthly or other intervals to ensure reliable trouble-free operation,
  - ♦ Complete overhaul, dismantling and reassembly, testing and re-commissioning,
  - ♦ The identification and selection of suitable lubricants standardized throughout the Works, identifying equivalents of local manufacturer's
  - ♦ Defect locating charts to facilitate tracing of the cause of malfunction or breakdown,
  - ♦ Routine and emergency safety precautions, procedures and recommendations,
  - ♦ Cleaning of the Plant and its components.
  - ♦ Guidelines for conservation of equipment in case of taking the equipment out of service,
  - ♦ Maintenance of protective coating,
  - ♦ Operational maintenance of the system, performance and treated water quality monitoring and reporting procedures.
- The instruction manuals shall describe the installation as a whole and shall give a step-by-step procedure for any operation likely to be carried out during the whole life of the Plant.
- A separate section of the manual shall be devoted to each size and type of equipment and to each system of Plant. The various sections shall be grouped into separate volumes relating (as appropriate) to functions like operation, maintenance, overhaul etc. The appropriate volume shall contain also a list of spare parts and the required procedure and addresses for ordering them. A list of recommended spare parts to be stored shall be supplemented each item of equipment.

### **3.3.6.3 Maintenance Scheme**

- The operation and maintenance instruction manuals shall be supplemented by the supply of a comprehensive yearly maintenance programme for the water works operation and

maintenance staff.

- A wall chart or charts shall be provided, covering a period of one year with coloured markers. It shall have vertical divisions in weeks and horizontal divisions for each item of Plant. A fitter's card system shall be provided with at least one card for each item of Plant. The cards shall detail the maintenance required with the relevant spaces for work done, parts required and the like, in order that for each task or day's work, the electrical works and mechanical maintenance staff may be presented with the card for routine work completion and signature.
- The markers shall be arranged with standard colours to indicate work required, parts outstanding, work completed and the like.
- The maintenance scheme shall be provided complete at the time of handing over of the Works. It should have sufficient space for extension to include any further routine work, which may be required.

### **3.3.7 Gabions and Mattresses for Pipe Protection**

#### **3.3.7.1 Materials for gabions and mattresses**

All units shall consist of woven steel wire mesh boxes of approved module and be of the sizes stated on the Drawings.

- **Mesh:** Mesh openings shall be hexagonal in shape.
- **Mesh joints:** All joints shall be flexible and consist of not less than one and one half full turns.
- **Galvanising:** All wire used shall be galvanised to BS 443, or equivalent, prior to weaving of the mesh.
- **Binding wire:** 3.4 mm diameter selvedge shall be incorporated along the edges of the wire mesh.

#### **3.3.7.2 Stone Filling**

Filling material shall be selected rock fill graded between 100 mm and 250 mm.

#### **3.3.7.3 Construction of Gabions and Mattresses**

- Prior to assembly, the units shall be opened out flat on the ground and stretched to remove all kinks and bends. The units shall then be assembled individually, by raising the sides, ends and diaphragms, ensuring that all creases are in the correct position and that the tops of all four sides are even. The four corners shall be laced first, followed by the edges of the internal diaphragms to the sides.



- In all cases lacing shall commence at the top of the unit by twisting the end of the lacing wire around the selvedge. It shall then be passed round the two edges being joined, through each mesh in turn and securely tied off the bottom.

The end of all lacing wires shall be turned to inside of the unit on completion of each lacing operation.

- Only assembled units or groups of units shall be positioned in the structure. The side or end from which work is to proceed shall be secured either to completed work, or by rods or stakes driven into the ground at the corners. These shall be secured and reach at least to the top of the unit. Further units shall then be positioned in the structures as required, each being securely laced to the preceding one at all corners, and diaphragm points.
- Final stretching of gabion boxes shall be carried out using a wire strainer or which of at least one tonne capacity firmly secured to the free end of the assembled gabion boxes shall be securely laced along all edges (top, bottom and sides) and at diaphragm points to all adjacent units).
- Filling shall be carried out only whilst the units are under tension. Filling shall be placed by hand to produce a neat face and line, with a minimum of voids. Vertical bracing wires at 500 mm horizontal centres shall be used in the top layer of unit. These bracing wires shall be wrapped around two mesh wires and extend from top to bottom so positioned to ensure a neat face and line free of bulges and depressions on completion to the satisfaction of the Project Manager.
- Tension on the units shall be released only when sufficiently full to prevent the mesh from slackening. Units shall be overfilled by 20 to 50 mm above their tops to allow for subsequent settlement 100 mm filling materials may be used for this purpose.
- Closing and wiring down of lids shall proceed immediately after filling operations. Lids shall be stretched tight over the filling with bars and wired down securely through each mesh along all edges, ends and diaphragms. The end of all tying and bracing shall be turned into the unit on completion of all lacing operations.
- Particular care shall be exercised throughout construction to ensure lightness of mesh, stone to be well packed with minimum of voids and secure lacing. The exposed faces of completed work shall present a neat face and line free of bulges and depressions.

### **3.3.8 Tools and Equipment**

#### **3.3.8.1 General**

- The Contractor shall furnish each of the new water offices with the tools and equipment listed hereunder.
- The tools and equipment shall be complete in all respects and be installed, calibrated and connected to the electric supply, if applicable.

- All tools shall be of high quality material (chromium-vanadium and high quality tool steel respectively) and shall be in accordance with the latest standard.

### 3.3.8.2 Specifications of Tools and Equipment

The equipment shall be provided according to the following technical requirements. It shall be of an approved quality and finish. These will include;

- Water Office Equipment for both systems
- Plumbing Tools and Equipment, for both systems
- Water Quality Test Kit, for both systems
- Miscellaneous Tools, for both systems
- Chemical Equipment and Chemicals for water supply system

**Table 3-15 Tools and Equipment**

| ITEM NO. | ITEM DESCRIPTION  | UNIT | QUANTITY |
|----------|---|------|----------|
|          | <b>OFFICE EQUIPMENT</b>   |      |          |
| OE 1.1   | Mahogany natural vanished hardwood writing desk 1,800 x 780 x 750 mm (L x W x H) with closed front view and 3 lockable drawers on each side | No.  | 1        |
| OE 1.2   | Mahogany natural vanished hardwood writing desk 1,560 x 780 x 750 mm (L x W x H) with closed front view and 3 lockable drawers on each side | No.  | 2        |
| OE 1.3   | Mahogany natural vanished hardwood conference table 2,000 x 1,000 x 750 mm (L x W x H)  | No.  | 1        |
| OE 1.4   | Executive swivel, high back tilting steel office chair with arm rests and padded seat and back in black rexine                              | No.  | 3        |
| OE 1.5   | Executive steel office chairs with arm rests and padded seat and back in black rexine   | No.  | 5        |
| OE 1.6   | Executive steel conference chairs with padded seat and back in black rexine   | No.  | 8        |
| OE 1.7   | Lockable steel filing cabinet with 4 drawers  | No.  | 2        |
| OE 1.8   | Steel cabinet 1,950 x 950 x 420 mm (L x W x H) with double lockable doors, 4 shelves; colour: grey  | No.  | 1        |
| OE 1.9   | Wooden shelf, 1.5m long X 2m high X 0.4m wide, Mahogany hardwood with natural vanish finish.  | No.  | 2        |
| OE 1.10  | Cash safe with minimum dimensions, 500mm wide, 500mm long and 700mm high secured to office wall   | No.  | 1        |
| OE 1.11  | HP Computer Workstation complete as specified   | No.  | 2        |
|          | Intel Core i7-2500 3.30GHz, 6M Smart Cache processor  |      |          |
|          | 16 GB of DDR 1066 MHz SDRAM; 2nr 1TB SATA Hard Disk Drive   |      |          |
|          | 16X DVD +/- RW; 17" TFT "Ultra Sharp touch screen Flat Panel  |      |          |
|          | Licensed Microsoft Windows 10   |      |          |
|          | Licensed MS Office 2016 & Kaspersky Internet Security 2018  |      |          |

|         |   |     |   |
|---------|---|-----|---|
|         | UPS of minimum specification 1500 VA  |     |   |
| OE 1.12 | HP Laser Jet Printer  | No. | 1 |
|         | Printer speed- up to 24 ppm black; Processor speed- 533 MHz   |     |   |
|         | Paper trays- 2 trays; Input capacity- Up to 500sheets   |     |   |
|         | Memory- 544MB (512MB DDR SDRAM)   |     |   |
|         | Media size- Max. A4; 10/100 Network Interface Card  |     |   |
|         | 5no. Replacement Toner Cartridges sets (4 colours@)   |     |   |
|         | Bi-directional parallel cable; USB printer cable  |     |   |
|         | <b><u>PLUMBING TOOLS AND EQUIPMENT</u></b>  |     |   |
| PE 2.1  | Blowlamp: pump action, pressure type, approx. 0.5 litre capacity, complete with wind proof nozzle and one set of replacement parts  | No. | 1 |
| PE 2.2  | Brushes, wire type for cleaning parts, 300 mm long, 3 rows of approximately 15 tufts with 25 mm long steel bristles   | No. | 2 |
| PE 2.3  | File, flat machinist's, length 250 mm, second cut   | No. | 1 |
| PE 2.4  | File, flat machinist's, length 250 mm, smooth cut   | No. | 1 |
| PE 2.5  | File, flat machinist's, length 250 mm, bastard cut  | No. | 1 |
| PE 2.6  | File, half-round machinist's, length 250 mm, smooth cut   | No. | 1 |
| PE 2.7  | File, half-round machinist's, length 250 mm, but bastard cut  | No. | 1 |
| PE 2.8  | File handles, 100 x 27 mm   | No. | 2 |
| PE 2.9  | Hammer, mechanic's, 200 & tempered forged steel head, ash or white hickory handle, polished face  | No. | 1 |
| PE 2.10 | Mattocks  | No. | 2 |
| PE 2.11 | Pliers, arc joint, minimum 5 adjustments, 240 mm long   | No. | 2 |
| PE 2.12 | Saw, Plumbers, 400 mm, fine tooth edge for cutting metal and coarse teeth for cutting wood, complete with 5No. blades   | No. | 2 |
| PE 2.13 | Screw drivers, assorted, hammer-proof, non-inflammable plastic handle   | Set | 2 |
| PE 2.14 | Shovels   | No. | 2 |
| PE 2.15 | Tape measure, Stanley type steel, metric units, 5 m   | No. | 2 |
| PE 2.16 | Tapping machine, furnished with ratchet crank for manual operation, for making tappings from DN 15 (1/2") to DN 50 (2") on mains of DN 25 (1") to DN 300 (12")                      | No. | 1 |
| PE 2.17 | Die set with stock, for threading from DN 15 to DN 150  | No. | 1 |
| PE 2.18 | Vice with parallel jaw 100 mm as Peddinghaus, Matador 10203, portable type, with tripod stand   | No. | 1 |
|         | <b><u>WATER QUALITY TESTING KIT</u></b>   |     |   |
| QE 3.1  | Portable analysis kit such as Potalab 1 (Wag-WE10010) of M/s Wagtech International or similar with reagents to carry out 300 tests for microbiological and physico-chemical testing | Set | 1 |
|         | <b><u>MISCELLANEOUS TOOLS</u></b>   |     |   |
| MT 4.1  | Contractor's pick axe with point and chisel steel end, length 800 mm  | No. | 2 |
| MT 4.2  | Steel hoe, blade width 200 mm, 1.5 kg complete with good wooden handle  | No. | 2 |
| MT 4.3  | Seamless pressed tray wheelbarrow, steel frame, with pneumatic wheels, 80 litres  | No. | 2 |
| MT 4.4  | 33CC 2-Cycle Petrol-Powered engine Straight Shaft Attachment Capable String Lawn Trimmer with 17-inch cutting path (including 10No. replacement trimmer lines)                      | No. | 1 |
| MT 4.5  | Steel rakes   | No. | 3 |
|         | <b><u>CHEMICAL EQUIPMENT AND CHEMICALS</u></b>  |     |   |

|        |   |     |    |
|--------|---|-----|----|
| CE 5.1 | Stainless steel graduated (metric) buckets (10 litres)        | No. | 2  |
| CE 5.2 | Stainless steel scoops for scooping chemicals - 1 kg capacity | No. | 2  |
| CE 5.3 | Chlorine in 50Kg Sacks  | No. | 12 |

### 3.4 Part 3: Sanitation

#### Waterborne Toilet Facilities

The contractor shall carry out sanitation works as detailed in Drawings. The sanitation works in the each town include the construction of 1 no. 4 stance waterborne public toilets.

The toilet blocks shall contain:

The sanitation facility will consist of the following

- a) 2No. stances for each gender inclusive of 1No. stance for the physically disabled
- b) 2No. shower stalls for the female and 1No shower for the male
- c) Handwashing facility
- d) 1000 litre tank connected to rainwater harvesting system connected to the handwashing facility
- e) 1000 litre tank connected to the piped water supply system. This tank will also be connected to the handwashing facility
- f) Incinerator
- g) Store. The store can also be used as a retail shop for an income generating activity for the operator of the toilet
- h) Septic Tank of effective capacity 15.4m<sup>3</sup> in brickwork and reinforced concrete, rendered water proof smooth inside complete with inlet and outlet manholes benching, heavy duty concrete manhole covers, OD 110 PVC ventilation pipe work clipped to toilet wall;
- i) Concrete grade C20 floors with terrazzo finish;
- j) Rendered and painted walls internally;
- k) Rough cast to walls externally;
- l) Pre-painted galvanised corrugated iron sheets of gauge 28 sheeting on hard wood trusses;
- m) Hard wood faced flush doors to internal doors, mild steel frame external doors with burglar proofing grills;
- n) Foul water drainage to soak pits;

- o) Wheel chair access ramp at entrance;

### **Institutional Sanitation Facilities**

The institution sanitation facilities will have the following features:

- i. 5No. stances inclusive of 1No. stance for the physically disabled
- ii. 1No. shower stall for girls' toilet to allow for promotion of menstrual hygiene
- iii. 1No. incinerator for the girls' toilet for proper disposal of items used in menstrual hygiene
- iv. Provision of urinal for boys' toilet
- v. Handwashing facility
- vi. 1000 litre tank connected to rainwater harvesting system connected to the handwashing facility
- vii. 1000 litre tank connected to the piped water supply system. This tank will also be connected to the handwashing facility

## **4. STANDARD SPECIFICATION FOR MECHANICAL AND ELECTRICAL PLANT**

### **4.1 Introduction**

Plant and Equipment includes all mechanical and electrical equipment and associated services and equipment as specified herein, or as listed in Schedules or shown on Drawings, and includes all materials and ancillary equipment required or which may reasonably be inferred to be necessary for the proper performance of the Works.

This chapter of the Specification sets out the standards of materials, workmanship and design to be used by the Contractor for mechanical and electrical plant and reference to any specific material or equipment does not necessarily imply that such material or equipment is to be included in the Works.

All component parts of the Works shall, unless otherwise specified, comply with the provisions of this chapter or be subject to the approval of the Project Manager.

### **4.2 Safeguarding of Machinery**

The Contractor shall ensure that all designs and equipment for which he is responsible are safe. Nothing in this Specification shall remove the Contractor's obligation from drawing the attention of the Project Manager to any feature of the Works which is not consistent with safety, or to prevent him making proposals for incorporating equipment or designs, which would increase the safety of the Plant.

The installation layout and plant design shall not allow any item of plant to be so positioned that danger to operating personnel could arise during normal operation and maintenance. Particular attention shall be paid to the position of hot pipes, air vents and rotating machinery.

All rotating shafts, couplings, gears, flywheels, belt drives or other moving parts shall be fully guarded. Guards shall be designed to provide ready access to bearings, grease points, thermometer sockets and other check points and to allow safe routine observation and servicing to be executed without the need to dismantle any part of their structure.

### **4.3 Rating Plates, Name plates and Labels**

All equipment, apparatus and Plant shall be clearly labelled or fitted with nameplates and rating plates generally as follows:

#### **4.3.1 Indoor Type Labels**

- Labels for the outside of equipment shall be of a rigid type laminated and engraved plastic material, with black block capitals on a white background. The labels shall be fixed by non-rusting screws, or similar approved.

- Labelling inside equipment shall be as above except that a flexible self-adhesive type labelling may be used if suitable for the ambient temperatures and if not less than 12 mm in width.

#### **4.3.2 Weather-proof Labels**

These labels may be vitreous enamelled or brass. Plastic labels will not be accepted unless proof can be given that the labels can withstand the environmental conditions found at Site.

Vitreous enamelled labels shall be secured by brass or non-rusting roundhead screws, with brass and fibre washers in contact with the enamel front and back to prevent damage.

#### **4.3.3 Name and Rating Plates**

Each main and auxiliary item of Plant shall have permanently attached to it in a conspicuous position a nameplate and a rating plate. Upon these shall be engraved the manufacturer's name, type and serial number of Plant, details of the loading and duty at which the item of Plant has been designed to operate, and such diagrams as may be required by the Project Manager. All indicating and operating devices shall have securely attached to them or marked upon them designation as to their function and proper manner of use. Provision shall be made to incorporate descriptive numbering codes as indicated on the Record Drawings. Details of proposed plates, labels and inscriptions shall be submitted to the Project Manager for approval before manufacture.

#### **4.4 Lubrication**

A complete schedule of recommended oils and other lubricants shall be furnished by the Contractor. The number of different types of lubricants shall be kept to a minimum. The schedule and the name of the supplier of the lubricants shall be submitted to the Project Manager for approval before incorporation in the instruction manuals. In the case of grease-lubricated roller bearings for electric motors a lithium-based grease is preferred.

Where grease is the lubricant, preference shall be given to a pressure system which does not require frequent adjustments or recharging. Where necessary for accessibility, grease nipples shall be placed at the end of extension piping and, when a number of such points can be grouped conveniently, the nipples shall be brought to a battery plate mounted in a convenient position. `Hydraulic' button-head type nipples, in accordance with BS 1486, shall be used for normal grease and all grease nipples shall be of the same size and type throughout the Plant as far as possible. Arrangements shall be provided to prevent bearings being overfilled with either grease or oil.

The Contractor shall supply grease-gun equipment for each type of nipple provided. Where more than one special grease is required a grease-gun for each special type shall be supplied and permanently labelled.

Oil containers shall be supplied complete with oil-level indicators of the sight glass type, or where this is not practicable, with dipsticks. The indicators shall show the level at all

temperatures likely to be experienced in service. The normal, maximum and minimum levels shall be clearly visible to an operator standing on the normal access floor to the particular item of Plant. The sight glasses shall be easily dismantled for cleaning.

#### **4.5 Initial Charges of Oil etc.**

The initial charges of oil, grease, electrolyte and similar materials necessary for the correct setting to work and operation of the Plant shall be included in the appropriate Plant item.

#### **4.6 Welding**

Welding procedure specifications shall be prepared and submitted to the Project Manager. They shall detail steel grades, joints design, material thickness, welding process, consumables, principal welding positions, working/pre-heating temperature and post-weld heat treatment.

Welding shall be carried out only under the direction of an experienced and competent supervisor.

No such welding shall be carried out before the Project Manager or Inspection Authority has approved the details proposed. No alteration shall be made to any previously approved detail of welding preparation without prior approval of the Project Manager. Welders shall be qualified in accordance with the requirements of BS 4872 or BS 4871 as applicable.

The welding plant shall be capable of maintaining at the weld the voltage and current specified by the manufacturer of the electrodes. The Contractor shall supply instruments for verifying voltage and current as and when required by the Project Manager.

Unless otherwise described in the Specification, metal-arc welding shall comply with SII 0192-78, or BS 5135, or ASTM A-671, as appropriate. Tack welds and temporary attachment shall follow the procedures laid down in BS 5135. The position of welds for temporary attachment shall be agreed by the Project Manager.

Radiographic examination, which may be required of highly stressed fusion welds shall comply with the provisions of BS 2600 or BS 2910 or other equivalent standard, except where otherwise specified or ordered by the Project Manager.

Mechanical and other non-radiographic tests, if required, shall be carried out in the presence of the Project Manager, or the Inspection Authority.

#### **4.7 Castings**

The structure of the castings shall be homogeneous and free from non-metallic inclusions and other defects. All surfaces of castings which are not machined shall be smooth and shall be carefully fettled to remove all foundry irregularities.

Minor defects not exceeding 0.25 mm in depth or 12.5% of total metal thickness whichever is



less and which will not ultimately affect the strength and serviceability of the casting may be repaired by approved welding techniques. The Project Manager shall be notified of larger defects and no repair welding of such defects shall be carried out without his prior approval.

If the removal of metal for repair should reduce the stress-resisting cross-section of the casting by more than 25%, or to such an extent that the computed stress in the remaining metal exceeds the allowable stress by more than 25%, then that casting shall be rejected.

Castings repaired by welding for major defects shall be stress-relieved after such welding or as otherwise instructed in writing by the Project Manager.

Non-destructive tests may be required for any casting containing defects whose effect cannot otherwise be established, or to determine that repair welds have been properly made.

Unless otherwise specified castings shall be produced to the following standards or equal:

|                         |         |  |
|-------------------------|---------|--|
| Grey-iron               | BS 1452 | Grade 220  |
| Carbon steel            | BS 3100 | Steel alloy  |
| Stainless steel         | BS 3100 | Steel 316C16   |
| Copper and copper alloy | BS 1400 | Group A grade LG 2<br>Group B grade CT1, AB2<br>Group C grade G1 |

#### **4.8 Forgings**

All major stress-bearing forgings shall be made to a standard specification, which shall be submitted to the Project Manager for approval before work is commenced. They shall be subject to internal examination and non-destructive tests for the detection of flaws, and shall be heat-treated for the relief of residual stresses. The name of the manufacturer and particulars of the heat treatment proposed for each such forging shall be submitted to the Project Manager, who may decide to inspect such forgings at the place of manufacture.

#### **4.9 Non-metallic Materials**

Fabrics, cork, paper and similar materials, which are not subsequently to be protected by impregnation, shall be treated, with an approved fungicide. Sleevings and fabrics treated with linseed oil varnish will not be permitted.

The use of organic materials shall be avoided as far as possible but where these have to be used they shall be treated to make them fire resistant and non-flame propagating.

The use of wood shall be avoided as far as possible. If used, woodwork shall be thoroughly seasoned teak or other approved hardwood, which is resistant to fungal decay and other blemishes. All woodwork shall be treated to protect it against damage by fire, moisture, fungus, vermin, insect, bacteria or chemical attack, unless it is naturally resistant to all these. All joints in woodwork shall be dovetailed or tongued and pinned. Metal fittings on wood

shall be of non-ferrous material. Adhesives shall be specially selected to ensure the use of types, which are impervious to moisture and fungus growth. Synthetic resin cement shall be used for joining wood.

#### **4.10 Engineering Hardware**

Nuts, bolts, studs and washers for incorporation in the Works shall conform to the requirements of the appropriate British, DIN or other approved standard. Nuts and bolts for pressure fittings shall be of the best quality steel machined on the shank and under the head and nut.

Bolts shall be of such a length that one thread shall show through the nut when in the fully tightened condition.

Fitted bolts shall be a light driving fit in the reamed holes they occupy, shall have the screwed portion of such a diameter that it will not be damaged in driving and shall be marked in a conspicuous position to ensure correct assembly at site.

Washers, locking devices and anti-vibration fittings shall be provided where necessary to ensure that no bending stress is caused in the bolt.

Where there is a risk of corrosion, bolts and studs shall be designed so that the maximum stress in the bolt does not exceed half the yield stress of the material under all conditions.

All bolts, nuts and screws that are subject to frequent adjustment or removal in the course of maintenance and repair shall be made of nickel-bearing stainless steel.

The Contractor shall supply all holding down, alignment and levelling bolts complete with anchorages, nuts, washers and packings required to attach the Plant to its foundation, and all bedplates, frames and other structural parts necessary to spread the loads transmitted by the Plant to concrete foundations without exceeding the design stresses.

Unless otherwise necessary to meet special requirements all thread shall be of preferred metric sizes with standard coarse threads.

ISO metric black hexagon bolts, nuts and screws shall comply with SII 0589-81, or ISO 885, ISO 888, ISO 898-1 and -2.

ISO metric precision hexagon bolts, nuts and screws shall comply with ISO 272, ISO 4759-1, ISO 885, ISO 888, ISO 898-1 and -2 or ASTM F-593, ASTM F-468 M, strength grade 8.8.

The dimensions of ISO metric countersunk head bolts screws, and hexagon nuts shall comply with ISO 225, or ISO 888, ISO 898-I.

Plain steel washers for use with ISO metric bolts shall comply with ISO 887 or ASTM F-844.

Taper steel washers shall comply with ASTM F-844 and ASTM F-436.

#### **4.11 Instruments**

Unless otherwise specified, any indicating and recording instruments supplied under the Contract shall be of the flush-mounted pattern with dust- and moisture-proof covers and shall be suitable for the environment in which they are installed. Where hinged covers are necessary, they shall be provided with locks.

Indicating instruments shall be of the dial type and shall be provided with a readily accessible zero adjustment.

Dials in general shall be white with black markings and not subject to fading. Scales shall be of such material that no peeling or discoloration will take place with age under humid conditions.

The use of iron and steel screws shall be avoided in instruments and electrical relays wherever possible.

Steel screws, when used, shall be zinc, cadmium or chromium-plated, or where plating is not possible due to tolerance limitations, shall be of stainless steel. All wood screws shall be of dull nickel-plated brass or of other approved finish. Instrument screws (except those forming part of a magnetic circuit) shall be of brass or bronze. Springs shall be non-rusting materials, e.g. phosphor-bronze or nickel-silver, as far as possible. Pivots and other parts for which non-ferrous material is unsuitable shall be of stainless steel.

#### **4.12 Spare Parts**

The Contractor shall supply all spare parts necessary for the continuous operation of the Plant for a minimum period of two years, and shall describe such spare parts in the Schedule of Spares.

The spare parts shall comply with the Specification and be new, unused and readily interchangeable with the parts for which they are replacements.

Spare parts shall not be packed with any items of Plant for erection or installation.

Each spare part shall be clearly marked with its identification reference and a detailed list shall be enclosed in each package containing spares.

They shall be treated and packed to afford adequate protection during transit and for an extended period of storage at the Site. All containers shall be clearly marked 'SPARE PARTS' together with sufficient information to allow complete identification of the spares and date of supply or packing.

Electrical and mechanical spares shall be packed and crated separately. Spares for different items of Plant shall not be mixed in the same container.

All cases, containers or other packages are liable to be opened for examination as the Project Manager may require, and packings shall be designed to facilitate opening and subsequent repacking.

#### **4.13 Special Tools and Test Equipment**

The Contractor shall supply a complete set of special tools and test equipment necessary for maintenance or testing of any part of the Plant to be carried out during the life of the Plant, whether of an electrical, mechanical or any other nature.

The tools and test equipment shall not be used for the erection of the Plant and shall be handed over in a new and unused condition excepting that the Project Manager may call upon the Contractor to prove their effectiveness.

The tools and test equipment shall be boxed separately in suitable containers marked or labelled with their contents.

All cases, containers or other packages shall be designed to facilitate opening and subsequent repacking.

When specified, tools and test equipment for internally sited Plant shall be mounted in suitable cabinets with lockable doors. Racks or clips shall be provided for individual items with outline markings and labels showing which tools or equipment are missing. The cabinets shall be wall mounted with best quality finish and appearances.

#### **4.14 Centrifugal Pumps**

Centrifugal pumps shall have head/quantity characteristics, which fall continuously from the maximum pressure at closed valve conditions and which are steep in order that variation in head shall have a minimal effect on the quantity discharged.

The preferred design speed of pump is 1,500rpm. Pump motor ratings shall exceed the maximum pump power consumption over the operational range of the pump by at least 10%. Waterways through the pump shall be smooth in finish and free from recesses and obstructions. Impeller passageways shall be as large as possible. The leading edges of the impeller vanes shall be rounded and smooth.

Water velocities in the suction or delivery branches of a pump shall not exceed 8 m/s when the pump is operating within its specified duty range and within this working range there shall be no discernible noise due to hydraulic turbulence or cavitation within either the pump or its associated pipework and valves.

The NPSH requirements of the pumps, based on the 3% output drop criterion shall be at least 2 m less than the NPSH available at every working condition.

The pump shaft shall be of alloy steel forgings compatible with the impeller and the impellers

and shaft sleeves shall be secured to the shaft by means of a key or keys. The impeller retaining nut shall be fitted with a locking device.

All parts exposed to wear shall be adequately protected by means of renewable sleeves, bushes, wear rings e.t.c. which shall be arranged for easy inspection, adjustment, or replacement without removal of the pump casings, pipework e.t.c., or the need to disturb the drive shaft alignment.

The pump thrust shall be taken by a combined thrust and radial type bearing assembly capable of taking the weight of the moving parts and the hydraulic loads under all conditions of operation with a minimum life of 100 000 hours.

Bearing cooling arrangements if used shall be designed on the closed-circuit principle; open discharge of cooling water into the pumping station drainage system is not permissible.

The pump casing and other parts of the pump subject to pressure shall be hydraulically tested by the manufacturer to at least one and a half times the maximum working pressure.

Integral inlet and discharge flanges shall be provided and integral lifting lugs shall be incorporated.

Facilities shall be provided for the removal of air during priming and for draining.

Glands may be fitted with mechanical seals or conventional soft packing. The gland arrangement shall be designed for easy adjustment and removal of the seal.

When soft packed glands are used suitable means shall be provided for collecting and preventing splashing of the gland leakage water.

Drainage and gland leakage water shall be piped into the building drainage system.

The shafts of pumps fitted with conventional packed glands shall be fitted with removable gland sleeves.

The rotating element of the pump and the motor shall be readily removable from the pump casing without the need to disconnect the adjoining pipework.

Rotating assemblies of pumps of 100 mm diameter inlet and over shall be statically and dynamically balanced and shall be designed so that the first critical speed is at least 50% greater than the maximum operating speed.

Lubrication arrangements shall be so designed that there is no contamination of the pumped fluid.

On pumps of 75 mm inlet and over, tappings shall be provided at both the suction and discharge flanges of suitable size for pressure gauges.

#### **4.15 Vertical Mixed Flow Bowl Pump**

Pump sets shall be of the vertical spindle suspended bowl mixed flow types, single or multistage. The pumps shall be designed to discharge above ground, the pump bowl and bell mouth being submerged in a sump with the discharge pipe situated in the pump house. The pump motor shall be vertical, close coupled and flange-mounted.

The impeller and shaft sleeves shall be manufactured in gunmetal and the suspension pipes shall be of cast iron to BS 1452 grade 260 or equal. The pump shaft shall be of high tensile steel to BS 970 grade 070M20 or equal and the motor support pedestal shall be of cast iron or fabricated mild steel.

The external wetted areas of the pumps shall be finished with a two pack epoxy/coal tar paint; other parts shall be finished in an epoxy based machinery gloss paint. All paint shall have a minimum dry film thickness of 200 microns.

The thrust bearings shall be oil or grease lubricated, the pump design shall prevent lubricant from contaminating the pumped flow. The shaft journal bearings shall be either of ceramic or of synthetic rubber. Where bearings of synthetic rubber are proposed they shall be water flushed prior to pump start up. A clean water lubrication system shall be provided for each pump. Where ceramic bearings are proposed product water lubrication without pre-lubrication is acceptable, subject to evidence of satisfactory and consistent performance in a similar application being supplied by the manufacturer.

The shaft seal shall be a soft packed gland and the pump shaft shall be fitted with a replaceable sleeve at each journal bearing and in the gland contact area.

The pump efficiency shall be maintained over the whole of the specified duty range, even if this necessitates the use of a larger motor to provide peak power demands.

The preferred design speed of the pumps is 1500rpm.

The NPSH requirements of the pumps, based on the 5% output drop criterion shall be at least 2 m less than the NPSH available at every working condition. Water velocities in the delivery branch of a pump shall not exceed 5 m/s when the pump is operating within its specific duty range and within this working range there shall be no discernible noises due to hydraulic turbulence or cavitation within either the pump or its associated pipework and valves.

#### **4.16 Sump Pumps**

Sump pumps used throughout the Contract shall, where practically possible, be identical. Sump pump duties shall include for:

- The removal of gland leakage and drainage water during maintenance of pump and/or pipe work within one hour.
- The emptying of the pump sump within 10 minutes.

Sump pumps shall be designed to pass solids of sizes less than the inlet parts of the pump and/or at least 20 mm diameter.

#### **4.17 Pump Performance Guarantees**

The pump performance guarantee shall relate to the flow rate, the total head and the efficiency of the pump when tested at the manufacturer's work.

The pump shall operate at its design point within acceptance tolerances for flow rate and total head laid down in Clause 9.4.1 of BS 5316: Part 2 (= ISO 3555).

Each pump shall be tested at the manufacturer's factory in accordance with BS 5316: Part 2 (ISO 3555) or other relevant standards in conjunction with one of the contract motors.

This test shall be carried out on at least one pump set using the flexible coupling and contract drive shaft arrangement to establish that the drive arrangement with supports and couplings operates satisfactorily under all operating conditions.

Where similar drive shaft arrangements have been installed by the Contractor and have been proven satisfactory in service this requirement may be withdrawn subject to the approval of the Project Manager.

A test shall be carried out of the performance from closed valve to the maximum quantity that can be delivered under abnormally low discharge heads.

Sufficient readings shall be taken at each test to produce accurate curves of the heads, flow, pump speed and power required at pump coupling throughout the operating range of the pump.

Vibration and noise dB(A) levels shall be measured and shown to be acceptable. The Contractor shall provide acceptable test certificates, showing the NPSH requirement for the pump is at least 2 m less than the NPSH available under all working conditions.

In the absence of the approved test certificates the supplier shall carry out a test on one pump of each type to verify the NPSH requirement based upon the 3% output drop criterion.

Test Certificates in duplicate shall be submitted to the Project Manager immediately following each of the tests mentioned above. Performance curves shall also be incorporated in the Operation and Maintenance Manual.

(a) **Single Pump Operation**

Head/quantity curve

Motor kW input/quantity curve

Overall efficiency/quantity curve

NPSH required/quantity curve

(b) Parallel Pump Operation

Head/quantity curves

#### **4.18 Electric Motors**

##### **4.18.1 General**

Electric motors shall comply with BS 4999 and BS 5000 and rated on the basis of duty type S1 (maximum continuous ratings).

Motors shall be suitable for two starts in succession from hot under the specified duty conditions of load torque and inertia and shall also be suitable for six equally spaced starts per hour under similar conditions.

Motor starting currents shall not exceed 6 x full load current as determined by the locked rotor test.

Motors shall be designed to operate continuously within the voltage range of 94% and 106% of rated voltage and between the frequency range 95% and 102% of nominal frequency.

Motors shall be capable of operating under conditions of three phase supply imbalance where the negative and zero phase sequence components of the voltage do not individually exceed 2% of the positive phase sequence components.

The motor shall be designed for the method of starting as follows:

- Designate N for direct on-line starting;
- Designate NY for star-delta starting;
- Designate D for direct on-line starting with reduced starting current.

##### **4.18.2 Construction**

Motor construction shall provide a degree of protection as follows:

- IP 44 - internal general industrial and pumping duty;
- IP 54 - external use or applications in dusty environments;
- IP 55 - external use in exposed locations.

Motor mounting arrangement shall be to suit application.



The motors shall be tropicalized.

Motor cooling shall be in accordance with ICO 141 (totally enclosed fan cooled) or ICO 661 (forced ventilation). Other forms of ventilation may be used with the approval of the Project Manager.

Motor bearings shall be provided with facilities to add additional lubricant. For grease lubricated bearings grease nipples shall be provided and a grease relief feature incorporated. Oil lubricated bearings shall be provided with site glasses which provide an accurate indication of bearing oil level when the motor is in use.

Motors shall be designed for normal sound power as defined by BS 4999. Windings shall be insulated to class F as defined by BS 2757.

Where specified motor windings shall incorporate:

- thermistors (PTC type), or,
- resistance thermometers (PT 100).

In each instance the temperature detecting devices shall be in close thermal contact with each phase of the stator windings. All thermistors shall be connected together to provide a single electrical circuit for connection to an external relay, which will be capable of tripping the motor.

Motors shall have the direction of rotation clearly indicated on the driving end.

Each resistance thermometer shall be connected separately to an external monitor relay, which shall offer alarm and trip settings.

Thermal protection shall be Class I or Class II for sizes of motor of 75 kW and below and Class II above 75 kW. Anti-condensation heaters shall be fitted to motors rated 11 kW and over. A warning label, red letters on a white background shall be fitted to indicate that the heater may be energised. Heater terminals shall be shrouded. On larger motors a separate terminal box shall be provided.

Anti-condensation heaters shall be sized to raise the temperature inside the motor several degrees above the dew point temperature. The heater surface temperature should not exceed 20°C.

Heaters shall be automatically disconnected when the motor is switched on.

### **4.18.3 Cable Terminations**

Cable termination boxes shall be suitable for air termination of cables. They shall be sealed with a neoprene gasket to provide dust and weather protection.

Cable boxes for voltages in excess of 1 000 V shall be treated with anti-tracking varnish.

Phase segregated terminal boxes shall be used for voltage of 11 kV and above.

#### **4.19 Submersible Pumps**

Submersible pumps shall be of the single entry design supplied complete with boltless self-aligning duck-foot assemblies giving automatic connection to the discharge pipework. The pump casing shall be manufactured from close grained grey iron to BS 1452.

An oil filled casing shall separate the electric motor from the centrifugal pump. Mechanical seals shall be fitted to the pump shaft, which shall prevent water from entering the oil casing, and oil from entering the motor casing. A moisture detection system shall be provided to initiate an external alarm.

The motor housings shall be impregnated to protect the ingress of moisture.

The shaft bearings shall be sealed and lubricated for life.

Each pump shall be provided with its own galvanised steel guide rails, fittings and all necessary support brackets. A suitable lifting chain shall be attached to each pump to enable the pumps to be raised and removed from the wet well without the necessity for personnel entering the well. The lifting chain shall comply with BS 1663 or BS 3113 and BS 4942.

The submerged cable shall be a multi-core flexible cord, vulcanised rubber insulated with tough rubber sheath and outer PCP sheath to BS 6500.

Where both thermal protective and moisture-sensitive devices are incorporated within the pump, both devices shall be brought out via separate conductors within the motor cable, although one such conductor may be common.

#### **4.20 Pipework and Layout - Pumping Stations**

In general all pipes and fittings shall be steel or ductile iron with flanges to BS 4504.

Where steel and cast flanges are mated together the steel flange shall be machined over its full face, after welding to its respective pipe is completed.

Flexible joints shall be provided to facilitate installation and removal and/or differential movement of plant. Where required, flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrust along the pipework as a whole.

The pipework shall be laid out and designed such as to facilitate its erection, painting in-situ, dismantling of any section for maintenance and to give a constant and uniform flow of working fluid with a minimum loss in head. Where steel pipework is used the number of

flanges is to be kept to a minimum with the size of each unit of pipework determined by the ease of handling, installation and general appearance of the completed pipe system. Positions of flanges shall take into account any necessary concrete pipe supports or thrust blocks.

Facilities shall be provided for draining the pipe system. Where a pipe passes through a wall, retaining wall or is subject to thrust it shall incorporate a puddle flange, which shall conform to the dimensions stated in BS 4504 but remain undrilled.

Unless otherwise specified, nuts, bolts and washers for pipework shall conform to the requirements of BS 4504.

Bolts shall be of sufficient length that one thread shall show through the nut when in the fully tightened condition.

#### **4.21 Gaskets and Joint Rings**

Joint rings shall be manufactured to conform to BS 2494 and shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80°C.

Joints shall be made in accordance with manufacturer's instructions or as specified herein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any constituent soluble in water of the quality stated in the Specification, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

After cleaning the flanges the gaskets shall be fitted smoothly to the flange and the joint made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using standard spanners.

Graphite grease shall be applied to the threads of bolts before joints are made.

#### **4.22 Steelwork**

The ladders, platform, covers and handrails to be supplied and fixed under this Contract are indicated on the Drawings or detailed in the Specification.

Any small areas of chequer plating or similar covering that are necessary to cover gaps between items of Plant and the surrounding structure, and any access ladders, platforms and handrails that must be attached to items of Plant to facilitate operation, inspection or maintenance, shall be supplied and erected by the Contractor.

The Contractor shall include in his Contract for providing adequate means of access to all hand wheels, sight glasses, gauges, lubrication points and any other items to which access is necessary for routine maintenance.

Handrails shall consist of double ball forged steel standards with tubular rails, hot dip galvanised in accordance with BS 729.

Chequer plating shall be of 'Durbar' or other non-slip pattern, not less than 4.5 mm thick (exclusive of pattern) and hot dipped galvanised after fabrication in accordance with BS 729.

Aluminium alloy flooring may be offered as an alternative, manufactured in accordance with BS 1470, material H30 TB.

#### **4.23 Pressure Gauges**

Pressure gauges shall comply with BS 1780 and shall not be less than 100 mm in diameter.

Unless otherwise specified, scales shall be calibrated in metres head of water, with zero representing atmospheric pressure. The lettering shall be in black.

Compound gauges shall read at least 5 m below atmospheric pressure using red lettering.

Where the working fluid is of a corrosive or dirty nature the pressure gauge shall be protected from the working fluid by a diaphragm or similar arrangement.

Each pressure gauge shall be fitted with a stopcock immediately adjacent to the gauge and all pressure gauge piping shall be fitted with an isolating valve at the point of connection to the main system.

Where pressure gauges are mounted within or on a panel a suitable connection for a test gauge shall be provided.

#### **4.24 Surge Vessels and Equipment**

Vessels shall be designed, constructed and tested to BS 5500. As a minimum requirement, but not limited to, the vessel shall include:

- Saddle supports and legs complete with holding down bolts;
- Drilled and tapped or flanged facings for and including the following fittings:
  - ♦ Pressure relief air valve rated for not less than 150% working pressure and to pass 200% maximum flow into vessel.
  - ♦ Adequate access to afford inspection of the inside of the vessel and to the top of the vessel by means of a ladder.

- ◆ Calibrated level sight glass of the reflective type covering the full range of water level in the vessel and having top and bottom shut-off cocks and hinged safety glass and pressure/level calibrations carried on a substantial engraved plate.
- ◆ Air vent and inlet valves.
- ◆ 150 mm diameter pressure gauge and isolating cock.
- ◆ Lifting lugs to enable handling of the vessel on Site without damage to the painted surfaces.
- ◆ Flanged inlet and outlet branch.
- ◆ Drain valve.
- ◆ Level control signals will be provided by a magnetic float switch with a mouse running up and down the external sights. The float switch shall be fitted with low/high level setting for air compressor control and low/high levels for alarms. Controls and alarms shall be timed out during transient conditions.

The Contractor will be required before ordering the equipment to submit detailed computer calculations done by the pump supplier for the Project Manager's approval. These shall show the maximum and minimum pressure developed in the protected and unprotected states.

The Inspecting and Regulating Authority will be Lloyds, TÜV (TECHNISCHER ÜBERWACHUNGSVEREIN) or equivalent regulating authority approved by the Project Manager.

#### **4.25 Compressors**

The compressors shall be rated for continuous operation at full duty.

Cylinder heads shall be readily removable for inspection. Each cylinder shall be constructed to provide easy replacement and maximum cooling.

All necessary fittings shall be provided including the following:

- Air line check valve
- Delivery pipe isolating valve
- Air filters.

Medium duty air compressor units, shall comprise:

- Reciprocating air compressor
- Induction drive motor
- Air receiver and filter
- Direct on-line starter and control panel
- Silencer
- Oil lubricator
- Oil eliminating filter
- Air delivery line including check valve, isolating valve, moisture trap and pressure regulator.

Compressors shall be tested in accordance with BS 1571.

Outlet pressure gauges shall be provided, and each gauge shall incorporate low and high pressure sensitive micro-switches with changeover contacts. Adjacent to the pressure gauge shall be fitted a pressure relief valve rated to pass at least 150% of the compressor's rated flow at 150% of the working pressure.

#### **4.26 Air Blowers**

Air blowers shall be of the Roots type, capable of delivering oil-free air at the specified output pressure and volume.

The bearing housing and gearboxes shall be separated from the blower housings by an air space. The bearings shall be generously designed to give long operational life. Bearings at the drive end may be oil or grease lubricated. The gears and bearings at the non-drive end shall be oil lubricated. Bearings shall be provided with oil throwers to prevent leakage of oil. The blower shall be arranged for horizontal inlet and delivery velocity not exceeding 25 m/s and each blower shall be provided with:

- Inlet silencer and filter
- Non-return valve in delivery branch
- Gate valves in both inlet and delivery branches
- Pressure relief valve or excess pressure safety device
- Bellows type couplings on inlet and delivery branches.

The interconnecting pipework shall be flanged. A drain cock shall be provided at the lowest point in the pipework.

#### **4.27 Electrodes**

Electrodes shall be stainless steel rods with PVC coating and housed in appropriate enclosures. Means shall be provided for adjusting the length of each electrode by a minimum of 75 mm without cutting. External enclosures shall be totally weather-proof to IP 55 with tapped cable entries.

Holder, subjected or liable to flooding shall be gasketed between cap and body and fitted with a sealed external terminal for connection with the electrodes.

Electrodes for alarm, or level control of surge vessels shall have robust, water and airtight heads fitted to the top of the vessel. Suitable arrangements shall be provided for the withdrawal of the electrodes, without the need for access to the inside of the vessel.

In all applications a separate electrode shall be provided for the earth return circuit.

Each alarm or control signal shall be initiated from a separate single electrode unit. Multi-electrode units will not be accepted.

The relay control box shall be totally weather-proof to IP 55 and suitable for wall mounting.

The relay control box shall include a hand-off-auto switch, in line fuses and neon lamp indicating the relay condition.

The alarm and control contacts in the relay box shall be set for 'fail safe'. In the event of the electrical supply to the relay box failing or the signal cabling being damaged, the alarm and control circuiting will be initiated.

The sensitivity shall be adjustable between 100 and 20 000 ohms and the switching differential better than 5% of sensitivity setting.

The supply voltage shall be 110 V, 50 Hz. The electrodes circuit shall be 25 V maximum open circuit, 30 mA short circuit. The relay contacts shall be rated for 5 A and 220 V, 50 Hz inductive load.

#### **4.28 Electromagnetic Flow meters**

Flow meters shall be of the fully submersible electromagnetic type suitable for fitting in a chamber outside the pump station, in accordance with BS 5792 with protection to IP 67.

Flow meters installed in steel pipelines, which are to be cathodically protected, shall be provided complete with insulating flanges, continuity bonding, earthing, etc.

Flow meters shall be flanged and rated to suit the delivery pipework and provided with a detector head and associated equipment to provide a linear 4 to 20 mA dc output, proportional to the rate of flow. Any equipment required to operate in conjunction with the flow meter shall be fully submersible or mounted in a location not subject to flooding.

The calibrated accuracy shall be better than  $\pm 0.5\%$  of actual flow from full scale flow rate to 50% flow rate increasing progressively to  $\pm 1\%$  of actual flow rate at 10% flow. Flow meters shall be installed in accordance with the manufacturer's instructions and with a minimum of five diameters straight pipe upstream and two diameters downstream.

#### **4.29 Adjustable Weir Plates**

The adjustable weir plates shall be manufactured from 316 stainless steel, or GRP to the approval of the Project Manager.

Weir plates shall be complete with fixing nuts, bolts and washers and suitable for a total vertical adjustment of 100 mm. Fixings shall be designed for ease of accurately levelling the plates, securing the plates, and shall enable the plates to be adjusted during the life of the Works to accommodate differential settlement of the structure. By the instructions of the Project Manager to all weir places there to install a scale with l/s indicated. The scale should be of stainless steel and the numbers should be milled in.

#### **4.30 Stop Gates and Stop Logs**

##### **4.30.1 Stop Gates**

Stop gates shall be of epoxy coated welded steel construction, with a vertical skin plate supported on a series of horizontal beams connected to vertical end members.

The gate shall be arranged to seal at the sides, top and bottom against water pressure acting from the upstream side of the gate.

Resilient seals shall be secured to the gate. The seals shall be adjustable and seal fixing bolts and nuts shall be of a corrosion resisting material to facilitate seal replacement.

Guide rails, lintel and sill shall be epoxy coated mild steel or 316 stainless steel and provided with adjusting and fixing devices to enable them to be accurately positioned and suitable for sealing in either direction.

Stop gates shall incorporate pressure equalising valves to enable the gate to be lifted under balanced hydraulic conditions.

Stop gates shall be fitted with lifting hooks and one stop gate lifting frame shall be supplied for each installation.



### **4.30.2 Stop Logs**

Stop logs shall be constructed from steel rectangular hollow sections and epoxy coated, complete with inter-log sealing strips and lifting hooks.

Stop logs shall be supplied with epoxy coated mild steel or 316 stainless steel guide rails for wall or channel mounting, as required, and complete with fixing bolts. Resilient seals shall be securely fixed to the guide rails by corrosion resistant materials to facilitate seal replacement.

A stop log lifting frame shall be supplied for each installation.

### **4.31 Standby Generator Set**

The generator set shall be used to provide all or part of the electricity requirements for the works in the event of a UEDCL power failure.

The set and its auxiliaries shall be mounted on a substantial skid under-base. The under-base shall be sufficiently rigid to prevent distortion when the set is being hauled into position. Means for the attachment of lifting slings shall be provided on the under-base.

The engine-alternator unit shall be mounted on a fabricated steel sub-frame, which is attached to the skid base by oil resistant resilient mountings. Where possible, all other accessories shall be mounted on the skid base so that they are free of vibration from the engine-alternator unit.

#### **4.31.1 Performance**

The generating set shall be designed to provide a 3 phase, 415 volt, 50 Hz supply at full load and shall be capable of sustaining a minimum of 10% over load.

The steady state voltage shall be maintained within + 2.5% of rated voltage at any load between no load and 110% full load, unity to 0.8 power factor lagging, hot or cold.

After any change of load the voltage shall not vary by more than +10% of the rated voltage and shall return to within 3% within 2 seconds. The voltage overshoot to starting shall not exceed 10% and shall return to within 3% in not more than 2 seconds.

The frequency regulation of the set shall be such that when it is taking full load at rated frequency and the load is suddenly removed, the frequency shall not rise above 110% of that frequency and shall return to within 105% within 3 seconds. The resultant steady rate frequency shall not exceed 104%. If full load is then re-imposed, the frequency shall not fall below 94% and shall return to 99% within 3 seconds and ultimately to the rated frequency.

The cyclic irregularity of the set at full load shall not be worse than 1/150.

The deviation of the waveform of the line voltage output from a pure sine wave shall not

exceed the limits specified in BS 5000 Part 99 but no single harmonic shall exceed 2%.

#### **4.31.2 Diesel Engine**

##### **4.31.2.1 General**

The diesel engine shall be automatic priming, cold starting, and multi-cylinder compression ignition type, in accordance with BS 5514. The engine shall operate on a 4-stroke cycle with direct fuel injection and may be naturally aspirated turbo-charged.

The engine shall be designed for satisfactory operation on fuel oil to BS 5569: 1970 Class A or equivalent and a lubricating oil available from all major oil companies.

##### **4.31.2.2 Engine Speed**

Manual speed adjustment shall be possible within + 5% of the rated speed of any load.

The engine speed shall not be more than 1500 r.p.m. and a centrifugal speed switch shall be incorporated to shut down the unit should the speed reach 15% in excess of this nominal design indication of engine speed.

##### **4.31.2.3 Lubrication**

The set shall be provided with pressure lubrication from an integral gear driven pump, through full flow filters with renewable elements. An oil cooler strainer and a relief valve shall be fitted.

##### **4.31.2.4 Cooling System**

The engine shall be water cooled by radiator. The cooling fan shall be mechanically driven from the engine.

A radiator of the air blast type with pusher flow fan shall be supplied, provided with either separate sections for water and lubricating oil or arranged for jacket water cooling only in conjunction with a water/lubricating oil head exchanger. The radiator shall be capable of providing the total water and lubricating oil cooling requirements of the engine under conditions of continuous full load and on a 10% over load for one hour.

The radiator shall be mounted on the set and the radiator cooling air shall be ducted from the exterior of the building.

Circulation of the jacket water and lubricating oil through the respective radiator sections and/or heat exchanger shall be by means of pumps, driven by the diesel engine.

**4.31.2.5 Air Intake**

Dry type air filters suitable for high dust concentrations shall be fitted on the engine air intake. The filters shall comply with BS 1701.

**4.31.2.6 Exhaust System**

The generating sets shall be provided with an exhaust ducting which shall duct all exhaust gases through the wall of the building as indicated on the drawings.

The exhaust system wall is adequately lagged such that it will not contribute significantly to an increase in the ambient temperature of the Generator Room.

**4.31.2.7 Electric Starting**

Electric starting shall be provided by means of an electric starter motor operating from a 24 or 12 volts, maintenance free heavy duty lead acid battery.

Battery charging by 240V grid supply and regulator shall be provided for the set. The battery shall be capable of providing four starts in succession in an eight hour period.

**4.31.2.8 Engine Instruments**

The engine instruments shall include the following:-

- Oil Pressure (gauge)
- Water Temperature Gauge
- Hours Run Meter
- Tachometer
- Low oil Level Warning.

**4.31.2.9 Automatic Engine Protection**

An automatic engine protection device shall be fitted. This device shall shut the generator down should the engine oil pressure drop below a predetermined level or the coolant temperature exceed a safe value.

**4.31.2.10 Guarding**

Under operating conditions all live and moving parts shall be adequately guarded to prevent injury to personnel.

Any part of the equipment which reached temperatures in excess of 80 degrees shall be shielded by a solid or mesh screen to prevent accidental contact by personnel.

### **4.31.3 Alternator**

The alternator shall be directly coupled to the engine by means of a flexible coupling. Stator shall be of the foot-mounted type but spigot mounted to the engine flywheel housing to ensure correct alignment.

The alternator shall be of the brushless, fully laminated, rotating shield type with interconnected pole face damping bars. It shall be continuously rated, self-excited, and of the self-regulating type.

The alternator shall be capable of operating within the range + or - 2.5% of nominal voltage according to the trim setting of the automatic voltage regulator.

The six ends of the alternator windings shall be brought out to one terminal box. A diagram showing terminal marking and phase rotation shall be provided. It is intended that the windings be connected in star to give 3 phases and neutral. The installation materials shall conform to BS 2757 with thermal classification Class F. Windings shall be vacuum dried and pressure impregnated. The insulation shall be finished with an oil and moisture proof varnish.

The alternator shall be capable of withstanding a short circuit for 3 seconds, when under control of the automatic voltage regulator.

#### **4.31.3.1 Alternator Control Panel**

A control panel mounted on the generator base frame or on the floor of the generator-house shall incorporate the following items:-

- 1 No. Main Circuit Breaker with adjustable over load protection
- 1No. Over-temperature protection for windings
- 1 No. Frequency Meter
- 1 No. Hours Run Meter
- 1 No. Voltmeter
- 1 No. Mains operated Battery Charger with a meter
- 1No. Relay combination for automatic start up

- 1 No. Key operated control switch marked:- TEST/RUN/STOP/REMOTE

#### **4.31.4 Fuel Oil Storage Tank**

The Bulk fuel oil storage tank shall be of such capacity as to enable the generator to run continuously for 240 hours at  $\frac{3}{4}$  full load. The tank shall comply with the requirements of BS 799 Part 5 and shall be of the mild steel welded type complete with support and holding down bolts.

The tank shall be installed within a catchment basin and shall be complete with the following fittings:

- Manhole Cover and dipstick
- Vent Pipe
- Filling line complete with fill valve and hose connection fitting
- Oil draw off point complete with outlet valve and duplicate filters
- Drain valve (lockable)
- Access ladder and partial top platform
- Contents Gauge
- Access ladder into Bund Area if applicable.

Also included shall be equipment and pipework for emptying the catchment pit of either rainwater or fuel oil leakage, and a concrete slab on which to place the tank.

### **4.32 General Requirements for Switchboards**

#### **4.32.1 Construction**

Switchboards for the control of equipment rated at 3.3 KV or above shall conform to BS 162, 5227 and IEC 298.

Switchboards for the control of equipment rated at 415 volts shall conform to BS 5486 (IEC 439).

All switchgear, distribution boards, motor control centres, and other panels shall comprise factory built assemblies of the multi-cubicle type.

Panels shall be free standing, of uniform height, flush mounted, and totally enclosed to not less than IP 42 in accordance with BS 5420:1977 (IEC 144:1963). When size of starters and other components does not justify this type of construction, wall-mounting patterns may be used.

The base of the panel shall be effectively sealed against the ingress of vermin and termites, and all equipment shall be rated for continuous operation in a tropical climate.

Any ventilation louvers shall be backed by brass fine mesh gauze to exclude termites.

Framework for the panels shall be of welded construction, and panels shall be fabricated from mild steel sheet of 2mm minimum thickness, folded and braced where necessary to provide a rigid structure.

All metal work shall be treated in accordance with Part 4 of this Specification. All bolts, nuts, screws, hinges, handles, etc. shall be corrosion resistant.

Interiors shall be finished white, and the exterior shall be finished to a light grey shade except the plinth, which shall be black.

Cabling access shall be from the rear by means of gasketed bolt-on plates.

Access to the cubicles or cubicle compartments for all normal routine maintenance shall be from front by hinged and lockable doors fitted with neoprene gaskets (all gaskets shall be termite resistant) and chromium plated lockable tee type handles. All doors shall be electrically bonded to the main frame, using adequate flexible conductors, protected against mechanical damage. All locks on a given part unit shall be operated by the same key.

Each multi-compartment control panel shall comprise an assembly of individually constructed cubicles. These shall be assembled to include a metallic sheet between adjacent cubicles.

In each multi-compartment panel at least one empty compartment shall be provided for future use.

In single unit panel, enough space shall be available for the addition of at least 10% more components for future use.

Panel shall be readily capable of extension at either end, within the bus-bar rating.

Where panel size is excessive easily handled sections shall be supplied for site assembly. Sections shall be fitted with eyebolts, which after positioning of the panel, shall be removed and replaced with plated bolts and washers.

Bases shall be of rigid construction capable of withstanding stresses during replacement, such as those imposed by moving the sections on rollers.

#### **4.32.2 Bus Bars**

All bus-bars shall be of electro tinned HDHC copper, and shall be of uniform section throughout the length of the panel.

They shall be run in separate screened compartment, divided with barriers into as many compartments as there are cubicles in the panel. Access to individual compartments shall be via bolt-on cover plates, each bearing the legend in White on a Red background:-

“DANGER - LIVE BUS-BARS”, also the Red Arrow symbol denoting danger from electric shock.

The neutral bus-bars shall be not less than half the cross-sectional area of the phase bars. Phase bus-bars shall be colour coded Red Yellow and Blue: the neutral shall be black.

#### **4.32.3 Earthing**

Each panel shall be equipped with a copper earth bar running the full length of the panel rated to withstand without damage, the thermal and dynamic effects of earth fault currents. Minimum size shall be 25 x 3mm.

Vertical tee-offs shall serve all compartments in each cubicle, all connections shall be bolted and bolted faces shall be cleaned.

The Contractor will be responsible for ensuring that all components, sub-assemblies, gland plates, etc., are solidly bonded to earth using green/yellow PVC insulated copper conductors of not less than 2.5 mm<sup>2</sup> cross-sectional area. Reliance on metal-to-metal joints for electrical continuity will not be accepted.

#### **4.32.4 Control Circuits**

Control circuits shall be protected by M.C.B.

#### **4.32.5 Over and Under-Voltage; Phase Failure and Phase Sequence Protection**

The main incoming 415 volt switchboards and control panels shall be equipped with high or low voltage, phase failure and phase sequence protection, if specified under detailed specifications.

The Lovato Electronic Voltmeter Relay type RVT manufactured by the Officine Electromeccanica Lovato of Italy meets the requirement for this application. Alternatives may be offered for the approval of the Project Manager.

#### **4.32.6 Surge Voltage Protection**

All solid-state control or electronic devices, which may be located within the panel, shall be

individually protected by surge arresters.

#### **4.32.7 Small Wiring**

All small wiring shall be 600/1000 volt grade multi-stranded copper wires, complying with BS 62311:1978, and of minimum cross section  $1.5\text{mm}^2$ . PVC insulation shall be used up to  $70^\circ\text{C}$  for temperatures in excess of this, (e.g. for final connections to heaters) fire resistant cable such as Pirelli FP 200 or equivalent shall be used.

Wiring looms shall be neatly bunched using proprietary straps and cleats. Alternatively plastic ducting may be used. Self-adhesive fixings are not acceptable.

All wires shall be fitted at each end with insulated pin type crimped terminations, to avoid splaying of the strands, and shall additionally be identified at each end, in line with the schematic diagram.

Identification ferrules shall be of the interlocking ring type, engraved black on white. Colour coded types will be accepted only if they are also number engraved. 'C' type or Adhesive markers are not acceptable.

Earth wires shall be green/yellow. Wiring shall not obscure components or labels, nor interfere with access to components, and shall be protected against damage by the use of grommets where necessary.

Terminations shall be made leaving sufficient length to allow making off again, if this proves necessary.

Identification ferrules shall be arranged so that wiring can be easily traced from the front of the compartment.

#### **4.32.8 Terminals**

Terminal board insulation shall be polyamide or equivalent. Melamine types are not acceptable.

All connectors shall be of brass or bronze, with screws of similar material. Contact between dissimilar metals is not acceptable. No steel screws plated or otherwise, shall be used. Insulating barriers shall be fitted between supplies at different voltages.

All terminal screws shall be captive.

Maximum two conductors shall be connected to each terminal. Multiple connections shall be effected using links.

Main power terminals shall be stud and nut types, with plain and locking washers. Conductors



terminating on these shall be fitted with insulated crimped lugs. Rail mounted terminals for cables in excess of 35 mm<sup>2</sup> cross-sectional area are not acceptable.

#### **4.32.9 Gland Plates**

Adequately sized blank gland plates shall be provided below each outgoing terminal section to accommodate the requisite glands.

Suitably sized compression type cable glands shall be provided for all cables. Glands used for armoured cable shall include provision for sealing the armour wires to protect them from corrosion and to prevent ingress of moisture into the cable.

Brass lugs shall be provided for connection of the cable armouring to earth.

#### **4.32.10 Anti-Condensation Heaters**

Heaters shall be fitted in every compartment, and controlled via an adjustable thermostat.

Heater locations shall be selected to avoid damage to components and wiring, and they shall operate at black heat.

Each heater shall be separately fused, and the final 100mm of wiring shall have heat resistant insulation. (see Clause 4.32.7).

Heater supplies shall be derived via compartment isolators. Heater switches shall be labelled "ON" and "OFF".

#### **4.32.11 Door and Desk Mounted Components**

All indicating instruments shall be moving iron type with a quadrant scale of minimum length 75mm and conform to IEC 51. Their accuracy shall be to class 1.5 or better.

All instruments and protective relays shall be flush mounted and effectively sealed against ingress of moisture, dust and insects.

Where connected in motor circuits, ammeters shall have 'overload' scales capable of withstanding starting inrush current.

Hours run counters shall be flush mounted cyclometer type, scale 99,999.9 hours.

Control and selector switches shall have their positions clearly labelled, and additionally shall each have a separate label to indicate the switch function. Labels shall correspond with the associated schematic diagrams.

Interlocks of a substantial mechanical type shall be provided on each cubicle between door

and the circuit breaker or fuse switch such that the door cannot be opened unless the circuit breaker or fuse switch is in the OFF position. On/Off switches and circuit breakers shall be padlock-able in the "OFF" position.

Pushbuttons and indication lamps shall be selected from a matching range and they shall be colour coded in compliance with IEC 73 as follows:-

| <b>Indicating Lamps</b> | <b>Colour</b> |
|-------------------------|---------------|
| On                      | White         |
| Off                     | Green         |
| Fault                   | Red           |
| Alarms                  | Yellow        |
| Heaters                 | Blue          |
| <br>                    |               |
| <b>Push Buttons</b>     | <b>Colour</b> |
| Start                   | Green         |
| Stop                    | Red           |
| Alarm accept            | Black         |
| Emergency stop          | Red           |

Each indicating lamp shall incorporate a push-test feature. Alternatively a test push button shall be provided which activates all lamps simultaneously via a contactor. Lamp fittings shall be capable of re-lamping from the front of the panel, and shall be positively locked against rotation.

Fault indicating lamps shall remain on until the associated trip relay is reset or the fault is corrected. Should there be an interruption to the electricity supply, all fault indicating lamps will again be illuminated on reconnection of the supply, until the fault is cleared or the trip relay is reset.

All exposed terminals on the rear of door-mounted components shall be shrouded to prevent accidental contact when the panel doors are open.

#### **4.32.12 Labels**

All labels shall be engraved on laminated plastic sheet, (Traffolyte or approved equivalent) and shall be fixed using non-ferrous screws or rivets.

Designatory or advisory labels shall be of White/Black/White laminate, while warning labels shall be Red/White/Red, or White/Red/White.

Adhesive labels of any kind are not acceptable.

Component labels shall also be of laminated plastic and shall show the reference by which it is identified on the schematic diagram.

On the front of each starter compartment a special label shall be attached on which shall be given particulars of the load including, for example:

- Motor voltage
- Motor FLC
- Pump total head
- Pump discharge

Adhesive labels of any kind are not acceptable.

#### **4.32.13 Rubber Mats**

Each floor mounted panel shall be supplied complete with a rubber mat, manufactured in accordance with BS 9921:1976.

Mats shall be 6mm thick (minimum) x 600mm wide and longer than the panel at each end by 600mm.

#### **4.33 Fault Levels**

The following prospective symmetrical fault levels are to be assumed for initial design considerations.

|          |  |             |
|----------|--|-------------|
| 11 KV    | UEDCL overhead supply line                               | 200 MVA rms |
| 415 Volt | bus-bars (secondary terminals of LV supply transformers) | 30 MVA rms  |

It shall be the responsibility of the Contractor to ascertain the true fault levels.

#### **4.34 Lightning Protection**

The installation shall be in accordance with the recommendations of the British Code of Practice as set out in BS 6651.

To ensure an effective system, particular attention shall be paid to the quality of the materials used which shall be electrically sound and provide good corrosion resistance in a tropical environment.

Each structure shall be provided with air terminations, down conductors and earth

terminations, together with all necessary joints, bonds and earth electrodes, including test joints.

Each down conductor shall be provided with a suitable test joint not less than 0.5m and not more than 1.5 m above ground level

#### **4.35 Earthing**

The installation shall be in accordance with the recommendations of the British code of Practice.

Earth terminations shall be constructed using copper rods driven into ground to a depth of at least 1.5m. In order to achieve the necessary earth impedance, rods shall be combined in groups with a separation between rods not less than the length of the rods.

Concrete inspection pits shall be installed above each earth rod complete with copper bars to which bolted connections can be made to link earth rods together to form an integrated network. To this bar shall also be connected all other earth connections

A substantial wall mounted copper earth bar shall be provided in each building for which an earth electrode system is installed. This bar will act as a terminal strip to which connections can be bolted from switchgear earth bars, the casing of electrical equipment and any other metal structures, which require bonding to earth. All such connections shall be sized in accordance with the IEE Wiring Regulations.

A separate earthing system shall be provided for lightning protection.

Earth termination networks, which incorporate lightning protection, shall have a resistance to earth of less than 1 ohm.

Earth termination networks not incorporating lightning protection shall have a resistance to earth determined by the maximum earth fault loop impedance (as defined by the IEE Wiring Regulations) which is acceptable for the correct operation of the overcurrent protection devices, which have been installed.

#### **4.36 Site Lighting**

The principal roads and access areas on the Site shall be illuminated by suitable discharge lamps mounted on lighting columns or wall brackets on buildings.

The control of the lights shall be by means of an electro-mechanical timer having adjustable contacts and capable of operating for a minimum of 48 hours after interruption of the main power supply. The lighting control relay shall be located in the main MCC and shall switch all the site lighting simultaneously via contactors.

Unless there are existing luminaires on site which can be matched by similar units, each luminaire shall comprise a lantern and gear for High Pressure Sodium lamp with protection to

IP 54. The Thorn Beta Seventy-nine range meets the requirements of BS 4533 and IEC 598 but similar types of alternate manufacture will be considered.

The Thorn QC3 column and GCBS 534 bracket complies with BS 3489. Similar alternatives will be considered.

The lighting columns shall be set in concrete blocks cast in situ with suitable conduit for cable entry.

#### **4.37 Power Factor Correction Capacitors**

Capacitors shall be installed within the panel, and shall comply with BS 1650.

They shall contain a biodegradable non-toxic dielectric impregnant. The use of polychlorinated biphenyl (P.C.B.) is not acceptable.

Discharge resistors shall be fitted to the capacitors in all cases such that 1 minute after disconnection; the terminal voltage shall not exceed 50 volts to earth.

#### **4.38 UEDCL Electricity Supply**

##### **4.38.1 11 KV Systems**

The existing high voltage supply at 11 KV consists of a 3-phase overhead transmission line system.

The present policy of the UEDCL is to provide dropout fuses at high voltage for transformers up to, and including, 500KVA. They will also provide and install the HV cable between overhead line and transformer. It shall be the responsibility of the Contractor to provide the low voltage cable and protection equipment.

Provision shall also be made for the installation of UEDCL metering for the incoming supply comprising the following:-

- KW max. Demand indication
- KWHr integrating meter
- KVA max. Demand
- KVAr max. Demand

The necessary C.T.'s and V.T.'s for metering shall also be provided and these shall comply with the relevant UEDCL standards, which are currently as follows:-

- Current transformers shall be ratio 100/50/5 A for use at 50 Hz having a burden of 15 VA at Class 'C'.

- Voltage transformers shall be of ratio 11000/110 volts for use at 50 Hz having a secondary burden of 100 VA per phase at Class 'B'.

A suitable battery and battery charger shall be installed in the 11 KV sub-station for switchgear tripping duties.

#### **4.38.2 11 KV Switch Gear**

If necessary, a cubicle shall be provided for the metering equipment. In addition to the meters already specified, an ammeter and a voltmeter shall be mounted on the front of the panel to read the current in one phase and the voltage between two phases, together with all necessary fuses.

Anti-condensation heaters shall be provided in all cubicles together with a control thermostat and isolation switch.

Padlocking facilities are required for all access doors.

The degree of protection of the cubicles shall be to IP 44 or better.

#### **4.38.3 Over-Current and Earth Fault Protection**

The overcurrent and earth fault protection shall comprise an integral system. The characteristics of the relays and other protection devices shall be selected so that acceptable discrimination is obtainable from the source (UEDCL high voltage supply) to the pump motors.

The Contractor shall show to the satisfaction of the Project Manager that the system proposed shall provide an entirely satisfactory installation for the operation of the plant and the safety of the personnel working there.

The Project Manager shall approve the proposal upon submission by the Contractor of curves illustrating the time/current characteristics and discrimination of all protective elements.

Relays shall be suitable for use with current transformers having a 1A secondary output. They shall be of the electromagnetic type and shall be contained in dust protected cases to IP 50 and fully tropicalized.

#### **4.38.4 Battery and Charger**

A suitable battery and battery charger shall be supplied for 11kV switchgear tripping duties.

The capacity of the battery shall be determined by the Contractor and shall have a nominal

output of 30 volts DC.

#### **4.38.5 Transformer Protection (1000 KVA Rating)**

A double-float Buchholz relay and a winding temperature indicator with alarm and trip settings shall be included with the transformer fittings. Indication of both alarm and trip shall be given by a four-element plug relay, which shall be mounted on the same panel as the overcurrent and earth fault relay

### **4.39 Transformers**

#### **4.39.1 Control Transformers**

Control transformers shall be liberally rated and conform to BS 3535. The windings shall be fully tropicalized and one pole of the secondary winding shall be connected to earth via a test link.

#### **4.39.2 Current Transformers**

Current transformers when used for operation of meters, relays or instruments shall comply with BS 3938. They shall be rated for 1 A output except for UEDCL See also, Clause 4.38.1.

Polarity of primary and secondary windings shall be clearly indicated in accordance with BS 158. One pole of the secondary windings shall be connected to earth via a test link.

Separate C.T.'s shall be used for metering and for protection purposes.

#### **4.39.3 Voltage Transformers**

Voltage transformers shall comply with BS 3941 Class I and be either mineral oil filled or encapsulated and shall be complete with HRC fuses on both the primary and secondary side. See also UEDCL specification for metering V.T.'s, Clause 4.38.

V.T.'s can be single phase or three-phase, nominal ratio 11 kV/110V, 199 VA per phase.

#### **4.39.4 Power Transformers**

Power transformers shall comply with BS 171 and shall be connected delta/star in accordance with vector group Dyn 11. They shall be double wound on a core of cold rolled, grain orientated sheet steel.

They shall be suitable for out-door use, oil immersed, natural air-cooled. (type ONAN).

The following fittings are required for all transformers:-

- Diagram and rating plate
- Lifting lugs
- Earth terminal
- Conservator with drain plug
- Oil level indicator
- Drain valve (To be used also for oil sampling)
- Oil filler hole with plug
- Dehydrating (silica gel) breather
- Jacking lugs

#### **4.40 415 Volt Equipment**

The attention of the Contractor is drawn to the relevant Parts of Clause 4.32, General Requirements for Switchboards.

##### **4.40.1 Main Switchboard**

This shall incorporate the main circuit breaker(s) for the incoming supply, as well as distribution switchgear for all other 415 volt panels on the site. In addition, it will house various motor starters for equipment installed in the principal buildings, relays and contactors.

The switchboard shall be a floor-mounted panel comprising sectional steel cubicles with protection to IP 4X.

The preferred type of switchgear for the main incomers is MCCB but switch fuses will be acceptable if it is impossible to integrate the protection characteristics of the MCCBs into the overall overcurrent protection scheme.

The following equipment will be housed in the panel:-

- Ammeter, Voltmeter and selectors for incoming supply
- Main incoming circuit breakers
- Distribution switchgear
- Motor starters
- Control supplies



#### **4.40.2 Control Panels**

These shall generally be wall mounted and incorporate an incoming Circuit Breaker for supply isolation. In addition to motor starters, the panel shall include the following:-

- Set of ammeters for incoming supply
- Voltmeters
- Selector switch(s) for duty/stand-by drives
- Control circuits
- Small Power and lighting circuits

#### **4.40.3 Emergency Diesel Generator Supply**

At certain locations, it is desirable to have a stand-by generator permanently installed to provide all or part of the electricity requirements of the Works. Alternatively, provision shall be made for a mobile generator to be connected in place of the normal UEDCL supply.

The specification for the installation of the diesel generator is fully covered in Clause 4.31.

An incoming circuit breaker shall be included in the 415 volt main M.C.C. panel for the generator, and this shall be mechanically interlocked with the circuit breakers for the UEDCL supply, so that both supplies cannot be connected simultaneously.

In the case of a mobile generator, it shall be possible to couple the generator into the system of the main 415 volt board. Terminals shall be provided for the cables from the generator.

#### **4.40.4 Motor Control Equipment**

##### **4.40.4.1 Contactors and Control Relays**

Contactors shall comply fully with IEC 158, 337 and 292 with duty to AC 3.

Main contacts shall have a rated operating current as AC 3 duty of at least twice the FLC of the motor.

Starting contactors shall incorporate where appropriate thermal type overload relays which shall be ambient temperature compensated and also provide single-phasing protection. The thermal overload relay should be selected so that the motor FLC lies in the middle of the range of settings.

There shall be space and facility for fitting add-on auxiliary contact blocks to the contactor.

Control relays shall comply fully with IEC 337 with duty to AC 11.

Contactors, thermal overload relays shall be selected to comprise a comprehensive system of motor control.

#### **4.40.4.2 Fuses, Links and M.C.B.'s**

All circuits shall be protected either by fuses or by M.C.B.'s but wherever possible M.C.B.'s shall be used in preference to fuses.

All fuses shall be HRC type to BS 88. Fuse bases and carriers shall be GEC Red Spot or equivalent approved by the Project Manager, and all live parts shall be fully shrouded. Fuse carrier shall be coloured Black, link carriers shall be coloured White.

All M.C.B.'s shall be type 2 to BS 3871. They may be single double or triple-pole as required and rail mounted.

M.C.B.'s fuses and links shall be grouped where appropriate according to their functions and shall be clearly marked both on panels and the associated wiring diagrams with their reference number.

The minimum rating of any fuse or M.C.B. shall be 5 A, unless it is essential to use a lower rating.

#### **4.40.4.3 Isolators**

All isolators and main switches shall be padlock-able in the "OFF" position, and shall be interlocked such that the door to the compartment cannot be opened with isolator in the "ON" position, except when otherwise specified. In such cases, such metalwork as may be live shall be adequately shrouded, and warning notices fitted.

#### **4.40.5 Motor Starters**

The method of starting motors shall be as follows:-

- Motors up to (and including) 10 kW - D.O. L.
- Motors 12 kW and over - Star/Delta or Auto Transformer

All motor starters must be suitable for a minimum of 15 starts per hour (up to 22 kW) or 10 starts per hour (30 kW and over).

**4.40.5.1 D.O.L. Starters**

Each starter shall be equipped with:-

- Line contactor
- Thermal overload/phase fault relay
- Over-temperature relay for use with thermistors embedded in the motor windings
- Current transformers for ammeter (if necessary)

On the door will be mounted the following:-

- Ammeter
- Start and Stop push buttons
- Overload reset push button
- Over-temperature reset push button
- Hours run indicator
- Indicating lamps and labels as necessary

**4.40.5.2 Star/Delta or Auto-Transformer Starter**

Each starter shall be equipped with the relevant items from the following:-

- Set of main contactors for automatic start sequencing including time delay relays
- Thermal overload/phase fault relay
- Over-temperature relay for use with thermistors
- Current transformers for ammeter (if necessary)

On the door will be mounted the following:-

- Ammeter
- Start and Stop push buttons
- Overload reset push button

- Over-temperature reset push button
- Hours run indicator
- Indicating lamps and labels as necessary

#### **4.40.6 Emergency Stop Push Button**

Every motor, which forms part of a fixed installation, shall be provided with an emergency stop push button adjacent to the equipment.

It shall be of the “lock-off” pattern with one normally open and one normally closed contact. The unit shall comprise a heavy-duty, weather proof box mounted on a substantial up stand and at a height of 1 m above floor level.

#### **4.40.7 Small Control Stations**

These shall be housed in sheet steel enclosures suitable for wall mounting and equipped either with a hinged lid or screw/on cover, to IP 42 or better.

The size of enclosures shall be such that adequate room is available for components, wiring and labels, and for easy access for maintenance purposes.

All components and their installation shall conform to the requirements detailed in other sections of this Specification.

Anti-condensation heaters will be required, but not the provision of rubber mats.

#### **4.40.8 Consumer Units and Distribution Boards**

These shall be of the multi-pole MCB type, suitable for combinations of TPN, TP, DP, and SP MCB's and shall comply with BS 5486.

Where distribution boards are integral with motor control centres or switchboards they shall be fed from the bus-bars via suitably rated MCB's.

Residual current circuit breakers (Residual current devices) shall be included to give added protection against earth faults in compliance with Regulation 413 of the IEC wiring Regulations.

Each consumer unit and distribution board shall be provided with an internal circuit designation chart. These shall be securely fixed, and equipped with perspex or similar covers, and shall have space for each outgoing circuit to give clear identification. Unprotected paper labels will not be accepted.

#### **4.40.9 Control Desks**

Control desks shall comprise a sheet steel enclosure and hinged lid. The lid will be set at an angle to facilitate operation of the controls, which are mounted on it. The index of protection shall be IP 42 or better.

Rear access will not be available but either hinged doors or screw-on panels shall be provided at the front.

All components and their installation shall conform to the requirements detailed in other sections of this Specification.

An anti-condensation heater will be required complete with adjustable thermostat and isolating switch, but rubber mats will not be required.

#### **4.41 Electric Motors**

All motors shall comply with BS 4999 and BS 5000, (IEC 34 and 72) and shall be cage type, TEFV with enclosures to IP 44 (unless otherwise stated).

They shall be continuously maximum rated and wound for a voltage of 415 volts at 50 Hz. The insulation shall be class F or better but shall be designed for a maximum temperature rise of 80deg.C in an ambient of 40deg.C.

The preferred motor speed is 1500rpm.

The rating of the motors shall provide an excess of power not less than 10 per cent over the maximum demand made by the mechanical load connected to them. Where necessary the motor shall be rated to take into account the effect of the altitude at which it will be operating. Anti-condensation heaters shall be incorporated in all motors over 4 kW. They shall be suitably rated and designed for connection to a 240 volt, single phase A.C. supply.

The windings of all motors shall have embedded P.T.C. thermistors.

All six ends of motor windings and heater leads etc., shall be brought out to a terminal block or blocks contained within a terminal box or boxes. The terminal box or boxes shall each be suitable for the reception of the requisite number of PVC/SWA/PVC or XLPE/SWA/PVC cables, of suitable voltage grade.

Motors other than submersible shall be fitted with grease lubricated ball and/or roller bearings. Bearing housing shall be fitted with grease nipples incorporated relief valves. Bearings shall be chosen to give an operating life of at least 80,000 hours.

#### **4.42 Cables and Wires**

All cables shall have multi-strand copper conductors, unless otherwise specified. PVC over-sheaths shall be impregnated with repellents to deter vermin and termites. All grades shall be suitable for operation under tropical conditions.

- PVC cables shall comply with BS 6346
- XLPE cables shall comply with BS 5467

The minimum size of conductors for power cables shall be 2.5mm<sup>2</sup>.

Joints in cables are to be avoided, except where cable lengths exceed drum lengths. In such circumstances, joints shall be made and tested under supervision, and their location indicated by a proprietary concrete marker.

Positions of joints shall be accurately recorded for incorporation on “as built” drawings.

##### **4.42.1 Buried Cables**

Where cables are laid in the ground, they shall be bedded on 50mm of graded sand, and after laying shall be covered, prior to backfilling, by another 50mm of graded sand.

Laying depth shall be a minimum of 500 mm below final grade, and all cables in the ground shall have a separation of at least one cable diameter and shall have a polythene warning tape installed below it:-

The warning tape shall be coloured yellow/black stripes and bear the following legend, in bold black capitals, at regular intervals:-

“CAUTION - ELECTRIC CABLE BELOW”. It shall be laid at a depth of 200 mm below final grade.

Concrete marker posts shall be erected at intervals at intervals of 25m or at changes of direction of cable trenches. A plate shall be fixed to the post stating “BURIED CABLES” and their position marked on the final “AS-BUILT” drawings.

At road crossings, ducts shall be provided for protection of the cables against mechanical damage. These shall be a minimum of 100mm diameter, of steel or PVC. Each duct shall be provided with a nylon drawing-in rope.

Adequate numbers of ducts shall be provided at points of entry into buildings. These shall be in the form of easy sweep bends, having a bending radius appropriate to the size of the largest cable but in any case not less than 10 times the cable diameter.

After installation and final test, all cable ducts shall be sealed using fire resistant materials to the satisfaction of the Project Manager, to prevent ingress etc. into buildings of water vermin,

termites etc.

#### **4.42.2 Cables in Ducts**

Cables shall be installed on heavy-duty return flange trays of proprietary design or by means of individual cleats. Trays shall be hot dip galvanised and the cables shall be installed using fixings such as nylon or PVC straps.

Single cable fixings shall be made using either aluminium or plastic cleats either fixed directly on to the sidewall or mounted on proprietary galvanised steel channel. BICC 'Leprack' steelwork and cable fittings or other approved type shall be used.

Where ratings permit, trefoil cleats may be used.

Trays shall be fixed to the wall using hot dipped galvanised standoff brackets.

Due regard to the current loading of cables shall be made but not more than two layers of cable shall be installed on cable trays and the separation between single or trefoil cables shall be a minimum of one cable diameter or equivalent.

It will not be acceptable to lay unsecured cables on the bottom of the duct.

#### **4.42.3 Building Services**

Other than in residential buildings, cables shall be run either in covered floor ducts, or on heavy duty return flange, hot dip galvanised cable trays. Trays shall be fixed to the wall using hot dip galvanised standoff brackets, and shall be covered with hot dip galvanised capping. (Small wiring may be run in conduit or ducting. See (Clause 4.43).

Cables shall be fixed by using nylon or PVC straps.

Each cable shall be labelled with its reference, (per the cable schedule) at each end, using proprietary cable markers. These markers shall be easily legible and firmly fixed. Clip-on or adhesive markers will not be accepted.

The blank gland plates within each panel shall be removed and drilled to accommodate the requisite glands, which shall be supplied under this Contract.

#### **4.42.4 Cable Terminations and Glands**

Cables shall be colour coded at the terminals by means of coloured sleeves as follows:

- Phase : red, yellow, blue
- Neutral and D.C. negative : black

- Earth : green or green/yellow
- D.C. positive : red

The individual cores of cables shall be made off to their respective terminal boards. Each core shall be fitted with insulation pin or lug type crimped terminations, as appropriate.

Each core shall be identified with interlocking ring type ferrules, to correspond with the fixed wiring on the other side of the terminal board. Adhesive types shall not be used.

Glands shall comply with the relevant British Standard and shall be of cadmium plated brass. They shall be of weather proof pattern incorporating an armour clamp and an earth lug or tag. After installation, PVC or neoprene shrouds shall be fitted over each gland.

At all termination sufficient slack cables shall be left to allow for future trimmings, stripping back and reconnecting to the terminals.

#### **4.42.5 Cabling Details**

The Contractor shall submit a schedule of all cables, detailing the following for each cable proposed:

- Reference Number
- Type
- Cross Sectional Area
- Number of Cores
- Origin
- Destination
- Cost per metre installed
- Cost for each termination (glanding and making off)
- Route Length
- Operating Voltage
- Estimated Current
- Percentage Voltage Drop



Rates (for cables) and (terminations) shall be used to assess costs in the event of any agreed route length variation.

The Contract price shall include all cables required for a fully operational installation.

#### **4.43 Conduit and Trunking**

Other than in residential buildings all conduit and trunking shall be surface mounted or, in the case of trunking for lighting cables and fittings, may be suspended using proprietary fixings.

All cabling in conduits and trunking shall be multi-strand, PVC insulated and not less than 1.5 mm<sup>2</sup> conductor cross-section.

All surface conduits shall be heavy gauge hot dip galvanised screwed tubing all accessories shall be hot dip galvanised.

Tubing and fittings shall comply fully with BS 4568:1970 Parts 1 and 2.

Minimum size shall be 20mm diameter and newly cut threads shall be painted without delay, using zinc rich paint.

Conduits shall be fixed using spacer saddles and brass screws at intervals not less than 1.2 meters on horizontal runs, and 1.5 metres on vertical runs.

Trunking shall be of galvanised cold rolled steel designed for lighting applications and shall be of robust construction and suitable for use in a tropical industrial environment. It shall be suitable for suspension and allow continuous unobstructed runways for cables. Luminaires shall be themselves suspended from trunking or fixed directly to it.

In locations where it is not possible to make direct connection by conduit due to vibration or difficult route, it will be acceptable to use flexible conduits. This shall be approved by the Project Manager and shall be of robust construction and suitable for use in a tropical environment.

#### **4.44 Junction Boxes**

Junction boxes shall be manufactured from hot dipped galvanised steel and shall be fitted with the requisite numbers and sizes of DIN rail mounted terminals. Cable cores on each side of the terminal boards shall be identified using ring type interlocking ferrules. Boxes shall have an ingress protection of IP 54, and all cable entries shall be from below, wherever possible.

#### **4.45 Lighting and Small Power**

Other than in residential buildings consumer units or distribution boards shall be provided in every building for internal lighting and small power supplies. They shall be single-phase or three-phase as necessary and shall comprise RCD's and MCB's. Re-wirable fuses are not

acceptable. (See Clause 4.40.8).

Luminaires for general lighting shall be single or twin tube fluorescent fittings fixed directly to ceilings or trunking or suspended by hangers to give optimum illumination.

The following minimum levels of illumination shall apply at a height of 1m above floor level:

- Laboratory 400 lux
- Offices, control rooms and workshop 300 lux
- Pump houses, machinery rooms and operational areas 200 lux
- Entrance halls and storage areas 100 lux

All light switches shall be surface mounted and of robust industrial type suitable for conduit connections. They shall be rated at not less than 5A but the steady state load shall not exceed 50% of the switch rating.

The mean mounting height of single switches or the bottom row of a multiple switch unit shall be 1.4m above floor level

Switched socket outlets for general purposes use shall be surface mounted and of robust industrial type suitable for conduit connections. They shall be rated at 13 A to BS 1363 and installed 0.5m above floor level.

#### **4.46 Emergency Lighting**

At power supply failure a basic lighting shall be provided. As far as possible, fluorescent bulbs with electronic converters shall be used. If not suitable small halogen light fittings shall be provided.

#### **4.47 Flood Lighting**

For operational purposes certain areas may require to be floodlit. Such as:-

- Intake works
- Filters

They shall be controlled by individual switches at a convenient location.

The luminaire shall be selected from the flood lighting range offered by Thorn Lighting or Philips Lighting or other approved manufacturer. They shall be mounted on lighting columns or wall brackets.

**4.48 3-Phase Plugs and Sockets**

The plugs and sockets shall be 5-pin suitable for 415 volts, 3-phase, 50 Hz with separate neutral and earth pins. They shall comply with BS 4343 and IEC 309 and be protected to IP 44 or better.

The plugs shall be of polycarbonate material but the sockets shall be of aluminium alloy, suitable for conduit connections. The socket shall be surface mounted at a height of 1.25m above floor level.

**4.49 Extract Fans**

Extract fans shall unless otherwise specified, generally be installed at high level within the wall of the building so that they project a minimum distance into the building. Air operated louvres shall be positioned over the fan opening on the outside of the building as a weather shield.

The fan motors shall be fully tropicalised and protected to IP 54 or better.

Fans shall be tested in accordance with BS 848.

**4.49.1 Fan Control**

The fan motor shall be suitable for 415 volts, 3-phase, 50 Hz and shall be controlled either manually or automatically by means of a wall-mounted thermostat. The thermostat shall be adjustable and shall be fixed at a height of 1.5m above floor level.

**4.50 Level Controls**

Level control relays shall be installed within the appropriate MCC and shall be activated by remote electrodes installed in the associated wet well or by pressure gauges.

Connections to electrodes shall be made at the electrode holders, the latter being fitted on proprietary brackets. The electrodes shall be used to provide a signal at specific depths for control purposes. They shall comprise an earth (or reference) electrode, together with as many other electrodes as are necessary for the application.

The electrodes shall comprise rods or tubes which shall be hot dip galvanised or of material resistant to corrosion. They shall have a minimum diameter of 15mm. Joints in electrodes will not be accepted.

Where electrodes exceed 2.0 metres in length or are immersed in fast flowing liquids, insulated support brackets shall secure them.

Electrodes shall be as those made by Hawker Electronics Ltd such as HAWKER HPE8 or E12 or similar approved type.

#### **4.51 Tests on Completion**

Testing on completion shall be carried out to demonstrate compliance with the IEE wiring Regulations.

The following tests shall be carried out: -

- Verification of polarity (dc and single-phase circuits)
- Phase rotation
- Resistance to earth of earthing system
- Insulation resistance. (Phase/phase and phase/earth)
- Earth loop impedance
- Operation of over current and earth fault relays by injection tests
- Operation of all other protective relays and devices
- Levels of illumination
- Correct sequencing of all control equipment

The Project Manager shall be given full opportunity to witness all tests and shall approve all test results.

The Project Manager shall have the right to ask for specific tests to be repeated.

## **5. STANDARD SPECIFICATION FOR PAINTING AND PROTECTION**

### **5.1 General**

The preparation, application and conditions for work shall comply with the recommendations of BS 5493 and BS 6150 or if the protection is of a special nature, in accordance with the manufacturer's directions.

Paints, primers and undercoats shall be obtained from the same manufacturer and except where a definite time is specified between mixing and application, shall be ready mixed for use. They shall be compatible with one another.

Paints shall be delivered in sealed containers bearing the manufacturer's name, batch number, etc. and shall carry a label giving details of quality and instructions for use.

No site painting shall be carried out unless the surface to be painted is dry, the air temperature above 4oC and the relative humidity less than 85%. The Project Manager shall approve the methods for removing all dirt, oil, grease, etc, before Site painting commences.

Test plates carrying finishes from the actual coating used may be required by the Project Manager for inspection and test purposes.

To facilitate inspection, no consecutive coats of paint shall be of the same shade except in the case of white.

Priming to two mating surfaces shall be applied prior to assembly.

All items of Plant shall be delivered to Site with the shop paint finish applied unless specified otherwise. A further coat of final finish paint shall be applied at Site, of sufficient thickness to produce a uniform colour and appearance. Such painting shall be carried out within one month of successful acceptance trials for the Plant.

All paint thicknesses shall be checked using an alcometer or equivalent instrument, supplied by the Contractor, for each layer of paint, to the reasonable satisfaction of the Project Manager.

### **5.2 Surface Preparation**

Surface preparation for the various substrates shall be as follows unless otherwise specified under Detailed Paint Systems:

#### **5.2.1 Steelwork**

All steelwork including structural steel and steel doors and frames shall be prepared by blast cleaning in the Shop. Blast cleaning shall be to a visual standard in accordance with SIS 05 59 00 standard Sa 2<sup>1</sup>/<sub>2</sub> at the time of painting (equivalent to 2nd Quality BS 4232).

Only dry abrasive blast cleaning techniques shall be employed. Abrasives shall be expendable copper slag or re-usable iron and steel grit or shot. All surface defects, including cracks, surface laminations and deep pitting, likely to be detrimental to the protective painting system shall be removed as laid down in BS 4360. All fins at saw cuts, burrs, and sharp edges shall be similarly removed. Where extensive grinding has been necessary, the dressed areas shall be re-blasted to remove all rust and provide an adequate paint key.

After blast cleaning, before the surface has time to re-rust, and in any case within 4 hours of blast cleaning (2 hours for outdoor blast cleaning) the first coat of primer shall be applied.

### **5.2.2 Metal Sprayed Coatings to BS 2569 : Part 1 (Zinc)**

The metal deposition shall be coated at once with two pack zinc chromate etch primer, and the first coat of the paint system shall be applied within 1 to 4 hours.

### **5.2.3 Galvanised and Non-ferrous Surfaces**

Surfaces shall be cleaned of dirt and building debris. All grease and handling marks shall be removed by the application of zinc chromate etch primer thinners.

The clean dry surfaces shall then be primed with two pack zinc chromate etch primer followed by the first coat of the paint system within 1 to 4 hours.

## **5.3 Detailed Paint Systems**

The exposed plant shall be painted white gloss to BS 00E55, unless otherwise stated or instructed by the Project Manager.

Equipment out of sight in rooms that are normally locked, i e HV switchgear and transformers shall be white gloss or manufacturers standard colour.

Penstocks shall be black, epoxy coal tar except for headstocks and handwheels which will match the actuator colour or be white gloss.

Diaphragm valves shall be black.

Motive water pumps shall be blue.

Chlorine equipment and drums shall be yellow.

Cranes and ancillary equipment shall be yellow.

**5.2.4 Structural Steelwork****5.2.4.1 Shop applied - Apply Overall:**

1 coat high build alkyd zinc phosphate primer to a minimum dry film thickness of 75 microns followed by 1 coat phenolic / alkyd coating containing micaceous iron oxide to a minimum dry film thickness of 50 microns.

**5.2.4.2 Site Applied:**

Any damaged areas to be prepared as for the shop coats and made good with the original shop coats to the specified dry film thicknesses.

**5.2.4.3 Apply Overall:**

1 coat phenolic/alkyd coating containing micaceous iron oxide to a minimum dry film thickness of 50 microns followed by 1 coat alkyd decorative enamel to a minimum dry film thickness of 40 microns.

**5.2.5 Steel Doors and Frames****5.2.5.1 Shop Applied:**

1 coat high build alkyd zinc phosphate primer to a minimum dry film thickness of 75 microns followed by 1 coat alkyd based undercoat to a minimum dry film thickness of 40 microns.

**5.2.5.2 Site applied:**

1 coat alkyd based undercoat to a minimum dry film thickness of 40 microns. 1 coat decorative alkyd enamel to a minimum dry film thickness of 40 microns.

**5.2.6 Steelwork in Contact with Water****5.2.6.1 Shop applied:**

Hot dip galvanising to BS 729.

**5.2.6.2 Site applied:**

Any damaged areas to be thoroughly cleaned of rust and surface deposits and painted with 1 coat of epoxy zinc phosphate to a minimum dry film thickness of 75 microns followed by 1 coat of epoxy micaceous iron oxide undercoat to a minimum dry film thickness of 100 microns followed by 1 coat of epoxy micaceous iron oxide to a minimum dry film thickness of 60 microns.

**5.2.7 Pipework and Valves**

All pipework and valves above ground, unless otherwise specified, shall be treated as described herein for pumping station steel pipework. All pipework and valves in chambers shall be treated as described in Chapter 6 for buried pipework.

### **5.2.8 Mechanical and Electrical Equipment**

Paints, including primers and undercoats, shall be obtained from the same manufacturers and shall, except where application has to be made within a limited time of mixing, be ready mixed for use and compatible with one another. Only paint that is delivered in sealed containers, bearing the name of the manufacturers and properly labelled as to its quality and instructions for use, will be acceptable.

The manufacturer's proposed paint and protection systems for all mechanical and electrical equipment shall be submitted to the Project Manager for approval at the time of submission of shop drawings.

All surfaces of Plant shall be protected against corrosion and/or erosion with the exception of stainless material and rotating gland or bearing surfaces.

Where dissimilar metals are in proximity and where the possibility of electrolytic or similar corrosion exists the mating surfaces shall be insulated.

Test plates carrying a sample of the actual coating used may be requested by the Project Manager for test and inspection purposes.

All items of Plant shall be delivered to Site with their protective paint finish applied and, except where otherwise specified or instructed by the Project Manager, shall be given further coats of final paint finish, at Site, of sufficient thickness to give uniform colour and appearance. Site painting shall not be carried out unless the surface to be painted is completely dry, the air temperature is above 20°C, and the surface temperature is at least 3°C above the dew point. Immediately before site painting all oil, grease, etc. shall be removed from the surfaces to be painted and all damage to the factory applied finish made good.

Unless otherwise specified or approved by the Project Manager (eg where the Contractor's normal protective finish is of a special nature giving equal or better protection) or where the material of construction has an inherent corrosion resistant property, the Plant shall be protected in accordance with the following:

- Component parts which may be in direct contact with water (excluding the pumping station steel pipework)
  - ◆ blast clean in accordance with the requirements of Swedish Standard SIS 05 59 00 Sa 2<sup>1/2</sup>.
  - ◆ Ferrous metal:
    - within 4 hours of (a) above apply zinc metal spray to a thickness of 0.1 mm or greater in accordance with BS 2569.



or

within 4 hours of (a) above apply sufficient coats of polyamide cured epoxy zinc rich primer containing at least 90% of zinc in the dry film to give a minimum dry film thickness of 30 microns.

Non-ferrous metal:

within 4 hours of (a) above apply sufficient coats of polyamide cured epoxy etch primer to give a minimum dry film thickness of 50 microns.

- ♦ thoroughly clean and degrease previous finish and within 2 hours apply sufficient coats of tar or pitch epoxy resin to give a minimum dry film thickness of 250 microns.
- Steel pipework:
  - ♦ fettle to remove all flash, weld spatter, sharp and rough surfaces.
  - ♦ blast clean in accordance with the requirements of Swedish Standard SIS 05 59 00 Sa 21/2.
  - ♦ within 4 hours of (b) above apply one coat epoxy polyamide primer to give a minimum dry film thickness of 25 microns.
  - ♦ apply second and third coat amine adduct cured epoxy, each coat to give a minimum dry film thickness of 125 microns.
- Exposed plant, not coming into direct contact with the water, excluding diesel engines:
  - ♦ blast clean in accordance with the requirements of Swedish Standard SIS 05 59 00 Sa 21/2.
  - ♦ within 4 hours of (a) above apply sufficient coats of polyamide cured epoxy primer containing red oxide or zinc phosphate to give a minimum dry film thickness of 50 microns.
  - ♦ thoroughly clean and degrease previous finish and within 2 hours apply sufficient coats of polyamide cured epoxy with inert durable pigments to give a minimum dry film thickness of 125 microns.
- Plant installed inside buildings excluding electrical panels and the pumping station steel pipework:
  - ♦ thoroughly clean surfaces to remove rust, scale, dirt, loose paint, etc. and degrease by the use of solvents which are compatible with the paint finish to be applied.
  - ♦ within 4 hours of above apply sufficient coats of polyamide cured epoxy or alkyd resin based primer to give a dry film thickness of not less than 40 microns.
  - ♦ thoroughly clean and degrease previously applied finish and within 2 hours apply sufficient coats of polyamide cured epoxy or alkyd resin based undercoat and gloss finish paint to give an even and uniform colour and covering.

- Ferrous nuts, bolts, washers, etc. and other small component parts shall be either hot dip galvanised to BS 729 or zinc electroplated. They shall be given further coats of site applied protective finish when the plant is undergoing site painting.
- Electrical panels installed within buildings shall be finished with sufficient stove dried enamel primer and gloss finish to give a dry film thickness of not less than 50 microns or alternatively a single coat of polyester sprayed powder where this is the manufacturer's standard finish.
- Electrical panels installed in exposed positions or in damp conditions shall receive a surface preparation containing zinc prior to stove enamelling. Electrical panels shall not be site painted, however, each item of plant shall be supplied with touching up paint and any damage shall be satisfactorily repaired.
- Electrical panels shall not be site painted, however, each item of plant shall be supplied with touching up paint and any damage shall be satisfactorily repaired.

### **5.3 Colour Coding and Labelling of Pipes and Equipment**

All pipes and equipment shall be colour coded to a schedule to be agreed with the Project Manager before any site painting starts, or earlier if necessary to suit manufacturing procedures. Valves and fittings shall be painted in the same colour as the pipe of which they form a part. Where a pipe enters or leaves a piece of equipment the pipe colour shall extend up to but not including the flange attached to the equipment.

All pipelines shall be identified by stick-on 90 micron thick vinyl film labels showing the name of the material to be carried by the pipeline and an arrow indicating the direction of flow. Letters of titles shall be pre-spaced on carrier tape and the complete title protected by one piece removable liners. Titles shall be at intervals not less than 8 m, but shall in any case be provided in every space through which the pipe passes. Locations of labels shall be subject to prior approval by the Project Manager. Lettering sizes shall be between 16 mm and 75 mm in height depending on the size of the pipe.

Pipes smaller than 22 mm outside diameter shall be labelled by the use of tags instead of labels. Tags shall be made of brass no smaller than 65 mm x 16 mm by 1.5 mm thick, with lettering etched and filled with black enamel.

Titles shall also be provided on all equipment in locations and in sizes to be approved by the Project Manager.

## **6. STANDARD SPECIFICATION FOR PIPEWORK AND VALVES**

### **6.1 General**

The pipework shall be laid out and designed so as to facilitate its erection, painting in situ, dismantling of any section for maintenance and to give a constant and uniform flow of working fluid with a minimum loss in head. Where steel pipework is used the number of flanges is to be kept to a minimum with the size of each unit of pipework determined by the ease of handling, installation and general appearance of the completed pipe system.

Flexible joints shall be provided on pressure pipes where necessary to facilitate installation and removal of Plant or to allow for differential movement. Where required, flexible joints shall be provided with tie bolts or other means to transfer longitudinal thrust along the pipework as a whole.

Wherever possible, standard fittings shall be used in preference to fabricated or special fittings.

Valves, strainers and other devices mounted in the pipework shall be supported independently of the pipes to which they connect.

All metal brackets, or other forms of support, shall be rigidly built up of steel by bolting or welding in preference to the use of castings.

Facilities shall be provided for draining the pipe system and releasing air. The period for drainage shall not exceed 30 minutes and there shall be suitable means of disposal for the drained fluid.

### **6.2 Marking and Protection of Pipes and Fittings for Shipment**

Except where otherwise specified all items shall have received their complete protective coatings before dispatch from the manufacturer's works and shall be additionally protected by approved means for the period of transit, storage and erection, against corrosion and accidental damage.

For the protection of pipe linings and in particular for protecting cement mortar linings from drying out, protective metal or timber discs shall be fitted over the ends of pipes and fittings. Similar timber protective discs shall be attached to all flanges of pipes and fittings, by means of bolts specifically provided for the purpose and which shall be discarded when the item is incorporated in the Works. The sleeves and flanges of flexible joints shall be wired together in suitable bundles.

### **6.3 Storage of Pipeline Materials**

Pipes and fittings shall be stored raised off the ground, and shall be carefully supported, cushioned and wedged. Pipes shall not rest directly on one another and shall not be stacked

more than four pipes high or two pipes high in the case of pipes of 500 mm diameter or over. Special care shall be taken to ensure that flexible pipes are cradled and supported in a manner that prevents any distortion of the pipes.

Flexible pipes shall be stored in sheds or covered areas.

Couplings and joints (and all components thereof) and other similar items shall be stored in dry conditions, raised from the ground in sheds or covered areas.

Storage areas shall be carefully set out to facilitate unloading, and checking of materials with different consignments stacked or stored separately with identification marks clearly visible.

Where items to be stored have a limited shelf life or require special storage arrangements, the method of storage shall be to the approval of the Project Manager and in accordance with the manufacturer's instructions.

All pipes and fittings supplied as spares shall have end covers, which are proof against the entry of sand and vermin. Mortar lined pipes and fittings shall have end covers, which form a complete seal, provision being made to accommodate the effects of temperature changes. Pipes and fittings supplied as spares shall have a temporary white external finish and shall be stored sheltered from the direct rays of the sun.

End covers and protection shall not be removed until incorporation of the pipes and fittings into the Works.

#### **6.4 Transportation of Pipes and Fittings**

Any vehicle on which pipes are transported shall have a body of such length that the pipes do not overhang. Large pipes shall be placed on cradles and the loads properly secured during transit. The pipes shall be handled in accordance with the manufacturer's recommendations.

Approved slings shall be used and all hooks and dogs and other metal devices shall be well padded. Hooks engaged on the inner wall surface at pipe ends shall not be used. Steadying ropes shall be employed. The positions of lifting slings shall ensure that stresses and tendency towards deformation in the pipes are kept at a minimum.

Pipe handling equipment shall be maintained in good repair and any equipment which in the opinion of the Project Manager may cause damage to the pipes shall be discarded.

Under no circumstances shall pipes be dropped, be allowed to strike one other, be rolled freely or dragged along the ground.

## 6.5 Inspection of Pipes and Fittings

Before incorporating into the Works each pipe shall be brushed out and carefully examined for soundness. Damaged pipes, which in the opinion of the Project Manager cannot be satisfactorily repaired, shall be rejected and removed from Site.

Damage to pipe coatings or linings shall be repaired to the satisfaction of the Project Manager.

## 6.6 Built-in Pipework and Other Plant

The pipes and other Plant in water retaining structures shall, wherever possible, be built in as the work on the structure proceeds. The Contractor shall ensure that delivery of the requisite pipework and other Plant is in accordance with the requirements of the programme.

Where a pipe subject to thrust passes through a concrete structure or where an external seal is required, a puddle flange shall be used. The puddle flange dimensions shall be to BS 4504 but shall be undrilled. The exterior of the pipe shall be cement washed symmetrically about the puddle flange by the manufacturer for a length at least equivalent to the thickness of the wall through which it passes.

The Contractor shall be responsible through every stage of the Works for checking the correctness of the setting of built-in Plant and shall satisfy himself they are positioned in accordance with his approved drawings.

## 6.7 Materials

Each pipeline shall be constructed in a material compatible with the fluid conveyed through that pipeline, ie the materials used in the pipes which are or can be in contact with the untreated or treated water, shall not contain any matter which could impart taste or odour or toxicity or otherwise be harmful to health or adversely affect the water conveyed. Nor shall any pipe be adversely affected by the fluid being conveyed through that pipe.

Pipework and valve materials for the following duties shall be as follows or equivalent to the approval of the Project Manager:

- Alum solution - rigid PVC-U
- Chlorine:
  - Drum connections - cadmium plated 70/30 copper nickel CN 107, BS 2871 : Part 1:
  - Chlorine gas or liquid - flanged or welded carbon steel, CAF flanged joints.
  - Chlorine gas lines below atmospheric pressure - polyvinylidene fluoride (PVDF) with solvent welded or flanged joints.

Chlorine solution - Class E PVC-U in concrete covered ducts outside building. Inside building and in exposed areas, rubber lined carbon steel.

Valves shall be globe type with forged steel bodies, monel spindles, stainless steel seats and PTFE gland packing or carbon steel, monel plug, PTFE sleeved plug.

- Sulphuric Acid:

Concentrated acid - flanged carbon steel and Hastaloy for diameters less than 50 mm.

Dilute acid - Polyvinylidene fluoride (PVDF) with solvent welded or flanged joints.

- Lime:

Lime slurry transfer pump suction pipework - steel, ductile iron or rigid PVC-U.

Lime slurry transfer pump delivery pipework - EPDM covered, reinforced, natural rubber line tube, approved for use with potable water and with chemical resistance to chlorine solution (35 g/l) and sulphur dioxide solution (3.5 g/l) with quick release couplings.

Saturated lime dosing pipework - steel, ductile iron or PVC-U.

- Water:

Raw water, backwash water, dirty washwater, supernatant and treated water - steel or ductile iron.

Service water - steel, ductile iron or PVC-U.

- Air:

Air scour - steel or ductile iron.

## 6.8 Ductile Iron Pipes and Fittings

Ductile iron pressure pipes and fittings shall comply with clause 3.1.17

**6.9 Steel Pipes and Fittings**

Steel pipes and fittings shall comply with clause 3.1.17.

**6.10 Grey Iron and Cast Iron Drain Pipes and Fittings**

Grey iron and cast iron drain pipes and fittings shall comply with BS 4622 and BS 437, respectively. Pipes shall be protected to the same standards and have the same type of joint as ductile iron pipes.

**6.11 Unplasticised PVC Pipes and Fittings**

Unplasticised polyvinyl chloride pipes, fittings and specials shall be to clause 3.1.17

Where PVC pipes, fittings and specials are to be connected to cast iron, stainless steel or steel pipes, 'Viking Johnson' type flange adaptors or stepped couplings shall be used.

**6.12 Polyethylene Pipes**

Polyethylene pipes shall comply with Clause 3.1.17

**6.13 Rubber Hosing**

Rubber hosing shall conform to BS 5119, Type 2. It shall be capable of handling chlorine and sulphur dioxide solutions at a working pressure of 12 bar.

**6.14 Copper Tubes and Fittings**

Copper tubing and fittings for work above ground level shall comply with BS 2871 and BS 864: Part 2 respectively and be jointed with capillary joints. For underground location the copper pipe shall be to BS 2871: Part 1.

**6.15 Flanged Joints**

All flanges shall comply with Clause 3.1.17 or Clause 6.9 for steel pipes. The nominal pressure rating for particular flanges shall be at least equal to the highest pressure rating of the pipes or fittings to which they are attached, but with a minimum nominal pressure of PN 16. All flanges shall be provided with all necessary nuts, bolts, washers and gaskets. In general, valves shall have flanged body ends.

All flanged joints that are buried or in chambers shall be protected with Densomastic and Densotape wrapping, applied in accordance with the manufacturer's instructions.

Flanges shall be installed on the pipes in the factory and field welding of flanges shall only be allowed with the approval of the Project Manager.

Where pipework outside pumping stations and surge vessel chambers is cathodically protected, an insulated flange shall be incorporated at the first flange inside the structure. These flanges shall be tested to ensure that electrical insulation is achieved.

#### **6.16 Gaskets and Joint Rings**

Joint rings shall be manufactured to conform with clause 3.1.17 and shall be of chloroprene rubber or other approved synthetic material suitable for temperatures up to 80°C.

Joints shall be made in accordance with manufacturer's instructions or as specified herein.

Until immediately required for incorporation in a joint, each rubber ring or gasket shall be stored in the dark, free from the deleterious effects of heat or cold, and kept flat so as to prevent any part of the rubber being in tension.

Only lubricants recommended by the manufacturer shall be used in connection with rubber rings and these lubricants shall not contain any soluble constituent, shall be suitable for the climatic conditions at the Site and shall contain an approved bactericide.

After cleaning the flanges the gaskets shall be fitted smoothly to the flange and the joint made by tightening the nuts to finger pressure first. Thereafter the final tightening of the nuts shall be made by gradually and evenly tightening bolts in diametrically opposite positions using standard spanners.

Graphite grease shall be applied to the threads of bolts before joints are made.

#### **6.17 Welded Joints for Steel Pipes**

Welding of joints in steel pipes shall be carried out manually by the metal arc welding process complying with AWWA Standard C206.

Before starting the welding of pipe joints in the Works the Contractor shall submit for the Project Manager's approval details of the plant, methods and materials he proposes to use, including make and size of electrodes, number of runs, current strength and arrangements for air testing of individual joints.

Welding shall only be carried out by welders approved by the Project Manager pursuant to the provisions of Clause 6.18 and each welder shall identify his work by means of a stencilled mark.

Welded joints other than for closing lengths shall be of the spherical spigot and socket type. For pipes of 675 mm diameter and smaller the pipe joint shall be welded externally. For pipes larger than 675 mm the pipe shall be welded internally and a sealing weld made externally.



All parts to be welded shall have loose scale, slag, rust, paint and other foreign matter removed by means of a wire brush and shall be left clean and dry. All scale and slag shall be removed from each weld run when it is completed. Pipes manufactured with longitudinal or spiral welds shall be lined up before jointing so that these welds are at least 15° apart around the joint circumference.

For pipes larger than 900 mm diameter a triple run convex fillet weld shall be used. For pipes of 900 mm diameter or less a double run convex fillet weld shall be used. The minimum leg length of the fillet as deposited is to be equal to the full thickness of the pipe wall. The actual throat depth shall not be greater than 9/10th and not less than 7/10th of the minimum leg lengths as deposited. The depositing of the weld metal shall be carried out in such a manner as to ensure that all the welds have adequate root fusion and are of good clean metal free from cracks, gas holes, slag inclusions and all other impurities. The surface of the weld shall have an even contour with regular finish and shall indicate proper fusion with the parent metal. All slag shall be thoroughly removed after depositing each run of welding by light hammering with a chipping hammer followed by wire brushing. Any welds showing cracks or other cavities or in which the weld metal tends to overlap on to the parent metal without proper fusion or containing any other defects whatsoever shall be cut out and rewelded to the satisfaction of the Project Manager at the Contractor's expense.

At closing lengths where two plain-ended pipes are to be joined by a welded joint the gap between the two ends shall not exceed 75 mm. An external steel sleeve collar, of a thickness not less than that of the pipe itself and approximately 300 mm in length shall be placed centrally over the two ends to be jointed and the end of each pipe shall then be fillet welded to the sleeve collar in accordance with the above procedure.

No weld or adjacent parts of the pipe shall be painted prior to inspection by the Project Manager.

#### **6.18 Welder Performance Test**

The Contractor shall submit for the Project Manager's approval the names of persons whom he proposes to employ as welders with evidence that, as a minimum preliminary qualification, they have passed the qualifying tests prescribed in Clause 11 of BS 2633 and possessed certificates from an independent testing authority. The Project Manager may further require any such person to perform satisfactory test welds under Site conditions and on pipes similar to those for use in the Works, before approving his employment as a welder. The Contractor shall maintain an up-to-date list of welders approved by the Project Manager and if ordered by the Project Manager he shall remove from the approved list any welder whose workmanship, as demonstrated by the results of air pressure tests on individual welded joints, is below a reasonable standard of quality of consistency in the Project Manager's opinion.

#### **6.19 Testing of Welded Joints**

Where directed by the Project Manager welded joints on pipes larger than 675 mm diameter

shall be subject to a nitrogen gas test after welding.

A tapped hole (approximately 6 mm diameter) shall be made in the socket end of each pipe by the Contractor and shall be fitted with a suitable non-return valve. Nitrogen, at 400 kPa pressure, shall then be pumped into the annular space between the spigot and socket and the pump disconnected.

If no drop in pressure occurs over the ensuing period of 30 minutes the test shall be deemed to be successful. If the test pressure cannot be maintained for 30 minutes all defects in the weld shall be cut back and rewelded and the test reapplied until successful. The cost of initial and subsequent testing of defective welds shall be at the Contractor's own expense.

The Contractor shall provide all items necessary for the nitrogen tests including compressor, valves, gauges and tubing.

## **6.20 Flexible Couplings and Flange Adaptors**

Flexible couplings and flange adaptors shall be of the Viking Johnson or similar approved pattern and be assembled in accordance with the manufacturer's instructions and protected, if buried or in chambers with Densomastic and Densotape wrapping applied in accordance with the manufacturers' instructions. Flexible joints shall be harnessed or tied where necessary.

## **6.21 Pressure Reducing Valves**

Pressure reducing valves shall be capable of maintaining a constant downstream pressure from a higher constant or variable upstream pressure and they shall be drop tight under no flow conditions.

The valve operation shall be achieved by the interaction of the inlet pressure, outlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valve.

The pilot valve or relay system shall be actuated by a diaphragm connected to the outlet pressure on its underside and a constant pressure on its upper side derived either from weights or from a spring.

Body ends shall be flanged and drilled to BS 4504.

The materials for the valves shall be as follows:

Cast iron body and cover. Internal valve, gunmetal with bronze liner, cups and facing rings in leather. Relay valve, bronze with stainless steel spindle and nylon valve face. Diaphragm, reinforced synthetic rubber. Loading spring, if employed - spring steel. Cylinder and weights, if employed - cast iron. Lever, steel with gunmetal pins and links. Connecting pipework to cylinder - copper. Cylinder, mild steel epoxy lined with internal working parts gunmetal bushed.

## **6.22 Pressure Relief Valves**

Pressure relief valves shall be capable of relieving pressure in the system to prevent the system being pressurised in excess of a preset maximum allowable pressure. The valves shall be drop tight under no flow conditions.

The valve operation shall be achieved by the interaction of the inlet pressure and an intermediate pressure produced by a pilot valve or relay system acting on the upper side of the main valve.

The pilot valve or relay system shall be actuated by a diaphragm connected to the inlet pressure on its underside and a constant pressure on its upper side derived either from weights or from a spring.

Body ends shall be flanged and drilled to BS 4505.

The materials for pressure relief valves shall be as specified for pressure reducing valves in Clause 6.21.

## **6.23 Gate Valves**

Gate valves shall comply with BS 5150, BS 5163 with Clause 3.1.32

Certain clauses of BS 5150 are amplified as follows:

### **Clause 14 Operation**

Manually operated valves shall not require a force of greater than 20 kg on the outer rim to operate with balance pressure across the valve, unless otherwise specified. To achieve this, gearing may be used in which case the time required to operate the valve under normal working conditions shall not exceed 20 minutes.

### **Clause 14.4 Indicators**

Indicators showing both OPEN and SHUT positions shall be supplied.

### **Bypasses**

Bypasses for valves 400 mm and over shall be fitted with integral bypasses as follows.

- 400 mm nominal diameter valve - 50 mm diameter bypass
- 500 mm nominal diameter valve - 80 mm diameter bypass
- 800 mm nominal diameter valve - 100 mm diameter bypass

Body ends shall be flanged and drilled to BS 4504

All valves shall be manually operated unless specified otherwise or to suit the system operation.

#### **6.24 Butterfly Valves**

Butterfly valves shall comply with BS 5155 or Clause 3.1.32

Body ends shall be flanged and drilled to BS 4504.

All valves shall be manually operated unless specified otherwise or to suit the system operation.

#### **6.25 Check Valves**

Check valves shall in general comply with BS 5153 or Clause 3.1.32

Certain clauses of BS 5153 are amplified as follows:

Clause 4      Type Swing type for either vertical or horizontal use.

The valve design shall ensure closure in the shortest possible time following deceleration of the water column, ideally reaching its seat without slamming at the instant forward motion of the column ceases.

Where specified the position indicators initiated by microswitches shall be provided to show when the gate is OPEN or SHUT, and provision made for initiating the operation of remote indicator lights and alarms.

Body ends shall be flanged and drilled to BS 4504.

For use with clean water and air duo-check type valves may be used and shall be of the flangeless type.

#### **6.26 Diaphragm Valves**

Diaphragm valves shall be of the full-bore type to suit the maximum working pressure ratings required. Body ends shall be flanged and drilled to BS 4504.

Indicators shall be supplied where specified showing both OPEN and CLOSED positions shall be supplied and provisions made for initiating the operation of remote indicator lights in the fully OPEN and CLOSED positions.

Valves used for toxic or hazardous fluids shall be provided with an additional 'O' ring seal of nitrite rubber or other approved material.

Diaphragms shall be composed of moulded reinforced, flexible material attached by studs to the compressor. Diaphragm materials shall, where required, be composed of corrosion resistant material.

### **6.27 Penstocks and Flap Valves**

Rising spindle penstocks shall be provided with headstocks and foot brackets as required. Guide brackets as necessary shall be included with the penstock. The handwheel with gunmetal rotating-nut shall have adequate diameter for the duty required and shall have cast on it the direction of closing which shall be clockwise.

Hand operated weir penstocks shall be lockable at any position.

Penstocks gates and frames shall be of cast iron and constructed of material of at least Grade 180 of BS 1452.

Seating faces shall be gunmetal or bronze, hand scraped, and securely fixed to the frame or door.

Frames shall be manufactured from continuously welded stainless steel Grade 316 S16. All frames shall be suitably reinforced and include corner gussets. All fasteners shall be stainless steel Grade 304 S16.

Anchor bolts shall be in stainless steel.

Non-return flap valves shall be designed to suit the hydrostatic conditions at a particular location so that they will automatically open when the downstream level falls below the upstream level and will close when the water levels equalise.

Flap valves shall be heavy pattern type with body and flap of close-grained grey iron, watertight faces of cast iron or non-ferrous rings securely riveted on, machined and hand scraped to a watertight finish. The flaps shall be double hung with non-ferrous hinge pins. Frames shall be drilled for bolting to concrete or to suit flanged ends of pipework.

### **6.28 Headstocks**

Mechanically remote operation of gate or butterfly valves shall be by the use of headstocks, or headstocks with operating spindle extension. Headstocks for direct connection to valves shall be for use with non-rising stem valves. They shall be of cast iron or fabricated carbon steel and fitted with a position indicator and handwheel, or bevel gear and handwheel to conform to the operational requirements. Stem bearings shall be gun metal bushed.

Where headstocks are structurally mounted above a valve chamber, or otherwise distant above a valve, then operating spindle extensions shall be used between the valve and headstock. These shall be suitable for length adjustment during assembly on Site and where necessary shall be fitted with universal couplings adjacent to the valve and to the headstock. Universal

couplings need not be fitted on sluice valves. The two couplings shall be so orientated as to give a linear transmission of rotational movement between headstock and valve stems.

### **6.29 Air Relief Valves**

Air relief valves shall be of the Apex type manufactured by Glenfield Neptune, Kilmarnock or equivalent approved.

### **6.30 Electric Valve Actuators**

Actuators shall incorporate a motor, integral reversing contactor starter, local control facilities and terminals for remote control and indication.

Actuators shall be sized to ensure valve operation at the maximum differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.

Motors shall be 3 phase squirrel cage, Class B insulated with a time rating of 15 minutes at 40°C or twice the valve stroking time, whichever is the greater, at an average load of at least 33% of maximum valve torque. Overload protection shall be provided by a direct sensing thermostat embedded in the motor windings.

The gearbox materials shall be suitable for the ambient temperature and enclosure protection shall be suitable for non-submerged outdoor use.

For butterfly valves the worm and quadrant gearing shall be housed in a robust iron gear case with 'O' ring seals. Adjustable mechanical stops shall be provided to cater for  $90^{\circ} \pm 5^{\circ}$ , these shall be designed to take the rated torque output of the actuator. The input and output drive mechanisms shall fully cater for resultant radial and axial loads. The assembly shall be grease packed for life.

For sluice valves and penstocks the gearbox shall be of the totally enclosed oil bath lubricated type suitable for operation at any angle and provided with appropriate filling and drain plugs. The drive shall incorporate a lost motion hammer blow feature. The output shaft shall incorporate thrust bearings of the ball or roller type. The design shall permit the gear case to be opened for inspection or dismantling without releasing the stem thrust or taking the valve out of service.

The gearbox shall be painted in the same colour as the actuator.

A handwheel shall be provided for manual operation, engaged when the motor is declutched by a lever. The drive shall be restored to power automatically by starting the motor. The handwheel drive must be mechanically independent of the motor drive and any gearing shall be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the handwheel shall give closing movement of the valve. The effort required for manual operation shall not exceed 250 N.

Actuators shall be provided with open and close torque and/or position limit switches as required by the type of valve plus two additional limit switches at each end of travel for remote indication and interlocking. A mechanical latch shall be provided to prevent the open torque switch tripping while the initial unseating hammer blows are applied. Space shall be provided for two additional sets of limit switches consisting of three switches per set. Each set shall be independently adjustable to any valve position. Switch contact ratings on inductive circuits shall be 5 A ac up to 400 V, 50 W dc up to 25 V.

A mechanical dial indicator shall be provided to show valve position fully open (red), fully closed (green) and intermediate (white). The mechanical dial shall show continuous valve movement. A sealed potentiometer shall be provided for continuous remote position transmission.

The reversing contactor starter and local controls shall be integral with the valve actuator, housed to prevent breathing and condensation buildup. The starter shall be suitable for 60 starts per hour, and shall comprise electrically interlocked reversing contactors of appropriate rating to the motor size. The primary winding of the control transformers shall be separated from the secondary by a grounded screen and shall be protected by two easily replaceable cartridge fuses. Secondary windings shall also be protected by cartridge fuses. Local controls shall comprise a pushbutton switch for open close and stop and a local/remote selector switch padlock-able in any one of three positions.

- Local control only.
- Off - No electrical operation.
- Remote control with local stop.

It shall be impossible to operate both open and close pushbuttons simultaneously. Stop pushbuttons shall be mushroom headed 'Stay put' type.

Each actuator shall incorporate the following:

- Easily resettable phase discriminator to prevent starting with an incorrect phase rotation or dead phase.
- Plug-in interposing relays with dust covers for open/close/stop control from a specified remote dc supply.
- Plug-in relay with normally open contacts coil energised from a control transformer only when local/off/remote switch is in the remote position to show the actuator is electrically operable by remote control.

Internal wiring shall be tropical grade PVC insulated stranded cable of 5 A minimum rating for control circuits and appropriate size for the motor 3 phase power. Each wire shall be

clearly number identified at each end. The terminal compartment shall include a moulded 'transfer back' terminal block of the study type, the 3 phase power terminals being segregated by a separate insulating cover. The terminal compartment shall include a double O-ring seal to provide a watertight barrier to the electrical enclosure so that electrical components are protected from moisture ingress while the terminal cover is removed.

The actuator enclosure shall be watertight IP 67.

All actuators shall be inspected and witness tested at works fitted to the appropriate valve or penstock. Test certificates shall be provided.

### **6.31 Pneumatic Valve Actuators**

Pneumatic actuators shall be of compact reliable construction and shall be sized to guarantee valve operation at maximum possible differential pressure.

Actuators shall be double acting with an adjustable air cushioning device to prevent piston slam.

The barrel shall be of cold drawn chrome plated steel, the piston rod of precision ground steel, and the piston head of aluminium alloy or malleable iron.

Fixing bolts shall be of high tensile stainless steel.

Valves shall be provided with facilities for manual operation.

### **6.32 Valve Operators**

Valves for operation shall be so geared that under the operating conditions as specified herein, the maximum force on the rim of the handwheel, crank, or other necessary for operation shall not exceed 20 kg and the maximum torque shall not exceed 5.5 kg/m. A spur, bevel, or worm gear reduction unit, if required, shall be attached to the pinion shaft of the operating mechanism.

The reduction gears shall be made of steel with machined teeth and unless otherwise provided, they shall be enclosed in a cast iron or fabricated steel sealed housing with oil seals, and shall operate in an oil bath. The pinion shaft and screw stems shall be made of alloy steel. The pinion shaft shall be provided with bronze sleeves.

The thrust bearings at each end of the pinion shaft shall have external fittings to permit lubrication with grease. The screw stem shall have a thrust bearing of the ball or roller type, which can be lubricated with grease through an external fitting.



## **7. TESTING**

### **7.1 General**

Testing will be required in the following two categories.

#### **7.1.1 Works Tests and Inspection**

These tests and inspections shall be carried out at the manufacturer's premises.

#### **7.1.2 Tests on Completion**

These tests shall be carried out on site and shall include:

- Tests on site during erection;
- Tests on completed plant systems;
- 30 day operation test.

#### **7.1.3 Further Tests**

These tests are described more fully in the following sections and in other chapters of the Specification as detailed below.

### **7.2 Works Tests**

All items of the Plant shall be liable to works inspection at all reasonable times by duly authorised representatives of the Project Manager or the Employer and the factory performance tests on completed units listed below shall be subject to witnessed testing. The Project Manager or his representative reserves the right to carry out pre-shipment inspection of the Plant.

Tests on the pumps shall, as a minimum, comprise the following:

- A performance test on one pump of each duty, the pump shall be driven by its electric motor and be complete with intermediate shafting etc;
- A performance test on all pumps not tested in (a) above.

The electrical equipment to be supplied shall be in tested in accordance with the requirements of the Specification and in accordance with the relevant BS, DIN or other applicable standard

and any other tests as required by the Project Manager to ensure that the Plant fully complies with the Specification requirements.

Complete performance tests are to be carried out on the motors as detailed in BS 4999 or equivalent. Motors shall be tested for temperature rise at full-load. For identical motors only the first motor for each type and rating need be tested as above, other motors may be subject to routine testing.

Routine and type tests shall be carried out on transformers to BS 171, IEC 214 or equivalent. Routine tests shall include:

- Insulation resistance;
- Ratio, polarity and phase relationship;
- Measurement of winding resistance on all tap positions and phases;
- Impedance voltage;
- Over-voltage withstand;
- Load loss;
- Noise level.

Low voltage switchgear shall be type tested to IEC 157 or equivalent. High voltage circuit breakers, vacuum contactors and earth devices shall be type tested to IEC 56 and IEC 470 or equivalent.

Routine tests shall be carried out on all high voltage circuit breakers, and vacuum contactors, including power frequency voltage tests, millivolt drop test and operational tests. Routine and operational tests shall be performed on all 415 V switchgear. Tests shall demonstrate that all control, protection and interlock systems operate satisfactorily.

High voltage cables shall be subjected to high voltage tests and insulation resistance tests. The dc resistance of the conductor shall be measured.

LV cables shall be routine tested in accordance with the relevant BS, DIN or national standard.

Miscellaneous items of electrical plant not specifically mentioned above but provided under the terms of the Contract shall undergo routine tests at the manufacturer's works, unless written approval is given by the Project Manager.

Any additional witness testing resulting from non-compliance of the equipment on initial testing shall be carried out at the Contractor's own expense.

Three copies of all pump and motor test certificates and pump performance curves shall be sent to the Project Manager within two weeks of the completion of the tests, whether the tests were witnessed or not.

The Project Manager will inspect the packing for shipment and confirm that this complies with the minimum standard called for in BS 1133.

Visual inspection shall include:

- Compliance with the Specification and the Contractor's undertaking in respect of description, quality and quantity;
- Standard of painting and corrosion protection;
- Standard and suitability of packing.

Where not otherwise specified, performance tests will be limited to those required by the appropriate British or equivalent International Standard Specification. Witness testing of small and standard plant will normally be waived.

Copies of all test certificates and graphs shall be supplied within two weeks of completion of any tests. Where standard equipment is used type test certificates may be supplied and the particular plant item not tested.

Each consignment of Plant delivered to the Site shall have been tested at the manufacturer's works or other approved place in accordance with the appropriate British or other approved Standard (such test being referred to herein as Works Tests). The Contractor shall provide the Project Manager with the manufacturer's test report for each such consignment before delivery to Site.

### **7.3 Tests on Completion**

#### **7.3.1 Tests on Site Erection**

Tests shall be carried out on individual items of plant and equipment during erection on site in order to confirm their suitability for the intended purpose. These tests shall include but not be restricted to the following.

##### **7.3.1.1 Mechanical and Electrical Equipment**

- A general inspection to check for correct assembly and quality of workmanship;
- Earth electrode resistance;
- Insulation levels;

- Voltage drops;
- Earth loop continuity and impedance;
- Overload and protection relay settings;
- Operation of protective devices;
- Motor running currents under no load and normal operating conditions;
- Security of all covers, fittings, conduits, trunking, cable fixings, etc;
- Security of earth terminations;
- Correction function of the plant;
- That all equipment is installed in accordance with the manufacturer's instructions;
- All installations generally as detailed in the IEE Wiring Regulations, 16th Edition. Test certificates shall be provided by the Contractor;
- Water, oil and air tightness of all services at or near maximum working pressure;
- Adequacy and security of fixing arrangements for machinery and pipework;
- Damp-proofing, rust-proofing and vermin-proofing and whether there are any unforeseen flood risks from failure to seal apertures between Plant and building structures (such as in pressurised floors and apertures for float rods, control systems and wiring).

The Contractor shall fully document the tests carried out and readings taken and submit to the Project Manager for approval.

Following the above inspections and tests, a 24-hour running test shall be carried out on each machine to prove:

- Correct functioning;
- Absence of fluid leaks;
- Correct bearing temperatures;
- Absence of undue vibration or noise.

During this test a check on the performance of the Plant shall be made, as far as site facilities will allow, to compare its site performance with the official factory tests and to identify any constraints on performance due to site conditions.

### **7.3.1.2 Pressurised Components**

Any enclosed systems including gas-holding components shall, as required by the Project Manager, be tested for mechanical strength and leakage at a pressure not less than 1.5 times the maximum operating pressure of the system, or the pressure called for in the appropriate British Standard. Any resulting damage or leakage shall be rectified by the Contractor at his own expense and the system shall be retested by the Contractor at his own expense.

Pipelines which are designed for internal pressure shall be hydraulically tested in accordance with this clause.

Gauges used for testing pressure pipelines shall either be of the conventional circular type, not less than 300 mm diameter, calibrated in metres head of water, or shall have a digital indicator capable of reading increments of 0.1 metre head. Before any gauge is used, the Contractor shall arrange for it to be checked independently, and a dated certificate of its accuracy shall be provided.

Before testing, valves shall be checked and sealed, the sections of main filled with water and the air released. After having been filled, pipelines shall be left under operating pressure for the period specified in the Contract, so as to achieve conditions as stable as possible for testing.

The pressure in the pipelines shall then be raised steadily until the specified test pressure is reached in the lowest part of the section, and the pressure shall be maintained at this level, by pumping if necessary, for a period of one hour. The pump shall then be disconnected, and no further water shall be permitted to enter the pipeline for a further period of one hour. At the end of the period the original pressure shall be restored by pumping and the loss measured by drawing off water from the pipeline until the pressure as at the end of the test is again reached.

Pressure testing against closed valves or air valves will not be permitted. The Contractor shall provide and install all necessary temporary caps and blank flanges and thrust blocks.

The test on a pressure line shall be considered satisfactory if there is no leakage after the specified time period for maintaining the test pressure.

### **7.3.1.3 Unpressurised Containers**

Reservoir tanks and other liquid containers not to be subjected to pressure shall be tested for leakage after installation. The completed structure will be tested by filling with water and measuring the water level. For concrete structures testing will only commence after the concrete has attained its design strength.

The following procedure based on BS 8007 will be used:

- a) The structure will be slowly filled to its normal operating level. The rate of filling should be uniform at a maximum of 2m depth in 24 hours. To cater for moisture

loss/gain due to evaporation and rainfall a control can shall be securely inserted in the water in the structure and also filled with water to a set mark. The water in the can is subject to the same gain/loss as the structure.

- b) Once filling has been completed, a stabilising (soakage) period of a minimum of 7 days will be observed. The level should be read daily at the same hour; the drop in level should reduce each day so that at the end of the initial 'soakage' period of 7 days, the recorded 24 hour drop should not exceed about 2 mm. This may be extended to 10 or 14 days before relative stability is achieved.
- c) The 7-day test period should then be started by recording the water level in the structure and in the can used to record the loss/gain due to evaporation/rainfall. Both levels should be recorded every day at the same hour. The level in the structure should be recorded at four different positions.
- d) The acceptable drop in water level should not exceed 1/500 of the average water depth or 10 mm, whichever is greater.
- e) If the drop in level over the 7-day test period does not exceed the acceptable drop and there are no signs of seepage on any of the exposed surfaces, the structure can be assumed to have passed the test.

Any leakage shall be rectified by the Contractor at his own expense and the tank or container re-tested by the Contractor at his own expense.

#### **7.3.1.4 Tests on Completed Plant Systems**

Following the successful completion of individual testing of each item of plant in a plant system, each plant system shall be tested for satisfactory operation through the full range of service duties. Tests shall include all anticipated duty under both automatic and manual control as appropriate.

#### **7.4 30 Day Operation Test**

When all testing under Clauses 7.2 and 7.3 have been completed and accepted by the Project Manager, the Contractor shall operate each section of the Works as a whole for a minimum period of 30 days. This operation shall be at the maximum capacity of the section of the Works, or lesser rate if required by the Project Manager for certain periods.

Daily reports shall be prepared on the operations that comprise of the amount of water in the system, hours in use, e.t.c. as directed by the Project Manager. These shall be submitted to the Project Manager and shall form part of the Employer's operation and maintenance manuals and As-Built drawings.

Training of the Employer's staff shall take place as described in Clause 8.06 during the operation period.

During the 30 days described above, the Contractor shall demonstrate that the Plant can produce consistently the specified quality of water at the design range of outputs. A comprehensive record shall be made of all aspects of the plant operation during this time and the results provided to the Project Manager in the form of a commissioning report.

#### **7.5 Further Tests**

Further tests may be required by the Project Manager during the Defects Liability Period to determine the performance of the Plant under raw water conditions different from those prevailing during the 30 day operation period. Should the Plant fail the test by not meeting the requirements of the Specification, the Plant shall be made good and re-tested by the Contractor at his own expense.

## **8. OPERATION AND MAINTENANCE TRAINING**

### **8.1 General**

The Contractor shall carry out full operation of the water supply system for 30 consecutive days. Daily reports shall be prepared on the operations that comprise of the amount of water in the system, hours in use, at least 6No off site detailed water quality tests e.t.c. as directed by the Project Manager. These shall be submitted to the Project Manager and shall form part of the Employer's operation and maintenance manuals and As-Built drawings. Training of the Private Operator's staff in basic operation and maintenance procedures of all plant and equipment shall be in this period.

The Contractor shall provide comprehensive training for the Employer's operation and maintenance staff and operators as part of the Transmission System (including Borehole Pump house and System Control) and the Distribution System (Reservoirs and Pipe Network Control). Training shall be provided in the following categories.

- Training in the operation of individual items of equipment.
- Training before issue of the Taking-Over Certificate.
- Training after issue of the Taking-Over Certificate.

These categories are described more fully in subsequent sections of this chapter.

### **8.2 Staffing Schedule**

The Employer will provide all the necessary operating staff and maintenance personnel to carry out the 30 day operation, for each section of the Works, under the Contractor's direction and to take over the plant operation after the 30 days operation.

### **8.3 Operating Instructions**

The Contract requirements concerning Operation and Maintenance Manuals are given in Clause 1.21 of the Specification. Two draft copies of the manuals are to be submitted for approval 2 months prior to the commencement of Tests on Completed Plant Systems (Clause 7.3 of the Specification). The draft manuals will be used during the training period and any amendments required will be communicated to the Contractor by the Project Manager before submission of the final version.



#### **8.4 Training for Individual Items of Plant**

Training in the maintenance, installation and operation of the following categories of plant and equipment is to be given to the Employer's staff prior to the hands-on training during the 30 day operation period for each of the sections of the Works:

- Borehole Submersible pumps;
- Water supply system control;
- Steel reservoir tanks flow control,
- Electrical switchgear.

#### **8.5 Formal Lectures**

The Contractor shall not be expected to give formal lectures; training is expected to be of a practical nature.

#### **8.6 Training after Completion**

Instruction shall be given to the Employer's operators and supervisory staff in the form of hands-on training throughout the 30 day operating period for each of the sections and parts of the Works. This training will be given as an integral part of the operation and shall be continuous during the 30 day period for each of the sections of the Works. All aspects of the plant operation shall be covered and the Contractor shall provide sufficient training personnel to cover all the necessary aspects fully.

#### **8.7 Training after Acceptance**

Following formal acceptance of the plant or part thereof by the Employer, the Contractor shall continue to provide training in an advisory capacity, while responsibility for the normal operation shall lie with the Employer. Training during this period shall include the provision of advice and assistance when required by the Employer.

#### **8.8 Training and Advisory Personnel**

The Contractor shall provide the following personnel to achieve the training requirements of the contract.

**8.8.1 Training Expert**

The training expert is to be experienced in operation and maintenance and in training unskilled operators in all aspects of the management and operation of the works which are being provided under this Contract. This shall be demonstrated by the submission of the Contractor's nominee's curriculum vitae to the Project Manager and the latter's approval to his appointment prior to the commencement of the training services. The training expert shall be fluent in English. The total duration of the training expert's input shall be a minimum of two months which may be split into a number of visits.

**8.8.2 Operations Engineer**

There shall be an operations engineer on the Site two weeks prior to the start of the first 30 day operation period. During the 30 day operation period for each of the sections of the Works he shall be fully responsible for the direction of the Employer's operating staff and for the correct operation. During the Defects Liability Period he shall act in an advisory capacity to the Employer. During both periods he shall be fully authorised to act on the Contractor's behalf to obtain necessary spares, materials and equipment to ensure the correct functioning of the Plant. The Contractor's nominee shall be subject to the Project Manager's approval and his linguistic abilities shall be similar to those of the training expert.

The numbers and durations of inputs of the training and advisory personnel are to be regarded as a minimum: the Contractor shall provide sufficient personnel to provide an operation, training and advisory service acceptable to the Project Manager.

**8.9 Programme**

Three months prior to commencement of the training the Contractor shall provide the Project Manager with a detailed programme of the various phases of the training, showing in particular when the different staff and operators will be required to attend.

**9. STANDARD SPECIFICATIONS FOR BUILDINGS****A. GENERAL****9.1 Introduction**

- This Part of the Specifications indicates the requirements of the Contract in respect of building and appurtenant work.
- Throughout the Drawings, and in this Specification, all reference to British Standard Specifications shall be deemed to be the latest edition of the British Standard to which the Clause refers at the time of tendering.
- The Specification is to be read in conjunction with other Parts covering the entire Works.
- Details on Drawings and in the Bills of Quantities and instructions given on Site by the Project Manager will take precedence over the Specifications given herein.

**9.2 Earthworks**

The Contractor shall keep a photographic record of surfaces to be reinstated, before the commencement of the works, and after completion of the reinstatement. Before the commencement of works that will damage surfaces, and will therefore need reinstatement, the Contractor shall inform the Project Manager in writing, one week in advance of date of carrying out the works and the anticipated date of reinstatement.

**B. CONCRETOR AND MASON****9.3 Sand**

All sand for making mortar shall be clean, well graded siliceous sand of good, sharp, hard quality equal to samples, which shall be deposited with and approved by the Project Manager. It shall be free from lumps of stone, earth, loam, dust, salt, organic matter and any other deleterious substance, sieved through a fine sieve and washed if so directed.

**9.4 Lime**

Lime for mortar shall be non-hydraulic or semi-hydraulic quicklime or hydrated lime in accordance with BS 890, Class B.

Quicklime shall be run to put it immediately after delivery to Site in a pit dug on the Site or in an approved container. The water to be first run into the pit or container and the lime to be added, until it is completely submerged, and stirred until all lumps are disintegrated. The resulting milk-lime shall then be run through a 3 mm square mesh sieve and into a pit or other container and kept clean and moist for not less than 4 weeks before use.

Hydrated lime shall be added to water in a clean receptacle, thoroughly mixed to the consistency of thick cream and allowed to stand, and be kept clean and moist, for not less than 16 hours before use.

### **9.5 Cement Mortar**

Cement mortar shall be 1:5, composed of 50.0 kg of Portland cement to 0.15 cu metres of sand, measured in specially prepared gauge boxes and thoroughly mixed in an approved mechanical mixer or mixed dry on clean and approved mixing platforms, with water added afterwards, until all parts are completely incorporated and brought to a proper consistency. Re-tempering of wholly or partially set mortar will not be allowed.

### **9.6 Gauged Cement Motor**

Gauged cement mortar shall be composed of 50.0 kg cement to 0.085 cu metres of lime to 0.34 cu. metres of sand, measured in specially prepared gauge boxes and thoroughly mixed dry on clean and approved mixing platforms, with water added afterwards, until all parts are completely incorporated and brought to a proper consistency. No partially or wholly set mortar will be allowed to be used or remixed.

### **9.7 Gauged Lime Mortar**

Gauged lime mortar shall be composed of 2 parts by volume of lime putty to 9 parts by volume of sand, measured in specially prepared gauge boxes and mixed dry on clean and approved mixing platforms, with water added afterwards, until all parts are completely incorporated and brought to a proper consistency.

The mortar shall be mixed 7 to 10 days before it is required for use and shall be stacked in a neat heap well smoothed off, covered with wet sacks and allowed to mature.

Immediately before use, 1 part by volume of Portland cement shall be added to 9 parts by volume of lime mortar, the whole being remixed, with the addition of extra water, until all parts are completely incorporated and brought to a proper consistency.

The gauged mortar must be used within 45 minutes of being mixed. Re-tempering of wholly or partially set mortar will not be allowed.

### **9.8 Protection**

All walling shall be properly protected while mortar is settling, as the Project Manager shall direct.

### **9.9 Setting out Rods**

The Contractor shall provide setting out rods and set out all work on same for courses, openings, heights, etc. and shall build the walls, piers, etc. to widths, depths and heights indicated on the Drawings. Setting out rods to be gauged to allow an average height of 22.5 cm for each course.

### **9.10 Bonding of Block work and Stone Walling**

Blocks or stone for general walling shall be bedded and jointed as described, properly bonded together in such manner that no vertical joint, in any one course, shall be within 125 mm of a similar joint in the courses immediately above or below. All walling of 300 mm thickness or less shall be built in single thickness of blocks or stone.

Walling exceeding 300 mm in thickness shall be built in two thicknesses of blocks or stones with through blocks or stones no more than 1.0 m (approximately) apart in each course as directed by the Project Manager.

Alternate courses of walling at all angles and intersections shall be carried through the full thickness of the adjoining wall. All walling shall be built entirely solid in blocks, without voids and all perpend, reveals and angles built strictly true and square. The walling shall be flushed up and grouted solid as the work proceeds.

Stone blocks shall be wetted before being laid and the walling kept wet while the mortar is setting. The top of walling, where left off, shall be well wetted, before recommencing work, as the Project Manager shall direct.

All putlong holes shall be not less than one course deep and carefully filled with concrete block or stone, cut to fit the size of opening, with beds and joints filled with mortar, well tamped in, after scaffolding is removed and, if in faced wall, to match facings.

### **9.11 Parging and Coring**

All flues shall be parged and cored in lime and sand mortar (1:4)

### **9.12 Quarry Tile Cills**

Quarry tiles for cills shall be throated, red, size 150 x 150 mm in accordance with BS 2871 type A. The tiles shall be set sloping and bedded in cement mortar (1:3) and neatly flush pointed with cement and sand grout (1:1) tinted to match tiles.

### **9.13 Damp Proof Course**

The bituminous felt sheet for damp proof courses shall be three-ply approved membrane in accordance with BS 743, weighing not less 0.5 kg per square metre. The sheeting is to be lapped 150 mm at running joints and the full width of walls at angles. Only the net area

covered is measured and the Contractor shall allow in his prices for all cutting and waste and extra material in laps as joints, angles, etc.

#### **9.14 Reinforced Walling**

Walls of less than 200 mm thickness shall be reinforced with one row of 20 gauge hoop iron, minimum 20 mm wide, built into every third course, well lapped at junctions and joints and carried at least 125 mm into abutting walls at intersections.

#### **9.15 Fixing of Timber Door Frames**

All door frames are to be bedded, and pointed in mortar and are to be securely fixed to reveals means of 25 mm mild steel cramps 300 mm long, bent and screwed to backs of frames, with a flanged end built 225 mm into joints of walling, three cramps to each side frame of each door. Where the door is provided with fanlights, four cramps are to be used to each side frame.

#### **9.16 Holes for Timbers in Walling**

Holes for timber built into or passing through a wall shall be squared out to suit the timber size and line with 3 ply roofing felt cut flush to finished wall surfaces.

#### **9.17 Concrete Block work Walling**

Concrete blocks shall be solid, hard, true to size and shall have sharp arises in accordance with BS 6073 Type "A" and be approved by the Project Manager.

They shall be obtained from an approved manufacturer or manufactured on Site in an approved block making machine. The mix used shall be not less than (1:9) by volume and the maximum size of aggregate shall not exceed 1.2 mm.

All concrete blocks used in walling must be capable of withstanding a crushing pressure not less than 0.280 kg/mm<sup>2</sup> after 28 days.

The blocks, on removal from the machine, shall be carefully deposited, on edge on racks under sheds, erected by the Contractor, and left for 3 days, during which period they shall be kept constantly wet. After this period, they shall be placed on edge, in the open on racks and protected by sacking, or other approved covering, and kept wet for a further 5 days. Thereafter, the blocks shall be left in the same position without wetting for a further 20 days.

No blocks will be allowed to be used in the work until 28 days old and until samples have been taken and approved by the Project Manager.

They shall be laid dry except for the top surface, which shall be wetted immediately before mortar is applied. After laying no further water shall be applied.

The concrete blocks shall be 225 mm high to bond in satisfactorily with all other walling.

Except where plaster finish is required internally, the internal faces of wall shall be finished fair with beds and joints neatly flush pointed as the work proceeds.

All walls to be plastered to have the joints raked out 12 mm deep as keys for plaster.

The concrete blocks shall be bedded and jointed in gauged lime mortar, as described, with beds and joints not more than 12 mm or less than 6 mm thick, all flushed up and grouted solid as the work proceeds, or pointed as required.

### **9.18 Hollow Clay Partition Blocks**

Hollow clay partition blocks are to be hard, well burnt, true to size and shape, with sharp arrises and keyed faces and joints in accordance with BS 3921. They are to be equal in every respect to a sample to be deposited with and approved by the Project Manager.

Hollow clay partition blocks shall be laid in courses 225 mm high to break joint in alternate courses and shall be bedded and jointed in cement mortar as before described.

### **9.19 Stone Walling**

The stone for walling shall be sound and hard throughout, free from all defects, and shall be obtained from a quarry approved by the Project Manager. It shall be chisel dressed into true rectangular blocks, with each surface even and at right angles to all adjoining surfaces.

Stone blocks for general walling shall nominally be 225 mm high and 100 mm, 150 mm, 225 mm, or 300 mm thick as required for the work, the maximum permissible variation of any of the foregoing dimensions being 1.0 cm.

Stones shall not be less than 450 mm long but a proportion of 20% will be permissible in lengths between 300 mm and 450 mm long. Samples shall be submitted to the Project Manager for approval when so approved shall become the standard for the work.

The stone blocks shall be bedded and jointed in cement mortar, as described, with beds and joints not more than 12 mm or less than 6 mm thick, all flushed up and grouted solids as the work proceeds, or pointed as required.

### **9.20 Brick Walling**

The brick shall be 225 x 115 x 75 mm (nominal) and shall be sound, hard, square, well burnt and of uniform size, shape and colour with sharp straight arrises. The bricks shall comply with BS 3921 and shall produce a clear ringing sound when struck against one another. No brick shall absorb more than twenty per cent of its dry weight during twenty-four hours immersion in water.

The Contractor shall be responsible for the transportation of the bricks to the Site in good condition and for ensuring that they are carefully unloaded and stacked on the Site. On no account will bricks be tipped from the vehicles. No broken or damaged bricks will be permitted to be used in the work.

All brickwork shall be built in English bond, consisting of alternate courses of headers and stretchers, all as detailed. Half brick walls shall be built in stretcher bond.

All bricks shall be well soaked with water immediately before being laid. Joints shall be not more than 10 mm thick and shall be bedded and jointed in cement mortar as described. All joints shall be solidly flushed up as the work proceeds. Bats shall not be used except where required for bond.

All brickwork shall be set out and built to the respective dimensions, thicknesses and heights specified or shown on the Drawings, and shall be built in a uniform manner, no one portion of two being raised more than 1.00 m above the other, at any one time, and, in such cases, the joints between the portions shall be in long steps to prevent cracks arising. All courses shall be truly horizontal and all perpend, quoins, jambs etc. shall be kept strictly vertical and square. All junctions of walls, etc. shall be formed in the correct bond as the work proceeds.

When walls are to be faced, only selected and approved facing bricks shall be used, the facing bricks shall be kept perfectly clean and no rubbing down of brickwork will be allowed. Walls must be protected against splashing caused by rain, paints or other causes.

All putlong holes shall be formed by leaving out headers in header courses or stretchers in stretcher courses as required, carefully filled up with headers or stretchers, as necessary, with beds and joints filled with mortar, well tamped in, after scaffolding is removed.

### **9.21 Precast Concrete Air Bricks**

Unless otherwise stated precast concrete airbricks are to be 225 mm wide, 150 mm high and 40 mm thick of approved pattern.

The air bricks shall be fixed double, one flush with the outer face of the wall and having approved copper mosquito gauze cut to size and fixed by folding over the edges of air bricks before building in. The other brick fixed flush with the inner face of the wall. Include for rendering around sides, top and bottom of brick opening in cement and sand mortar (1:4).

### **9.22 Built-in Services**

Particular care shall be exercised by the Contractor to ensure that all pipes, ducts, drains, conduits, junction boxes, anti-static installations, etc., are laid before the concrete for the floor and roof slabs is poured, and the Contractor will be held responsible for the cost of any additional cutting etc., and making good which becomes necessary through his failure to make proper arrangements for all work to be done in close cooperation.



**9.23 Precast Concrete**

The mixes for precast concrete units shall be as follows unless otherwise stated on the Drawings.

| UNIT            | CONCRETE                      |
|-----------------|-------------------------------|
| Lintels         | C20-20 mm nominal aggregate   |
| All other Units | C20 – 12 mm nominal aggregate |

**9.24 Entrance Steps**

Entrance steps, as required, to suit ground and floor levels shall be formed in concrete (C15/20), with suitable foundations as directed by the Project Manager. Treads shall be not less than 250 mm wide and risers not more than 175 mm high. All exposed surfaces shall be finished in cement and sand rendering (1:4), trowelled smooth with a wood float, 18 mm thick on treads and 12 mm thick on risers and finished with Carborundum dust on treads.

**9.25 Concrete Apron**

To all buildings where directed, provide a 50 mm thick concrete (C20/12) apron, 1.0 metre wide around the perimeter, laid on a 100 mm bed of hard-core, shall be provided.

**9.26 Savings**

Where required, these shall be size 600 x 600 x 50 mm thick of vibrated (C20/12) concrete finished on top with a wood float, clean cut edges and free from all cracks, chips or broken corners. The slabs shall be laid on a 75 mm thick consolidated bed of sand or stone dust, laid to falls where necessary and jointed and pointed in cement mortar (1:4).

The jointing mortar to be worked well down into the joints and the pointing to be key drawn and all excess mortar cleaned off.

**9.27 Concrete Shelves**

All suspended precast or in-situ concrete shelves, pot slabs, etc., shall be reinforced with B.R.C. Ref. NO. A252 or other equal and approved fabric reinforcement.

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### **9.28 Quality of Timber**

The qualities of timber are stated hereinafter:

- All timber described as “sawn podo” shall be Grade 11 (Select Grade) sawn podocarpus.
- All timber described as “wrot podo” shall be Grade 1 (Prime Grade) wrot podocarpus.
- All timber described “cedar wrot” shall be first (Prime Grade) wrot cedar.

All Musharagi, Mvule, Mahogany, and all other hardwoods, shall be selected quality, kiln seasoned or air dried and, when delivered to Site, shall have a moisture content of not more than 14% of its dry weight.

All timber for permanent work in the building shall before use, be approved by the Project Manager for quality in accordance with the foregoing specification for its respective grade.

### **9.29 Treatment of Timber**

All structural timber used in the Works shall be treated with an approved preservative. Such timbers shall be impregnated under pressure before fixing with Tanalith, Celcure, or other approved medium, toxic termites, cryptotermes and other timber pests. All cut end of timber so impregnated are to be treated with two coats of “B” crystals or other approved method.

### **9.30 Tolerance of Scantlings**

Variations from specified dimensions of scantlings shall not exceed the tolerance agreed with the Project Manager. Boards 25 mm thick or less shall hold up to the specified sizes. All timber shall be as long as possible and practicable to eliminate joints.

### **9.31 Sizes and Thickness**

Sizes and thickness of wrot carpentry and joinery are nominal, that is to say a 3 mm reduction off specified sizes will be allowed for each wrot face, except where described as finished sizes in which case no reduction from the stated thickness or size will be permitted.

### **9.32 Insulation Board**

Insulation board shall be 12.5 mm thick “CELOTEX”, or other equal and approved fibreboard, in accordance with BS 1142. Insulation board ceilings shall be fixed to a symmetrical pattern in each room.

**9.33 Soft Board**

This board is similar to insulation board but having high moisture absorbing properties.

**9.34 Block Board**

Block board shall be of approved local or imported manufacture, to BS 3444, softwood or hardwood faced, as specified, equal to a sample to be deposited with the Project Manager for approval and which, when so approved, shall form the standard for the work.

**9.35 Plywood**

Plywood shall be of approved local or imported manufacture, in accordance with BS6566, and of approved first or second grade softwood faced, unless otherwise described. "Exterior Quality" plywood shall be exterior moisture resistant type.

**9.36 Hardboard**

Hardboard shall be suitable for painting, in accordance with BS 1142 and shall be used, prepared and fixed strictly in accordance with the manufacturer's printed instructions.

**9.37 Chipboard**

Chipboard shall be approved, or local softwood, faced in accordance with the manufacturer's printed instructions.

**9.38 Plastic Sheets**

Laminated plastic sheeting shall be "Formica", or other equal approved, in accordance with BS 3794 of the type and grade specified. It shall be used, prepared and fixed strictly in accordance with the manufacturer's printed instructions.

**9.39 Wood Wool Slabs**

Wood wool slabs shall be approved Normal Quality to BS 1105 and fixed in accordance with the manufacturer's printed instructions.

**9.40 Defects**

Should any of the carpentry or joinery shrink, warp, wind or develop any other defects within six months after the completion of the work, the same shall be removed and new fixed in its place, together with all other work, which may be affected thereby, all at the Contractor's cost and expense.

#### **9.41 Carpentry**

All carpentry work shall be left with sawn surface except where particularly specified to be wrot. Scantlings and boarding shall be accurately sawn and set out, in strict accordance with the Drawings, and shall be framed together and securely fixed in the best possible manner with properly made joints. Provide all beads, nails, screws, etc. as necessary and directed and approved.

#### **9.42 Wall Plates**

Wall plates are to be bedded on walls in cement mortar and secured with 12 mm diameter bolts, 300 mm long at 1.00m centres, built 225 mm deep into walling. Plates to be in long lengths, halved and spiked at joints and angles.

#### **9.43 Valley Rafters**

Valley rafters to be fixed double and bolted or spiked together as directed or shown on the Drawings.

#### **9.44 Gang Boarding**

Gang boarding 25 mm thick, butt jointed and securely nailed to ceiling joists, shall be provided to form an access floor 450 mm wide between ceiling opening and water storage cisterns unless otherwise specified.

#### **9.45 Fascia and Barge Boards**

Fascia and bargeboards shall be in wrot cedar or as specified and according to detailed Drawings.

#### **9.46 Bat Proofing**

The underside of projecting eaves to buildings with ceilings shall be bat proofed by means of 50.0 x 25.0 mm wrought podu framing filled in with stout galvanised coffee tray mesh.

The framing shall be nailed on one edge to ends of rafters to butt up against fascia board and, on other edge, 50.0 x 25.0 mm sawn podu bearers plugged to wall.

**9.47 Building in of Timbers**

Timbers such as purlins, etc., required to be built into or through inner and outer walls, shall have 12 mm air space between same and walling.

**9.48 Joinery**

All joinery shall be executed with workmanship of the best quality and in strict accordance with the detailed Drawings. All mouldings shall be accurately run and all work planed, and papered and finished to the approval of the Project Manager. All finishes shall be slightly rounded. All framed work shall be cut out, properly tongued, shouldered, etc., and framed together, as soon after the commencement of the work as is practicable, but should not be wedged up until required for fixing in position. Any portions that warp, wind, develop shakers, or other defects, shall be replaced with new ones.

As soon as required for fixing in position, the framing shall be glued together with best quality glue and properly wedged or pinned, etc. as described.

Oval or round brads or nails shall be used for fixing all face work. All heads shall be properly punched in and puttied.

The quality of all workmanship shall conform to Part 11 of BS 1186.

**9.49 Plugs**

All fixing for joinery etc. shall be approved and plug fixed into holes of a recommended size. The holes shall be drilled with special masonry drills and not cut with a cold chisel and hammer. Under no circumstances will wooden plugs be permitted. The expression "plugged" shall be taken to mean fixed with and including plugs as last described to stone or concrete.

**9.50 Protection**

Any fixed joinery which, is liable to become bruised or damaged in any way, shall be properly cased and protected by the Contractor until the completion of the work.

**9.51 Setting out of Joinery Work**

All joinery work shall be accurately set out on boards to full size, for information and guidance of artisans before commencing the respective work, with all joints, ironwork and other items connected therewith fully delineated. Setting out will be required to be submitted to the Project Manager and approved before the respective work is commenced. All joinery work shall be wrot unless otherwise described.

**9.52 Ceiling Joists**

Where ceilings are shown on the Drawings, ceiling joists shall be fixed at 600 mm centres and around walls and the undersides shall be perfectly level.

Branding is to be 50 x 50 mm, fixed to and level with the underside of ceiling joists, at 600 mm centres, maximum, in both directions. The Contractor shall include for cutting and fitting at trusses.

**9.53 Ceilings**

Where shown on the Drawings, ceilings to all rooms shall be formed of approved insulation board not less than 12 mm thick

Ceilings shall be fixed to branding in a symmetrical pattern with edges chamfered to form “V” joints, all to the approval of the Project Manager.

**9.54 Priming of Woodwork**

Where intended to be in contact with stone, concrete blocks, concrete, cement or plaster, the backs and other surfaces of all door, window or other frames and linings, posts, architraves, skirting, fillets and fascias, and cornices etc. shall be treated with one coat of aluminium priming paint applied before fixing.

**9.55 Cornices**

The Contractor shall provide 100 x 25 mm cedar moulded cornices, securely fixed to rafters and branding, at the junction of walls and fibreboard ceilings in all rooms or provide 75 mm wide strips of insulation board, planted on to the junction of walls and fibreboard ceilings, as shown on the Drawings.

**9.56 Doors, Frames and Finishings****9.56.1 Flush Doors**

Flush doors shall be in hardwood and obtained from an approved local manufacturer, sizes of members and method of construction shall be to the approval of the Project Manager.

**9.56.2 Framed, Ledged and Braced Doors**

Framed, ledged and braced doors shall be 5.0 cm (nominal) thick 830 x 2,030 mm overall, or to size specified on the Drawings, and shall consist of 100 x 25 mm stiles and top rail, 225 x 25 mm lock and bottom rails and 100 x 25 mm diagonal braces filled in with 25 mm tongued, gooved and “V” jointed both sides boarding, in matched width, and shall include chamfers on edge of stiles and adjacent boarding to form “V” joints.

### **9.56.3 Ledged and Braced Doors**

Ledged and braced doors shall be 50 mm (nominal) thick 830 x 2,030 mm overall, or to sizes stated on the Drawings, and shall consist of 100 x 25 mm top rail and diagonal braces, 225 x 25 mm lock and bottom rails and covered on one face with 25 mm thick tongued, grooved and “V” jointed both sides boarding in matched widths.

### **9.56.4 Door Frames**

Door frames shall be in rebated and moulded cedar 100 x 75 mm. Wardrobe door frames shall be in rebated cedar 75 x 50 mm. Cupboard doorframes shall be in rebated cedar 75 x 38 mm.

### **9.56.5 Wardrobe and Cupboard Doors**

Wardrobe and cupboard doors shall be 25 mm thick flush doors constructed of approved blockboard and hardwood lipped on all edges.

### **9.56.6 Architraves**

The finishings of doorframes to all doors shall consist of 75 x 20 mm wrought cedar splayed architraves plugged to walling and mitred at all angles. When the doorframe is set against the face of the wall or where there is insufficient room for the architrave, the finishing shall consist of a 20 mm wrought cedar quadrant moulding planted on the frame.

### **9.56.7 Door Stops**

40 mm diameter rubber doorstops shall be provided to all door and securely plugged and screwed to floors with screws 40.0 mm long.

### **9.57 Shelves**

Slatted shelving shall consist of 50 x 25 mm wrought podo slats 20 mm apart screwed to bearers.

All board shelving exceeding 225 mm wide shall be cross-tongued.

Blockboard shelving shall be 25 mm thick with hardwood or softwood veneer, as stated or shown on the Drawings, with 132 x 25 mm softwood or hardwood edge strip to match, tongued in on all edges and the shelving screwed bearers.

#### **9.58 Pelnets and Curtain Track**

Pelnets shall be in cedar and mm bearers plugged and screwed to concrete lintol or stone wall. The whole to be formed of 100.0 x 25.0 m twice rounded at front and ends. The top, 125.0 mm rounded, screwed to 50.0 x 25.0 properly tongued, grooved, glued and screwed together, fitted with, and including, approved curtain track cut to length, and screwed to pelmet and fitted with 4 no. rollers per 300 mm run and all fittings.

#### **9.59 Window Boards**

Window boards shall be formed in cedar and shall be 25 mm thick, rounded on edge to project 40.0 mm beyond jambs, notched at ends and plugged and pelleted to walling under.

#### **9.60 Trap Doors**

Where shown, or directed, in fibreboard ceilings, the Contractor shall trim ceiling, joints and brandering for and form access door size overall 1000 x 850 mm. At hanging side of opening provide and fix 75.0 mm splayed frame and plant 75.0 x 50.0 mm stop on top of trimmer. Form the door with 50.0 x 25.0 mm frame covered with fibreboard to match ceiling and hang on pair of approved strong 75 mm steel butts and finish around opening with 40 x 25 mm rebated fillet screwed to trimmers to form stop.

#### **9.61 Panelling to Bath**

The bath casing shall be provided with a removable access panel 300 x 450 mm of approved tempered hardboard, fixed to 38.0 mm x 38 mm sawn poddo framing plugged to concrete floor and walls.

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#### **9.62 Ironmongery**

All ironmongery shall be of the description and manufacture described and shall be fitted and fixed in an approved manner. All locks shall be provided with two keys and shall have a sufficient number of differs to ensure that no two external locks may be opened with the same key. The Contractor shall include for all cutting, sinking, boring, mortising, fitting and for supplying all necessary and suitable matching screws. The Contractor shall also include for removing door furniture, during painting operations, and afterwards refixing and for labelling all keys with door references and handing to the Project Manager on completion. Master keys



shall be provided and properly labelled where directed. Face plates with all locks shall match the door furniture.

All locks, springs and other items of ironmongery with movable parts shall be properly tested, cleaned and adjusted where necessary to ensure they are left in perfect working order by the Contractor.

Samples of all ironmongery specified shall be submitted to the Project Manager for approval, and the approved samples shall thereafter be regarded as the standard for the work. Ironmongery which in the opinion of the Project Manager, does not conform to this standard, shall be removed from the Site.

Alternatively, ironmongery of an equal standard will be acceptable provided samples are submitted to and approved by the Project Manager before orders for such ironmonger are placed.

### **9.63 Structural Steel and Metal work**

Mild steel shall be sound, of approved manufacture and comply with the requirements of BS 4360 and have full threads to all screw works. With welds neatly executed, filled smooth and left clean. Prices for all mild steel shall include for removing all rust and scale and applying one coat of red oxide or other approved priming paint to all surfaces before fixing. Cast iron shall be best quality cast clean and sharp and free from all cracks, vents, holes and other defects.

### **9.64 Galvanised Sheet Iron**

Galvanised sheet iron shall be No.24 B.W. gauge of approved manufacture, free from all defects and hold up to the gauge as specified.

Flashings, gutters etc. shall be lapped 75 mm minimum and riveted and soldered at joints where required.

Where applied to walls, the side overlaps shall be seam bolted at 300 mm centres maximum with 6 mm diameter seam bolts 19mm long, each with diamond shaped bitumen washer, galvanised steel washer and galvanised steel nut.

### **9.65 Burglar Protection**

All windows, external doors and openings shall be burglar protected. Mesh window guards shall be provided to all ground floor bedroom windows. Window guards shall be galvanised "Weldmesh", or other equal, of approved welded steel with 50 mm square mesh with No.8 gauge galvanised wires in each direction.

Burglar bars, which shall be provided to all but bedroom windows, shall consist of 19 x 5 mm high yield steel flats or hollow sections as directed by the Project Manager, behind the line of the glazing bars to the casements, with the ends of the bars welded to metal or sunk into the timber frames, whichever is applicable. Louvre windows and openings shall be provided with an external grill of 20 mm twisted high yield bars or hollow sections as directed by the Project Manager, built all round into the walling at intervals not exceeding 0.12 m. The bars shall be welded at 150 mm centres horizontally and 450 mm centres vertically.

External doors shall be provided on the outside with similar grills hinged to 50 x 50 mm angle iron frames built into the walling as previously described. One pair of butt hinges shall be used and hinge pins welded, after fixing the grill, so that the grill cannot be lifted off the hinges. The grill shall, on the inside, be provided with a 20 mm barrel bolt, welded to a 5 mm thick backing plate, 200 mm square, and secured by an approved padlock with hardened steel shank. The grill and frame shall further be provided with staples at the top and bottom to accommodate additional padlocks if required.

### **9.66 Metal Windows**

Metal windows shall be of standard type of approved manufacture with plastic or bronze fittings, lugs, glazing clips and other accessories all in accordance with BS 6510. Windows shall be delivered to Site after correct selection of the windows, with red oxide dipped finish. Care shall be taken in the transportation, handling, storing and building into their requirement positions. Special attention to the care of the various window accessories shall also be given as no badly fitting, damaged or incomplete windows will be accepted by the Project Manager. All such windows and accessories shall be replaced at the Contractor's own expense.

### **9.67 Louvre Windows**

The vertical side members for louvre windows shall be profiled from 18-gauge aluminium strip to BS 1470. Blade holders and operating components shall be of injection-moulded polypropylene, or similar approved, with the blade holders sized to accommodate 152,4 mm (6 in) deep glass louvre blades, and pivoted on the vertical side members at centres of blades. They shall be linked together by 18-gauge aluminium section, specially profiled to form weathering links when the louvres are closed. The louvres should be capable of being locked in any position by means of plastic knob and steel bolts used in conjunction with a quadrant or in any other approved manner. Head and cill stops shall be either of 20 gauge aluminium or of suitable wood.

For louvre windows, glass to BS 952, with exposed edges bevelled, shall be used as follows:-

- Glass widths not exceeding 600 mm: 4.0 mm clear sheet glass
- Glass widths from 600 to 750 mm: 5.0 mm polished plate glass
- Glass widths from 670 to 1000 mm: 6.5 mm polished plate glass

**9.68 Open Mesh Steel Flooring**

Open mesh flooring shall be to BS 4592 and shall be painted black in accordance with the Specification. Kicking plates, 100 mm high shall be provided around all openings unless otherwise stated.

**9.69 Ladders**

Ladders shall be galvanised mild steel, with 20 mm diameter solid rungs and 75 mm by 10 mm stringers turned over at top and bottom, flanged and drilled for 12 mm diameter rag bolts.

Rungs shall be set at 230 mm centres and stringers shall be 420 mm apart. Stays shall also be of mild steel, heavily galvanised, 75 mm by 10 mm with length to suit, bent to shape, drilled for 12 mm diameter bolts for fixing to stringers and walls etc, with maximum distances between fixing points of 2.5 m. Ladders shall generally conform to BS 4211 “Steel Ladders for Permanent Access”.

**9.70 Hand railing**

Hand railing shall consist of 25 mm internal diameter water tubing, galvanised after being cut to length. The standards shall be of best quality forged steel, heavily galvanised after manufacture, 900 mm high, having two 80 mm balls drilled to suit the tubing and position of standard. The shanks of the standards shall be 30 mm diameter and of a type suited to their position. The movable hook bars 750 mm long shall be 25 mm diameter solid mild steel round bars heavily galvanised, with suitable hooks and eyes, complete with appropriate fixings to standards and walls. Hand railing shall generally conform to BS 499.

**9.71 Rolling Shutters**

These shall be in galvanised steel, slatted, manually operated, with a locking device and prime coated. Frame size, type and fixing details shall be to the Project Manager’s approval.

**9.72 Fencing**

Galvanised chain link fencing shall comply in all respects with BS 1722 Part 1.

Boundary fencing shall be 1.8 m high, topped by three strands of best quality barbed wire. The fencing shall comprise steel or precast concrete straining posts 2.6 m or 2.67 m long respectively, topped by a cranked extension piece 450 mm long, and set 750 mm in the ground in concrete Class C15/40 with all necessary struts.

Straining posts, intermediate posts and struts shall all be of either steel or precast concrete, corresponding to fence type LS 72A Table 4 or LC 72A Table 3 respectively of BS 1722 Part 1.

The chain link cladding shall be 50 mm mesh by 3 mm dia., complete with three strands of 3.5 mm galvanised iron wire, to which cladding shall be secured, at 150 mm centres on the top line wire and 450 mm centres on the middle and bottom line wires.

Straining posts shall be provided at all ends, corners, junctions and changes in direction, and at intervals not exceeding 45 m on straight stretches. Intermediate posts shall be provided at intervals not exceeding 3 m.

### **9.73 Gates**

Gates to boundary fencing shall be constructed at 25 mm dia. galvanised mild steel pipe frame, with rounded corners and covered with wire mesh. Each gate shall be complete with all hinges and ironmongery.

Keeps for drop bolts shall consist of 25 mm diameter galvanised pipe, 250 mm long, embedded 150 mm deep in Class C 15/40 concrete.

### **9.74 Wrought Iron Gates**

The manufacturer, pattern, locking devices and fixings shall be approved by the Project Manager.

### **9.75 Reservoir Roof Vents**

Roof vents for reservoir shall be double swan-neck type, manufactured from fibreglass or stainless steel. The vent internal diameter shall be 50 mm and corrosion resistant wire mesh guards shall be fitted to cover the ventilator openings. The vent shall project no less than 500 mm above the reservoir structural roof level and shall be cast in the positions indicated on the Drawings.

### **9.76 Reservoir Access Covers**

Access covers for reservoirs shall be hinged, lockable, single seal, light duty manufactured from fibreglass or stainless steel. The clear access opening provided when the cover and frame are in position shall be as indicated on the Drawings. The seals shall be filled with non-toxic grease on commissioning of the reservoirs.

### **9.77 Reservoir Level Gauges**

Level gauges shall be fitted externally to all reservoirs. Where reservoirs are covered by earthen embankments, gauges shall be fitted to roof slabs. The gauges shall be float operated with an external pointer travelling along a calibrated scale to read the depth of water in the reservoir at 100 mm intervals. Pointer and float shall be connected by nylon or corrosion-resistant cables. Calibrated gauges shall be fabricated from suitably treated mild steel components with each 100 mm depth point.

## **E. PLASTERER AND TILER**

### **9.78 Plaster and Rendering**

All surfaces to be plastered or rendered shall be brushed clean and be well wetted before the plaster is applied. All plaster and rendering shall be kept continuously damp for seven days after application.

All arrises shall be finished true and slightly rounded, except where otherwise stated, and shall be run at the same time as the adjoining plaster. No partially or wholly set plaster or rendering will be allowed to be used or re-mixed.

The Contractor shall prepare samples of the plastering and rendering, as directed, until the required quality, texture and finish is obtained and approved by the Project Manager, after which, all plastering executed in the Works shall conform to the respective approved samples.

The Contractor shall cut out and make good all cracks, blisters and other defects and leave the whole of the work perfect on completion. When making good defects, the plaster or rendering shall be cut out to a rectangular shape, with edges undercut to form a dovetailed key, and finished flush with the face of the surrounding plaster or rendering. "Gypsum", or other equal and approved plaster, shall be used when remedying defective work.

Gauged plaster internally shall consist of a first or rendering coat composed of one part cement, two parts lime, and nine parts sand and a finishing coat composed of one part cement, three parts lime, and six parts sand. The first or rendering coat shall be laid to a uniform surface, finished with a wood float, well scored and allowed to dry out for at least seven days before applying the finishing coat. The second or finishing coat shall be thoroughly worked and finished hard and smooth with a steel trowel.

Great care shall be taken in applying the finishing coat to obtain uniformity of the surface, smoothness and hardness. The total finished thickness of plaster shall be not less than 12 mm.

Cement plaster internally shall be composed of one part cement to five parts sand applied in two coats, the first coat well scratched to form a key and allowed to dry out at least 24 hours before applying the second coat. The second coat shall be finished with a steel trowel. The total finished thickness of plaster shall not be less than 12 mm.

Where the wall plaster is carried over wall plates, a strip of expanded metal shall be spiked to the wall plate to form a key.

Particular care shall be taken to ensure that plaster is made good around plumber's water, soil and waste pipes and around electrician's conduit, fittings and switches.

The Contractor shall include in his rates for dubbing out as necessary in cement and sand (1:7), hacking concrete to form a key and for all internal angles, arrises, other labours and for making good up to windows, door frames or other openings.

#### **9.79 Wall Tiling**

Glazed wall tiles shall comply with BS 6431, be free from all blemished and defects and true to size shape and colour. Wall tiles shall be obtained from an approved manufacturer and shall be supplied in 150 x 150 x 6.5 mm units of an approved design and colour.

The bedding for wall tiles shall be a 12 mm thickness of 1:3 cement sand mortar rendering finished to a true plumb surface. Before it has hardened, this surface shall be scratched to provide a key for the tile bedding. Tiles shall be set on the rendering in a bed of parian cement or alternatively an approved adhesive. Joints between tiles shall be uniform in width and exactly in line and these joints shall be pointed up with parian cement.

The rates shall include for all radi-used and special tiles and for cutting and fitting around doors, reveals and pipes.

#### **9.80 Floor Finishes**

Cement and sand pavings and finishings shall include for finishing surface perfectly smooth and hard, with a steel trowel, dead level or to true falls if so described, all temporary rules and formwork, to stop pavings at openings or edges as required; all knife edges, or slightly rounded arrises, for preparing concrete beds to receive paving by thoroughly brushing surface clean with a steel wire brush, well wetting and painting the same with cement and sand (1:1) grout immediately before paving is laid, for any additional thickness of paving required, beyond the thickness specified, due to irregularities in the concrete bed, and for keeping paving damp for at least 7 days after laying.

At the junctions of different floor finishings, fix in position 3 x 25 mm plastic or aluminium jointing strips cut to lengths bedded in and finished flush with pavings. All pavings shall be laid with joints set out in accordance with a detailed pattern approved by the Project Manager.

The Contractor shall protect the floor finish with heavy quality building paper, sheeting or sawdust, to the satisfaction of the Project Manager, as each area is completed.

#### **9.81 Terrazo Flooring**

The Contractor shall arrange for the terrazo work to be executed only by experienced personnel.

Before commencing the application of these finishings, the surface to receive the same, shall be thoroughly cleaned by wire brushing and left free of all dust, oil, grease, or any other deleterious substances, well wetted and painted with cement and sand (1:1) grout immediately before work commences.

All terrazzo finish shall conform in every respect to the colour and texture of a sample of the work, which must be approved by the Project Manager.

The rates for terrazzo finishes shall include for surfaces perfectly smooth, dead level or to true falls as specified, for all temporary rules, formwork to stop pavings at opening and edges, all knife edges, or slightly rounded arrises as required, and for any additional thickness beyond that specified or required due to irregularities in the surface to receive such finish.

Terrazo work shall be polished to an approved texture by mechanical means. The floors shall be first thoroughly washed clean and then rough polished and all holes etc. filled in with an approved filler and left for a 24 hour period. Finally the work shall be washed down and given a final polish to the texture approved by the Project Manager.

All skirtings, corners, working round pipes, door frames and sanitary fittings etc. shall be thoroughly hand polished to a similar texture by Carborundum block.

## **F. PLUMBER AND DRAIN LAYER**

### **9.82 Eaves Gutters and Rainwater Pipes**

Eaves gutters and rainwater pipes shall be made from No.24 B.W. gauge galvanised sheet iron. The eaves gutters shall be lapped and soldered at joints, have beaded edges and be fixed to falls with approved 25 x 6 mm galvanised iron brackets, with a galvanised sheet iron clip, riveted on outer edge and bent around the beaded edge of the gutter, 900 mm apart, bent to the shape of the gutter and each screwed to fascia boards or rafters with two stout steel screws. The gutters shall be half round and 150 mm diameter.

The rainwater pipes to be 100 mm diameter and have beaded shoulders, 100 mm distant from the lower ends, and fitted so that each length rests on the pipe section below. The upper part of the 100 mm long shoulder to be wrapped in hemp or yarn and coated with linseed oil putty to form a tight sealed joint with the length below. Any surplus putty is to be neatly cleaned off. 150 mm diameter ball gratings are to be fitted at gutter outlets.

All rainwater pipes to be fixed 40 mm clear of the extreme outer face of walls with strong, galvanised, malleable iron holderbats having a 120 mm long ragged tail and circular strap, in two pieces to form galvanised bolted connections.

The rainwater pipes are to be fixed in locations as shown and, unless otherwise stated, provided with 3.0 m length of open concrete drain channel. The Contractor shall provide proper purpose made swan neck bends, plinth bends, shoes, stoppered ends, etc., where required.

**9.83 Flashings, Aprons, Valleys etc., in Galvanised Sheet Iron**

Cover flashings, cover turn up of gutter linings, etc. to be 150 mm wide, minimum, lapped and soldered at angles, bent and turned into chases in walling 25 mm deep, wedged with metal wedges at not more than 150 mm centres and pointed in cement mortar (1:3).

Apron flashings to be 250 mm wide, minimum, dressed over roof coverings, turned up chimney stacks, lapped, soldered and turned into chases all as last.

Valley linings to be 600 mm width minimum, lapped not less than 150 mm and soldered at joints, dressed to shape of boarding and turned up 25 mm minimum, dressed over splayed tilting fillets, both sides, laid loose on boarding to allow for free movement in expansion and contraction.

**9.84 Pipe Material and Installation**

Galvanised mild steel tubing shall be of medium thickness in accordance with BS 1387.

Fittings for the same shall be galvanised malleable iron in accordance with BS 4609. Joints are to be screwed and socketed and put together in approved jointing compound. Long screws and any other un-tapered threads shall have yarn as well as jointing compound incorporated in the joints or be jointed with PTFE tape.

Polythene tubing for cold water services shall be normal or heavy gauge, as required or specified in accordance with BS 6572 and 6730. Joints and fittings shall be in accordance with the manufacturer's printed instructions.

All brass work and fittings shall be in accordance with BS 1010 for draw off taps and stop valves and BS 1212 for ball valves. Plastic float valves to be in accordance with BS 2456, and high or low pressure as directed by the Project Manager.

Soil, waste and vent pipes and their fittings shall be coated medium grade cast iron spigot and socket pipes. Pipes, fittings and accessories shall be in accordance with BS 16. All joints shall be made with P.C.3 compound or other similar and approved jointing compound.

Where directed, pipes shall be fixed in chases in walling and secured with approved holderbats built into walls, not more than 1.30 metres apart.

All surface fixings, unless otherwise specified herein, shall be carried out in "Philplug" or "Rawlplugs". The fixing holes shall be drilled with special masonry drills and not cut with a chisel. Under no circumstances will wooden plugs be permitted. Lavatory basin brackets shall be fixed to solid walls with 6 mm diameter bolts 100 mm long with head nut and washer.

Tubing for hot water services, waste and overflow pipes, etc. shall be galvanised mild steel.



The Contractor shall make arrangements with the water undertaking for connection to the existing water main including supplying all fittings and paying all dues.

### **9.85 Plumbing**

Pipes and tubes shall be cut by hacksaw or other method, which does not reduce the diameter of the pipe or form a bead or feather, which might restrict the flow of water. Bends shall be formed on an approved machine and in no case to an internal radius of less than eight times the outside diameter of the pipe. Elbows may only be used on pipes of 12 mm and 19 mm diameters and not on hot water systems of any description. All tubing, exposed on faces of walls, shall be fixed at least 25 mm clear of adjacent surfaces with approved holderbats built into walls not more than 1.30 metres apart. Polythene tubing must be supported throughout its entire length in horizontal positions as directed.

Pipes fixed in roof spaces or to joinery shall be fixed with approved clips screwed to timber members, not more than 1.30 metres apart. Easy bends in the line of piping shall be made with an approved bending machine. No fire-bends will be permitted. Where elbows are allowed, they will be of the rounded pattern.

### **9.86 Cold Water Storage Tank**

The cold water storage tank shall be by an approved manufacturer and shall conform with the requirements of Class A cisterns to BS 417.

It shall be of the capacity shown on the Drawings. Where tanks are required to sit on concrete slabs, 25 mm timber boarding must be provided under the tanks.

### **9.87 Hot Water Storage Tank**

Connect expansion pipe to water heater and run through ceiling to discharge over cold water tank in roof including all necessary fittings etc. as detailed on the Drawings, or as directed by the Project Manager.

Connect to cold water storage tank and run cold supply to water heater and make connection hereto. Provide low pressure gate valve at a point immediately before the cold supply enters the hot water cylinder or water heater.

### **9.88 Connection of Pipes and Tanks**

Each connection of tubing to cold water storage tanks shall be made by drilling a hole in the tank side and using a long screw union and two back nuts all well screwed up in red lead. Joints of tubing to glanded and bossed connections of hot water cylinders or boilers shall be made with a long screw, union and backnut screwed up in red lead.

Connections to sanitary fittings shall be made with a 450 mm length of copper tubing bent to shape as required, with copper to iron couplings at each end, and red lead joints to union of fitting and tubing.

### **9.89 Sanitary Fittings**

The descriptions entered in the Bills of Quantities, intended to outline the scope of the work and drawings indicate the general arrangement and approximate sizes and locations of equipment, piping and outlets. Where Site conditions require reasonable changes in indicated locations and arrangements, these shall be made without extra cost.

The Contractor shall submit, for approval by the Project Manager, a complete schedule of all sanitary fittings he proposed to supply and install. The schedule shall name and describe each item and the name of the manufacturer.

Once the schedule has been approved, no departures from it may be made without the written consent of the Project Manager. No orders for sanitary fittings shall be placed until the schedule has been approved.

### **9.90 Stop Cock Pit**

Construction stop valve pit size 250 x 250 x 600 mm deep internally consisting of 100 mm thick concrete sides, 75.0 mm concrete base size 600 x 600 mm, precast concrete cover slab size 450 x 450 x 50 mm thick reinforced with 75 mm mesh, no. 10 gauge "Weldmesh" or other equal and approved fabric reinforcement, with two 10 mm diameter mild steel rod lifting handles cast in the cover slab. Allow for holes through the sides for pipes.

### **9.91 Concrete Drain Pipes**

Concrete drain pipes shall be spigot and socket pipes of approved manufacture in accordance with BS 5911 and be totally immersed in water for at least 3 hours immediately preceding laying.

The joints, for concrete drain pipes shall be made by first wrapping three turns of cement slurried yarn to the end of the socket, then caulking well home so that the consolidated width of the yarn does not exceed one quarter of the depth of the socket. The yarn shall be best quality, white spun, long staple yarn, soaked in water for 24 hours before use and inserted in the joint while still wet.

The remaining portions of the socket shall be filled solidly and homogenously with cement mortar (1:2) and finished with a neat cement fillet on the outside at an angle of 30 degrees. Immediately after jointing, a tight fitting wad or scraper shall be drawn several times through the bore of the pipe to ensure it is left clean and free from obstruction. The joints shall be protected from injury until they have set hard.

**9.92 Pitch Fibre Drain Pipes**

Pitch fibre pipes, coupling and fittings shall be of approved manufacture in accordance with BS 2760 for pitch impregnated fibre drain and sewer pipes. The laying, cutting and jointing of pitch fibre pipes, and the jointing to pipes of other materials, shall be carried out strictly accordance with the manufacturer's printed instructions.

**9.93 Cast Iron Pipes and Fittings**

Cast iron drainpipes shall be coated spigot and socket pipes of approved manufacture in accordance with BS 437. All joints shall be made with P.C.3, or other similar and approved jointing compound, in accordance with BS 5292.

Cast iron soil fittings shall comply in all respects with BS 416. Those of spigot and socket type for drains to BS 437 and will be used as drain connectors to manholes.

**9.94 Step Irons**

Step irons shall be provided to manholes and septic tanks and shall be approved malleable galvanised cast iron to BS 1247.

**9.95 Concrete Beds and Surrounds**

All drain pipes shall be laid on a concrete bed, or blinding, as directed by the Project Manager.

Beds shall first be laid to correct falls and levels with recesses formed for the pipe sockets so that the whole of the soffit of the pipe barrel bears evenly on the bed. When the concrete has set, sufficient mortar (1:5) shall be spread on the bed to receive the pipe barrel, and ensure a surplus is squeezed out when the pipe is laid and finally adjusted to level. After jointing, the recesses around sockets shall be filled with concrete of the same mix as the bed and the haunching or surrounding completed.

Where pipes are laid under driveways and parking areas, the pipes shall be bedded and surrounded with concrete if the cover on the pipe is less than 1.0 m.

**9.96 Laying of Pipes**

Pipes shall be laid in straight lines to even gradients and to the required depths commencing at the lowest end.

Before each pipe is laid, it shall be examined to ensure that the barrel is clean and all foreign material removed. Any cracked or damaged pipes shall be rejected.

**9.97 Gulleys**

Gulleys shall be approved 100 mm salt glazed stoneware or cast iron trapped gulleys with 150 x 150 mm cast iron gratings to receive the wastes from waste fittings. Bed the gulleys on and surround with concrete (C15/20) 100 mm minimum thickness, carried up to form 75.0 x 75.0 mm curb, with all exposed surfaces finished in cement and sand (1:2), trowelled hard and smooth and all angles rounded. Make good cement joint to drain pipe and run drains to adjacent manholes.

**9.98 Manholes**

Manholes shall be constructed in stone, concrete, or concrete blocks in the positions and to the depths shown on the Drawings or as directed by the Project Manager. Construction in stone and concrete blocks is only allowed to depth of 1.5 m.

Cast iron manhole covers and frames shall be provided to all manholes, and shall be manufactured in accordance with BS 497 and approved by the Project Manager, size 60.0 x 45.0 cm single seat, minimum 23.42 kg weight, as shown on the Drawings or as directed by the Project Manager. Where wheeled traffic is liable to pass over the manholes, the Contractor shall provide medium or heavy-duty covers and frames as directed by the Project Manager.

Covers shall be bedded in grease and sand in the rebates and painted with two coats of black bituminous paint on completion.

Internal rendering to manhole walls and benching shall be 12 mm thick minimum, composed of one part of Portland cement to two parts of sand.

The surface is to be trowelled hard and smooth, coved at all internal angles and rounded on all arrises. The Contractor is to include for all coves, rounded angles, making good to pipes etc. and all other labours. The rendering to benchings is to be applied whilst the concrete is green.

**9.99 Testing**

Each length of drain and manhole shall be tested, as described hereinafter, and approved by the Project Manager before any backfilling of the trench takes place.

Testing shall not be carried out until at least 12 hours have elapsed after jointing takes place.

The test shall be as follows:-

- The lower end of the pipe and all junctions shall be securely stoppered and the whole length under test filled with water.
- When full, a further stopper shall be inserted at the top leaving a pipe attached to the drain plug. This pipe shall be bent through 90 deg., and shall terminate in a header tank 150 mm

square. The vertical distance between the centre line of the drain plug and the top of the header tank shall be not less than 900 mm.

- Water shall then be poured into the header tank, which shall be kept full for a minimum period of 3 hours to allow absorption to take place. At the expiration of this period, the header tank shall be topped up and the testing of the drain commenced. If, after a further period of 30 minutes, the water level in the header tank has not fallen by more than 12 mm the test will be considered satisfactory.
- In the event of a pipeline failing to withstand the test, the point of failure shall be completely surrounded, at the Contractor's expense, with concrete 1:3:6, using 19 mm aggregate, so there is a minimum cover of 15.0 cm in all directions. The length shall then be retested.
- Immediately a length of drain has been approved, the trench shall be backfilled for a depth of at least 30.0 cm above the top of the pipes.
- Air testing of drains may be used with the approval of the Project Manager.

**G. ELECTRICIAN****9.100 Electrical Installations**

All work in connection with the electrical installations shall only be carried out by an experienced and approved personnel.

All wiring shall be single core P.V.C. insulated copper conductors. Standard colour codes must be adopted viz: Red - Live, Black - Neutral, Green - Earth. The wiring shall be carried out by looping cables from point to point. No tee joints or any other joints shall be permissible.

Cables shall be drawn after installation of the conduit systems and any plaster has dried. Cross entry of cables and more than 6 cables in a conduit shall not be acceptable. Draw wires shall be threaded in at the time of installation of the conduits.

All electrical installations shall comply with UEB Regulations, with fittings of a type readily available in Uganda and approved by the Project Manager.

**9.101 Conduits for Electric Cables**

Best quality unplasticised, rigid, heavy gauge Class "A" P.V.C. conduits shall be used everywhere. The conduits shall be suitable for plain connections. On wooden trusses the conduits shall be secured at intervals of not more than 3 metres. Deformed, misshaped and bent conduits must not be used under any circumstances. At all bends and curves, the effective cross sectional area shall not be reduced below the normal cross sectional area. Conduits less than 19 mm nominal diameter shall not be used.

All conduits shall be laid in straight horizontal and vertical lines. In case of straight runs of conduits exceeding 50 m, suitable inspection boxes shall be placed at intervals of not more than 15 m. No more than 4 easy bends and 2 right angle bends shall be allowed between two such inspection boxes. The conduits shall be secured to reinforcement bars at intervals of not more than 3 m.

**H. PAINTER AND GLAZIER****9.102 Glazing**

All glass shall be of approved manufacture, in accordance with BS 952, free from flaws, bubbles, specks and other imperfections, cut to size to fit the opening for which it is intended, with not more than 1.6 mm play all round.

The glass for glazing generally shall be clear and flat drawn and shall be Ordinary Quality (O.Q) sheet glass of the required thickness to suit the size of sheet and position. 5 mm semi obscured glass shall be fitted to windows of toilets and bathrooms. Glass louvre blades shall not exceed 750 mm in length.

Putty for glazing shall be tropical putty of approved manufacture suitable for glazing to metal or wood frames as appropriate. Putty shall be delivered to the Site in the original manufacturer's sealed cans or drums and used directly therefrom with the addition only of pure licensed oil if necessary. No mineral or other oils be used.

The rebates of all windows shall be painted one under coat before puttying.

The putty shall, within 14 days, dry and harden without wrinkling of the surface or caking and shall adhere satisfactorily to the surface of the glass and the frame.

All glazing to wood frames shall be sprigged and to metal frames fixed with clips. All glass shall be properly back - puttied, and the front putty finished neatly and cleanly in line with back putty. Glass to glazed doors shall be fixed with glazing beads, secured with brass screws.

The Contractor shall clean all glass inside and out, remove all paint and putty marks replace any broken scratched or cracked panes and leave all glazing sound and perfect at completion.

### **9.103 Painting and Decorating**

Before commencing the painting work, the Contractor shall submit to the Project Manager, for approval, a list of all the brands of paints and finishings including the necessary primers and undercoats to be used. Immediately upon being approved orders shall be placed and the total requirements obtained for the work. Once approved, no other brand of materials shall be used without the permission of the Project Manager expressed in writing.

All materials shall be delivered to the Site intact in the original containers and shall be mixed and applied strictly in accordance with the manufacturer's printed instructions. No addition will be allowed to be made locally without the permission of the Project Manager.

The priming, undercoats, and finishing coats shall each be of different tints. The priming and undercoats shall be the correct brands and tints to suit the respective finishing coats, in accordance with the manufacturer's instructions. All finishing coats shall be to the colours and types specified by the Project Manager.

The Contractor shall include for the preparation of surfaces, rubbing down between each coat, stopping, knotting and all other work as previously described and as necessary to obtain a first class finish.

Plaster, finished with a steel trowel and fair face concrete surfaces, shall be well rubbed down, filled and made good as necessary, and thoroughly cleaned down, immediately before decoration is applied.

Cast in-site concrete, with a rough textured surface, shall be made good as necessary, and thoroughly wire brushed clean, immediately before decoration is applied.

Insulation board or similar surfaces shall be filled, and made good as necessary and lightly brushed down to remove all dirt, dust and loose particles.

Metal work to be painted shall be scaled clean and thoroughly wired brushed and wiped clean with white spirit (using rag or brush) to ensure that all loose particulars of rust and scale are removed completely.

Galvanised surfaces shall be treated with approved calcium plumbate primer applied strictly in accordance with the manufacturer's printed instructions.

Aluminium and other non-ferrous metal shall be primed with an approved zinc chromate primer.

Ironwork coated with bituminous solution shall receive an isolating coat of aluminium metal primer.

All exposed cast iron or asbestos cement, waste and vent pipes shall be primed with two coats approved aluminium metal primer before further treatment.

Woodwork to be painted shall be well rubbed down and primed with aluminium wood primer well brushed into the wood. All knots shall be covered with good shellac knotting before priming and all defects shall be filled with a hard stopping after priming.

Plywood to receive finishes other than paint shall have all stains removed, be well rubbed down and have all defects levelled up with hard stopping of a colour to match the adjoining surfaces.

After each coat, the work shall be allowed to dry and shall then to be well rubbed down with fine glass paper on blocks, or other means as required for the particular work, before the next coat is applied. The paintwork shall be finished smooth and free from brush marks.

All door furniture and other ironmongery shall, during painting operations, be removed and afterwards re-fixed.

#### **9.104 Distemper and Lime wash**

Distemper shall be oil or case in bonded and washable. It shall be thinned only with petrifying liquid made by the manufacturer of the approved distemper to be used, and in accordance with the printed instructions.

Lime-wash shall consist of slaked lime and coarse salt mixed in the following manner:

To 25.0 kg of slaked lime add water into which has been dissolved one kilogram of coarse salt. Add clean water until the required consistency is obtained.

All materials for external use shall be of exterior quality recommended by their manufacturers for such use.



**9.105      Covering up**

Sweep clean and cover up all floors, etc. with dust sheets when executing all painting and decorating work.

Paint splashes, spots and stains, shall be removed from floors, woodwork, etc. Any damaged surfaces shall be touched up and the whole of the work left clean and perfect upon completion.

## **10. PROJECT MANAGER'S REQUIREMENTS**

### **10.1 Office Accommodation for the Project Manager**

The Contractor shall provide a Site Office, for the use of the Project Manager. The Contractor shall maintain, service and insure the offices for the Contract Period or for such additional or lesser time as the Project Manager may direct. The offices shall be for the sole use of the Project Manager's staff. On completion of the Works, or at such a time specified by the Project Manager, the ownership of all furniture and equipment, except for survey equipment, shall be transferred to the Employer.

### **10.2 Location of the Buildings**

The Site Office building shall be provided at a position within the Contract Temporary Works Area specified by the Project Manager.

Surface water drainage facilities shall be provided to protect the buildings from surface run-off and to convey it away from the buildings.

### **10.3 Site Office Building**

The Contractor shall construct or alternatively rent a Site Office building. The Site Office building shall have a minimum floor area of 125 m<sup>2</sup>. The Contractor shall submit his proposals for the office building to the Project Manager for approval. The offices shall be constructed of new, durable, strong and weatherproof material to the satisfaction of the Project Manager.

The building shall have lockable doors, burglar-proof windows fitted with mosquito netting and shall be divided up by block work partitions into private offices and meeting rooms as required by the Project Manager. Covered communal passageways shall connect separated units.

The office shall have a toilet and washbasins to cater for the Project Manager and his staff, and the office shall be provided with a pantry/kitchen.

The offices shall be detached completely from the Contractor's site offices although they may both be contained within one compound suitably fenced and guarded.

The Contractor shall provide all services and infrastructure. He shall light, clean and maintain the building and shall provide a water and a sanitary system. The Contractor shall provide an electricity supply of sufficient power for general use.

The office with all furniture, fixings, equipment, services, carport etc., all as detailed below, shall be provided complete within 30 days from the date of the Project Manager's order to provide the same. The Contractor shall provide alternative accommodation to the satisfaction of the Project Manager if he fails to provide as appropriate, the building within the above stated time.

The Contractor shall provide 24 hour security for the Office.

#### **10.4 Access Roads and Parking**

All accommodation shall be provided with temporary, well drained access roads 3 m wide and carports for 3 cars. Access roads and the surfaces of the carports shall be surfaced with a minimum thickness of 150 mm of well-compacted gravel.

#### **10.5 Furniture, Fixings, Laboratory Equipment etc**

The Contractor shall supply the furniture, fixtures and equipment listed in the table below, and shall install them in the offices as required by the Project Manager. They shall be for the sole use of the Project Manager and his staff. All furniture, fixtures and equipment shall be supplied new, following the Project Manager's approval of a manufacturer's description or catalogue. The Contractor shall keep insured all furniture, fixtures and equipment to their full value (including duty where appropriate) and shall maintain them in good order until the end of the maintenance period. On completion of the Works, the equipment, shall be transferred to the Employer.

#### **10.6 Stationery and Office Supplies**

The Contractor shall supply all stationery and office consumables required for the normal functioning of the Project Manager's offices, including inter alia survey books, drawing office supplies, computer DVDs, CDs (Re-writable and Recordable), memory sticks, computer printout paper, but excluding headed correspondence paper. The Contractor shall continue this supply while the Project Manager's office is on the Site. If the Contractor fails to provide supply, the Project Manager shall be entitled to withhold the issue of a Payment Certificate until such time as the supply is provided.

#### **10.7 Laboratory Supplies and Equipment**

The Contractor shall supply all materials, chemicals and other laboratory consumables required for conducting the tests outlined in this Specification as directed by the Project Manager for the full period that the Project Manager's Site Office is on Site or for such greater or lesser period as required by the Project Manager.

The Contractor shall provide and maintain the following items but not be limited to:

- Apparatus conforming to BS 1881 "Methods of Testing Concrete" to enable site compaction and slump tests to be performed and sufficient steel cube moulds, with base plates and tamping rods, to enable sufficient concrete cubes to be made.

- One complete set of BS sieves to comply with BS 410 for “Test Sieves” and all other apparatus necessary for the purpose of testing sand, ballast and stone.
- Sufficient equipment to carry out daily tests indicated in these Specifications, especially the equipment to test the soil compaction.

### **10.8 Water, Gas and Electricity**

The Contractor shall supply or make provision for 24 hour water, gas and electricity supplies to the Project Manager's Site Office and shall arrange for sewage and refuse disposal.

Whenever these supplies are not available from the public utility services, the Contractor must continue to provide the facilities from his own resources.

### **10.9 Communications**

The Contractor shall arrange for the installation, commissioning and maintenance in use of one telephone line to serve the Project Manager's Site Office from the public exchange. The Contractor shall also provide full time uncapped high speed 4G+ mobile internet access facilities (2No.). In addition, he has to supply and maintain one mobile phone with post-paid system.

The Contractor shall allow in his rates for paying all costs, charges and fees in connection with the provision, hire and use of these telephones and internet / email services.

All necessary accessories, fittings, spares and maintenance for the telecommunications systems shall be provided by the Contractor who will be responsible for paying for the necessary licences for installing and operating these facilities. On completion of the Works, all communications equipment shall be transferred to the Employer.

### **10.10 Surveying Instruments and Equipment**

The Contractor shall provide for use by the Project Manager, survey and other instruments and equipment, as listed in the Schedule below. The instruments and equipment shall be new and shall be maintained in a good state of repair. In the event of loss or damage, they shall be replaced by items of a similar nature. On completion of the time specified by the Project Manager, all survey instruments and equipment shall revert of the ownership of the Contractor.

### **10.11 Assistance to the Project Manager**

The Contractor shall provide competent English-speaking drivers to the approval of the Project Manager for all vehicles used on the Site. Each driver shall have a minimum continuous driving experience of 5 years, with a certificate in driving, and aged between 25

and 45 years old. Any driver found unsuitable by the Project Manager shall be replaced immediately. These drivers shall be available during all normal site working hours and when specifically required by the Project Manager, outside those hours.

The Contractor shall supply the services of survey chainmen, either continuously or from time to time, as may be required by the Project Manager, to assist in the checking of materials on Site and in the setting out of the Works and in measuring the Works.

The Contractor shall provide all tools, protective clothing, wooden pegs, iron pins, water, concrete and transport for labourers as may be required by the Project Manager and his staff for supervision of the Works.

The Contractor shall keep all buildings provided by himself or the Employer, for the use of the Project Manager and his staff, in a well maintained, clean and fully habitable condition and shall maintain all access roads, car parks, footpaths, fences, gates, drains, potable water supplies and water-borne sewage disposal systems in a good state of repair, all to the satisfaction of the Project Manager. The Contractor shall also provide an adequate refuse disposal service for all residences and offices. The Contractor shall maintain all furniture and equipment, provided by him, in a good state of repair and usable condition and shall replace any item which becomes unserviceable due to fair wear and tear.

The Contractor shall provide soap and towels in the offices of the Project Manager, cleaning and sanitary staff, cleaning equipment and day and night watchmen for the office, residence and motor vehicles wherever they will be packed.

## 10.12 Equipment Schedules

**Table 10-1 Furniture, Fixtures and Equipment for Project Manager's Office**

| Item Nr   | Description   | Unit | Quantity |
|---|---|------|----------|
| Supply and install the following items of furniture, fixtures and equipment in the Project Manager's office |   |      |          |
| 1   | Desk, metal framed, with 6 drawers fitted with locks (2.0 m x 1.0 m approx)                           | Nr   | 2        |
| 2   | Chair, swivel, upholstered, wheeled chair with arms for above desks                                   | Nr   | 2        |
| 3   | Table, metal framed (1.2 m x 0.9 m approx.)   | Nr   | 1        |
| 4   | Filing cabinet, metal, 4 drawer with suspended filing system, locking                                 | Nr   | 2        |
| 5   | Chairs, metal framed, upholstered for above table   | Nr   | 4        |
| 6   | Waste paper basket  | Nr   | 2        |
| 7   | Letter tray (each set of 3 trays)   | Nr   | 2        |
| 8   | Sundry office items: paper punches (1no), staplers (1no.), scissors (1no.), staple removers (1no) etc | Set  | 2        |
| 9   | Electric kettle   | Nr   | 1        |
| 10  | Drinking mugs   | Nr   | 6        |

| Item Nr | Description                          | Unit | Quantity |
|---------|--------------------------------------|------|----------|
| 11      | Tea set (6 Nr cups, saucers, plates) | Sets | 1        |
| 12      | Tea spoons, small knives             | Nr   | 6        |
| 13      | Tea tray                             | Nr   | 1        |
| 14      | First aid kit                        | Nr   | 1        |
| 15      | Mop and bucket                       | Nr   | 1        |
| 16      | Plastic bucket                       | Nr   | 3        |
| 17      | Plastic jerry cans 20 litre capacity | Nr   | 2        |
| 18      | Broom                                | Nr   | 2        |
| 19      | Dust pan and brush                   | Nr   | 1        |

**Table 10-2 Surveying Instruments and Equipment**

| Item Nr   | Description  | Unit | Quantity |
|---|--|------|----------|
| Supply the following items of surveying equipment to the Project Manager's office |  |      |          |
| 1   | Total Station (Theodolite WILD T1000, Distomat WILD DI5, data recorder WILD GRE4 or similar approved), notebook with surveying software RIB STRATIS, complete with tripod, carrying case and all accessories | Nr   | 1        |
| 2   | Steel tape, 50 m length  | Nr   | 1        |
| 3   | Steel hand tape, 5 m long  | Nr   | 2        |
| 4   | Rain gauge with measuring bottle/can   | Nr   | 1        |
| 5   | Hand held Global Positioning System device- Leica viva/Magellan  | Nr   | 1        |

### 10.12.1 Vehicle and Transport:

The Contractor shall supply motor vehicles as detailed below.

#### **Pick-up trucks: 2 nr.**

The vehicles shall be for the sole use of the Engineer and his staff and shall be available at all times. Only those makes of vehicles having satisfactory permanent repair and maintenance facilities already well-established in Kampala will be acceptable and shall first be approved by the Engineer. All the vehicles shall be of the same make.

The vehicles shall be new right-hand drive diesel-powered Toyota vehicle for the exclusive use of the Engineer. They shall have four-wheel drive capability, high ground clearance, an engine capacity of at least 2900 cc, power steering, power windows, anti-lock braking system, air bags for driver and front passenger, lockable

glove box, and central locking system. The front seats for all vehicles shall be separate and all seats shall have headrests.

The vehicles shall be fitted with the manufacturer's tropical and off-highway extras including tow bars, front bull bars and air conditioning. The vehicles shall be equipped with an auto alarm system, central locking system and radio and compact disc facilities. Each vehicle shall also be provided with a first aid kit supplied by the supplier of the vehicles. Kerb weight and tyre pressures shall be stated on each vehicle, and the vehicles shall conform in all respects to the regulations of the appropriate registration authority.

The pick-ups shall be double cabin type with wireless door entry and locking system, front automatic wheel hubs for four-wheel drive, side impact beams, and a tonneau cover supplied by the supplier of the vehicles.

The Contractor shall provide competent English-speaking drivers to the approval of the Engineer. The drivers shall have a minimum continuous driving experience of 8 years, with a certificate in defensive driving, and aged between 30 and 55 years old. The take-home monthly salary shall include all taxes and compliance with all other statutory requirements and allowances such as housing allowance, medical expenses and fees and per diem allowances for travelling. If the driver is found unsuitable by the Engineer shall be replaced immediately.

The driver shall be available during all normal Site working hours and when specifically required by the Engineer, outside those hours.

### **10.12.2 Vehicle Operation and Maintenance**

The vehicles provided shall be maintained at all times in good running order. Should any vehicles at any time become, in the opinion of the Engineer, unserviceable by normal use in the conditions and demands of the Site, the Contractor shall replace them without delay. If the Contractor fails to provide replacement transport, the Engineer shall be entitled to withhold the issue of a Payment Certificate until such time as a replacement is provided.

The Contractor shall provide all necessary fuel, lubricants, etc, and shall bear all expenses in connection with running, servicing, maintenance, repairs, upkeep, licensing and insurance. All vehicles shall be serviced, maintained and repaired at the supplier's workshop.

Insurance for all vehicles shall be 'comprehensive' for the replacement value of each vehicle and shall also include:

- Cover for the Engineer and his staff driving the vehicle, and for any other persons that the Engineer requires to be included; and
- Liability to third parties (including passengers whether the Engineer, his staff or others) for an unlimited indemnity in respect of death or personal injury and for

the maximum indemnity reasonable in respect of loss, destruction or damage to property.

When not used by the Engineer the Contractor shall provide adequate and secure garaging for each vehicle and will not permit use of any vehicle other than that authorized by the Engineer.

The Contractor shall provide similar replacement vehicles whenever the original vehicles are not available for use for whatever reasons.

On completion of the Works, all the vehicles shall be handed over to the Employer. The Contractor shall be responsible for the running, servicing, maintenance, repairs, etc of one of the vehicles which shall be handed over to the Employer at the end of the Defects Notification Period. Before the vehicles are handed over to the Employer, the Contractor shall first arrange for a complete overhaul of each vehicle to the satisfaction of the Engineer. The Contractor shall arrange for transfer of ownerships and registration in favor of the Employer and pay all costs and fees. The final complete overhaul of each vehicle, before it is handed over to the Employer, shall include:

- servicing of the vehicle;
- fitting the vehicle with new tyres, new spare tyre, and new battery(ies);
- repair of all dents;
- cleaning up and technical verification of all-important parts of the vehicle;
- replacement of the parts found damaged or worn-out;
- repair and/or replacement of worn-out or damaged seats, seat covers, and floor mats;
- spraying of the vehicle to the same original colour as directed by the Engineer.

All the Contractor's expenses and costs arising under this Clause shall be reimbursed against the rates and prices entered in the Bills of Quantities. Purchase costs will be paid after handing over of the vehicles to the Engineer. Standing costs are on a number basis while operating costs will be paid according to the kilometres travelled as recorded on the vehicle odometers.

The standing costs will include items such as provision of the vehicles, insurance, registration, road taxes, delivery to Site, garaging and provision of temporary replacement vehicles. The rate will also include for the cost of the final complete overhaul, transfer of ownership and registration in favour of, and delivery of all vehicles to, the Employer.

The kilometre rate will include all day-to-day running expenses such as fuel and lubricants, routine servicing, maintenance including provision of new tyres and batteries, repairs, provision of drivers and their overtime.

The vehicles shall be provided within 56 days after the Commencement Date. Prior to the supply of the vehicles, the Contractor shall provide and maintain temporary similar vehicles starting from the Commencement Date. If the vehicles for the use of the



Engineer and his staff are not supplied within the specified period of 56 days, the Contractor shall provide, at his risk and cost beyond the specified period of 56 days, the temporary similar vehicles for the Engineer's staff.