Bidding Document for Procurement

BARICHO WELL FIELD PROTECTION WORKS

Volume 2 of 3

NCB No: KE-CWSB-233052-CW-RFB

Project Name: WATER AND SANITATION DEVELOPMENT (WSDP)

Employer: COAST WATER WORKS DEVELOPMENT AGENCY (CWWDA)

Country: KENYA

Part 2: Work Requirements

Attachment VII.1- SPECIFICATIONS

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The Contractor shall construct and complete all Works detailed in the Contract, in accordance with the Conditions of Contract, this Specification and the Drawings.

1.2 Use of Construction Facilities and Work Areas

1.2.1 Rights of Others to Use Construction Facilities

Other Contractors employed by the Employer and their workmen and workmen of the Employer and of other Government authorities who will be carrying out work on or near the Site of the Works, shall have the right to use, without charge, the access facilities, including bridges and roads, of which the Employer has given possession to the Contractor or which have been constructed or acquired by the Contractor for use in constructing the Works.

1.2.2 Facilities to be made Available by the Contractor

Reticulated water, drainage system and any other such facilities, constructed or acquired by the Contractor for use in carrying out the Works, which are available without entailing any increase in capacity of the Contractor's facilities shall be made available without charge to the Employer and any other Contractor’s employed by the Employer at mutually convenient times.

1.2.3 Protection of Electrical and Mechanical Plant

During and after installation of the electrical and mechanical plant and equipment, the Contractor shall prevent any damage which might arise from his operations including that from harmful quantities of airborne dust. For this purpose, mixing of concrete and handling of any cement within the vicinity of plant and equipment will not be permitted after the commencement of installation and any grinding of concrete shall be completed before plant and equipment in the vicinity is installed.

1.3 Contract Documents and Drawings

1.3.1 Contract Documents

The Contractor will be provided with one set of the Contract Documents for his own use. A complete set of the Contract Documents supplied by the Engineer and all further instructions issued by him shall be always kept by the Contractor on the Site and shall be available at all reasonable times to the Engineer and his staff. On the

completion of the Contract all Contract Documents supplied shall be returned to the Engineer.

1.3.2 Tender Drawings

The Drawings included in the Tender Documents (Tender Drawings) are to be used for tendering purposes only. The Drawings show the work to be carried out in accordance with the Contract, as definitely and in as much detail as is possible at the tender stage of the development of the design.

1.3.3 Drawings Approved for Construction

Construction will proceed only with drawings designated Approved for Construction ("AFC") by the Engineer. These will supplement or supersede the Tender Drawings as necessary for the purpose of the proper and adequate execution of the Works.
If the AFC drawings contain portions of works that cannot be finalized at the time of issue, such portions shall be marked "Hold" indicating the said portions are not approved for construction.
The Contractor will prepare working drawings and shop drawings for approval as per the schedule of Paragraph 1.33 of the present Specifications. These will be submitted to the Engineer in two (2) hard-copies and Autocad DWG. The Engineer may prepare and issue drawings or may modify drawings by the Contractor and issue them as AFC.
All costs for preparation of Drawings by the Contractor are deemed to be included in the item "Preparatory Works" in the priced Bill of Quantities.

1.3.4 As-Built Drawings

The Contractor shall prepare "As-Built Drawings" showing all Permanent Works constructed under this Contract and incorporating such details as actual excavation levels and lines, full details of reinforcement and locations of construction joints, electrical wiring and installations etc. including all changes, revisions, deviations and corrections from the issued AFC Drawings.
The size, scale and form of the "As-Built Drawings" shall be as approved by the Engineer.
Drawings shall be submitted in six hard copy prints and soft copy AutoCAD files in DWG format.
All costs for preparation of these Drawings are deemed to be included in the item "Preparatory Works" in the priced Bill of Quantities.

1.4 Royalties, Compensation, Services and Land Acquisition

1.4.1 Royalties

The Contractor will not be required to pay royalties in respect of rock, stone, sand, gravel and clay removed from designated sources at the Site for use in the Works.

If the materials are obtained from other sources the Contractor shall make his own arrangements with owners or government agencies having control of such sources and pay whatever royalty, rent or charges that may be imposed.

1.4.2 Contractor's Activities in Respect of Property Outside the Permanent Works Designated Land and of Services Moved, Damaged or Altered

1.4.2.1 Statutory Provisions

The Contractor shall exercise any rights that may be ceded to him by an Authority in terms of any statutory provisions for purposes of executing the Contract, on condition that:

i. the Contractor complies strictly with the requirements of such statutory provisions, particularly in regard to the matters relating to serving notice on the Owner or consultation with him.
ii. In each case a written agreement is made with the Engineer regarding the details of the Contractor's proposed actions before the rights of the Contractor in terms of the statutory provisions are exercised.

The provisions shall apply mutatis mutandis to:

i. those areas approved for the purpose of disposing of spoil material; and
ii. those areas occupied by the Contractor for his establishment on the Site or for any other purpose and for the Engineer's houses, office, and laboratory.

1.4.2.2 Agreements with Owners or Legal Users of property

The Contractor shall put in writing all his agreements with Owners of property outside the Permanent Works designated land or of services inside or outside the Permanent Works designated land in respect of the following matters:

i. The location, extent and use of borrow pits, haul roads, construction roads and Permanent Works outside the designated land.
ii. Compensation, if applicable, for land or materials taken or for land temporarily used or occupied.
iii. The reinstatement of property occupied, used, damaged, or destroyed, or compensation therefore in lieu of reinstatement.
iv. The procedure for the moving of services and details as to how and when this is to be done.
v. Any similar matter directly related to the Contractor's activities on or in respect of private property or services.

These agreements shall be signed by all the parties concerned and delivered to the Engineer.

Where the Contractor cannot obtain the Owner's agreement in writing, he shall refer the matter to the Engineer and shall furnish him with details, in writing, of any verbal agreement made.

1.4.2.3 Notice on Owner

Where, in addition to any agreement with the Owner of any property to be entered upon or temporarily occupied or any service to be moved, it is understood or required that the Contractor shall serve notice on the Owner immediately before entering upon or occupying the private property or moving a service, and shall give proper notice thereof in writing, and the Engineer shall be supplied with a copy of such notice, together with acknowledgement of receipt.

1.4.2.4 Completion Statement from Owner

On completion of its operations, the Contractor shall obtain from the owner concerned, a written statement to the effect:

i. that the Contractor has fulfilled its obligations under a written agreement
ii. in the absence of a written agreement, that the Owner has received all the compensation he is entitled to and is also satisfied that all property occupied, including borrow pits, haul roads and access roads, has been properly restored and is in a satisfactory condition.

All such statements shall be signed, dated and delivered to the Engineer.

1.4.2.5 Use of Land outside provided Area

Should the Contractor wish to use land outside the area provided by the Employer for storing or keeping material or equipment required for the construction of the permanent works, it will be subject to the following:

i. That the Engineer approves any area selected for this purpose.
ii. That such land be physically separated from any production plant or activities and suitably fenced in.
iii. That the area used for the aforesaid purpose be surveyed, and, where the land does not belong to the Contractor, he shall enter a contract of lease with the Owner of such land in respect of the full period for which such land shall be used for such purpose.
iv. That the contract shall stipulate that the Owner shall not have any right whatsoever to any material stockpiled on such land during the occupancy of the contract of lease. That suitable, permanent reference beacons, approved by the Engineer, be placed next to the area, at the cost of the Contractor, for use by the Engineer with a view to, if applicable, taking cross-section for determining quantities.
v. That only material to be used for this contract shall be stored on such land.

1.4.2.6 **Fences, Gates and Signs (private*)***

The Contractor shall be responsible for ensuring that livestock cannot stray because of his operations or enter a construction area including borrow areas. When existing fences and gates must be removed or altered for the proper execution of the Works

or are required to exclude livestock, the Contractor shall, at his own expense, erect temporary fencing and gates, and if necessary, provide watchmen to ensure that livestock cannot stray. New tension wires shall be used when re-erecting existing mesh fences. For permanently relocated existing fences and new fences, each horizontal wire shall be tensioned between braced posts using a wire strainer. Each wire shall also be securely fixed to each post using wire ties through drilled holes.

1.4.2.7 Land Acquisition

The Employer shall make available free of charge to the Contractor land on which the Permanent Works are to be executed or carried out, as indicated on the Drawings.
It is entirely the Contractor's own responsibility to obtain all land required for his activities falling outside the designated works area including sources of fine and coarse aggregates, filter medium, rock fill, hand core etc. The location of land that may be required by the Contractor for any purpose including, construction of public utilities, establishing a quarry for fine and coarse aggregates, filter medium, rock fill, hand core etc. shall be subject to approval by the Engineer.
Where it is necessary for the Employer, in fulfilling his obligations, to acquire any of the above land during the Contract, the Contractor shall determine the ownership of and shall pay on instruction from the Engineer the cost of the land or rent, and/or compensation as valued by Licensed Government of Kenya Land Valuer. Although the Contractor may, in the first instance, provide the money for the purchase of the land, all such land shall be the property of the Employer.
On or before completion of the Contract, the Contractor shall remove all temporary works and shall restore all such land to the condition in which it was immediately prior to the occupation thereof as far as is reasonable and practicable. No separate payment will be made to the Contractor on account of these items and the Contractor must make due allowance for them in his rates.
The Contractor shall be required to appoint a competent surveyor who will liaise with the Engineer on matters related to the demarcation of the allocated Permanent Works designated land, site measurements, removal and reinstatement of existing services.
The attention of the Contractor is drawn to the provisions of Sub-clause 1.4.2 above as regards his activities on private land.
The Contractor shall observe all the legal provisions and the provisions of the Conditions of Contract in respect of his activities at borrow pits, quarries, camp sites etc. and when rehabilitating such areas on completion.

1.4.3 Services

1.4.3.1 Location of Services

The Contractor shall acquaint himself with the position of all existing services, such as drains, underground and overhead telephone and electricity lines, ducts, poles, water

mains, fittings, railway lines, etc. before any excavation or other work likely to affect the existing services is commenced.

The Contractor shall, at his own cost, check and determine on the Site the position of any services, whether known or not. This shall be done by consultation with owners of services, visual inspections, use of detecting apparatus and by making excavations as required to expose the position of the services. These positions shall be surveyed carefully, marked on the ground and then drawn accurately on the Drawings. These services will then be defined as known services.

1.4.3.2 Damage to Services

The Contractor shall be held responsible for injury to existing works or services and shall indemnify the Employer against any claims in this respect (including consequential damages). The Contractor shall be responsible for the reinstatement of the services so affected.

The Contractor shall take all reasonable precautions to protect existing services during construction and during the relocation of such services. Where protective measures involve the construction of permanent work, the Contractor shall execute the work in accordance with the Engineer's instructions.

All pipes, cables, conduits or other known services of any nature whatsoever damaged as a result of the Contractor's operations shall be repaired and reinstated forthwith by the Contractor or by the Authority concerned, to the satisfaction of the Engineer, all at the expense of the Contractor.

1.4.3.3 Safety by Overhead Power Lines

Where work is to be carried out in the vicinity of overhead power lines, the Contractor shall ensure that all persons working in such areas are aware of the relatively large distance that high voltage electricity can "short" to earth when cranes, or other large masses of steel, are in the vicinity of power lines. The Contractor shall be required to work outside the clearances stated in BS EN 50522:2010, BS EN 61936-1:2010+A1:2014 which gives safe clearance for the various voltages.

1.4.3.4 Relocation of Services

It shall be clearly understood that, in certain instances, existing services can be relocated only after the Contractor has advanced sufficiently on or has completed certain sections of earthworks or certain structures. Whenever services are encountered which interfere with the execution of the Works and which require to be altered in any way or relocated, the Contractor shall advise the Engineer and the appropriate Authority whose agreement shall be obtained regarding arrangements for such works. The Contractor shall be responsible for these works which shall comply with the specifications of the relevant statutory authority.

1.4.3.5 Negotiations with Owners of Services

The Contractor shall work in close co-operation with private owners or public authorities controlling services, which have to be protected, moved or relocated.
Details regarding the state of negotiations concluded between the Employer and the Owner at the time of bidding in respect of the time when either the Owner is prepared to start moving such services or when the Contractor is required to or will be allowed to start moving the services, and the duration of such operations, will either be stated in the bid documents or be made available within 30 days of the Commencement Date for the Works.
Further such consultations and negotiations with private owners or public authorities shall be carried out as required by the Contractor. Should the Owners of services refuse to co-operate with the Contractor in a reasonable manner in connection with the protection or moving of services belonging to them, the Contractor shall refer the matter to the Engineer.

1.4.3.6 Programming Relocation of Services

When the Contractor prepares his contract works programme he shall clearly indicate when he proposes to start and conclude the moving of each service. He shall have discussed with and received the agreement of the relevant service owner with respect to each activity shown on the programme.
Should it thereafter, through delays on the part the Employer or the owner of the service to be moved, be impossible to adhere to the programme of work, such programme shall be suitably amended by the Contractor in consultation with the Engineer so as to limit, in so far as is possible, the extent of any damages or delays. Should it be impossible to limit entirely the damages or delays resulting from the amendments necessary to the programme of work, the Contractor shall be reimbursed for any additional costs incurred or damages suffered.

1.5 Hours and Days of Working

Before commencement of work on the Contract, the Contractor shall notify the Engineer, in writing, of the hours and of the number of shifts that he proposes to work and shall give at least forty-eight hours' notice to the Engineer of any changes to such hours of working and/or number of shifts that may be necessary during the currency of the Contract. The hours of work shall be subject to the Labour Laws of Kenya at that time.

1.6 Construction Programme, Resources, Reports and Monthly Statements

1.6.1 Construction Programme

In accordance with the Conditions of Contract, the Contractor shall submit to the Engineer a detailed construction programme. Thereafter the Contractor shall furnish an updated programme at monthly intervals, revised where necessary, but always showing the original baseline programme.

The Construction programme shall provide further detailed information to that submitted with the Tender. The programme shall show the major construction operations for each activity and be linked to each item of the Bill of Quantities, labour, plant and equipment resources assignments from the Commencement Date to the Completion Date. The programme shall be so prepared that all of the Works are completed within the time stipulated in the Contract Data, and all the interface Milestones are completed within the milestone dates attached to the Contract Data.

The programme shall be submitted in bar chart and CPM network forms. The critical path(s) shall be marked on the network as well as float for each activity. Together with the programme, the Contractor shall submit his estimated monthly payments for each major item of the Bill of Quantities. The Contractor shall adhere to the programme unless any deviation there from is directed by the Engineer.

The Contractor shall submit his construction programme in a form of five (5) hard copies and as electronic files or as directed by the Engineer.

Whenever the Contractor proposes to change the approved construction programme he shall immediately advise the Engineer in writing and if the Engineer considers the change is a major one the Contractor shall submit a revised programme. If such a change in the construction programme affects the Contractor's design and drawing programme, the Employer will not be responsible for the consequences of the late issue of any Drawings which are attributable to that change.

If the Contractor falls behind the construction programme, he shall within 14 days of the date of such default submit to the Engineer a revision of the programme showing the proposed measures to complete the Permanent Works on time.

When requested by the Engineer, the Contractor shall promptly furnish a detailed sub-programme for particular sections of the Permanent Works.

1.6.2 Resources Reports

During the course of construction the Contractor shall submit to the Engineer each month a detailed list by trade classification of manpower employed during the report period and a list of all major items of Constructional Plant on Site.

1.6.3 Monthly Statement

The Contractor shall submit a monthly statement in accordance with the requirements of the Conditions of Contract. The monthly statement shall be accompanied by copies of all survey notes, records of measurements and calculations required by the

Engineer to be prepared by the Contractor in support of the amounts claimed for the work executed.

1.6.4 Monthly Reports

The Contractor shall by the tenth (10) day of each month, submit ten (10) paper copies of the monthly progress report, and an electronic format acceptable to the Engineer, detailing the progress of the work carried out during the preceding month. The report which is generally generated from the Contractor's programme shall contain but not be limited to the following:

(a) A Bar-chart showing scheduled and actual progress of each activity;
(b) The individual and total percentage of the activities completed and the individual and total percentage of the work planned;
(c) Detailed reasons explaining any slippage, together with a statement on how the lost time shall be recovered. Utilising float shall not be accepted as a reason for slippage of an activity;
(d) The percentage of each main work activity completed as well as the projected percentage to be completed in the forthcoming month;
(e) For design, a status report showing the progress of the Drawings approved 'For Construction';
(f) The Drawing and Document as per Control Register;
(g) A list of quantities of the Permanent Work performed during the month with illustrations showing the exact location of work done, such as concrete lift schedule and progress of the Works;
    (i) Combined concrete histogram for all classes of concrete showing planned versus achieved;
    (ii) Concrete histogram for each class of concrete showing planned versus achieved;
    (iii) Excavation histogram for soil showing planned versus achieved;
    (iv) Excavation histogram for rock showing planned versus achieved;
    (v) Embankment construction histogram showing planned versus achieved.
(h) A list of major works scheduled to be started within the next three months and estimated quantities thereof. If the expected starting and/or completion dates are different from those shown on the CPM schedule, reasons other than utilising float shall be given;
(i) A list of labour (in man-day and by trade classification) employed during the month including shifts and hours of works executed and a statement about labour relations and an explanation of any actual or potential labour problems;
    (i) Cumulative combined labour histogram for the Contract showing planned versus achieved;

(ii) Labour histograms by trades, showing planned versus achieved;

(j) A list of expatriate personnel (in man-month by position) employed during the month;

(k) A table showing each item of Construction Equipment, a list of stand-by equipment, and a list of broken down equipment describing action being taken to get it back in operation;

(l) For all major items of Plant, a status report showing the progress of the design, manufacture, shipping, delivery to site, installation and commissioning;

(m) A quantity list of the Contractor's construction materials consumed or used during the month and accumulated quantities;

(n) Photographs and video (DVD);

(o) Results of all quality control/quality assurance tests required under the Contract, together with a comparison against the specified requirements;

(p) A record of daily weather, listing rainfall in mm, maximum and minimum temperatures;

(q) A statement concerning the effectiveness of the safety/security programme including a list of each accident;

(i) Minor accident not requiring treatment;

(ii) Minor accident requiring treatment but able to return to work;

(iii) Minor accident requiring treatment but able to return to work within 24 hours;

(iv) Accident involving hospitalisation;

(v) Fatal accident;

(r) A list of any accidents in which equipment was damaged to the extent it became inoperable, and any fire which occurred;

(s) A list of any major thefts;

(t) A list of interim payment applications including;

(i) Date of application;

(ii) Amount of application;

(iii) Date certified by the Engineer;

(iv) Amount certified by the Engineer;

(v) Date payment due;

(vi) Date payment made;

(vii) Amount received;

(viii) Cumulative amount received;

(ix) Updated cash flow estimate;

(x) Comments;

(u) A list of claims (if any) submitted during the month, including claim amounts and extension(s) of time;

(v) A list of all Variations and their status;

(w) An Import/ Export report for shipments of Plant, Materials and Contractor's Equipment;
(x) A list of the correspondence to/from the Engineer during the month; and
(y) Environmental Monitoring including all incidents and issues that have arisen during the reporting period.

1.6.5 Progress Photographs

At least 70 colour digital photographs showing the progress of the Works shall be taken every month from positions selected by or agreed with the Engineer. The Contractor shall arrange for additional photographs to be taken of any works being manufactured off Site, to provide a complete record of such activities.

Photographs shall incorporate the imprinted date when taken and an identification number. Three prints at 150 mm x 100 mm (nominal) and three prints at 225 mm x 175 mm (nominal) of each photograph shall be submitted each month together with an electronic copy on CD with a permanent label. Each set of prints shall be mounted in a separate folder with a caption underneath each photograph stating the identification number and description or title, and accompanied by a schedule of identification number, date taken and description or title and, when appropriate, by suitable maps, plans or Drawings indicating the vantage point and field of view of each photograph, all to the approval of the Engineer. One set of the larger size prints shall be mounted in an album for use by the Employer. The photographs shall be submitted to the Engineer at the same time as the monthly progress reports.

All photographs shall be numbered and retained on the Site. On completion of the Works the Contractor's digital files containing the photographs shall become the property of the Employer. The Contractor shall not use these or any other photographs of the Works for publicity purposes without the approval of the Employer, which will not be unreasonably withheld.

1.7 Performance Security and Insurances

The Contractor shall provide a Performance Security for the Works in accordance with Conditions of Contract.

The Contractor shall effect all insurances in accordance with Conditions of Contract.

Nothing contained within this Clause precludes the Contractor from effecting other additional insurances which he considers necessary over and above those specified in the Conditions of Contract.

1.8 Road Access to the Site

1.8.1.1 General

The Contractor shall improve and maintain such haul or temporary access roads he considers necessary at his cost subject to the approval of the Engineer.

1.8.1.2 Load Limits

The existing, roads and bridges have widely varying load and turning limits. The Contractor shall be responsible for determining the load and turning limits existing at the time of Tender and ensuring that his construction equipment and plant does not exceed such limits. Before moving any heavy/large transporters onto the highways, roads and bridges, the Contractor shall make suitable arrangements with the appropriate Government authorities or land owners and obtain their approval for the passage of such traffic.

1.8.1.3 Tracked Equipment

The Contractor shall not travel tracked vehicles or plant on any bituminous sealed road surface. Rubber tyred vehicles conforming to applicable load restrictions will be permitted to use bituminous sealed roads.

1.9 Standards

Except as otherwise specified in this Specification, all materials and workmanship shall comply in all respects with the requirements of the appropriate standards and codes issued by the Kenyan Norms and in case there is no Kenyan Norms, by the European Norms (EN) or such other approved by the Engineer current at the Base Date, as may be applicable to any parts of the Permanent Works. If, after the Base Date there is an amendment to a standard or code relevant to the Contract, the Engineer will direct whether the amendment is to apply.

The Contractor shall always have available in his site office at least one copy of every standard or code referred to in this Specification, any additional standard or code which may be referred to therein and shall make these available for reference by the Engineer upon request.

The Contractor shall provide two (2) sets (hard and soft copy) of unabridged standards referred in this Specification or such standards that may be approved by the Engineer during the execution of the Works. These standards shall be provided within 60 days of the signing of the Contract Agreement.

1.10 Materials and Plant to be Furnished by the Contractor

1.10.1 General

The Contractor shall furnish particulars of all the Materials and Plant which shall be incorporated into the Permanent Works together with corresponding Specification Clause numbers and /or Standards.

1.10.2 Trade Name and Catalogue Numbers

Unless stated otherwise, any reference in this Specification or on the Drawings to trade names or catalogue number or to a particular manufactured product does not imply that the article or product so mentioned is the only one that may be supplied or used. Any reference so made is purely given as a standard of the quality, class, type and finish of the items specified to be used. Articles or products of similar type and quality produced by other manufacturers shall be submitted by the Contractor to the Engineer for approval for use.

1.10.3 Conformity of Materials and Plant with the Specification

All Materials and Plant that will become part of the Permanent Works shall be new and shall conform to this Specification. Where the requirements for any Material are not stated in this Specification, the Material shall conform to the appropriate and most recent European Norms Specification or such other specifications as the Engineer may approve.

The Contractor shall make diligent effort to procure the specified Materials and plant but where, because of priorities or other causes, Materials required by the Specification are not available, substitute materials may be used but no substitute materials shall be used without prior written approval of the Engineer, and the written approval will state the amount of price adjustment, if any, to be made. The price adjustment shall not exceed the tendered price in the Bill of Quantities. The Engineer's decision as to whether substitution will be permitted and as to what substitute material may be used will be final, binding, and conclusive.

1.10.4 Inspection, Examination and Testing of Materials and Plant

Materials and Plant furnished by the Contractor, which will be incorporated in the Permanent Works, shall be subject to inspection, examination and testing as provided in the Contract. To allow sufficient time to provide for inspection, examination and testing, the Contractor shall submit to the Engineer, at the time of issue, copies in duplicate of all orders, including Drawings and other pertinent information, covering the Materials and Plant to be furnished by the Contractor, or shall submit other evidence in the event of such orders being issued verbally or by letter. The inspection, examination and testing of Materials and Plant or the waiving of inspection, examination and testing thereof shall not relieve the Contractor of the responsibility for furnishing Materials and Plant meeting the requirements of this Specification.

1.11 Setting Out of Works

1.11.1 Responsibility for Setting Out

The Contractor shall be solely responsible for the correct setting out of the Works and shall employ experienced qualified surveyors acceptable to the Engineer for this purpose.

1.11.2 Establishment of Reference Marks

The Contractor shall be given necessary reference marks to define datum lines and the reduced levels of suitably located reference benchmarks to enable the Contractor to set out the Permanent Works.

The Contractor shall establish additional reference marks and construct all benchmarks as per the approved Geodetic Reference System for the project and will confirm in writing, prior to commencement of the Works, that the reference marks are sufficient for the purpose of construction of the Permanent Works.

The Contractor shall take responsibility for the safeguarding of all reference marks which will be used to set out and construct the Works. If at any time during the execution of the Works the Engineer suspects that one of the reference marks has been disturbed, the Contractor shall have the reference marks surveyed and re-levelled. Any setting out which was done after the reference mark was disturbed shall then be rechecked and corrected if necessary, including any remedial work required for the Works, by the Contractor without any additional payment.

Where a reference mark is likely to be disturbed during construction operations, the Contractor shall establish suitable replacement reference marks at locations where they will not be disturbed during construction. Before erecting replacement beacons, the Contractor shall obtain the Engineer's approval for his proposals, including construction details and positions. No reference mark shall be covered, disturbed, or destroyed before accurate replacement reference marks have been established and details of the position and levels of such reference marks have been submitted to the Engineer and approved by him.

All necessary sight rails, pegs, and other items required for the proper alignment of the Works shall be erected by the Contractor to the satisfaction of the Engineer. The Contractor shall record all field observed data calculations for setting out and check surveying in a suitable permanent form, which shall be always available to the Engineer on request. These records shall be accompanied by field setting out sketches showing the relation between setting out pegs, marks, beacons, etc. and the permanent works. The Contractor shall supply two copies of any such calculations to the Engineer on request.

The Contractor shall furnish all materials, labour and equipment including stakes, templates, pattern, platforms and special labour that may be required by the Contractor in setting out any part of the Works.

1.11.3 Internal Consistency of Reference Marks

Before commencing construction of any part of the Permanent Works, the Contractor shall check that all the reference marks are internally consistent within each working area and are sufficiently accurately placed for the construction of the Works to the required tolerances. The Contractor shall notify the Engineer in writing of any

discrepancies found or confirm in writing the acceptable consistency of the said beacons.

1.11.4 Subsidiary Beacons, Survey Stations and Benchmarks

The Contractor shall establish, permanently tag and protect all subsidiary beacons, survey stations and benchmarks required for accurate setting out and level control during construction of the Works. Survey stations shall be of rigid construction and be protected from damage and the design and construction thereof shall be agreed with the Engineer. Pegs placed by the Engineer which may be disturbed during construction shall be referenced by the Contractor by surveying and placing other pegs nearby in safe positions and all such pegs shall be carefully protected to the satisfaction of the Engineer.
The Contractor shall supply the Engineer with the coordinates, levels and other relevant information relating to subsidiary beacons, survey stations and benchmarks.

1.11.5 Preservation and Replacement of Beacons and Benchmarks

The Contractor shall be responsible for the safety of any Government survey beacons, survey benchmarks and boundary beacons encountered. If such beacons or benchmarks are disturbed or destroyed by the Contractor, they shall be replaced without additional payment to the Contractor, within three months by a Registered Land Surveyor.
In cases where displacement of or damage to such beacons or benchmarks is unavoidable the Contractor shall notify the Engineer in good time so that he may arrange to have such beacons or benchmarks suitably referenced and later reinstated.

1.11.6 Survey of Ground Profiles

1.11.6.1 Original Ground Profiles

The Contractor shall inform the Engineer in writing, at least 14 days before commencing such work, of his intention to perform any work which will result in a change to the original ground profiles of the existing Site whether such work be for the Permanent Works to be constructed on the Site or for Temporary Works which the Contractor intends to execute for his own convenience. Thereupon, before commencing any work, the Contractor shall survey the original topography to the approval of the Engineer over the entire area to be occupied or disturbed. Such survey may again be required after removal of vegetation, topsoil or other overburden.
The information so obtained shall be recorded by the Contractor on a drawing or Drawings which shall be signed by both the Contractor and the Engineer. The Contractor shall then provide the Engineer with a reproducible copy of each drawing to serve as a permanent record for the purpose of determining both the quantities of excavation and earthworks carried out in the construction of the Permanent Works and the extent to which Temporary Works shall be removed or temporary excavations

shall be refilled upon completion of the Works. In addition to hard copies, the Contractor shall provide each drawing in a 3-dimensional digital format approved by the Engineer.

1.11.6.2 Excavated and Final Ground Profiles

The Contractor shall survey all excavated and final surfaces as required by the Engineer for the purpose of recording as-constructed details and, where applicable, for the measurement of quantities:

(a) on completion of excavation and prior to commencement of placing backfill, concrete or other work; and

(b) on completion of placing backfill, concrete or other work.

1.11.7 Setting Out Checks

The Engineer may carry out check surveys during construction and the Contractor shall co-operate with and provide assistance as required by the Engineer.

The Contractor shall liaise with the Engineer to program the check survey to be carried out during non-production periods or in parallel such that the minimum delay or inconvenience is caused to production work, wherever and whenever possible. The Contractor shall afford the Engineer every co-operation and assistance in this regard including, but not limited to, the provision of drainage, lighting and ventilation and the removal or placing of Contractor's Equipment and other obstructions such that they do not interfere with the setting out checks.

1.12 Safety

1.12.1 General

The Contractor shall comply with all the relevant Acts, regulations and statutory requirements of Republic of Kenya with respect to occupational health and safety and shall supply Personal Protection Equipment [PPE] to all his staff and labour. No person shall be allowed on to the Site without wearing Personal Protection Equipment [PPE]. Any person working at height shall wear a safety harness.

“Within twenty-eight (28) days of the Commencement Date, and before commencing any construction on Site, the Contractor shall provide a Site Safety Manual, which shall be subject to the Engineer’s consent and prepared specifically for the Site and which shall establish all of the requirements for effecting and maintaining a safe working environment for the Contractor, Contractor’s subcontractors’, Engineer’s and Employer’s personnel and any other authorised personnel entering the Site in accordance with the Contractor’s obligations stated herein.

The Site Safety Manual shall conform to all international, country, provincial and local safety and environmental regulations and practices for such works and shall include safety requirements for all Site activities, including personal protective equipment

required for each working area. The Manual shall be revised as deemed necessary by the Contractor's accident prevention officer or, without relieving the Contractor of any of his obligations or responsibilities under the Contract, at the request of the Engineer.

The Contractor shall direct his personnel to take all precautions necessary to protect themselves and others against injury and damage to property. The Contractor shall continuously inspect the work and supervise his personnel to determine and enforce compliance to the provisions of the Safety Manual. The Contractor shall cooperate with other contractors, the Engineer and the Employer for the purpose of implementing the provisions of the Manual.

The Contractor shall comply with any safety instruction given by the Engineer.

In the performance of the Works, the Contractor shall exercise every reasonable precaution to protect from injury persons and property. The Contractor shall erect and maintain all necessary temporary fencing, barricades, barriers, multi-lingual signs and lights and provide fire alarm, fire extinguishing and firefighting services at strategic points on the Site and adequate ventilation and lighting for his workmen engaged in all aspects of surface and underground works. The Contractor shall adopt and enforce such rules and regulations as may be necessary, desirable or proper to safeguard the public and all persons engaged in the work and its supervision.

1.12.2 Safety Officer

The Contractor shall throughout the progress of the works, employ a team of professionally qualified Safety Officers of sufficient numbers to ensure that all the work areas are covered, and that they are familiar with the type of work being performed.

Their assignment shall include initiation and enforcement of measures for the protection of health and the prevention of accidents and who shall see, by personal inspection, that all safety rules and regulations are enforced.

The Contractor shall hold safety meetings, at least once each month with his engineers, supervisors and foreman and when directed by the Engineer. The Contractor shall keep the Engineer advised as to when these meetings are to be held and shall provide the Engineer with a copy of the proposed agenda.

Regular toolbox safety meetings shall be conducted with the site Engineers, foremen and labour to enforce a culture of safety. For record purposes a copy of the Minutes of these meetings shall be forwarded to the Engineer.

1.12.3 Temporary Fencing

The Contractor shall erect and maintain as a security measure suitable and approved temporary fencing to enclose such areas of the Permanent Works and areas of land occupied by the Contractor within the Site as may be necessary to implement his obligations under the Contract, to the satisfaction of the Engineer. Temporary fencing

shall enclose any existing installations. Where any temporary fence has to be erected alongside a public road, footpath, etc. it shall be of the type required by and shall be erected to the satisfaction of the Government authority concerned. The temporary fencing shall be removed by the Contractor after completion of all Works under the Contract.

1.12.4 Lighting

(a) Without limiting the Contractor's obligations under the Contract, the Contractor shall provide sufficient lighting to ensure that, in all places where work is in progress:
   (i) safe working conditions are provided both for the Contractor's personnel, personnel of other Contractor's employed by the Employer and for the personnel of the Engineer; and
   (ii) the Works can be constructed in complete compliance with the Contract and a complete inspection of all Works in progress can be made by the Engineer.

(b) Unless otherwise directed by the Engineer the minimum service luminance on ground or working surfaces to be provided for the various operations or work areas shall be as shown in Table 1-1.

Table 1-1. Luminance Requirements

Operation or Area	Luminance	
	Design value – Lux	Minimum measured value – Lux
Earthworks and excavation (other than underground work)	150	100
Bridges	20	10
Access and haul roads where cross traffic or other hazardous conditions exist	20	10
Concrete placing	150	100
Maintenance shops and auxiliary buildings	300	200

(c) The Contractor shall supply a suitable instrument for measuring the intensity of illumination. The instrument shall comply with BS 667: 2005.

(d) Illumination for areas or operations not listed in the above table shall conform to the requirements of the Lighting Guide, Building and Civil Engineering Sites (Illuminating Engineering Society, London).

(e) All moving equipment or plant used during night operations shall be equipped with sufficient lights and reflectors to ensure safe working conditions.

(f) The submission to or approval by the Engineer of the Contractor's proposals for lighting shall not relieve the Contractor of any of his liabilities or obligations under the Contract.

1.12.5 Signs

(a) The Contractor shall provide all necessary signs for the Works. These shall include, but not be limited to:
    (i) standard road signs;
    (ii) warning signs;
    (iii) danger signs;
    (iv) control signs;
    (v) safety signs; and
    (vi) direction signs.

(b) Wording on all signs shall be in English and other local languages as appropriate. The size, colour, lettering and location of all signs will be subject to approval. The Contractor shall maintain all signs placed by itself, as well as those placed by the Employer.

(c) If the Engineer considers that the system of signs provided by the Contractor is inadequate to ensure safety, or unsatisfactory in other respects, the Contractor shall add to, amend, or otherwise change the system to include approved multi – lingual signs.

1.12.6 Other Safety Measures

(a) Work in the vicinity of electrical equipment:

In the interest of safety and security the Contractor shall complete the erection of any safety fencing round electrical and mechanical equipment before the said apparatus is connected to any electricity supply.

(b) Explosives:

In the use, handling and storage of explosives, the Contractor shall comply with all statutory regulations of the Republic of Kenya. The handling or use of explosives shall be discontinued during the approach and progress of a thunderstorm. All persons shall be removed from danger areas to a place of safety during such periods. The Contractor shall supply and install a suitable, approved instrument to continuously measure atmospheric electric activity during blasting operations and to sound an alarm when such activity reaches danger levels.

(c) Use of lasers:

The use of lasers on the Site shall conform to the requirements of EN BS 60825:1992.

(d) Safety instructions:

The Contractor shall at his own cost supply and issue to each of his employees, those of his subcontractors and the Engineer, printed booklets, of pocket-size, in English and in the other languages used by his employees at Site, safety instructions based on

good practice. Within 60 days of the Commencement Date, proof copies of the booklet shall be submitted to the Engineer for approval before printing and amendments shall be made to the booklet to his entire satisfaction. The Contractor shall issue the booklet immediately after printing as required by this Clause and ensure that all employees are fully conversant with the instructions. Safety instructions shall deal with all safety including:

(i) protective clothing, headgear and footwear;
(ii) use of lifting equipment;
(iii) use of drilling equipment;
(iv) underwater blasting;
(v) use and storage of explosives;
(vi) grouting;
(vii) earth-moving;
(viii) ground anchor stressing;
(ix) formwork erection;
(x) concreting;
(xi) erection of structural steelwork;
(xii) compressed air;
(xiii) welding;
(xiv) routine for accidents or fires; and
(xv) watchmen, warning notices, and barriers.

The Contractor shall allow for 100 booklets for the use of the Engineer.

1.12.7 Accident Reports

The Contractor shall promptly report to the Engineer in a form to be prescribed, all accidents involving death or serious injury to staff or workmen, and furnish monthly reports of all accidents to staff or workmen involving loss of time, giving such information as may be prescribed by the Engineer.

1.13 Blasting

When carrying out blasting operations, the Contractor shall use the standard blasting warning code, on which prior approval has been obtained in writing, take all precautions for the protection of persons, the Works and all property, and shall be responsible for any injury caused to or death of any person, or damage done to the Works or to property by blasting. Protected detonators shall be used in all blasting operations which use electric firing. The location and design of powder magazines, methods of transporting explosives, use of explosives and, in general, the precautions taken to prevent accidents shall be in accordance with all statutory regulations of Republic of Kenya and with BS EN 60079-0:2012+A11:2013, PD CLC/TR 50427:2004, PD CLC/TR 50426:2004, BS 5607: 2017 and the 'Safety Recommendations for

Sensitised Ammonium Nitrate Blasting Agents' (United States Department of the Interior, Bureau of Mines), Clause 1.21 Security, and such other precautions as the Engineer may require with special reference to the presence of high-voltage electric power transmission lines and substations near sections of the Works which may preclude the use of electric detonators. Nevertheless, the Contractor shall assume any liabilities resulting from injuries to, or deaths of persons or damage to property caused by his blasts or explosions.

1.14 Temporary Works

1.14.1 General

(a) The Contractor's proposals for the erection of all Temporary Works shall be in accordance with the proposals submitted with the Tender or with such modifications as approved by the Engineer from time to time.

(b) Except for the permanent access roads described in Clause **Error! R eference source not found.**, Temporary Works shall include the work covered in Clause 1.15 .

1.14.2 Approval of Temporary Works

(a) The Contractor shall submit to the Engineer for approval Drawings and full particulars of all Temporary Works which he intends to construct at least sixty (60) days before he desires to commence constructing such works. The submission to or approval by the Engineer of any such proposals by the Contractor shall not relieve the Contractor of any of his responsibility for the sufficiency of the Temporary Works for their intended purpose. The Contractor shall also obtain any necessary approval from local statutory or other Government authorities or landowner before commencing construction. Such work shall not be started without prior approval of the Engineer.

(b) No house, office, store, workshop or other habitable building will be permitted underneath or within 3 m of the nearest point in plan of the uninsulated overhead conductor of low or medium voltage of an electricity supply mains (existing or planned).

(c) Construction facilities on which interim payments have been made shall be maintained in good order and shall not be demolished, removed from the Site or otherwise disposed of without the prior approval of the Engineer.

1.14.3 Removal of Temporary Works on Completion

On completion of the Works, all Temporary Works constructed by the Contractor or handed over to the Contractor by the Employer, unless otherwise specified or directed by the Engineer, shall be removed from the Site, as approved by the Engineer. The Contractor shall make safe all areas affected by Temporary Works and reinstate natural drainage. The Contractor shall finish, reinstate, clean up and relinquish parts of the Site at the end of the Defects Notification Period or such earlier times as directed by the Engineer. Buildings and facilities removed from the Site will become the Contractor's property.

1.15 Electric Power

1.15.1.1 General

(a) Scope of Work:

The Contractor shall supply, install and operate electric generating plant until Grid power is available at Site. Also, the Contractor shall install the distribution systems covering the Site, including its operation and maintenance.

The installation shall provide for the following:

(i) Power, as required for the execution of the construction Works, including the Contractor's construction site areas, crushing plant, concrete mixing plant, laboratories and other sites.

(ii) Power for the Contractor's camp and facilities and the

(iii) Contractor's offices, stores and workshops, medical centre and First Aid huts and all other facilities necessary for the execution of the Works.

(iv) Power to the Employer's/Engineer's camp, temporary and main Site office, canteen and laboratory.

(b) Technical Requirements:

The power supply shall be three-phase, four wire, 50 Hz, 415 V (ph-ph) for power and 240 V (ph-N) for lighting and small power and shall comply with the regulations of Republic of Kenya. Facilities shall be provided to permit the isolation of individual supply points while maintaining supply to the remainder of the system.

(c) Submission of Proposals:

Not less than 60 days prior to the installation of the generating plant and distribution system, the Contractor shall submit in full detail his proposals and Drawings to the Engineer, including location.

(d) Removal of Plant and Distribution System:

Unless otherwise directed, on the completion of the Works the Contractor shall remove from the Site the generating plant supplied by him and the electrical distribution systems in and amongst the various work sites, the Contractor's camp and facilities, and the Contractor's offices, stores and workshops and other areas.

The Contractor shall continue to supply power to the Employer's and Engineer's Main Office until the issuance of the Performance Certificate.

1.16 Telecommunications

1.16.1 Communications

The Contractor shall make arrangements directly with a telecommunication services company for a normal telephone service at each major section of the Works and for any other telecommunications service he may require.

1.16.2 Removal of Telecommunications System

On the issuance of the Performance Certificate, the Contractor shall remove from the Site the telecommunications system provided under this Clause.

1.17 Water Supply

1.17.1 General

(a) The Contractor shall provide potable water supply to his camp and facilities, offices, stores and workshops, First Aid huts and for all Site needs.

(b) The Contractor shall submit his plan for water supply to the authorities concerned for their approval.

1.17.2 Potable Water Quality

Potable water shall comply with the standards of World Health Organization or Kenyan National Standards, whichever is higher. The pH values shall be in the range 7.5 to 8.5.

1.17.3 Non-Potable Water Supply

The Contractor shall provide an ample supply of clean water for aggregate processing, concrete production, washing down, and other uses on the Works.

1.17.4 Submission of Plans

The Contractor shall submit his plans for the potable water supply and reticulation system, (including filtering, chlorinating and other proposed treatment) and non-potable water supply to the Engineer for approval, not less than 30 days before commencing construction of the installation.

1.18 Sewage Disposal

1.18.1 Requirement

(a) The Contractor shall design, construct, operate and maintain a sewerage collection system, to convey sewage from the Contractor's camp and facilities, Contractor's offices, stores and workshops, First Aid huts and for all Site needs.
(b) The Contractor shall submit his design to the authorities concerned for their approval.

The wastewater discharges are to meet the Kenyan National Standards or, in their absence, the treated sanitary discharge sewerage values which are recommended in the Environmental, Health and Safety Guidelines for Water and Sanitation for the World Health Organization (WHO).

(c) The Contractor shall construct, operate and maintain at the Site temporary toilet facilities complete with adequate water closets, urinals and hand basins, septic tanks, absorption trenches or other sewage disposal installations, for all personnel of other contractors employed by the Employer working in the powerhouse area.
(d) The temporary toilet facilities shall meet the requirements of the Government health authority. The location of these facilities and their construction shall be as approved by the Engineer.
(e) Sewage from temporary facilities shall be disposed of in a hygienic manner as approved by the Engineer.

1.18.2 Removal

On the issuance of the Performance Certificate, the Contractor shall remove from the Site the sewerage system reticulation installed in and amongst the Contractor's housing, contractor's staff quarters, contractor's offices, stores and workshops and other areas as directed by the Engineer.

1.19 Garbage Disposal

1.19.1 Scope of Work

The Contractor shall undertake the collection of and disposal of garbage from the Contractor's camp and facilities, Contractor's offices, stores and workshops, First Aid huts and for all Site needs.

For the First Aid huts all surgical and/or medical waste shall be incinerated.

Garbage collection shall be made daily at times approved by the Engineer and the services shall be continued until completion of the Contract.

The facilities shall revert to and become the property of the Employer upon completion of the Works.

1.19.2 Method of Disposal

Garbage shall be disposed properly in compliance with requirement of the local authorities as approved by the Engineer. The Contractor shall also bury any non-combustible material and the waste construction materials delivered for disposal from other contractors.

1.20 Fire Fighting Services

1.20.1 Scope of Work

(a) The Contractor shall be responsible for all fire prevention measures, fire protection and fire fighting for the duration of the Contract. The areas to be covered include but are not limited to the Contractor's camp and facilities, Contractor's offices, stores and workshops, First Aid huts and for all Site facilities including those of other contractors working on the site.

(b) The Contractor shall be guided by the recommendations of the local fire department, where applicable.

(c) The Contractor shall provide, maintain and operate all firefighting equipment including, but not limited to, water pumps, trucks, lines, hydrants, hoses and chemical fire extinguishers adequate for the protection of all structures, buildings or work under construction.

1.20.2 Fire Alarm System

The Contractor shall supply, install and operate an adequate fire alarm system at all work, camp and other Site locations.

1.20.3 Fire Fighting Force

The Contractor shall provide and train an adequate fire-fighting force under the direction of a full-time qualified Fire Officer to maintain and operate the firefighting equipment. The Fire Officer's duties shall include training firefighting personnel, inspection of firefighting and alarm equipment, and directing operating in any situation.

1.20.4 Fire-Fighting Depot

A central firefighting depot shall be established in an approved location and shall be manned on a continuous basis, 24 hours a day. Fire drills shall be arranged by the Contractor at regular intervals to ensure that firefighting methods are effective.

1.21 Security

1.21.1 Responsibility of Contractor

The Contractor shall be responsible for the security of the Works and shall provide and maintain an adequate security force to fulfil this obligation. The duties of the

Contractor's security force shall include maintaining order and security to the Contractor's camp and facilities, Contractor's offices, stores, workshops, First Aid huts and for all Site needs including the central storage area.
Security shall include the provision of lighting, fencing, guards, flagmen, and all other measures necessary for the protection of the Works and all materials, plant and equipment delivered to the Site, the public and all persons employed in connection with the Works, continuously throughout working and non-working periods, including nights, weekends and holidays, for the duration of the Contract until such time as the Maintenance Certificate is issued and the Temporary Works completely demobilised and taken away from the Site.

1.21.2 Other Contractors

Other contractors working on the Site concurrently with the Contractor will provide security for their own equipment and materials.

1.21.3 Vehicles

All vehicles used by the Contractor shall be clearly marked with the Contractor's name. The entry to the Site and speed of vehicles within the Site shall be strictly controlled by the Contractor's Security personnel.

1.21.4 Contractor's Security Guards

(a) As required by the competent authority, the Contractor shall take the necessary security measures to ensure the security of lives and property within the Site, camps and accommodation areas. This responsibility shall be borne solely by the Contractor.
(b) The Contractor's security guards shall be suitably trained personnel.
(c) Qualification and suitability of all the Contractor's security guards shall be determined by the police. All the Contractor's armed or unarmed security guards shall be provided with uniforms and accoutrements as required or approved by the police or other competent authority.

1.21.5 Handling of Explosives

(a) Handling and use of explosives shall be in accordance with Clause 1.12 and this Clause.
(b) Special attention must be paid to the security of the main explosives' magazines and any secondary explosives magazines, when transporting explosives from:
    (i) the main magazine to a secondary magazine.
    (ii) the main magazine to any locations requiring the use of explosives within the Site; and
    (iii) the secondary magazine(s) to any location requiring the use of explosives within the Site.

(iv) Detonators shall be stored in a magazine separate from the explosive's magazines

(c) Explosives transported within the Site shall be escorted by the Contractor's security guards, a certified Inspector of Explosives or the police. This includes transport or handling of explosives to any blasting.

(d) The Contractor shall arrange for police to escort the delivery of explosives from the factory or from any other locality he may wish to purchase or take delivery of explosive to the site upon approval of the police. The costs of such police escort shall be borne by the Contractor.

1.21.6 Explosives' Magazines

(a) The location, specification and capacity of the main and secondary explosives magazine shall be in accordance with Clause 1.13 and are subject to the approval of the competent authority.

(b) The main explosives magazine shall be located at a safe distance from any inhabited building and the various work sites. Secondary explosives magazines shall be located likewise. The magazines should be secluded from public view and shielded by earth bunds. In addition to the requirements of Clause 1.12, additional security requirements imposed for explosives magazines include but are not limited to the following:

(i) Each explosives magazine shall be enclosed by two wire security fences. The distance between the two fences shall be as directed by the police or other competent authority. The wire fence shall be of the chain link type variety with the lower part of the fence embedded in concrete to a depth of not less than 400 mm below ground level. The height of the chain link part of the fence above ground shall not be less than 1.90 m with strands of barbed wire above this, making the total height above ground not less than 2.30 m;

(ii) Each explosives magazine shall be illuminated at nighttime;

(iii) Each magazine shall be guarded on a 24 hours basis by the Contractor's security guards or police with armed or unarmed

(iv) personnel, depending on the direction of the Chief Police Officer or other competent authority, the security situation and the location of the magazine.

(v) All vegetation growth within a distance of 10 m outside the outer security fence surrounding any explosives magazine shall be cleared and removed. All vegetation growth within the fenced area shall likewise be cleared and removed. The Contractor shall at regular intervals and/or when conditions require, keep the areas described clear from new vegetation growth as long as the magazines are in use or contain explosive materials;

(vi) A stock book shall be maintained for each magazine. These stock books are to be kept under lock and key at all times and made available to the police or other competent authority upon request at any time;

(vii) All explosives taken out of the magazines for any purposes shall be escorted by the Contractor's security guards or police;

(viii) The Contractor shall ensure that at all times the quantity of explosives, detonators, cords, fuses and other consumables taken out of a magazine shall be utilized in full as far as practicable and therefore the Contractor shall determine his exact requirements before each blasting operation;

(ix) Any excess explosives, detonators, cords, fuses and other consumables from any blasting operation shall be returned to and recorded at the same magazine from which it was taken;

(x) Detonators and other blasting accessories shall be kept in a separate room from the bulk of the explosives in accordance with the requirements of Clause 1.13;

(xi) Additional conditions and restrictions other than described in this Clause may be imposed or implemented on instruction by the police or other competent authority from time to time;

(xii) A security hut and bachelor accommodation for the Contractor's security personnel or police guarding the magazines shall be provided at each magazine.

1.22 Contractors Camp and Facilities

1.22.1 General Requirement

The Contractor shall provide and maintain camps and facilities on the Site at the locations proposed by him and approved by the Engineer. The Contractor shall make arrangements as necessary for the provision of all administrative offices, workshops and other buildings and for accommodating and provision of facilities for feeding of all his employees and others as required by providing, servicing and maintaining a messing service on the site approved by the Engineer. The following installations and facilities are required and shall be considered part of the camp and facilities:

(a) accommodation for Contractor's personnel;
(b) accommodation for Engineer's personnel;
(c) recreation facilities;
(d) transport facilities;
(e) security facilities;
(f) internal roads and services; and
(g) first aid hub.

1.22.2 Location and Control of Contractor's Camp and Facilities

(a) The Contractor will propose to the Employer for approval sites for the construction of housing, camps and for other required facilities and amenities for his employees, if necessary.

(b) The Contractor shall be deemed to have inspected these sites and made his own evaluation as to their adequacy and suitability for the development of the required township and camp facilities and will thus assume responsibility for the suitability of the sites.

(c) All buildings shall always be open to inspection by the Engineer. Any instruction given by the Engineer for the proper cleaning, disinfection and general maintenance and sanitary and hygienic condition of any building must be forthwith carried out by the Contractor. Before any buildings are occupied, the Contractor shall draw up a code of rules and regulations for their control which shall be approved by the Engineer.

(d) The entire camp area shall be subject to the security requirements set out in Clause 1.21 Security**.**

1.22.3 Removal of Buildings and Facilities

Unless otherwise directed by the Engineer, the Contractor shall remove all buildings erected for his requirements from the Site, on the issuance of the Performance Certificate. The Contractor shall fill in all excavated areas as directed by the Engineer, remove all refuse, debris and other objectionable materials and leave the camp area in a clean and sightly condition to the approval of the Engineer.

1.23 Contractor's Offices, Stores and Workshops

1.23.1 General

(a) the Contractor shall provide and maintain such offices, new washroom facility, stores, workshop and delivery compounds as are necessary for the execution of the Works, including all necessary services for water supply, drainage, lighting, roads, paths, parking places, sewerage and garbage disposal.

(b) On the issuance of the Performance Certificate, all buildings and facilities provided by the Contractor in accordance with the provisions of this Clause shall remain the property of the Contractor and shall be removed from the Site.

1.24 Engineer's requirements

The procedure to be followed in providing the Engineer's facilities (requirements) such as vehicles, office and residential accommodation, equipment and furniture for the office and residential accommodation shall be as outlined below:

(a) The Contractor shall first submit the technical details, together with any brochures and leaflets, of the vehicles, equipment, furniture, etc for approval by the Engineer.

(b) The Engineer shall inspect the proposed facilities, where appropriate, at the supplier's premises.

(c) The Engineer shall approve or make comments on the proposed facilities.

(d) The Contractor proceeds to procure the approved facilities.

The Contractor shall be responsible, and shall be deemed to have allowed in his rates and prices, for delivery of facilities to their final destinations, unpacking, disposing to rooms, assembling, connecting up and testing of electrical appliances, installation of all the required software, and setting the facilities to work.

1.24.1 Office accommodation for the engineer

The Contractor shall provide site offices, for the use of the Engineer. The Contractor shall maintain, service and insure the offices for the Contract period or for such additional or lesser time as the Engineer may direct. The office shall be for the sole use of the Engineer's staff. On completion of the Works, or at such time as specified by the Engineer, the ownership of the office (if not rented) and all furniture and equipment, except for survey equipment, shall be transferred to the Employer. Prior to handing over to the Employer, the Contractor shall provide and maintain the office accommodation, furniture, equipment, facilities and services without any interruption.
The Contractor shall carry out complete redecoration, including re-painting, of the office accommodation before handing over to the Employer. The Contractor shall be deemed to have allowed in his rates and prices for this redecoration.

1.24.2 Location of the office

Two site office buildings with toilets shall be provided: one near the upstream wellfield and one near the downstream wellfied, or as specified by the Engineer.

The main office will be at Baricho Pumping Station. The office will be located in an existing building which is owned by the client.

The building for the offices is already existing and owned by the Employer. The offices must be rehabilitated for the use of The Engineer and his staff. Two offices can be provided at the existing facility.

The bidder should forward for approval the proposed rehabilitation for:

- walls
- floor
- lighting
- doors
- toilettes
- shower

Before commencing the painting work, the Contractor shall submit to the Engineer, 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 Engineer 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 Engineer. 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 Engineer.

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.

1.24.3 Fully furnished Office

The Contractor shall be responsible for maintaining the water and electricity services and pay all charges and fees for the supplies.
The Contractor shall provide and maintain cleaning staff and cleaning facilities. The Contractor shall also provide an adequate refuse disposal service for the office. The office, including toilets, shall be cleaned daily and shall be maintained for the duration of the Contract. A supply of toilet paper, soap and towels is to be provided and maintained; clean towels are to be supplied each day.
The office as well as all the equipment and furniture supplied under this Contract shall be insured on a full comprehensive basis against theft, fire, water damage and burglary.
The office with all furniture, fixings, equipment, services, carport etc., all as detailed below, shall be provided complete within 45 days after the Commencement Date. Until the office accommodation is ready for occupation, the Contractor shall provide, starting from the Commencement Date, alternative office accommodation of comparable area and facilities to the satisfaction of the Engineer. This alternative office accommodation shall be furnished and equipped with similar facilities as described below. If the office accommodation for the Engineer's staff is not ready for occupation within the specified period of 45 days, the Contractor shall provide, at his

risk and cost beyond the specified period of 45 days, the alternative office accommodation for the Engineer's staff.

1.24.4 Furniture, Fixings

The Contractor shall supply the furniture, fixtures and equipment listed in Table 2, and shall install them in the offices as required by the Engineer. They shall be for the sole use of the Engineer and his staff. All furniture, fixtures and equipment shall be supplied new, following the Engineer'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.

1.24.5 Stationery and Office Supplies

The Contractor shall supply all stationery and office consumables required for the normal functioning of the Engineer's offices, including inter alia survey books, drawing office supplies, computer CDs (re-writable and recordable) and diskettes, computer printout paper, (but excluding headed correspondence paper), copying paper, cartridges for printers, cartridges (toner) for photocopier, box files A4, index dividers for A4 box files, ruled pads A4, squared pads A4, pocket files (document wallets) A4, erasers, selfsticking notes (post-it), pens (assorted colours), envelopes (assorted sizes), pencil refills (leads) 0.5 mm 2B or HB and staples.

The Contractor shall also supply books for Site records including: Daily Works Records, Notice of Operation, Request for Inspection/Approval, Measurement Records (Sheets), Confirmation of Verbal Instructions, Site Instructions and Site Diary. The books shall be of A4 size, with minimum of 50 pages; and each page shall be self-carbonised and in triplicate; and each page shall have a serial number. A sample page of each book shall be approved by the Engineer before the Contractor places procurement orders for the books.
The Contractor shall also supply all consumables and spare parts for photocopier and computers from the manufactures‟ authorized representatives. The Contractor shall put in place a service contract with each authorized representative of the manufacturer of the office equipment.

The Contractor shall supply all the required stationery, office consumables, spare parts for office equipment, and books for Site records from the Commencement Date until the TakingOver Certificate has been issued for the Works or until such time as specified by the Engineer. If the Contractor fails to provide the supply, the Engineer shall be entitled to withhold the issue of a Payment Certificate until such time as the supply is provided.

1.24.6 Communications

The contractor shall supply and maintain 3 mobile phones with post-paid system. Moreover, the contractor shall provide fast internet connection to The Engineer and his staff.
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.

1.24.7 Computers

The Contractor shall supply computer hardware and software as detailed below and in Table 2 for the sole use of the Engineer and his staff.
The desktop computers are to be tower computers of a reputable make. They shall be two (2) in number with one having a high specification and the other medium specifications as detailed below.
The laptop computers are to be 2 No. of a reputable make with high specifications as detailed below.

1.24.8 High Performance Computer

The Contractor shall supply 1 No. (one) high performance computer with high specifications as follows or equivalent:

Type:	Mini Tower
Processor:	AMD Ryzen 5 5600X
RAM:	32GB DDR4
Graphics Card:	Gigabyte GeForce RTX 1660 OC 6GB
M.2 SSD:	250GB M.2 NVMe
SSD:	1 TB
PSU:	650W, 80 Plus Gold
Interfaces:	USB 3.0, USB 2.0, HDMI
Operating System:	Windows 10 Pro 64-bit

Each computer shall be true branded with widescreen display colour monitor and shall be supplied with a suitable automatic voltage regulator with surge protection. Full documentation and backup discs for the software (MS Office Professional) and the computers are to be provided.

1.24.9 Laptop Computers

The Contractor shall supply 2 No. (two) laptop computers with specifications as follows:

 Huawei MateBook D 15 or equivalent

Display:	15.6'', Full HD (1920x1080)
Processor:	AMD Ryzen 5
RAM:	8GB DDR4
Graphics Card:	Radeon Vega 8 Graphics
Memory:	SSD 256GB
Interfaces:	USB 3.0, USB3.1, USB-C, Wi-Fi, Bluetooth, HDMI

Operating System: Windows 10 Pro 64-bit

The computers shall be true branded and shall be approved by the Engineer. All hardware and all software (MS Office Professional) shall be supplied new and fully licensed in the name of the Employer.

1.24.10 Printer and Related Equipment

The Contractor shall supply one officejet A3 colour printer and one A3 scanner as specified below:

(a) Colour All in One Printer: Epson Workforce Pro WF-C8690 A3 Color MFP With PCL/Postscript or equivalent

On completion of the Contract or at such time as specified by the Engineer, the ownership of all computers and such like equipment shall be transferred to the Employer. One laptop computer will be handed over to the Employer at the end of the Defects Notification Period.

1.24.11 Transport for the engineer

The Contractor shall supply motor vehicles as detailed below:

- Pick-up truck – double cabin: 2 nr.
- Short-term provision on a call basis of a passenger car 1 Nr, inclusive drivers and all running and maintenance costs

These 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 Mombasa will be acceptable and shall first be approved by the Engineer. All the vehicles shall be of the same make.
All the vehicles shall be new right-hand drive diesel-powered Toyota, VW Amarok 2.0 TDI or equivalent vehicles 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. Each pick-up shall have wireless door entry and locking system, front automatic wheel hubs for fourwheel drive, side impact beams, and a tonneau cover supplied by the supplier of the vehicles.

The passenger car shall be fully covered with permanent roof and have adequate seating for a driver and four passengers. Each car shall have wireless key and remote, switch for four wheel drive, and side impact protection bars.

The Contractor shall provide competent English-speaking drivers to the approval of the Engineer for all vehicles used on the Site. Each driver shall have a minimum continuous driving experience of 8 years, with a certificate in defensive driving, and aged between 30 and 55 years old. Any driver found unsuitable by the Engineer shall be replaced immediately. These drivers shall be available during all normal Site working hours and when specifically required by the Engineer, outside those hours.

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:

(a) cover for the Engineer and his staff driving the vehicle, and for any other persons that the Engineer requires to be included;

(b) usage on the business of the Engineer and his staff for social, domestic and pleasure purposes; and

(c) 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 authorised by the Engineer. The Contractor shall provide similar replacement vehicles whenever the original vehicles are not available for use for whatever reasons.

The vehicles shall be provided within 40 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 40 days, the Contractor shall provide, at his risk and cost beyond the specified period of 40 days, the temporary similar vehicles for the Engineer's staff.

1.24.12 Residential accommodation for the engineer

The following Accommodation has to be provided:

- 1 accommodation for Resident Engineer and 1 accommodation for the Project Civil Engineer
- 4 accommodations for Engineer's staff

The Contractor shall rent approved, furnished and equipped residential accommodation for the Engineer's staff to the satisfaction of the Engineer. The residential houses for the Engineer's staff shall be separate from that of the Contractor's staff housing.
Each house shall have a minimum floor area of at least 100 m2 and shall have at least a kitchen, a sitting room, 2 bedrooms, one of them self-contained with a separate toilet and bathroom.
The Contractor shall provide armed guards at all times to ensure adequate security of the houses, furniture and equipment and the Engineer's staff. The Contractor shall, at all times, be responsible for the immediate replacement of any and all items stolen or damaged.
In all cases where gas or kerosene appliances are provided, the Contractor shall be responsible for purchasing refill gas cylinders and kerosene and supplying them promptly to the houses as required.
Each house shall have a compound with sufficient parking space. The individual compounds within which the residential houses for the Engineer's staff will be located shall each have external security lights and each be bounded by a perimeter wall or by 1.8 m high chain-link fencing, surmounted by a minimum of two tensioned strands of barbed wire, and provided with a suitable entrance gate, all to the approval of the Engineer.

The Contractor shall provide and maintain one domestic assistant per house. The Contractor shall also provide an adequate refuse disposal service for each house.
The Contractor shall hand over each house to the Engineer including the following items:

(a) Provision and maintenance of furniture and equipment for all rooms to the satisfaction of the Engineer. The Contractor is to allow in his rates for delivery to houses, unpacking and disposing to rooms and connecting up and testing of electrical appliances. The furniture and equipment to be provided for each house shall be new and shall be as indicated in Table 3 below. The Contractor shall supply, install, connect and set to work the items of furniture and equipment for each house. One house shall be equipped, in addition to the other items, with a washing machine.

(b) Provision and maintenance of adequate potable water and electricity supplies, if necessary from his own resources, water borne sanitation facilities and other essential services. The Contractor shall be responsible for maintaining the water and electricity services and pay all charges and fees for the supplies.

(c) Provision and purchasing refill cooking gas cylinders and kerosene.

(d) Provision and maintenance of all temporary access roads, footpaths, fencing and gates.
(e) General maintenance including the garden and repair of the premises including complete external and internal redecoration, including re-painting, before handing over to the Engineer and later on to the Land Lord.

f) Provision and maintaining of highly effective 24 hour armed security guarding for each house.

(g) Provision and maintaining of a domestic assistant and an adequate refuse disposal service.

Residential accommodation for the Engineer's staff shall be ready for occupation within 35 days after the Commencement Date. Until the residential accommodation is ready for occupation, the Contractor shall provide, starting from the Commencement Date, alternative residential accommodation including hotel accommodation for the Engineer's staff in Malindi. All alternative accommodation shall be acceptable to the Engineer in location, quality, facilities and accommodation. If the residential accommodation for the Engineer's staff is not ready for occupation within the specified period of 45 days, the Contractor shall provide, at his risk and cost beyond the specified period of 45 days, the alternative residential accommodation including hotel accommodation for the Engineer's staff in Malindi.
On completion of the Works, or at such time as specified by the Engineer, the furniture, equipment and other items provided by the Contractor shall become the property of the Contractor. Prior to reverting to the Contractor, the Contractor shall

provide and maintain the residential accommodation, furniture, equipment, facilities and services without any interruption.

1.24.13 Hotel accommodation

The Contractor has to provide Hotel accommodation for the client's staff and for short term experts of the Engineer in Malindi during their visits. Hotel has to be a 4 star hotel.

1.24.14 Assistance to the engineer

The Contractor shall supply such labour, either continuously or from time to time, as may be required by the Engineer, to assist in the checking of materials on Site 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 Engineer 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 Engineer 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 Engineer. 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 Engineer, cleaning and sanitary staff and cleaning equipment.

Table 1: FURNITURE, FIXTURES AND EQUIPMENT FOR ENGINEER'S OFFICES

Item No	Description	Unit	Quan-tity
1	Desk, metal framed (2.0 m x 1.0 m approx), with 6 drawers fitted with locks	No.	1
2	Chair, swivel, upholstered, wheeled chair with arms for above desks	No.	2
3	Desk, metal framed (1.7 m x 0.8 m approx.), with three drawers fitted with locks	No.	2
4	Chair with arms for above desks	No.	2
5	Chairs, metal framed, upholstered for above table	No.	4

Item No	Description	Unit	Quan-tity
6	Filing cabinet, metal, 4 drawer with suspended filing system, locking	No.	2
7	Cupboard, double door, metal with 4 shelves, locking (0.9 m wide x 0.45 m deep x 1.8 m high approx.)	No.	2
8	Scale rule, flat and triangular	No.	2
9	Calculator, 11 digits, with scientific functions	No.	2
10	Mechanical pencil sharpener	No.	2
11	Waste paper basket	No.	2
12	Letter tray, A4 size (each set of 3 trays)	set	3
13	Sundry office items: paper punches (4 inc 1 heavy duty), staplers (4 inc 1 heavy duty), scissors (4), staple removers (4), clutch or mechanical pencils 0.5mm (4) clipboard A4 size (4),	set	3
14	Plain paper Canon photocopier or equivalent, desktop type with variable magnification that can take both A4 and A3 full-size copies, minimum capacity 25 copies/minute, including (i) supply of consumables and spare parts, (ii) service contract with the manufacturers‟ authorized representative and (iii) automatic voltage stabilizer with surge protection suitable for this equipment.	No.	1
15	Benching and shelving as required	As required	
16	Horizontal plan chest on legs with eight drawers (1525 x 1080 x 740 mm high approx.)	No.	1
17	Desktop computer, colour monitor as specified	No.	1
18	Laptop computers as specified	No.	2
19	A3 colour printer HP Officeject 7000 Wide Format capable of printing up to 33 pages per minute (ppm) black and 32 ppm colour	No.	1
20	Scanner, 1600x3200 dpi, A3 size, with USB port and software Software as specified	No.	1
21	Electric stove, 2 ring type	No.	1
22	Electric refrigerator 0.28 cubic metre capacity	No.	1
23	Electric Philips metallic kettle, minimum capacity of 1.7 litres	No.	1
24	Drinking mugs	No.	8
25	Tea tray	No.	1
26	Electric fans	No.	2

Item No	Description	Unit	Quan-tity
27	Fire extinguisher including refills and servicing.	No.	1
28	First aid kit	No.	1
29	Water heater, 140 litres storage capacity	No.	1
30	Toilet brush with holder (at least)	No.	2
31	Mop and bucket	No.	1
32	Plastic bucket	No.	1
33	Broom	No.	1
34	Dust pan and brush	No.	1
35	Sony digital camera, optical zoom x10, digital zoom x10, minimum 10 megapixels, storage media/capacity of 4 GB memory card, size of LCD monitor of 2.5 inches, high speed USB 2.0 memory stick reader, JPEG-RAW file format, complete with downloading cable, strap, carrying case and manuals	No.	2

Table 2: Supply, install, connect and set to work the following items of surveying equipment for the Engineer's office.

Item No	Description	Unit	Quan-tity
1	Level, Zeiss NI 2 automatic level, or similar approved, complete with tripod, carrying case and all accessories	No.	1
2	Levelling staff, engine divided 4 m long, folding, including staff level	No.	1
3	Staff levelling plate	No.	1
4	Steel tape, 25 m length	No.	1
5	Fibreglass, PVC coated tape, 30 m length	No.	1
6	Steel hand tape, 3 m long	No.	1
7	Steel hand tape, 5 m long	No.	1
8	Ranging rod, 3 m length	No.	4
9	Arrow, 400 mm length	No.	20
10	Conical plummet, 200 g weight	No.	1
11	Steel straight edge 1 m long	No.	1
12	Spirit level with aluminium body, 1 m long	No.	1
13	Pipe measuring tape with linear and diametric scales	No.	1
14	String line, 50 m long	No.	1
15	Hammer, 3 kg weight	No.	1

16	Hand shovel	No.	1
17	Pocket counter, counting to 9999 with push button for automatic return plus re-set knob	No.	1
18	Thermometer, maximum and minimum graduated in ^{o}C and F	No.	1
19	Thermometer, wet and dry bulbs, graduated in ^{o}C and ^{o}F	No.	1
20	Concrete thermometer	No.	1
21	Rain gauge with measuring bottle	No.	1
22	Flask with thermal insulation, 1 litre capacity	No.	1
23	Water containers, 5 litre capacity	No.	1

TABLE 3: FURNITURE AND EQUIPMENT FOR ENGINEER'S RESIDENTIAL ACCOMMODATION per House

	Item Description	**Unit**	**Quantity of items per house**
1	Bed with mattress	No.	2
2	Pillows	No.	2
3	Bed sheets, pairs	No.	2
4	Pillow case	No.	2
5	Blankets	No.	6
6	Dressing table with mirror and stool	No.	2
7	Chest of drawers	No.	2
8	Wardrobe (if not built in)	No.	2
9	Bedside tables	No.	3
10	Bedside chairs	No.	3
11	Bedside rugs	No.	3
12	Bedside lamps	No.	3
13	Mosquito nets	No.	3
14	Medicine cabinet (if not built in)	No.	1
17	Dining table (extended type to accommodate 6 covers)	No.	1
18	Dining chairs	No.	6
19	Sideboard	No.	1
20	Lounge chairs	No.	2
21	Settee	No.	1
22	Refrigerator (200 litres capacity with deepfreeze compartment not less than 10 litres)	No.	1

23	Electrical/gas cooker with 2 gas burners and 2 radiant plates, oven and grill, including all connections and accessories.	No.	1
24	Gas cylinders, each 15kg	No.	1
25	Waste paper bins	No.	1
26	Lampshades, for all light	set	1
27	Lined curtains, for all windows	set	1
28	Plastic refuse bin with cover, minimum capacity 70 litres	No.	1
29	Crockery set comprising: 6 plates, 6 forks, 6 knives, 2 frying pans, 2 cooking pots, 2 serving spoons, 1 sugar bowl, 6 cups and saucers, 6 teaspoons, 6 table spoons, 6 glasses, 1 flask.	set	1

1.25 Medical and Health Services

1.25.1 General

(a) The Contractor shall make arrangements which are satisfactory to the Government medical authority for provision of all medical, minor surgical and health services for all persons employed by him and by any subcontractors employed by him on the Works, including the dependents of such persons, provided such dependents are resident on Site. Special arrangement shall be made with the nearest hospital.

(b) The provision of medical facilities under this Clause shall in no way relieve the Contractor of his obligations under the Conditions of Contract.

(c) On the issuance of the Performance Certificate, all buildings and facilities provided by the Contractor in accordance with the provisions of this Clause shall remain the property of the Contractor and shall be removed from the Site.

(d) The Contractor shall provide on-site medical, minor surgical and health services as approved by the Engineer, to all Registered Persons designated by the Engineer, including the Employer's staff and their immediate dependents resident on Site and employees of other contractors employed by the Employer and their immediate dependents resident on the Site. The number of Registered Persons likely to be designated by the Engineer is not expected to exceed 200 at any one time.

(e) The standard of service and accommodation to be provided shall be not lower than that laid down for modern public medical centres of like function in Kenya.

The supply of all drugs and medicines prescribed shall be included but the following services shall be excluded:

(i) specialist medical attention
(ii) surgical attention apart from first-aid and minor injuries
(iii) medical centre attention where the illness would normally require residence in hospital for more than 14 days and
(iv) dental treatment.

1.25.2 First-Aid Stations

(a) The Contractor shall supply, erect and maintain the required number of first-aid stations with qualified staff until the completion of the Contract. The first-aid stations shall be lockable and shall have two rooms, one for medical examination and one for first-aid treatment and dispensing. The combined floor area shall be not less than 20m2 and in addition there shall be a covered veranda area of not less than 10 m2.

(b) Each hut shall be equipped with:

(i) table 2 m x 1 m, couch and two chairs;
(ii) cupboard and shelves;
(iii) adequate lighting;
(iv) hand-basin with running drinking water and running hot water;
(v) separate W.C. cubicle;
(vi) facilities for boiling water;
(vii) telephone connected to the closest hospital;
(viii) ceiling fan;
(ix) stretchers; and
(x) medicines and medical equipment of a scope, quantity and standard deemed by the doctor to be sufficient for first-aid.

(c) On the completion of the Contract the first-aid huts will remain the property of the Contractor and shall be removed from the Site.

1.25.3 Advice of Competent Health Authority

The Contractor shall obtain and follow the advice of the competent health authority on all such matters as water supply, sanitation, garbage and sewage disposal, health and hygiene.

A proportion of the Contractor's employees, normally one (1) man per gang, shall be trained in first aid and emergency resuscitation. The Contractor shall provide a list of the names of these persons together with details of the training given.

1.26 Central Storage Area

1.26.1 Scope of Work

(a) the Contractor shall clear and level the land, add crushed stone, fill, compact, level, drain and install a security fence around the area which shall be used by himself and other contractors employed by the Employer. The Contractor shall be responsible for the day to day security of the Central Storage Area.

(b) The Contractor shall provide services for the operation of the Central Storage Area which shall include:

(i) a gatekeeper for checking and control of personnel and vehicles requiring entry to and exit from the Central Storage Area for 24 hours per day 7 days per week;

(ii) security guards to watch the area for 24 hours per day 7 days per week; and

(iii) personnel to carry out daily maintenance of the Central Storage Area, including repairs and maintenance of the drainage system and fences and the removal of plant growth and rubbish to prevent the development of fire and health hazards.

1.26.2 Temporary Access Road

The Contractor shall construct an access road to the Central Storage Area and maintain it in a serviceable condition allowing all weather access by sedan type vehicles.

1.26.3 Fencing

The Contractor shall fence the area with security fence, including a double-leaf 6 m wide gate at each end. The fence shall be constructed on the perimeter of the area with the gates located where directed.

1.26.4 Use by Contractors for Permanent Plant

The area will be used by all contractors working on the Project and will provide a facility for safe storage of individual items of plant, including turbines, generators, transformers, and associated ancillary plant.

1.27 Quality Assurance

1.27.1 General

The Contractor shall be completely responsible for implementing a Quality Assurance Plan covering all the Works contained in the Contract. The Quality Assurance Plan will be prepared by the Contractor and reviewed and authorized by the Engineer and shall be implemented by the Contractor. Specificaly it will be managed by the Contractor's Quality Assurance Manager. The Contractor's Quality Assurance Plan is the means by

which the Contractor ensures the control and quality of all design functions, all fabrication by his suppliers and subcontractors and all construction activities including site laboratory testing carried out by him and his subcontractors, all work by equipment installation engineers and the testing and commissioning activities associated with all the mechanical and electrical equipment.

1.27.2 Contractor's Quality Assurance Plan

(a) The Contractor's Quality Assurance Plan shall meet all the requirements of ISO 9001. As appropriate, the Contractor will impose on his designers, suppliers, fabricators and subcontractors the requirements of ISO 9002, ISO 9003 and ISO 9004. The Quality Assurance Plan will be prepared in 45 days after Commencement and presented in three different volumes namely:

(i) Volume 1 Quality Plan;
(ii) Volume 2 Quality Assurance Procedures; and
(iii) Volume 3 Quality Control Procedures.

(b) Collectively, the three Volumes shall comprise the Contractor's Quality Assurance Plan (PLAN). Each volume will address the issues enumerated in the following Sub-Clauses. The Quality Assurance Plan shall recognize and include the potential necessity for revision during the project at which time reauthorization shall be sought from the Engineer. Within twentyeight (28) days of the Commencement Date, the Contractor shall produce and submit to the Engineer an outline of the PLAN. Within a further 28 days of the above submittal date, the Contractor will submit the detailed Plan incorporating the comments made by the Engineer. The authorized detailed Plan will be supplemented by comprehensive details for specific work activities at least 28 days prior to their commencement. The Contractor's Quality Assurance Plan will be managed and directed by a dedicated Quality Assurance (QA) Manager who will be physically on the Project Site throughout the implementation and will report directly to both the Contractor's Representative and independently and directly to the Contractor's Home Office Senior Management. The QA Manager shall have at least 15 years' experience in administering QA plans, of which at least 5 years shall have been spent in heavy civil engineering construction

(c) The QA Manager shall represent and be authorised by the company to manage quality assurance activities and to implement the Contractor's QA system. The Contractor's management shall afford to the QA manager all qualified assistance that he requires to perform his function and to maintain records throughout the whole project.

1.27.3 Requirements of Contractor's Quality Assurance Plan

(a) Volume 1 "Quality Plan"

This section of the Contractor's Quality Assurance Plan will address the following topics:

(i) Purpose and Scope
(ii) Policy
(iii) Organization and Responsibilities
(iv) Project Manager Review
(v) Applicable Standards
(vi) Definitions

The purpose, scope and policy chapters will establish the general philosophy and parameters that the Contractor's senior management requires for the Quality Assurance Plan. Organization and responsibilities will clearly present the detailed Contractor's organization as it pertains to Quality Assurance and Quality Control activities. A description of assigned responsibilities is required. Project Management Review will address the Contractor's procedures for addressing quality issues raised by the Quality Manager to the Site Project Manager and Head Offices senior management. The standards that will be used to support the Contractor's Quality Assurance Plan are required to be listed. These will include all applicable industry codes, standards and practices and specifically those referenced in the Contract documents and the Specification. For clarification in the use of the Contractor's Quality Assurance Plan document by Contractor's personnel, it is required that a glossary of specific terms used in the documents be itemized (Definitions).

(b) Volume 2 "Quality Assurance Procedures"

This Volume will present clearly the Quality Assurance (QA) procedures developed by the Contractor to provide a planned and disciplined approach for the achievement of project quality objectives. The procedures, in general, require the prompt detection and correction of deviations, which are or may be, detrimental to quality and generate documentation necessary to provide objective evidence of achievement of quality objectives during design, fabrication, construction and commissioning phases of the project. As a minimum the QA procedures will include but not be limited to:

(i) Contractor's quality statement;
(ii) Contractor's organization structures including Quality Control organization;
(iii) Contractor's quality procedures addressing requirements of ISO 9001;
(iv) Principal staff and its tasks and responsibilities;
(v) Contractor's plant management procedures;
(vi) Construction programme management;
(vii) Progress reporting procedures;
(viii) Contractor's design procedures;

(ix) Contractor's procedures for selecting and appointing subcontractors and suppliers including independent testing laboratories;
(x) Contractor's procedures for obtaining, reviewing and approving subcontractors' and suppliers' quality procedures and for quality auditing of subcontractors and suppliers;
(xi) Contractor's method statements for all work to be executed;
(xii) Control of construction procedures;
(xiii) Temporary work;
(xiv) Topographic survey;
(xv) Materials control and approval;
(xvi) Method statements, including transportation and handling of materials;
(xvii) Contractor's site laboratory facilities, equipment and personnel;
(xviii) Verification, testing and reporting procedures for design, equipment, materials and workmanship in the office, factory or on site;
(xix) Document control procedure;
(xx) Health and safety procedures;
(xxi) Site operational control procedures;
(xxii) Contractor's internal quality audit control procedures;
(xxiii) Non-conformance reporting (NCR) procedures;
(xxiv) Closing out NCR for the Taking-Over procedures;
(xxv) Training procedures;
(xxvi) Interim measurements and payment procedures;
(xxvii) Final measurement procedures;
(xxviii) As-built information and operation and maintenance manuals;
(xxix) Change control of project quality procedures;
(xxx) Organization charts illustrating the main tasks and their sub-divisions, the reporting structure;
(xxxi) Interface between the Contractor, the Engineer and the Employer;
(xxxii) Interface within the Contractor's internal project team;
(xxxiii) Interface Milestone procedures with other Contractors;
(xxxiv) The Contractor's coordination with local and statutory authorities; and
(xxxv) The Contractor's internal quality management arrangement including quality assurance and auditing personnel.

The QA Procedures are the requirement for the Quality Assurance Manager to formulate an audit plan, designate organisational elements subject to audits and establish a schedule for providing regular auditing activities. The Contractor's internal quality audit control procedures will be written and submitted to the Engineer for review and approval and as a minimum will contain the following items:

(i) Audit title and number;
(ii) Organization affected;
(iii) Purpose;
(iv) Scope;
(v) Activities to be audited;
(vi) Performance standards;
(vii) Audit team members overall schedule;
(viii) Any interfaces;
(ix) Review and approval authority; and
(x) Schedule of audits.

The Contractor's internal quality audit control procedures and schedule of audits will be forwarded to the Site Project Manager and other key members of his organization. The Engineer shall have the right to require revision of the Contractor's internal quality audit control procedures during the project.

(c) Volume 3 "Quality Control Procedures"

This volume will present the procedures and systems that the Contractor will perform to maintain an effective Quality Control (QC) programme. In general, the Contractor will perform sufficient checks, inspection and tests on all items of the work including:

(i) Design engineers;
(ii) Suppliers;
(iii) Subcontractors; and
(iv) Contractor's Site work activities.

The Contractor shall ensure conformity with respect to the design, materials, workmanship, construction, finish and functional performance. The Quality Control Plan shall include adequate provision for access by the Engineer to inspect any and all facilities of the project and facilities such as laboratories etc. required to implement the plan. Specifically Volume 3 will address the following items as a minimum:

(i) The QC organization;
(ii) The number and qualifications of personnel to be used;
(iii) Authority and responsibility of QC personnel;
(iv) Methods and procedures of QC control for all the work including design, suppliers and subcontractors;
(v) Inspection and Testing Plan;
(vi) Details of the site laboratory including the physical layout and proposed on-site testing equipment;
(vii) Details of any off-site laboratory testing;

(viii) Details of the physical site tests and laboratory tests proposed for all the construction materials with emphasis on cement, concrete, soils and rock testing. Frequency of testing shall be included;

(ix) Off-site testing of manufactured items and type testing;

(x) Procedures that will ensure that the latest applicableDrawings, shopDrawings, specifications and instructions required by the Contract Documents, as well as authorized changes are used for fabrication, construction, inspection and testing; and

(xi) Procedure for the issuance, tracking and closeout of Non-Conforming Reports (NCR's) and Deviation Reports (DR's). This procedure shall prioritise the NCR's and ensure the closeout of such matters in a timely manner to the satisfaction of the Engineer.

(d) Engineer's Quality Assurance

The Engineer will have the responsibility to evaluate and verify the Contractor's QA/QC operations. Observations, inspections, tests or approvals by the Engineer or any other person shall not relieve the Contractor from his obligations to perform the work in accordance with the Contract documents. The Engineer has the right to visual inspection of all Contractor's work. If work is to be covered, the Contractor shall notify the Engineer of work completion and the Engineer will inspect within a reasonable time. If any work is covered without such notification, it must, if requested by the Engineer, be uncovered for observation. Such uncovering shall be at the Contractor's expense unless the Contractor has given the Engineer timely notice of Contractor's intention to cover such work and the Engineer has not acted with reasonable promptness in response to such notice. "Reasonable Notice" shall never be less than 24 hours, excluding Friday, Saturdays, and holidays.

(e) Laboratories

The Contractor is required to carry out all test in certified Laboratories whose particulars will be submitted for approval by the Engineer.

The Engineer also has the right to carry out any physical testing of the Contractor's work. Samples of site work (e.g. concrete, soils, cement, rock, reinforcing steel etc.) will be supplied by the Contractor at no charge. The Engineer will also have the right to perform any off-site testing of materials. Samples for such testing will be supplied at no cost by the Contractor, suppliers and subcontractors. The Engineer may inspect all records and audits performed by the Contractor at any stage throughout the Contract period and shall also take part in the audit process.

1.28 Operation and Maintenance Manuals

1.28.1 Scope

(a) The Contractor shall provide Operation and Maintenance manuals in English, the scope of which shall be suitable for fully informing the Employer's personnel and personnel of the Employer's operation and maintenance contractor on all aspects of the operation and maintenance of the works as further defined in this Clause. The manuals shall be provided in draft and final forms. If the need to modify the final manuals arises, the Contractor shall provide the necessary modified content as soon as possible after the need for modification arises.

(b) The content of the manuals shall be directly applicable to the civil works and the Electrical and Mechanical Plant. Typical manuals will not be accepted. Standard manuals and brochures covering a number of sizes and/or models of proprietary equipment will be accepted provided they cover the items supplied and these items are clearly identified throughout the manuals and brochures. Clear and concise cross-references to these brochures and standard manuals shall be made in each appropriate section of the operation and maintenance manuals.

(c) The Contractor shall, in preparing the manuals, take into account the lack of experience and lack of familiarity of the operating and maintenance personnel with the type of work and type of equipment supplied. The information shall be presented as simply, clearly and precisely as possible.

(d) The Contractor shall keep one copy of the manuals, in draft or final form as appropriate, in its Site office. This copy shall be available at all reasonable times for inspection by the Engineer. The Contractor shall require its site supervisors and site supervisors of its Subcontractors to comment from time to time on the draft manuals. The Contractor shall take account of these comments and comments by the Engineer when preparing the final manuals for approval.

(e) In order that the manuals are complete and clearly understandable it is required that they are produced by some combination of the following:

  (i) specialist technical authors;
  (ii) the designers; and
  (iii) the site erection and testing personnel.

(f) The manuals shall be subdivided on a civil work feature or structure by civil work feature or structure basis and a plant feature by plant feature basis, with the content for any one such feature or structure in a self- contained volume, complete and separate in all respects from the content for other such features or structures.

(g) The instruction content for each such feature or structure of the manuals shall comprise the following separate sections:

  (i) Section 1 – Contents;
  (ii) Section 2 – Description;

(iii) Section 3 – Operation;
(iv) Section 4 – Maintenance;
(v) Section 5 – "As-built"Drawings;
(vi) Section 6 – Brochures for Proprietary Equipment.

(h) This subdivision and the section reference numbers shall be adhered to, except that brochures covering more than one section will be accepted for minor components of proprietary equipment.

1.28.2 Format, Compilation and Quantity – Final Manuals

(a) The text, diagrams,Drawings, brochures and all other manuals content shall be reproduced in ink by letterpress, offset printing or in carbon by electrostatic printing. Reproductions obtained by using dyes, chemicals, photo-sensitive or heat-sensitive materials are not acceptable. (Note: The purpose of requirements for printing and paper quality is to ensure that the operation and maintenance manuals will remain clearly readable and in good repair for at least the useful lifetime of the Facility to which they refer - assumed 50 years.)

(b) All text shall be on size A4 paper except that brochures of smaller sizes will be accepted for minor components of proprietary equipment, provided they have adequate binding margins.

(c) Diagrams andDrawings provided as part of the manuals shall be A3 size wherever the original is A3 size or larger and A4 size for all others.Drawings bound into the text shall have an A4 size margin on the left- hand side so that they may be unfolded and viewed in full while reading the associated text. Insertion of looseDrawings into cover pockets is not acceptable.

(d) Text,Drawings, diagrams and illustrations included in the manuals shall be easily readable by a person having normal eyesight.

(e) The main text shall be on white paper. The tabulated design and other data shall be on yellow paper. The instructions for action to be taken on receipt of alarms shall be on pink paper.

(f) Each page in Sections 1 to 4 of the manuals shall be clearly and sequentially numbered, and each page shall also show the following information at the top of the sheet:

(i) project feature number and title; and
(ii) civil work feature or structure; or
(iii) plant feature number and title.

(g) Project and plant feature numbers shall be assigned by the Contractor to the Engineer's approval.

(h) The paper used in the manuals shall be of the following archival quality material:

(i) white sheets – offset or bond of 70 g/m^2 to 106 g/m^2;
(ii) coloured sheets – bond of not less than 70 g/m^2.

(i) The Contractor shall arrange for the compilation of the operation and maintenance manuals into volumes, including the provision of strong, durable and washable binders, and punching, trimming and collating the material.

(j) The Contractor shall deliver five (5) copies of the operation and maintenance manuals to the Engineer.

1.28.3 Format, Compilation and Quantity – Draft Manuals

The format, compilation and quantity of the draft manuals may differ from the requirements of this Clause, subject to the following:

(i) The Contractor shall deliver the draft manuals in six (6) copies to the Engineer;

(ii) All text,Drawings, diagrams and illustrations included in the draft manuals shall be easily readable by a person having normal eyesight.

1.28.4 Content of Manuals

The requirements for instruction content of the manuals for civil works set out in this Sub- Clause apply to the draft and final content unless specifically stated otherwise.
The manuals for each work feature or structure shall include all the requirements of this Sub-Clause:

(a) Section 1 – Contents

This section shall show the project feature number and title, civil work or plant feature or structure number and title, and list of sections and subsections as appropriate.

(b) Section 2 – Description

(i) Subsection 2.1 – History

This subsection shall include a brief statement of the organisations involved in the design and construction of the feature or structure, including Major Subcontractors, and the date when the feature or structure became operational.

(ii) Subsection 2.2 – Performance Data

This subsection shall be printed on yellow paper and shall include the following:
All performance data and charts over the full range of operating conditions, both normal and abnormal. Tables shall list all design conditions applicable.

(iii) Subsection 2.3 – Description

This subsection shall include, for each work feature or structure, comprehensive descriptions of the feature or structure, including the following information:

(i) basic type of structure;
(ii) definition of the structure;
(iii) purpose and function;
(iv) method of construction (if appropriate);
(v) materials of main components (if appropriate);
(vi) design features and summary;

(vii) relationship with other features or structures;

(viii) any associatedDrawings or diagrams that will assist in providing a clear understanding of the purpose and function of the feature or structure;

(ix) concise cross-references to associated brochures and pamphlets.

(c) Section 3 – Operation

(i) Subsection 3.1 – Operating Sequences

The operation instructions shall include brief descriptions of the normal and emergency operation requirements, limitations, limits and rules for the feature or structure.

(ii) Subsection 3.2 – Pre-operation Check List

The pre-operation check list shall include a comprehensive tabulated list or sequence diagram of all conditions which must be checked before the feature or structure may be operated before being placed in service initially or after being out of service.

(iii) Subsection 3.3 – In-service Check List

The in-service check list shall include a comprehensive tabulated list of all observations to be made during periodic inspections and tests, defining the location, range of acceptable values and action to be taken if incorrect values are found.

(iv) Subsection 3.4 – Abnormal Conditions

This subsection shall be printed on pink paper and shall contain a table of all abnormal conditions which can arise due to malfunctions of the feature or structure. The table of abnormal conditions shall include the following:

- nature of the abnormal condition;
- details of how the abnormal condition becomes apparent;
- essential action to be taken (immediate), following detection of the abnormal condition, to ensure safety of personnel and structures;
- diagnosis to establish details of the nature and cause of the abnormal condition.

(d) Section 4 – Maintenance and Inspection

Routine maintenance and inspection instructions are required for all features and structures.

(i) Subsection 4.1 – Maintenance and Inspection Schedules This subsection shall include the following:

- feature or structure and condition to be checked or inspected;
- required frequency of checking and inspection;
- maintenance and inspection equipment and plant required;
- required condition for service or maintenance, including required isolation.

(ii) Subsection 4.2 – Access, Isolation and Restoration This subsection shall include the following:

- methods of access and precautionary procedures to follow before gaining access or undertaking maintenance;
- instructions for isolating the whole or any section of the feature or structure so that maintenance or repair operation or inspection can be carried out in complete safety;
- instructions for the placing in service of the feature or structure after maintenance or repair or inspection. List of checks required after maintenance or repair or inspection;
- all of the above shall include easily readable diagrams, flow charts orDrawings whenever this will assist in understanding the descriptions.

(iii) Subsection 4.3 – Maintenance and Inspection Equipment and Plant. This subsection shall include the following:

- separate lists of maintenance equipment supplied under the Contract or required to be purchased by the Contractor or Employer;
- recommendations for storage and handling of maintenance and inspection equipment.

(e) Section 5 – "As-built"Drawings

(i) This section shall contain one copy of each drawing referred to in the text or necessary for clear understanding and use of the text, including all general arrangement and arrangementDrawings, drawn as "as-built"Drawings. The Drawings shall be preceded by a list with titles and numbers, in numerical order.

(ii) Because theseDrawings will be submitted after the final manuals are submitted, they shall be submitted separately in a form suitable to be bound into the final manuals by the Employer. The final manuals as submitted shall include "Final"Drawings in lieu of "as-built"Drawings.

(f) Section 6 – Brochures for Proprietary Building Materials and Equipment

This section shall contain manufacturers' brochures, instruction pamphlets and the like, containing the maintenance information as specified in Paragraphs c., d., and e. of this Sub-Clause, in respect of proprietary building materials and equipment.

1.29 Environmental Protection and Environmental and Social Management Plan

1.29.1 General

(a) Applicable Legislation and Regulations

The Contractor shall comply with all Country, State and Local government laws and regulations applicable to the project area and intended operations, as applicable to the Contract, and in particular the Environmental and Social Management Plan (ESMP), with respect to environmental and social matters.

(b) Environmental Social Health and Safety (ESHS) Management Strategies and Implementation Plans (MSIP)

(i) The Contractor shall be responsible for instituting ESHS Management Strategies for the project and complying with the National Environmental Management Authority (NEMA) regulations and guidelines and the Environmental and Social Management Plan (ESMP).

(ii) The Contractor shall prepare, as part of the ESMP, the following:

- Social, Safety and occupational health plan;
- Waste management plan;
- Internal environmental audit plan;
- Quarries Environmental compliance plan; and
- Emergency response plan.

(iii) The Contractor shall implement an approved ESHS Management Strategies and Implementation Plans for the above.

(c) Responsibility to his Staff and for the Project Area

(i) The Contractor shall instruct his employees and subcontractors concerning these requirements and impose a range of penalties, including instant removal from Site for serious breaches in respect to environmental protection and pollution attributable to his employees or subcontractors.

(ii) The Contractor shall assist the Employer for liaison with the Government authorities and agencies for all environmental, social and health and safety matters relating to his operations and construction activities.

(d) Approvals of and Compliance with Government Authorities

The Contractor shall be responsible for all approvals required from government authorities and agencies for his operations and activities.

(e) Extent of the Engineer and Employer Responsibility

(i) The Employer shall not be liable for any delays of any approvals, actions or inaction by the NEMA or other approving and enforcement agencies with respect to environmental aspects applicable to the Contract.

(ii) The Employer shall not be liable for any delays or stoppages of any activities with respect to the Contractor's compliance to the laws and regulations.

(iii) The Contractor shall comply with all written instructions given to him by the NEMA with respect to the Contract without additional cost incurred to the Employer.

(iv) The Engineer will perform monitoring of environmental parameters to ensure full compliance with NEMA conditions, laws and regulations.

(v) The Engineer will perform environmental audits to verify and complement the Contractor's internal environmental audits.

(f) Construction Meetings

(i) The Contractor shall address environmental, social and health and safety matters at construction progress meetings.

(ii) The Contractor shall brief the construction workers on environmental awareness.

(iii) The Engineer shall be informed regularly of the environmental and mitigation measures undertaken by the Contractor.

1.29.2 ESHS Management Strategies and Implementation Plan

1.29.2.1 Requirement of an ESHS MSIP

(a) The Contractor shall prepare an ESHS Management Strategies and Implementation Plan (ESHS MSIP) for the Contract as required in the Bidding Documents.

(b) As appropriate the Contractor shall impose on his Subcontractors the requirements for ESHS MSIP as adopted by him.

(c) The ESHS MSIP shall be reviewed, new environmental plans added to when required and amended accordingly from time to time.

1.29.2.2 Integration of ESMS MSIP with other Systems

The ESHS MSIP shall form an integral part of the Contractor's organization overall management system. The structure, responsibility, practices, processes and resources for implementing environmental policies, objectives and target shall be coordinated with operations, quality assurance, occupational and health etc.

1.29.2.3 Content of ESHS MSIP

The contents of ESHS MSIP shall be in accordance with the requirements of the Bidding Documents.

1.29.3 Environmental and Social Management Plan

1.29.3.1 General

(a) The Contractor will prepare an overall project Environmental and Social Management Plan (C-ESMP) on which basis the Contractor shall prepare his detailed ESHS MSIP. The Contractor shall submit amendments and new elements to the C- ESMP as required by the Engineer.

(b) The Contractor shall comply with the requirements for Water Control, Pollution Control and Environmental Protection.
(c) The Contractor shall adhere to Good House Keeping Rules for all his operations and construction activities at all times.

1.29.3.2 Scope of Contractor's Environmental and Social Management Plan

(a) The Content of the C-ESMP shall include, but not necessarily limited to the following:
    (i) Safety and occupational health plan;
    (ii) Water pollution control plan;
    (iii) Wastewater management plan.
    (iv) Solid Waste management plan.
    (v) Quarries Environmental Management plan
(b) The plans shall include mitigation measures and contingency procedures.
(c) The Contractor shall prepare detailed emergency preparedness response plans and procedures for elements of the detailed C-ESMP to be included in the section of "Emergency Response Plan" of the **ESHS MSIP.**

1.29.4 Detailed Environmental Elements of C ESMP

1.29.4.1 Water Pollution Control Plan

Based on the overall project EMP and local environmental requirements, the Contractor shall prepare and submit a detailed Water Pollution Control Plan to the Engineer for approval.

1.29.4.2 Wastewater Management Plan

(a) Based on the overall project EMP, the Contractor shall submit a detailed wastewater management plan to the Engineer's approval for all wastewater and foul effluent from offices, workshops, site accommodations etc. to be collected and treated at a wastewater treatment plant prior to discharge into open watercourses or into groundwater. The plan shall include the type, volume and discharge points, conforms to the requirements of the authorities, and shall follow the principles of current and best management practices.
(b) Wastewater from industrial sites and sewage from the package plants at the camps shall be treated prior to the release to open watercourses and shall comply with Kenyan Regulations as applicable.
(c) Fuel Storage and Machinery Maintenance:
    (i) The Contractor shall provide and maintain bund walls around fuel storage areas within the site. Such walls shall be of a sufficient height to contain a volume of at least 150% of the entire content of the fuel storage facility in case of spillage.

(ii) Drainage from fuel storage and machinery maintenance area shall be treated to remove oil and/or fuel.

(iii) Soil contaminated by fuel leakage shall be removed and placed in disposal areas as directed by the Engineer.

(d) When water quality is below that recommended, the Contractor shall propose measures that he intends to take to improve the quality of such discharge and, when approved by the Engineer, shall implement the proposals at no additional cost and without delay.

1.29.4.3 Solid Waste Management Plan

(a) The Contractor shall designate on his layout plan and the updated EMP, the location of waste dumps, collection schedule and the treatment of solid waste including industrial waste from the various camps, construction sites, laydown or storage areas and the residential camps.

(b) This plan shall be executed according to the District laws and regulations and shall consider the opinions of local residents. Specific arrangement shall be included by the Contractor for any known hazardous or toxic wastes to be disposed of at a recognised site, operated by the district or state waste disposal authorities. Handling and disposal of scheduled wastes shall comply with Kenyan Regulations.

(c) Waste oil and grease arising from the earthworks and construction and operation activities shall not be disposed of into any watercourse. Such waste shall be stored in proper drums or containers and either reused or disposed at the site approved/licensed by the appropriate local authority.

(d) The Contractor shall implement the best practices and management with respect to solid wastes disposal.

1.29.4.4 Safety and Occupational Health Elements

(a) In Safety and Occupational Health Plan, the Contractor shall explain his overall plan and outline the details of the works, staffing and the programme to be implemented in respect of safety and health as per his Quality Assurance.

(b) The Contractor shall comply with the safety aspects, including the appointment of a Safety Officer and Safety Committee as outlined in the Conditions of Contract, this Section and the relevant legislation and regulations.

(c) The Contractor shall take control measures on infectious diseases, especially water borne (such as typhoid, gastroenteritis and malaria) as required by the Health Ministry of Republic of Kenya , in areas outside the Civil Contractor's responsibility, if any.

(d) Temporary sewage treatment for toilet facilities shall be in accordance with the specifications as prescribed by the Ministry of Health and shall be provided at Works area before commencement of any works.

(e) The Contractor shall conform to the best practices and management to his Safety and Occupational Health Plan and shall engage a qualified expert to advise him, if required.

1.29.5 Emergency Response Plan

1.29.5.1 General

(a) The Emergency Response Plan shall be included in the Contractor's ESMP. The Contractor shall submit amendments as required by the Engineer.

(b) The emergency preparedness and response plans and procedures shall be established to ensure appropriate response to unexpected or accidental incidents to BS EN ISO 14004:2004 Clause 4.4.7 – Emergency Preparedness and Response Plan. The Contractor shall submit amendments as required by the Engineer and due to his intended operations and shall be updated in his **ESHS MSIP**.

(c) The emergency response procedures shall take into account accident arising, or likely to arise, as a consequence of abnormal conditions, accidents and potential emergency situation including evacuation procedure.

1.29.5.2 Content of Emergency Response Plan

(a) The content of the Emergency Response Plan shall include, but not necessarily limited to, the following:-

- (i) Purpose and Scope of Emergency Response Plan;
- (ii) Emergency organization and responsibilities;
- (iii) A list of key personnel;
- (iv) Details of emergency services;
- (v) Co-operation and co-ordination with Police Department, Fire Department, local government etc., where required;
- (vi) Co-operation and co-ordination with the other contractors;
- (vii) Emergency preparedness and response procedures;
- (viii) An internal and external communication plan;
- (ix) Information on hazardous materials, including each material's potential impact on the environment, and measures to be taken in the event of accidental release;
- (x) Training plans, simulated emergencies for effectiveness.

(b) The Contractor shall submit the monitoring results on safety and occupational health to the Engineer at three monthly intervals for record purposes.

1.29.6 Environmental Audit Plan

(a) The internal environmental audit plan and procedures shall be in compliance with BS EN ISO 14004:2016 as appropriate for the Contract. All aspects of the

internal environmental audit shall be integrated with his internal quality audit of his Quality Assurance Programme.

(b) The Contractor shall perform internal environmental audit of his operations and activities at regular basis to ensure compliance with ContractDrawings, Specifications, Contractor'sDrawings, regulation and legislation. The Engineer will participate in the Contractor's environmental audit from time to time.

(c) The Contractor shall include the following in his internal environmental audit:

(i) Evidence of pollution due to his operations and construction activities.

(ii) Non-conformance: incidents, complaints and follow-up actions.

1.29.7 Communications and Reports

(a) Besides his internal reports, the Contractor shall also prepare reports and compile data for submission to relevant government authorities and the Engineer's records. The reports are subject to Engineer's approval prior submission to the government authorities.

(b) The Contractor shall prepare reports to be submitted to the Engineer, but not necessary limited to the following:

(i) **ESHS MSIP** : components of the **ESHS MSIP** will be submitted to NEMA by the Employer as required by the department;

(ii) Internal environmental audit report sheets at monthly intervals;

(c) Environmental non-conformance report sheets as soon as they are issued and after the corrective actions are taken.

1.30 Site Conditions

It is the responsibility of the Contractor to liaise with meteorological department and other relevant departments and Authorities to obtain the full range and updated details of data for the planning and use in the Project.

1.31 Name Boards

The Contractor shall erect and maintain one name board at the main entrance to his site establishment. The design of the name board shall be agreed with the Engineer and provision shall be made for the Employer, the Engineer at the top, and Subcontractors' names to be mounted on panels attached beneath the Contractor's name board. The Contractor shall ensure that these are painted and attached to the board when the Subcontractors arrive on Site.

The board shall be made up from durable materials that will not warp due to weathering. The board shall be mounted on adequately braced poles and shall be kept neat and legible at all times. The board shall be a maximum of 7 m x 3.5 m in size and

be mounted at a clear height of 2.0 m above ground level. The Contractor shall keep the name board in good repair and order for the duration of the Contract and shall remove it on completion of the Contract. Contractor's and Subcontractor's company boards shall only be displayed at the entrance to their respective office areas/buildings. The Engineer will order the removal and replacement of any board which falls into a state of disrepair or illegibility.

1.32 Truck-mounted Crane

The Contractor shall supply for the ownership of the Employer one truck mounted telescopic crane. The crane will be used for service access in the new protection structures of all wells. The Contractor will examine the accessibility, reach and lifting needs of the wells and will propose for approval a suitable truck mounted crane with minimum characteristics as follows:

- Truck-mounted telescopic crane with lifting capacity not less than 5t and height reach not less than 20m.: 1 nr.

The vehicle will be new, of right-handed drive, from a reputable manufacturer with servicing capacity in the Mombasa-Coast area, conform to all relevant National Standards of Kenya and will fulfil all licensing requirements for driving in the public roads and highways of Kenya.
The Contractor will provide training for the usage of the crane to suitably qualified personnel of the Employer.

1.33 Drawings and Method Statements prepared by the Contractor

The Contractor may be requested to prepare and submit for approval Drawings and Method Statements at different stages of the Contract and for the different components of the works as follows:

(a) Working Drawings, Shop Drawings and Method Statements – To be submitted for approval at least two weeks prior to commencement of the corresponding works of the project.

(b) Working-drawings and Shop Drawings for the electrical connections/installations including main supply, lighting and signaling for the production-well structures, the new transformer building in the upstream wellfield and the existing transformer building that serves wells BH9, BH10 and BH11. To be submitted for approval at least two weeks prior to commencement of the corresponding works of the project.

(c) As-built Drawings – To be submitted at least two weeks prior to the issue of the Certificate completion of construction.

The Employer and Engineer retain the right to prepare designs on their own and to modify drawings prepared by the Contractor. The Contractor is obliged to execute designs and working drawings issued by the Employer and Engineer for construction.

All costs for preparation of these Drawings and Method Statements are deemed to be included in the item “Preparatory Works” in the priced Bill of Quantities.

Chapter 2: WATER CONTROL

2.1 Scope

This section covers the performance of all temporary work in connection with dewatering during construction. The work specified includes care of all water from any source, as may be required so that the construction work may be performed in areas free from water, except as otherwise directed or specified, and so that the works and work areas, including foundations, borrow and stockpile areas, are protected from damage.

2.2 Description

Except in case of force majeure, the Contractor shall be solely responsible for the control of water at the Site during the construction period and shall provide such temporary drainage or water barrier works, dewatering works, including pumping as may be necessary. The Contractor shall submit, for the consent of the Engineer, appropriate method statements, at least one week prior to the commencement of each component of the works.

Chapter 3: EARTHWORKS

3.1 General

3.1.1 Works included

Earthworks as specified hereunder shall include the location of underground structures, the preparation of the Site including protective fencing, excavation, disposal of excavated materials off Site, backfilling including delivery of backfill material and Site clearance including disposal of surplus material.
The Contractor shall carry out works described in this Specification in accordance with the appropriate EN Standard. The Contractor may carry out the works or provide materials in accordance with local or other international standards, provided their requirements are superior or equivalent to the quality described by the standards cited in the Specifications.

3.1.2 Excavation

The Contractor shall examine the Site and familiarize himself with the nature of ground, the excavation methods to be applied and physical obstructions that may affect the work.

The Contractor shall not execute any excavation without having the Engineer's prior approval to the methods which he proposes to employ. The Contractor shall not modify such methods thereafter without the Engineer's consent.

The Contractor shall make excavations in any material for the several parts of the Works and shall dispose the excavated materials as specified, shown on the Drawings, or ordered by the Engineer. Heavy trucks transporting excavated or other material, shall avoid passing through the neighboring villages if possible.

Before commencing or recommencing each excavation, the Contractor shall give to the Engineer at least 7 days written notice of the proposed date, which shall not be less than 7 days after the appropriate part of the Site has been cleared. Within this period an agreed record of the ground levels and topography shall be made for the measurement of the Works.

Excavation, which is to remain open permanently, shall be carried out to the lines and levels shown on the Drawings or to such other lines and levels as the Engineer may direct as the work proceeds depending on the nature of the ground exposed. In soft excavation the exposed faces shall be trimmed to the required profiles. In rock excavation the face shall be trimmed so that no point of rock protrudes within the required "Payment Line".

Excavation, which is to remain open only temporarily, shall be carried out in such a manner as to permit the proper execution of the Permanent Works. Sides of soft excavation which, at the Contractor's choice, are excavated to unstable slopes shall be adequately supported at his own expense. No face of any excavation shall be covered before it has been approved by the Engineer.

Where a structure or embankment is to be founded on sound ground, not necessarily rock, the excavation shall be taken down until the required formation is exposed, with all loose soil, turf, vegetable soil and peat being removed.

Where the formation of any excavation, being other than rock, is to support the foundation or floor of a structure, the bottom 150 mm thereof shall not be excavated and trimmed until immediately before placing the Permanent Works upon it.

When a structure or embankment is to be founded on rock but does not require penetration into it, all soft overburden shall be removed and the surface of the rock cleared of any loose pieces of rock by barring and wedging.

Where the foundation calls for penetration into the rock, the excavation of the rock may be carried out by blasting. The explosives shall be used in such a manner as to prevent the shattering of the rock, and loose or shattered rock shall be removed by barring and wedging so that the exposed surface is sound.

Where directed, the Contractor shall wash down the surface of the excavated rock for inspection and shall examine all excavated rock faces as soon as possible and regularly thereafter and shall remove all insecure pieces of loose rock.

For the purpose solely of the descriptions given in the Specification the following classification shall apply:

“Rock or Hard Ground”
Rock shall mean a hard-compact natural formation which in the opinion of the Engineer can only be removed by the prolonged and persistent use of pneumatic tools, or by sledgehammer and wedges, or using explosives.

“Soft Rock or soil”

Materials which can be excavated by hand with pick and shovel or can be machine ripped (by a tractor not larger than caterpillar D8 or machine of similar capacity) prior to excavation.

3.1.3 Trench Excavation

Trench excavation shall be carried out in accordance with EN 1610 Construction and testing drains and sewers.
Trench excavations for pipes and interconnections shall be open-cut trenches with minimum width. The width of the trenches in accordance with EN 1610 shall be deemed sufficient to permit the pipes to be laid and jointed properly and to place and compact the backfill as specified.
All pipes, sewers and cables shall be laid in trenches excavated in undisturbed soil.
The trench shall be excavated to such depths as necessary to permit placing pipe bedding material or concrete encasement as required and to allow the pipe to be laid at the required elevations, slopes and depths. Trench bottoms shall be cleared of projections such as rocks stones roots and the like.

3.1.4 Stripping of Topsoil

Where specified or ordered by the Engineer, the Contractor shall strip the topsoil from the areas to be occupied by the Works and shall keep it separate from other excavated materials until its final disposal by spreading and levelling elsewhere on the scheme as specified or ordered by the Engineer.
Where the Temporary Works will be not subsequently covered by the Permanent Works or movement over topsoil, which is, in the opinion of the Engineer, substantially more fertile than the sub-soil, will occur, the Contractor shall strip the topsoil to the full depth (not exceeding 0.50 m) and shall store it, at the commencement of the Works. After completion of the Works, or the appropriate part thereof, the Contractor shall replace the topsoil as far as practicable in the original positions and to the satisfaction of the Engineer.

3.1.5 Excavation of Unsound Material

If any unsound material occurs in the bottom of any excavation, or at the foundation level, the Contractor shall remove and dispose it.
Unless otherwise specified or ordered by the Engineer, the Contractor shall fill the voids so formed with the same material as that which comprises the fill in the formation of embankments, and with suitable granular material to the approval of the Engineer in the case of pipelines and embankment pitching.
If the Contractor encounters any material which in his opinion may be unsound, he shall immediately inform the Engineer, who will instruct the Contractor in writing as to whether or not the said material shall be treated as unsound, provided that if in the Engineer’s opinion the unsoundness of the formation is due to the Contractor's method of working or his failure to keep the excavation free from water, the removal,

disposal and replacement of unsound material shall not be measured for payment. The omission by the Engineer to give an instruction shall not relieve the Contractor from any responsibility for defects in the Works, if prior to construction the Contractor shall have failed to request the Engineer, in writing, to inspect the exposed foundation.

3.1.6 Extent of Excavations

The extent of excavations shall be subject to the prior approval of the Engineer and as shall have been reasonably justified to him by the Contractor.

3.1.7 Support of Excavations

The Contractor shall provide the supports necessary for the excavations and shall not remove such supports until in the opinion of the Engineer, the Permanent Works is sufficiently far advanced to permit such removal. He shall submit his proposals for such supports to the Engineer when required.
If, in the opinion of the Engineer, the support proposed by the Contractor is insufficient, then the Engineer may order the provision of stronger support, in which event the Contractor shall provide and shall make no charge for providing such stronger support to the satisfaction of the Engineer.

3.1.8 Slips, Falls, and Excess Excavation

The Contractor shall prevent slips and falls of material from the sides of the excavation and embankments.
In the event of slips or falls occurring in the excavations, and where excavations are made in excess of the dimensions shown in the Drawings, the voids so formed shall be filled by the Contractor. When such voids occur in rock and, in the opinion of the Engineer, may affect the stability of the ground for the support of the Works, or of the adjacent structures and services, the Contractor shall fill the void solid with selected excavated material placed and compacted to the approval of the Engineer. The Contractor shall make no charge for additional payment in respect of filling such voids.
The Contractor shall, at his own expense, remove from the Site all material resulting from excess excavation and shall make good the same with such kind of fill material or concrete as may be reasonably required by the Engineer having regard to the circumstances.

3.1.9 Shoring

When the material being excavated has sliding planes inclined towards the trench, adequate shoring must be carried out immediately after excavation. Particular care shall be taken if the earth, though firm, may be rendered unstable when trenched or by rain or seepage of groundwater.
If slipping or collapsing of the sides unavoidably increases the width of the trench, work shall be suspended, and the Engineer informed on the occurrence. The Engineer

shall decide whether the design of the pipeline has to be reviewed in view of trench width or, if necessary, the class of bedding and shoring.
The method of shoring to be used is up to the discretion of the Contractor, but subject to the approval of the Engineer with regard to safety. The Contractor shall be fully responsible for the stability and the effectiveness of the shoring. Costs for shoring shall be included in the rates and prices entered for other items in the Schedule of prices.
The method statement shall include engineering computations for the sheeting, shoring, and piling for different excavation depths.

3.1.10 Excavations to be Kept Dry

Unless otherwise approved and such approval will only be given in exceptional circumstances, the Contractor shall keep the excavations free from water from whatever source, so that the Works shall be constructed in dry conditions. The Contractor shall maintain the accumulated or sub-soil water at level below that of the bottom of the Permanent Work by such methods, to such depth and for such duration as the Engineer may approve. Where the method approved by the Engineer involves the use of mechanical plant, the Contractor shall maintain on Site in working order as much stand-by plant as is necessary to ensure the safety of the Works.
The method and position of disposal of water from the excavations shall be subject to the approval of the Engineer.
In the event of the Contractor requiring drainage grips, channels or sub-drains, the Engineer may permit them to be constructed below the level and within the width limits of the Permanent Work. Full proposals shall be submitted for the Engineer's approval.
Any provision that the Contractor makes below the Permanent Work shall, if left in place, be made to provide support at least equal to the permanent support. No sub-drainage pipes shall be left in unless they are filled with concrete or other approved material.

3.1.11 Trial Holes

The Engineer may direct that trial holes shall be excavated well ahead of excavation to such depths, as he shall order to determine the location of existing works. Such excavation shall be held to be incidental excavation.

3.1.12 Disposal of Excavated Material

The Contractor shall transport and dispose of all excavated material not required for the Works, frequently and regularly (at least once per day). The locations proposed by the Contractor for disposing or storing excavated materials, whether temporarily or permanently, shall be subject to the approval of the Engineer and shall suit the overall requirements for the execution of the Works.

Disposal on Site

Excavated material shall be disposed within the Site in any of the following ways:

I. Transporting and placing in temporary stockpiles and backfilling to excavations including any double handling of materials; or
II. Transporting and placing of approved materials in permanent stockpiles, including the shaping and drainage of such tips; or
III. Transporting of selected excavated materials to locations within the Site for embankments and filling around structures including tipping for spreading and compaction.

Stockpiles on Site

Only such materials approved by the Engineer shall be placed in the various stockpiles. No tree trunks, stumps, roots, foliage, or rubbish of any kind shall be placed in stockpiles. Temporary stockpiles to store excavated materials shall be arranged by the Contractor. Such stockpiles shall be shaped as to always maintain stability and good drainage. Topsoil stripped from the Site shall be stored in separate stockpiles for later use in reinstatement and landscaping.

Disposal of Excavated Material Off-Site

Excavated material, which is not required or not suitable for reuse in the Works shall become the property of the Contractor. The Contractor shall dispose such material Off-Site at locations to be determined by the Contractor. Such locations shall be in accordance with the regulations of NEPA (National Environment protection Agency).

3.1.13 Excavation for Foundations of Concrete

Foundations shall be excavated to the grade of foundation material or depth as shown on the Drawings or to such other depths as the Engineer may direct and no concrete shall be placed until the foundations have been examined and approved by him. Due notice shall be given to the Engineer to enable him to examine foundations in advance. If, in the opinion of the Engineer, due to the fault of the Contractor the ground becomes weathered prior to the placing of concrete, the Contractor shall remove the weathered soil and replace it with concrete to the original formation level at his own expense.

The surface of rock excavation under concrete or masonry structures shall be prepared by picking, barring and wedging and other approved methods, which will leave the rock in a sound condition as may reasonably be expected according to the rock quality.

All surfaces shall be free of oil, water, mud or any material which in the opinion of the Engineer is not desirable. Rock surfaces shall be thoroughly cleaned by compressed air and water jet or other suitable means before concrete is placed.

Areas of excavation, which are to receive a layer of concrete as a blinding layer, a screeding or drainage layer under the structural concrete, shall be covered immediately after the excavation has been completed.

3.1.14 Explosives and Blasting

The Contractor shall at all times take every possible precaution and comply with the Explosives Laws of Kenya and regulations relating to the handling, transportation, storage and use of explosives and shall at all times when engaged in blasting operations post sufficient warning flagmen to the full satisfaction of the Engineer.
The Contractor shall at all times make full liaison with and inform well in advance and obtain such supervision and permission as is required from the Police and all Government Authorities, public bodies and private parties whosoever concerned or affected by blasting operations.
Blasting shall only be carried out on those sections of the Works for which permission in writing shall have been given by the Engineer and shall be restricted to such hours and conditions as he may prescribe. Such permission shall not be withheld, nor such hours and conditions imposed unreasonably.
The greatest care shall be taken in the use of explosives, the charges being so placed and of such amount as in no way to weaken existing structures or the foundations or ground adjacent to the existing and proposed works. The Contractor shall take all necessary precautions to prevent loss, injury or accident to persons or property and shall be entirely liable for any accident or damage that may result from the use of explosives.
The Contractor shall submit to the Engineer for his approval details of the intended drilling patterns, depths of holes, the amounts of explosives at each location and the method or sequence of detonation that he proposes to use. The Engineer may find it desirable to direct the Contractor to use special methods to obtain sufficient, even and undamaged rock surfaces.

3.1.15 Storage and Handling of Explosives

The Contractor shall provide a special store for explosives in accordance with Kenyan Regulations. The Contractor shall provide experienced men with valid Kenyan blasting licenses for handling explosives to the satisfaction of the Engineer and the Authorities concerned.

3.1.16 Backfill and Fill

Backfill shall mean the material required to refill excavations outside the Permanent Work up to the ground levels prevailing at the commencement of the Works, or to the levels shown on the Drawings, or ordered by the Engineer with due allowance for settlement. This applies to all provided structures, manholes, chambers etc.

Fill shall mean the material required above the ground levels prevailing at the commencement of the Works to make the embankments comprised in the Works, with due allowance for settlement.
Unless otherwise specified the material used for fill and backfill shall be selected excavated material to the approval of the Engineer.
The selected excavated materials for backfill against the Permanent Work are specified as materials free from boulders, cobbles, rock fragments and the like greater than 50 mm nominal size.
Fill material shall be free of organic, soluble or other deleterious materials.
Should the material selected as backfill become unacceptable to the Engineer for any reason including exposure to weather conditions, contamination and segregation during the progress of the Works, the Contractor shall remove such damaged, softened or segregated material and replace it by fresh approved material at his own expense.
After approval by the Engineer for filling or backfilling to commence, the operation shall start with the minimum delay and shall continue until the work is completed in that part of the Works for which the approval is given.

3.1.17 Compaction of Backfill and Fill to Structures

For compaction where the degree of compaction of the backfill or fill is specified, the Contractor shall always use mechanical equipment and shall adopt such methods and use such Constructional Plant as is necessary, and always will use mechanical equipment, to achieve the degree of compaction specified.
At least one month before commencing such compaction of the fill in the Works, the Contractor shall submit to the Engineer details of the method and Constructional Plant proposed to be used.
The Engineer will make such tests of the materials before and after compaction, as he considers necessary to ascertain to his satisfaction that the degree of compaction specified is attained.
The Contractor shall exercise careful control of the moisture content of the backfill or fill material prior to and during compaction, such that it lies within the range of values specified.
The degree of compaction of fill and backfill, unless otherwise specified, shall be at least 95% of maximum dry density .

3.1.18 Finish of Earthworks

Except where otherwise specified or ordered by the Engineer, the tops and side slopes of fill shall be neatly trimmed equal to the best practicable finish which in the opinion of the Engineer can be obtained by the skilled use of the earth moving equipment used in the placing and, where specified, compacting of fill.

Where precise lines and levels of embankments are not specified or ordered by the Engineer, the Contractor shall construct embankments in straight lines between smooth curves to give a pleasing appearance.

3.1.19 Granular Material for Drainage

In case granular material is used as backfill, this shall be obtained from sources approved by the Engineer. The material shall be such that it lies within the following grading limits:

Particle Size	Fine Limit (% Finer)	Coarse Limit (% Finer)
50 mm	100	100
20 mm	100	80
6.3 mm	95	50
2.0 mm	70	25
600 µm	45	5
212 µm	20	0

Excavation of granular material may be carried out underwater, but the Contractor must ensure that the water content of the material so procured is satisfactory for the conditions in which the material is to be used.

3.2 Preparations of Foundations and Abutments in Rock

Where a structure is to be placed against rock foundations the rock shall be excavated to the lines and dimensions indicated on the Drawings. The rock shall be so shaped as to form a smooth and regular surface to the satisfaction of the Engineer so that the structure can be properly founded against it. In case explosives are used for the excavation, any loose or damaged rock fragments shall be removed by bar, pick or jack hammer to leave a smooth surface as specified to the satisfaction of the Engineer. All cavities, fissures, and areas where a smooth surface cannot be achieved shall be treated with concrete as directed by the Engineer. In any stage of the excavation, stagnant water should be pumped, or any other measures should be taken in order to ensure adequate drainage.

All obvious cracks in the rock shall be cleaned out and a cement slurry in the proportions of 1 part cement to 2 parts water shall be spread over the contact zone and in the cracks.

Where granular material is to be placed against rock the Contractor shall ensure that all weathered and loose rock fragments are removed. Sharp promontories and overhangs which might affect the settlement of the works are to be removed by jack hammers to the satisfaction of the Engineer.

3.3 Coarse Granular Material for Drainage

The drainage layers will consist of coarse granular materials from selected excavation material or borrow areas or crushed quarry material and may need processing by screening, sieving, washing and/or crushing to achieve the required gradation for the individual layer requirements. Such processing will be performed by the Contractor, to the satisfaction of the Engineer. The required gradation should conform to the following or equivalent ranges as may be approved by the Engineer:

Sieve Opening (ASTM) (mm)	Percent Passing (%)
50 mm	100
25.4 mm	80-100
9.5 mm	50-85
No. 4 (4.76 mm)	28-63
No. 10 (2.00 mm)	0-35

The required gradation shall be tested in the laboratory every 100m^3 of placed coarse granular material.

Materials suitable for the drainage layer (sand size) should have loss during the Los Angeles abrasion test not higher than 85%. All drain materials should have less than 20% loss in the Soundness test (ASTM C88).

3.3.1 Drainage Layer Sand without Fines

A single pure sand zone without fines will be used for the construction of the 0.4 m thick horizontal filter-drainage zone. Filter-drain materials will consist of granular materials (fine sand to fine gravel) from the sand-gravel borrow areas or from processed colluvium or from crushed quarry material with the range of gradations, which means:

Dmin = 0.1 mm, D15 = 0.13 – 1.5 mm, D50 = 0.35 – 5 mm, D85 = 1.5 – 15 mm. The material will not contain any fines.

The required gradation of the single zone filter-drain layer conforms to the Filter gradation criteria required by the US Bureau of Reclamation (1994) and the US Army Corps of Engineers.

Materials obtained from the borrow areas may need processing by screening, sieving, washing and/or crushing to achieve the required gradation for the individual layer requirements. Such processing will be performed by the Contractor, to the satisfaction of the Engineer.

Materials suitable for the drainage layer (sand size) should have loss during the Los Angeles abrasion test not higher than 85%. All drain materials should have less than 20% loss in the Soundness test (ASTM C88).

The drainage layer will be placed in a single 0.40m thick horizontal layer and will be lightly compacted by two passes of a 10 tons smooth drum roller without vibration. The objective is to avoid over compaction of the layers.

Where drainage layer is placed on slopes with inclinations up to 1 vertical to 4 horizontal, it may be placed in inclined layers not exceeding 0.30m in thickness after compaction, subject to the approval of the Engineer. During or immediately prior to compaction, the material shall be thoroughly wetted. The outer slopes of each layer shall be true to the lines and grades shown on the Drawings. Placement of filter or drain on slopes steeper than 1:4 will not be permitted to avoid material segregation during placement.

In order to avoid contamination of the drains, these materials will be always placed in advance of the embankment material (i.e., at a higher elevation by about 40cm, compared to the adjacent zones). In this way the surface of drains will be one layer above the adjacent embankment surface.

It is of utmost importance to ensure that the drainage layer is not contaminated by other fill materials, and the Contractor shall ensure that constructional traffic does not cross such sections of the embankment or otherwise contaminate the drainage material. If, in the Engineer's opinion, contamination does take place, the contaminated material shall be removed from the Works.

3.4 Earthfill Compaction Control

Earthfill shall be compacted in such a manner that the average percentage compaction of the fill at any time defined as the ratio Field Dry Density over Laboratory Maximum Dry Density, shall be not less than 95% unless otherwise specified,

where:

Field Dry Density equals the average of results of all tests to determine field dry density to date, for each material type, and

Laboratory Maximum Dry Density equals the average of results of all laboratory Dry Density tests to determine Proctor Maximum dry density to date, for each material type.

Results of field dry density tests shall be examined in consecutive batches of 10 results, which shall conform to the following requirements:

(i) The average of the Field Dry Density for each batch shall be not less than 95% of the Laboratory Maximum Dry Density.

(ii) No more than 10% of the results in each batch shall show a compaction of less than 90% Laboratory Maximum Dry Density and no result shall be less than 85% Laboratory Maximum Dry Density.

(iii) The standard deviation of the results in each batch shall be not greater than 3%.

Separate compaction records shall be kept for materials of different properties.

In the event that the Engineer has required Proctor compaction tests to be carried out adjacent to the field density tests and at the same frequency, the percentage compaction shall be defined for each individual sample. Compaction results obtained in this way shall be examined as described above.

Material which has been compacted to a dry density less than that required by this Specification or at water content outside the agreed range shall be removed or re-worked and re-compacted until the required properties are achieved. In this case the field dry densities recorded before removal or re-compaction of the material shall be omitted from the calculations of mean percentage compaction and standard deviation.

Compaction criteria may be varied along the foundation core interface at the discretion of the Engineer or his Representative.

3.5 Backfill Adjacent to Completed Structures

The layers of backfill material shall be placed in such a manner as to maintain adequate drainage and to prevent accumulation of water. The material shall be placed with particular care for insulation and watertight paints and all other protective or conserving surfaces and as to exert a uniform pressure around the walls of a structure and each layer shall be placed with fall to prevent the accumulation of water.

Special attention shall be paid to the compaction of material laid immediately adjacent to concrete walls as to ensure that the material is well compacted. Hand operated vibrating plate compactors; vibro-tampers or power rammers shall be used. The compacting shall be carried out in such a way as to avoid in any case direct contact of the compacting machinery and the building.

3.6 Embedding of Pipes

Embedding of pipes shall be carried out in accordance with EN 1610.

Unless otherwise directed by the Engineer the following will apply:

> Ductile Iron pipes shall be laid on a 150 mm compacted bed of sand or approved excavated material and shall be embedded by sand or approved excavated material to a level of 300 mm above the top of the pipes. Embedding material shall be placed by hand and compacted in layers of not more than 100 mm compacted thickness. The material shall be compacted to at least 95 % proctor density according to ASTM 698 below and around the pipes as to provide firm and continuous support.

The Contractor shall ensure that the pipe is not displaced or damaged by the embedding operation.

Approval of Embedding

The Contractor shall take all precautions to fix the pipes in their location. This includes the bedding of pipes and partial refilling of trenches leaving the joints exposed while awaiting pressure tests.
Formal approval of embedding shall be obtained from the Engineer prior to the testing of pipes.

3.7 Main Backfill of Trenches

Backfilling of trenches shall be carried out in accordance with EN 1610.
From the top of the bedding layer up to the finished ground level, the trench shall be backfilled with approved selected material, compacted by mechanical methods approved by the Engineer in layers with a thickness of not more than 150 mm.
Each layer shall be compacted separately. Compaction shall be not less than 95 % proctor density according to ASTM 698. Where necessary, the Contractor shall adjust the moisture content of the refill material to assist the compaction either by drying out or by sprinkling with water.
The Contractor shall provide adequate number of power tampers or other compaction equipment subject to the approval of the Engineer and sufficient water on Site for moistening.
The Contractor shall, when placing the backfill, make due allowance for any settlement that may occur before the end of Defects Liability Period. Where necessary, the Contractor shall at the end of this period remove any excess material or make up any deficiency of backfilling to specified levels.
In the event that excavated material is insufficient or unsuitable for backfilling, the Contractor shall use imported fill material from approved borrow pits.
Where directed by the Engineer, trench excavations shall be backfilled with concrete, class C 8/10. Likewise, the Contractor shall use cement stabilised backfill where shown on the Drawings or as directed by the Engineer.

3.8 Disposal of Surplus Material

The disposal of surplus backfill material shall be deemed to be included in the rates for the respective backfilling operations.
The Contractor shall make his own arrangements to dispose off of all surplus backfill and unsuitable excavated material from any part of the Work. The material shall become the property of the Contractor and shall be disposed Off-Site under his sole responsibility.
The Contractor shall clean the Site and the surrounding ground immediately after completion of works and leave the construction Sites clean and tidy to the satisfaction of the Engineer.

3.9 Backfilling Sundries

3.9.1 Backfilling under existing Paved Areas

When excavation is made in roads, sidewalks or any other paved area, the trench shall be backfilled and thoroughly compacted up to the bottom of the sub base of the surrounding pavement.
The remaining top of the trench shall be filled with graded and well compacted aggregate up to the top of the base of the pavement.
The further reinstatement of surfaces shall comply with the existing pavements.

3.9.2 Backfilling around Manholes

Backfilling around manholes and material used for it shall meet the specifications set out for the backfilling of adjacent trenches.
In roads with a width over 3 m, the material around manholes shall be selected and compacted to meet the requirements of base and sub base.

3.9.3 Backfilling in Watercourses

In riverbeds the pipes shall be fully encased with reinforced concrete and the top of the excavation shall be covered with gabions, laid by hand and extending 1m on either side of the excavated trench; likewise in ditches clad with masonry, the masonry shall be reinstated after completion of backfill with concrete and in small ditched without any surface cladding the trench shall be backfilled to the invert of the ditch with concrete. Concrete shall be reinforced with 80kg/m3 steel. Concrete shall be of class C20/25.

3.9.4 Field Drains

Should any existing subsoil or field drains be uncovered during general excavation, the Contractor shall either carefully replace them when backfilling, or, if this is impracticable, shall divert them to new drains or ditches, or otherwise relay them as the Engineer may direct.

3.10 Embankments

3.10.1 Embankments in General

The term “embankment“ includes the construction of embankments around structures, hard or other backfill, embankments for road works and the like.
Backfilling to general excavations, the forming of soil tips and the re-filling of trenches are specified and included in the clauses dealing with backfill.

3.10.2 Materials for Embankments and their Compaction

Excavated material (including material from borrow pits) to be used as fill material for embankments shall be free from clods and lumps and shall be approved by the Engineer.
If not otherwise directed, cohesive soil shall be placed in layers not exceeding 200 mm in compacted thickness; cohesionless soil shall be placed in layers not exceeding 300 mm in compacted thickness.
Unless otherwise specified by the Engineer, the degree of compaction of embankments shall be at least 95% of maximum dry density .
Material for hard filling shall be as specified below.
Should the material being placed as filling, while acceptable at the time of selection, become unacceptable to the Engineer due to exposure to weather conditions or due to flooding or become puddled soft or segregated during the progress of the works, the Contractor shall at his own expense remove such damaged, softened or segregated material and replace it with fresh approved material.

3.10.3 Filling with Hardcore

All fill under structures, unless indicated otherwise on approved Drawings or instructed by the Engineer, shall be constructed with hardcore obtained from sources approved by the Engineer.
Hardcore shall be hard inert material passing a 75 mm sieve and be free from clay, silt, soil and vegetable matter and shall not deteriorate in the presence of water.
Hardcore shall be placed in layers not exceeding 150 mm thickness after consolidation and each layer shall be compacted by mechanical means. The final surface of hardcore shall be blinded with fine crushed stone and thoroughly compacted.

3.11 Reinstatement and Maintenance

3.11.1 Reinstatement of Paved Surfaces

The Contractor shall restore all pavements or other surface structures removed or disturbed as a part of the work to a condition suitable and satisfactory to the Engineer.

No pavement shall be restored unless and until, in the opinion of the Engineer, the condition for backfill is given in such a way as to properly support the pavement.
The reinstatement of road surfaces and other pavements shall be commenced upon approval of the Engineer of the completed backfill and shall be done, if not otherwise stated, as follows:

(i) The top of the pipe trench (below the top of the base) shall be filled with graded aggregate (0 – 60 mm of natural stabilized material), watered, placed

in layers of max.15 cm thickness and compacted to not less than 95% of maximum dry density according to modified proctor test.

(ii) At pipeline crossings, the top 30 cm of the trench shall be filled with plane concrete C12 / 15.

(iii) At the top of the base, the width of the trench shall be increased for 15 cm on each side. In order to ensure appropriate adjustment of the surfaces the Contractor shall use such methods as shall ensure the breaking of the pavement along straight lines, preferably by cutting. The face of the remaining pavement shall be approximately vertical.

(iv) The surface shall be restored in accordance with the existing pavement and/or the direction of the Engineer.

3.11.2 Reinstatement of Unpaved Surfaces

Gravel roads and unpaved roads shall be reinstated to their original condition. If the original road construction cannot clearly be applied, then 100 mm approved large gravel and 150 mm well-graded gravel compacted to 95% of maximum density shall be provided.

3.11.3 Reinstatement of Existing Services

Where excavation is carried out close to or across the line of sewers, pipes, cables or other services, whether underground or overhead, the Contractor shall, where necessary, provide at his own cost temporary supports or slings and where such services are temporarily disturbed, they shall be replaced.

3.11.4 Reinstatement of Hedges, Fences and Walls

Where excavation disturbs features such as hedges, fences and walls, the Contractor shall, as a temporary measure, provide temporary fencing for any such parts of such barriers.

After excavation has been reinstated, the Contractor shall carry out such work as approved by the Engineer for permanent restoration of such barriers.

In case of hedges, saplings of the appropriate species and on both sides shall replace the section removed by providing an adequate post and barbed wire fence.

During the period of maintenance all hedges replanted in the above manner shall be inspected and any dead sapling replaced by the Contractor.

The reinstatement of the backfilled surface shall be done at the Contractor’s own expense and include (1) the re-excavation of the top surface, base and sub base, (2) compacting the backfill in the trench, (3) backfilling the base and sub base with graded aggregate and (4) reinstatement of the surface according to surface conditions met before.

3.12 Auxiliary Works

Unless otherwise specified, all and any kind of works, materials, services, safety measures, etc., as well as, and if so requested by the Engineer, all tests and samples required for the Completion of the Works shall be included in items and prices figuring in the Bill of Specifications and in the Price Schedules. Hence, the auxiliary works comprise, but are not necessarily limited to, the following:

(i) Removing and storing of boundary stones, bench marks, etc., protection of surveying points and designation by means of boards, survey and protection of all secondary survey points, profiles, etc.;
(ii) Difficulties to be overcome where excavation may have to be carried out in layers of by hand;
(iii) Keeping off or diversion of water, any pumping, required, difficult work caused by water, etc.;
(iv) Removal of any groins, buried pipes, wattlework, fascines and the like that might interfere with excavation profiles, irrespective of whether or not such structures are specified in the Price Schedules;
(v) Difficulties resulting from the specifications relating to fills, compaction tests, eliminating unsuitable material from fills, and, if necessary, mixing of different soil materials;
(vi) Transport of excavated material to fill or deposit, placing and spreading in layers according to conditions and Drawings, and careful compaction;
(vii) Difficulties in transport due to existing subsoil conditions;
(viii) Grading of intermediate and top fill surfaces and slopes to lines and levels required;
(ix) Sorting of excavated material which, if necessary, is to be used for special purposes;
(x) Any expenditure for providing, maintaining and later removal of drive ways and roads, providing, placing, maintaining and later removal of conveying and dumping equipment that might be required.

3.13 Topsoil

So far as practicable, topsoil shall be obtained from material emanating from excavations and separately stored in temporary spoil tips as specified or directed by the Engineer.

If, in the opinion of the Engineer, the Contractor cannot reasonably obtain sufficient topsoil in this way, the Engineer may order the Contractor to provide extra material from an approved source off the Site.

Topsoil shall be evenly spread and trimmed over embankments and filled excavation to the slopes and levels as shown on approved Drawings. The depth after spreading and trimming shall be 250 mm measured perpendicular to the surface. All clods and

lumps shall be broken up and any rubbish, large stones, roots and weeds shall be removed.

Where the upper layer of natural soil is poor in organic matter, it shall be improved to a minimum depth of 25 cm by adding either clay or sand or silt to create a loamy soil texture consisting of 40% sand (size > 0.05 mm), 30% silt (size 0.05- 0.002 mm) and 30% clay (size < 0.002 mm).

A shallow ripping shall be required before adding clay or sand or silt which shall be mixed properly by using a disk harrow. If it shall be necessary for topographical reasons, levelling shall be carried out before mixing clay, sand or silt.

3.14 Construction Tolerances

Unless otherwise approved, the lines and levels of completed earthworks surfaces shall not vary from the design lines and levels specified in the Drawings, or directed by the Engineer, by more than the values specified below. Measurement shall, however, be to theoretical levels and lines.

Vertical tolerances in mm.

I. Soil excavation: +0, -200
II. Evenness of excavated permanent slope surface: 200 mm measured along 5.0 m straight edge
III. Embankments (compared to any given camber):
    1. Impervious material and filter zones: -0 /+ 50
    2. All other zones – 0 / + 100
IV. Sub-grade: ± 30

Horizontal tolerances for the given width of material zones and construction lines on the Drawings shall be – 0, + 200 mm.

Chapter 4: CONCRETE

4.1 General

According to this Technical Specification, the Contractor will provide materials, equipment, and labor for all the activities related to the concreting works.

4.2 Organisation of Concrete Production

At the commencement of the Contract, the Contractor shall submit for approval of the Engineer a method statement detailing his proposal for the organisation of concreting activities at the Site. The concrete production plant shall preferably be placed at the Site.

The method statement shall include:

- Plant proposed and layout of the production facility;
- Proposed method of organisation of the production facility;
- Quality control procedures for concrete and concrete production;
- Method of transport including heat protection and placing of concrete;
- Striking times for formwork and procedure for temporary support of beams and slabs;
- Curing of concrete and ways to assure an optimum curing.

4.3 Cement

The cement must conform to Kenya Cement Standard KEBS/TC077 or to the Norm EN197-1:2000 “Cement: Composition, specifications and conformity criteria for common cements” (Type CEM I, CEM II/A-M, CEM II/A-L and CEM II/A-P). Unless it is specified otherwise in the contract, the cement must have minimum typical strength at 28 days 42.5 MPa and must be type N. The Contractor must submit to the Engineer the type of cement that will be used.

The Contractor must take all necessary measures to protect the cement from exposure to humidity. The Engineer reserves the right to demand the removal from the site of cement that has been influenced by humidity.

The Engineer reserves the right to demand at any time from the Contractor to carry out laboratory test to verify whether the quality of the cement delivered on the Site is according to the specifications. Whatever quantity of cement is not according to the specifications will not be used and will be removed from the site.

4.4 Storage of Cement

Immediately upon arrival on Site, the cement shall be stored in silos or in dry, weather tight and properly ventilated structures with adequate provisions to prevent absorption of moisture.

All storage facilities shall be subject to the approval by the Engineer and shall be such as to permit easy access for inspection and identification.
Each consignment of cement shall be kept separately and the Contractor shall use the consignments in the order in which they are received.

4.5 Aggregates

The sand and gravel must conform to the Kenya Concrete Standard KEBS/TC078 or to the Norm EN12620:2002 “Aggregates for Concrete”, and the requirements listed in the following Table must be respected.

EN12620:2002: Aggregates for Concrete				
Paragraph Norm	Characteristic	PRESCRIBED LIMIT		
		Coarse Aggregates	All-in Aggregates	Fine Aggregates
4.4	Particle shape	Maximum allowable Class F120	Maximum Allowable class F120. It refers to coarse part	
4.2	Particle size	The ratio d/D of the product is declared	The ratio d/D of the product is declared	The ratio d/D of the product is declared
5.5	Particle density	The value shall not be smaller than 2,00Mg/m³ as dry density	The value shall not be smaller than 2,00Mg/m³ as dry density	The value shall not be smaller than 2,00Mg/m³ as dry density
4.6	Fines content	Maximum allowable class F1.5	Maximum allowable class F3	Maximum Allowable class F10. For natural sand produced from natural gravel maximum allowable class F3.
5.2	Resistance to fragmentation	Maximum Allowable class LA30	Maximum Allowable class LA30. It refers to the coarse part	
5.4.1	Resistance to polishing	The PSV class is declared for the concrete used as pavement for vehicles	The PSV class is declared for the concrete used as pavement for vehicles. It refers to the coarse part. (I)	

EN12620:2002: Aggregates for Concrete				
Paragraph Norm	Characteristic	PRESCRIBED LIMIT		
		Coarse Aggregates	All-in Aggregates	Fine Aggregates
5.4.2	Resistance to abrasion	The AAV class is declared for the concrete used as pavement for vehicles	The AAV class is declared for concrete used as pavement for vehicles. It refers to the coarse (I)	
6.2	Chlorides	It is declared for aggregates used for reinforced concrete. The allowable content must not exceed 0.1%	It is declared for aggregates used for reinforced concrete. The allowable content must not exceed 0.1%	It is declared for aggregates used for reinforced concrete. The allowable content must not exceed 0.1%
6.3.1	Acid sulfates	Maximum Allowable class ASO.8	Maximum Allowable class ASO.8	Maximum allowable class ASO.8
6.3.2	Total sulfur	The value must not exceed 1%	The value must not exceed 1%	The value must not exceed 1%
5.5	Water absorption	The value must not exceed 4%	The value must not exceed 4%	The value must not exceed 4%
5.7.1	Durability against freeze-thaw	Maximum allowable category MS18	Maximum allowable category MS18	Maximum allowable category MS18
5.7.3	Durability against alkali silica reactivity	Specified for aggregates produced from natural gravels	Specified for aggregates produced from natural gravels	Specified for aggregates produced from natural gravels

Note: (I) Coarse is the size greater than 4 mm

Sand and gravel will be kept in different stockpiles and in generally their mixture must be avoided. The stocks of both sand and gravel must be placed on inclined bases of lean concrete or of another surface approved by the Engineer so as to avoid contamination by soil and facilitate the drainage of the stockpiles. Aggregates that have been placed direct on soil will not be used in concrete mixes.

The Engineer reserves the right to demand at any time from the Contractor to carry out laboratory test to verify whether the quality of the aggregates comply with the Norm EN 12620:2002.

The Engineer reserves the right to demand from the Contractor not to use aggregates that are not of his approval and to have them removed from the Site.

4.6 Storage of Aggregates

The Contractor shall provide storage facilities for aggregates:

- Each normal size of coarse and fine aggregates shall be kept separate at all times
- Contamination of aggregates by the ground or other foreign matter shall be always prevented effectively
- Each heap of aggregate shall be capable of draining freely
- Aggregates are kept as cool as possible by shading and provision of water sprinkling if required.

The Contractor shall ensure that graded coarse aggregate is not segregated during tipping, storing and removal from storage.

Fine aggregate shall not be used unless, in the opinion of the Engineer, it is conditioned to acceptable and uniform moisture content. If necessary, to meet this requirement, the Contractor shall protect the heaps against weather and condition fine aggregate in accordance with requirements.

4.7 Water

The water used for the concrete mixing must be from clean water supply. Non potable water may be used if it complies with EN1008:2002 “Mixing Water for Concrete. Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry as mixing water for concrete” or it is approved by the Engineer.

If not otherwise directed or approved, the water for concrete mixing shall be drawn from the public supply at the Contractor’s expense.

The water shall enter the mixer at the lowest possible temperature and shall not exceed 30°C.

During the execution of works the Contractor shall ensure that sufficient quantities of water for production and curing of concrete are available on Site at all times.

4.8 Additives – Admixtures

The concrete will be composed of cement, aggregates, and water as it is specified. No other substance will be mixed in the concrete or the mortar without the approval of the Engineer. The use of chlorides is prohibited.

The contractor may examine the use of natural pozzolans for the partial replacement of cement in the mix or alternatively the use of admixtures with hydraulic properties that will contain pozzolans and that in cases only of massive concretes.

These materials must conform to standards ASTM C618-73 “Standard Specification for coal fly ash and raw or calcined natural pozzolan for use in concrete” and ASTM C595-75 “Standard Specification for blended hydraulic cements”, respectively, and will be tested in combination with the cement and/or the aggregates used on site so as to

prove their beneficial properties to the satisfaction of the Engineer before the contractor may gain approval for their use.

If the Engineer approves the use of additives, such as retarders or plasticizers that comply with standards EN 480:2006 “Admixtures for concrete, mortar and grout. Test Methods” and EN 934:2001 “Admixtures for concrete mortar and grout. Concrete admixtures. Definitions, requirements, conformity, marking and labeling”, their use will be subject to the following rules:

(i) The average strength of the tested specimen shall not be lower than the average strength of the tested specimen without the use of additives.

(ii) The quantity of the cement shall not be reduced below the minimum limit described for the specific concrete category.

(iii) International approved tests will be carried out to determine the time of solidification, the workability and the strength of the concrete mixes that contain additives.

(iv) The amount of additives added as well as the mixing time must follow the instructions of the manufacturer of the products, adjusted to the existing conditions on site.

4.9 Concrete Quality

The concrete’s designed compressive strength and the size of aggregates used must comply with what is written on the Drawings and the specifications.

The following concrete classes will be used: C10, C15, C20, C25, C30, C35 and C40. The above-mentioned concrete classes must satisfy the requirements presented in the following table.

Concrete class	C10	C15	C20	C25	C30	C37	C40
Maximum Aggregate Size (mm)	20	20	20	20	20	20	20
Minimum Cement Quantity (kg/m^3)	200	220	250	280	310	330	360
Slump (mm)	120	120	120	120	120	120	120
Maximum Water/Cement Ratio	0.65	0.60	0.55	0.55	0.55	0.50	0.50
Specified Strength of 150 mm cube specimens							
Tested at 7 days (N/sq.mm)	6.5	10.0	13.5	16.5	20.0	27.0	28
Specified Strength of 150 mm cube specimens							
Tested at 28 days (N/sq.mm)	10	15	20	25	30	37	40

NOTE: The maximum cement content in any mix shall not exceed 500 kg/m³ for normal structures and 425 kg/m³ for liquid retaining structures.

4.10 No-Fines Concrete

No-fines concrete shall be made with the aggregate/cement ratio from 6:1 to 10:1. Aggregates used shall be 20 mm single size. The water / cement ratio shall vary between 0.38 and 0.52. Strength shall be between 5 and 15 N/mm^2 at 28 days.

4.11 Mix Design

For concrete mixes with specified strength equal or greater than 20 N/ mm^2, the Contractor must submit a design mix report.

After the approval of the submitted design mix report, with the weight percentage of cement, water, sand and gravel clearly stated, the contractor shall perform 1÷3 trial mixes with the presence of the Engineer and following any orders the Engineer issues. From every trial mix two (2) to six (6) cube test samples (according to the Engineer's instructions) will be taken to be tested for their compressive strength. ¼ of the taken cube test samples will be tested at 7 days for their strength and the rest samples at 28 days. The strength of each cube test sample tested at 28 days must be considerably higher than the specified strength. In the case that there are no previous data the average strength of the tested samples must be 3 N/mm² greater than the specified strength.

As soon as the Engineer approves the design mix and is satisfied by the trial mixes and the tests carried out then the contractor is prohibited from changing the source and quality of the supplied materials and the mix proportions without prior approval of the Engineer. If for any reason any of the above-mentioned parameters are altered, then the contractor is obliged to submit a new design mix for approval.

4.12 Predetermined Concrete Mixes

For concrete strength requirements of 15 N/mm^2 or lower strength ready-made mixes described in the Table below can be used. The weight proportion per material indicated for the ready-made mixes can be used for the first mix and according to the results from the tests against compression they could be changed if required so.

Predetermined Mixes

Quality or Concrete Class	Maximum Aggregate Size (mm)*	40			20		
	Fluidity*	Low	Medium	High	Low	Medium	High
	Slump (mm)	0-30	30-60	60-180	0-30	30-60	60-180
C5 (W/C=0.7)	Minimum Cement Weight (kg)	-	180	200	200	210	230
	Minimum Aggregates Weight (kg)	-	1995	1940	1995	1920	1800

	Fine Coarse Aggregates (Sand) (%)	-	25-50	25-50	35-55	35-55	35-55
C10 (W/C=0.65)	Minimum Cement Weight (Kg)	-	210	230	220	240	260
	Minimum Aggregates Weight (kg)	-	1965	1925	1975	1890	1835
	Fine Coarse Aggregates (Sand) (%)	-	25-50	25-50	35-55	35-55	35-55
C15 (W/C=0.65)	Minimum Cement Weight (Kg)	235	270	290	255	300	320
	Minimum Aggregates Weight (kg)	1995	1900	1850	1940	1820	1775
	Fine Coarse Aggregates (Sand) (%)	25-50	25-50	25-50	35-55	35-55	35-55

* Specified by the Engineer

4.13 Concrete Testing

The verification of the concrete compressive strength shall be based on the crushing of 150mm cube test samples. The maximum cement content in any mix shall not exceed 500 kg/m^3 for normal structures and 425 kg/m^3 for liquid retaining structures. The Contractor must have on site a cone so as to perform slump tests and a necessary number of cube molds so as to be able to fulfill the sequence of tests listed below:

a) 1-3 cube test samples from each mix if the volume of concrete is of the order of 4-6 m^3
b) 1-2 cube test samples every 4 mixes if the volume of the concrete is of the order of 0.5 m^3
c) 1-2 cube test samples every 10 mixes if the volume of the concrete is smaller than 0.5 m^3

The Engineer may alter the sampling sequence according to the quality of concrete and the type of works it is going to be used. All test samples must be numbered.

A small number of test samples will be tested at 7 days (approximately ¼ of the total number of samples) and the rest at 28 days. The results from the specimens tested at 7 days will be treated as indicative.

The concrete will comply with the specifications when both of the following criteria are satisfied:

a) The average strength of the cube test samples of 4 consecutive tests* crushed at 28 days must be greater than 3 N/sq.mm for concrete categories C20 and greater than 2 N/sq.mm for categories lower than C20.
b) The strength of any test sample crushed at 28 days must not be smaller than 3 N/sq.mm for concrete categories C20 and smaller than 2 N/sq.mm for categories lower than C20.

*Every crushing of a cube specimen is considered as a test.

The Engineer may demand the testing of cylindrical test samples from the laboratory for more appropriate results. The tests of the cylindrical samples will be executed in accordance with EN 12350:2000 “Testing fresh concrete”, EN 12390:2000 “Testing hardened concrete”, EN 12504:2000 “Testing concrete in structures” and EN 13791:2007 “Assessment of in situ concrete compressive strength in structures or in precast concrete components”.
In the case where the strength criteria set by the specifications are not met, the Engineer retains the right to demand the demolition of the structures. The Contractor is responsible for the cost and the delays caused. The Contractor must take all necessary additional remedial measures for improving the concrete’s strength following the Engineer’s Orders before new concreting takes place.
The Contractor is obliged to keep full records regarding the concrete’s category, the concreting date and location and all relative data and results for the cube and cylindrical test samples. The records must be at the disposal of the Engineer at any time.
The equipment used for the concrete mixing must be appropriate and in good condition. The Engineer retains the right to prohibit the concrete mixing and demand the removal or substitution of inappropriate equipment.
The sampling, transportation, storage, protection and testing of the cube test samples will be executed according to Standards EN 12350, 12390, 12504 and 13791. The concrete’s workability will also be checked according to these standards.

4.14 Concreting Records

The contractor is obliged to keep records regarding the concreting works. The specific record must be submitted every day to the Engineer for approval. The Engineer must note on the record the observations made on site and comments regarding the contractor’s schedule. The record must include notes and data for the following:
(a) The names of the supervising engineers and their assistances assigned by the Contractor that will be involved during the specific concreting works.
(b) A description of the weather conditions, the temperature, and the humidity. A list with the temperature of the water, the cement, the aggregates, and the concrete itself must also be included.

(c) The invoices of the materials for the concrete mix delivered on site. (Quantities of materials, Cement brand name, etc.).
(d) Any specific instructions issued by the Engineer.
(e) The supervision by the Engineer.
(f) The time of starting and finishing the concreting works, mentioning also segments of implementation. The time of erection and removal of the formworks.
(g) The quantities of the cement, admixtures, fine and coarse aggregates and any additives used in every concreting work. The number of quality tests executed in the above-mentioned materials and the water used.

4.15 Transportation

The transportation from the batching plant to the site may be done with delivery concrete truck carriers (rolled mixer) or any other appropriate means indicated by the Engineer.
Concrete shall be transported from the mixer to its place in the works as rapidly as possible by methods, which shall prevent segregation or drying out and ensure concrete of the required workability at the time of placing:

(i) Concrete shall not be placed when unsuitable wind and temperature conditions prevent proper placement and curing as determined by the Engineer.
(ii) Concrete shall be placed by hoppers and chutes and, if necessary, by vertical ducts;
(iii) The free fall of concrete after chutes and ducts shall in no case exceed 1.5 m;
(iv) Concrete shall not be dropped through any reinforcement or into any deep form in order to avoid segregation
(v) Concrete shall be placed and compacted before the initial set has occurred and, in any event, not later than 30 minutes from the time of mixing. In case where retarding additives are used as specified in Paragraph 4.4 then the transportation time will be adjusted according to the instructions of the Engineer. During concrete casting, the concrete must have the predefined slump.

The concrete shall be placed in the presence of the Engineer, unless agreed otherwise. The Contractor shall notify the Engineer by writing 24 h prior to the placing of any concrete.
The order of placing in all parts of the work shall be subject to the approval of the Engineer.
In order to minimise the shrinkage, the concrete shall be placed in units as bounded by construction joints. The placing of the units shall be done in such a way, that each unit shall have cured for at least 7 days before the continuous units are placed, with

the exception of walls which shall be placed not before the wall footings or adjacent wall panels have cured for at least 14 days.
Whenever a run of concrete is stopped or completed, the surface of the concrete shall be levelled with a trowel and all laitance shall be removed.
Concrete, which is, before placing, found not to be conform to the requirements shall be rejected and immediately removed from the Site. Concrete not placed in accordance with the above requirements or found to be of inferior quality with respect to the working Drawings shall be removed and replaced by and at the expense of the Contractor.

Concrete placing shall not be permitted if, in the opinion of the Engineer, the Contractor does not have proper facilities available on Site for placing, curing and finishing the concrete in accordance with these specifications.

4.16 Concrete Casting

The Engineer must be present during concrete casting. Formwork and reinforcement must have been checked and approved according to Drawings. In no case should the concrete be left to fall free from a height exceeding 1.5 m. In no case should the concrete be placed in stagnant or running water unless it is approved by the Engineer. The concrete must be compacted by mechanical vibrators. The vibrators must be embedded well in the concrete mass and in appropriate distances that ensure adequate concrete compaction without voids. The vibrators must be slowly drawn out from the poured concrete after their embedment so as to avoid air voids.
If the concrete is poured in the formwork with the use of a pump this should be taken into account in the concrete mix design. The concrete may be richer in fine aggregates and contain admixtures of the approval of the Engineer. The concrete must have a relative high slump (7-12 cm).

4.17 Construction Joints

The concrete casting must be continuous till the completion of the scheduled works or till a pre-specified construction joint according to Drawings. In case the concreting is stopped before a pre-specified construction joint the Engineer must be notified immediately for his approval and instructions. Before new casting takes place, the hardened surface must be washed with water. Compressed air must be used to remove the previously applied water. The newly poured concrete must be placed near the hardened surface and vibrated adequately.

4.18 Concrete Curing after Casting

The concrete must be treated immediately after pouring so that it is protected from the harmful effects of sun, drying winds, rains, running or surface water and against any shocks. The concrete protection may be done with one of the following measures:

i) Covering the concrete surface with a saturated membrane. The membrane must be kept saturated for at least 7 days.
ii) Covering the concrete surface with wet sand. The sand must be kept wet for at least 7 days.
iii) Using different chemicals for concrete curing that have previously been approved by the Engineer.

The formwork shall also be kept damp and if struck earlier than seven (7) days, shall be replaced for the remaining period with some other approved damp material:

i) Keeping wooden formwork wet until it is removed;
ii) Covering the concrete surface with burlap mats and keeping them wet;
iii) Covering the surface with moist soil/sand (not before 4 h and not longer than 24 hours after concreting);
iv) Spraying the surface with water or a liquid curing compound.

No traffic or constructional loads shall be permitted on newly placed concrete until it has hardened sufficiently to take such traffic or load without surface damage or deformation.
If directed by the Engineer, the finished concrete works shall be fenced in such a manner as to prevent the access of traffic, unauthorized persons, or animals on the surface of the newly paved concrete, until such time when the concrete will have hardened not to show any imprints or defects caused by any interference.

4.19 Concreting Under Warm Weather

During warm weather, the stockpiles of aggregates must be protected from solar radiation or watered. The water tank and distribution pipes must be insulated. The concrete's temperature during pouring must not exceed 32°C.
The formwork surfaces and the reinforcement must be wetted before casting takes place so that water is not absorbed from the concrete. Immediately after pouring the concrete surfaces must be protected according to the provisions set by Paragraph 4.18.

4.20 Preparation of Surfaces prior to Concreting

Rock or existing concrete surfaces should be carefully cleaned with water and air under pressure just prior to concreting and shall be brought to a uniform surface dry condition.
Earth foundations shall be damp when concrete is placed against them. Surfaces shall be thoroughly moist but not muddy to a depth of 15 cm or to impermeable material, whichever is less.

The surfaces at construction joints must be meticulously treated and loose aggregates should be removed from the top surface. The surfaces should be left undisturbed, clean without water, sand, loose materials etc. After concreting the hardened surface must be kept wet but without allowing the presence of stagnant water.

4.21 Ready Made Concrete Mix

The ready-made concrete mix will be transported from the Concrete Plant to the site with concrete mixer trucks or other appropriate vehicles approved by the Engineer. During the transport, the mixer must be rotating continuously so as to avoid concrete segregation. The mixing speed during transport and haulage must be set at the specified limits. In generally the transport time (starting from loading the truck mixer and ending with the delivery on the site) shall not exceed 30 minutes. In case where retarding additives are used, then the transportation time will be adjusted according to the instructions of the Engineer. During concrete casting, the concrete must have the predefined slump. The loading time must be written on the Concrete's Delivery Invoice. Loading time starts when the cement is added on the aggregates.

Addition of water in the concrete mix is strictly prohibited during transport. When mixing takes place in truck mixers, then any water added at the batching plant or at site will be done under the supervision of an experienced and authorized technician.

With the approval of the Engineer, ready mixed concrete may be used. The ready mixed concrete must comply with Norm EN 206-1:2006 "Concrete. Specification, performance, production and conformity" and Norm EN 12620:2002 "Aggregates for concrete".

4.22 Finish of Concrete Surfaces

Workmanship in formwork and concreting shall be such that concrete does not require making good, i.e. surfaces are perfectly compacted, smooth and with no irregularities. Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing or roughness of any kind.

Except if otherwise provided, unformed top surfaces of concrete shall be brought to a uniform surface and worked with suitable tools to a smooth wood-float finish. Excessive floating of surfaces while the concrete is plastic shall not be permitted.

As soon as forms are removed, all exposed surfaces shall be carefully examined, and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth and uniform surface.

Plastering or coating of surfaces shall not be permitted. No repairs shall be made until after inspection by the Engineer and then only in strict accordance with his directions. Concrete containing voids, holes, honeycombing or similar depressions shall be completely removed and replaced.

4.23 Prefabricated Concrete Member

Prefabricated concrete member shall be obtained from an approved manufacturer or prepared by special skilled employees and shall be true to dimension and shape, with true arises and with perfectly smooth exposed faces free from surface blemishes, air holes, crazing or other defects, whether developed before or after building-in.
The concrete shall comply in every respect with the provisions of the contract whether such units are manufactured on the Site or obtained from other manufacturers.
All cement, aggregate and other materials for precast concrete units with faces, which are exposed whether internally or externally, shall be from the same sources throughout.
Exposed surfaces of the units shall be uniform in colour and in texture.

4.24 Reinforcement

4.24.1 Steel

The reinforcement shall consist of high or low tensile steel that conforms Kenya Steel Standard KEBS/TC079 or to the Norms EN 10080:2005 “Steel for the reinforcement of concrete. Weldable reinforcing steel. General”. The Engineer retains the right to demand from the Contractor to present certificates of quality control from the supplier. The steel bars bending shall be carried according to Norm EN 10080.
The reinforcement bars must be clean, free of impurities, dust, oil, and paint. The reinforcement must be placed and mantled with precision according to the Drawings. Where it is not specified the concrete cover is set to 40 mm.
The reinforcement must be supported adequately so as not to deform and be able to carry loads during concreting. In order to ensure the appropriate cover concrete, plastic or other spacers approved by the Engineer must be used.
The overlapped bars will not be welded unless in specific cases approved by the Engineer. In the above-mentioned cases the bars will be welded according to standards EN 1011-1:1998 “Welding. Recommendations for welding of metallic materials. General guidance for arc welding”, EN 1011-2:2001 “Welding recommendations for welding of metallic materials. Arc welding of ferritic steels” and EN 60974:2002 “Arc welding equipment” and IEC 60974-12:2005 “Arc welding equipment: Coupling devices for welding cables”.

4.24.2 Submissions and Approvals

The following submissions are required by this Specification:

i) Manufacturers test certificates for each delivery of reinforcing steel, showing the country of origin and tests
ii) Manufacturer’s data on accessories;

All reinforcement Drawings and bending schedules prepared by the Contractor.

Before concrete is placed against any formwork, the reinforcement shall be inspected by the Contractor and offered for inspection and approval by the Engineer.
In no case concreting shall be commenced prior to the inspection of the reinforcement by the Engineer and his written approval to proceed with concreting.
The approval procedure shall be preferably supported by a 'pour-card' system.

4.24.3 Accessories

The Contractor shall supply all accessories such as reinforcing steel supports, hold-downs, spreaders, hangers, tie wire and all other incidentals necessary to complete an acceptable installation of all concrete reinforcement.
All accessories shall be of steel with the exception of spacers to maintain concrete cover.
If not otherwise directed by the Engineer, the concrete spacers shall be in the form of a truncated cone or pyramid and shall be used with the larger face towards reinforcing steel.

4.24.4 Cutting and Bending of Reinforcement

Bars shall be cut and bent in accordance with the Norm EN 10080. All bending shall be done cold with an approved bending machine.
Cut and bent bars shall be bundled and labelled for identification until they are incorporated into the work. Re-bending or straightening of bars shall not be permitted.

4.24.5 Storage of Bars and Mesh

The Contractor shall stack separately and label the various type of reinforcement for identification.
Steel reinforcement shall be kept clean and free from pitting. Loose rust, mill scale, oil, grease, earth paint or any other material impairing the bond between the concrete and the reinforcement have to be removed thoroughly before fixing.
Reinforcing steel shall be stored under cover on wooden support, elevated from the ground surface.

4.24.6 Fixing of Reinforcement

All reinforcement shall be securely and accurately fixed in positions shown on the approved Drawings using approved spacer blocks and chairs. The Contractor shall ensure that all reinforcement is maintained in position at all times, particular care being taken during placing of concrete.
Reinforcement in slabs shall be maintained in position by means of stirrups at 90-cm centres maximum. Reinforcement in walls with two layers of reinforcement shall be maintained in position by means of 6 mm U-or Z-shaped spacers at 180-cm centres maximum.

No part of the reinforcement shall be used to support formwork, assess ways, working platforms or the placing of equipment. Welding of reinforcement is subject to the permission of the Engineer.

4.24.7 Concrete Cover

Except as otherwise shown in approved Drawings, reinforcement shall be installed with clearance coverage as follows:

i) All surfaces in contact with water or placed against soil: 5.0 cm
ii) Underside of slabs over water and beams and columns not exposed to soil or water: 4.0 cm
iii) Surfaces exposed to air and all interior surfaces in buildings: 3.0 cm

4.24.8 Tolerances

Tolerances in placing reinforcement shall be:

i) For members 60 cm or less in depth: +/- 0.5 cm
ii) For members more than 60 cm in depth: +/- 1.5 cm

4.24.9 Approval by Engineer

In no case shall any reinforcing steel be covered by concrete until the number, correct diameter and position of the reinforcement have been checked by the Engineer and his permission given in writing to proceed with the concreting.

4.25 Formworks

The formworks must comply with precision the shape, location, line and height required on site or specified in the Drawings. The formworks must be supported adequately so as not to deform during concreting or compaction. The formwork joints must be watertight.

Top surface formworks must be used when concreting takes place on surface with inclination greater than 1:2.5.

Before the formwork is mounted it must be thoroughly checked and cleaned. The inner surface of the formworks must be oiled with special oil preferable before it is mounted and certainly before the reinforcement placement. The use of steel plates or small diameter reinforcement, embedded perpendicular in the concrete in order to facilitate the stability of the formwork, is prohibited. If this is required, then special bolts and plastic tubes must be used or any other support method that in any case must have the prior approval of the Engineer.

Concrete casting is prohibited before the formwork and reinforcement are approved from the Engineer. The Engineer retains the right to demand, in certain cases (i.e. bridges), a calculation report proving the formwork/shuttering stability-rigidity. This report must be submitted 6 weeks before the scheduled concrete works. Although the

Engineer issues the approval of the formwork/shuttering, its structural adequacy is full responsibility of the Contractor.

The Contractor is at all cases responsible for the stability of the formwork. The Contractor is responsible for all remedial works, compensations and time delays in case of accidents and unsatisfactory work due to inadequate formwork support.

The type of surface finishing of the concrete must comply with the one prescribed in the Drawings, specifications or the Engineer's instructions. All formwork joints shall be either vertical or horizontal as per the agreed pattern. Any holes serving support or spacing purposes shall be sealed with plastic covers or cement mortar identical to the poured concrete following the Engineer's orders. The Engineer reserves the right to demand the placement of trowels, water cut offs or whatever is required to achieve the required result.

The removal of the formwork must be carried out carefully without causing damage to the concrete. The time for the formwork removal will be proposed by the Contractor and approved by the Engineer. The Contractor must take into account the type of cement used, the admixtures/additives added and the weather conditions. The indicative Table below provides formwork removal time for normal structures and weather conditions.

Prior to the removal of the formwork, the Engineer must be notified well in advance. After the formwork removal no part of reinforcement must be visible. If so, remedial works of the Engineer's approval must be carried. All costs regarding remedial works or even partial demolition will be covered by the Contractor.

Time for Formwork Removal

Formwork Removal	Days
Side Formwork	2
Slab Formwork (deck)	14
Columns for slabs, beams, and frames	21-28
Columns under Cantilevers	28

4.26 Number of Forms

A sufficient number of forms of each kind shall be provided to permit the required rate of progress to be maintained.

Whenever, in the opinion of the Engineer, additional forms are necessary to maintain the progress of works, such additional forms shall be provided by the Contractor at his own expense.

The design of concrete forms, false work and shoring shall comply with applicable standards.

4.27 Formed Surfaces

Unless otherwise specified in the Drawings, the formwork surfaces must comply with one of the following classes listed below:

Class F1: It refers to cases where the concrete surfaces will be backfilled or covered with concrete. The formwork surface must be such that the loss of any of the concrete components is prohibited and allows for a compact top surface.

Class F2: It refers to cases where the concrete surface will be permanently exposed unless otherwise specified in the Drawings. The formwork surface must be such that the loss of any of the concrete components is prohibited and a durable lean surface is formed without discontinuities, cavities, etc. Although cavities are prohibited, small imperfections can be repaired with techniques and materials approved by the Engineer.

Class F3: It refers to cases where the concrete surfaces will be in contact with water flow of specific requirements (high velocities, cavitation risk, etc.). The formwork surfaces must be such that a lean straight surface correctly aligned vertically and horizontally is achieved free of cavities and humps. The Engineer retains the right to demand the plastering of the surfaces with the appropriate mortar mix so as to achieve the desirable surface finish.

When a surface is partially backfilled and exposed then the surface finish of the exposed surface must extend 500 mm into the backfill.

4.28 Unformed Surfaces

Unless otherwise specified in the Drawings the finishing of surfaces concreted without the use of formwork must comply with one of the finish classes listed below:

Class U1 (Screeded Surface): It refers to road pavement, foundations slabs or other structural elements backfilled that do not require better surface finish. This surface finish is a prerequisite for surfaces with a higher quality final finish such as class U2 and U3. The screeded finish will be achieved by hand sawing motion using a straight-edge timber of 50 mm thickness.

Class U2 (Floated Surface): It refers to all exposed surfaces of permanent works unless otherwise specified in the Drawings. The floated surface will be achieved by wood or bull float so as to allow abundance of fine aggregates on the top surface.

Class U3 (Troweled Surface): This class refers to all surfaces that will be subject to contact with water flow of specific requirements (high velocities, cavitation risk etc.). Surfaces finishing of class U1 and U2 must have already been implemented. Manual or mechanical steel troweling must be applied on the floated surface after the concrete has sufficiently hardened. If required a custom-made cover must be applied to protect the final surface from rain.

4.29 Acceptance Tolerances of Concrete Surfaces

The abnormalities observed for the different classes of the formed and the unformed surfaces must be within the limits set by the subsequent Table. If the abnormalities exceed the pre-specified limits, the Engineer will issue orders so that this does not re-occur. If the abnormalities exceed the maximum pre-specified tolerances limits, the Engineer retains the right to reject totally or partially the executed works.

In the Table below, the number in the brackets under the type of abnormality refers to:

(1) The element dimensions (walls, columns, beams, etc.) where for construction purposes the deviation must be kept to the allowable tolerances specified for the alignment and levels.

(2) Consecutive abnormalities created from the wrong formwork alignment and dimensions that are specified in the Drawings and are measured with a 3 m long trowel.

(3) Abrupt changes in the surface created from the formwork/shuttering wrong placement, loss of support and defective equipment or uneven surface in case of unformed shapes.

Tolerances for Abnormalities in Concrete Surfaces (mm)

Type of Abnormality	Type of Final Shape											
	Formed Surface						Unformed Surface					
	Allowable Tolerance			Maximum Limit			Allowable Tolerance			Maximum Limit		
	F1	F2	F3	F1	F2	F3	U1	U2	U3	U1	U2	U3
Deviation from the alignment and levels specified in the Drawings	+20 -5	±5	±5	+25 -10	±10	±10	±5	±3	±3	±10	±5	±5
Deviation from the element dimensions (**1**)	+5 -3	+5 -3	+5 -3	+10 -5	+10 -5	+10 -5	-	-	-	-	-	-
Abrupt changes in Surface (**3**)	±5	±3	±1	±10	±5	±3	±5	±3	±1	±10	±5	±3
Deviation from the crawler (**2**)	±5	±5	±3	±10	±10	±5	±5	±3	±3	±10	±5	±5

Chapter 5: ROAD WORKS

5.1 General Requirements

Road works, as specified hereunder, shall include the construction or reinstatement of roads and pavements as shown on the Drawings or as directed by the Engineer.
Earth works are not covered by this chapter.
All materials shall be new and shall comply with standard quality and dimension provision.
For non standardised materials and building components the Contractor shall, on demand of the Engineer, supply samples and name of manufacturer, and shall be subject to the approval of the Engineer.
Mineral materials shall be weatherproof, of adequate hardness and of sufficient adhesion to bind. They shall not contain any swelling, weathering, loamy, clay or organic components in harmful quantities.
Bituminous mixes shall be blended so as to be suitable for the purpose of application. Special consideration shall be given to climatic conditions, volume and type of traffic.

5.2 Maintenance and Reinstatement of Existing Roads and Footpaths

The Contractor shall maintain existing roads and footpaths within the Site. He shall reinstate the pavements, curbs and other parts of the roads after execution of works to its original state.
The Contractor shall remedy any settlement occurring after execution of works immediately upon notification by the Engineer.
Such remedy of pavement shall be done at the Contractor's own expense and shall include the re-excavation of the top surface, base and sub-base, the backfilling of base and sub-base with graded aggregate and the reinstatement of the surface.

5.3 Sub Grade

Where the sub grade is the natural soil, compaction shall be carried out at or near to the natural moisture content of the ground.
Surface of subgrade shall be kept free of standing water at all times and drains shall be provided so that it shall drain quickly and effectively during rain.
Any irregularities or depressions that develop during compaction of the sub grade or any area which becomes muddy, broken-up or loosened due to weather conditions shall be corrected by loosening the surface of these places and adding, removing or replacing these materials and re-compacting so that the surface is smooth and uniform.

5.4 Paved Roads and Hardstand Areas

5.4.1 Backfill and Embankment Material for Roads and Hardstand Areas

This shall be approved material obtained as much as possible from excavations on the Site. It shall be free from rubbish and organic matter.
Where excavated material is unsuitable or insufficient, the Contractor shall import material from a site approved by the Engineer's representative.
Material shall be placed in successive horizontal layers not exceeding 200 mm in thickness, before compaction.
The Contractor shall compact each layer of material prior to placing the successive layer to 95% Heavy Compaction Test to EN 1997 "Eurocode 7 – Geotechnical Design" (ENV 1977).
The formation level, whether in cut or fill, shall be compacted to achieve an in situ CBR value of not less than 20%.
The Contractor shall program their work such that subgrade preparation and sub-base placement follow each other in close sequence. If the subgrade is not covered immediately by base course and as a result deteriorates or suffers damage due to traffic, water or any other cause, then the Contractor shall make good the subgrade at his own expense by recompacting or reconstructing as the case may require.

5.4.2 Sub-Base and Base

The material used for sub-base/base shall be naturally occurring gravel or crushed rock capable of being compacted to achieve a well-knit dense layer. Stones larger than 100 mm shall be removed.
The gradation is given in the following table:

BS Sieve Size	% Passing by Weight
50.0 mm	100
9.50 mm	30 - 65
4.75 mm	25 - 55
2.00 mm	15 - 40
0.425 mm	8 - 20
0.075 mm	2 - 8

Sub-base material shall be spread evenly in layers of not more than 150 mm compacted thickness and compacted to obtain a well-bound surface finish, any loose or segregated areas being made good by the addition of fines or by removing and replacing with fresh materials as directed by the Engineer.
Compaction shall be carried out by approved plant operating on the material until a dry density of not less than 95% of the laboratory maximum dry density as measured by the Heavy Compaction Test to Eurocode 7 is obtained. The CBR value shall not be less than 25% after four days soaking in water.

5.4.3 Surfacing, general

Wherever possible, the operations of final trimming of the formation, compaction of the sub-grade and placing and compaction of the granular sub-base and road base shall be carried out immediately one after another.

The Contractor shall take all necessary steps to prevent damage to the previously completed layer or layers by excessive wetting or drying out due to weather conditions or by traffic or any other cause. If the Contractor considers it as advisable or if so ordered by the Engineer, the completed layers shall be sealed using bitumen road emulsions.

In any case, the completed surface of the road base shall be sealed with suitable emulsion (M.C.70 or similar) at a rate of 1.5-2.0 kg/m² immediately when it has been completed and checked for compliance with the specified tolerances.

5.4.4 Flexible Pavement

Unless otherwise specified or detailed, materials for flexible pavement shall be bituminous concrete and asphalt. The surface on which each course of coated bituminous material to be laid shall be free from standing water and any loose or deleterious material and shall be tested for accuracy.

Before laying commences in any area, a tack coat of bitumen road emulsion shall be applied to the whole area of the preceding course and any other surfaces with which the coat shall be in contact.

After cleaning, the top of the base shall be sprayed with suitable emulsion (M.C.70) at a rate of 1.5-2.0 kg/m²; the surface of the bituminous coat shall be treated with asphalt tack coat (RC-250) at a rate of 0.5 kg/m². The emulsion shall be allowed to break completely before the subsequent bituminous layer is laid on it.

Coated macadam material shall be delivered to Site in clean vehicles and shall be covered to minimise loss of heat in transit and against contamination by dust or other deleterious matter.

The rate of delivery to the Site shall be regulated so as to enable the material to be laid with the minimum of delay and so that the paver can operate continuously.

The coated thickness of individual layers shall be not less than the minimum compacted thickness specified or shown on the approved Drawings. If not otherwise directed, the bituminous base course shall have a thickness of 10 cm, the wearing course of 5.0 cm.

5.4.5 Rigid Concrete Pavement

Rigid paved areas shall be constructed in concrete in accordance with the relevant requirements of the Specification and Standards for Concrete works.

Concrete for rigid pavement shall be of class C 20/25. The use of additives shall be subject to the approval of the Engineer. Concrete courses shall be as per the approved drawings and never less than 100 mm thick.
Reinforcement shall be of steel mesh of not less than 2 kg/m², unless otherwise approved. The reinforcement shall not influence the effectiveness of the joints. The concrete cover shall be not less than 30 mm.
Transport and placing of the concrete shall be coordinated so that the concrete can be completely placed before setting.
Expansion joints shall be executed at the required intervals and shall enable expansion to the concrete slabs and be fixed. The expansion joints shall be 20 mm wide. The strength of the concrete and the properties of the concrete surface shall not be influenced by the execution of joints.
The concrete shall be protected against harmful influences until correct setting, i.e. against drying out, especially due to sun and wind, against washing out due to rain, against heat or quick cooling. The concrete surfaces shall be cured and kept moist for at least 7 days.

5.4.6 Kerbs

Kerbs shall be pre-fabricated and comply with the following Standards:

(i) EN 1343 Kerbs of natural stone for external paving – Requirements and test methods
(ii) EN 1340 Concrete kerb units - Requirements and test methods

Kerbs shall be flayed true to line and level. Kerbs found to be more than 1 cm out of line or level at either end shall be lifted and relied.
Kerbs shall be bedded on a layer of 3:1 sand/cement mortar, minimum 10 cm thick on a grade C 8/10 concrete foundation and shall be backed with concrete shaped up to the required cross section. Kerbs shall be jointed with cement mortar except at expansion joints, which shall be made with joint filler, 10 mm thick.

5.4.7 Footpaths

Footpaths shall be surfaced with coated macadam, concrete, pre-cast concrete slabs or natural stones. The base for footpaths shall be formed from flexible surfacing, laid and compacted to a minimum thickness of 100 mm using a roller of at least 2 tons mass or other approved equipment allowing for equivalent compaction.

Where footpaths receive coated macadam surfaces, the construction shall be as follows:

(i) pre-cast concrete edging in accordance with appropriate the Standards as mentioned above shall be bedded and backed with in-situ concrete C 8/10;
(ii) the base shall be constructed as specified above and shall then be sealed;
(iii) the surfacing shall consist of a single course of coated macadam and be compacted to minimum thickness of 25 mm.

Pre-cast concrete slabs shall be bedded on a layer of sand, of thickness not less than 50 mm, and tamped into place.
Natural stones shall be sound, durable, hard and free from undesirable weathering and shall be of such properties that they shall not disintegrate from the action of weather in handling and placing.
The density of stones shall be not less than 2.2 t/m³ (solid volume without voids). The dimensions of stones shall range between 150 and 200 mm.
The stones shall be rough hammered dressed so that they fit reasonably close together.
They shall be laid to a true and even surface on a layer of sand, approximately 100 mm thick and tamped into place.

Concrete footpaths shall be surfaced with concrete C 20/25, at least 10 cm thick with mortar topping, constructed on a prepared bed as specified above and in accordance to the Specification for Concrete works.

5.4.8 Disposal of Surplus Material

Unless otherwise directed by the Engineer, the Contractor shall make his own arrangements to dispose off of all surplus backfill and unsuitable excavated material from any part of the Work. The material shall be disposed off-Site and shall become the property of the Contractor who shall be entirely responsible for its removal from the Site and its ultimate disposal. The Contractor shall clean the Site and the surrounding ground immediately and leave the construction Sites clean and tidy to the satisfaction of the Employer.

Chapter 6: PIPEWORK AND FITTINGS

6.1 General

Pipe materials shall be of the best quality of the class most suitable for working under the conditions specified and shall withstand traffic loads, operating pressure, corrosion and abrasion, and the variation of temperature and climatic conditions without distortion or deterioration or the setting of undue stresses in any part of the Works and without affecting the strength or the suitability of the various parts of the work which they shall perform.

Where corrosion or abrasion may be expected from contact with water, sediments or from any other cause, the Contractor shall supply suitably resistant materials.

Any material showing signs of corrosion, distortion or pitting before expiration of the maintenance period shall be replaced with material approved by the Engineer, at the Contractor's own expense.

The Contractor shall submit documentation on the details of the delivered goods; these documents shall bear the stamp and the signature of the manufacturer.

All pipes shall be permanently and legibly marked in such a way that the marking does not initiate cracks or other types of failure and that normal storage, weathering handling, installation and use shall not affect the legibility of the marking.

6.2 Ductile pipes

6.2.1 Materials and Standards

Ductile iron pipes and fittings shall be manufactured and supplied in accordance to EN 545:2011. Any deviation from this Standard shall be inadmissible and lead to rejection of the material.

Ductile iron pipes and fittings shall be manufactured with spigot and socket ends in which the seal is achieved by means of suitable retained rubber gasket (automatic push-on joint). Wall thickness shall be Class C for pipes as per EN 545:2011.

Rubber gasket materials shall be of Ethylene Propylene Diene Monomer (EPDM) in accordance with the requirements of EN 681-1:1996, type WA. For flanged joints, the gasket shall be made of Ethylene Propylene Diene Monomer (EPDM) in accordance with the requirements of EN 681-1:1996, type WA. The gaskets for flanged joints shall be reinforced by means of a metallic ring.

In case of flanged connections (valves, air valves, dismantling joints etc.), the bolts, nuts and washers shall be made of stainless steel. Bolts and nuts shall comply as a minimum with the requirements of EN ISO 4016:2000 and EN ISO 4034:2000, grade

4.6. Washers shall comply with EN ISO 7091. All bolts, nuts and washers used for flanged connections shall be of stainless steel.

Flanges shall comply with EN 1092-2. Where flanged connections are covered by backfill, all flanged joints shall be wrapped in PE-sheets in accordance with ISO 8180:2006 (ductile iron pipelines – polyethylene sleeving for site application).

Socket joints for pipes laid in steep slopes (s > 1:6) shall be of restraint type.

Generally, the ductile pipe materials shall be manufactured and tested according tothe following standards

- EN 545:2011 (ductile iron pipes and fittings for water pipelines),
- ISO 4179:2005 (ductile iron pipes and fittings for pressure and non-pressure pipelines – cement mortar lining),
- ISO 8179-2:2005 (ductile iron pipes – zinc coating with finishing layer),
- EN 681-1:1996 (rubber seals – joint rings for water pipelines),
- EN 14901:2006 (epoxy coating (heavy duty) of ductile iron fittings and accessories).

For all items of supply the Contractor shall submit to the Engineer a certificate of compliance with the specified Standards. Where other Standards are proposed, they shall be equal or superior to the relevant Standards.

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 supplies shall be new, second hand material will be rejected.

The Engineer shall be empowered to reject any material, components and workmanship found to be inferior to the appropriate EN 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 pipefittings must conform to the latest relevant Standards.

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

- The manufacturer’s name or mark;
- The material identification such as ductile iron;
- The identification of the year of manufacture;
- The DN;
- The PN rating of flanges when applicable;
- The reference to the Standard;

in order to confirm that the material complies with the requirements.

6.2.1.1 Potable Water Certification

All materials in contact with potable water shall be tested and approved by the Water Regulations Advisory Scheme (WRAS) or other worldwide known. Quality Certifiers subject to the approval of the Engineer.

6.2.1.2 Material required for connection to or branches from existing Mains or other Pipelines

The Contractor is obliged to determine the material and exact diameter of any existing pipe, to which a new pipe will be connected and shall submit to the Engineer a proposal for the intended transition pieces for approval before ordering the respective accessories. (The temporary excavation for searching / inspecting existing pipe will be paid as set forth in the Bill of Quantities).

6.2.1.3 Toxic Materials

The Contractor shall not import or use any toxic or poisonous grouts, for use in piping, its accessories, lining sealing etc., or in various kinds of concrete, soils or whatsoever.

6.2.1.4 Inspection of Material

All materials shall be inspected prior to shipment by an internationally recognized Third Party Agency (TPA) such as Bureau Veritas subject to the approval of the Engineer.

The Third Party Agency shall inspect the materials in accordance with the Technical Specifications and conduct tests. For any clarifications, Third Party Agency shall contact the Engineer. The Third Party Agency shall submit the detailed inspection report along with observation data sheets directly to the Engineer.

The Engineer shall hold the final inspection upon arrival of the material on site.

The Engineer shall reserve the right to reject the supplied material during final inspection or at later date, if found not as per the Technical Specifications and will have the right to put the manufacturer under “ON HOLD” or “BLACK LISTED” until further action.

The Engineer shall reserve the right to inspect the material sin the factory.

The manufacturer shall allow access of the Engineer and / or Third Party Agency at all times during manufacture and testing to the premises in which the material being manufactured and / or tested.

6.3 Steel Pipes and fittings

Steel pipes shall be welded and in accordance with EN 10220. Steel shall be low alloy St 37.0 acc. to DIN 1626 and shall have the following wall thicknesses:

DN	OD (mm)	T (mm)	DN	OD (mm)	T (mm)	DN	OD (mm)	T (mm)
80	88,9	3,2	250	273	4,0	500	508	5,6
100	114,3	3,2	300	323,9	4,5	600	610	6,3
150	168,3	3,6	350	355,6	4,5	700	711	6,3
200	219,1	3,6	400	406,4	5,0	800	813	7,1

Pipes shall be supplied with an inspection certificate acc. to EN 10204 Table 1 and shall be suitable for PN 25 up to DN 600 and to PN20 for larger DN. Otherwise, DIN 2460 shall apply.

Standard pipes for laying in trenches shall have pushfit socket and spigot ends for jointing with elastomeric seal rings. Standard fittings shall be with either sockts or flanges as required.

Fittings with flanges shall be for butt-welding acc. to DIN 2605pp and DIN 2615pp, wall thicknesses shall harmonise with the PN of the adjacent straight pipe. Flanges shall conform to DIN EN 1092-1 in all respects. If not stated otherwise flanges shall be of type 11 shape B for butt-welding. All welds at main diameters exceeding DN300 or PN10 shall be subject to an ultrasonic test.

The individual sections of manifolds shall be prefabricated in required lengths.

6.4 Internal Lining and External Coating

6.4.1 General

The Contractor shall provide detailed information and technical documentation of the internal and external protection of pipes. He shall specify the guarantee period of the coatings

All pipes and fittings shall be coated at the manufacturer's Works. The metal surface shall be free of corrosion prior to application of coating to guarantee maximum adherence of the coating.

Internal lining of pipes and fittings shall be certified for use for potable water. Internal lining shall guarantee that the hydraulic performance of the pipes and fittings shall be maintained long term even if the water shall be aggressive.

In general, the quality of internal lining and external coatings shall be excellent upon delivery. The Engineer shall not accept pipes with damaged lining and coatings.

6.4.2 Ductile Iron Pipes and Fittings

Ductile iron pipes and fittings shall have coating and lining in accordance with EN 545:2011 as follows:

- Pipes, external coating: 99.99% metallic zinc of a minimum quantity of 200 g/m² plus bituminous paint with a minimum dry film thickness (DFT) of 100 microns in accordance with ISO 8179-2:2005
- Pipes, internal lining: sulphate resisting cement (SRC) lining in accordance with ISO 4179:2005
- Fittings, external coating: fusion bonded powder epoxy coating with a minimum dry film thickness (DFT) of 250 microns in accordance with EN 14901:2006
- Fittings, internal lining: fusion bonded powder epoxy coating with a minimum dry film thickness (DFT) of 250 microns in accordance with EN 14901:2006
- Polyethylene sleeves: in accordance with ISO 8180:2006 (ductile iron pipelines – polyethylene sleeving for site application).

Thickness of cement mortar lining		
Diameter	**Nominal**	**Minimum**
DN 80 - DN 300	4,0 mm	2,5 mm
DN 400 - DN 600	5,0 mm	3,0 mm
DN 700 - DN 1200	6,0 mm	3,5 mm

6.4.3 Steel Pipes

Steel pipes and fittings to be installed in plant or in manholes or buried as part of system points shall receive their coating and lining in the manufacturer's Works prior to shipping.

The surfaces shall be sand blasted prior to application of coating or lining and shall receive one primer of zinc chromate and two finish coats of solvent based two component epoxy resin paint 0f a total minimum thickness of not less than 250µ.

External colour shall be blue if not directed otherwise by the Engineer. Internal colour shall be black or brown.

Steel pipes and fittings to be installed as part of a buried main shall have the following lining and coating:

Pipes and fittings, external coating: rich zinc paint and extruded PE-lining, blue colour Pipes and fittings, internal lining: cement mortar of blast furnace cement.

Thickness of cement mortar lining		
Diameter	**Nominal**	**Minimum**
DN 80 - DN 300	3,0 mm	2,0 mm
DN 400 - DN 600	5,0 mm	3,0 mm
DN 700 - DN 1200	6,0 mm	3,5 mm

Internal lining shall end 10mm before the butt welding end.
PE-sleeves for application by shrinkage and rich zinc paint shall be provided for field-coating and wrapping after buttwelding.

Steel pipes and fittings to be installed in plant shall have the following lining and coating:
Pipes and fittings, external coating: epoxy minimum 250µ, blue colour
Pipes and fittings, internal lining: epoxy minimum 250µ, blue colour.

6.4.4 Pipeline Appurtenances

Bolts, Nuts and Washers

All bolts and nuts necessary for assembly shall be supplied together with the equipment. The Contractor shall supply an extra 20% of this assembly material as reserve. The cost of the assembly material and reserve material shall be included in the unit price of pipes and fittings.

Bolts and nuts shall comply as a minimum with the requirements of EN ISO 4016:2000 and EN ISO 4034:2000, grade 4.6. Washers shall comply with EN ISO 7091. All bolts, nuts and washers used for flanged connections shall be of stainless steel.

6.4.4.1 Seals, gaskets and tightening material

All seals, gaskets and tightening material necessary for assembly shall be supplied together with the equipment. The Contractor shall supply an extra 20% of this assembly material as reserve. The cost of the assembly material and reserve material shall be included in the unit price of pipes and fittings.

6.4.4.2 Dismantling Joints

Dismantling joints shall be provided according to DIN 2541 or DIN 2547 or flange adapters as indicated on drawings or directed by the Engineer. Flanges to EN 1092-2, PN10/16

If not otherwise directed, body and glands of steel welded dismantling pieces shall be of pressure class PN 16 with bolts and nuts of stainless steel.

Surface protection shall consist of fusion bonded powder epoxy coating with a minimum dry film thickness (DFT) of 250 microns. PE-sleeves for application by

shrinkage and epoxy paint shall be provided for field-coating and wrapping after installation.

Rubber sealing rings made of Ethylene Propylene Diene Monomer (EPDM)

6.4.4.3 Flexible Couplings and Flange Adapters

Flexible couplings and flange adapters shall be of low alloy carbon steel and of an approved type suitable for making a watertight flexible connection. Surface protection shall consist of fusion bonded powder epoxy coating with a minimum dry film thickness (DFT) of 250 microns. PE-sleeves for application by shrinkage and epoxy paint shall be provided for fieldcoating and wrapping after installation.

All mechanical couplings shall be of appropriate internal diameter, shall allow a joint deflection of up to 4° in any direction and longitudinal movements up to 9 mm. and shall be capable of withstanding the maximum working test pressure specified for the pipes they are to connect.

Flange adapters shall be capable of providing half of the flexibility of the couplings. Sliding action shall not provide the horizontal movement. It shall occur by deforming of the sealing rings.

All mechanical couplings and flange adapters shall be supplied complete with all necessary coupling rings, nuts, bolts, washers and rubber rings.

Wedge joint rings shall comply with EN 681-1:1996 and shall be made of Ethylene Propylene Diene Monomer (EPDM). The sealing shall be resistant against corrosive water.

6.5 Handling and Storage of Pipes

6.5.1.1 Handling and Transport of Pipes

The Contractor’s arrangements for handling, lifting and transporting of pipes, fittings, valves and other appurtenances shall ensure that these appurtenances are brought to their final place on site undamaged and in good order.

Handling and storage on Site must conform to manufacturer's recommendations and standards. Open-air interim storage of ductile iron pipes is permissible if proper positioning is maintained; PVC-U and PE must be protected against sunlight.

Pipes, fittings and appurtenances shall be handled with utmost care and the Contractor shall provide cranes and other appliance approved by the Engineer wherever it is necessary to lift or lower pipes or pipe specials.

For the handling of pipes with external coating and lining, slings of canvas, rubber belting or special fittings shaped to fit the pipe ends shall be used. Hooks shall not be used for lifting of pipes nor shall pipes be dropped or dragged.

Ductile iron pipes being transported shall be supported by timbers, sand bags or padding arranged in such a way that the pipes do not rest on their sockets but on their barrels and those adjacent pipes do not touch.

The height of the load for the various pipe diameters shall not be more than prescribed by the manufacturer and approved by the Engineer.

Ropes or other lashing arrangement shall secure each load so that the pipes do not move or chafe and suitable padding shall be used to ensure that the pipe coating is not damaged by these lashings.

Pipe specials shall be supported by sandbags or other padding and lashed down as described above so that they are not damaged during transport.

6.5.1.2 Storage on Site

All materials provided by the Contractor shall be stored in a proper storage area subject to the approval of the Engineer.

The Contractor shall foresee a fenced and lockable compound in which all fittings, valves and other pipe appurtenances are to be kept, and also maintain shelters of sufficient size and capacity to store the materials and to protect them from the effects of weather always in accordance with the manufacturer's prescriptions.

The Contractor shall be responsible for cleaning, levelling and enclosing the storage site and shall provide all necessary security. The Contractor shall at all reasonable times allow the Engineer or the Employer free access to any place for inspection and testing.

In all cases the Contractor shall satisfy the Engineer that all material has been delivered in good and clean condition, identification markings shall be clear and stock piling shall be in approved manner.

The Contractor shall keep detailed records in a format approved by the Engineer of all pipes, fittings, valves and other pipe appurtenances, showing the quantities of each type and class which have been

- Received by the Contractor during the course of the Works;
- Broken, damaged or lost during the course of the Works;
- Found to be surplus to the requirements and held by the Contractor.

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

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

6.5.1.3 Stacking of Pipes

The Contractor shall properly stack the pipes in storage yards at Site(s) and the stacks shall be laid out in regular pattern as prescribed by the Manufacturer. The limits of each stack shall be marked so that the movement of cranes and vehicles shall be restricted to access tracks between the stacks and the control of delivery and removal of pipes is facilitated.

Where the pipes are to be delivered and stacked on designated sites along the pipeline route, the areas where the pipes are to be stacked shall, if directed by the Engineer, be graded flat by the Contractor at his own expense to provide a firm and even surface and be kept free from loose stones, rubbish or waste liable to damage pipe coating.

Material 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.

6.5.1.4 Distribution at the Site

In distributing the material at the site of works, each piece shall be unloaded adjacent or near to the place where it is to be laid. Rubber rings for pipe joints shall be stored and protected in an appropriate manner to prevent deterioration.

The Contractor shall keep the pipe and the appurtenances clean during the progress of the Works. Dirt, debris or other foreign material shall be removed from the interior of the pipe and the joints before installation.

6.6 Pipe Laying

6.6.1 Routing

The Drawings show the approximate lines and levels to which pipes are to be laid however such alignments are subject to the amendments made by the Engineer on Site. He may vary or abandon any part or parts of the route of pipes indicated on Drawings and issue the respective instructions to the Contractor. The Contractor shall prepare the working Drawings and shall lay the pipes in accordance with any such variation the Engineer may issue.

6.6.2 General Requirements for Pipe Laying

All pipes and specials shall be laid in accordance with the alignment, levels and gradients shown on the working Drawings approved by the Engineer, adjusted in the field by the Contractor as may be required from time to time and as finally authorised by the Engineer. Pipes shall run straight between the bends or any curved alignment

and a uniform gradient shall be accurately maintained between changes of gradient as shown on Drawings or otherwise instructed by the Engineer.
The bottom of the trenches shall be graded and prepared to provide a firm and uniform bearing throughout the entire length of each pipe; bell holes shall be provided as required.
The Contractor shall inform the Engineer sufficiently in advance when a section of trench has been prepared ready for inspection. No pipe shall be laid until the trench bottom has been inspected and approved by the Engineer.
Before being positioned, each pipe shall be thoroughly examined to ensure that it is free from defects and shall have all dirt removed from the inside thereof. The Contractor shall lay the pipe in accordance with professional practice and install all fittings, specials and adaptors as may be required for the proper execution of the works.
The Contractor at his own expense shall repair any injury of the protective coating of the pipes from any causes during the construction of the pipeline to the satisfaction of the Engineer.
At the end of each day's work a strong wooden plug or iron disk shall be firmly fixed in each open end in order to prevent any foreign material to enter the laid pipe.

6.6.3 Cutting of Pipes

The Contractor shall cut pipes exclusively with the cutting tools recommended by the manufacturer for the particular pipe material and approved by the Engineer. Cuts shall be smooth and perpendicular to the axis of the pipe. Damages to coatings or linings (if any) shall be repaired. Spigot ends to be joined to sockets shall be chamfered.

6.6.4 Matching Pieces

Matching pieces required in any section of a main or to terminate the main in manholes or other parts of the works shall be cut only after all adjacent pipes have been installed and jointed.

6.6.5 Laying of Ductile Iron Pipes

Installation
The pipes shall be positioned and bedded in the trenches on the compacted and finished bedding and jointed in an approved manner.
After placing a length of a pipe in the trench, the spigot shall be centered in the socket of the corresponding pipe using the proper lubricant, rubber rings and methods in strict accordance with the manufacturers' instructions and the pipe shall be forced home by rack and lever and brought to the correct line and grade. Particular care shall

be applied to ensure that the spigot end of the pipe does not damage or displace the rubber ring joint. The pipe shall be secured in place with approved backfill material tampered around it, except at the socket.
The Contractor shall supply all the materials, equipment and tools required for the proper jointing of the pipes at his own cost.
All joints shall remain uncovered until successful completion of the pressure test.

Thrust Blocks
Bends, tees, tapers, plugs, caps, valves etc. shall be well braced against undisturbed soil at the edge or the end of the trench with concrete thrust blocks or collars (end caps), except for in case of restrained joints of the pipes and fittings.
The blocks shall be placed so that the joints shall remain accessible for repair.
Where it is not possible to brace against undisturbed soil, suitable fetters shall be arranged as directed by the Engineer.

Thrust forces and shaping of the thrust blocks and collars shall conform to the field test pressure (STP) and be calculated by the Contractor for each individual thrust block considering the actual soil bearing capacity. Where large abutments are required, the bearing plate and the transmitting prism shall be of reinforced concrete B20/25. The dimensions, classes of concrete and steel reinforcement given in standard Drawings are approximate only.
Alike for thrust blocks, the Contractor shall determine the structural requirements and design manholes to safely transmit the thrust into the natural soil.
Concrete thrust blocks and collars shall be allowed to cure for at least 7 days before backfilling or bringing thrust to the blocks.

Restrained joints
The Contractor shall lay sections with restrained joints strictly according to the manufacturer's instructions. Lengths of anchoring tails shall be computed by the Contractor acc. to the field test pressure (STP) for each individual bend or tee considering the actual soil parameters. Adjacent to the respective bend, upper bedding and side fill shall be of concrete B8/10 acc. to Standard drawing. Anchoring tails shall be completely backfilled prior to the pressure test.
Pipe with restraint joints shall be laid in steep slopes of s > 1:6. Additionally, on such steep slopes the laid pipe shall be provided with anchor blocks at spacing of 10.0 m to 15.0 m to prevent soil erosion of trench backfill thru gushing surface water.

6.6.6 Laying of Steel Pipes

If ordered steel pipes shall be used as directed by the Engineer, the procurement, laying in trenches and measurement of steel pipes with socket and spigots ends shall be in accordance with the rules outlined for DI pipes.
In case of the specific requirements for the jointing by welding, jointing and handling of black steel pipes are summarised as follows:

1. Steel pipes shall be jointed together by electric butt-welding. Welding shall be in accordance to approved standards and Manufacturer's prescriptions. The electrodes used shall be suitable for over head welding and shall be subject to the Engineer's approval. Pipes shall be joined beside the trench.
2. The Contractor's welders shall have passed welding tests as prescribed by the Engineer and no welder shall work on the pipes before passing the test and being approved by the Engineer in writing.
    2.1. After passing the prescribed pressure test, external coating of all joints shall be completed in accordance with the Engineer's instructions and to his satisfaction.
3. After inspection of the joints, the pipes shall be lowered into the trench. Steel pipes shall be joint together by electric butt-welding. Welding shall be in accordance to approved standards and Manufacturer's prescriptions. The electrodes used shall be suitable for over head welding and shall be subject to the Engineer's approval. Pipes shall be joined beside the trench.
4. The Contractor's welders shall have passed welding tests as prescribed by the Engineer and no welder shall work on the pipes before passing the test and being approved by the Engineer in writing.
    4.1. After passing the prescribed pressure test, external coating of all joints shall be completed in accordance with the Engineer's instructions and to his satisfaction.
    4.2. After inspection of the joints, the pipes shall be lowered into the trench.

6.6.7 Marker Posts

Marker posts for pipelines shall be placed to mark locations of pipe alignment, bends, sectional valves, air-release valves, washouts, fire hydrants, etc. in accordance with the relevant Drawings or as instructed by the Engineer.

The marker posts shall be placed in a concrete bed of 30/30/30 cm. The marker post shall protrude minimum 40 cm from the ground level.

6.6.8 Reinforced Concrete Chambers

Reinforced concrete chambers shall be located as indicated on Drawings or directed by the Engineer. In-situ concrete chambers shall comply with the applicable specified requirements for Earth works and Concrete works.
All external pipework 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.

The structures shall be built into the pipelines in accordance with the Drawings. Given dimensions on the Drawings shall be verified by the Contractor so as to suit the pipe installation and the prevailing condition on Site.

All concrete surfaces in contact with soil shall receive two (2) coats of protective bituminous paint prior to backfilling.

6.6.9 Pipework in Chambers and Pumping Stations

6.6.9.1 Erection of Pipework

Preparation of Pipes
The Contractor shall be responsible for ensuring that the internal surface of all pipework is thoroughly cleaned before and during erection and before it is placed into commission.
Cleaning shall include the removal of all dirt, rust, scale and welding slag due to Site welding. All small bore pipes shall be blown through with compressed air before connection is made to instruments and other equipment.

Installation of Pipes
Care shall be taken during the erection of pipework to ensure that no loads of any kind are transmitted through to the pump flanges or the flanges of any other equipment. Care shall also be taken that pipe flanges are accurately aligned to prevent distortion of flanges and/or pipework when bolting together. Bolts of flanged connections shall be tightened uniformly, so that the gasket pressure is evenly distributed around the circumference.

Support of Pipework and Valves
All necessary supports including structural steel work foundations, hangers, saddles, sliding, expansion pieces, fixing bolts, foundation bolts, fixing and anchor points and all attachments shall be supplied to support the pipework and its associated equipment in an appropriate manner.

Valves, meters, strainers and other devices mounted in the pipework and its associated equipment shall be supported independently of the pipe to which they connect.

Supports and Passage of Pipes through Walls
Whenever pipework passes through walls, the Contractor shall provide block outs and install the pipes only after the structure has been completed and grout the pipes in secondary concrete after the pipes have been accurately positioned. Where axial thrust is to be transmitted, puddle flanges shall be grouted and reinforcement be placed in such manner that the thrusts shall be safely transmitted into the structure.
In exceptional cases the Engineer may accept to incorporate the pipes into primary concrete provided that all pipe elements and appurtenances are completely wrapped into PE-sheets.

6.6.10 Disinfection of Mains

Disinfection of mains shall be carried out in accordance with EN 805.
EN 805 recommends several disinfectants. The disinfectant may be selected by the Contractor and submitted to the Engineer for approval together with the method of application. It is recommended to use a hypochlorite solution; the process for the hypochlorite solution is given hereinafter.
After a section of the mains has been hydraulically tested successfully and before being commissioned, the Contractor shall proceed with the disinfection.
Firstly, the mains section shall be flushed with clean water to remove foreign matter.
Then the mains section shall be disinfected with a chlorine solution at a rate as to obtain 50 mg/l of active chlorine at the point of introduction. The line shall be blown-off until a residual of 5 mg/l chlorine is obtained at the point of blow-off.
If a residual of 5 mg/l chlorine is obtained, the blow-off shall be closed and the water allowed to remain in the pipe for a minimum of 24 hours (static method). After this period the water shall be tested for residual chlorine at the point of blow-off. If no residual chlorine remains, the process shall be repeated until satisfactory results are obtained.
After completion of the disinfection process the main shall be flushed with 0.5 mg/l chlorinated water until effluent concentration at the point of blow-off is less than 0.5 mg/l.
Any effluent from the disinfectant shall be duly neutralised.

Chapter 7: SUPPORT MEASURES FOR CONCRETE STRUCTURES

7.1 General

7.1.1 Scope

This section deals with the supply, installation, testing and maintenance of rock support for use on concrete structures.
Support measures will consist of the following measures or any combination thereof:

(i) Rock anchors

(ii) Wire mesh reinforcement and

(iii) Sprayed concrete

(iv) Polymeric fibres

(v) Structural steel supports (steel arches)

Rock support measures may be required on the excavated profile and they will be applied as presented in the Drawings or as directed by the Engineer.

Installation and testing of rock support shall only be undertaken by operators who can satisfy the Engineer that they are experienced in the various techniques specified.

The diameter, orientation and lengths of drill holes for rock anchors, the method of drilling, cleaning etc., shall be such as to ensure the correct setting and anchorage of the dowels to the satisfaction of the Engineer.

7.1.2 Standards and Guides

The following Standards present part of these Technical Specifications. Where the European standards are not applicable, American or other international standards will be followed, after approval by the Engineer.

STANDARDS	DESCRIPTION
EN 196	Methods of testing of cement
EN 197-1	Cement – Part 1: Composition, specifications and conformity criteria for common cements
EN 197-2	Cement – Part 2: Conformity Evaluation
EN 206-1	Concrete – Part 1: Specification, performance, production and conformity
EN 934	Admixtures for concrete, mortar and grout
EN 10080	Steel for the reinforcement of concrete
EN 10020	Definition and classification of grades of steel
EN 10024	Hot rolled taper flange I sections

STANDARDS	DESCRIPTION
EN 10025	Hot rolled products of structural steels
EN ISO 887	Plain washers for metric bolts, screws and nuts for general purposes – General plan
EN ISO 898-1	Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs
EN ISO 10644	Screw and washer assemblies made of steel with plain washers – Washer hardness classes 200 HV and 300 HV
EN 14488-1:2006	Testing shotcrete – sampling fresh and hardened concrete
EN 14488-4	Testing shotcrete – Bond Strength of Cores.
EN 14487-1:2006	Shotcrete. Definitions, specifications and conformity
EN 14487-2	Shotcrete. Part 2: Execution.
9252	Steel for the reinforcement of concrete – Weldable reinforcing steel B 500
EN 1008	Mixing water for concrete. Specifications for sampling, testing, testing and assessing the suitability of water.
EN 1097-(2-9)	Testing of Mechanical and Physical Properties of Aggregates. Parts 2 – 9.
EN 12350	Testing of fresh concrete. Parts 1 to 7
EN 12390	Testing of hardened concrete.
EN 12620	Aggregates for Concrete, including Ones for Roads and Road Pavements.
EN 12620+A1/NA	Aggregates for Concrete. National Appendix (NA) to EN 12620+A1:2008.

7.2 Submittals

A. Submittals preceding Construction Works commencement

Not later than 5 days before commencement of rock support works, the Contractor shall submit for Engineer's approval details of offered methods, equipment, materials, procedures, measuring and reporting and a list of equipment the Contractor intends to use for rock support operations as specified for the different applications.

All details, specifications and number of offered equipment shall be given in an Engineering Report including type and number of special equipment to be employed in restricted spaces.

B. Submittals during Construction Works

The Contractor shall submit all results from all the tests carried out by him prior to and in the process of rock support works. Results from the tests shall be submitted within 2 days of the test performance unless otherwise specified within.

The as-built Drawings shall be drawn up in the course of execution of the rock support works and shall be submitted to the Engineer upon request or within 7 days after completion of a given section.

The Contractor shall submit to the Engineer three-month reports showing in summary the performance of tests and the results of the rock support works.

Every month the Contractor shall submit a detailed program of the rock support works performance, current reports and Drawings showing the progress of the works.

7.3 Rock Anchors

7.3.1 Program

The location, length, diameter, inclination and pattern of the rock anchors are presented in the related Drawings. Rock anchors on open excavated slopes will be used for the spillway cut slopes, while in underground excavations they will be used in the diversion tunnel, at the Plug. Other places that rock support might be required will be proposed by the Contractor to be approved by the Engineer.

7.3.2 Materials

a) Rock anchors shall be manufactured from hot rolled deformed bars B500C or B500A.

b) Face plates, hemispherical washers and nuts for rockbolts shall be manufactured to suit the loading requirements.

c) Cement for the production of grout

d) Water for the production of grout, drilling and washing of the boreholes

e) Admixtures, if required by the Engineer, for plastification of the cement grout. Admixture accelerating the grout hardening, may be necessary for obtaining early strengths.

f) Resin grout shall be a commercially produced epoxy or polyester product in capsule form with both fast and slow setting times as applicable especially formulated for use with rockbolts or dowels, and transported, stored and utilised in accordance with the manufacturer's recommendations.

7.3.3 Installation

A. Drilling

Holes for rock anchors shall be drilled as specified herein and in accordance with the applicable provisions of Chapter 9: "Drilling and Grouting Works".

The hole diameter for the anchors shall be such that it allows placing of the anchor and grouting. In no case it should be less than 20 mm larger than the rod diameter. The holes shall not be more than 100 mm longer than the grouted length of the rock anchor unless otherwise proven acceptable by site trials. The downward holes shall extend 150 mm to 200 mm beyond the length of the anchor. The holes shall be washed clean of rock dust prior to insertion of the grout.

B. Anchor Bars

The rod length specified shall be the required length of bar to be bonded to the rock and due extra allowance in the cutting length shall be made for any length including the threaded portion protruding from the rock as required for installation. One end shall be threaded for at least 150 mm with a coarse cut thread which shall not reduce the overall specified bar diameter by more than 3 mm. The other end shall be chamfered to facilitate installation.

Face plates shall have dimensions 150 mm x 150 mm, 8 mm thick for use with 25 and 32 mm diameter rock anchors of lengths greater than 1.0 m.

The face plates shall be fitted with a hemispherical washer to permit seating of the face plate at inclinations up to 30° from normal to the bolt.

The surface of the anchor bars shall be clean of rust, scale, dirt or other foreign matter.

The rods shall be manufactured from reinforcing bars B500A or B500C.

C. Grout

Grout should consist of the following:

- cement complying with provisions of **Error! Reference source not found.** and E N 197
- water complying with provisions of Chapter 4: and EN 1008
- admixtures, if required by the Engineer

Water to cement ratio of the grout mix should be in the range of 0.35 to 0.4.

The pressure for the application of grouting should be sufficient in order for the grout to fill the hole using a pump of minimum capacity 0.70 MPa.

Thick grout is pumped into the hole by inserting the grout tube to the end of the hole and slowly withdrawing the tube as the grout is pumped in.

For installation of anchors in boreholes with inclination that allows flow of the grout towards the surface of the excavation, the holes should be sealed during the injection of the grout.

Requirements to the ready grout:

- Viscosity: Measured by the Marsh's funnel, in seconds, at flowing of 0.7 l out of 1.0 l of grout, shall be in the range from 35 sec. to 40 sec.
- Spreading: Measured by the AzNII cone, in mm, shall be lower than 120 mm. The cone shall be with diameter d/D=35/66 mm and height H=58 mm.
- Bulk Density: Measured by hydrometer, shall be higher than 1880 kg/m^3.
- Water loss: Measured by one-litre cylinder, shall be lower than 5%.

D. Deviations

Rock dowels shall be installed within ±150 mm of the positions, and within ±5° of the alignment shown on the Drawings or agreed with the Engineer.

7.3.4 Testing

A. Preliminary tests

Prior to the installation of rock anchors in the Works the Contractor shall carry out a series of tests as agreed with the Engineer to prove the capacity of the system and the Contractor's capability to correctly install and tension the dowels.

The tests shall demonstrate:

(a) the strength of the cement grout to fully anchor the bars.

(b) the capacity of the equipment to install the longest fully grouted rock dowels.

(c) the capability of each crew to correctly install the rock dowels.

The Contractor shall undertake the tests with the equipment to be used on the Works and shall install the test dowels in a suitable rock face in a steeply upward direction.

The Contractor shall provide a suitably calibrated direct tensioning jack and/or load cell of capacities in excess of the characteristic strength of the rock dowels. Loads and deformations shall be recorded during the tests.

The tests will be pullout tests and at least 3 tests shall be performed for each combination of rock type / bolt type to be able to assess the suitability of the element.

B. Control tests

Criteria for determining the quality of installed anchors in control tests shall be determined with regards to the in situ geological environment, diameter and length of anchor and the time period after which the test is performed in relation to the time of anchor installation.

These criteria shall be determined by the Engineer as a complement to these technical conditions.

It is considered satisfactory for installed anchors, if the results of the control tests of individual anchors are not lower than 10% of the median for the control series, and if the mean value of the control series is not lower than 10% of the mean values of the corresponding series of tests in the initial phase of installing anchors.

If the control tests show that the installation of anchors in a particular area of excavation was not performed satisfactorily in terms of the above-mentioned criteria the Contractor shall, at its own expense, install additional anchors according to pattern approved by the Engineer. Additional anchors shall be of the same diameter and length as the previous. Number of additional anchors will be determinated by the Engineer.

During the progress of the work the Contractor shall, in general, perform pull- out tests, in the presence of the Engineer on at least 1 per 50 anchors installed or 2 tests per application area. The Engineer will determine the elements to be tested depending on the local conditions. In case of failure, additional testing shall be performed on selected anchors installed in the vicinity of the failed one.

Anchors shall be tested after grout has achieved its design strength.

C. Forces for pull – out tests

Pull-out tests will have to be performed under the following forces depending on the diameter and length of the bars of the anchorage system:

Diameter of rod (mm)	Length (m)	Force (KN)
25	3	40
25	4	50
32	6	90

Pull-out tests will be performed by reaching the above-mentioned pull-out strength multiplied by a factor of 1.25.

7.4 Welded Mesh

7.4.1 General

Welded mesh shall be installed as reinforcement for shotcrete usually in combination with rock anchors.

7.4.2 Program

Welded mesh will be used as reinforcement of the shotcrete that will be used for the stabilization of the cut slopes for the construction of the spillway and on slopes that the Engineer might indicate during the civil works.

7.4.3 Materials

The fabric will have a square mesh of 150 mm x 150 mm spacing made of wires with yield strength f_{yk}=500 MPa. The diameter of the wires shall be 8 mm.

7.4.4 Installation

The mesh shall be securely fixed at maximum centres 1 m both ways, generally in hollows at the optimum distance from the rock face for the application process such as to minimise rebound and prevent voids. The minimum cover between the mesh and the exposed face of the sprayed concrete shall be as presented in the Drawings unless a greater cover is ordered by the Engineer. Overlap of wire fabric shall be at least 3 times the mesh spacing with the clearance between parallel bars and not less than 300 mm.

Welded wire fabric shall be firmly stretched between the rock anchors. Care shall be taken to ensure that air pockets are not formed behind the wire mesh when used as a reinforcement for sprayed concrete.

7.5 Shotcrete

Materials, design, equipment, execution of works and testing must comply with the provisions of **Error! Reference source not found.**"Concrete", and Chapter 11: " Shotcrete".

7.6 Structural Steel Support

7.6.1 General

The Contractor shall install the structural steel support consisting of steel arches from HEB 120 as primary support measures for the excavations of the plug.

7.6.2 Materials

The steel arches will be from wide flanged steel sections HEB120 from steel class St. 37.2 or equivalent.

7.6.3 Installation

Steel arches shall be cold bent to the dimensions within 1% of the theoretical excavation profile. Reshaping of the bent arches at the place of installation may only be undertaken with the Engineer’s consent and only if the material properties would not be impaired. All structural steel used for arches shall be true to dimension, square,

plumb and level. Joints and intersecting members shall be accurately fitted with adequate fastenings. All work is subject to acceptance by the Engineer prior to installation.

When the conditions encountered at any location in the tunnel, are considered by which require the installation of steel arch supports, Contractor shall install such supports with the minimum possible delay after receiving written instructions from the Engineer. Whenever Contractor encounters conditions at any location which Contractor considers to require the installation of steel arch supports, Contractor shall immediately inform the Engineer, who will give his decision on such requirements. Should the Engineer consider that steel arches are not required for support of the excavation, the Contractor may, nevertheless supply and install steel arches for its own purposes, at his cost.

Steel arches shall be placed as near as possible to the excavated surface or current support and at a spacing as determined by the Engineer.

Concrete blocks shall be provided as footings for the steel arches. Use of timber as foot blocks shall be strictly prohibited. The foot plates shall be of sufficient size and rigidity. If required, the legs of the arches shall be anchored to the rock by the rockbolts.

Immediately after placing the arches in a correct position, they shall be interconnected and braced by means of steel rods or beams in order to prevent any displacement and to maintain spacing. Use of timber spreaders shall be strictly prohibited.

The space remaining between the outer flange of the steel arches and the rock surface shall be backfilled immediately after the arch has been placed with shotcrete over the entire circumference of the steel arch in order to provide uniform load distribution. In over-excavation, the bulk of the void space may be filled with concrete blocks or boulders, followed by the shotcrete. Shotcrete shall also be applied between the steel arches and encasing them to form an arched bracing in the direction of tunnel centreline.

The Contractor shall survey and record the position of all steel arches installed in order to facilitate drilling operations. Their position shall be marked on the finished concrete lining surface.

Blocking and wedges used to set the steel arches may be timber, steel, or concrete blocks. If timber is used, it shall be placed as individual blocks with sufficient space to permit the blocks to be encased in the shotcrete or concrete lining by at least the width of the wood block.

Any steel arches which have been improperly placed or which have become misaligned or damaged due to negligence of Contractor shall be adjusted, repaired or replaced by Contractor within 48 hours, after being notified by the Engineer.

In case the steel arches installed get buckled/distorted/damaged beyond repair and the Engineer certifies that this buckling/distortion/damage is purely on account of collapse/slide/free fall taking place due to adverse geological conditions and not because of any improper installation of arches including inadequate packing/wedging between the arch supports and rockmass or not due to inadequate and delayed treatment of excavated area, such failed/fallen, arches shall be removed by Contractor and replaced with arches acceptable to the Engineer.

Steel arches currently in place or placed in the frame of this Contract shall not be removed under any circumstance unless requested or authorised in writing by the Engineer.

7.7 Fibres

7.7.1 General

Fibres will be used as reinforcement for the shotcrete that will be used as support measure in underground excavations.

7.7.2 Materials

The reinforcing fibres to be used in the shotcrete will be synthetic macrofibres (∅>0.3 mm) based on polymeric material such as polyolefin. The length of each fiber will be 50 mm.

7.7.3 Application

The minimum dosage rate for the fibres will be 7.0 kgr/m^3 of shotcrete. The mean value of minimum three tests shall not be less than the minimum fibre dosage rate and none of the results of each test shall be less than 75% than the minimum fibre content. The fibre content shall be determined with at least 6 samples.

Chapter 8: DRAINAGE

8.1 General

This work shall consist of the construction of surface drains, subsoil drains, pipe culverts, box culverts and other drainage structures in accordance with this Specification or as directed by the Engineer. Drainage works shall be constructed to the lines, levels, grades and cross-sections shown on the Drawings or as directed by the Engineer.

8.2 Excavation and Backfilling for Drainage Works

8.2.1 Description

This work shall consist of excavation for the construction of surface drains, subsoil drains, cast in situ box culverts, and other drainage structures, and shall include furnishing, placing, compacting and shaping foundation bedding materials, backfilling excavations against completed structures with suitable material or granular backfill where specified, and the removal and disposal of all excess excavated material, in accordance with this Specification and as shown on the Drawings and required by the Engineer.

8.2.2 Excavation Material

The excavated material shall be classified as common excavation covering both soft material and rock.

(i) Granular Bedding Material

Granular bedding material for the foundations of structures shall be suitably graded broken rubble, crushed stone, crushed gravel, sand or other material as specified on the Drawings or as required by the Engineer.

(ii) Concrete Bedding

Concrete bedding or blinding for the foundations of structures shall conform to the requirements of the relevant Chapter of this Specification for the class of concrete specified on the Drawings or required by the Engineer.

(iii) Ordinary Backfill Material

Ordinary backfill material shall be suitable material as defined on the relevant Chapter of this Specification. The maximum particle size of the backfill material shall be 50 mm.

(iv) Granular Backfill Material

Granular backfill material shall be sand, crushed stone, crushed gravel or a mixture of crushed and natural aggregates, shall be essentially free from vegetation and other

organic matter and clay, and shall not contain lateritic or concretionary materials. The material shall conform to the following physical and mechanical quality requirements:

(i) the fines shall be non-plastic

(ii) sand shall have a gradation conforming to the envelope shown in the following table

Grading Limits for Sand Backfill

B.S. Sieve Size	% Passing By Weight
10.0 mm	100
5.0 mm	90 ÷ 100
1.18 mm	45 ÷ 80
300 µm	10 ÷ 30
150 µm	2 ÷ 10

(iii) material other than sand shall have a gradation conforming to one of the envelopes shown subsequently.

Grading Limits for Granular Backfill other than Sand

B.S. Sieve Size	% Passing By Weight		
	A	B	C
37.5 mm	100	-	-
28.0 mm	70 ÷ 100	100	-
20.0 mm	60 ÷ 90	70 ÷ 100	100
10.0 mm	45 ÷ 75	45 ÷ 75	-
5.0 mm	30 ÷ 60	35 ÷ 65	45 ÷ 75
2.0 mm	20 ÷ 50	20 ÷ 50	30 ÷ 60
425 µm	10 ÷ 30	10 ÷ 30	15 ÷ 35
75 µm	0 ÷ 2	0 ÷ 2	0 ÷ 2

(iv) concrete backfill: Concrete backfill where specified shall be of the grade as shown on the Drawings and shall conform to the relevant Chapters of these Specifications.

8.2.3 Excavation

The Contractor shall notify the Engineer sufficiently in advance of the beginning of any excavation so that cross-section elevation and measurements may be taken of the undisturbed ground. The natural ground adjacent to the structure shall not be disturbed without permission of the Engineer.

Trenches and foundation pits for structures and structure footings shall be excavated to the lines, grades and elevations shown on the Drawings or as directed by the Engineer. Excavations must be kept free from water and temporary drains, sumps and pumps shall be provided when necessary. The rate of excavation and backfill shall be approved by the Engineer.

Boulders, logs and other objectionable materials encountered in excavation shall be removed.

After each excavation is completed the Contractor shall notify the Engineer to that effect and no footing, bedding material or structure shall be placed until the Engineer has approved the depth of excavation and the character of the foundation material.

Rock and other hard foundation material shall be cleared of all loose material and cut to a firm surface, either level or stepped or serrated, as specified or shown on the Drawings or directed by the Engineer. All seams and crevices shall be cleared out and grouted with Portland cement grout at the time the footing is placed.

All loose and disintegrated rock and thin strata shall be removed. When the footing is to rest on material other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall be deferred until just before the footing is to be placed. When, in the opinion of the Engineer, the foundation material is soft or mucky or otherwise unsuitable, the Contractor shall remove the unsuitable material and insert foundation fill material or concrete as specified or shown on the Drawings or directed by the Engineer. If foundation fill material is required, it shall be placed and compacted in layers not more than 150 mm thick or as directed by the Engineer. The degree of compaction shall be equivalent to that of the surrounding foundations.

All excavation surfaces and surfaces of backfill material against which concrete is to be placed shall be even and firm and true to line and level.

All excavated material that is suitable for construction shall be utilized as backfill or embankment. The surplus material, whether or not temporarily allowed to be placed within a stream area, shall be finally disposed of in such a manner as not to obstruct the stream nor otherwise impair the efficiency or appearance of the works, nor is it to endanger the partly finished structure.

Excavated material suitable for use as backfill may be deposited by the Contractor in storage piles at points convenient for rehandling of the material during the backfilling operation.

Excavated material shall be deposited in such places and in such a manner as not to cause damage to roads, services or property either within or outside the Works reserve, and so as to cause no impediment to the drainage of the Site or surrounding area.

8.2.4 Backfilling with Ordinary or Granular Backfill Material

All spaces excavated under this Specification and not occupied by a permanent structure shall be backfilled. Backfill material shall be free from large lumps, wood and other extraneous material.

Backfill not within the embankment areas shall be placed in layers not more than 250 mm in depth (compacted measurement) and shall be compacted to a density comparable with the adjacent undisturbed material.

Backfill within the embankment areas shall be made with approved material placed in uniform layers not to exceed 150 mm in depth (compacted measurement) and each layer shall be constructed in accordance with Chapter 3: of this Specification except that mechanical tampers may be used for compaction. Each layer of backfill shall be wetted uniformly as necessary and compacted to the same requirements as the adjacent earthwork as specified in Chapter 3: of this Specification. Unless otherwise approved by the Engineer, hand tamping will not be accepted.

In placing backfill and embankment, the material shall be placed insofar as possible to approximately the same height on both sides of the structure. If conditions require backfilling appreciably higher on one side, the additional material on the higher side shall not be placed until permission is given by the Engineer or until the Engineer is satisfied that the structure has enough strength to withstand any pressure created.

No backfilling shall be placed against any structure until the Engineer has given permission. Jetting of fill or other hydraulic methods involving, or likely to involve, liquid or semi-liquid pressure shall be prohibited.

Special care shall be taken to prevent any unduly high pressures against the structures. The placing of embankment and the benching of slopes shall continue in such a manner that at all times there will be a horizontal berm of thoroughly compacted material for a distance at least equal to the height of the abutment or wall to be backfilled.

8.3 Surface Drainage

Surface drains of the types shown on the Drawings shall be constructed to the lines, levels, grades and cross-sections as specified or as directed by the Engineer.

Any of the above drains may be constructed either unlined or lined using cast in-situ concrete, precast or porous concrete drain sections, or stone pitching.

In case of main drainage ditches with intense longitudinal slopes wooden check dams will have to be constructed to minimize water velocities and silt transportation. The cross-section of the check dams is shown in the Drawings and their locations will be determined by the Engineer, based on the site conditions.

Excavation for unlined drains shall be trimmed to form a smooth, firm surface to the required lines, levels, grades and cross-sections as shown on the Drawings or as required by the Engineer.

Any areas of over excavation shall be restored to the satisfaction of the Engineer, all at the Contractor's expense.

8.3.1 Surface Drain Construction

8.3.1.1 Unlined Drains

Excavation for unlined drains shall be trimmed to form a smooth, firm surface to the required lines, levels, grades and cross-sections as shown on the Drawings or as required by the Engineer. Any areas of over excavation shall be made good to the satisfaction of the Engineer, all at the Contractor's expense.

8.3.1.2 Cast in Situ Concrete Drains

Excavation shall be carried out to the lines and levels as specified and as shown on the Drawings. Templates which may be of timber or steel shall then be provided to ensure the thickness and shape of the concrete, drains. The concrete shall be poured in sections not exceeding 2 m unless indicated otherwise, in length and shall be carried out between end forms in alternate bays. Construction joints shall not be formed in the inverts.
All concrete shall be Grade C30 concrete unless otherwise specified and shall conform to the requirements of this Specification. Weep holes shall be cast in-situ as shown on the Drawings or as directed by the Engineer.

Chapter 9: DRILLING AND GROUTING

9.1 General

9.1.1 Scope

According to this Technical Specification, the Contractor will provide materials, equipment and labor for all the activities related to the drilling and grouting works. Drilling and grouting works for the Project include:

I. Drilling for grouting, testing and instruments installation

II. Exploratory holes with core recovery

The Contractor's attention is drawn to the fact that the number, location, direction and depth of each grout hole, the order and sequence of drilling and grouting, the proportions of the constituents of the grout, the time of grouting, the pressure used in grouting, the amount of grout injected, are all uncertain and are subject to modification by the Engineer depending on conditions encountered as the work progresses. The unit rates bid for drilling and grouting shall be deemed to include for all costs arising from such modifications, which may result in increase or decrease of the quantity estimated in the Bill of Quantities.

The Engineer’s approval in writing shall be obtained before any pressure grouting operations are performed. All Construction Plant and materials required or which may be required during drilling, water pressure testing, grouting, cleaning and other attendant operations in grouting shall be on Site and fully prepared for the work. The Engineer’s approval to commence drilling and grouting will only be given after all these preparations and other relevant requirements of the Specification have been complied with.

No drilling will be carried out until all excavations with explosives have been concluded in the area.

The Contractor shall ensure that at all times the injection operations are under the direct control of skilled and experienced specialist engineers and chargehands, who will be responsible for ensuring that good practice is observed.

The Contractor shall supply all the required plant and piping necessary for drilling, testing and grouting holes at all stages.

9.1.2 Standards and Guides

The following publications under the titles listed below, but referred hereinafter by basic designation only, present part of these Technical Specifications. Where the European standards are not applicable, American or other international standards will be followed, after approval by the Engineer.

STANDARDS	DESCRIPTION
EN 197-1	Cement – Part 1: Composition, specifications and conformity criteria for common cements
EN 197-2	Cement – Part 2: Conformity Evaluation
EN 206 -1	Concrete – Part 1: Specification, performance, production and conformity
EN 1008	Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water
EN 12620	Aggregates for concrete
EN 933	Testing of Geometric Characteristics of aggregates
EN 934-4	Admixtures for concrete, mortar and grout. Admixtures for grout for pre-stressing tendons. Definitions, requirements, conformity, marking and labelling
EN 1008	Mixing water for concrete. Specification for sampling, testing and assessment of water suitability
EN 12350	Testing of fresh concrete. Part 1: Sample Taking
EN 12390	Testing of hardened concrete
EN 12715	Execution of special geotechnical works – Grouting
EN ISO 13500 E2	Petroleum and natural gas industries – Drilling fluid materials - Specifications and tests
EN ISO 22282-2	Geotechnical investigation and testing -- Geohydraulic testing – Part 2: Water permeability tests in a borehole using open systems

9.1.3 Submittals

A. Submittals preceding Construction Works commencement

Not later than 5 days before commencement of drilling and grouting works, the Contractor shall submit for Engineer's approval details of offered methods, procedures measuring and reporting and a list of equipment the Contractor intends to use for drilling and grouting operations as specified for the different applications.
All details, specifications and number of offered equipment shall be given in an Engineering Report including type and number of special equipment to be employed in restricted spaces.

B. Submittals during Construction Works

The Contractor shall submit all results from grout tests carried out by him prior to and in the process of drilling and grouting works. Results from material and grout tests shall be submitted within 5 days of the test performance unless otherwise specified within.
Logs for the drilling, water testing and grouting shall be submitted to the Engineer not later than 24 hours after the execution of a given borehole. The as-builtDrawings shall be drawn up in the course of execution of the drilling and grouting works and shall be

submitted to the Engineer upon request or within 7 days after completion of a given section.
The Contractor shall submit to the Engineer three-month reports showing in summary the performance of tests and the results of the drilling and grouting works.
Every month the Contractor shall submit a detailed program of drilling and grouting works performance, current reports andDrawings showing the progress of the works, including works related to instruments installation.

9.2 Drilling Works

9.2.1 Program

The layout and the depth of the drilling works for the grouting is presented in the related Drawings.

9.2.2 Drilling Equipment

Boreholes in rock with core recovery
Holes with core recovery in rock shall be drilled with standard rotary drills and core drilling equipment using double-tube core barrels with bottom discharge bits. For drilling through rock, diamond core cutters will be used. The rigs shall be capable of drilling vertical and inclined boreholes in rock to depths of more than 45 m. The rigs should be capable of installing protective casing to the full depth of the hole in case of difficulty in advancing the borehole due to wall instability or any other reason. The minimum core diameter shall be 62 mm. The diameter of the hole will be such that allows the above minimum core diameter. For instrument installation the minimum diameter of the hole will be 100 mm.
Drilling for grouting without core recovery
Grout holes shall be drilled with rotary or rotary-percussive drills with bits, but up to 10% of the grout hole length may be ordered by the Engineer to be drilled with core recovery drilling methods. The drilling rig must be capable of drilling vertical and inclined boreholes in any kind of ground of a diameter not less than 62 mm to the depths shown on the Drawings and shall be equipped to provide a continuous water flush of not less than 15 l/min issuing from the drill bit.
Boreholes for the grout curtain will be of a diameter not less than 62 mm. Where core recovery is required, the minimum core diameter shall be 62 mm.
The use of grease or other lubricants on the drill rods or in the grout holes will not be permitted but an approved neutral liquid soap may be added to the drill water.

9.2.3 Washing and Cleaning

At the completion of the drilling of any stage and before grouting is commenced, the drilling water shall be allowed to run until the return water from the hole is clean. The quantity of water flowing into the hole during this washing period shall not be less

than 15 l/min. If necessary, air and water under pressure shall be used to remove erodible material.
In case that connections take place to adjacent holes, the washing shall be continued until the flow of water from the hole to which the connection was made is clear.

9.2.4 Storage and Preservation

The borehole cores will be placed into special wooden boxes, so as their mechanical integrity will be preserved. The soil samples will be wrapped in celluloid and double plastic bags, to preserve their natural water content. Each wooden storage box will labeled with the title of the project, the Contractor's legend, the code of the borehole as well as the depth of the containing samples. The samples will be photographed in-situ together with a colour code and a scale. The borehole cores shall be logged and described by a geologist.

9.2.5 Reporting for the Drilling Works

The Contractor must submit daily reports for the drilling works. The reports should include the following:

- Purpose of borehole (e.g. instrument installation, curtain grouting etc.)
- Borehole code
- Date of drilling (start and finish times)
- Position
- Inclination
- Type of drilling and borehole diameter
- Depth
- Elevation of top and bottom of borehole
- Water level in the borehole
- Percentage of core recovery (for exploratory boreholes)
- Encountered formations descriptions
- RQD

For the borehole codes of the grout curtain the following should be followed:

- According to the category of the borehole, (P) for primary, (S) for secondary, (T) for tertiary and (Q) for quaternary.
- The Chainage for each hole according to the grout curtain axis.

A different coding might be proposed by the Contractor for approval by the Engineer.

For the control holes, the letter (C) will be used and the Chainage that each hole is drilled.

9.3 Grouting Works

9.3.1 Program

The layout and the depth of the grouting works is presented in the related Drawings.

9.3.2 Injection Equipment

Grout pumps shall be of variable pressure ram type continuous supply pumps or other approved type of pumping equipment that is capable of continuous delivery of grouts up to the maximum pressures required. A standby pump shall be supplied as part of the grouting plant. In no circumstances shall grouting equipment relying on the direct application of air pressure be used for injection. Each pump shall be provided with two mixing tanks of about 500 litres capacity, each tank having a mechanical mixer and arranged so that grout is mixed effectively in the first tank using a high speed impeller type mixer (min. speed 1500 rpm) and delivered through a screen to the second or agitator tank. The suctions of the grout pump shall be connected only to the delivery from the second tank. The mixer shall be provided with an accurate meter, reading in litres to an accuracy of one tenth of a litre, for controlling the amount of mixing water used in the grout.
When it will be necessary to incorporate sand, silt or other inert filler in the grout in proportions greater than one part filler to one part cementitious material, the grout shall be mixed in a high speed colloidal unit capable of producing a highly intimate mixture of main and subsidiary ingredients.
Where bentonite is incorporated in the grout, separate mixing tanks must be provided in which the bentonite-water mix can be prepared and kept agitated until required.
The piping system employed will be of the continuous circulation type. Holes shall be injected by direct connection to the grouting plant. The manifold at the top of the grout pipe shall be provided with a pressure gauge, a relief valve and a valve enabling the delivery from the pump to be cut-off from the hole. A return grout line, equipped with a pressure relief valve set to the required pressure, shall be connected to the manifold as a precaution against the application of excessive pressures which might cause up-lift and to allow continuous circulation of the grout. The return line shall be led back to the agitator tank. An accurate pressure gauge shall also be provided at the grout pump.

9.3.3 Materials – Requirements

General
The water to cement ratio will normally be in the range 2:1 to 0.6:1 by weight. Bentonite will be added in quantities varying from 0.5 to 2.5% by weight of cement in

order to minimise bleed and achieve a stable grout. Where grout consumption is large the use of sand or other inert filler in the basic grout may be approved by the Engineer. The Contractor shall make tests with the materials available and submit proposals for grout mixes for the approval of the Engineer at least 5 days prior to their application.

Water

The water that will be used for grouting and pressure testing must be clean and must not contain acids, alkaloids or high content of salt, silt, organic impurities and sediments. The water must not contain materials that will affect negatively the grouting works or the grout mix and shall conform to the requirements of BS EN 1008. Lab testing for the quality of the water can be requested by the Engineer.

Cement

Cement that will be used must conform to the following requirements:

- EN 197-1
- EN 197-2

The main type of cement to be used is Portland Composite Cement Type CEM II/B-M (W-T) 42,5N – microcement with cement particles size smaller than 45 μm, 0% residue on 90 μm sieve and specific surface higher than 3500 cm^2/gr by Blaine, conforming to EN 197-1.

The cements to be used for the grout mix shall comply with Technical Specifications TS 2.3.3 "Cement" and will submitted to the Engineer for approval 2 months before the start of grouting.

Cement will be supplied in bags. Quantities must be sufficient, so that no interruption of the works can be caused due to lack of materials.

Sand

Sand must conform to the requirements of EN 12620.

Maximum dimension and shape of sand particles should exclude every possibility of blocking the tubes during pumping of the grout, in the lowest design pressure and for the lowest water to cement ratio.

Admixtures

Admixtures that might be used should conform to the requirements of EN 934-4.

If the use of Sodium Silicate is required by the Engineer, then it should conform to the following requirements:

- Chemical type Na2SiO3
- Viscous liquid
- Ratio SiO3/Na2O>3
- pH 12
- Density in Baume units 39

Bentonite

Bentonite shall be from an approved source. The Contractor shall obtain a certificate from the manufacturer of the bentonite powder, stating from which manufacturer's consignment the material delivered to Site has been taken, and showing properties of the consignment. The certificate shall indicate the type, the moisture content and the liquid limit of the bentonite provided. The liquid limit must have a mean value higher than 350%, for every 3 tests. This certificate shall be made available to the Engineer on request.

Before use in preparing the grout mix, bentonite shall be mixed with water with a proportion of 9 parts of water to 1 part of bentonite. The mixing will be done 6 hours before the use of the mixture in the grouts.

Grout mixes

Stable grouts will be used for the grouting in Mara Valley Project construction with consistencies:

Water to Cement ratio by weight	Bentonite percentage by cement weight
2:1	*2.5%*
1.5:1	*1.5%*
1:1	*1%*
0.8:1	*0.5%*
0.7:1	*0.5%*
0.6:1	*0.5%*

Addition of fine sand, admixtures and different grout consistencies might be ordered by the Engineer in order to suit grouting needs.

Required properties

The grout should meet the following requirements:

- Maximum bleed (water separation) 5%,
- Marsh cone less than 45sec,
- Minimum grout compressive strength in 70mm cubes after 7 days 5 MPa,
- Density of grouts:

  W:C ratio 2:1, $\geq$ 1,25 g/cm^3

  W:C ratio 1.5:1, $\geq$ 1,32 g/cm^3

  W:C ratio 1:1, $\geq$ 1,43 g/cm^3

  W:C ratio 0.8:1, $\geq$ 1,50 g/cm^3

  W:C ratio 0.7:1, $\geq$ 1,55 g/cm^3

W:C ratio 0.6:1, $\geq$ 1,61 g/cm^3

9.3.4 Testing and Quality Control

Required testing before starting of grouting
The Contractor will perform the following testing (minimum of three tests per consistency) on grout consistencies (W:C) 2:1,1.5:1, 1:1, 0.8:1, 0.7:1 and 0.6:1, and submit the results to the Engineer for approval, at least 5 days before the commencement of the grouting operations:

- Density
- Marsh cone viscosity
- Water separation (bleed) 2hr after preparation, with the specimen placed in the shade at temperature between 17 and 22O Centigrade
- Setting time with Vicat needle

Additional to that, the compressive strength will be measured on 70 mm cubes for consistencies 1:1, 0.8:1 and 0.6:1 (minimum of three tests per consistency) after 7 and after 28 days.
The Engineer will examine the results and might propose changes and/or additional testing to be carried on before commencement of grouting.
Required testing during grouting operations
The Contractor shall perform testing for all used grout consistencies and immediately submit to the Engineer for approval. The frequency of grout testing will be as follows.
Every hour:

- Density.
- Temperature.
- Marsh cone viscosity.

Every day:

- Water separation (bleed) of all used grout mixes
- Setting time with Vicat needle of all used grout mixes

Every week:

- Compressive strength will be measured on 70mm cubes

The above testing frequency might be adjusted by the Engineer to better serve the monitoring and quality control of operations. All tests will be submitted for approval within 12 hr from execution.

9.3.5 Injection of Grout – Procedures

For the grout curtain, the grouting pressure will be the maximum that do not cause hydraulic fracture and/or up-lift in the rock mass. Unless otherwise directed by the Engineer the maximum pressure at the injected depth for holes drilled from the surface should be:

- for depths up to 5 m - 0.25 MPa (~2.5 bar);
- for depths from 5 to 10 m - 0.5 MPa (~5 bar);
- for depths from 10 to 15 m - 0.7 MPa (~7 bar);
- for depths from 15 to 20 m - 0.9 MPa (~9 bar);
- for depths from 20 to 25 m - 1.2 MPa (~12 bar);
- for depths from 25 to 30 m - 1.5 MPa (~15 bar);
- for depths from 30 to 35 m - 1.8 MPa (~18 bar).
- for depths from 35 to 40 m - 2.1 MPa (~21 bar).
- for depths from 40 to 45 m - 2.4 MPa (~24 bar).

Where grout holes are above the water table, these shall be saturated with water over a period of 30 minutes, (pressure to be determined on site) directly in advance of the grouting.

The holes will be drilled to the full depth and will be flushed out and grouted in upwards stages. Each stage will be grouted using a single packer.

The grout mix will be gradually thickened in relation to the variation of the pumping rate and pressure built up during the injection. The grout injection will start with applying a pressure of 0.1MPa (~1bar) for 5 minutes and then gradually increasing the pressure over the next 25 minutes until the maximum specified pressure is reached.

The stage can be considered as being complete when the absorption of grout at the required pressure is less than 1 lt/m/min averaged over a period of 10 minutes. The final grouting pressure will then be maintained for another 10 min and after that the stage will be considered completed and the packer will be moved to the stage above.

Once the grouting of a stage has been commenced it shall be continued without interruption until completion. However, where the grout hole continues to take a large amount of grout, even after the mix has been thickened (total absorption larger than 400 litres per metre of hole), the Engineer may order the pumping to be stopped and continued after 24 hours. The hole will then be re-drilled to the bottom of the problematic stage and grouting will resume. If the pressure cannot be reached after another 400 lt per metre of hole, a grout mix with fine graded sand will be used until

pressure is built up. Then the grouting will continue without sand until the stoppage criteria are met.

In places where the loss of grout is attributed to underground flowing water, additives such as Sodium Silicate will be used to speed up setting time.

The following procedure will be applied regarding thickening of the grout mix:

- An initial consistency of 2:1 by weight (W:C) will be applied.
- If the pumping rate does not decrease and / or the pressure does not reach the maximum value after the injection of 50lt/m, the mix shall be thickened to a consistency of 1.5:1 by weight.
- If the pumping rate does not decrease and / or the pressure does not increase after the injection of another 50lt/m the mix shall be thickened to a consistency of 1:1 by weight.
- If the pressure rate does not decrease and / or the pressure does not increase after the injection of another 50lt/m the mix shall be thickened to a consistency of 0.8:1 by weight.
- If the pressure rate does not decrease and / or the pressure does not increase after the injection of another 50lt/m the mix shall be thickened to a consistency of 0.7:1 by weight.
- Finally, if the discharge rate is not gradually reduced and / or the design pressure is not reached after the injection of another 200lt/m the injection will be terminated. The hole will be re-drilled after at least 24 hours and grouted again as described above.

Should it be necessary to interrupt an injection before it is complete, for instance if there is a plant breakdown, about 500 litres of clean water shall be run into the hole before it is allowed to stand.

Should any hole link to another during injection, the grout shall be allowed to escape from the linked hole until it is of the same consistency as that being injected; the linked hole shall then be plugged and the grouting of the initial hole continued.

Where leakages of grout occur on the ground surface they shall be restricted by caulking or by thickening the grout, followed by retreatment with thinner grouts if necessary.

After satisfactory tests on completion of grouting in an area, all grout holes and water pressure test control holes shall be filled with thick grout (consistency of 0.6:1 from the bottom of the hole upwards so as to ensure that no significant voids exist.

The grout preparation and injection plant should be such that continuous and uninterrupted flow of grout is ensured at all times. Stand-by equipment should be available, ready to be put into operation should any of the main equipment breaks down.

A circulation system will always be used, linking the agitator tank, the grout pump, and the head of the grouted hole and back to the tank. In order to prevent excessive warming and aging of the grout during repeated circulation the temperature and viscosity will be tested continuously. Grout in circulation for more than 2hours will be disposed off and a new batch will be prepared.

9.3.6 Reporting for the Grouting Works

The Contractor must submit daily reports for grouting works. The reports should include all necessary information including the following per stage of grouting:

- Borehole code
- Date of works
- Position
- Inclination
- Depth of interval
- Mixture composition - consistency
- Pressure
- Time that injection started
- Absorption
- Time of interruption of the injection
- Diameter of borehole

Chapter 10: JOINTS and JOINT SEALERS

10.1 Water-Stops

The Contractor shall supply and fix water-stops in all contraction and expansion joints in structures which are to be water retaining and where shown on the Drawings. Such joints shall be watertight.

Water-stops unless otherwise specified shall be of rubber or PVC. They shall be obtained from manufacturers approved by the Engineer and shall be stored, fixed and jointed in accordance with the manufacturer's instructions. They shall be fabricated into the longest practicable units complete with angles and junctions, at the manufacturer's plant, and shall be made continuous throughout the structure and below the highest water level. The Contractor's proposals for jointing water-stops on Site shall be to the approval of the Engineer. Rubber water stops shall be jointed with an approved sleeve jointing system, and PVC joints shall be welded.

The water-stop shall be carefully maintained in the required position and properly protected from damage and the harmful effects of light and heat during all stages of construction. The stop-boards on each side of the water-stop shall be accurately wrought to match the profile of the water-stop. The concrete shall be carefully compacted under and around the water-stop so as to leave no cavities.

The Contractor shall supply the manufacturer's test certificates for each consignment of water-stop delivered to Site, and shall, if requested, supply to the Engineer certificates, sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure.

10.1.1 PVC Water-Stop

The PVC for PVC water-stop shall be high grade primary polyvinyl chloride containing no filler reclaimed or scrap material. It shall comply with the following specifications or equivalent.

Sika® Greenstreak® PVC Waterstops		
Property	Test	Value
Water absorption	ASTM D570	0.15% max.
Tear resistance	ASTM D624	300 lb/in min.
Ultimate elongation	ASTM D638	350% min.
Tensile strength	ASTM D638	2000 psi min.

Low temperature brittleness	ASTM D746	Passes @ -35°F / -37°C
Stiffness in flexure	ASTM D747	700 psi min.
Specific gravity	ASTM D792	1.38 max.
Hardness Shore A15	ASTM D2240	79±3
Accelerated extraction		
-Tensile strength	Corps of Engineers CRD-C 572	1600 psi min.
-Elongation		300% min.
Effect of Alkali		
-Weight change	Corps of Engineers CRD-C 572	+0.25% -0.10%
-Hardness change		+/-5 points

For the installation of the PVC Water-Stops the Contractor shall follow the guidelines and of the Manufacturer.

10.1.2 Rubber Water-Stop

The rubber for rubber water-stop shall satisfy the following requirements when tested as moulded sheet in accordance with BS 903-5:2004 “Physical testing of rubber. Guide to the application of rubber testing to finite element analysis” and ISO 815:2008 “Rubber, vulcanized or thermoplastic – Determination of compression set at ambient, elevated or low temperatures”.

Minimum tensile strength	20 N/mm² (204 kg/cm²)
Minimum elongation at break	500%
Hardness	60 to 65 degrees
Maximum compression set by constant deflection method	20% of original deflection
Maximum water absorption after 2 days at 20° C	5%
After accelerating ageing (48 hours at 70°C in oxygen at 2.0 N/mm² (20 kg/cm²)	
Minimum tensile strength	75% of initial value
Minimum elongation at break	75% of initial value

10.1.3 Hydrophilic Swelling Waterstop

This waterstop tape will have certified characteristics equivalent or better to SIKASWELL A2010.

Placing will satisfy the following:

- The substrate must be sound, clean, dry, 'mat damp', free from all surface contaminants.
- All loose particles, release agents, laitance, paint, rust and other poorly adhering materials must be removed by suitable hand or mechanical preparation.
- Required concrete cover 8 cm on both sides.
- It is important that a full and continuous contact between the profile and the substrate is achieved.
- During concreting, compact the concrete well around the profile, in order to ensure that a dense concrete, without any honeycombs or voids, is produced.
- Once installed, the profile shall be protected against water until the concrete is placed.

10.2 Joint Fillers – General

The Contractor shall supply and fix joint fillers in movement joints. Unless otherwise specified the joint filler shall be of impregnated fibreboard or resin bonded cork. It shall be obtained from manufacturers approved by the Engineer and shall be stored and fixed in accordance with the manufacturer's instructions. The joint filler of the material and thickness specified, shall be cut to shape and fixed to fill the whole space between the concrete faces to the joint not otherwise filled by water-stop and joint sealer. Abutting pieces shall be placed in close contact and the joints covered on each side to prevent the passage of cement grout.

The Contractor shall supply the manufacturer's test certificate for each consignment of each type of joint filler delivered to Site and shall, if requested, supply to the Engineer certificates, sufficient of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate standard test procedure.

10.2.1 Cork Filler

The resin-bonded cork filler shall comply with United States Federal Specification HH-F-341 "Filler, expansion joint, bituminous (asphalt and tar) and non-bituminous (preformed for concrete" Type II Class B (and ASTM D1751-04 "Standard specification for performed joint filler for concrete paving and structural construction") with the following limitations when tested in accordance with the above Specification:

(i) The load required to compress the material to 50% of its thickness shall be more than 0.035 N/mm² and less than 0.35 N/mm².

(ii) The recovery after compression to 50% of the original thickness shall be to not less than 95% of the original thickness.

10.2.2 Dowel Bars

Where dowel bars are to be provided through movement joints the part of the bar to be free to move shall be coated with bitumen and fitted with a compressible cap of material as specified for impregnated fibreboard joint filler or other materials approved by the Engineer.

10.3 Joint Sealers – General

The Contractor shall construct recesses for joint sealers where ordered at movement joints. The recesses shall be accurately formed to the lines and dimensions ordered by the Engineer.

The Contractor shall prepare the surfaces of the recess and shall supply a joint sealer and fill or caulk the recess completely with it. The joint sealer shall be either a non-sagging elastomeric polysulphide or a polyurethane based compound similar or better than Sikaflex 1a. It shall be approved by the Engineer before ordering and shall be used in accordance with the manufacturer's instructions, inclusive of the supply and application of any priming materials or bond breakers. The application of joint sealer shall not be commenced without the Contractor having first obtained the approval of the Engineer.

The Contractor shall supply the manufacturer's tests certificate for each consignment of each type of joint sealer delivered to Site and shall, if requested, supply to the Engineer sufficient samples of each type and consignment for confirmatory tests to be carried out in accordance with the appropriate test procedure.

10.3.1 Polysulphide Sealer

The polysulphide based compound for joint sealing shall comply with EN ISO 11600:2002 “Building Construction. Jointing products. Classification and requirements for sealants” or DIN 18540 “Sealing of exterior wall joints in building using joint sealants”. It shall be non-sagging for use in vertical joints and light grey in colour for use with concrete.

10.3.2 Bitumen-Coated Joints

Where bituminous paint is required between concrete faces the Contractor shall clean and dry the face to which the bitumen is to be applied and shall then paint the bitumen in two separate applications. The bitumen shall be a straight run bitumen, Grade 40/50 penetration, or other approved by the Engineer.

Chapter 11: SHOTCRETE

11.1 General

11.1.1 Scope

This specification deals with concrete or mortar which is pneumatically placed onto a surface. Sprayed concrete covers both wet and dry processes. Preferable technology is wet.
Sprayed concrete can be categorized according to application as follows:

- Repair
- Supporting rock and excavation
- Short-term support
- Surface improvement
- Structural

Accordance with these Specifications, the Contractor shall:

- to supply all facilities, materials, equipment, labor and other kinds of works, required for production, transportation, placement, protection, curing and repair of shotcrete
- supply and place needed reinforcement
- supply the materials in needed volume and quality
- provide needed test for the quality of the used material
- provide communication connection between the members of the construction team.

11.1.2 Definitions

Sprayed concrete is a mixture of cement, aggregate and water projected pneumatically from a nozzle into place to produce a dense homogeneous mass. Sprayed concrete normally incorporates admixture sand may also include additions or fibres or a combination of these.
Wet process is a technique in which cement, aggregate and water are batched and mixed together prior to being fed into a purpose-made machine and conveyed through a pipeline to a nozzle where the mixture is pneumatically and continuously projected into place. The mixture normally incorporates admixtures and may also include additions or fibres or a combination of these.
Dry process is a technique in which cement and aggregate are batched, mixed and fed into a purpose made machine wherein the mixture is pressurised, metered into a compressed air stream and conveyed through hoses or pipes to a nozzle where water is introduced as a spray to wet the mixture which is then projected continuously into place. The mixture may also incorporate admixtures or additions or fibres or a combination of these.

Layer is a term used for a discrete thickness of sprayed concrete, built up from a number of passes of the nozzle and allowed to set

Rebound losses are part of the overall production losses and consist of material which, having been sprayed through the nozzle and struck the surface, does not adhere.

Nozzle is the equipment through which the mix is discharged; it consists of a pipe with a mixing unit into which constituents are injected. With the dry process, water and any liquid admixtures are added with the wet process, liquid admixtures and pressurized air are added.

Binder is the total amount of cement and cementitious addition in the sprayed concrete.

Fibre reinforced sprayed concrete is primarily made of cements, aggregates and discrete reinforcing fibres. Fibres suitable for reinforcing concrete and mortar have been produced from steel and organic polymers. Glass and carbon fibres have also been used in mortar matrices.

11.1.3 Building Codes

This Technical Specification is produced based on the following Standards and Codes.

EN14487-1 Shotcrete. Part 1: Definitions, Specifications and Conformity.

EN14487-2 Shotcrete. Part 2: Execution.

EN 14488-1 Testing of Shotcrete. Part 1: Sampling of Fresh and Hardened Concrete.

EN 14488-4 Testing of Sprayed Concrete. Part 4: Bond Strength of Cores. 7268 Concrete. Classification and Technical Requirements.

EN 206-1 Concrete. Part 1: Specification, Performance, Production and Conformity.

EN 206-1/NA Concrete. Part 1: Specification, Performance, Production and Conformity. National Appendix (NA) to EN 206-1:2002.

EN 932-(1-6) Testing the Main Properties of Aggregates. Parts 1 to 6.

EN 933-(1-9) Testing the Geometrical Characteristics of Aggregates. Parts 1 to 9.

EN 1008 Mixing Water for Concrete. Specification for sampling, testing and assessment of the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete.

EN 1097-(2-9) Testing of Mechanical and Physical Properties of Aggregates. Parts 2 to 9.

EN 1504-1 Products and Systems for Protection and Repair of Concrete Structures – Definitions, Requirements, Quality Control and Conformity Assessment – Part 1: Definitions

EN 12350-(1-7) Testing of Fresh Concrete. Parts 1 to 7.

EN 12390-(1-8) Testing of Hardened Concrete. Parts 1 to 8.

EN 12620+A1/NA Aggregates for Concrete. National Appendix (NA) to EN 12620+A1: 2008.

Regulations for Control and Acceptance of Concrete and Reinforced Concrete Structures.

11.1.4 Documentation to be Submitted by the Contractor

- Aggregates. Water for Aggregate Washing. Producer's certificate and declaration of conformity for all shipments and all required test results.
- Shotcrete Mixing Water. Shotcrete Curing Water, Design for provision of water for production needs – sources, location. Certificate for conformity and meets EN 1008.
- Bunkers for aggregates handling. Report should include dimensions, type and capacity of each piece of facility. Test results for conformity with the specification shall also be submitted.
- Certificate and declaration of conformity from the Manufacturer and/or the Distributor for all delivered facilities and equipment.
- Certificate and declaration of conformity from the Manufacturer and/or the Distributor for all delivered machines and equipment.
- Transportation Equipment Certificate
- Shotcrete Placement. Methods of shotcrete placement, data about shotcrete transportation and placement facilities and equipment, shotcrete curing –
- The Method Statements shall obligatorily contain a time schedule in real time for execution of the concrete works on the structure.
- Concrete Curing. Methods and materials for ensuring of the conditions for concrete maturing.
- Construction Laboratory Accreditation certificate according to EN ISO / IEC 17025
- Concrete Mix Designs. Test results of concrete and concrete component samples. Within 7 days after the Contract signing, schedule for designing, testing and certification of the shotcrete mix designs for all structures.
- The final shotcrete mix designs shall be submitted within 5 days from the start of construction of a given structure.

11.1.5 Delivery and Storage

All materials must be delivered on Site in original, new, unopened packages and containers bearing the Manufacturer's name and label and the following information:

- specifications, function, if applicable
- Manufacturer's stock numbers and the date of manufacture
- Manufacturer's name
- contents by volume
- thinning instructions
- application instructions

- labour safety instructions
- fire safety instructions, and
- colour name and numbers.

Materials must be stored and preserved in compliance with the Manufacturer's instructions at adequate specified temperature and must be protected from moisture Materials shall be only used within the pot life recommended by the Manufacturer.
Thinners must be added and components must be mixed with strict adherence to Manufacturer's instructions.
Measures must be undertaken to prevent coating damages while transporting, storing and laying pipes with applied anticorrosion system.

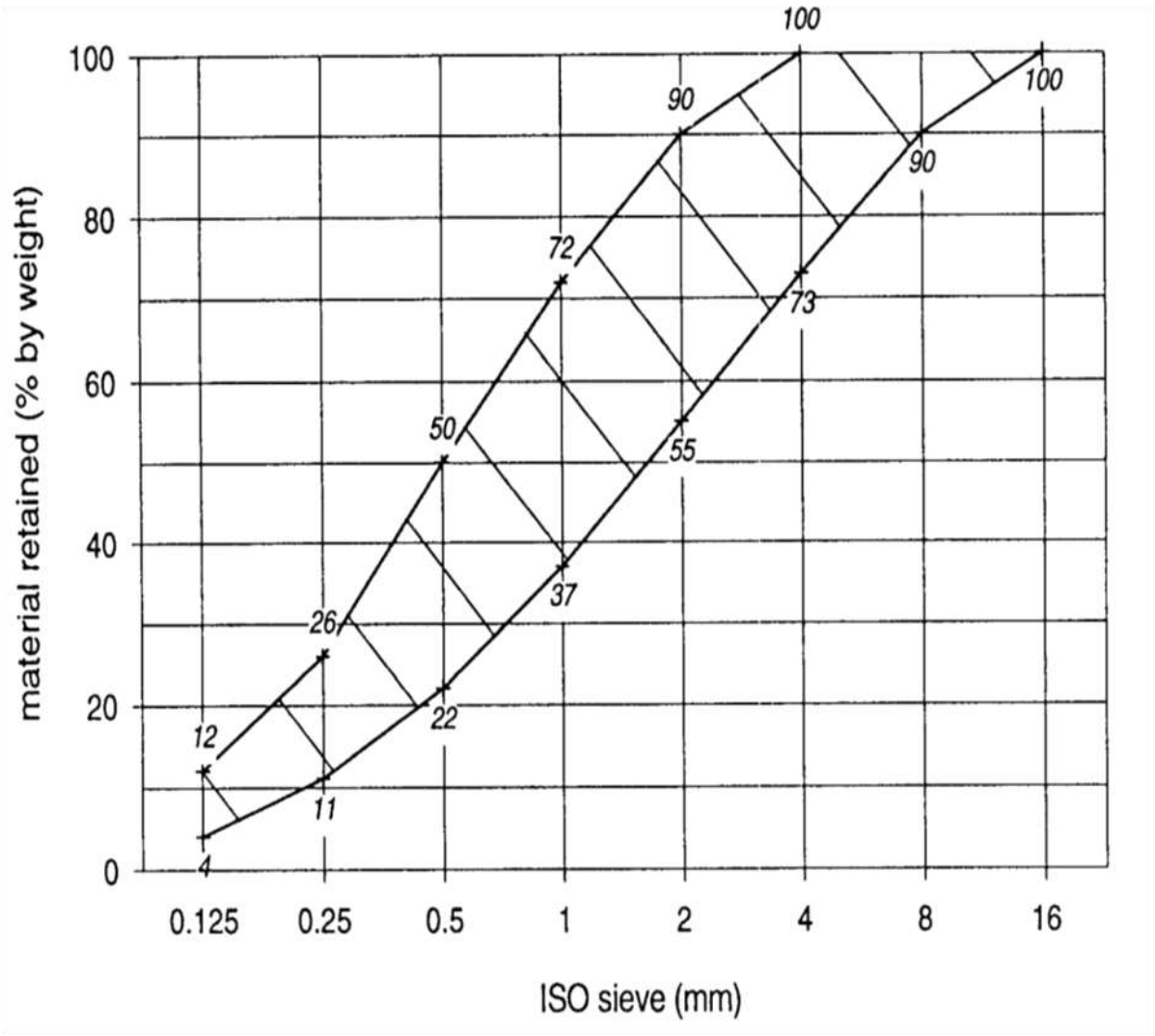
11.2 Products

11.2.1 Manufacturers

All materials, deliveries and articles must be standard make of recognized and reputable Manufacturers and must have acceptable high commercial quality class.

11.2.2 Materials

Material could be ready-mix shotcrete, supplied directly to the site with certificate of manufacturer. Or could be mixed at the site but in accordance the following requirements.
Cement. Cement shall comply with the provisions of Chapter 4: Fine (sand) and Coarse Aggregate. The following grading curve boundaries are recommended for aggregates with Dmax = 10-12 mm.



The Contractor shall submit the grading curve dispersion area of the aggregates to be used in shotcrete.

When dry mixture is used for spraying, the aggregate moisture shall be less than 6%.

It is recommended the aggregate moisture to be kept as constant as practically possible.

Water. Water for shotcrete preparation and curing and aggregate processing shall comply with requirements for potable water.

In case that admixtures are used, they shall comply with the provisions of 4.8 of the present Specifications.

Fibers. Upon approval of the Engineer, steel or synthetic fibers may be used for reinforcement and improvement of the shrinkage processes in the shotcrete. The fibers used for shotcrete shall comply with the provisions of EN 14487-1.

The length of the steel fibers shall not exceed 0,7D, where D is the inside diameter of the shotcrete machine feeding line.

The amount of fibers used for shotcrete reinforcement depends on the fiber type, shape and dimensions. Advisable fiber amount limits shall be specified by the

Manufacturer and the optimal fiber amount shall be determined by experimental concrete works.
Reinforcement Meshes and Reinforcement bars should comply with 4.24 above.

11.2.3 Shotcrete Mix Proportions

11.2.3.1 General

Shotcrete mix proportions shall be selected in such way that the placed shotcrete meets the requirements of the ready product according the following table
Compressive strength classes for sprayed concrete (EN 206)
In situ strength characteristics:

- Class of water impermeability Вв0,6 on the 28-th day;
- Class of frost resistance Вм100 on the 28-th day
- Minimum concrete-to-rock cohesive strength 0,5 MPa
- Minimum concrete-to-concrete cohesive strength 1,0 MPa
- Consistency class by unit of concrete mix setting at the place of mixing F5 (62 – 65 cm)
- Class of environmental impact Group III (XC3)
- Minimum cement content 300 kg/m^3.
- Maximum size of coarse aggregates (Dmax) 10 (12) mm
- Maximum water-cement ratio 0,50

11.2.3.2 Shotcrete Mix Proportions depend on the Method of Placement

Wet Placement – when cement, aggregates and water are mixed in a concrete mixture, having a specified consistency, then the concrete mixture is delivered by a pump and pneumatically sprayed on rock or concrete surface. The concrete mixture must obligatorily contain chemical admixtures (superplastificators and accelerating the setting) and/or fibers and mineral admixtures.
Dry Placement – when cement and aggregates are dry mixed, then the dry mixture is delivered through a material feeding hose under pressure to the machine spraying nozzle where it intermingles with water jet and chemical admixtures also delivered under pressure. Admixtures (chemical and/or mineral), fibers or a combination of the above may also be used in dry shotcrete placement.
The shotcrete mix design shall be such that the shotcrete placed on rock or concrete surface shall meet the requirements:

- The water-cement ratio is recommended to be 0,40-0,45. Concrete mixture with water-cement ratio under 0.35 and above 0.50 is not recommended for shotcrete.
- The minimum amount of cement shall be more than 300 kg/m^3.

The shotcrete mix design shall be determined by experimental works, executed with the foreseen equipment and by shotcrete quality control examinations, performed in

compliance with the requirements. The quality control results shall be reported to the Engineer for approval 1 month prior to the commencement of shotcrete placement.
According to the current TS, shotcrete is regarded as design concrete with specified properties and the Producer is responsible for determination of the shotcrete mix proportions and for ensuring the conformity of the shotcrete with the specified properties during production.

11.2.3.3 Consistency of the Concrete Mixture for Wet Shotcrete Placement

In wet shotcrete placement, a concrete mixture with specific consistency, depending on the type of the applied spraying equipment, is prepared prior to placement.
The consistency of the concrete mixture shall be determined by slump measuring by a cone with diameter d/D=130/200 mm and height H=200 mm in compliance with EN 12350-5.
The admissible deviations, the consistency conformity criteria and the minimum sampling frequency for conformity assessment shall conform to the norms of EN 206-1.

11.2.4 Control

Compressive strength can be determined by testing specimens cut from test panels or structure in accordance with BS EN 14488-1.
Sample plates are sized 500/500/150 mm for manual placement and auto- placement at 1000/1000/150. Sample plates to meet EN206 - 1 under water, saturated with lime or in a humid chamber with 90% W and t = 20 ± 3 °C.
The inside area of the plates to cut a minimum of 3 samples, cubes 100 mm for concrete for all ages tested. Sample plates to age in a humid chamber with 90% W and t = 20 ± 3 °C to testing 28 days.
Compressive strength is determined as the average of the three results in accordance with BS EN206- 1. Assessment be done EN206-1/NA.
The minimum frequency of sampling is in accordance with Table № 12 of BS EN 14487-1 for category 3 in the recovery and healing.

11.2.4.1 Control Waterproofing

To be determined by testing a series of 6 rolls with diameter of 150 mm and height 100 mm. Sample plates to age under water, saturated with lime, with t = 20 ± 3 °C to cutting and testing. Test is carried out according to EN 206-1/NA.
The minimum frequency of sampling is in accordance with Table № 12 of BS EN 14487-1 for category 3 in the recovery and healing. with EN 7031 shall be 50 mm, and the mean average value shall be less than 20 mm.
Alternatively, water-tightness can be determined by measuring water permeability. Sprayed concrete is considered water-tight when the coefficient of water permeability is less than 1012 m/s.

11.2.4.2 Control Frost

To be determined by testing a series of 15 pieces of cubic samples with dimensions 100/100/100 mm. Sample plates to mature under water saturated with lime, with t = 20 ±3 °C to cutting them. Test is carried out according to EN 206-1/NA.
The minimum frequency of sampling is in accordance with Table № 12 of BS EN 14487-1 for category 3 in the recovery and healing.

11.2.4.3 Adhesion – Old Concrete and New Shotcrete

Be determined by testing a series samples consisting of 3 specimens. Specimens to be tested by direct tension to establish bond strength shotcrete old concrete and shotcrete-shotcrete. Method for sampling to follow EN 12504-1, and the test is according to EN 14488-4, A1.
The minimum frequency of sampling is in accordance with Table № 12 of BS EN 14487-1 for category 3 in the recovery and healing.
Prove quality of concrete structures
Concrete whose properties do not meet the design requirements, the quality must be evidenced by:

- Further tests on laboratory samples.
- Taking specimens or cubes of construction and testing according to EN 206-1/NA.
- Reporting documentation

Documenting the quality of the concrete works to be carried out according to BS EN 206-1 by recording the results of the test specimens in journals and protocols. Diaries to record all details of sampling and test results of concrete compressive strength, water resistance, frost resistance and results of studies of the components of the concrete.
When concreting to keep a logbook in which to record data of placement of the concrete, account type, length of working section of the starting mixture and laid concrete, technology breaks.
For shotcrete to be recorded the number of layers too.

11.3 Execution

11.3.1 Shotcrete Placement

Shotcrete placement shall conform to the provisions of EN 14487-2.
Shotcrete placement cannot start unless the following is available: sufficient materials, allowing continuous placement; cleaned substrate and joints involved in the placing, which have been inspected and approved by the Supervisor. Acceptable facilities and equipment for concreting as specified or as directed, shall be available.
Before spraying of the concrete can start the following preparatory work shall be done.

For rock support:

- poor and loose rock shall be removed from the surface
- the rock shall be mapped so the total need for support can be clarified; and
- water leakages shall be drained out, either by drainage channels or shall be blocked by the use of an accelerated cement paste - mortar or by grouting.

For repair of concrete:

- the condition of the structure shall be assessed
- the causes of deterioration shall be identified and eliminated wherever possible
- defective and loose substrate (concrete, brick, etc.) shall be removed and the remaining material must provide a sound substrate
- if concrete substrate is carbonated or penetrated by chlorides, the concrete shall be realkalised or the chlorides removed. If this is not possible the contaminated concrete shall be removed, subject to maintaining structural integrity.

11.3.1.1 Execution of Shotcrete Support

The execution of shotcrete support shall follow the technological sequence given in the Drawings.

The execution of shotcrete support with thickness d=10 cm shall be carried out in sections with machines allowing wet concrete mixture placement. The length of a given work section depends on the capacity of the placing machine and is determined by the condition that a certain stage of the support shall be completed. The shotcrete placement starts with smoothing of the rock surface and filling of irregularities bigger than 0,5 m2, with depth bigger than 10 cm. The smoothing shall be executed from the bottom upwards. The first layer of shotcrete with thickness of 5 cm shall be placed after the smoothing of the rock surface. The shotcrete placement for a given layer in a given section shall be executed in horizontal strips with width of about 2 m. The maximum admissible break of placement for monolithic bond of strip to strip during the execution of a given section shall not be more than 3 hours. In case of forced standstill, this break shall not be more than 3 days.

The joint between the layers of the separate sections shall be shaped step wise with length of the step about 1 m.

Metal marks – one mark for every 25 m2 of shotcrete shall be installed perpendicular to the surface for control of the thickness of the separate layers. The marks for the last layer of shotcrete shall be 1 cm shorter than the thickness of the layer. The shotcrete thickness may be controlled by surveying methods.

Shotcrete placing shall not start when it rains. In case of unexpected rain, there shall be readiness to stop the shotcrete placement.

Drainage boreholes at a depth of minimum 50 cm shall be made to drain the seepage water that may generate hydrostatic pressure between the contact surface and the shotcrete.

The shotcrete curing shall start 24 hours after its placement. The watering shall be executed at an interval of 3-4 hours for a period of minimum 14 days. Shotcrete shall not be watered at temperatures lower than +5°C.
During the execution of all shotcrete placing operations, it is necessary the provisions of the regulations and the safety instructions regarding work with machines under pressure and work with chemical substances, used as admixtures for concrete, to be strictly observed.
Admixtures, accelerating the setting, shall be used for placement of the wet concrete mixture according to EN 934-2. The accelerating admixture shall be fed with dosing pump directly in the concrete mixture sprayer.

11.3.1.2 Shotcrete Temperature

Shotcrete shall not be placed in the open in winter conditions when the average daily ambient temperature is lower than +5°C and the minimum temperature is lower than 0*C.
The requirements for shotcrete placement in hot weather conditions shall be observed at temperatures, measured at 2 p.m., higher than 25°C and humidity lower than 50%.
When concrete works are executed in summer conditions, the following shall be taken into consideration:

- The quick reduction of the consistency of concrete mixtures, designated for wet placement, during transportation;
- The intensive evaporation of the moisture from the placed concrete.

11.3.1.3 Finishing Works

The last layer of shotcrete shall be cleaned from rebound and other deposits by water-air jets with p = 0,4 – 0,6 MPa. The time of washing shall be picked up properly so that the concrete surface shall not be damaged during washing. The contour of the structure, executed with shotcrete, shall be shaped with the last layer of shotcrete. The contour of the profile shall be checked with templates if required. The length of the template shall be 3 m for flatness checks and curve checks.

11.3.1.4 Shotcrete Curing and Protection

General
Concrete shall be cured under conditions conforming to ENV 13670-1. All shotcrete shall be wet cured for a period of not less than 14 consecutive days or until the moment of its covering with fresh shotcrete by an approved method or combination of methods applicable to the local conditions. Prior to each concrete placement all equipment and materials needed for curing and protection of the concrete shall be available or ready to install.

Shotcrete Curing

- Shotcrete shall be cured by maintaining of all surfaces wet during the entire curing period, or until covering with fresh concrete. Water for curing shall be clean and free from any elements that will cause staining or coloring of the concrete. Water quality shall conform to the requirements of EN 1008.
- The watering of the surface of a given layer of shotcrete shall start 24 hours after its placement. The watering shall be executed at an interval of 2-3 hours for a period of minimum 14 days or until the placement of the next layer of shotcrete. Dry spots are not allowed. Shotcrete shall not be watered at temperatures lower than +5°C.
- During the curing period the shotcrete shall be protected against damages from equipment, rain or running water for minimum 14 days.

Chapter 12: PAINTING AND SURFACE PROTECTION

12.1 General

This Specification covers the general requirements and standards of workmanship and the painting and protective coatings required to be carried out by the Contractor of the works, except where particularly redefined in individual specification clauses or as necessary due to a particularly corrosive local environment, the possible reaction of escaping chlorine on the works or on the structures or the reaction of chlorine residuals on phenolic paints (e.g. inside pipelines), harmful or toxic paint in contact with process liquids, or other special requirements, in which case the Contractor submit his own special specification along with his Bid. No alternative or substitute painting standard or specification will be accepted unless it is specifically required for the above stated reason. No painting or protective coating will be accepted by the Engineer unless it is at least to the standard and of the quality specified herein.

12.2 Contractor's Responsibility

Every possible precaution shall be taken to keep down dust before and during painting processes. No paint shall be applied to surfaces structurally or superficially damp and all surfaces shall be ascertained to be free from condensation, efflorescence, etc., before the application of each coat.

Primed or undercoated woodwork and metalwork shall not be left in an exposed or unsuitable situation for an undue period before completing the painting process. No exterior or exposed painting shall be carried out under adverse weather conditions, such as rain, extreme humidity, dust storms, etc.

Metal fittings such as ironmongery, and electric fittings such as wall plates etc., not required to be painted shall first be fitted and then removed before the preparatory processes are commenced. When all painting is completed the fittings shall be cleaned and re-fixed in position.

The Contractor shall be required to repaint, at his own expense, any paintwork if it is found to be incorrectly applied. The Contractor shall be responsible for protecting from damage the paint-work and other work during and after painting operations including the provision of all necessary dust sheets, covers, etc.

Brushes, pails, kettles, etc., used in carrying out the work, shall be clean and free from foreign matter. They shall be thoroughly cleaned before being used for different colour types or classes of materials.

Colours of paint shall be described as in BS 4800:2011 "Specification of Paint Colours for Building Purposes".

All paints shall be standard materials of the best quality from approved manufacturers and in colours approved by the Engineer. They shall be delivered to the Site in the

manufacturer's sealed cans and used strictly in accordance with the manufacturer's instructions.

Unless otherwise approved by the Engineer all paints to be applied to a particular surface as part of a system shall be obtained from a single manufacturer. Where priming of materials is executed before delivery to the Site the Contractor shall ensure and obtain a written guarantee from the appropriate supplier that the primers used in these instances shall be obtained from the same manufacturer as that approved by the Engineer for the finishing coats.

Mixing and application of paints shall be in accordance with the recommendations of the manufacturers concerned and to the approval of the Engineer. The mixing of paints, etc., of different brands, before or during application, will not be permitted. No dilution of painting materials will be allowed except strictly as detailed by the manufacturers and approved by the Engineer.

12.3 Painting of Non-Steel Surfaces

Concrete, block work, plaster, rendered and timber surfaces, which are to be painted, shall be washed down prior to painting with a toxic wash applied by brush or spray. The surfaces shall then be allowed to dry out thoroughly before applying paint. The surfaces shall be rubbed down smooth and any cracks cut out and filled. Before applying the paint, the surfaces shall be free from oil, dirt, dust, efflorescence and the like, and shall be dry.

Emulsion paint shall be applied in a minimum of these coats with such further coats as may be necessary in accordance with the manufacturer's instructions. The finished surface shall present a satin finish. Gloss or semi-gloss finishes shall not be used.

Emulsion paint shall be based on a polyvinyl acetate emulsion, shall be alkali resistant and suitable for application on damp wall surfaces. It shall be provided in ready-mixed form suitable for thinning with water, if necessary.

Masonry paints for concrete or block work surfaces shall be solvent-thinned, textured paints containing fine sand, stone or mica reference 5/10 to Table 5 of BS 6150:2006 "Painting of Buildings. Code of Practice".

All concrete, block work and rendering shall be prepared and painted in accordance with BS 6150:2006. One coat of alkali-resisting primer, or as recommended by the manufacturer shall be applied, followed by two coats of masonry paint.

All plasterwork to be painted shall be prepared and painted in accordance with BS 6150:2006. One thinned coat of alkali-resisting primer, or as recommended by the manufacturer, shall be applied, followed by a minimum of two coats of emulsion paint.

Woodwork, manufacturer board, wood products and the like shall be rubbed down and freed from dust and a thin coat of knotting applied over all small knots, sappy or resinous parts. Any large or loose knots shall be cut out properly plugged and filled. All nail holes, cracks or other defects shall be filled and levelled up with hard stopping. The woodwork shall then receive one priming coat. The exposed work shall then be

lightly sandpapered, dust removed and two undercoats and one finishing coat applied, each coat being smoothed down before the next is put on. Joinery shall be knotted, primed, stopped on all faces before delivery or soon after delivery to the Site.

12.4 Painting Iron and Steel Surfaces

Paints, primers, sealer, etc. shall comply with EN ISO 12944:1998 “Paints and Varnishes. Corrosion Protection Steel Structures by protective paint systems. Development of specifications for new work and maintenance”, EN ISO 14713:2009 “Protection against corrosion of iron and steel in structures” and BS 6150:2006 “Code of Practice for Painting of Buildings”.

Steelwork which is not galvanised (see Chapter 8) shall be painted with chlorinated rubber paint and all primers etc. shall be suitable for use with the paint to be applied. Where appropriate the Contractor shall certify to the Engineer that paints supplied for use on the Works are compatible with any timber preservation or fire proofing treatment, which may be specified.

Separate supplies of solvents shall be kept on the Site for brush or other cleaning purposes. Solvents for these purposes shall be tinted a different colour to thinners. The type and quality of thinners shall be that recommended by the manufacturer of the particular type of paint and approved by the Engineer.

Priming coats, undercoats and finishing paints shall be of different colours or shades, so as to ensure that each coat is applied throughout the whole of the work. Paint shall not be applied to any damp surface or during wet, foggy, or frosty weather. At least 48 hours shall elapse between the application of consecutive coats and each coat shall be thoroughly dry and free from dew and other moisture when the next one is applied. All preparation, blast cleaning, washing, drying and painting shall be carried out only by men fully experienced in this type of work.

All surface preparation and painting shall be carried out in accordance with the general principles laid down in the EN ISO 12944 and EN ISO 14713 except where specifically directed otherwise in this Specification.

All steelwork shall be blasted free from all millscale, rust, grease and other contamination; it shall be to a minimum of SA 2.5 as define in Swedish Standard SIS 05 59 00. The maximum profile of height of the blasted surface shall not exceed 100 micron. The time between commencing shot blasting and applying the first coat of primer shall not exceed 4 hours when blasting under cover. On Site the maximum time shall be 2 hours.

Painting at works shall consist of two coats of chlorinated rubber priming paint to achieve a nominal dry film thickness of 70 microns followed by one coat of chlorinated rubber drying-oil type undercoat (as travel coat) to achieve a nominal dry film thickness of 35 microns.

Painting at Site shall consist of one coat of high-build chlorinated rubber undercoat to achieve a nominal dry film thickness of 100 microns and one coat of high build chlorinated rubber topcoat to achieve a nominal dry film thickness of 100 microns.

12.5 Waterproofing of Concrete Surfaces using Asphalt Layers

This Clause refers to works for waterproofing, insulation, and protection of concrete surfaces, as shown on the Drawings.

12.5.1 Materials

The main materials to be used for these works are the following:

- Bitumen primer
- Bitumen binder
- Double layer of asphalt membrane
- Cement mortar protective layer

The individual layers of the waterproofing system will be compatible with each other and their production process will be in accordance with the EN ISO 9001:2008 Standard.

Bitumen primer

The minimum requirements regarding the layer's characteristics are the following:

- Viscosity: Outflow time 10 sec
- Bitumen content: 30%
- Softening point of the recovered asphalt: 80ºC

Bitumen binder

The material to be used will have an asphalt base that can be improved using polymers or other additives, such as asphalt modified with hot or cold application polymers or asphalt emulsions modified with polymers. The minimum requirements for the binder layer are the following:

- Ash content: 5%
- Softening point: 100º C
- Flexibility at low temperatures: No cracks
- Shear resistance at 50º C: 8.0 N/cm^2
- Weight loss: 2.5%

The material will be applied according to the manufacturer specifications.

Asphalt membrane

The asphalt membranes shall consist of polymerized asphalt, with elastomers or plastomers. Fibers, synthetic fibers, fiberglass etc. can also be inserted. The membranes will have to be accompanied with all necessary certifications. Their minimum requirements are the following:

External texture	Uniform surface without cracks, good coupling of the individual layers
Flexibility at low temperatures	No cracks at - 5^{o}C
Longitudinal and transverse elongation at breaking point	
- with inserted synthetic fiber	35 % to 70 %
- with inserted fiberglass	2,0%
Tensile strength (break load)	>700N
Shear strength at 50^{o}C	8,0 N/cm^2
Thickness	
- for casting fabrication	3,0 mm
- for flame treatment	4,0 mm
Thickness of the bitumen binder in flame treated films (lower layer)	3,0 mm

Minimum requirements for the installed waterproofing system

Tensile strength of the adhesion at 0°C of the film that is provided at the lower layer – average value	0,7 N/mm^2
Shear strength at 50^{o}C	8,0 N/cm^2
Time dependence	Should be given
Compatibility of the materials	Full
Blisters on the cast asphalt	No blisters should be observed
Swelling of the bitumen binder	No swelling should be observed

Cement mortar protective layer
The typical mortar consists of 600 kg/m^3 cement applied on a 2 cm layer unless it is otherwise specified in the Drawings or directed by the Engineer.

12.5.2 Construction Method

The reinforced concrete surfaces that will be waterproofed using asphalt layers are determined by the design. The surfaces must be levelled, dry and without dust, ash, oil, paraffin or other substances and materials. Any imperfections of the surfaces will be restored by local scrape or grout with strong cement mortar. The asphalt membranes of the second layer shall be placed so that their overlaps do not coincide with the overlaps of the lower layer (the recommended distance is around half the width of the membrane roll).
Attentive sealing with bitumen binder is required at the membrane edges, or wherever it is crossed by pipes etc., so that it is fully protected against water penetration. The concrete surface temperature must be at least equal to +5º C for the commencement of the waterproofing works.
The works will take place under favorable weather conditions (lack of rain, average temperature). The works will ensure that the final surface will be free of blisters, pores

or cavities. During flame treatment the exuded bitumen binder will be spread while it is still hot. The responsible personnel will be trained in the implementation of the materials according to the manufacturer guidelines.

During the construction of the waterproofing system records on the temperature of the environment, the condition of the concrete surfaces, the humidity, the implementation methods in case of unfavorable or irregular cross-section shapes, the temperatures of implementation, the shifting of superposed layers' joints and the checks of the joints will be regularly collected. These records are required for the approval of the works.

Placement of asphalt membranes

The bitumen binder will be regularly stirred at temperatures between 150º C and 180º C. Boilers with stirring mechanism and temperature indication will be used for heating the material, so that any overheat is avoided.

The implementation of primer or hot bitumen binder will begin from the edge of the surface, so that the upstream bitumen sheet overlaps the downstream sheet. The implementation is usually lengthwise. The implementation of the hot bitumen binder requires drying of the primer. The injection of the bitumen on the surface will be concurrent with the membrane unfolding, which must be realized before the reduction of the bitumen temperature.

The sequence of the waterproofing activities is as follows:

- Implementation of the primer on the surface
- Implementation of the hot bitumen binder on the concrete surface, at an area slightly wider than half the membrane roll
- Direct paste of the membrane on the binder, with sufficient compression to ensure good application and avoid blisters of air
- Implementation of hot bitumen mix over the first membrane and at the adjacent section of the second, so that an asphalt stripe of width slightly larger than the overlap is created
- Direct paste of the membrane on the hot binder with compression, as described above
- Paste of hot asphalt over the last membrane and at the adjacent stripe, at a width slightly larger than the overlap
- Direct paste of a new membrane on the hot binder, with an overlap of 10 cm

The works shall continue so that the entire surface is covered. The membrane overlaps will be at least 10 cm widthwise and 15 cm lengthwise. The asphalt layers that are described above will ensure that no part of the membrane is in contact with another membrane or with concrete surfaces without an intermediate binder layer.

Placement of self-adhesive membranes (soldering torch treatment)

Following the application of the primer on the dry and clean concrete surface, and the drying of the primer the membrane is adhered. The work starts from the surface edge so that the upstream membrane covers the lower layers.
During flame treatment the heat will affect uniformly the entire width of the roll. The membrane will be heated so sufficient adherent material of the substrate is melted to precede the unfolding of the membrane roll. Following the binder melt the membrane will be compressed using either mechanical equipment or suitable tools.
The heating source during the treatment needs to affect uniformly the entire width of the membrane rolls (series of soldering torches), in particular for the placement of the lower layer. The use of individual gas boilers is allowed for small surfaces (< 200 m^2), for joints and for localized repair works, as well as for particular cases, such as locally elevated parts of the cross-sections. The membrane overlaps will be at least 10 cm widthwise and 15 cm lengthwise.
The waterproofing system will be protected by a cement mortar layer of 2 cm thickness, with 600 km cement per m^3 of the material. The protective layer will be implemented after the waterproofing system is cooled at the environment temperature. The implementation of mortar on hot membranes is forbidden.

12.5.3 Protecting Masonry Surfaces using Epoxy Resin

The inner masonry walls of the chambers located in marshy areas will be protected using a double layer of epoxy resin and cement mortar, as shown in the Drawings. The properties of the resin will be approved by the Engineer prior to its supply and implementation. The resin will be applied on a clean surface, using a suitable brush. The application will take place at two coats, at an interval of 12 hours each. The resin must be applied precociously, so that any spots, laps, brush marks, runs, droopiness and other surface imperfections are avoided. The typical mortar will consist of 600 kg/m^3 cement applied on a 2 cm layer, unless it is otherwise directed by the Engineer. The application of the mortar will follow the self-curing of the resin, in accordance with the Engineer's directions.

12.6 Surface Treatment and Painting for Hydraulic Steelworks

The Contractor shall provide the complete surface treatment of the equipment furnished. Such work shall include the workshop and site coating up to and including the finished painting. Unless otherwise specified, the coating and painting shall be carried out in accordance with Enfo Publication No. 277-1998, Paint Specification for Mechanical Hydroelectric Power Equipment.
The document is attached to these Technical Specifications in pdf format.
The Contractor shall, however, in all respects fulfil the requirements imposed by the site conditions, such as the quality of water, climatic conditions and other environmental conditions which may in any way affect the quality and suitability of the surface protection. The quality shall in all respects ensure long life protection of

the equipment, and due consideration shall be given to the fact that the supplies, to a large extent, will be difficult to maintain once they are taken into use.

Each coat of primer and painting shall be compatible with the previous and subsequent coats.

The Contractor shall supply full details regarding the extent to which blasting, priming and painting will be carried out in his workshop (or his subcontractor's, as the case may be), at the site and after erection.

Before any primer or coat of paint is applied, the surfaces shall be properly prepared. Such preparation includes any cleaning, drying and similar operation that may be required to ensure that the primer and/or paint are applied to a suitable base.

Each coat shall be free from runs, drops, pinholes, waves, laps, sags and unnecessary brush marks, and shall be allowed to dry or to cure before the succeeding coat is applied, unless otherwise specified by the paint manufacturer.

Temporary protection of steel materials, prior to and during production, is not included in this specification. Blast cleaning and painting should, as far as possible, be done after the construction is welded, machined and approved. Equipment which cannot be blasted after the last machining should, prior to the machining, be blasted and shop primed. The shop primer should be a two-component iron-oxide primer or a two-component zinc based epoxy primer. The zinc content in the dry film must be at least 85% by weight. The dry film thickness of shop primer shall not exceed 20 µm.

Components of stainless steel shall in general not be painted or galvanised.

Details exposed for radiation from the sun must be painted with a light and reflecting coating in order to reduce the temperature deformations.

The instructions from the paint manufacturer concerning the directions for use, requirements to preparation of surfaces and application must be carefully kept and documented concerning the surface cleanness, application method, application environment, coat thickness, drying time and supervision.

Components which are not in stainless steel or other non-corrosive material, shall be anti-corrosion treated in the workshop and on-site accordance to the following detail specifications.

A general requirement is that for surfaces exposed water and condensation Painting system No.1 shall be used with an approved epoxy-based paint with specified dry film thickness (SDFT) of minimum 500 µm.

The Contractor shall propose his selection of paint brand, but final selection of paint shall be agreed with the Purchaser/the Purchaser’s Representative.

Valves, armatures, etc. shall be delivered professionally painted from factory. This surface treatment shall have the same quality as the main delivery.

Concreted goods in black steel shall be corrosion protected in such a way that minimum 150 mm of painted surface shall be concreted. Surfaces near site welds shall be left unpainted from the factory / manufacturer to a distance of 300 mm from the weld. After welding final corrosion protection treatment shall be performed on site.

Not corrosion protected machined surfaces shall during transport or storage be corrosion protected or preserved with Vaseline compound. This is also the case for assembled parts, bolted connections, etc.

Blasting cleaning and painting at site during erection shall be agreed in each instance. Waste from blast cleaning is the Contractor's responsibility to take away.

The Purchaser/the Purchaser's Representative shall be informed about the progress to be able to execute desired controls in all stages of the work.

The colour on different components / installations shall be subject to approval by the Purchaser/the Purchaser's Representative.

The Purchaser/the Purchaser's Representative shall be free to choose standardized RAL colours. His choice of colour shall not have consequences on the Contract Price.

Chapter 13: GEOTEXTILES

13.1 Scope

This specification covers nonwoven geotextile properties for subsequent use as protection (or separating) materials.

Note 1: The typical use will be as a protective covering or underlayment of a geomembrane against puncture or tear due to rock, stones, concrete or other hard surfaces and/or objects.

This specification sets forth a set of physical, mechanical and endurance properties that must be met, or exceeded by the geotextile being manufactured.

13.2 Referenced Documents

13.2.1 ISO Standards

ISO 09864 Test Method for Determination of Mass per Unit area

ISO 10319 Test Method for Determination of Wide Width Tensile Strength of Geotextiles and Geogrids

ISO 13434 Test Methods for Geotextiles and Geotextile-Related Products (Trapezoidal Tear Strength)

ISO 12236 Test Method for Determination of Static CBR Puncture Strength

13.2.2 ASTM Standard

D 7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus.

13.3 Definitions

13.3.1 Formulation

The mixture of a unique combination of ingredients identified by type, properties and quantity. For nonwoven geotextiles, a formulation is defined as the exact percentages and types of resin(s), additives and/or carbon black.

13.3.2 Manufacturing Quality Control (MQC)

A planned system of inspections that is used to directly monitor and control the manufacture of a material which is factory originated. MQC is normally performed by the manufacturer of geosynthetic materials and is necessary to ensure minimum (or maximum) specified values in the manufactured product. MQC refers to measures taken by the manufacturer to determine compliance with the requirements for

materials and workmanship as stated in certification documents and contract specifications

13.3.3 Minimum Average Roll Value (MARV)

For geosynthetics, a manufacturing quality control tool used to allow manufacturers to establish published values such that the user/purchaser will have a 97.7% confidence that the property in question will meet published values. For normally distributed data, "MARV" is calculated as the typical value minus two (2) standard deviations from documented quality control test results for a defined population from one specific test method associated with one specific property.

13.4 Material Classification and Formulation

1. This specification covers geotextiles used as protection (or cushioning) materials.

2. The type of resins is usually polypropylene, polyester or polyethylene, but other resins are also possible in this regard.

3. The type of geotextile style is designated as a nonwoven since research has shown these fabrics to be most effective in the typical applications. While needle-punched nonwovens are usually used, heat bonded and resin dipped manufacturing styles (or others) can also be considered.

13.5 Constructional Requirements

The requirements should contain the ultraviolet radiation reaction of the geotextile and the measures taken by the industry of production. The geotextiles should always be delivered to the worksite packed with suitable protecting wrapping against ultraviolet radiation. Proportionally to the sensitivity of the geotextile in ultraviolet radiation, the placement must be regulated in correlation with the remaining of the site work, in order to have the geotextile covered in a way to ensure it from ultraviolet radiation. The time interval should be such to maintain at least a rate of ninety per cent (90%) of the initial tensile strength.

The longer a geotextile can be exposed in ultraviolet radiation should in no case be more than three months. In the case the geotextile remains exposed in ultraviolet radiation beyond the allowed time then it is considered, conventionally, as useless and should be replaced at no extra cost to the Contract.

The joints of the geotextiles should be made according to the instructions of the production factory. However, for the jointing there should be coverage of the two edges of at least 0.25m.

In cases where the geotextile is placed in contact with concrete it is prohibited to use geotextiles made of polyester material.

The geotextiles for use as protection (or separating) materials shall conform to Table 16-1 in SI (Metric) units.

Material shall be non-woven of at least four hundred grams per square meters (400 g/m^2) and as described in Contractor's submittal approved by the Engineer.

13.6 Workmanship and Appearance

The finished geotextile shall have good appearance qualities. It shall be free from such defects that would affect the specific properties of the geotextile, or its proper functioning. General manufacturing procedures shall be performed in accordance with the manufacturer's internal quality control guide and/or documents.

13.7 Sampling, Testing, and Acceptance

Geotextiles shall be subject to sampling and testing to verify conformance with this specification. In the absence of purchaser's testing, verification may be based on manufacturer's certifications as a result of testing by the manufacturer of quality assurance samples obtained using the procedure for Sampling for Manufacturer's Quality Assurance (MQA) Testing. A lot size shall be considered to be the shipment quantity of the given product or a truckload of the given product, whichever is smaller.

Testing shall be performed in accordance with the method referenced in this specification for the indicated application. The number of specimens to test per sample is specified by each test method. Product acceptance is determined by comparing the average test results of all specimens within a given sample to the specification MARV.

If the results of any test do not conform to the requirements of this specification, retesting to determine conformance or rejection should be done in accordance with the manufacturing protocol as set forth in the manufacturer's quality manual.

13.8 Shipment and Storage

Geotextile labeling, shipment, and storage shall follow acceptable manufacturers practice. Product labels shall clearly show the manufacturer or supplier name, style, and roll number. Each shipping document shall include a notation certifying that the material is in accordance with the manufacturer's certificate.

Each geotextile roll shall be wrapped with a material that will protect the geotextile, including the ends of the roll, from damage due to shipment, water, sunlight and contaminants. The protective wrapping shall be maintained during periods of shipment and storage.

During storage, geotextile rolls shall be elevated off the ground and adequately covered to protect them from the following: site construction damage, precipitation, extended ultraviolet radiation including sunlight, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 71^{o}C, and any other environmental condition that may damage the property values of the geotextile.

13.9 Certification

1. The contractor shall provide the engineer with a certificate stating the name of the manufacturer, product name, style number, chemical composition of the filaments or yarns, and other pertinent information to fully describe the geotextile.

2. The manufacturer is responsible for establishing and maintaining a quality control program to assure compliance with the requirements of the specification. Documentation describing the quality control program shall be available upon request.

3. The manufacturer's certificate shall state that the finished geotextile meets MARV requirements of the specification as evaluated under the manufacturer's quality control program. A person having legal authority to bind the manufacturer shall attest to the certificate.

4. Either mislabeling or misrepresentation of materials shall be reason to reject those geotextile products.

Table 16-1. Required Properties, Test Methods and Values for Geotextiles Used as Geomembrane Protection (or Separating) Materials – S.I. (Metric) Units

Property	Test Method	Unit	Class					
Mass per unit area	EN ISO 9864	g/m^2	350	400	600	800	1000	2000
Tensile Properties • Strength • strain at max. load	 EN ISO 10319 EN ISO 10319	 kN/m %	 16 50	 21 50	 27 50	 32 50	 36 50	 45 50
Trouser Tear Strength	ISO 13937-2	kN	0.42	0.51	0.66	0.89	0.96	1.32

Property	Test Method	Unit	Class					
Mass per unit area	EN ISO 9864	g/m^2	350	400	600	800	1000	2000
CBR Puncture • max. force • elongation at max. force	EN ISO 12236	kN mm	3.1 38	3.6 38	4.1 38	4.9 38	7.6 38	11.0 38
UV Str. Ret. after 500 lt. hrs. exposure	ASTM D7238	%	70	70	70	70	70	70

13.10 Geotextile Installation

13.10.1 Subgrade Preparation

A. The Contractor should prepare surface upon which geotextile is to be placed, it should be firm, reasonably even and smooth, and free of offsets, abrupt indentations, and protruding materials be smaller than thirty five centimeters (35 cm).
B. The sand gravel subgrade is vibratory rolled and approved by the Engineer.

13.10.2 Installation

A. The Contractor should place geotextile in the manner and at locations shown on Drawings.
B. Geotextile should be laid smoothly, free of tension, stress, folds, wrinkles, or creases so far as is practical.
C. On slopes the upstream roll should be overlap the downstream roll.
D. The geotextile is held in position pinned, stapled, or weighted.
E. The terminal ends of geotextile should be anchored with key trenches or aprons at crest and toe of slopes.
F. In the presence of wind, geotextiles should be weighted with sandbags or equivalent until cover material placed.
G. Stones, soil, excessive dust, or moisture that could damage geotextile or hamper subsequent seaming not be entrapped in geotextile.

H. Driving or operating equipment directly on geotextile is prohibited. Cover material depth required is: seventy five millimeters (75 mm).
I. Geomembrane and the Geocell and concrete infill should be placed consecutively.
J. Geotextile should be covered within 14 days after geotextile placement. If covering geotextile with specified material is not possible within 14 days, protect exposed geotextile with suitable cover approved by the Engineer. Replace geotextile if not protected.

13.10.3 Seaming

A.1. The Contractor should submit the method of joining adjacent sheets of geotextile and approved by the Engineer.
B.1. Overlap minimum: thirty centimeters (30 cm).
B.2. Upstream/upslope roll placed over the downstream/downslope roll.
B.3. Weight or pin on 3-foot centers to secure the overlap during placement of cover material.
C.1. Sewn twice.
C.2. Thread: a. Contrasting color. b. Chemical resistance: Equal to geotextile.
C.3. Sew geotextiles continuously. Spot sewing is not allowed.
C.4. Sewn seam strength: Not less than 70 percent of parent material strength.

13.10.4 Geomembrane Placement and Repairs

A. At placement, geotextile will be rejected if it has defects, rips, holes, flaws, deterioration, contamination, or damage.
B. Replace or repair geotextile damaged during installation or placement of cover in the following manner:
1. Cover should be removed from damaged area of geotextile.
2. Any soil or other material which may have penetrated torn geotextile should be removed.
3. Damaged geotextile should be repaired by placing additional layer of geotextile to cover damaged area and overlap undamaged geotextile by at least one meter (1.0 m) on all sides.

13.10.5 Safety

A. If white colored geotextile is used, take precautions against “snow blindness” of personnel.

13.10.6 Field Quality Control

A. Execute field quality control testing as specified by the manufacturer
B. After installation, examine entire geotextile surface to ensure that potentially harmful foreign objects (such as needles) are not present.
C. Remove foreign objects or replace geotextile.

Chapter 14: GABION BASKETS AND MATTRESSES

14.1 Materials

This section describes the assembling and installing of gabion baskets and/or gabion mattresses which consist of double twisted hexagonal mesh (DTHM) filled with stone for the protection of works against erosion.

DTHM gabions shall conform to SANS 1580: 2010 and ASTM A975 standards and be equivalent or better to the corresponding Maccaferri products.

STANDARDS	DESCRIPTION
SANS 1580: 2010	Hexagonal steel wire mesh gabions and revet mattresses
ASTM A 975	Standard specification for double-twisted hexagonal mesh gabions and revet mattresses (metallic-coated steel wire or metallic-coated steel wire with poly vinyl chloride (PVC) coating)

14.2 Gabion baskets

Gabion baskets are factory fabricated so that sides, ends, lid and internal diaphragms can be readily assembled on site into rectangular baskets of indicated sizes. Baskets are assembled into a single unit construction or into constructions with multiple baskets connected with joints that have strength and flexibility equal to that of the mesh.

Gabion baskets shall be rectangular of the required dimensions as shown on the Drawings or as ordered by the Engineer. Unless otherwise specified, they shall be of the following standard dimensions:

(a) width: 1.00 meter
(b) length: 1.00 or 2.00 meters
(c) height: 0.50 or 1.00 meter

Gabions longer than 1.00 m shall be divided into compartments of equal length not exceeding 1.00 m with wire mesh diaphragms securely tied along to all edges. Each gabion or compartment of a gabion shall be provided with at least 4 cross-connecting wires if its height is 0.50 m or less, and with at least 8 cross-connecting wires if its height is between 0.50 m to 1.00 m.

14.2.1 Wire mesh

Gabions are baskets manufactured to SANS 1580 with hexagonal

woven wire Mesh Type 80, commonly referred to as double twist
wire mesh. Materials used to make the gabion mesh shall be classified as Galfan steel wire which has a high corrosion resistance performance and a high ductility and deformability. Wire mesh shall have a uniform hexagonal pattern, woven with a double twist with openings of approximately 80 x 100 mm fabricated to be non-raveling. The perimeter of the edges of the mesh should be securely selvedged so that joints formed by connected selvedges are as strong as the body of the mesh. The steel wire used in the manufacture of Gabions is 2.7 mm in diameter to SANS 675. The wire should be heavily galvanized to class A with zinc or zinc alloy (Galfan Zn 95Al5) according to SANS 1580, with tensile strength between 350 – 575 N/mm2. Interlocking wire fasteners: galvanized steel according to SANS 1580.

To reinforce the structure, all mesh panel edges are selvedged with a wire having a greater diameter than the mesh wire i.e. 3.4mm selvedge for 2.7mm.

The gabion is divided into cells by means of diaphragms positioned at approximately 1m centres.

14.2.2 Coating

A Polymer coating is extruded over the galvanised wire to provide added protection for use in aggressive environments where corrosion is present. The two types of Polymer coatings available are, PVC coating to SANS 1580 which has a nominal thickness of 0,5 mm and PA6 Nylon coating to EN 10245-5.

14.2.3 Filling

The Gabions must be filled with rock ranging between 100 mm and 250 mm. The range in sizes may allow for a variation of 5% oversize and / or 5% undersize rock, provided it is not placed at the exposed surface. In all cases, oversize rock shall not be larger than 300 mm and the undersize rock shall not be smaller than 100 mm. Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Care should be taken when placing the stone to ensure that the Polymer coating on gabions is not damaged.

At a minimum, the following should be specified:

- Specific gravity, ASTM C 127, minimum:2.60
- Absorption, ASTM C 127, maximum: 2 percent
- Loss, sulfate soundness ASTM C88 maximum: 10 percent
- Loss at 100 cycles, Los Angeles abrasion, ASTM C131, maximum: 10 percent

- Loss at 500 cycles, Los Angeles Abrasion, ASTM C131, maximum: 40 percent

The rock samples shall be tested in accordance with the relevant ASTM or EN standards and shall be approved by the Engineer.

14.2.4 Lacing

The diameter of the wire for the lacing of the gabions is 2.2mm for 2.7mm.

14.3 Mattresses

14.3.1 Wire mesh

Mattresses should be factory fabricated so that sides, ends, lid and internal diaphragms can be readily assembled on site into rectangular mattresses.
Mattresses are manufactured to SANS 1580 with hexagonal woven wire Mesh Type 60, commonly referred to as double twist wire mesh. The steel wire used in the manufacture of the mattress is 2.2mm in diameter to SANS 675 and is heavily galvanised to Class A with zinc or zinc alloy (Galfan Zn 95Al5) coated wire according to SANS 1580 and has a tensile strength between 350- 575N/mm2.

The wire mesh of the gabion mattresses shall have a uniform hexagonal wire pattern, woven in a double twist with openings of approximately 60 x 80 mm and fabricated to be non-raveling.

Perimeter edges of mesh shall be securely selvedged so that joints formed by tying adjacent selvedges are as strong as the body of the mesh.

14.3.2 Coating

A Polymer coating is extruded over the galvanised wire to provide added protection for use in aggressive environments where corrosion is present. The two types of Polymer coatings available are, PVC coating to SANS 1580 and has a nominal thickness of 0,5 mm and PA6 Nylon coating to EN 10245-5 which and has a nominal thickness of 0.4mm.

14.3.3 Filling

Rock filling shall be of high strength and quality and not likely to degrade or abrade over time. Rock filling shall be clean and rough, quarry stone, pit or river cobbles, or a

mixture of any of these materials, and shall be essentially free from dust, clay, vegetative matter and other deleterious materials.

Mattresses should be filled with rock ranging between 75 mm and 150 mm. The range in sizes may allow for a variation of 5% oversize and / or 5% undersize rock, provided it is not placed
at the exposed surface. In all cases, oversize rock shall not be larger than 200 mm and the undersize rock shall not be smaller than 50 mm. Rocks shall be hard, angular to round, durable and of such quality that they shall not disintegrate on exposure to water or weathering during the life of the structure. Care should be taken when placing the stone to ensure that the Polymer coating on the Reno mattress is not damaged.

At a minimum, the following should be specified:

- Specific gravity, ASTM C 127, minimum:2.60
- Absorption, ASTM C 127, maximum: 2 percent
- Loss, sulfate soundness ASTM C88 maximum: 10 percent
- Loss at 100 cycles, Los Angeles abrasion, ASTM C131, maximum: 10 percent
- Loss at 500 cycles, Los Angeles Abrasion, ASTM C131, maximum: 40 percent

The rock samples shall be tested in accordance with the relevant ASTM or EN standards and shall be approved by the Engineer.

14.3.4 Lacing

The diameter of the wire for the lacing of the gabions is 2.2mm for 2.7mm mesh.

14.4 Installation

Gabions and mattresses should be installed to lines and grades as indicated in the Drawings or as directed by the Engineer. The assembling of the baskets and mattresses shall be done in accordance with the manufacturer's instructions.

The surface where gabions and mattresses will be installed must be levelled and prepared. Prior to placing gabions and mattresses, the surface where they are to be positioned shall be prepared and finished in accordance with the relevant provisions of the Chapters of these Specifications. Notwithstanding any earlier approval of the finished surfaces, any damage to or deterioration of the surface shall be fixed to the satisfaction of the Engineer before gabions and mattresses are placed.

Each gabion basket and mattress shall be put in place in its turn, completely set up except for the fastening of the lid, stretched to the correct shape and dimensions, and fastened securely to all contiguous baskets along each edge by tying wire so that joints are as strong as mesh. The lid of the basket shall be securely fastened using tying wire along all unfastened edges, to the satisfaction of the Engineer. In no case shall the weight of the finished gabion be less than 1300 kg per cubic meter.

Gabions and mattresses should be tensed according to manufacturer's instructions before filling them with stone. Do not release wall tension until sufficient stone fill has been placed to prevent wall slackening.

The baskets and mattresses shall then be tightly packed by hand with the approved stone in such a manner that voids are kept to a minimum and are uniformly distributed. On the exposed side of the gabions, stones should be placed by hand with their flattest part bearing against the face of the mesh in order to produce satisfactory alignment and appearance.
Unless otherwise specified, vertical joints between gabions shall be staggered in a pattern similar to the typical running brick bond.
Where the gabions serve as protection against erosion, a geotextile might be used in accordance with the approved drawings or as directed by the Engineer, in order to separate the gabion baskets from the backfilling material.

14.5 Material for Rip Rap

For the material forming the rip rap protection the diameter, strength, and density of the stones, proposed by the Contractor, shall be approved by the Engineer.
Riprap material shall be sound, un-weathered and with low water absorption capacity in order to avoid cracking, bursting and dripping as a result of weather influences.
The rock shall mainly consist of large pieces with lateral lengths from 150 to 400 mm and smaller parts to secure the boulders against sliding and to provide stability to the fill structure.
The density of riprap material shall be not less than 2.2 t/m³ (solid volume without voids) and each piece of riprap shall have its greatest dimension not larger than twice its least dimension.
The dimension of the riprap material shall be 0.5m thickness, D50=200 mm for 90 percent of the material.
The material delivered shall be dumped and graded off to a uniform surface up the lines and grades shown on approved Drawings. No pockets of rocks and clusters of large blocks shall be permitted.
The Contractor shall submit full details of the proposed source, certified test results and samples for the approval of the Engineer.

Approved material for inclusion in the rip rap protection shall be transported without intermediate handling direct to the point of final use, where it shall be dumped and graded off in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments fill the spaces between the larger rock fragments to form compact uniform layers of rip rap of the specified thicknesses as shown on the Drawings. Hand placing will be required only to the extent necessary to secure the results specified above.

Chapter 15: CONCRETE PILES

15.1 GENERAL

15.1.1 Description

This specification is applicable to piles to be used for the foundation of concrete protective structures at the productive wells of Baricho Wellfield.
The Contractor shall always be responsible for the adequacy and the successful function of the support and ground stabilization measures during the execution of the retaining works, as well as during the safe foundation of the buildings using piles.

15.1.2 Reference standards

The following referenced documents are indispensable for the application of this specification. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1536:2010 + A1:2015: Execution of Special Geotechnical Works – Bored Piles
EN 197-1:2000, Cement — Part 1: Composition, specifications, and conformity criteria for common cements
EN 206-1:2000, Concrete — Part 1: Specification, performance, production and conformity
EN 791, Drill rigs — Safety
EN 934-2, Admixtures for concrete, mortar and grout — Part 2: Concrete admixtures — Definitions, requirements, conformity, marking and labelling
EN 996, Piling equipment — Safety requirements
EN 1008, Mixing water for concrete — Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete
EN 1990, Eurocode — Basis of structural design
EN 1991 (all parts), Eurocode 1: Actions on structures
EN 1992 (all parts), Eurocode 2: Design of concrete structures
EN 1993 (all parts), Eurocode 3: Design of steel structures
EN 1994 (all parts), Eurocode 4: Design of composite steel and concrete structures
EN 1997-1, Eurocode 7: Geotechnical design — Part 1: General rules
EN 1997-2, Eurocode 7: Geotechnical design — Part 2: Ground investigation and testing
EN 1998 (all parts), Eurocode 8: Design of structures for earthquake resistance

EN 10025-2, Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels
EN 10080, Steel for the reinforcement of concrete — Weldable reinforcing steel — General

EN 10210 (all parts), Hot finished structural hollow sections of non-alloy and fine grain steels
EN 10219 (all parts), Cold formed welded structural hollow sections of non-alloy and fine grain steels
EN 10248 (all parts), Hot rolled sheet piling of non-alloy steels EN 10249 (all parts), Cold formed sheet piling of non-alloy steels EN 12620, Aggregates for concrete
EN 12794, Precast concrete products — Foundation piles
EN 13670, Execution of concrete structures
ISO/DIS 22477-1, Geotechnical investigation and testing — Testing of geotechnical structures — Part 1: Pile load test by static axially loaded compression

15.1.3 Submittals

The Contractor shall submit for approval a Method Statement which shall include full details of the Contractor's proposed methods to be employed, the equipment, a risk analysis and safety procedures to minimize risks, the on–site testing proposals and any other information referred to in the present Article.

15.2 MATERIALS

15.2.1 Concrete for piles

Concrete used in cast in situ concrete bored pile shall comply with EN 206-1.
Cast in situ concrete shall be composed to minimize segregation during placing, to flow easily around the reinforcement, and when set, to provide a dense and watertight material.
The concrete shall comply with the requirements related to strength and durability in the hardened state as well as with the requirements related to consistency in the fresh state.
Compressive strength classes for hardened concrete are given in EN 206-1:2000. The range for the secondary bored piles will be not less than C25/30. For primary piles of secant pile walls a lower compressive strength class of concrete or mortar is used (see Figure 1) and the required class is C20/25.
In order to minimize segregation, aggregates shall not be gap graded and round aggregates are preferred.
The maximum size of the aggregate shall not exceed 32 mm or ¼ of the clear space between the longitudinal bars, whichever is the smaller.
The fines contents and cement contents of concrete for bored piles shall comply with the following Table.

Minimum cement and fines content for concrete

Cement content placement in dry conditions	≥325 kg/m^3
placement in submerged conditions	≥375 kg/m^3
Fines content	
coarse aggregate d > 8 mm	≥400 kg/m^3

coarse aggregate *d* ? 8 mm	≥ 450 kg/m^3
a Fines: *d* < 0,125 mm (including additions and cement).	

The water/cement ratio shall comply with EN 206-1 and shall not exceed 0.60.

15.2.2 Steel reinforcement

Reinforcement material used in bored piles shall comply with the relevant European Standards, this standard and the execution specification.
The reinforcement steel cages used in bored piles shall comply with EN 10080 and shall be suspended or supported so as to maintain their correct position during concreting.
The steel elements used in bored piles shall comply with EN 10025-2, EN 10210 (all parts), EN 10219 (all parts), EN 10248 (all parts), EN 10249 (all parts) and EN 13670 where relevant.
Steel reinforcement shall be stored in clean conditions and shall be clean and free from loose rust, and loose mill scale at the time of installation and concreting.

15.3 EXECUTION

A template of steel or concrete should be installed at the working platform for the maintenance of the pile positions.
Excavations of secondary piles should be supported by temporary casings.
Secondary piles only are reinforced, and they should be constructed after the initially installed unreinforced piles on either side are in place.
The construction sequence of secant and contiguous pile walls, and the concrete composition employed, shall be chosen such that the concrete of the primary piles has achieved sufficient strength for stability but has not developed a strength that would be restrictive to the boring of the secondary reinforced piles.

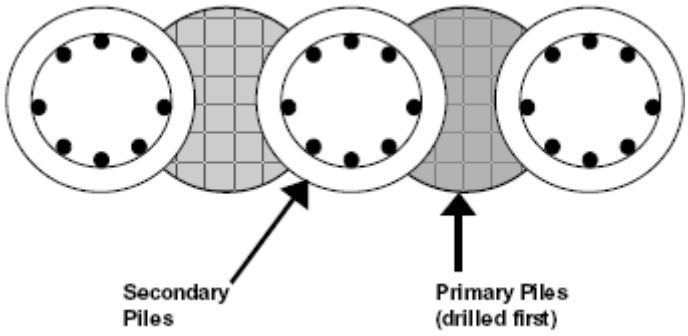


Figure 1: Secant pile wall

Immediately prior to placing the steel reinforcement in the borehole, the bottom of the excavation shall be checked for the presence of loose material. Should any loose material be found, this shall be removed, and any support fluid shall also be re-circulated and cleaned. During its placing, the reinforcement (cage) shall be kept in a vertical position.

In order to satisfy the requirements of minimum cover along the whole length of the reinforcement, the appropriate spacers shall be used.
Placing of concrete shall be undertaken with a hopper connected to a tremmie pipe, from the bottom of the borehole and upwards. Prior to starting concreting, a plastic ball shall be placed in the pipe in order to avoid mixing the concrete with water or bentonite during concreting. In the case of a dry bore the end of the pipe shall not be placed more than 1.50m above the level of the concrete. In case there is water or bentonite in the borehole, the base of the pipe shall be placed initially at the base of the bore and subsequently shall be retained fully within the concrete so that the concrete rises upwards, displacing water or bentonite. As concrete is placed, the tremmie mouth shall be retained at least 3 m below the concrete surface in the bore. Should, at any time the tremmie mouth be raised above the level of the concrete thus breaking the seal, concreting shall immediately be stopped. The tremmie pipe shall be removed and be re-prepared before being re-inserted into the bore to a level at least 3m below the surface level of the concrete. Following this, concreting may be re-started; however, the completed pile shall be considered to be of suspect quality and will require testing of the pile prior to acceptance.
When a support fluid is used, the level shall be maintained a minimum of 2m above the ground water level at all times.
The total tolerance for piles comprising location tolerance and vertical tolerance shall comply with the construction drawings and shall not exceed 0.10m in any direction.
A minimum of 70 cm of concrete, clean of laitance and un-contaminated with drilling fluid shall be cast above cut off level to allow for trimming back of the pile head. For reasons of economy, quality, speed and safety, the Contractor may propose alternative methods of cutting off the pile head, besides the traditional hydraulic hammer, such as using the ELLIOT pile breaking method. Provisions shall be made for reinforcement starters which shall protrude a minimum of 100 cm above cut-off level of the piles.

15.4 QUALITY CONTROL

The following quality checks will be subjected to continuous monitoring by the Contractor's personnel and data submitted to the Engineer for approval. The Engineer may execute independent checks:

- The size of the piles is as shown on the drawings.
- The piles and the reinforcement are in a vertical alignment.
- The requirements for the cover and the percentage of reinforcement are satisfied.
- The quality of the concrete and the reinforcement are in conformance with the Specification.
- The bottom of the bore has been checked for the presence of loose material immediately prior to concreting and has been cleaned if necessary.
- The tremmie pipe has continuously been maintained within the concrete column and the seal has at no time been broken.

- Drilling fluid, if used, has at all times been maintained a minimum of 2m above ground water level.
- A minimum of 70cm of sound concrete has been cast above cut-off level.
- Sound and undamaged reinforcement protrudes a minimum of 100 cm above cut-off level.

Chapter 16: ELECTRICAL WORKS

16.1 GENERAL REQUIREMENTS

The following clauses shall specify general electrical requirements and standards of workmanship for the equipment an installation materials. General specification clauses shall apply where appropriate except where particularly redefined in the individual specification clauses.

16.1.1 Relevant standards

All electrical work must be carried out by personnel in possession of a current license acceptable to the Authority, which permit the Contractor to carry out work on low voltage equipment and cabling. The Contractor shall carry out works described in this Specification in accordance with the appropriate EN, IEC Standards. These are, but are not limited by, the following:

EN 418 Safety of machinery. Emergency stop equipment, functional aspects EN 837 Pressure gauges
EN 1050 Safety of machinery. Principles of risk assessment.
EN 60204 Safety of machinery - Electrical equipment of machines
EN 60269 Low-voltage fuses
EN 60439 Low-voltage switchgear and control gear assemblies
EN 60947 Low-voltage switchgear and control gear

IEC 76 Power transformers
IEC 185 Current transformers
IEC 227 Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V
IEC 364 Electrical installations of buildings
IEC 446 Identification of insulated and bare conductors by colours
IEC 529 Degrees of protection provided by enclosures (IP code)

ISO 3046 Reciprocating internal combustion engines - Performances
ISO 5167 Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full
ISO 12100 Safety of machinery - Basic concepts, general principles for design

Any other codes and standards and approved by the Consulting Engineer where the equipment or part of it complies with other internationally recognized standards, which are less stringent than the above-mentioned standards, the differences shall be stated in writing and must accompany the Bid submission.

Any particular requirements of the EN or IEC standards shall take precedence to any other standards. All electrical equipment shall be approved by the Electrical Supplies Company.

16.1.2 Regulations

Additionally, the handling of equipment and the complete installation shall be carried out and tested in accordance with the latest issues or amendments of the following regulations, as applicable:

a) The National Electricity Ordinance
b) The National Factories Ordinance
c) The National Building Regulations
d) The Standards and Regulations as issued by the National Electricity Company
e) The local Fire Regulations as issued by City Council
f) The Regulations as issued by the National Telecommunication Company

16.2 WORKMANSHIP

Particular attention shall be paid to the neatness of appearance of the electrical installation; arrangements of which shall be agreed upon by the Engineer before the commencement of installation if the Contractor proposes positions of equipment deviating from specified arrangements in drawings. The Contractor shall ensure that the installation is completed to the highest standards of quality and neatness with respect to the visible appearance of cable runs and the arrangement and alignment of equipment, apparatus and fittings.

The Contractor shall determine the quantities and locations of fittings and equipment and shall prepare surveys and detailed design with installation arrangement drawings. The final locations of all building services, fittings and equipment shall be agreed at Site with the Engineer before installation.

The Contractor shall arrange for the switch-gear and panel manufacturers to provide skilled labour for the supervision of off- loading, placing in position on prepared foundations, erection and commissioning of all switch-gear and control panels.

16.3 MATERIALS

All materials incorporated in the works shall be most suitable for the duty concerned and shall be new and of first-class commercial quality free from imperfection and selected for long life and minimum maintenance.

All materials and material finishes shall be selected for long life under the climatic conditions at Site. Materials used in ventilated or air-conditioned areas shall be selected to allow for the conditions expected in case of failure of the ventilation or air-conditioning equipment. Tropical grade materials and panel components shall be used except if not available.

16.4 CABLES

All cables used in the construction of the electrical installation unless otherwise specified, shall be manufactured to comply with IEE regulations and the relevant National Standards.

All cables shall be of suitable voltage grade, with stranded copper conductors, selected for the climatic conditions specified and shall be rated by the approved factors laid down in the latest issue of relevant standards. The selection of all cables and rating factors shall be based on the followings:

a) Ground Temperature
b) Thermal resistivity of soil
c) Cable depth L.V: 0.7 metres
d) Cable depth, Control and Instrumentation: 0.7 metres
e) Cable grouping in accordance with the relevant tables
f) Cable in air in accordance with the relevant tables

Each cable shall be of sufficient rating for its duty under normal, fault and Site installation conditions. To assess the rating and cross–section required for each cable, the following factors must be considered as a minimum:

a) Fault level
b) Conditions of ambient temperature relevant to method of laying
c) Voltage Drop
d) Voltage drops in motor circuits due to the starting method
e) Over current settings of circuit breakers
f) Disposition of cabling, whether in air, ducts or trays/ladders

Where cables are run in conduit any requirements of the EN standards must be complied with. Where a neutral conductor is required, its cross–sectional area shall not be less than that of the phase conductors, unless otherwise specified. Each and every mains supply cable shall be provided with an individual earth continuity conductor (PE), which shall be not less than that of the phase conductors, unless otherwise specified. The PE conductor can either be one core of a multicore cable or a separately run, PVC insulated (yellow–green) stranded single core cable sized in accordance with the EN standards. The use of cable armouring, conduits, water or other service pipes as the only means of an earth continuity path is strictly prohibited.

Each cable shall be supplied in lengths suitable for a continuous run, as no through joints will be permitted in any cable run without the prior consent and written permission from the Supervisor.

Prior to dispatch to Site, the supplier shall pass to the Engineer, in triplicate, copies of the cable manufacturers test certificates for approval.

16.4.1 L.V. cables, General

All L.V. power cables shall be of the thermoplastic insulated type of either polyvinyl chloride (PVC) or cross-linked polythene (XLPE). These shall be manufactured in accordance with VDE 0271 or DIN 46235. They shall be of 600/1000 V grade and comprise stranded copper conductor, PVC or XLPE insulated with suitable bedding, sheathed overall with extruded PVC. All
L.V. cables shall be from an approved manufacturer.

16.4.2 L.V. cables small wiring

Small wiring cables for use on power, lighting, ventilation etc. shall be 600/1000V grade and a minimum conductor size of not less than 1.5 mm2 cross sectional area. All conductors shall be stranded.

16.4.3 Control and instrumentation cables

Control and instrumentation Site cables shall be shielded and have polyethylene or PVC insulation. These shall be manufactured in accordance with VDE and IEC standards as IEC 227. Each cable shall have its individual cores identified along their entire length by permanently printed numerals or letters. At every point of termination, core identification shall be carried out using an approved system of ferrule markers. At points of interconnection of wiring at which a change of numbering is unavoidable double ferrules shall be provided on each wire.

Any change of numbering shall be recorded on the wiring diagrams of the equipment at which the change is made.

Where it is proposed to use junction boxes for the marshalling of control and instrumentation cables to a common item of equipment, etc., any such junction box shall be of the wall mounting type, purpose made, complete with double terminal blocks of the pressure plate pattern.

All incoming wires shall be identified with core ferrules in accordance with the system schematic and cable diagrams. Prior to the installation of any junction box, the Contractor shall submit to the Engineer full details of the box and proposals for its use and only commence installation on the receipt of written approval from the Engineer. Steelwire armouring is re-quired for underground cables.

16.4.4 Cabling method for electrical power

Every cable shall be installed in accordance with the relevant codes of practice and shall be neatly run in all situations.

When more than one cable is to be terminated at an item of equipment, particular care shall be taken to ensure that cables to that equipment are routed from a common direction and each is terminated in an orderly and symmetrical fashion. Each and every cable shall be permanently identified at each end by its cable number, as noted within the schedules. The identification label shall be of adequate size and style to a pattern approved by the Supervisor and shall be securely fixed to its relative cable.

Where cables enter or leave structures or panel plinths, the ducts shall be sealed at the points of entry or exit. Chaulking shall be carried out with an approved compound and followed by not less than 40 mm of epoxy resin, two mix–cold waterproof compound or a weak sand/cement mixture as directed by the Engineer. This shall include any spare ducts. The Contractor shall be responsible for temporarily sealing all cable ducts into structures during the installation stage to prevent accidental flooding of the structures.

During caulking care shall be taken to ensure that the serving and/or armouring of any cable is not damaged. In the event of any armouring or serving fault being made it will be the responsibility of the Contractor to repair or make good any such fault to the satisfaction of the Engineer. Where any such fault occurs, these shall be made known to the Engineer and subsequently recorded on the final record drawings.

All power cables shall be connected to switchboards and the like in such a manner that the correct phase sequence, phase number and colour coding are preserved throughout the systems.

The PVC and XLPE insulated L.V. cables shall have their cores identified, as follows:

a) No.1 Phase L1 (RED)
b) No.2 Phase L2 (YELLOW)
c) No.3 Phase L3 (BLUE)
d) Neutral Black or N
e) Earth Green or Green/Yellow

Single core power cables shall have their cores identified as follows:

a) Phase Red or Brown
b) Neutral Blue or Black
c) Earth Green or Green/Yellow

All cable conductors shall be terminated in suitable copper lugs or brass thimbles using an approved compression tool.

Under no circumstances shall the use of hand crimpers be permitted. All cables shall be delivered on robust cable drums which shall bear the full details of manufacturer, size, length and insulation and shall be offered to the Engineer for inspection prior to installation.

Straight through joints will not be permitted except where a route length is in excess of a maximum drum length in which case the Engineer is to be notified. At the terminals of rotating machines, each cable core shall have core ferrules to match the notation of each connection terminal of each machine.

Wherever it is required to remove the PVC sheath of a cable e.g. at a point of termination, the minimum length necessary shall be removed and the exposed conductor, sheath or armouring shall be adequately covered by an adhesive PVC tape or a PVC sleeve.

All L.V. cables whilst on their drums shall be adequately sealed at each end against the ingress of moisture. When a cable is cut from a length on a drum the drum length shall be immediately sealed. All cables once cut and laid shall be terminated in their final position or effectively sealed. All cables shall be drawn from the top of its drum which shall be jacked and positioned for easy draw off in relation to its final position of installation. Where a long length of cable is drawn from its drum, cable rollers or skid boards shall be used.

The general routing of cables shall be as generally indicated on the Contract drawings, but the final routes shall be those agreed with the Engineer prior to any cable installation work being carried out. All cables shall be installed in strict accordance with the requirements of this Specification.

16.4.5 Cable trench work

The Contractor shall prepare drawings giving the exact requirements for all cable trenches, detailing the width and depth of each trench and detailing road crossing cable ductwork to be provided. The drawings shall be prepared in conjunction with the Engineer and shall be approved in writing before issue to Site.

The excavation and back filling of cable trench work shall form part of the work by a civil works Contractor together with the supply and laying of road crossing and other ducts. The Contractor shall work closely with the excavating and back filling Contractor (the civil works Contractor).

The laying of all cables shall satisfy the following requirements:

a) Cable depths shall be assessed from the finished ground level unless otherwise directed by the Engineer.

b) Before laying cables the Contractor shall inspect the trench work to ensure that the trench bottom is of a smooth and firm contour and free from broken stones or rocks.
c) Cable bedding within the trenches shall be of a 75 mm sand layer.
d) Cables shall be laid with adequate separation and shall be “snaked” to avoid tension during backfilling operations and subsequent settlement.
e) All cables when laid shall be inspected by the Engineer.
f) Thereafter cables shall be covered by a further 75 mm of sand which shall be well tamped around the cables.
g) After sanding, concrete cable covers and red warning tapes shall be placed as required.

16.4.6 Cable tray work

The Contractor shall supply and erect all required cable tray work.
The following points shall be taken into account in selecting routes for cable trays:

a) Number of drive, power and control cables to be located on each cable tray.
b) Separate cable tray works for machinery (EN 60204-1) and building installations (IEC 364)
c) The avoidance of existing pipework and pipework required for future extensions.
d) The avoidance of maintenance areas of machinery, pipes, etc.
e) The avoidance of unnecessarily long runs of cable.
f) Tray runs to be at high level as far as possible with droppers to plant items.
g) The tray to be arranged vertically as far as possible.

The cable tray shall be manufactured from heavy duty, hot dip galvanised mild steel complete with approved type fixings and installed in accordance with manufacturer's instructions to permit maximum expansion.

Support brackets shall be constructed from galvanised steel, heavy duty type, and installed at a maximum of 1,200 mm centres. Fixings of these brackets will depend on the tray loading. Bends, tees and junction pieces shall be of standard design and have an inside radius of not less than 300 mm.

The trays shall be of adequate width for cables to be laid flat and not bunched. All cables shall be saddled or cleated in position as they are installed along the route. Cables on vertical trays shall be securely fixed at 600 mm maximum spacing. Cables on horizontal trays shall be fixed at suitable intervals to ensure a neat and orderly installation.

Care shall be taken on vertically rising tray work, and adequate cable fixings shall be supplied to ensure security and distribution of load.

16.5 BUILDING WORKS

The Contractor shall mark out all necessary holes and chases in the course of carrying out the installation and be responsible for the correct positioning of all fixings. All cutting away and grouting in of fixings in brick and concrete work and the making good shall be carried out by the Contractor. The Contractor shall arrange for the general requirements necessary for the electrical installation such as floor ducts, chases, etc., to be carried out at various stages of building work to ensure continuity of construction. In all cases the Contractor shall drill and plug walls, ceilings, floors, etc., and provide any special fixings for securing conduits, cables, etc.

16.5.1 Conduit systems

Approved conduit systems shall be rigid steel conduits with metric threads and for flexible steel conduit and adapters, as appropriate. All rigid steel conduit and fittings shall be screwed and hot dip galvanised, inside and outside.

In all plant buildings and structures, conduit shall be fixed to the surface of the wall or concealed in the floor screed when they cross the floor. Conduit shall be concealed in those locations where the wall or ceiling finishes as shown on the drawings or detailed in specific clauses make this possible.

All conduits shall be installed in an approved manner and arranged with adequate ventilation and drainage where necessary. Where practicable, all bends or sets, shall be formed in the conduit itself. Inaccessible junction boxes shall not be used.

The whole of the conduit system shall be completely swapped through to remove any loose matter or dirt before cables are drawn in. Where conduits connect to switch boxes, drawin boxes, etc., the conduits must have a machined faced socket, screwed on to the end which when tightened, is flush with the outside of the box. The conduit is then to be secured to the apparatus by means of a hexagon smooth bore brass bush screwed from the inside of the apparatus into the conduit socket, in order to make a sound and tight mechanical joint. Conduits secured by locknuts in plain drilled holes will not be permitted.

All exposed threads shall be cold galvanised after installation. Surface run conduits shall be supported at intervals in accordance with the following schedule:

Size	Interval
20 mm	1.2 m
25 mm	2.0 m
30 mm	2.5 m

Where bends and sets occur in the conduit run, the conduit shall be securely fastened at a distance of 250 mm on either side of the diversion. Standard junction or adaptable boxes shall be provided at all junctions and at sharp changes of direction, in addition

to any special positions where they are called for by the Engineer. Steel or malleable cast iron inspection couplers may be used in long runs to facilitate drawing in cables.

Only continuous lengths of buried conduit shall be installed between boxes, no joint boxes being allowed in the floor screeds. Conduits crossing expansion joints shall be fitted with couplings of approved manufacture, with an earthing clip at each side of the coupling, connected by the correct size of tinned copper stranded wire.

The ends of conduits laid or set in shuttering prior to concreting, shall be temporarily sealed off with a coupler and a solid brass plug. Installations of conduits shall be made on the exterior surface of buildings shall be done only after acceptance of the Engineer.

Fixing to surfaces of walls shall be by means of spacer bar saddles securely fixed by screws. Where conduits are concealed or laid in construction floors they shall be held in position with substantial fixings of make and pattern approved by the Engineer.

Conduit shall be of the screwed pattern galvanised by the hot dip process. All conduit fittings not carrying accessories shall be supplied with flat covers, fixed in position with round head brass screws. Each fitting shall be supplied with a neoprene gasket.

Adaptable boxes shall be constructed of minimum 3 mm sheet steel or best quality cast iron, finished as previously detailed for conduit fittings and sized to prevent the undue packing of cables.

Weather proof boxes and accessories shall be used outdoors, and where indicated in the Specification. Conduit shall be installed such as to permit complete rewiring, without the need to carry out builders works. No single conduit serving single phase socket outlets, lighting points and switches shall contain more than one phase.

16.5.2 Flexible conduits

Where the conduit system terminates at any equipment requiring a non–rigid connection, a flexible conduit shall be installed of the PVC or PVC sheathed metallic type, fully watertight with purpose made connection adapters.

Each flexible connection shall include not less than 400 mm length of flexible conduit.

16.6 LIGHTING AND SOCKET OUTLETS

16.6.1 Lighting switches

Indoor surface switches shall be of minimum enclosure standard IP44. Where appropriate, they shall be of the multiple phase type and where possible shall be arranged in multi–gang boxes.

Special care shall be taken to ensure that all switches are securely fixed, truly vertical and that flush mounted switches are flush with the wall finish so that the overlapping cover plates seat on to the rims of the boxes.

16.6.2 Lighting fittings

Lighting fittings shall be complete with all supports, suspensions, flexible cables, pendants and plugs. They shall be connected to the main circuit wiring with flexible cables of a minimum conductor size of 1.5 mm² insulated with silicon rubber or PVC. Break joint rings shall be used in conjunction with batten holders, ceiling roses or back plates mounted on to a flush installation.

Standard fluorescent lighting fittings shall have two suspension fixing points. All lamp holders for flexible pendants shall be of the all-insulated skirted pattern with cord grips suitable for batten or wall mounting and shall be of similar pattern. All lamp holders shall be of the Edison screw pattern.

All fluorescent tubes shall be of an approved manufacture and standard white. They shall be suitable for the lighting fittings in which they are installed and of correct voltage. All incandescent lamps shall be of an approved manufacture with metal coil filaments, gas filled, clear finish in all standard sizes with standard caps to suit the fittings in which they are installed.

The Contractor shall supply and install all lamps for the entire lighting fitting installation and shall replace all burned out lamps up to the time that the Engineer takes final acceptance of the Works. The lighting layouts and fittings shall be approved by the Engineer.

16.7 BUILDING FOR ELECTRICAL APPURTENANCES

16.7.1 Switchboard Housing Unit and E/M Works at the New Upstream Transformer Building

This Housing Unit will be positioned on the top concrete slab of the new transformer building that the Contractor will construct at the upstream wellfield, in order to replace the existing transformer building.
The housing unit will have a floor area of not less than 40 m^2 and can be either prefabricated or constructed in-place. It will satisfy all National Standards of Kenya for similar buildings.
The works shall comprise:

- the designs of the housing unit and its connection to the rest of the building for approval by the Engineer.
- all necessary E/M designs and method statements for the transfer of the existing transformer and all other equipment from the old building, of all necessary new cables, fittings, connections, lightings etc. and all other

necessary works so that the full functionality of the old transformer building can be established in the new transformer building.

- supply of all material and complete civil and E/M works as per the approved designs.
- Relocation of transformer and all other equipment from old building and installation and connection to working order in the new building.

16.7.2 Raising the level of the Transformer and Other Electrical Equipment in the existing Transformer Building for Wells BH9, BH10 and BH11

The scope of the works is to raise the transformer and other vulnerable electrical equipment by 500mm from their current positions for increased resilience against flood inundation.

The works shall comprise:

- the designs and method statements for the raisings for approval by the Engineer.
- supply of all material and complete civil and E/M works.
- Relocation of transformer and all other equipment and connection to working order in the new raised positions.

Chapter 17: BUILDING WORKS

General: Building works under this contract shall be executed according to relevant Kenya standards and EN standards.