

(IN) GOVERNMENT OF MAURITIUS
MINISTRY OF ENERGY, WATER RESOURCES AND POSTAL SERVICES
CENTRAL WATER AUTHORITY

THE DETAILED DESIGN
ON
THE PORT LOUIS WATER SUPPLY PROJECT
IN MAURITIUS

FINAL REPORT (2)

TENDER DOCUMENTS

FOR

LOT III : RAW WATER TRANSMISSION PIPELINE AND
TREATMENT FACILITIES

VOLUME II

GENERAL SPECIFICATIONS
TECHNICAL SPECIFICATIONS

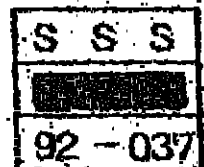
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MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY



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THE PORT LOUIS WATER SUPPLY PROJECT IN MAURITIUS

FINAL REPORT (2)

TENDER DOCUMENTS
FOR LOT III VOLUME II

MARCH 1992

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MINISTRY OF ENERGY, WATER RESOURCES AND POSTAL SERVICES
CENTRAL WATER AUTHORITY**

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TECHNICAL SPECIFICATIONS**

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PHOENIX - MAURITIUS**

THE PORT LOUIS WATER SUPPLY PROJECT

TENDER DOCUMENTS

FOR

**LOT III : CONSTRUCTION OF WATER SUPPLY FACILITIES
(RAW WATER TRANSMISSION PIPELINE AND
TREATMENT FACILITIES)**

VOLUME II

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PART A GENERAL SPECIFICATION

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**THE PORT LOUIS WATER SUPPLY PROJECT
LOT III : RAW WATER TRANSMISSION PIPELINE AND
TREATMENT FACILITIES**

PART A GENERAL SPECIFICATIONS

CHAPTER 1 DESCRIPTION OF PROJECT

101 General

The State of Mauritius comprises volcanic islands such as Mauritius, Rodrigues, Agalega and St. Brandon and located about 900 km east of Madagascar in the Indian Ocean. A total land area of the State is 2,040 km², of which the Mauritius island accounts for about 91.4% or 1,865 km².

The Project Site located in the upper Grand River North West (GRNW) basin in the Mauritius island, approximately 11 km south of Port Louis, the capital city of Mauritius. The GRNW which is one of major rivers in Mauritius originates in the central plateau of the Mauritius island and runs northwestward till it finally enters into the Indian Ocean through the southwestern fringe of the port Louis city area.

THE PORT LOUIS WATER SUPPLY Project aims at supplying municipal and industrial water for Port Louis city from the GRNW basin by constructing a rockfill dam with a crest length of around 230 m and a height of around 80 m above river bed and its appurtenant structures and water supply facilities including raw water, transmission pipeline and treatment works.

Raw water required for the treatment works is to be released from the Dam to the GRNW and taken in at the Municipal Dyke, and conveyed to the treatment works through the raw water transmission main by a gravity flow. The raw water reached to the treatment works is purified through treatment processes of chemical application, coagulation, sedimentation and filtration and treated water is stored in the existing Clear Water Tank upon chlorination.

Present Project is composed of the construction of Intake Chamber at the Municipal Dyke, Raw Water Transmission Pipeline from the intake chamber to the treatment works, treatment facilities of Receiving Tank, Rapid Mixing Tank, Flocculation and Sedimentation Tank, Rapid Sand Filter, Chemical Dosing Equipment, Operation and Chemical Buildings, and other associated facilities in the existing Pailles Treatment Works.

102 Port Facilities

Port Louis is an international trade port, situated along the northeastern coast of the Mauritius island.

The port is equipped with the following facilities:

(1) Approach channel (or canal) to wharf

Length	: 1.3 km
Width	: 0.2 km
Water depth from Higher Low Tide Water Level	: 12.5 m
Water depth from Lower Low Tide Water Level	: 11.0 m

(2) Berth capacity : 6 ships of 27,000 DWT class

(3) Warehouse : Approximately 40,000 m² in floor area

(4) Loading/unloading facilities

Equipment	: 4 units of heavy-duty toplift truck
Capacity	: 35 ton class ; 1 unit 26 ton class ; 3 units

Aside from the above information, the Contractor shall fully acquaint himself with the availability of the harbour facilities at the port of Port Louis as well as the size, and possible other limitations imposed by the authority concerned, etc. The Contractor shall take such information into account when making arrangements for handling and transporting the materials, equipment and the construction plants.

The Employer shall make his best endeavours to assist the contractor in securing priority

in the harbour with respect to customs clearance of the Contractor's equipment, materials and goods.

103 Location of Site

The Works are to be constructed in the Geographical District of Moka in Mauritius specifically to the west of the existing Pailles Treatment Works located on Pailles Junction Road approximately 5 kms south west of Port Louis docks.

104 Site Information

The construction works include Intake remodelling the existing one, Raw Water Transmission Pipeline and Treatment Works. Details of site conditions are described below:

(1) Raw water transmission pipeline

An access road from the treatment works to the Municipal Dyke is to be constructed under the Lot I Project and will be completed before starting the pipelaying works.

The Intake Chamber is to be constructed next to the existing chambers. During the construction work, the Contractor shall pay attention for that no turbid water by the construction flows into the existing chamber.

At present, three pipelines of 27" reinforced concrete pipe and 18" and 19" gray cast iron pipes are installed and in operation as the raw water mains for the existing slow sand filtration. The locations of pipelines are shown on the Contract Drawings but precise positions are not necessarily indicated so that the Contractor shall confirm the precise location and depth by test digging required spots. The Contractor shall pay attention for preventing the existing pipelines from destroying by the construction machines during pipelaying work.

(2) Treatment works

Presently twelve slow sand filters are in operation in Pailles treatment works. New Treatment Works is to be constructed on the unoccupied land located in the existing

filtration plant. The Contractor shall start replacing the existing filtered water and drain pipelines, which have been laid in the position of new sedimentation tanks and filters, before commencing excavation work. The elevations of pipeline centres are indicated on the Drawings but precise elevation shall be confirmed by the Contractor by the test digging of the position.

Logs of test boring showing a record of the data obtained on sub-soil conditions in the treatment works site are included in the Drawings for the information of the Contractor. The information derived from inspection of logs of test boring, or from plans showing location of utilities and structures will not in any way relieve the Contractor from any risk, or from properly examining the Site and making such additional investigations as he may elect, or from properly fulfilling all the terms of the Contract.

As the construction site is in the existing treatment works, the Contractor shall programme and organise the Works in cooperation with the existing plant manager to ensure the minimum interference with existing operators.

105 Scope of the Works

The Works to be carried out under the Contract shall, except as otherwise provided in the Contract, comprise the supply of all materials, labour, equipment, and other items necessary for the execution, completion and maintenance of the Permanent Works and Temporary Works in strict accordance with the Contract and as directed by the PMO/Engineer.

The Works to be carried out by the Contractor under the Lot III Contract are generally listed as follows, but are not necessarily limited thereto:

- (1) Construction of Intake Chamber remodelling the existing ones.
- (2) Construction and commissioning of raw water transmission pipeline with 800 mm in diameter to convey raw water to the treatment works.
- (3) Construction and commissioning of treatment facilities of rapid sand filtration with a treatment capacity of 30,000 m³/d in the Pailles Treatment Works, comprising of receiving tank, rapid mixing tank, flocculation and Sedimentation tanks, rapid sand

filters, chemical dosing facilities, buildings, mechanical and electrical facilities etc.

106 Works by Other Contractors

The Employer may arrange for, before the issuance of the Maintenance Certificate, works necessary for the completion of the Project other than that covered by this Contract, which will be executed by the other contractors. In such an event, the Contractor shall cooperate with the Employer and other contractors for the following Lots to ensure the satisfactory completion of the Project as a whole.

- Lot I : Civil Works
- Lot II : Construction of dam and appurtenant structures

CHAPTER 2 DRAWING

201 Drawings to be Furnished by the Engineer

In essence, the Tender Drawings which are included as Volume IV of the Tender Documents, are the Engineer's Final Design Drawings and provide information the Tenderer needs to prepare his Tender Price.

After the Contract Agreement has been signed, the Tender Drawings and any other drawings issued by the Engineer will then become the official Contract Drawings and will be used as a basis for the Contractor to prepare his Construction and Shop Drawings, which in turn must be submitted to the PMO/Engineer for Approval. After being approved, the Work shall be executed by the Contractor in conformity with the Contract and Shop Drawings, as well as other types of drawings prepared by the Contractor as outlined Clause 202.

It should be noted that the Tender/Contract Drawings shall be carefully checked by the Tenderer/Contractor after receipt thereof and if any errors, ambiguities, etc. of any type whatsoever are discovered, the PMO/Engineer shall be promptly notified. Any such errors, ambiguities, etc., so discovered will be checked out and corrected or clarified by the PMO/Engineer, if necessary.

Two(2) blue print copies of each Contract Drawing in 'A-1' size and two(2) sets of Contract Specifications will be issued by the PMO/Engineer to the successful Contractor free of charge. Additional copies of the Contract Drawings and Specifications will be provided at the cost of reproduction upon written request by the Contractor.

202 Drawings to be Furnished by the Contractor

(1) General

All types of drawings which have to be prepared by the Contractor must be done in a form approved by the PMO/Engineer and should be submitted well in advance so that the PMO/Engineer can review and/or approve them without any delay being caused to the field work.

The Contractor at his own advantage should prepare various types of drawings as described in sub clause (2) through (7). These drawings shall be submitted sufficiently in advance so that the PMO/Engineer is able to review and approve without any delay being caused to the field work.

(2) Construction Drawings

As mentioned in Clause 201 above, the Contractor will use the Contract Drawings as a basis for preparing the Construction Drawings. Such drawings will be made for all items of permanent work and where applicable will show concrete outlines, bending/cutting schedules and layout of reinforcement steel bars, types of material to be used, grades, exact dimensions and any other details which may be required. All Construction Drawings must be approved by the PMO/Engineer prior to the time the Contractor plans to start the particular items of the work.

(3) Shop Drawings

In general, Shop Drawings will be prepared by the Contractor or the Contractor's material/equipment supplier to show the outline, dimensions, type of material, etc. of special items which are to be incorporated into the permanent works. Such Shop Drawings must be submitted to the PMO/Engineer for approval.

(4) Working Drawings

Working Drawings will be prepared by the Contractor to show the full details of items which are not to be incorporated into the permanent works such as timber or steel forms, steel scaffolding, etc. Such Working Drawings must be submitted to the PMO/Engineer for his review and comments.

(5) Layout Drawings for the Temporary Works

Within thirty (30) calendar days after the issuance of Notice to Commence, the Contractor shall submit to the PMO/Engineer for his review and comments three (3) sets of drawings which show the layout of the Temporary Works. These drawings will show the locations and other pertinent details of the principal components of the constructional plant, offices, storage buildings, housing facilities, storage areas, etc. which the Contractor proposes to construct at the site of authorised areas. In

addition, the drawings will show the unloading facilities for the materials and equipment which the Contractor proposes to bring to the site, and the capacity of each major plant.

If any changes are made concerning the above-mentioned items during erection or after the items become operational, the Contractor must submit revised drawings showing such changes to the PMO/Engineer for his review and comments.

Two (2) sets of the reviewed layout drawings will be retained by the PMO/Engineer and one (1) set will be returned to the Contractor.

(6) As-built Drawings

The Contractor shall provide and keep up-to-date as-built drawings of which the original was prepared by the Contractor. These drawings shall show all changes or revisions from the original drawings and specifications, including the exact as-built locations, sizes and kind of metal work, embedded piping, if any and other concealed items of work. At the end of every month, all entries, changes or revisions made in drawings by the Contractor shall be checked and approved by the PMO/Engineer. As detailed work delineated on each Construction Shop Drawing is completed, the pertinent as-built drawings, after approval by the PMO/Engineer, shall be mutually signed by the PMO/Engineer and the Contractor or their representatives.

Prior to the last Final Completion of the Works under the Contract, the Contractor shall furnish the Employer one complete and duly checked set of as-built drawings consisting of one (1) reproducible copy and four (4) normal prints of each drawing.

(7) Other Drawings

Drawings other than those mentioned above, which are of a general nature such as proposed construction methods, schematic diagrams, outlines of how various types of work are to be performed, etc., must be submitted to the PMO/Engineer for his review and/or approval.

In preparing the Drawings, the Contractor shall leave a 14.5 cm x 10 cm space beside the title box for the signatures and stamps of the PMO/Engineer and the Employer.

203 Samples, Pamphlets and Data

The Contractor shall submit as requested to the PMO/Engineer for his approval three (3) sets of samples, pamphlets and data for materials which the Contractor intends to use under this Contract.

All items shall be submitted well in advance of the execution of the Works, but not later than thirty (30) days prior to purchase such items.

The responsibility for so ordering and delivering materials and manufactured articles and samples that they may be tested sufficiently in advance of the work as not to delay it shall rest upon the Contractor. He shall not be entitled to any time credit for delay occasioned by his neglect to order sufficiently in advance or to his neglect to order sufficiently in advance or to payment of any costs he may incur as the results thereof. Any and all costs incurred there shall be borne by the Contractor.

204 Operation and Maintenance Instructions

For each item/equipment supplied by the Contractor, instruction manual shall be prepared and shall include parts, catalogues, test certificates and test records, installation and operating instructions and any other information or instructions which may be needed or required or useful in the installation, operation, maintenance, repair, dismantling or assembling of the equipment and for repair and identification of parts for ordering replacements, all collated under a suitable common cover. If the manufacturer's standard bulletins are supplied, they shall be clearly marked to indicate the specifications applicable to the particular equipment which is supplied. Prints of drawings reduced to suitable size shall be included in each instruction manual. Six (6) complete copies of these instruction manual shall be delivered to the PMO/Engineer at latest thirty (30) days prior to the arrival of each item at the Site.

English language is to be used throughout all instruction manual. The cost of preparing and supplying instruction manual delivered in accordance with the above requirements shall be included in the Contractor's rates in the Bills of Quantities.

205 Submittal and Review or Approval of Contractor's Drawings

It is to the Contractor's advantage to prepare his drawings and submit them to the PMO/Engineer at the earliest possible time in order to avoid the possibility of delaying the field work because of not having the reviewed or approved drawings in hand when needed by the construction crews.

Generally, the Contractor should plan to submit his Construction Drawings and Working Drawings to the PMO/Engineer for approval or review as the case may be at least thirty (30) days prior to the time he plans to start construction of any particular items of work. Shop Drawings for the items which may be fabricated outside of Mauritius and shipped to the Site shall be submitted within one hundred and twenty (120) calendar days prior to shipment of the items for the approval of the PMO/Engineer.

Three (3) copies of clearly readable blue print copies of each drawing shall be submitted to the PMO/Engineer to which a log (control) number has been assigned. The format of the sheet will be approved by the PMO/Engineer. Within thirty (30) working days after the receipt of the prints of the drawings submitted by the Contractor, the PMO/Engineer will return one copy marked and signed with one of the following classifications, depending upon whether the drawings are "approved" or "reviewed."

(1) Drawings Requiring Approval:

- a) "APPROVED"
- b) "APPROVED EXCEPT AS NOTED--RESUBMITTAL NOT REQUIRED"
- c) "RESUBMIT AFTER MAKING CORRECTIONS"
- d) "DISAPPROVED FOR REASONS NOTED"

(2) Drawings Requiring Reviewal:

- a) "REVIEWED--RESUBMITTAL NOT REQUIRED"
- b) "REVIEWED--MUST BE RESUBMITTED FOR REASONS STATED"

- c) "RESUBMIT AFTER MAKING CORRECTIONS"
- d) "REVIEWED BUT NOT ACCEPTED FOR REASONS STATED"

Upon receipt of any drawings and documents which have been marked as shown in (1)-a) and b) or (2)-a) above, the Contractor will be authorised to proceed with the work covered by the drawings and documents. All the approved and reviewed drawings must be maintained at the Contractor's Site Office in proper order and hung in easily available "Stick Files" which are classified into the various project activities.

When returned drawings and documents have been marked as shown in (1)-c) or (2)-b) above, the Contractor shall make the necessary corrections and/or revisions to the drawings and documents and shall resubmit them to the PMO/Engineer by logged transmittal sheet in the same manner as for a new drawings and documents, i.e. three (3) copies. When the returned drawings and documents have been re-submitted for approval, the PMO/Engineer will try to complete his review and/or approval of the drawings and documents within fifteen (15) working days; however, this will depend on the number and complexity of the correction/revisions which have to be checked. This procedure will continue until the drawings and document have eventually been marked as shown in (1)-a) and (2)-a), above.

If any revision is made to drawings and document after it has been approved, the Contractor shall re-submit three (3) prints to the PMO/Engineer for further approval. The PMO/Engineer shall have the right to request for any additional details and to ask the Contractor to make any change in the drawings which are necessary to conform to the provisions and intent of the Specifications without additional cost.

Any work done prior to the PMO/Engineer's approval of drawings and/or documents shall be at the Contractor's risk. Approval by the PMO/Engineer of the Contractor's drawings and/or documents shall not relieve the Contractor of his obligations such as meeting all the requirements of the Specifications, the responsibility for the correctness of the Contractor's drawings and documents, the responsibility for the adequacy of the method of construction, etc.

CHAPTER 3 SCHEDULE AND REPORTS

301 Commencement, Carrying Out and Completion of Works

The Contractor shall commence the Works under the Contract in accordance with Clause 41 of the Conditions of Contract and shall complete the works listed in the following table within the number of months specified therein counting from the last day of the period named in the Appendix to the Tender as that within which the Works are to be commenced:

Item No.	Work	Months within Which the Work is to be Completed
1.	Raw Water Transmission Pipeline	24
2.	Treatment Facilities including Buildings and Yard Piping	24
3.	Completion of all the Works restoration of site	24

In addition, the Contractor shall have an obligation to carry out the Test Operation for two (2) months after the Provisional Completion of the Works as specified in Clause 81 of the Conditions of Contract.

302 Liquidated Damages

- (1) Should the Contractor have failed to complete a work and to complete the whole of the Works specified in Clause 301 above within the periods or such other period or the later dates for the respective works as may be allowed pursuant to Clause 44 of the Conditions of Contract, the Contractor shall pay to the Employer as fixed, agreed and liquidated damages the sums stated in the following table for each calendar day or part of a day of delay.

The accounting for liquidated damages for each work or the whole of the Works

shall begin on the last day of such period or date, as the case may be, or such other period or the later dates as may be allowed pursuant to Clause 44 of the Conditions of Contract and count forward in time till the completion of that work that work as certified by the PMO/Engineer.

Final clean-up of the premises and any other work that does not interfere with the normal and continuous operation of the Project may be done, after the above-mentioned completion time without incurring liquidated damages. However, this will be subject to the Employer's approval, depending on the prevailing on the site at that time.

Item No.	Work	Liquidated Damages per Day (U.S.\$)
1.	Raw Water Transmission Pipeline	15,000
2.	Treatment Facilities including Buildings and Yard Piping	15,000
3.	Completion of all the Works and restoration of site	15,000

303 Construction Programme

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

- (1) Within sixty (60) days after receiving Letter of Acceptance, the Contractor shall submit to the PMO/Engineer for approval, a detailed programme based on the key date stated hereinafter or other dates which shall be given in the Letter of Acceptance in the form of a Critical Path Method (hereinafter referred to as CPM Network) showing the order of procedure in which he proposes to carry out the works including design, manufacture, delivery to the Site, transport, storage, survey, construction, commissioning and maintenance. This programme shall indicate clearly all activities and its duration along with the earliest and the latest event, times and

the first and last dates of the submission of the Drawings and each date of shop inspection by the PMO/Engineer for the section or portion of the Works.

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

- (2) The CPM Network shall be in accordance with commonly accepted practices and shall show graphically the chain of activities/sub-activities and their sequential relationship with each other from the start of construction to the completion of the Contract. The Time Bar-chart Schedule shown in weeks shall list all main activities and its applicable sub-activities.
- (3) In preparing the CPM Network and the Time Bar-chart the Contractor shall make due allowances for possible delays. Under no circumstances shall the CPM Network or the Time Bar-chart schedule show a completion in excess of the "Time for Completion" stated in the Form of Tender.
- (4) The programme once approved by the PMO/Engineer shall thereafter be referred to be the Contractual Programme. The PMO/Engineer's approval for such programme shall not relieve the Contractor of any his duties or responsibilities under the Contract.

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

The Contractor shall pay his full attention on Works especially Electrical and Mechanical Works which may be carried out by the Electrical/Mechanical Contractor, intimately with the overall Works under the Contract for efficient execution of the Works, and shall clearly indicate them on the construction programme.

The Contractor shall also describe the conditions of working shifts, if necessary, to execute works at night and/or on Sundays and holidays, to be applied in the

particular works of his construction programme.

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

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

When requested by the PMO/Engineer, the Contractor shall promptly furnish detailed sub-programme of the Contractual Programme for the particular sections of the Works.

The Contractor shall provide, whenever requested by the PMO/Engineer or the PMO/Engineer's Representative, any information, particulars, etc. in writing of the Contractor's arrangement, within ten (10) calendar days of such request or other number of days stated in his request.

The CPM Network and bar chart to be submitted in the programme shall be compiled with the following provisions.

Activities shown on the CPM Network and Time-bar schedule shall consist not only of the actual construction operations but also shall include time allowances for the preparation and approval of drawings and samples, procurement and shipping of materials and equipment, installation of special and critical items, possible delays which can be caused by rains, flood and/or inclement weather, religious holidays, etc. The critical path shall be clearly marked on the CPM Network.

Both the time bar-chart schedule and CPM Network shall be closely monitored and kept current. In addition, they will be formally updated by the Contractor every month or as directed by the PMO/Engineer, and submitted to the PMO/Engineer for his review and comments.

304 Construction Reports

(1) Monthly Progress Report

The Contractor shall, on the tenth (10) day of each month or at any time designated by the PMO/Engineer, submit to the PMO/Engineer's Representative for his rectification and approval three (3) copies of the detailed written reports in a form prepared by the Contractor and approved by the PMO/Engineer showing the progress of the Works during the preceding month. The report shall show the percentage of each type of the work completed for each structure during the month and the total percentage of completion as on the date of the report. The report shall include, but shall not be limited to, the following matters:

- a) A general description of the works performed during the reporting period on each main activity to include any notable problems which were encountered.
- b) A list of all activities of scheduled progress and actual progress during the reporting period including the Contractor's actual or forecast start date versus scheduled start date, and the actual or forecast completion date versus scheduled completion date for each activity, with appropriate remarks in writing to explain any differences.
- c) A list of activities scheduled to be started within the next three (3) months, with expected starting and completion dates. If the expected starting and/or completion dates are different from those shown on the CPM Network schedule, an explanation is to be given.
- d) A list of local manpower (by trade classification) employed during the reporting period.
- e) A list of expatriate personnel (by position) employed during the reporting period.
- f) A list of the Constructional Plant, equipment and materials presently located at the Site.
- g) A progress and financial chart.

- h) A general description of the weather and water level in the rivers including the listing of rainfall (in mm) and maximum and minimum temperatures for each day throughout the month.
- i) Photographs showing the progress of works to date and others as may be directed by the PMO/Engineer.

The cost for provision of Reports, Drawings, Schedules, Photographs, etc., covered under this Clause shall be included in the rates in the Bills of Quantities.

305 Weekly and Monthly Work Schedule

(1) Weekly Work Schedule

The Contractor shall at the end of each week submit four (4) copies of a written weekly schedule listing the main work items which are to be accomplished during the successive week. The schedule shall be in a format approved by the PMO/Engineer and shall contain appropriate comments in regard to major work items to be undertaken during the week. One page of the schedule shall list each day of the week and show in the appropriate place each concrete pour which is planned to be made during the week.

(2) Monthly Work Schedule

The Contractor shall at the end of each month submit four (4) copies of a monthly bar chart type of schedule to show the work which proposed to be accomplished during the successive month. This schedule will show, by means of bars, the days within the month which each main activity will be worked on and will indicate on which day each proposed concrete pour is to be made.

306 Progress Photos

The Contractor shall furnish to the PMO/Engineer photographs (not less than 8 cm x 12 cm) of the work in progress, at locations directed by the PMO/Engineer throughout the Contract period. The photographs shall be taken at the start and completion of each major component

of the work and at other time as directed by the PMO/Engineer.

The photographs to be furnished to the PMO/Engineer shall be attached to the applicable monthly progress report specified in Clause 304 hereinabove and shall be in five (5) prints for each photograph.

A brief description and date of each photograph shall be included. The cost of such photographs shall not be paid separately and be deemed to be included in the price for various items in the Bill of Quantities.

The negatives of the photographs shall be the property of the Employer and no print from these negatives shall be supplied to any person or persons unless so authorised by the Employer. The negative shall be submitted to the PMO/Engineer along with the Photographs.

Upon completion of the Works, the Contractor shall submit two (2) sets to the Employer and one (1) set to the PMO/Engineer of colour photographs adequately edited and in a booklet form showing the entire sequence of the work from start to the completion.

CHAPTER 4 SETTING-OUT THE WORKS

401 General

The Contractor shall undertake field surveys required for the performance of the Works. The PMO/Engineer will provide to the Contractor with data on the initial lines and grades, including a stationed centre line, bench marks, essential control points for structures, and other principal control points.

402 Bench Marks

The basic bench mark shall be as shown on the Drawing (Drawing No. 01-G-003). The elevation of this bench mark (BM.MT) is +70.393 metres above mean seawater level. Before using such bench marks for setting-out of the Works, the Contractor shall carry out a check survey thereon and satisfy himself as to their accuracy. The PMO/Engineer shall not relieve any responsibility for the accuracy of such bench marks.

The Contractor may establish additional temporary bench marks for his own convenience but each temporary bench mark so established shall be of a design and in a location approved by the PMO/Engineer, and shall be accurately related to the bench marks established by the PMO/Engineer.

403 Stakes, Marks, Templates, Etc.

From the data on the initial lines and grades provided by the PMO/Engineer, the Contractor shall furnish and place all additional stakes, marks, template and materials necessary for making and maintaining point and lines and elevation for the performance and completion of the Work. The stations (distance marks and/or intermediate pegs) which will be supplemented by the Contractor on the centre lines shall be placed in accordance with the profile of the line and the distance between each station shall not exceed fifty (50) metres. The Contractor shall carry out cross-sectioning as well as profile levelling for the said stations. Special care shall be taken for the installation and electrical equipment that require setting with great accuracy. The Contractor shall be responsible of the finished work with

the lines and grades established by the PMO/Engineer.

The Contractor shall also set out the side-width pegs required for construction at the site based on the Drawings.

Survey stakes established by the PMO/Engineer and/or the Contractor shall be preserved by the Contractor unless authorised to remove, and in case of their destruction or removal by the Contractor's labour where construction operations require removal of the stakes, the Contractor shall replace them at his own expense and as required for the performance of the work.

The PMO/Engineer shall have the right to check the Contractor's lines, grades and measurements at any time and to require correction of inaccuracies in the work at no additional cost to the Employer.

CHAPTER 5 MATERIALS AND STANDARDS

501 General

All materials, equipment and testing apparatus etc. to be furnished and works to be executed by the Contractor in this Contract shall conform to the requirements of the International Standards Organisation (ISO), British Standard, Japanese Industrial Standard or other approved applicable standard in Mauritius unless otherwise specifically stated.

Equipment to be purchased shall be from well recognised manufacturers whose products are standardised and controlled by any recognised standard organisation. All dimensions and measurement units shall be of S.I. units.

The Contractor may propose to the PMO/Engineer an alternative Standard other than specified, in which case he shall submit six (6) copies of English translation of the proposed standard and all other information required for the materials, equipment and testing, together with the written proof that his proposed standard is equivalent in all significant respects to the standard specified.

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

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

502 Tropicalisation

In choosing materials and their finishes, due regard shall be given to the humid tropical

conditions of the site to which they will be subjected. The Contractor shall submit details of his practices which have proven satisfactory and which he recommends for application on the parts of the Works which may be affected by the tropical conditions.

503 Inspection and Test Operation

(1) Inspection and Test

Materials and equipment shall be subject to inspection and test at the Site, at manufacturer's premises or at testing laboratories as specified and as required by the PMO/Engineer. The tests shall include those detailed hereafter, but are not necessarily restricted to those.

The Contractor shall give every facility to enable the PMO/Engineer to carry out the inspection and witnessing of test. The Contractor shall give reasonable notice in writing to the PMO/Engineer of pending inspections and tests. The PMO/Engineer shall at all times have right of entry to all places where materials and/or equipment are being manufactured, fabricated, erected, tested or stored.

The Contractor shall provide all things necessary for the carrying out of tests including water, electric power, instruments, temporary connections, fuel, etc. All instruments used in tests shall carry calibration certificates from a reputable testing laboratory and shall perform within the limits of error necessary to carry out the test satisfactorily.

The approval by the PMO/Engineer of such inspections and tests will not, however, prejudice the right of the Employer to reject the material or equipment, if it does not comply with the required standard, and shall in no way relieve the Contractor from any of his obligations under the Contract.

The cost of testing in accordance with the requirements of this Clause, shall be included in the Contractor's rates in the Bills of Quantities.

(2) Test Operation

The Contractor shall perform in the presence of the PMO/Engineer test operation of

the equipment and instruments to demonstrate that the works have been completed in conformity with the Contract.

The whole water supply facilities under the Contract will be run for two months during which the PMO/Engineer's Representative will carry out various measurements and tests. The Contractor shall furnish all necessary personnel, materials, equipment, and others for the test operations and tests. The water, power and chemicals required during this period, for operating the treatment works will be supplied by the Contractor. The cost for testing and test operation shall be included in the Contractor's rates in the Bills of Quantities.

504 Approved Manufacturer's instructions

The Contractor shall supply the items or materials from the approved manufacturers listed or equal and approved.

All items or materials shall be delivered to the site in the manufacturers original unopened containers with the manufacturers brand and name clearly marked on.

All items or materials shall be assembled, mixed, fixed or otherwise incorporated in the works in accordance with the printed instructions of the manufacturer of the items or material.

505 Spare Parts

All spare parts shall be fully inter-changeable and suitable for use in place of the corresponding parts supplied with the equipment and shall be properly packed for shipment and for storage without deterioration over long periods on the Site. Fast consumable parts shall be supplied with priority.

The Contractor's rate for supply of Mechanical/Electrical Equipment should include for supply of all spare parts as recommended by the manufacturer and the list of spare parts included in the pricing to be submitted with the Tender.

All spare parts ordered shall be clearly marked with their description and purpose to

facilitate easy identification.

Whenever required by the PMO/Engineer, the Contractor shall submit to the PMO/Engineer for his approval a price list of spare parts for each equipment furnished under the Contract.

506 Transportation to the Site

(1) Packing

All materials and equipment shall be packed for transport to the Site so that it is protected against the climatic conditions and mechanical shocks to which it may be subjected in transit and in storage at the Site. Each crate or package, etc. shall be marked carefully on the outside with the mark of " Central Water Authority, Port Louis Water Supply Project, Phase I" showing the total weight, and indication of where the weight is bearing and the correct position for the slings shall be shown.

(2) Identification and Marking

All apparatus and fittings that require assembly at Site shall have distinguishing marks, punch-stamped or otherwise marked in accordance with code approved by the PMO/Engineer. These marks shall be made in two places on each item and galvanised parts shall be stamped before galvanising. All marks shall be visible and legible.

(3) Handling and Storage of Materials

All materials and equipment to be incorporated in the work shall be handled and stored by the manufacturer, supplier, fabricator, and the Contractor before, during and after shipment in a manner to prevent warping, twisting, bending, chipping, rusting and any injury, theft or damage of any kind whatsoever to the material or equipment.

Cement and lime shall be stored, covered and off the ground, and shall be kept completely dry at all times. All structural steel, miscellaneous steel, and reinforcing steel shall be stored off the ground or otherwise to prevent accumulation of dirt or grease, and in a position to prevent accumulation of standing water and to minimise

rusting. Beams shall be stored with the webs vertical. Precast concrete elements shall be handled and stored in a manner to prevent accumulation of dirt, standing water, staining, chipping or cracking. Masonry products shall be handled and stored in a manner to reduce breakage, chipping, cracking, and spalling to a minimum.

All equipment subject to corrosive damage by the atmosphere if stored outdoors, even though covered shall be stored in a building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it must be satisfactory to the PMO/Engineer.

Any materials which, in the opinion of the PMO/Engineer, have become so damaged as to be unfit for the use intended or specified shall be promptly removed from the site of the work, and the Contractor shall receive no compensation for the damaged material or its removal.

Manufactured materials shall be delivered and stored in their original containers, plainly marked, with identification of material and manufacturer.

(4) Transportation

The Contractor shall transport all materials and equipment from the Bonded Warehouse to the Site with his own expense.

(5) Transportation Costs for Materials and Equipment

The Contractor shall pay the transportation costs from the sea or airport to stockyards in the site for pipe materials, valves, gates and mechanical and electrical equipment to be imported, and construction machinery to be imported and re-exported.

CHAPTER 6 THE SITE

601 Right of Way

The Employer will provide the right of way of the site for permanent works or installations, storage yards, and right of way for access thereto over routes established by the PMO/Engineer as shown on the Drawings. The Contractor will be permitted to use land for construction purpose.

Not later than forty-five (45) calendar days prior to the commencement of the construction work at the site, the Contractor shall submit to the PMO/Engineer for approval drawings showing the details of the land and right of way according to the survey and the Drawings as specified in Chapter 2 "Drawings" and Chapter 4 "Setting-Up."

Any additional right of way or land which are not shown on the Drawings that may be required for temporary construction facilities or for storage of materials, equipment and supplies shall be provided by the Contractor at his own responsibility.

The Employer will pay compensation for damage to property, land, crops, timber and buildings situated on the land on which permanent structures are to be built.

The Contractor shall not obstruct any existing road or drainage on the land so furnished for construction purpose unless and until given written permission by the Employer.

602 Access to the Works

Right of way for access to the permanent works from existing roads will be provided by the Employer. All work on the right of way necessary for access to the project site shall be performed by the Contractor at his expense. The Employer assumes no responsibility for the condition or maintenance of any existing road or structure thereon that may be used by the Contractor for performing the work under the Contract and for travelling to and from the site of the work. No direct payment will be made to the Contractor for constructing temporary roads used for construction operations, or for improving, repairing, or maintaining an existing road or structure thereon that may be used by the Contractor for performance

of the work under the Contract. The cost of all work described in this Clause shall be deemed to have been included in the prices in the Bill of Quantities.

603 Materials Found on the Site

Any sand, gravel or other building materials found on the site shall be the property of the Employer and shall not be used in the execution of the works without the prior written consent of the PMO/Engineer.

604 Sign Boards

The Contractor shall erect and maintain two signboards at locations assigned by the PMO/Engineer bearing the Project Title, Employer, PMO/Engineer, PMO/Engineer's Representative and Contractor(s) names and titles. Each name shall be painted on a separate wood plate supported by steel posts as specified in Section 11, Part-B of this Specification.

Other smaller signposts shall be provided by the Contractor indicating the location of Raw Water Pipeline Works, Treatment Works, Contractor's Camp(s), PMO/Engineer's Representative office, etc.

All expenses and costs incurred thereto shall be included in the prices in the Bill of Quantities.

CHAPTER 7 SECURITY AND HEALTH CONTROL

701 General

All security and health control necessary for execution of the Works such as, but not limited to, sanitary arrangements, clearance of Site, explosives and fuel, safety precautions, fire prevention, public morality, etc. shall be done by the Contractor at his own expense.

The Contractor shall make himself responsible for all management works of security and health control and shall submit to the PMO/Engineer the organisation and regulations for his approval. The Contractor shall arrange and submit proposed procedures to the authorities concerned for the approvals necessary for execution of the Works at his own expense and responsibility. The cost of security and health control shall be included in the Contractor's rates in the Bills of Quantities.

702 Security Control System

The Contractor shall establish the security control system and its organisation for the Works and submit the programme to the PMO/Engineer for his approval. The security control system shall have sufficient equipment, facilities and persons to avoid the accidents and damages for persons and properties concerned.

The security control system shall be operated in accordance with the approved programme which shall be established on the basis of law and regulations of the Government.

The PMO/Engineer or the PMO/Engineer's Representative shall have the right to instruct the Contractor for operation of the system from time to time if it is deemed necessary in the opinion of the PMO/Engineer.

703 Sanitary Arrangements and Clearing of Site

The Contractor shall keep the Site in a clean and sanitary condition and shall provide and maintain sanitary conveniences for the use of persons employed in the Works to the extent

and in the manner and at such places as approved by the PMO/Engineer and by any local or other Authority concerned, and all persons connected with the works shall be obliged to use these conveniences.

The Contractor shall also post notices and take such other precaution as may be necessary to keep the site clean.

No tree felling shall be permitted outside the Land. Clearing shall not take place without written approval of the PMO/Engineer and presence of the Employer's personnel and shall be kept to a minimum. All timber fell shall be property of the Employer and the Contractor shall hand over the same to the Employer at the designated points, if ordered to do so.

704 Explosives and Fuel

The Contractor shall make arrangements to store and handle the explosives and fuel in such safe conditions from public in accordance with the laws and security regulations in force relating to their movement, handling, use and storage.

The Contractor shall obtain all necessary licenses and shall pay all fees and charges in respect of the same as may be necessary for the purpose of moving explosives and fuel from place to place and storing the same, and shall carry out all applications to obtain the approvals from relevant authority of the Government.

The Contractor shall supply and install an efficient warning system so that adequate warning be given for all persons that may be endangered, when charges or group of charges are to be fired. The Contractor shall ensure, prior to discharging of an explosive, that the area to be blasted is clear of all residents, pedestrian and vehicular traffic, and shall post flagmen, on each of the roads entering to the said area, to stop and prevent any traffic into that area until the "all clear" notification is given.

The locations of magazines shall be approved by the relevant Authority. Above-ground gasoline and liquefied petroleum gas storage tanks shall not be permitted to be located within the limit of camp site or closer than 100 metres of any building in the Site. The Contractor shall not make use of any explosive without the written approval of the relevant Authority.

Approval of the relevant Authority shall not relieve the Contractor of his obligations and responsibilities for all blasting operations.

705 Precautions for Safety

The Contractor shall take all necessary precautions against risks of loss life or of injury to any person employed on the Works or to employees of the Employer and the PMO/Engineer or of others or to visitors or to persons having sufficient reasons to be about the Works and shall properly safeguard the Works to the satisfaction of the PMO/Engineer.

The Contractor shall furthermore take all necessary precautions against damage to the property of the Employer or of others located at or adjacent to the Site.

The Contractor shall at all times comply with any accident prevention regulations and any safety regulations peculiar to the various trades employed on the Works and any safety regulations published by the Government.

The Contractor shall report promptly to the PMO/Engineer all accidents involving the death injury to any person, on the Site or resulting from the Contractor's operations, and give written explanations outlining details which led to such accident and action taken by the Contractor.

706 Fire Prevention

The Contractor shall take every precaution to prevent fire occurring on or about the Site. He shall comply with laws and regulations regarding fires and with respect to the prevention of fires. No fire may be lit in the dry season without permission in writing obtained from the PMO/Engineer's Representative/relevant Authority.

The Contractor shall fight diligently any fire which occurs on the Site. He shall employ all requisite equipment and manpower available on site.

707 Temporary Fencing

The Contractor shall erect, maintain and remove on completion of the Works at his own expense suitable and approved temporary fencing to enclose such areas of the works to be carried out and all area of land occupied by the Contractor within the Site as may be necessary to implement his obligations as specified in the Conditions of Contract to the satisfaction of the PMO/Engineer.

708 Public Morality

The Contractor shall pay attention to public morality of his staff and labourers regardless in or out of the Site and shall be responsible to prevent such arbitrations between his employees and persons in the neighbourhood of the Works.

The Contractor shall also be responsible to keep the public traffic including pedestrian, on the existing National roads, to be passed safely and smoothly without danger.

CHAPTER 8 TEMPORARY WORKS

801 General

All the temporary works, including but not limited to aggregate production plant, concrete plant, water supply system, electric power supply system, telecommunication system, buildings, drainage system and other facilities shall be installed, operated, maintained and removed by the Contractor.

At least twenty (20) days prior to the installation of the temporary works, the Contractor shall prepare and submit to the PMO/Engineer for approval the details including scale, capacity, layout, installation programme and schedule, and foundations for the temporary works. The PMO/Engineer shall have the right to direct the Contractor to modify or change the Contractor's proposals if it is deemed necessary in the opinion of the PMO/Engineer, such direction of the PMO/Engineer shall not relieve the Contractor of his obligations and responsibilities under the Contract.

The construction of the temporary facilities shall not be started without the PMO/Engineer's approval. The PMO/Engineer has the right to request the Contractor to leave whole or part of the temporary construction facilities on the Site for use during the period of operation and maintenance.

No separate payment shall be made for the items and works described in Clauses 801 through 808 and all such necessary costs shall be deemed to be included in rates in the Bill of Quantities.

802 Temporary Roads

The Contractor shall provide all temporary sleeper tracks, temporary roads, crossings, gangways, stagings, hardstandings, etc. over existing roads, streams or unsuitable ground for forming access to and on the Site, alter and adapt for his own and subcontractors use and clear away at the completion of the works.

803 Water for the Works

The Contractor shall be responsible for making all necessary arrangement for providing adequate quality and quantity of water for the appropriate performance of the work at all times during the entire period of the Contract together with all transport, temporary plumbing, storage and distribution. The Contractor shall alter, adapt and maintain temporary works as necessary and shall remove and make good at completion of the work.

804 Electricity for the Works

The Contractor shall make all necessary arrangements and provide and maintain all artificial lighting and power for the proper execution and security of the work and its protection with all meters, temporary wiring and fittings, and alter, adapt and maintain the temporary works as necessary and remove and make good at the completion.

805 Drainage System

The Contractor shall construct, maintain and subsequently remove drainage system for the execution of the works at his own expense including installation, operation and maintenance of drainage equipment with sufficient units of standby. The facilities and equipment for the drainage system shall be subject to the approval of the PMO/Engineer.

806 Temporary Buildings

Subject to the PMO/Engineer's approval, the Contractor shall provide and maintain the Site Office including conference rooms, sheds, workshops, mess-rooms, sanitary accommodation, warehouse, repair shops and recreational facilities and other temporary works or any other facilities whatsoever for the Contractor's staff and workpeople and for subcontractor's staff employed upon the works.

The following shall be considered as facilities of the temporary buildings: lighting system, telephone system, water supply system, sewage disposal and sanitation and fire protection. The Contractor shall also construct and maintain adequate roads or paths to all buildings.

The Contractor will be permitted to use for the construction-camp purpose any land available in the vicinity of the work that is the property of the Employer, provided that such use shall not interfere with any part of the work of other Contractors or of the Employer in the vicinity. If private land is used by the Contractor for camp or other construction purposes, the Contractor shall make all the necessary arrangements with the owner and shall pay all rentals or other costs connected therewith.

All temporary buildings and so on shall be situated in approved positions and as directed by the PMO/Engineer. All temporary buildings shall be removed and made good on completion by the Contractor.

Before any building is occupied, the Contractor shall draw up a code of rules and regulations for their control which shall be approved by the PMO/Engineer.

The Contractor's site office shall be open during the working hours to receive instructions, notices or other communications.

Sheds shall be suitable to store all materials which in the opinion of the PMO/Engineer need protection from the weather.

The Contractor shall maintain on the Site adequate sanitary accommodation for his staff, workmen and subcontractors. This sanitary accommodation shall be kept in a clean and orderly condition to the approval of the Public Health Authority and the PMO/Engineer to ensure that no nuisance is caused. The sanitary accommodation shall be removed at the completion of the works and all trenches shall be chemically treated and completely backfilled to the satisfaction of the PMO/Engineer.

807 Telecommunication System

An internal telecommunication system shall be installed, maintained and subsequently removed by the Contractor.

One private telephone exchange having necessary number of links shall be installed and maintained at a place of the Contractor's office, and the lines shall be extended to such places in the work sites as the Contractor's office, shops, camp buildings and the PMO/Engineer's site office, laboratory, clinic and others as may be necessary.

Free use of such telecommunication system shall be allowed by the Contractor to the Employer, the PMO/Engineer, their Representative or any other person authorised to be on the site by the Employer or the PMO/Engineer.

808 Storage Yard and Motor Pool

The Contractor shall prepare lands necessary for storage yard and motor pool at his own expense. He shall construct necessary works such as grading, gravelling surfacing, drainage system and fencing in the area and access from existing roads to the area. The Contractor should maintain these works as well as remove and make good at the completion.

809 Removal of Camps

On completion of the Contract the Contractor shall, if otherwise required by the PMO/Engineer, take down and remove all structures erected on the camp site or sites connected with his own camp, workshop, office, etc. and the PMO/Engineer's Representative offices. He shall remove temporary water supply, all drains and culverts, backfill trenches and ditches, fill in all latrine pits, soakaway, septic tanks, and other sewage disposal excavations, and shall restore the site as far as practicable to its original condition and leave it neat and tidy to the satisfaction of the PMO/Engineer.

CHAPTER 9 THE WORKS

901 Contractor's Responsibility for Utility Properties and Services

At points where the Contractor's operations could cause damage which might result in considerable expense, loss and inconvenience when his operations are adjacent to or near telegraph, telephone, power, watermains, sewers, irrigation, or other private or public systems, the operations shall be suspended until all arrangements necessary for the protection thereof have been made by the Contractor.

The Contractor shall notify all utility offices which are affected by the construction operation at least 14 days in advance. Under no circumstances shall any utility be exposed without first requesting permission and being granted to do so from the appropriate agency. Once permission has been granted, locate if necessary, and expose and provide temporary support for all existing underground utilities in advance of the trenching operation.

Power poles will be protected at no cost to the Employer. If interfering power poles, telephone poles, guy wires or anchors are encountered, the Contractor shall notify the appropriate utility agency at least 14 days in advance of construction operations to permit the relevant utility agency to protect or relocate the interfering structure.

In the event of interruption to domestic water supply, sewer, storm drain, or other utility services as a result of accidental breakage, or as a result of being exposed or unsupported, promptly notify the proper authority. The Contractor shall co-operate with said authority in restoration of service as promptly as possible and bear all costs of repair, in no case shall interruption of any water or utility service be allowed to continue unless prior approval is received from relevant authority.

Neither the Employer nor its officers or agents shall be responsible to the Contractor for damages as a result of the existence of underground utilities not shown on the Drawings.

Where any existing structures or facilities which are intended to remain are damaged by the Contractor during demolition or construction, the Contractor shall promptly repair or replace the damaged portion or facility at no additional cost to the Employer.

902 Construction at Existing Farm Ditches, Pipelines and Natural Drainage Crossing

Where the work to be performed under these Specifications crosses or otherwise interferes with existing streams, water courses, canals, farm ditches, pipelines, drainage channels, or water supplies, the Contractor shall perform construction during the progress of the work such that no damage will result to the above-mentioned public or private interests, and the Contractor shall be liable for all damage that may result from failure to do so. Unless otherwise specified, the cost of such work shall be included in items in the Bill of Quantities.

Where new structures or modifications of existing structures to render the watercourses or pipelines operative beyond the period of the Contract are required at these crossings, as shown on the Drawings or as directed by the PMO/Engineer, payment will be made at the prices bid in the Bill of Quantities for the required items of work.

903 Temporary Staging for Structures

Temporary staging shall be provided by the Contractor to enable the construction operations to be performed in the required sequence. The staging shall be properly designed and constructed for the loads which it will be required to support, and complete details of the arrangements proposed shall be submitted to the PMO/Engineer for approval. Such approval however, will not relieve the Contractor of his responsibility for the adequacy of the staging. The cost of such staging will not be separately paid for and shall be deemed to be included in the tendered rates and prices entered in the Bill of Quantities.

904 Dust Abatement

During the performance of the work included in these Specifications or any operations appurtenant thereto, whether on right of way provided by the Employer or elsewhere, the Contractor shall carry out proper and efficient measures wherever and as often as necessary to reduce the dust nuisance and to prevent dust, which has originated from his operation, from damaging crops, cultivated fields and dwellings or causing a nuisance to person(s). The Contractor will be held liable for any damage resulting from dust originating from his operations under these Specifications on right of way or elsewhere. The cost of sprinkler or

of other methods of reducing the formation of dust shall be included in the prices bid in the *Bill of Quantities for other items of work.*

905 Pollution of Water Courses

During the period of execution of the works, the Contractor shall take all necessary precautions to prevent the pollution of rivers, streams, watercourses, reservoir catchment areas, surface water drains or the surface of the ground by poisonous, noxious or polluting matter arising from his operations, and shall provide any setting ponds or purifying equipment required.

906 Noise Control

All work shall be carried out without unreasonable noise. Compressors used on the site shall be silenced either by using only full silenced models fitted with effective exhaust silencers and properly lined and sealed acoustic covers all to the design of the manufacturers of the compressor or by the use of effective screens to enclose the noise source. Ancillary pneumatic percussive tools used on the Site shall be fitted with silencers of a type recommended by the manufacturers of the tools. Compressors, silencers or other equipment shall be maintained in good and efficient working order and shall not have been altered in such a way that the noise caused in operation is made greater by the alterations.

907 Tree Protection

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

908 Watercourses

Excavations carried out for the diversion, enlargement, deepening or straightening of watercourses shall include the operations of any necessary trimming of slopes, grading of beds, disposal of excavated materials and pumping, timbering works and materials necessary for dealing with the flow of water.

The beds and sloping sides of watercourses shall be protected against the action of water.

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

Existing ditches shall, where shown on the Drawings, be cleared by removing vegetable growths and deposits. The sides shall be trimmed throughout and the bottoms uniformly graded and the ditches kept clean and maintained for the period of execution of the works. Material removed from existing ditches shall be disposed of in tips off the site provided by the Contractor.

CHAPTER 10 OFFICE FOR PMO/ENGINEER'S REPRESENTATIVE

1001 Office Accommodation For PMO/Engineer's Representative

Before commencing the Works the Contractor shall provide and erect on the Site directed by the PMO/Engineer at Pailles an office furnished and equipped for the exclusive use of the PMO/Engineer's Representative having the following accommodation:-

- 2 rooms of dimensions 5 metres by 4 metres approximately
- 1 room of dimensions 4 metres by 3.5 metres approximately
- 1 conference room.
- 1 washroom and W.C. accommodation of dimensions 2 metres by 2.5 metres approximately.

The rooms and washrooms shall all be connected by an internal corridor. The floor shall be covered by a heavy duty plain linoleum. The washrooms shall be sub-divided into two compartments provided with a wash basin and hot and cold water supplied and a flush operated W.C. connected either to a public sewer or to a septic tank provided by the Contractor to the satisfaction of the PMO/Engineer in respect to construction, design and siting.

Before placing any orders or delivering any materials or fittings for the offices the Contractor shall obtain the approval of the PMO/Engineer in writing to the location and type of the building and the furniture fittings, air conditioning and other equipment to be supplied.

The offices for the PMO/Engineer's Representative shall be completely separate from that of the Contractor and, if so required by the PMO/Engineer, shall be fenced with a 2 metres high barbed wire fence and gate with padlock and chain.

Unless the office are accessible via an existing paved road the Contractor shall, if so required by the PMO/Engineer Representative, provide an access road at least 3 metres wide

to the Office, together with a 100 square metres car parking area of at least 150 millimetres consolidated thickness of gravel properly graded, cambered, drained and culverted. Carports for the PMO/Engineer's Representative vehicles are to be provided at both the sites.

Contractor shall provide soap and towels in the offices of the PMO/Engineer Representative, and also cleaner and sanitary staff, cleaning equipment, etc and shall keep the offices in a well-maintained, clean and habitable condition. The cost of providing the staff referred to above shall be included in the rates of the Bills of Quantities.

The Contractor shall provide all assistance such as instruments, chainmen, clerks and junior staff, all tools and protective clothing, wooden pegs, iron pins and pickets, water, cement and aggregate for concreting, transport for labourers and materials, as may be required by the PMO/Engineer's Representative and his staff for supervision, checking, setting out, surveying, measuring and/or testing the work. All costs due to this provision are deemed to be covered in his rates in the Bill of Quantities.

1002 Office Furniture and Equipment

The Contractor shall supply the following furniture and equipment for the offices of the PMO/Engineer's Representative:

(1) Office Furniture

- 6 – desks with 3 lockable drawers and chairs for engineer
- 8 – desks and chairs for local staff
- 4 – meeting table, 1 set with 2 x chairs
- 2 – drawing boards
- 2 – stools
- 6 – chairs
- 2 – lockable metal filing cabinet
- 1 – plan chest
- 2 – tee squares
- 4 – air-conditioners
- 1 – refrigerator with 250 lit capacity

(2) Office Equipment

- 1 - micro-computer
- 1 - printer
- 1 - photocopy machine
- 1 - blue print machine
- Stationery as required
- 2 - Drafting machine
- 2 - fire-extinguishers

(3) Lighting and water supply

The Contractor shall provide lights and taps of water supply in the office of the PMO/Engineer's Representative and to the satisfaction of the PMO/Engineer. The Contractor shall maintain light and air condition in the office throughout the period of the Contract and pay the power charges arising in the office. The cost shall be covered in his rates in the *Bill of Quantities*.

(4) Telephone and Facsimile

The Contractor shall arrange with the Department of Telecommunications for the provision and installation in each of the offices of the PMO/Engineer's Representative of one telephone with at least one extension and one facsimile for the exclusive use of the PMO/Engineer's Representative at Pailles and shall pay the rent thereof throughout the period of the Contract. The cost of telephone calls made by the PMO/Engineer's Representative shall be paid by the Contractor and charges to the appropriate item in the *Bill of Quantities*.

(5) Security

Guards for day and night security and a messenger are to be provided at site for the exclusive use by the PMO/Engineer's Representative throughout the period of the Contract.

1003 Time for Erection of Offices

The office to be provided under this Contract shall be handed over to the PMO/Engineer's Representative in finished and fully habitable condition not later than ninety (90) days after the PMO/Engineer's notice to commence work and the office shall be to the entire satisfaction of the PMO/Engineer. During this period the Contractor shall arrange equal accommodation to the approval of the PMO/Engineer and all costs for renting and providing all other facilities to be borne by the Contractor, and included in his rates in the Bill of Quantities.

1004 Insurance and Ownership, Furniture and Equipment

All the furniture and equipment provided by the Contractor for the PMO/Engineer's Representative office shall be insured by the Contractor against any loss or damage by accident, fire or theft for the duration of the Contract.

Ownership of any the PMO/Engineer's Representative office, furniture and equipment on completion of the Contract shall be reverted to the Employer.

1005 Maintenance Offices, Furniture and Equipment

The Contractor shall maintain all the furniture and equipment provided by him in a reasonable state of repair and shall replace promptly any item which becomes unserviceable due to the manufacturers' faults.

CHAPTER 11 PARTICULAR ITEMS

1101 Performance Bond and Advance Payment Bond

The Contractor shall furnish a Performance Bond and Advance Payment Bond in accordance with Clause 10 of the Conditions of Contract for the due performance of the Contract and to secure the refund of Advance Payment.

No separate payment shall be made for the cost for providing the Performance Bond and Advance Payment Bond and all the cost shall be deemed to be included in the Contract unit and lump sum prices stated in the Bill of Quantities.

1102 Insurances

The Contractor shall indemnify certain insurances relating to the Contract in accordance with Clauses 21, 23 and 24 of the Conditions of Contract. In handling compensation to the workmen under the above Clauses, the Contractor shall arrange for such that any compensation amount determined shall be paid without delay by the Contractor to the workmen who are entitled to such compensation whatever the time for payment of insurance amount from the insurance company to the Contractor is.

The Insurance of the works must be issued for the quantity equivalent to one hundred per cent (100%) of the Contract Price up to the issue of the Certificate of Completion.

The Transport and Erection Insurance shall cover all the Permanent Equipment and Constructional Plant from the production or purchase site to the site of their erection and installation for the amount equivalent to one hundred percent (100%) of the Contract Value including the final tests.

The Contractor shall subscribe a Public Liability and Hold Harmless Policy with a Surety approved by the Employer, covering damages and injuries to third parties to their goods and persons, which shall be valid to the Completion of the Works.

The amount of said insurance for the Contractor is _____ (Rs. _____) for any one or more persons, and _____ (Rs. _____) for one or more cases, when damages to property are concerned. The amounts indicated are the minimum required by the Employer and shall not limit the Contractor's responsibility.

Payment for insurances will be made at the lump sum price of Items of A/01 and A/02, which lump sum prices shall include all the costs related with the said insurances.

Payment for insurances will be made on the basis of progress rate of the Works calculated from the comparison rate between the original Contract Value and the certified progress value of the Works made up to the end of the said month on monthly basis. Payment shall not exceed the lump sum price stated in the Bill of Quantities for each Item.

1103 Transportation Cost

No separate payment shall be made for all the transportation costs, including those for the Constructional Plant to the Site and from the Site, which shall be deemed to be including in the relevant Contract unit and lump sum prices stated in the Bill of Quantities.

1104 Payment of Allotment Fee for Central Electrical Board

The Contractor shall submit CEB the application on the Power Receiving work for the new treatment system on behalf of CWA and pay the allotment fee of the work to CEB. This cost shall be included in the prices in the Bill of Quantities.

CHAPTER 12 METRO – HYDROLOGICAL INFORMATION

1201 Meteorology

From the climatical viewpoint, the year is divided into two (2) seasons, namely the summer and winter seasons. Usually, the former lasts for November to April, while the latter for from May to October, varying year by year. In general, seventy (70)% of annual rainfall occurs in the summer season.

According to rainfall records at Reduit (El. 311 m) for four (4) years of 1987 to 1990, mean monthly rainfall exceeds 250 mm for January to March. The mean annual rainfall thereat for the period is 1,519 mm/year.

The annual mean monthly temperature at Vacoas varies from 24.0°C in February to 17.9°C in August for the period in 1961 to 1980. The mean annual air temperature thereat for the period is 21.6°C.

The mean monthly relative humidity at Vacoas is comparatively constant throughout the year, ranging 85% in April to 79% in October according to the records observed between 1971 and 1980.

The Mauritius Island has been suffering damage from heavy rains and floods caused by the tropical cyclone. The tropical cyclone so often occurs in the summer season of November to April and May, but it is not free from the tropical cyclone during the rest of the year.

A summary of meteorological is tabulated in Appendix I.

1202 Streamflow

The Grand River North West (GRNW) which is one of the largest rivers in Mauritius originates in the central plateau and runs northwestward till it finally flows into the Indian Ocean through the southwestern fringe of Port Louis City, collecting such five (5) main tributaries in the upper reach as named the Moka, Profonde, Terre Rouge and Plaines Wilhem rivers. The proposed damsite is located on the lower reach of the Terre Rouge river,

just downstream of the confluence with the *Plaines Wilhems* river.

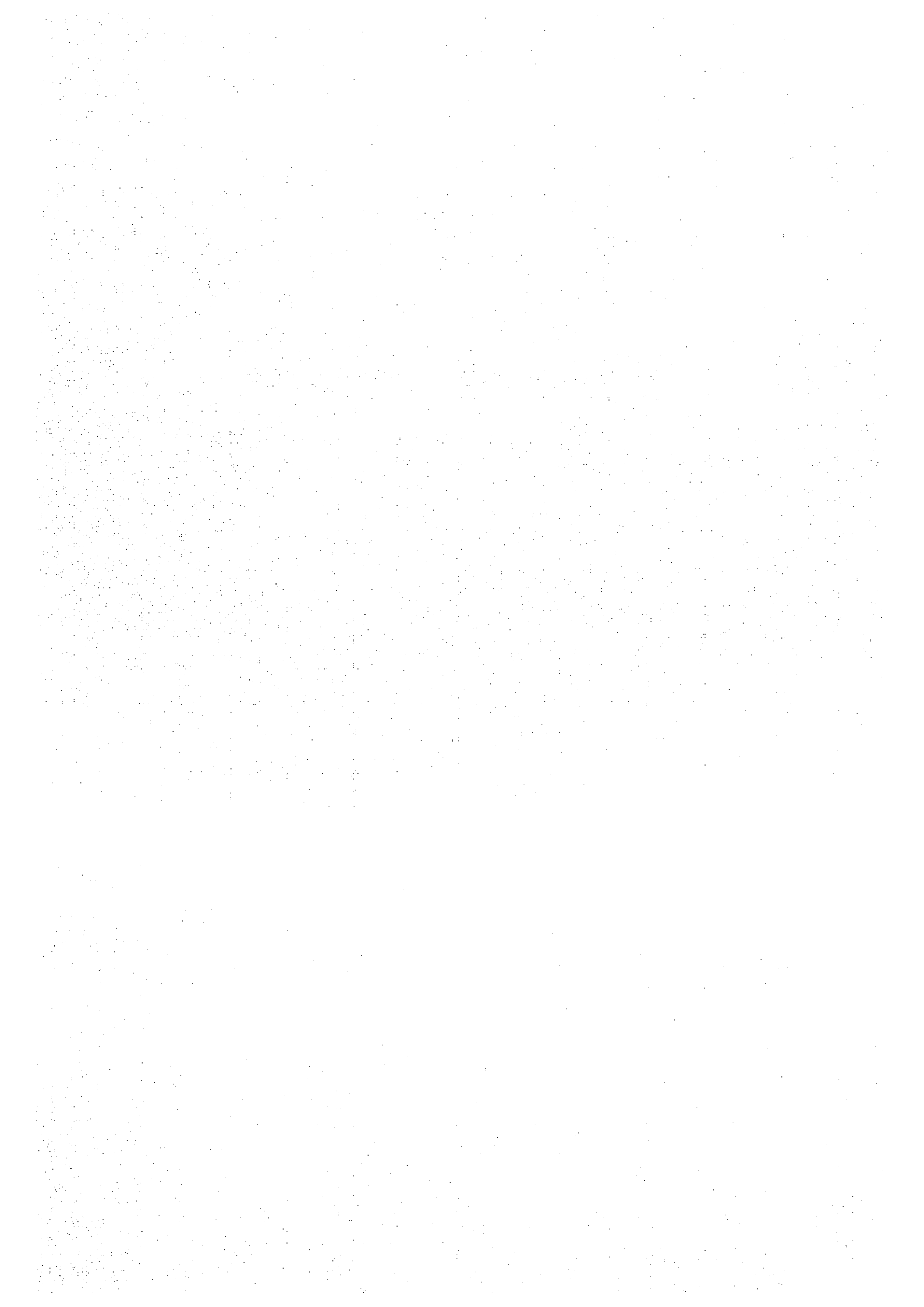
There are six gauging stations in operation in the GRNW basin, of which five stations are on the aforesaid tributaries in the Central Plateau and the rest one is at *Municipal Dyke* on the main stream of GRNW. Mean monthly discharges at these gauging stations are listed in Appendix II together with their catchment areas. It is noted that the occurrence of major floods in Mauritius is responsible for passage of the tropical cyclone thereon.

1203 Water Quality

Water of GRNW is being taken at existing *Municipal Dyke* situated downstream of the proposed damsite and conveyed to *Pailles* treatment works for the use of municipal water supply. Hence, the measures required to retain the present condition on water quality of the river have to be taken during the construction period.

The results of water quality analysis made in the course of the feasibility study for the Project are summarised in Appendix III. Water samples for the water quality analysis were taken from the *Moka* river (at *Baptiste* and *Vocage*), the *Profonde* river, the *Cascade* river, the *Terre Rouge* river, the *Champagne* river and the *Valetta* reservoir.

PART B TECHNICAL SPECIFICATIONS



TECHNICAL SPECIFICATIONS

CHAPTER 1

CIVIL WORKS

PART B TECHNICAL SPECIFICATION
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PART B TECHNICAL SPECIFICATIONS

CHAPTER 1 CIVIL WORKS

10100 DEWATERING DURING CONSTRUCTION

10101 General

The work specified in this Section is applied for the dewatering of all open-air construction sites. The work shall include the design and construction of pits, trenches, dykes, pipes, plants of dewatering equipment including furnishing, operation, maintenance and relocation required for the performance of the Works.

All excavation areas shall be drained off. The required dewatering system will consist of pumps, pump sumps, pits, trenches, pipes, dykes and all auxiliary facilities for a safe and continuous operation of the dewatering.

The Contractor shall be responsible for maintenance of these facilities until completion of the respective Works or section of the Works and subsequent removal.

10102 Execution of Work

The Contractor shall design the complete dewatering system required for all construction sites in such a way that water coming from any source can be drained. These dewatering equipment include pumps, pump sumps, pits, trenches, pipes, dykes, etc. and mechanical, electrical and structural appurtenance.

General design drawings, working procedures and time schedule with explanatory reports shall be submitted to the PMO/Engineer for his approval prior to commencement of any work under this Section. These shall show quantity, type, capacity, arrangement, location, etc. of the required equipment and shall be subject to the approval of the PMO/Engineer.

The Contractor shall supply all the labour, materials, equipment and installations for the dewatering system required for the performance of the Works.

The Contractor shall maintain ready-for-service and cleaning of all the dewatering equipment during construction period of the pertinent structures. After the dewatering equipment have served their purpose, they shall be removed upon the approval of the PMO/Engineer in such a manner that will have a sightly appearance and will not interfere with the operation or usefulness of the Works. If any damage to the Works arises from improper removal of the dewatering system, removal or disposal of the structures including incidental repairs and adjustments shall be made by the Contractor at his own expense.

In order to be able to continue water drainage in the event of power failure, diesel driven emergency units shall be made available.

The Contractor shall be responsible for and shall repair at his own expense any damage to the Works caused by water, flood or failure of the dewatering.

10103 Measurement and Payment

No separate payment will be made for the work under this clause. The cost of the dewatering system shall be included in the unit prices stated in the Bill of Quantities to which the work is incidental.

10200 EARTH WORKS

10201 Clearing and Stripping

10201.1 Site Clearing

The Contractor shall demolish, break up and remove, structures and superficial obstructions on the Site in the way of or otherwise affected by the Permanent Works. He shall clear each part of the Site at times and to the extent required or as directed.

Underground structures and chambers shall be demolished to the depths as directed. They shall be properly cleaned out and filled with suitable material, as defined in Clause 10202 "Excavation Works," compacted in compliance with Clause 10205 "Backfilling and Embankment." Disused soil and surface water drains within 1 metre of formation level shall be removed and trenches shall be backfilled in accordance with Sub-section 10205.3 "Earth Embankment."

All materials, other than soil materials, arising from Site clearing, which are surplus to or unsuitable for use in the Permanent Works, shall become the property of the Contractor and shall be disposed of by him either off the Site to his tip, or if approved, on the Site in an approved manner. Surplus or unsuitable soil materials shall be dealt with as required by Clauses 10202 and 10205.

Bushes, undergrowth or small trees the trunks of which are less than 300 millimetres in girth at 1 metre above ground level, tree stumps less than 100 millimetres diameter and hedges shall be uprooted and burnt or disposed of otherwise.

10201.2 Existing Trees, Stumps and Roots

Where directed, trees shall be uprooted or cut down as near to ground level as possible. All felled timber shall be removed from the site or burnt. Stumps and tree roots shall, unless otherwise directed, be grubbed up, blasted or burnt and deposited off the Site in dumps to be provided by the Contractor. Holes left by the stumps or roots shall within one week be filled with suitable material. Prior to any tree felling work being started those trees to be felled shall be surveyed, marked, measured and recorded by the PMO/Engineer and the Contractor.

Any trees cut on the site belong to the land owners and shall not be removed from the site except when directed or permitted.

10201.3 Stripping

Unless otherwise provided, the entire construction site shall be stripped of all vegetation and debris, and such material shall be removed from the Site prior to performing any excavation or placing any fill. If excavation is carried out preparatory to construction of structure which will be covered by an earth fill, the top 60 centimetres of excavated material, shall be stockpiled for that purpose.

The use of top soil as fill material shall be restricted to surface layers which are not subject to loading by pavements or structures.

10202 Excavation Works

10202.1 Classification of Excavation Material

Except as otherwise specified in these Specifications, open-cut excavation will be classified for measurement and payment as follows:

(1) Rock

Rock is sound and intact rock in place that cannot be excavated without drilling and blasting as determined by the PMO/Engineer. Classification of rock shall be based on judgement, decision of the PMO/Engineer.

(2) Weathered rock

Weathered rock is disintegrated rock by weathering that can be excavated efficiently after loosening by ripping or the use of power tools without drilling and blasting as determined by the PMO/Engineer.

(3) Common

Common is all material other than rock and weathered rock including, but not

limited to, clay, silt, sand, solid rock not exceeding 1.0 m³ in volume, and mixtures thereof with gravel and boulders as determined by the PMO/Engineer. Solid rock exceeding 1.0 m³ in volume is classified into rock.

When the Contractor observes the boundary lines between weathered rock and common, and rock and weathered rock, as defined above during excavation work, the Contractor shall prepare and submit the survey maps to the PMO/Engineer for his approval in advance of weathered rock excavation and rock excavation, respectively. The Contractor shall also prepare and submit to the PMO/Engineer for his approval the survey maps for the final excavation lines actually excavated. These survey shall be performed in the presence of the PMO/Engineer, and be the basis of quantities for claim for payment. The Contractor shall notify the PMO/Engineer of his intention to take such survey.

10202.2 Open-Cut Excavation

(1) Common Soil Excavation

Except where otherwise specified or instructed by the PMO/Engineer (for a particular structure), excavation shall be carried out to the grade of the bottom of the footing, slab or drain.

Excavation under areas to be paved shall extend to the bottom of the aggregate base, if such base is called for, otherwise it shall extend to the paving thickness. After the required excavation has been completed, the exposed surface shall be scarified, brought to optimum moisture content, and compacted to 95 per cent of maximum dry density.

Suitable excavated material other than that surplus to requirements of the Contract shall not be removed from the Site except when directed or permitted. Should the Contractor remove suitable material from the Site, to suit his operational procedure, then he shall make good at his own expense any consequent deficit of filling arising therefrom.

If any suitable material excavated from within the Site is removed by the Contractor for purposes other than the forming of embankments etc, sufficient suitable filling material to occupy after full compaction, a volume corresponding to that which the

excavated material occupied shall, unless otherwise directed, be provided by the Contractor at his own expense.

Suitable excavated material, topsoil, all unsuitable materials from general excavations and surplus to the total requirements of the Permanent Works shall be disposed of in spoil heaps on the Site or as directed by the PMO/Engineer. The excavations shall be kept dry. No water shall be allowed to be in contact with masonry and concrete until the concrete and mortar has set and in any event, not sooner than 12 hours after placing the masonry. Water pumped or drained from the work shall be disposed of in a suitable manner without damage to adjacent property or to other work under construction. Any damage caused by dewatering work shall be promptly repaired by the Contractor.

(2) Rock Excavation

The removal of hard materials by use of explosives will normally be permitted subject to compliance by the Contractor in all respects with the Explosive Laws of the Government.

The Contractor shall also be responsible for the prevention of any unauthorised issue or improper use of any explosives brought on the works and only experienced and licensed men shall handle explosives for the purpose of the works.

The shots shall be properly loaded and tamped and, where necessary, the Contractor shall use heavy mesh blasting nets. Blasting shall be restricted to such parts of the works as the PMO/Engineer may prescribe. If, in the opinion of the PMO/Engineer, blasting would be dangerous to persons or property or to any finished work or is being carried on in a reckless manner, he may prohibit it, and order the rock to be excavated by other means. Payment will be made at the rate for rock excavation where blasting is permitted. The use of explosives by the Contractor in large blasts, as in seams, drifts, shafts, pits, or large holes, is prohibited unless authorised in writing by the PMO/Engineer.

The faces and bottoms of all excavation shall be trimmed and cleared of all loose or decomposed material and finished with firm and smooth perpendicular, level or inclined surfaces where required. All seams, cracks, fissures, holes or soft spots in the bottoms of excavation shall be cleaned out and filled with concrete, mortar or

grout, where directed by the PMO/Engineer. The surfaces of the excavation shall be protected from deterioration and be provided to be clear uniform.

Unsuitable material shall be removed from foundations of the Permanent Works, and elsewhere on the Site as may be directed. All excavated materials not required for refilling and unsuitable materials shall be disposed of in accordance with the requirements of Clause 1206 hereof.

The Contractor shall provide and maintain necessary means to remove water from the excavation as in Item (1) of this Clause.

(3) Over Excavation

If for any reason, excavations are beyond the established lines and without the PMO/Engineer's prior approval, the Contractor shall backfill with rubble concrete or other approved material at his own expense, the volume corresponding to over-excavation.

(4) Stockpiles and Disposal

Excavated material from the work selected by the PMO/Engineer for re-use shall be placed in its final position, if possible, or otherwise be stockpiled or deposited on site as directed by the PMO/Engineer. The Contractor shall not be entitled to additional payment for work required for stockpiling materials.

(5) Test and Properties

The Contractor shall carry out all tests including field and laboratory tests, such as compaction density tests, grain-size distribution, water content, shear test, etc. as directed by the PMO/Engineer.

10202.3 Trench Excavation

(1) Common Excavation

Top soil shall be stripped, laid aside and separate from other excavated materials. Where directed turf shall be stripped by hand and carefully stacked. Road bottoming

and surfacing material which is approved as suitable for re-use shall be laid aside and kept separate from other excavated materials.

Where shown or directed, top soil shall be stripped over the full width of the working area before any other operation is carried out and soil deposited in dump. On completion of the other operations the soil shall be evenly spread over the stripped surface.

Trenches for pipes shall be excavated to a sufficient depth and width to enable the pipe and the specified or other approved joint, bed, haunch and surround to be accommodated.

The Contractor shall provide whatever additional pipe protection is necessary should the specified maximum width be exceeded due to his method of working.

Trenches for pipes carrying water under pressure shall be excavated to a sufficient depth to ensure, after consolidation of the refilling, a normal minimum depth of cover of 600 millimetres from the ground surface to the top of the pipe. Where the pipeline is required to be laid to a depth which does not permit this condition to be fulfilled the ground surface shall be made up locally with banking as directed.

Where the trench formation is in ground that, in the opinion of the PMO/Engineer, is too soft to afford proper support to the pipes, either

- a) the trench shall be excavated down to solid ground and the extra depth shall be refilled with Type E concrete, granular bedding material, gravel or crushed stone, as directed by the PMO/Engineer and well compacted to form an even bed or,
- b) the pipes shall be supported by fascines, piles or such other means as directed by the PMO/Engineer.

The Contractor shall avoid unduly disturbing the finished trench formation and shall make good disturbed areas and excavate any wet or puddled material which might result from his failure to do so. Voids shall be made good as described above in subsection (1)-a) of common excavation.

Unsuitable material excavated for pipe trenches shall be taken to spoil and replaced with suitable material. Suitable material shall be set aside for use as backfill. Surplus excavated material shall be disposed of in spoil tips to be provided by the Contractor.

(2) Rock Excavation

Rock excavation for pipelines shall be done in accordance with Clause 1202.2-(2), unless otherwise specified or directed.

Where rock or boulders are present in pipe trenches specified to have borrowed material beddings, the sides of the trench shall be trimmed such that when the pipe is laid to the correct level and alignment no projection of rock comes within 100 millimetres of the outside of the pipe barrel at any point.

10203 Blasting and Explosives

The Contractor shall not use any explosives in the construction of the Works without the permission of the PMO/Engineer which permission shall not be unreasonably withheld. Each such application to the PMO/Engineer shall specify the size of charges to be used.

In the event of such permission being granted the Contractor shall obtain his own information as to any restriction or objection to blasting and shall conform to all Government and other regulations relevant to blasting and the storage and use of explosives. The Contractor shall also obtain all necessary licences and he shall provide a properly secured store for the explosives in accordance with the statutory requirements and to the approval of the Police and he shall give facilities to the Police for any inspection they from time to time may require to make.

Blasting operations shall be carried out under the supervision of a skilled foreman.

The Contractor shall carry out such operations in such a manner as not to cause injury or damage to any person, animal or property and he shall provide and cause to be used at all times when firing is to take place sufficient screens, shields or matting and other things necessary to intercept rock, stones, earth debris or other material liable to be scattered or blown inside or outside the Site.

In no circumstance will blasting be permitted in or under building, canals, docks, bridges or culverts. Blasting will not be permitted in the proximity of such buildings and structures or any other apparatus where in the opinion of the PMO/Engineer any damage or injury whatsoever may be caused to any person, animal or property.

The Contractor shall give due warning of the times he proposed to fire charges to all persons liable to be affected and he shall employ watchmen provided with red flags at sufficient distances and in such directions as are required to warn persons and traffic that such operations are being carried out.

The Contractor shall in all cases be entirely responsible for any damage whatsoever caused by blasting operations and shall indemnify the Employer in respect thereof and settle all claims resulting therefrom and make good any damage all at the Contractor's expense.

10204 Support of Excavation

The Contractor shall provide the support of excavations as necessary to secure the safety of the public and the men working in excavations and prevent collapse or any fall of rock, earth or other materials into the excavation. If for any reason whatsoever and howsoever or in spite of such support any such fall shall occur, the Contractor shall be entirely responsible for all renewed excavation and remedial work and shall remove the fallen material and refill the space or cavity at his own cost and without any claim on the Employer in any way whatsoever.

If in the opinion of the PMO/Engineer the support proposed by the Contractor is insufficient then the PMO/Engineer will order the provision of stronger support for the excavations than that provided by the Contractor and in this event the Contractor shall adopt and make no charge for adopting the method so ordered by the PMO/Engineer.

The Contractor shall not remove temporary works supporting the excavations until in the opinion of the PMO/Engineer's Representative the permanent work is sufficiently advanced to permit such removal which shall be executed under the personal supervision of a competent foreman.

Any advice, permission, approval or instruction given by the PMO/Engineer or PMO/Engineer's Representative relative to such support or the removal thereof shall not

relieve the Contractor from his responsibilities under the Contract.

10205 Backfilling and Embankment

10205.1 Backfilling of Excavation around Structure

(1) Excavated Material

Backfilling shall be tamped and compacted to finished grades indicated on the Drawings and as specified in this Clause. No backfilling shall be placed against walls until they and their supporting slabs, if applicable, have attained sufficient strength. Fill shall be placed only on the surfaces which have been inspected and approved by the PMO/Engineer.

Backfilling shall be placed in layers measuring not exceeding 30 centimetres thick prior to compaction. Each layer shall be compacted by a minimum of two passes of a tractor dozer weighing not less than a sheep's foot roller or other convenient compaction equipment approved by the PMO/Engineer.

Except where otherwise specified for a particular structure or ordered by the PMO/Engineer, backfilling placed around and beneath structures, and beneath paved areas, shall be placed in horizontal layers not exceeding 15 centimetres thick. Compaction shall be attained by means of hand-operated power-driven tampers. The backfilling shall be brought up evenly with each layer moistened and compacted by mechanical means to 95 per cent of maximum density beneath structures, and 90 per cent of maximum density around the sides of structures and beneath paved areas.

(2) Borrowed Material

The term "Borrowed material" used herein shall mean sand, soil, or other materials dug elsewhere to backfill excavated voids to replace the original materials. Where the soil condition is, in the opinion of the PMO/Engineer, not suitable to afford proper support to structures or pipes, the ground shall be excavated down to the depth as shown or directed, and the extra depth shall be refilled with borrowed material as specified. The borrowed material shall be well compacted to form an even bed to the satisfaction of the PMO/Engineer.

The borrowed material to be used for pipe bedding shall be of selected soil material approved by the PMO/Engineer. The selected material shall comprise uniform readily compactable material free from trees roots, vegetable matter, building rubbish and other large objects, and excluding clay lumps and stones.

10205.2 Backfilling in Trench

Unless otherwise specified in the Drawings or directed by the PMO/Engineer, backfilling in trench for permanent works shall be carried out as specified in Section 10504.1 Pipe Trench.

Backfilling to trenches shall only be carried out after the pipe or duct has been laid, inspected and tested. Where required to meet the Specification for testing pipelines, trenches shall be partially backfilled to provide anchorage, but joints shall be left exposed. Backfilling shall wherever practicable be undertaken immediately the specified operations preceding it have been completed. No backfilling shall be placed in trenches containing water. Temporary restoration of streets shall be carried out in compliance with the requirements of the relevant road authority.

10205.3 Earth Embankment

(1) Forming of Embankments or Other Areas of Fill

The areas on which embankments or other areas of fill are to be constructed shall be stripped of top soil unless otherwise directed.

Embankment and other areas of fill shall be formed of suitable material.

All earthworks material placed in or below embankments, below foundation levels or elsewhere in the Permanent Works other than on roofs of tanks and underground chambers shall be deposited and compacted as soon as practicable after excavation in layers of thickness appropriate to the compaction plant used as directed. Embankments shall be built up evenly over the full width and shall be maintained at all times with a sufficient camber and an even surface to enable surface water to drain. During the construction of embankments the Contractor shall control and direct constructional traffic uniformly over their full width. Damage to compacted layers by constructional traffic shall be made good by the Contractor, at his own

expense.

Filling on roofs of tanks and underground chambers shall be placed and compacted in an approved manner using plant that will not damage the structure through excessive loading.

Compaction of embankment and other areas of fill shall conform to the requirements of Item (2) of this Clause..

If the material deposited as fill subsequently reaches a condition such that it cannot be compacted in accordance with the Specifications, the Contractor shall either:

- i) make good by removing the material off the embankment either to tip or elsewhere until it is in a suitable physical condition for re-use, and replacing it with suitable material; or
- ii) make good the material by mechanical or chemical means; or
- iii) cease work on the material until its physical condition is again such that it as described in the Specification.

(2) Compaction of Embankments and Other Areas of Fill

All materials used in embankments and as filling elsewhere shall be compacted as soon as practicable after deposition. Compaction shall be undertaken to the requirements of this Specification by approved plant, unless a variation thereof is approved.

The PMO/Engineer may at any time carry out field density tests in accordance with B.S. 1377 Method of Test for soils for Civil Engineering Purpose, or other standard approved method on compacted test No.15 material. If the test results show the state of compaction to be inadequate, the Contractor shall carry out such further work as may be directed.

When materials of widely divergent characteristics are used in embankments and fill areas they shall be spread and compacted in separate clearly defined areas in such a manner as to comply with the requirements of B.S. If more than one class of

material is being used in such a way that it is not practicable to define the areas in which each class occurs, compaction plant shall be operated as if only the material which requires the greatest compactive effort is being compacted.

(3) Embankments and Other Areas of Fill to be kept Free from Water

The Contractor shall arrange for rapid dispersal of water, shed on to the embankments and other areas of fill or, compacted formation of access roads during construction, or which enters such works from any source and when practicable, the water shall be discharged into the permanent outfall for the pipe drainage system. Adequate means for trapping silt shall be provided on temporary systems discharging into permanent drainage systems.

The Contractor shall provide where necessary temporary water courses, ditches, drains, pumping or other means of maintaining the earthworks free from water. Such provision shall include carrying out the work in such a manner that their surfaces have at all times a sufficient minimum crossfall and, where practicable, a sufficient longitudinal gradient to enable them to shed water and prevent ponding.

10206 Disposal of Materials

Excavated material which are unsuitable or not required for permanent construction shall be disposed in the disposal area as shown on the Drawings or elsewhere as approved by the PMO/Engineer. Such material shall be disposed in a horizontal layer not exceeding 0.5 m in thickness to receive appropriate compaction. Unless otherwise approved by the PMO/Engineer, the finished outer slopes of the disposed material shall not be steeper than 1 vertical to 3 horizontal and shall be covered with strip sodding or other approved means.

The Contractor shall grade the top surface of all material placed within the disposal area and shall construct drains and other protective works sufficient to ensure that surface run-off will not erode the slopes of all material placed therein.

The cost of disposing excavated material and the cost to form disposal areas to the satisfaction of the PMO/Engineer shall be included in the unit prices stated in the Bill of Quantities for the various items of work for excavation.

Location changes or additions of disposal areas for the Contractor's own convenience shall be subject to the approval of the PMO/Engineer and relevant authorities, and made at the expense of the Contractor.

10207 Gravel Surfacing

Gravel surfacing shall consist of hard, durable coarse gravel, placed and compacted by sprinkling and rolling with all spaces between gravel filled with sand to form a dense layer of the required thickness after compaction.

The gravel surfacing materials shall be 40 millimetres maximum size aggregate complying with B.S. 882 or other approved standard, blinded with approved material, watered if required, and rolled to compaction.

The gravel shall be spread on the compacted surface in the location as shown on the Drawings or as directed by the PMO/Engineer. The Contractor shall compact the gravel in layers not exceeding 100 millimetres thick to a dry density of not less than 90 per cent of the maximum dry density. The method of compaction shall be subject to the approval of the PMO/Engineer. Segregation of the fine and coarse materials shall be avoided and the surface of the material kept free from corrugations during compaction.

10208 Cobble Stone Bedding

Cobble stone material to be used for bedding shall consist of naturally occurring material complying with the local standards approved by the PMO/Engineer. The material shall be strong, hard, durable stone washed clean, and free from injurious amount of shale, coal, clay, lumps, soft fragments, dirt, grass and organic and other deleterious substances. The maximum particle size shall be 100 millimetres.

All material shall be placed and spread evenly. Spreading shall be undertaken concurrently with placing. As soon as possible after the material has been spread, it shall be thoroughly compacted by an appropriate method to the satisfaction of the PMO/Engineer.

The material shall be laid to a compacted thickness as shown. The material shall be laid to a compacted thickness in one layer of 150 millimetres, or in two layer each not less than

75 millimetres after compaction.

10209 Measurement and Payment

Measurement for payment for the works specified in **10200 Earthworks** will be made based on the work unit as shown on the Contract or directed by the PMO/Engineer as follows:

Work Items	Measurement
1) Cleaning and Stripping	– area to the line shown on the Drawings
2) Open-cut Excavation	– volume in lines shown on the Drawings
3) Trench Excavation	– volume in liner length based on the standard trench section shown on the Drawings
4) Backfilling and Embankment	– volume in place to the prescribed lines, grade and dimension
5) Gravel Surfacing and Cobble Stone Bedding	– volume in line shown on the Drawing

Payment for the work items mentioned above will be made at the unit prices per unit stated in the Bill of Quantities, which shall include the cost of all labour, materials and equipment, and for all incidental work connected therewith, but excluding the cost of obtaining and transporting materials for which payment is provided in the Bill of Quantities for various items of earth-works for permanent work.

10300 CONCRETE WORKS

10301 Concrete

10301.1 General

All reinforced concrete work shall conform to the requirements of relevant of Mauritian Standards, relevant British Standard or other equivalent approved standards.

10301.2 Materials

(1) Cement

All cement shall be Portland cement from an approved manufacturer and shall conform to MS 36 – 1983, Standard for Ordinary and Rapid-Hardening Portland Cement, B.S. 12, Specification for Ordinary and Rapid-Hardening Portland Cement, or equivalent. The same brand of cement shall be used throughout the work.

If bagged cement is to be used, it shall be supplied in unopened and undamaged bags bearing the manufacturer's brand, place of production, type of cement, the year and month produced and the weight contained. Cement shall not be more than 6 months old when used in the work and any cement that has become lumpy or partially set prior to mixing will be condemned and shall be removed from the site immediately.

Cement shall be stored at the site in sufficient volume to guard against possible stoppage of works by irregular delivery, rejection or other cause, and in dry, watertight, properly ventilated warehouse, with adequate prevention of absorption of moisture. Not more than thirteen (13) bags of cement shall be permitted to be piled up. It shall be stored so as to permit access for inspection, identification and sampling, different consignments being stacked separately.

Cement shall be required to be tested on every 100 tonnes lot of respective cement in such manner as to represent the average quality of the lot. Any portion of work constructed with cement which is found to be unsatisfactory shall be demolished and rebuilt with approved materials.

(2) Water

Water used in mixing concrete shall be clean and free from injurious amounts of oil, acid, alkali, organic matter or other harmful substances.

If required by the PMO/Engineer, the Contractor shall carry out necessary tests on the water at his own expense to prove that the water is acceptable for concrete mixing. The relevant of the tests shall be to the PMO/Engineer's approval.

(3) Aggregates

All coarse and fine aggregates shall consist of hard, tough, durable particles, free from loam, clay, dust, alkali, organic impurities and other foreign matter and shall be stored in such a manner as to prevent segregation, excessive breakage and the introduction of foreign materials.

Aggregates shall conform to B.S.882 (1983), Specification of Aggregate from Natural Sources for Concrete and with all the additional requirements of this specification.

Aggregates shall be delivered to the site in clean and suitable vehicles. Different types of sizes of aggregates shall not be delivered in one vehicle.

Each type or size of aggregate shall be stored in a separate bin or compartment having a floor so constructed that contamination of the aggregate is prevented. Dividing walls between bins shall be substantial and continuous so that no mixing of types or sizes occurs.

The storage of aggregates shall be so arranged that as far as possible rapid drying out in hot weather is prevented so as to avoid sudden fluctuations in water contents. Storage of fine aggregates shall be arranged so that they can drain sufficiently before use so as to prevent fluctuations in water content.

(4) Admixture

No admixtures including surface-active agent or air entering agents shall be used unless approved by the PMO/Engineer. If any other substance, apart from cement,

aggregates and water as specified, is added to the concrete without the written approval of the PMO/Engineer, the PMO/Engineer may refuse to authorise payment for any such concrete and may require the removal of any concrete in which the said substance has been used.

10301.3 Concrete Mixes

(1) Concrete Classification

Classes of concrete containing ordinary Portland cement for use in the Works are specified in table below. Concrete mixes are to be designed primarily on strength characteristics.

Class	Minimum Compressive Strength at 28 days	Nominal Max, size of Aggregate	Range of Slump	Min. Cement Contents
	(N/mm ²)	(mm)	(cm)	(kg/m ³)
A	25	20	12-14	345
B	20	20	12-14	300
C	20	75	5-10	220
D	15	40	8-10	240
E	15	20	-	260
F	30	14	8-10	370

Note :	Class A	Reinforced Concrete, building works, superstructures and retaining structures,	C25/20
	Class B	Pipeline protection, foundation of building works	C20/20
	Class C	Mass and backfill concrete	C20/75
	Class D	Blind concrete	C15/40
	Class E	Screed concrete	C15/20
	Class F	Concrete effluent trough, precast concrete Cover	C30/14

(2) Mixing Proportion

The proportions of aggregates to cement for any concrete shall be such as to produce a mixture which will work readily into the corners and angles of the form, around reinforcement and embedded items with the least possible segregation of the material or allowing excess free water to collect on the surface. It shall be the Contractor's responsibility to ensure that the aggregates are selected, graded and all materials proportioned and mixed, and to ensure that subsequently concrete complies with this specification in every respect without the addition of admixtures.

Consistency shall be measured by the slump test carried out in accordance with the requirements of B.S. 1881 or equivalent. The necessary standard slump testing apparatus shall be provided by the Contractor who shall carry out all sampling and testing under the supervision and direction where necessary of the PMO/Engineer.

The required slump of concrete shall be as follows:

- i) Concrete by sliding form;

not more than 15 cm for applying concrete – pumping car.
not more than 12 cm for others.

- ii) Foundation concrete including pile;

not more than 12 cm for foundation and pile.

- iii) Other concrete;
not more than 18 cm.

The Contractor shall submit to the PMO/Engineer his designs for all concrete mixing proportions he proposes to use in the work. He shall carry out 3, 7 and 28 days compression tests in accordance with the relevant portion of Clause 10301.5 "Sampling and Testing." The proposed mixing proportions will not be accepted if the average strength of the three trial mixes is less than the specified cube strength plus the designed standard deviation. The mix proportions shall be adjusted and a new set of trial cubes prepared for testing.

(3) Mixing

The equipment for mixing concrete shall be capable of combining the ingredients of the concrete into a uniform mixture within the time limit specified and of discharging this mixture without segregation.

Mixers may be of the stationary type or truck mixers. Mixers shall not be charged in excess of the recommended capacity, nor shall they be operated at a speed in excess of that recommended by the manufacturer. All equipment shall be maintained in a satisfactory condition.

Truck mixed concrete shall be continuously mixed in transit and must be in place within one hour after water is introduced into the mix. When concreting is started, it shall be carried on as a continuous operation until the placing has been completed. The maximum interval between any two consecutive batches or loads shall not exceed 45 mins. If, for any reason, concreting is interrupted during the pour of a section, the Contractor shall place a construction joint at the location and of a type specified by the PMO/Engineer.

(4) Concreting in Hot Weather

In hot weather the aggregate stockpiles shall be shielded or sprayed with water and the mixing water shall be adequately cooled or insulated to ensure that the temperature of the concrete when placed shall not exceed 32°C (90°F).

Mixing by hand will be allowed except when authorised in writing by the PMO/Engineer, for cases involving less than 2 cubic metres for work to be accomplished in one day.

10301.4 Ready-Mixed Concrete

The use of ready-mixed concrete as defined in B.S. 5328 (1981), Method for Specifying Concrete, including Ready-Mixed Concrete batched off the site and delivered in a plastic condition ready for placing in its final position shall be permitted, provided,

- i. the constituent materials and the concrete mix comply with all the requirements of the Specification,

- ii. the concrete shall be produced in accordance with the standards laid down in the current edition of the "Authorisation Scheme for Ready-Mixed Concrete" published by the British Ready-Mixed Concrete Association (BRMCA), unless otherwise stated in the Specification,
- iii. the concrete shall be supplied by a depot designated as a BRMCA Approved Depot. In the case of designed mixes the depot shall operate approved quality control procedures,
- iv. water shall be added to the mix only under the control the central batching plant at the depot,
- v. works test cubes shall be made on the site by the Contractor as required by the Specification irrespective of any cubes made by the supplier.

10301.5 Sampling and Testing

Trial mixing and cube tests shall be carried out for each type of concrete stated in Clause 10301.3 – (1) Concrete Classification prior to commencing the concrete works. 9 cubes shall be prepared for each trial mix and 3 cubes each tested at 3, 7 and 28 days.

During concreting 6 test cubes of each class of concrete for every 50 cubic metres of concrete cast shall be taken. Of the 6 cubes, 3 cubes shall be tested at 7 days and the rest at 28 days for compression strength.

The standard procedure for sampling of concrete and for making and testing of test cubes and the acceptance criteria for the concrete represented by the samples tested shall conform to B.S. 1981 or equivalent.

The cost of moulds, materials, labour, packing and transportation, and all laboratory fees entailed shall be borne by the Contractor.

The Contractor shall keep on the site, a log book in which the following information is recorded:

- i) Test cube number or identifying mark.

- ii) Date and time of sampling.
- iii) Portion of structure represented by the sample.
- iv) Date when tested.
- v) Test result.

This log book shall be available for inspection by the PMO/Engineer at all times.

For acceptance, average strength of the cubes and the strength of two thirds of them shall exceed the specified strength. If two thirds of the cubes fail to attain the specified strength, the Contractor shall immediately notify the PMO/Engineer and examine the work to find the cause of the failure. Any improper materials, mixing, placing and curing found on examination shall be corrected. The suspected concrete shall be taken as directed by the PMO/Engineer.

The cost of these tests, cutting out and replacing of inferior concrete be borne by the Contractor.

10301.6 Transport and Placing

The methods and equipment used for placing concrete shall not cause appreciable segregation of coarse aggregate in the concrete as it is delivered to the works.

The Contractor shall establish Item (i) to (v), hereinunder, and obtain the approval of the PMO/Engineer, prior to transporting and placing of concrete.

- i) The transporting and placing method, and equipment to be used.
- ii) The labour organisation for transportation and placing concrete.
- iii) Time limit from start of concrete mixing to completion of placement of the batch.
- iv) Sections to be placed and sequence of placement.

v) Volume of concrete to be placed per unit length of time.

In case of rain, or other conditions which may affect the quality of concrete, the Contractor shall take necessary measures as instructed by the PMO/Engineer.

Before commencing to place concrete in any section of the work, the formwork shall be checked and tightened, all joints effectively sealed and all debris shall be removed from the space to be occupied by the concrete. The forms and all surfaces upon which concrete is to be placed shall then be thoroughly soaked with water. All chutes shall be flushed with water before and after each run.

All concrete shall be placed in position within one hour after being mixed, and no partially set material shall be used in the work.

The arrangements for placing concrete shall be such that in all cases the material shall be handled and placed in the required position without re-handling or segregation. Concrete shall not be dropped from a height greater than 1.5 metres unless otherwise approved by the PMO/Engineer.

10301.7 Compaction of Concrete

All concrete shall be compacted to produce a dense homogeneous mass. It shall be compacted with the assistance of vibrators. Class C concrete may be compacted by hand or mechanical vibration. Sufficient vibrators in serviceable condition shall be on Site so that spare equipment is always available in the event of breakdowns.

Vibration shall not be applied by way of the reinforcement. Where vibrators of the immersion type are used, contact with reinforcement and all inserts shall be avoided, so far as is practicable.

Concrete shall not be subjected to vibration 3 days after compaction.

10301.8 Curing of Concrete

Immediately after compaction, and for the period thereafter concrete shall be protected from harmful effects of weather including rain, rapid temperature changes and from drying out. The methods of protection used shall be approved.

The approved method of curing shall minimize the loss of water from the concrete. On concrete surfaces which are to be waterproofed, curing membranes which would impair adhesion of the water-proofing material shall not be used.

10301.9 Early Loading

Concrete shall at no time be subjected to loading, including its own weight, which will induce a compressive stress in it exceeding 0.33 of its compressive strength at the time of loading or of the specified 28 days strength.

For the purpose of this clause, the assessment of the strength of the concrete and the stresses produced by the loads shall be subject to the agreement of the PMO/Engineer.

10301.10 Repairing and Rendering

Walls and Vertical Surfaces : Immediately after removal of form or absorptive form lining, concrete surfaces shall be inspected for defects. All defects, voids, defective concrete and tie rod holes shall be repaired immediately after the forms are removed. The concrete used for repairing shall be of such quality that it can be thoroughly bonded to the concrete.

In addition, all permanently exposed surfaces, unless specifically allowed by the PMO/Engineer, shall be free from local building and all unsightly ridges or lips shall be removed to leave a smooth and flat surface. Excessive rubbing will not be permitted. The final colour of the cured patching mortar shall be the same as the surrounding concrete.

Floors : After the concrete has been placed and vibrated to achieve maximum compaction without honeycombing, segregation or bleeding, it shall be finished off by the sawing motion of a straight edge, to remove excess concrete and to produce even uniform surfaces.

Floating shall be started as soon as the moisture film or "shine" has disappeared and the screed surface has hardened sufficiently to prevent laitance. This process may be performed by hand or power driven equipment and shall be the minimum necessary to produce a surface that is uniform in texture and free from screed marks, but shall continue until a small amount of mortar without excess water is brought to the surface so that effective trowelling may be carried out.

When the floated surface has hardened sufficiently to prevent an excess of fine materials

being drawn to the surface, steel trowelling shall be started and shall be performed with firm pressure such as will flatten the sandy texture of the floated surface and shall produce a dense, uniform surface, free of ripples and trowel marks. During the trowelling the surface shall not be dusted with cement, or a mixture of sand and cement, to absorb moisture or to facilitate trowelling.

All screeding, floating and trowelling shall be done either by tradesmen plasterers or by specialist workmen thoroughly experienced in such work.

10302 Shotcrete

10302.1 General

This specification applies to all work in which shotcrete will be used, such as for strengthening rock surfaces, slope protection, and for various kinds of relatively thin linings.

Shotcrete is an intimate mixture of Portland cement, aggregate, water and additives, if necessary and shot into place by means of compressed air through a spray nozzle. If this shotcrete is properly proportioned, mixed, placed and cured, it forms a very hard, high-strength concrete.

Every effort shall be made to ensure a minimum bond of 0.3 N/mm^2 and a minimum shear strength of 2 N/mm^2 to the shotcrete base. All steel parts such as wire, reinforcing steel fabric mesh (100 x 100 x 3) arched steel rib supports and the like remaining in the shotcrete shall be covered throughout their entire extent by at least 30 millimetres of shotcrete.

Any adherent rebound from previous shotcreting shall be carefully removed before further shotcreting. Any steel inserts shall be fixed in such a way that they will not give rise to laminated cross-sectional separation.

10302.2 Material

(1) Cement

The range of cement content in the shotcrete will be 320 kg/m^3 to 400 kg/m^3 . For the cement content, a tolerance of + 5% will be allowed.

Cement shall be Portland cement of approved type. The Contractor shall submit his proposed type of cement to the PMO/Engineer beforehand so that the type of cement to be, supplied by the Contractor can be agreed upon by the PMO/Engineer.

(2) Aggregates

Aggregates for shotcrete shall be uniformly graded. Dense, hard particles are required to avoid crumbling and forming fine powder of the grains by passing through the nozzle.

Unless otherwise approved by the PMO/Engineer, the fine and coarse aggregates shall conform to the gradings, measured by weight, shown in the table below:

Percentage Passing by Weight			
Sieve Size Square Mesh (mm)	Fine Aggregates	Coarse Aggregates	
		2.5 to 10 mm Size	5 to 20 mm Size
25	-	-	100
20	-	-	90 - 100
15	-	100	20 - 55
10	100	85 - 100	0 - 10
5	95 - 100	10 - 30	0 - 5
2.5	80 - 100	0 - 10	-
1.2	50 - 85	0 - 5	-
0.6	25 - 60	-	-
0.3	10 - 50	-	-
0.15	2 - 10	-	-

Both the purity and the uniformity of the fractions to the appropriate standards shall be guaranteed continuously. The aggregates shall be stored in adequate quantities and

in appropriate manner so that purity and aggregates composition remain unchanged.

(3) Additives

Only accelerating agents free from chloride shall be used. They shall not promote steel corrosion or adversely affect the strength development and hardening pattern of the concrete.

The Contractor shall be fully responsible for the suitability of the additive.

The quantity used shall be the optimum necessary. The additive shall be fed by the machine directly and in the exact proportion by weight.

(4) Reinforcement

For better bonding and dependant upon the thickness of shotcrete profiled steel inserts, such as fabric mesh reinforcement, expanded metal, or equivalent, shall be used, where required. The steel wire mesh shall be made of 3.2 millimetres (#10) iron wire of approved quality.

10302.3 Execution of Work

(1) Commencement of Work

Before shotcrete work begins, a progress chart giving details of the work operations shall be prepared and submitted by the Contractor for the approval of the PMO/Engineer.

The Contractor shall have available all equipment and plant, necessary for continual shotcreting, particularly with respect to the thick shot-concrete structural linings.

The Contractor shall advise the PMO/Engineer of the brand names and type, number and capacity of the shotcrete machines he proposes to use, together with all other equipment required to carry out the shotcrete operations. All equipment shall be approved by the PMO/Engineer. Only dry mix equipment will be approved. All equipment required to prepare, mix and place shotcrete shall be kept clean and maintained in good operating condition at all times during the construction of the

works. Batching and mixing equipment shall conform to the applicable portion of the Specification.

The shotcrete machine shall have an adequate placing capacity to ensure minimum delays to excavation and other operations. The equipment shall be such that the rapid hardening additive can be mixed satisfactorily and immediately before placing.

The Contractor shall ensure that adequate air water is supplied to the machine, as specified by the equipment manufacturer and as directed by the PMO/Engineer.

In all areas where excavation is proceeding, the Contractor shall ensure that sufficient equipment is available to apply shotcrete at any face, as specified herein.

(2) Preparation of Surfaces

All loose rock and concrete and also all sharp protruding edges as well as dirt, grease, oil, scale and other contamination shall be carefully removed. Then, the base to be sprayed, especially if concrete or masonry, shall be thoroughly cleaned with water under pressure and compressed air. Excess water shall be blown away by compressed air.

Any seepage water entering locally shall be dealt with by suitable means, such as drainage boring with grouted pipe nipples connected to pipe, local sealing measures, drainage measures, etc. No water shall come in contact with the fresh shotcrete until such time that it has sufficiently set.

Weep-holes with PVC pipes of 50 millimetres in diameter, if required on the Drawings or directed by the PMO/Engineer, shall be made in each 4 square metres of slope surface of the shot concreting.

The rock surface to be treated shall be covered by welded wire mesh approved by the PMO/Engineer. The mesh shall be fastened with approved clips at intervals of not less than 0.5 metre in each direction and further fastened to steel bars of 13 millimetres in diameter anchored to a minimum depth of 300 millimetres at intervals of not more than 2 metres in each direction.

When reinforcement is to be covered, it shall be held securely in place by expansion

bolts and dowels anchored firmly in place.

(3) Mixing

Thorough mixing of aggregates, cement additives and water shall be ensured for all shotcrete. The optimum mix contains a little less water than which will cause sloughing, and just enough cement for the desired water-cement ratio. The water-cement ratio of the fresh shotcrete in place shall in general be between 0.35 and 0.5.

The non-lift mixing process shall take at least 2 minutes and the composition of the ready mix shall constantly remain unchanged until it is applied. During handling, the mixed concrete shall be protected against dripping water. Not later than one hour after having been mixed, the dry mixture must be placed, the maximum time depending on the type of cement used.

(4) Placing

Shotcrete shall not be applied to any surface without the approval of the PMO/Engineer. The PMO/Engineer shall examine rock faces following blasting and scaling operations and shall direct the Contractor, if required, to proceed with the immediate shotcreting of surfaces such that placement of shotcrete shall be performed not later than four (4) hours after blasting.

Shotcrete above ground shall not be carried out when, in the opinion of the PMO/Engineer, shotcrete cannot be placed effectively because of adverse weather or wind conditions, unless adequate cover is provided over the working area until the shotcrete has been cured sufficiently to prevent damage.

The Contractor shall develop operating procedures and operations to the satisfaction of the PMO/Engineer to give:

- minimum rebound
- no inclusion of rebound in the finished shotcrete
- as smooth a finished surface as possible

- no hollow areas in the shotcrete
- a minimum of shrinkage cracks
- good adherence of the shotcrete to rock or other surface.

The quantities of shotcrete to be discharged at the nozzle shall be determined on the basis of the average thickness of shotcrete shown on the Drawings or required by the PMO/Engineer and taking due account of rebound. Once procedures for the placement of shotcrete are established, subsequent work shall be carried out accordingly.

The minimum water pressure shall be 0.34 N/mm², and the minimum air pressure shall be 0.25 N/mm². Compressed air and pressure water shall be free from oil and shall not be liable to pressure fluctuations.

When shotcrete is to be performed near existing structures, the Contractor shall ensure that no damage results to the structure and shall protect the surface of structures before shotcreting.

Construction joints or stop joints shall be provided as approved or required by the PMO/Engineer and shall be sloped at 45 degrees to the adjacent shotcrete surface in a clean, regular edge. Before placing the adjoining work, the sloped portion and adjacent shotcrete shall be prepared as specified herein.

Before the next layer of shotcrete is placed, the previous layer shall be checked for drumminess to the satisfaction of the PMO/Engineer.

(5) Curing

During certain periods depending upon local conditions and to be agreed with the PMO/Engineer, the freshly placed shotcrete shall be protected against sunshine, cold, rain, running water, chemical attack, and vibrations until it hardens, and it shall be kept moist for at least seven days.

If shotcreting is carried out under adverse weather conditions or low temperatures, the protection of placed shotcrete shall be provided.

10302.4 Test and Properties

For the purpose of approving mix design, the Contractor shall prepare not less than three (3) test panels for each mix for testing by the PMO/Engineer, at least forty (40) days before any shotcrete is started in the works, or before approval of an additive is given, or when the use of new equipment is proposed, and subsequently, whenever in the opinion of the PMO/Engineer, shotcrete is being produced which does not meet these Specifications. Sets of three (3) panels for mix design approval and for routine quality control shall consist of one shot downwards onto a horizontal surface.

All panels shall have a minimum thickness of eight (8) centimetres. Panels shall be made in the presence of the PMO/Engineer. The panels shall be left undisturbed at the point of placement until the final set has taken place.

The PMO/Engineer will determine the compressive strength of the shotcrete by testing eight (8) centimetres cubes sawn from the test panels immediately before testing. Ends shall be capped in accordance with B.S. 1881 or other appropriate standards approved.

Test results shall be consistent with the average twenty eight (28) days compressive strength required to limit the probability of tests falling below the specified crushing strength to one out of every five (5) tests with a coefficient of variation of fifteen per cent (15%) for test for mix design approval and twenty per cent (20%) for test for quality control. The average of any six (6) consecutive tests shall not be less than the specified crushing strength.

For approximately every 1,000 square metres for each important shotcrete section, one test consisting of three (3) panels shall be performed.

If the test results are unsatisfactory, the test is to be repeated at the Contractor's expense on a sample taken from the in-place shotcrete. At the PMO/Engineer's request specimens shall be drilled, chiseled and brought to the site laboratory.

10303 Formwork

10303.1 Adequacy of Formwork

The Contractor shall be responsible for the design of all formwork unless otherwise

indicated in the Contract.

Forms shall be so constructed that the concrete can be properly placed and thoroughly compacted and that the hardened concrete while still supported by the forms shall conform accurately to the required shape, position and level, and to the finishes specified. Care shall be taken to maintain the stability of the formwork and the tightness of the joints during vibrating operations.

When so instructed the Contractor shall submit the design and details of formwork and support for the PMO/Engineer's approval.

10303.2 Ties and Formwork Supports in Concrete

The material, type and position of any ties passing through concrete shall be approved. The whole or part of the ties shall be capable of being removed so that no part remaining embedded in the concrete shall be nearer to the surface of the concrete than the specified thickness of cover to the reinforcement in the same member. In mass concrete, the minimum cover to embedded parts shall be as shown on the Drawings.

In general structural concrete, holes left after the removal of ties shall be carefully cleaned out and filled with concrete mortar of approved composition.

On water retaining faces of concrete all supports for formwork or other temporary work shall be located by means of cast-in anchors, and where directed the filling of the resulting holes shall be stopped off 12 millimetres from the surface and the remainder of the recess primed and pointed with an approved sealing compound. The pointing and the surrounding concrete surface for a distance of 150 millimetres shall be painted with two coats of pure bitumen in addition to any general painting of the surface.

10303.3 Top Formwork

Top formwork shall be used on any concrete face steeper than 15 degrees to the horizontal.

10303.4 Arrises

All exposed arrises shall be chamfered and shall be 25 millimetres by 25 millimetres unless otherwise indicated in the Drawings or directed.

10303.5 Removal of Debris

Rubbish debris and water shall be removed from the interior of forms before concrete is placed and temporary openings shall be provided in the formwork to facilitate their removal.

10303.6 Preparation of Formwork Before Concreting

The inside surfaces of forms shall, except for permanent formwork or unless otherwise agreed, be coated with an approved material to prevent adhesion to the concrete. Such materials shall be applied strictly in accordance with the manufacture's instructions and shall not come into contact with the reinforcement or pre-stressed tendons and anchorages. Only one manufacturer's product shall be used on formwork for concrete which will be visible in the finished Permanent Works.

10303.7 Notice of Intention to Place Concrete

The Contractor shall give sufficient notice of his intention to place to allow the PMO/Engineer reasonable time to inspect the elected formwork. Final approval of the preparation of the formwork shall be obtained immediately before concreting begins.

10303.8 Types of Finish

(1) Type F1 Finish

This finish is obtained by the use of properly designed formwork or moulds of closely-jointed sawn boards. The surfaces will be imprinted with the grain of the sawn boards and their joints. In addition, small blemishes caused by entrapped air or water may be expected, but the surface shall be free from voids, honeycombing, or other large blemishes. This Type shall be used for the concrete to be covered by backfill, etc.

(2) Type F2 Finish

This finish is obtained by the use of properly designed forms of closely-jointed wrought boards. The surfaces will be imprinted with the slight grain of the wrought boards and their joints. Alternatively, steel or other suitable material may be used for the forms. Small blemishes caused by entrapped air or water may be expected, but

the surface shall be free from voids, honeycombing, or other large blemishes. This finish shall be used for such exposed finish as walls, columns, etc., with concrete surface irregularities within a range of 5 – 10 millimetres.

(3) Type F3 Finish

This finish can only be achieved by the use of high quality concrete and by using properly designed forms having a hard, smooth surface. The concrete surfaces shall be smooth with true, clean arrises. Only very minor surface blemishes shall occur and there should be no staining or discolouration from the release agent. This finish shall be applied for soffits of slab, beams, etc. with tolerances for concrete surfaces of 3 – 6 millimetres.

10303.9 Quality of Finish

The quality of finish shall be as shown in the Contract, and shall not be inferior to that described in the following:

- | | | |
|-----|------------------------------------|--|
| (1) | Intake Chamber | F1 – outside and inside of chamber |
| (2) | Receiving Tank | F1 – outside of tank, below ground
F3 – inside of tank and outside above ground |
| (3) | Coagulation and Sedimentation Tank | F1 – outside of tank, below ground
F2 – Manhole block
F3 – inside of tank and outside above ground |
| (4) | Filter | F1 – outside of filter, below ground,
F3 – inside of tank and outside above ground |
| (5) | Wastewater pond | F1 – outside of pond
F2 – inside of pond |

If any portion of the concrete finish should prove unsatisfactory on removal of the formwork, it shall, without delay, be cut out and made good as directed. No plastering of concrete surfaces shall be allowed. At the discretion of the PMO/Engineer, boardmarks or

minor discontinuities on exposed faces may be removed by rubbing down with carborundum, and pinholes, small voids or minor porosity of the surface, may be filled, by rubbing down with cement and sand mortar of the same richness as in the concrete. Treatment shall be made immediately after removing the formwork.

Any concrete, the surface of which has been treated without consent, shall be liable to rejection.

The finished surface of water retaining concrete shall not be drilled, punctured by any temporary fixing, or otherwise broken into except as directed in the Contract.

10303.10 Applied Finishes

Where an applied finish is to be used the concrete shall be finished as directed in the Contract. Approved adhesives and materials shall be applied in accordance with the manufacturer's instructions. Joints in applied finishes shall be made only where directed. After application, remedial treatment other than complete reapplication shall not be permitted on any face.

10303.11 Removal of Formwork

The Contractor shall give the PMO/Engineer reasonable notice of his intention to strike any formwork. The time at which the formwork is struck shall be the Contractor's responsibility, but the minimum periods between concreting and the removal of forms, unless otherwise approved, shall be as stated in the following Table.

Minimum Period Before Striking Formwork

Type of Formwork	Minimum Period Before Striking
Vertical formwork to columns, walls and large beams	9 hours
Soffit formwork to slabs	4 days
Props to slabs	11 days
Soffit formwork to beams	8 days
Props to beams	15 days

Forms shall be removed without shock, vibration or other damage to the concrete. The PMO/Engineer may direct the manner in which the forms are struck.

10304 Reinforcement Steel Bars

Mild steel bar reinforcement shall comply with the requirements of MS 10 – 1980, Steel Bars for the Reinforcement of Concrete, B.S. 4449 (1988) Specification for Carbon Steel Bars for Reinforcement of Concrete, or JIS G 3112–1987 Steel Bars for Concrete Reinforcement, or other equivalent approved standards. Cold worked steel bar reinforcement shall comply with the requirements of MS 10 – 1980, or other equivalent approved standards. Steel fabric reinforcement shall comply with the requirements of B.S. 4483 (1985), Specification for Steel Fabric for Reinforcement of Concrete. The wires shall be welded at the intersections and the fabric shall be delivered to the site in flat mats. The Contractor shall procure and furnish to the PMO/Engineer certifications from the manufactures that all steel supplied is in accordance with these standards.

Steel reinforcement shall be stored in clean conditions. It shall be clean and free from mortar, loose rust and loose mill scale at the time of fixing in position and subsequent concreting.

Reinforcement shall be cut and/or bent in accordance with B.S. 4466 (1981) Specification for Bending Dimensions and Scheduling of Reinforcement for Concrete and in a manner that will not damage the material.

Cold worked and hot rolled bars shall not be straightened or bent again having been bent once.

Bending hot at cherry–red heat (not exceeding 840 degrees C) may be allowed except for bars which depend for their strength on cold working. Bars bent hot shall not be cooled by quenching.

Reinforcement shall be fixed in the position shown on the Drawings, and unless specified otherwise the actual cover of concrete shall be within ± 5 millimetres of the required nominal cover. Unless otherwise approved, all intersecting bars shall be tied together with the wire and the ends of the wire shall be turned into the main body of the concrete.

Splices shall not be made in reinforcement except where described in the Contract or where approved.

Reinforcement shall not be welded except where permitted in the Contract. All welding procedures shall be subject to prior approval in writing.

Reinforcement shall be supported in the correct position by approved methods. Spacers shall be of such materials and designs as will be durable, not lead to corrosion of the reinforcement, and not cause spalling of the concrete cover.

10305 Expansion, Contraction and Construction Joints

10305.1 Movement Joints

Movement joints for expansion or contraction shall be constructed in the position shown and as detailed shown on the Drawings or where otherwise ordered by the PMO/Engineer and shall consist of waterstop, joint filler and sealant as herein specified.

Following three types of expansion joints are applied for the flocculation and sedimentation tank and filter:

- 1) consisting of waterstop and joint filler with 20 millimetres, and corking filler edge by sealant (20 mm x 20 mm) for bottom slab and walls of the sedimentation tank,
- 2) putting-up joint filler with 10 millimetres thick and corking filler edge by sealant (20 mm x 10 mm) for back-to-back portion of walls between the tank and dislodging pit, bypass channel and other structures,
- 3) putting-up joint filler with 20 millimetres thick and corking filler edge by sealant (20 mm x 20 mm) for back-to-back walls of the sedimentation tank and filter, and
- 4) waterstop and protection cover of galvanised thin plate for preventing from sunshine and weathering for jointing with concrete wall and slab to be connected the next expansion structures.

10305.2 Waterstop

Polyvinyl chloride or rubber waterstops as shown on the Drawings or detailed in the Bill of Quantities shall be incorporated in all expansion and contraction joints in members which are liquid retaining.

Waterstops in floor slab expansion joints shall be of the surface type of 300 mm width. Waterstops in walls shall be the centre bulb type of 230 mm width with a web thickness of 9 mm.

Before ordering water stops the Contractor shall submit to the PMO/Engineer for approval, samples of the water stops which he proposes to use together with the manufacturer's certificate.

Waterstops shall be supplied in lengths as long as possible consistent with means of transport and efficiency of handling so as to reduce site jointing to a minimum.

Water stops shall be stored to avoid damage or contamination in cool, well ventilated places and away from sunlight. Before they are embedded in concrete water stops shall be thoroughly cleaned of grease, oil dirt and old mortar.

All water stops shall be securely supported before concreting and the shuttering shall, unless otherwise approved by the PMO/Engineer, be constructed to accommodate the water stops in their normal position.

When embedding the water stops, the concrete shall be deposited at a sufficient distance to avoid knocking or twisting the water stops. The concrete shall then be carefully vibrated into position around the water stops, with all stones in their immediate vicinity being removed. Particular care shall be taken to ensure that the concrete is completely compacted around water stops. Water stops shall be carefully protected against damage or puncturing until entirely embedded in concrete.

Where water stops are installed so that one wing is embedded in concrete while the other wing is exposed temporarily to high velocity water, the Contractor shall provide protection to the exposed water stop wing, as approved by the PMO/Engineer.

10305.3 Joint Fillers

Expansion and contraction joints shall be filled with joint filler. The joint filler shall be compressible cellular and resilient and shall not be adversely affected by the local climate conditions. It shall be formed of bitumen impregnated fibreboard or cork or cork bound with rubber or resin.

10305.4 Construction Joint

The Contractor shall submit the schedule and sequence for concrete placing together with locations and treatment methods of construction joints prior to the commencement of the work for the approval of the PMO/Engineer.

Construction joints shall be of the plain butt type except where otherwise shown on the Drawings. Where construction joints contain waterstops the requirements for waterstops shall be as Clause 10305.2.

Before placing new concrete against concrete which has already set the latter shall be treated to *expose the aggregate over the full section and leave a sound irregular surface*. This shall be done while the concrete is still green by means of water spray and light brushing or with the use of a retarding agent approved by the PMO/Engineer.

Immediately before the fresh concrete is placed all foreign matter shall be thoroughly cleaned away and the surface moistened.

Before continuing concreting against or on top of the face previously cast the vertical faces of construction joints shall be covered with a thick grout of neat cement and the horizontal faces shall be covered with a layer of cement mortar approximately 5 millimetres thick immediately prior to placing new concrete against the joints. New concrete shall be thoroughly tamped into the grout or mortar layer. In the case of a joint between new concrete and a surface other than concrete similar treatment as specified above shall be carried out.

10306 Mortar Plastering

10306.1 General

Concrete ceilings, ceiling beams, columns and stanchions shall be dubbed out as necessary before plastering is commenced and the mix used for dubbing shall be similar to that used for first undercoating. The surface of in situ concrete shall be cleaned of all dust, loose particles, and other matter and any ridges left by shuttering imperfections removed before cleaning down. Surfaces of brickwork, hollow partitions, concrete etc. shall be thoroughly wetted immediately before plastering is commenced.

10306.2 Materials

Cement, sand and water shall comply with the requirements of Sub-section 10301 "Concrete." Damaged or deteriorated materials shall be removed from the site. Mortar shall be mixed in the proportions as shown below:

- i) Watertight masonry; 1 part cement and 2 parts sand.

- ii) Ordinary masonry
 scratch coat; 1 part cement and 2 parts sand.

- iii) Brown coat, finish
 coat; 1 part cement and 3 parts sand

The ingredients shall be mixed in an approved mechanical mixer or shall be mixed together dry on a clean wooden stage until the mix is homogeneous in colour. Water shall then be added through a hose in sufficient quantity to give no more than stiff workability. The whole shall then be turned until perfectly mixed.

Mortar shall be used within 30 minutes of mixing and shall not be remixed or worked up again after it has stiffened. Any mortar that has commenced to set shall be removed from the Works.

10306.3 Plastering

Surfaces that are to receive plaster shall be carefully examined by the Contractor and any

unsatisfactory surfaces shall be repaired as directed by the PMO/Engineer.

Scaffolding shall be constructed and maintained in conformance with applicable laws and local ordinances and in such a manner as not to interfere with or obstruct the work of others.

Where finished surfaces such as tile, lighting or other fixtures have been installed prior to plastering they shall be protected from damage during plastering. Protection shall consist of covering with a non-staining kraft paper or polyethylene sheet. Protection shall be removed after plaster work is completed.

Concrete masonry and brick surfaces work shall have sufficient roughness to provide proper bond and shall be dampened by brushing or spraying with water followed by plastering.

All completed plaster work shall be flat and smooth and any undulating surfaces or cracks shall be repaired as directed by the PMO/Engineer.

Plastered surfaces shall be shielded from the direct rays of the sun for two days and shall be kept moist but care shall be taken not to wash out cement.

Upon completion of the work, all plastered surfaces shall be cleaned and all rubbish, debris and excess material and equipment shall be removed.

10306.4 Thickness

All plastering to be applied shall be according to the following thicknesses. Additional thickness will be required to provide for any unevenness in the masonry surface:

Thickness (mm)				
Location	Scratch coat	Brown coat	Finish coat	Total thickness
Floor	-	-	30	30
Interior wall	10	6	4	20
Exterior wall	10	9	6	25

10306.5 Workmanship

Plastering shall be of three coats; scratch, brown and finish coats. If plaster is to be applied to a smooth cement or other surface which does not offer bonding characteristics for plaster, dash coat shall be applied as a bonding surface.

- i) Dash coat shall be of mushy consistency, composed of 1 part of Portland cement and 1.5 parts of sand. Apply the dash coat with a whisk bloom or fibre brush, in a whipping manner. The dash coat shall be kept moist for 48 hours before scratch coat is applied to the dash coat.
- ii) Scratch coat shall cover the full length of the wall or to the border line formed by columns, doors and windows. Before scratch coat hardens scratch the surface of the coat to provide mechanical key for the brown coat. Keep this coat moist for not less than 24 hours and allow it to set for not less than 14 days before applying brown coat.
- iii) Before starting to apply the brown coat, dampen the surface of the scratch coat. Brown coat shall be brought to a true and even surface, then roughened with a wood float to provide bond for the finish coat.
- iv) Finish coat shall be applied while the brown coat is moist and if brown coat dries out it shall be wetted evenly. Finish coat shall be first floated to a true and even surface, then trowelled in a manner that the sand particles are not exposed on the surface and with the final trowelling, leave the surface burnished smoothly and free from trowels marks, checks, or other blemishes.
- v) Before starting to apply the plastering to floor slab, dampen the surface of the floor and apply the cement paste with the whisk bloom or fibre brush, to the floor entirely. The stiff-consistency plastering shall be applied to the floor slab tamping it with wood float until the cement paste squeezes up through the surface of the plastering and finally trowelled to an even surface leaving the surface burnished smoothly and free from trowels marks, checks and other blemishes.

10306.6 Defects

Any cracks in the plastering or parts which sound hollow, or are found to be soft or

otherwise defective after the plastering has dried, shall be cut out and replaced by the Contractor.

10307 Measurement and Payment

Measurement for payment for the works specified in this Section "Concrete Works" will be made based on the work unit as shown on the Contract or directed by the PMO/Engineer as follows:

Work Items		Measurement
1)Concrete	-	volume in neatlines of the structure as shown on the Drawings
2)Shotcrete	-	area actually placed as directed by the PMO/Engineer
3)Formwork	-	area of formed surface of concrete including steeper than 1 (vertical) : 2 (horizontal), formed surface contraction and construction joint shown on the Drawings, and formed surface of voids larger than 0.1 m ²
4)Reinforcement	-	weight of the bars embedded in the concrete in accordance with the bar lists approved by PMO/Engineer, including furnishing, cutting, bending, and fabricating.
5)Waterstop and Fillers	-	length of waterstop and fillers and area for put-up filler in place with no allowance made for laps at splices and intersections, including furnishing and placing
6)Mortar Plastering	-	area actually used as shown on the Drawings

Payment for the work items mentioned above will be made at the unit prices per unit stated in the Bill of Quantities, which shall include the cost of all labour, materials and equipment required in the constructions. These unit prices shall also include the cost of :

- 1) Concrete : all concrete materials, mixing, transportation, placing curing, preparation of construction joints, trial mixes, tests and other items necessary to complete the work.
- 2) Shotcrete : all labour, materials and equipment including furnishing and placing wire mesh and plastic pipes for weeping as required for rock slope excavated.
- 3) Formwork : furnishing, transporting, fabricating, erecting, fixing, dismembering, removing the form and other items necessary to complete the works.
- 4) Reinforcement : all labour, materials and equipment required for transporting, cutting, bending, cleaning, fabricating, tying, spacers, and the cost for providing drawings on bending, cutting and arranging steel bars.
- 5) Waterstop and fillers : furnishing, making field splices and installing the waterstop and fillers, and corking length of sealant.
- 6) Mortar plastering : all labour, materials and equipment required for mixing, transporting and plastering.

**10400 EQUIPMENT AND MATERIALS FOR SEDIMENTATION AND
FILTRATION FACILITIES**

10401 General

This section prescribes for Effluent Troughs in the Sedimentation tanks and Underdrain System, Sand and Gravel in the filter beds to be furnished, delivered, installed and placed.

10402 Baffle Plate

Baffle plates to be erected in the flocculation tank as regulating headloss shall be made of timber with a dimension as shown on the Drawing. The plates shall be treated with the preservative suitable treatment for submerging approved by the PMO/Engineer. After treatment and before erection, the plates shall be thoroughly dried and properly stacked and protected from the weather for period of at least 3 - 4 weeks or until the correct moisture content is achieved.

10403 Precast Concrete Cover

Precast concrete cover is put on an opening for carrying-in and - out the equipment. The cover shall be 100 millimetres thick of uniform width of 300 millimetres and chamfered on the surface edges for sealing and put with handles of 22 millimetres in diameter painted by bitumen on both sides shown on the Drawings.

The cover shall be fixed on the opening supported with cement mortar (1 : 3) and chamfering shall be sealed with appropriate sealant approved or directed by the PMO/Engineer.

10404 Effluent Trough in Sedimentation Tank

The Contractor shall furnish and install Effluent troughs as shown on the Drawings or specified herein.

Troughs shall be fixed in the positions shown. Troughs shall be bedded on cement mortar(1:2) of 2 centimetres thick laid on the bracket extended at one side and the other side on the bottom of rectangular opening, so that the troughs when positioned are true in lines and levels. The troughs, after being adjusted to the centres and levels by the mortar, shall be fixed tightly to the positions by means of stainless bolts and nuts.

10405 Underdrain System

Filter Underdrain system shall be nozzle type due to applying air-scouring as auxiliary scour for backwashing. Type K Nozzle of PWT Project Limited, England is employed in designing as the underdrain including furnishing, transporting and installing of the equipment and testing of evenness of the air distribution.

The Contractor may offer other alternative underdrain system equivalent to or more effective other than the mentioned above together with a design criteria, drawings and necessary materials to the PMO/Engineer for approval.

10406 Filter Sand and Gravel

Range of gravel specified, not more than 8 percent by weight shall be finer than the lower designated size limit and not more than 8 percent by weight shall be coarser than the upper designated size limit.

10406.1 General

The Contractor shall furnish and deliver filter sand and gravel to the site of the work, and shall place them in the filters. Filter media and supporting gravel shall conform to the requirements specified herein.

10406.2 Materials

(1) Sand

Filter sand shall be washed and graded and shall consist of hard, sharp, uncoated siliceous grains free from soft particles, clay, and other deleterious substances. Sand

shall have an effective size of 1.0 millimetre and a maximum uniformity coefficient of 1.5 and a Saturated-surface-dry specific gravity of not less than 2.50.

(2) Gravel

Gravel shall consist of hard, durable, clean material, screened and washed to remove all fine material and dust, and to retain only sizes specified. Grading of gravel shall be of particle size of 2.38 mm to 4.76 mm and one layer of 100 mm thickness.

Gravel shall have a saturated-surface-dry specific gravity of not less than 2.5 unless a higher minimum specific gravity requirement is specified to meet a design requirement for particular layer or filter.

(3) Approval of Materials

Before use, samples of sand and gravel shall be submitted for test, and no material shall be used until approved by the PMO/Engineer.

10406.3 Storing and Placing

(1) Placing of Gravel

Gravel shall be placed manually so as to prevent damage to the filter underdrain system. Provisions shall be made to protect underdrain system with adequately supported planking at all locations where gravel is lowered into filter units. The placement of gravel in layer shall be checked and approved by the PMO/Engineer before the placing of the next layer starts. For gravel less than 15 millimetres diameter, the workmen shall not stand or walk directly on the gravel but upon boards which will sustain the weight of the workmen.

(2) Placing of Sand

Sand shall be placed to the depth shown on the Drawings, and the depth shall be measured after all necessary backwashing and surface scraping have been done.

Particular care shall be taken in transportation and placing sand to avoid any possible contamination. Sand shall be so placed as to avoid segregation of fine and coarse

particles and disturbance of upper layer of gravel.

After being placed, sand shall be backwashed three (3) times under direct supervision of the PMO/Engineer by means of backwash devices connected to the filters. Each of the backwashing shall be continued at least 5 minutes, and the backwash water shall be applied at the rate of 5 metres per hour at start and then gradually increased to the maximum rate of 7.5 metres per hour.

The fine sand accumulated on the bed surface after the backwashing shall be scraped off and removed as directed by the PMO/Engineer. In case that the sand depth becomes smaller than required by the scraping, the Contractor shall at his own expense refill sand to the depth required.

The Contractor shall place surplus sand (roughly estimated at cubic metres) at a stock yard in the Treatment Works site as directed.

(3) Top Surface Elevation

The top surface of the filter materials, after initial washing, shall have an elevation equal to the finished elevation plus the thickness of material to be removed by scraping. To provide for initial expansion of the bed due to segregation of particle sizes, the top surface before washing shall be approximately 10 percent of bed thickness below finished elevation. To avoid the removal of an excessive amount of material by scraping, which may result in a coarser filter than was intended, no material shall be placed in the filter in excess of that necessary to produce the finished surface elevation.

(4) Contamination

Any filter material that becomes dirty, contaminated, or mixed with another material or size shall be removed and replaced with clean material of the proper type and size.

10407 Measurement and Payment

Measurement for payment for the works specified in this Section "Equipment and Materials

for Sedimentation and Filtration Facilities" will be made based on the work unit as shown on the Bill of Quantities or directed by the PMO/Engineer as follows:

	Work Items		Measurement
1)	Baffle Plate	-	number of plates set in the flocculation tank as shown on the Drawing
2)	Precast Concrete Cover	-	number of cover set in the valve chambers of receiving and rapid mixing tanks and carrying-in opening in the filter
3)	Effluent Trough	-	number of trough installed in the sedimentation tank as shown on the drawings
4)	Underdrain System	-	area actually placed in the filter as shown on the drawing
5)	Filter Media and Gravel	-	volume actually placed in the filter and stored in the Treatment Works as shown on the drawings.

Payment for the work items mentioned above will be made at the unit price per unit stated in the Bill of Quantities, which shall include the cost of all labour, materials and equipment required in the construction. These unit prices shall also include the cost of :

- 1) Baffle Plate : furnishing, transporting, carpentering, preservative, setting and other items necessary to complete the work.
- 2) Precast Concrete Cover : all concrete materials, mixing, placing, curing, fabricating and removing the form, fabricating the reinforcing bar, transporting and installing and other items necessary to complete the work.

- 3) Effluent Trough : all concrete materials, mixing, placing, curing, fabricating and removing the form, fabricating the reinforcing bar, transporting and installing the troughs, and other items necessary to complete the work.
- 4) Underdrain System : furnishing, transporting, fabricating, erecting, fixing, and other items necessary to complete the work.
- 5) Filter Media and Gravel : furnishing, transporting, sieving, placing, storing, backwashing and scraping, and testing directed by the PMO/Engineer.